Geo Business Intelligence for Fast Moving Consumer Good (FMCG) Industry in Pakistan

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LIST OF ABBREVIATION

Abbreviation	Explanation
AHP	Analytical Hierarchical Process
ANN	Artificial Neural Networks
BPMS	Business Process Management Systems
CBR	Case-Based Reasoning
CIS	Contemporary Information Systems
CPG	Consumer Packed Goods
DNPWD	Dutch National Public Works Department
DSS	Decision Support System
FMCG	Fast Moving Consumer Goods
GDB	Geodatabase
GDP	Gross Domestic Product
GEO-BI	Geo-Business Intelligence
GIS	Geographical Information System
GPRS	General Packet Radio Services
GPS	Global Positioning System

GSM	Global System for Mobile Communications
GUI	Graphical User Interface
IMF	International Monetary Fund
KML	Keyhole Markup Language
KPI	Key Performance Indicators
LAN	Local Area Network
LDF	Linear Discriminant Function
MCDM	Multi Criteria Decision Making
MLE	Maximum Likelihood Estimation
OGC	Open Geospatial Consortium
OLAP	Online Analytical Process
OSM	Open Streets Maps
QGIS	Quantum GIS
REST	Representational State Transfer
SDSS	Spatial Decision Support System
SMS	Short Messaging Service
SOAP	Simple Object Access Protocol

SVM	Support Vector Machine
WFS	Web Feature Service
WMS	Web Map Service

ABSTRACT

The Geo-Business Intelligence (Geo-BI) is a collection of technologies that combines Geographic Information Systems (GIS) and Business Intelligence (BI) for evaluation of the results achieved, planning and decision-making. In this research we developed a Geo-BI for fast moving consumer goods industry like Anhaar Foods in Islamabad with the objectives (1) to provide Geo-Visualization capability for viewing FMCG distribution networks and other statistical information on maps (2) to design and optimize economically efficient routes for delivery dispatch (3) to develop spatial decision support system for potential sites selection for new warehouses and their network optimization. The survey was conducted to collect the different business attributes including monthly sale/purchase of Anhaar Foods items as well as their GPS coordinates. Road network taken through OSM and was corrected topologically and a network routable dataset was prepared. A web based system was developed where ArcGIS server was used to publish retail outlets location and network dataset for routing. Widgets were customized to provide spatial intelligence capabilities like directional distribution, mean location, standard distance, site suitability, and network routing etc. The web based Geo Business Intelligence platform developed in this research will allow managers and business analysts monitor data and statistics, make decisions, analyze market trends, study the insertion of new products and maintain profitable and long-lasting relationships with customers in order to stay competitive in a global world.

Chapter 1

INTRODUCTION

1.1 Geo-business Intelligence

Business intelligence is the use of information that enables organizations to best decide, measure, manage and optimize performance to achieve efficiency and financial benefit (Gartner, 2006). Business Intelligence is a technology devoted to analyze business data and processes with the aim to obtain the appropriate KPI (Key Performance Indicators) of interest, to keep them under control, and to achieve an immediate display of them (reports, dynamic dashboards, historical analysis systems, etc.) (Angelaccio, 2013). Typical business intelligence tools are unable to provide location intelligence. Business intelligence tools are unable to handle spatial dimension of the data. About eighty percent of the data stored in corporate databases has a spatial component (Franklin, 1992). Therefore, there is a need to merge business intelligence and GIS software to fully exploit the spatial component of the data. Combining business intelligence and location intelligence gives us geo-business intelligence, more commonly known as geographic business intelligence. We define GEO-Business Intelligence (GEO-BI) as a geo-referenced BI, which adds to the business information extracted from Data Warehouse the territorial information concerning the positioning of the quoted sizes within dashboard. Hence, the Geo Business Intelligence or Location Intelligence, is a set of technologies, combining the Business Intelligence with Geo-Location (Buttarazzi, 2013).

1.2 Fast Moving Consumer Goods

Fast moving consumer goods (FMCG) industry, sometimes also known as CPG (consumer packed goods) industry primarily deals with the production, distribution and

marketing of consumer packed goods which are designed to be sold quickly and at a reasonably low cost (Erdoğan And Taymaz,2005). Fast moving consumer goods are those daily household consumable items which are normally consumed by the consumer at regular intervals. It includes a variety supermarket products starting from perishables, such as meat, dairy, vegetables products etc., to long lasting goods like toiletries, cosmetics and cleaning products. Pharmaceutical, plastic goods, printing, stationary, detergents, dry cells, detergents, tobacco and low-end electrical goods which are designed to be low cost but not particularly durable, may also be included in this category. FMCG industry has some of the biggest and oldest names in the world. It includes loads of major multinational companies like Coca-Cola, Pepsi, Reckitt Benckiser, Nestle, British American Tobacco, Unilever and Procter & Gamble to name a few.

Many companies in FMCG industry may be well known for of their products but often have a whole range of products in the same area. A good example to understand it is Coca-Cola, best known for selling Coca-Cola but also sells Sprite, Fanta, Dr. Pepper and a whole lot of other soft drinks. It is found that multinational FMCG companies become responsible for different products in entirely different areas.

The economic model for FMCG products and companies is quite complex although one major driving factor for its success is, greater the consumption by consumer, greater would be profits (ZHANG And LU ,2009). In general, profit margins for FMCG products are not particularly high but large volumes in which these products are brought, followed by high purchase rates and the inevitability of repeat purchases means that there is a lot of money to be made in the industry. The competition among FMCG manufacturers is fierce since the consumers are scarce, the industry is highly saturated and the competitors try to snatch their market share(Corstjens et al., 1995). Low operational cost, solid operational cost and emergence

of new companies is what makes it a highly competitive industry. Although continuous growth in the competition brings investment in the industry on a whole which leads to growth of FMCG.

FMCG industry plays an important role in the economic up rise and growth of countries across the globe. In spite of fierce competition, market saturation, and limited purchasing power of consumers, FMCG is an ever green and ever growing industry. This can be made ascertained from the fact that even during the slowdown of the economy, the FMCG sector has registered a growth rate of 14.5 per cent for the year 2007-08. According to the Grocery Manufacturers Association, the 2011 US FMCG market was worth $2.1 trillion. The GDP numbers from the IMF (international monetary funds) shows that US only represents about 21.6 percent of global GDP, the global FMCG market size can be projected to be more than $10 trillion; which makes about one seventh of the global economy. FMCG's contribution to United Kingdom's GDP is 19 percent. FMCG sector being the largest sector in New Zealand accounts for 5 percent of GDP. FMCG industry in India accounts for 14-15 percent of its GDP.

The growth of the FMCG sector in Pakistan is very interesting to note. Its share in overall services sector is estimated to be at 31.5 percent. Currently stocks in the FMCG sector trade at nearly 34times 2012 earnings compared to the seven times earnings that the overall market trades. In 2012-13, this grew at 2.5 percent as compared to 1.7 percent in the last year. It is interesting to note here that Pakistan has surpassed India, a bigger country and a bigger economy, in FMCG sector, with 2.5 time's per capita greater consumption of milk and dairy products. Nestle Pakistan's chief Ian Donald summed up the rising demand for his company's product in these words

"It's a common perception that China and India are much bigger in terms of growth than Pakistan. But for Nestle, the per capita consumption of our products in Pakistan is twice as much as we have in China and India".

This sums it up all that Pakistan is a country with a very well established and growing FMCG industry. One major factor for the success of the industry is increasing population of Pakistan. Since greater population means greater consumption and greater consumption in turn means greater investment which eventually empowers the industry. In addition to global giants of FMCG industry, Pakistan also has a very handsome amount of local FMCG companies which are surviving in tough competition but instead growing day by day, giving an even tougher competition to the multinational giants of FMCG industry.

From the discussion above it can be concluded that FMCG industry is closely related to, location and its locality, in addition to population and demographics. Technology can help us better understand and coupe with factors. In the past few, the rapid growth in technology has changed our lives. Technology has become an integral part of our lives, making them easier in every aspect of life. Technological advancements in the past few decades, has brought about a revolution in the business world, affecting each and every aspect of working life. FMCG business is not anomaly in this case.

With the advent of database management systems and powerful data mining techniques, managing data becomes easier than ever. When preserving and managing data was not an issue, big data becomes the real power for companies to unleash their full potential. Then combination of business intelligence and data mining, data became the gained immense importance for companies. All was going smooth but then geographic information system (GIS) came into the

scene. A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. GIS is most useful when you are coping with location problems. GIS plays a special role in business management and decision making empowering your business and broadening your view about problems catering and risk free management. Today GIS is used in a variety of businesses among which Insurance agencies, retail, media, real estate, banking and marketing are a few.

Managing a FMCG company is a real hectic task as there is continuous outflow of the goods from warehouse to retail outlets and then from their taken away by end user. The whole process occurs at a rapid pace because of large volume of the goods bought by the consumers, purchasing rate and inevitable repetition of this cycle makes, therefore a support system is necessary in order to keep yourself on the toes 24x7 for rapid and accurate decision making in addition to enhanced management of the goods. If the structure of a FMCG company is broken down, geography (location) plays an important role, whether it's about choosing a new retail outlet site or whether it's about managing warehouse network with respect to retail outlets and most important of all delivery and dispatch solutions of the consumer goods. Other attributes of the location also plays an important in solving these problems which includes local population, demographics of the area, economic conditions etc. There can be many other parts of the FMCG business mechanism that can be better done by the use GIS technology which includes marketing and market analysis by use of Geo-Marketing etc.

Unfortunately Pakistan lags behind other countries when it comes to use of technology in business and especially the use of GIS. Although. Multinational companies in Pakistan might be using database management systems, data mining and business intelligence for their companies

but GIS is not the news yet. Small scale local FMCG companies, are even far behind these multinationals companies in Pakistan. Most widely used technology in such companies, is some sort database management system, with very limited functionality. This approach almost takes them out the race and cease most of their opportunities to expand business and take it to the next level. GIS itself is an expensive technology too. Even if one wishes to take advantage of it is not economical for them. This project tries to provide integrated GIS with basic business intelligence that would not only be useful but at the same time economical too for small and local FMCG companies.

GIS tools provide a powerful visual and analytical power to the user. Combining the power of databases along with visual, analytical and mapping capabilities of GIS, the results are beyond simple map display.

Since, a few benefits of GIS for FMCG have been mentioned, it would have been clear till now that GIS can be integrated into FMCG business almost at its every aspect. However, in this case the scope of the project has been limited to most important and essential tasks of an FMCG company, which is as follows

- Geo-Visualization
- Warehouse site suitability selection and network optimization
- Fleet Intelligence

1.3 Geovisualization

Before the evolution of GIS the geospatial data was handled by the understanding and visualization of the paper maps. A researcher must have analytical and map reading skills to

interpret the information presented by those maps. But with the evolution of GIS and the concept of geovisualization even a layman can read and interpret the geographic information displayed on the map. With the help of GIS the visualization of geospatial data has become more attractive and comprehensive.

The term “Geovisualization” is often referred as the displaying of comprehensive data along with the spatial component on the map but at the same time on backend cartography, human-computer interaction and cognitive science and representation expertise are being used (Altmaier And Kolbe,2003). Geovisualization is a technique to provide the insight of the geospatial data and prompt the visual thinking towards the complex data and analytics. The human visual interpretation system is the most powerful interpretation and analytic system. Geovisualization helps the human mind’s analytical skills to understand and analyze the large datasets by combining the powers of virtual reality, animation and computer graphics. With all these powers geovisualization provides insight to find the patterns and relationships between the widely spread geospatial data. It provides greater understanding of the problems and help humans in making decisions (Andrienko et al.,2007).

The referencing of information with their spatial component integrates vastly spread information in a small frame. Geovisualization can also be defined as a technique of communication (McMaster at al.,2009). Every map communicates a set of information to the audience. The purpose of cartography can be explained by the communication power of geovisualization science. Cartography is an art of communicating useful information to the audience by using the visual techniques, interactive guidance and appropriate symbology. Geovisualization strongly emphasize on the human-computer interaction for better understanding, visually comfortable, attractive and interactive design to increase the interest of

target audience and to communicate the information. Human computer interaction is the mashup of computer science, behavioral sciences, designing, psychology and many other fields of study. It is a science of designing the interfaces of computer programs such that the human's interaction is maximized. Wickens et al. (2004) defined thirteen principles for designing the interfaces to achieve maximum human interest. The other science used as a building block of geovisualization is cognitive science. Cognitive science determines the human perception of information, this means that how a human perceives a piece of information and how a human wants information to be perceived. The cognitive science refers to the human reaction or interest toward a particular thing. In case of geovisualization the audience interest is the major priority. Geovisualization combines the experience and guidance of all the three sciences and implement it through the presentation. It represents the data in such a way that the purpose of communicating the information is achieved. The representation techniques involve a number of concepts such as cartograms, dasymetric maps, public participation and scientific visualization.

Geovisualization combines the power of cartography, human computer interaction, and cognitive science and representation techniques to create a human centered design of the application.

Geovisualization is an important tool for decision support system in business organizations (MacEachren at al.,2004). It helps the viewer to make instant decision. Geovisualization has become a great tool for decision making in modern era. Geovisualization simplifies the complex data by drawing relations and making statistical reports by combining the powers of database system and GIS mapping system. Many different type of organizational reports can be generated along with their spatial reference to assist the professionals in decision making. There are two types of reports in business anatomy, these are internal (inside

organization) and external (outside organization). The internal type focuses on the working hierarchy and the employee's performances and hence it is not a much complex task, but the external type includes many other factors like competition in the market, customer's loyalty, customer's location, outlet or distribution management etc. To generate these types of reports and to communicate a meaningful message to the user geovisualization plays an important role by drawing the relations graphically and the influence of external factors on the growth and development of organizations.

Geovisualization is an interactive tool for planning and prediction (Jiang et al.,2003). On the basis of analytical powers of GIS systems geovisualization can predict many of the phenomenon. Geovisualization can be used to view the predictions about the organization's growth and for the planning of any abnormal behavior that can affect the organizational structure using the underlying capabilities of GIS system.

1.4 Site Suitability Analysis

Coming towards the structure of FMCG industry, the end products come directly from factory to a warehouse/distribution center. These warehouses are used for storage and later on distribution of these products to different retail outlets present in their respective zones.

From the above discussion it can easily be concluded that these warehouses are an integral part of FMCG industry. So warehouses should be located in such a way that the transportation cost could be minimized (Demirel et al., 2010). Which in turn proves that optimal location of these warehouses is key to increase the profit of an organization. Unfortunately business intelligence tools lack the capability to optimally locate these warehouses.

To encounter this problem we are going to integrate GIS into our business intelligence tools. We are going to make a stand alone web connected system ,a software which will have basic business intelligence tools along with GIS capabilities to not only spatially locate your existing network of warehouses and retail outlets but will also provide site suitability analysis for establishing new warehouses .

Suitability analysis is a process through which we establish the suitability of a system, to meet the needs of a stakeholder. It is a term which is normally used in the GIS context. It tells us whether an area is suitable or unsuitable for a particular set of activities on basis of constraints provided by the user. This process is done by multifactor analysis taking in account physical, cultural and economic factors. Site suitability is a part of suitability analysis which helps us to identify a site that meets our specifications (Fung and Remsen, 2011). Site suitability is an integral part of our system. This system will help us establish a warehouse or network of warehouses. This system will also have the capability to tell us whether an already established warehouse is on the right place according to our specifications. As it is mentioned above that warehouse is an integral part of FMCG industry. So optimal location of warehouse network is one of the most important tasks of this system. In this system, on basis of some input data we are going to find suitable sites for a ware house .The data needed to optimally locate a warehouse is as follows

- Road Network
- Parcel Information
- Hydrology Information

1.4.1 Road Network

Road network is one of the most important data when it comes to locating a outlet or a warehouse. As we need road network when we have to deliver products to retail outlets. So proximity to main road network is a necessary part when it comes to locating a ware house network.

1.4.2 Parcel Information

Information about parcel is necessary as it will tell us about the classification of concerned area. In this way we could avoid the concerned people from establishing our warehouse in residential areas or other restricted areas as per defined by the local authorities.

1.4.3 Hydrology Information

Information about canals, rivers and other water reservoirs should also be included so that as a result of applied operations the resultant may not be in a water reservoir or a canal or in an area that may directly be affected by a rise in river level.

1.5 Fleet Intelligence

Along with a network of warehouses the other thing that is necessary for delivering consumer goods to retail outlets are vehicles. We are going to make a system that is going to ensure timely and economical delivery of consumer goods at retail outlets.

As it is rightly said by Pamela Bailey, Grocery Manufacturer's Association President and CEO, “Given the CPG industry's laser focus on delivering value… it's no surprise that it appears to be weathering this economic cycle better than other sectors.”

As is the quote by Jack Levis UPS Director of process management “When you have 60,000 drivers, if I can just reduce 1 mile per driver per day that’s more than 20 million miles a year, that’s tires that are being wasted, 2 million gallons of fuel, 20,000 metric tons of carbon not

going into the air, if I can just save. We spend million dollars on technology to make that happen."

By integrating fleet intelligence into our system we are going to be able to get a lot of advantages that are economic and environmental. Some of them are as follows

- Reduced Fuel Consumption
- Reduced Driving Violations
- Reduced Driver Overtime
- Improved Fleet Safety
- Reduced Emission Of Harmful Gases

1.5.1 Reduced Fuel Consumption

A study shows that every hour a diesel truck idles it consumes about one gallon of fuel. This system will generate optimized routes which will help prevent idling of your vehicle. In these days when fuel prices are at record highs this will really help minimize transportation costs and in turn will increase our profit margins.

1.5.2 Reduced Driving Violations

Traffic violations is a major expense when it comes towards operating a fleet. This does not only costs you a lot of money but also delays the timely delivery of consumer goods, which can be disastrous in some cases. The routes created by this system will have information about speed limits, one ways and parking places which will reduce traffic violations.

1.5.3 Reduced Driver Overtime

Overtime of drivers can be can be a huge burden on a company. Every hour of a driver's overtime means a decrease in profit of the organization. On basis of routes created by this system not only costs but time will also be minimized which will help reduce driver's overtime.

1.5.4 Improved Fleet Safety

When you own a fleet risks are a necessary part and are unavoidable.But what this system can do is minimize your exposusers to dangers and bad road situations which will in turn help improve your fleet's safety.

1.5.5 Reduced Emission of Harmful Gases

Fleet intelligence reduces the emission of harmful gases in the atmosphere. As the driving directions are determined by using the shortest path algorithms so there is less emission of harmful gases from vehicles and it also reduces the amount of fuel used. Thus, fleet intelligence helps in reducing the harm to the environment and it also saves the natural resources.

1.6 Web-GIS

Web based GIS system is a system that is deployed on web and is accessible through World Wide Web. A web based GIS system provides user the functionality of GIS operations no matter which platform user is using. Web based GIS systems are capable of facilitating the user even he is unaware of the backend operations. All the backend and processing algorithm designs are considerations of the GIS practitioner. The major considerations for developing a web-GIS system are

- Web application
- Base maps

- Operational layers
- Tasks and tools in the web GIS application
- Geodatabases

1.6.1 Web Application

A web application provides an interactive interface to the end user. Web application is the place where client and the geographic information interact. All the functionality of visualizing, exploring the tools and geographic information. The choice of application is based upon the operations, tools, the visualizing methods and user's experience required by the client.

1.6.2 Base Maps

Basemaps provide the geographic context of the web-GIS application. The type and requirement of application defines the type of basemap to be used. There are different kinds of basemaps used in web-GIS applications like transportation, topographic, terrain, satellite imagery etc. Basemaps are relatively static. They are updated after a certain period defined by the vendor.

1.6.3 Operational Layers

Operational layers are relatively small as compared to basemaps and they are usually the set of layers that user work with or produces as a result of some operation. The operational layers depend the area of work of the user or maybe sometimes it is just the result of query or operation performed by user on the dataset.

1.6.4 Tasks and tools in the web GIS application

Tasks and tools contain in context of web-GIS a set of operations that are available in a particular web-GIS system. All the tasks available in web-GIS applications are hidden from the

user and are controlled by the server. The tasks are made available to the user through the web application and the necessary inputs for certain tool is obtained from the user to provide the results related to user's needs but the model or working of the tool is hidden from the user.

1.6.5 Geodatabases

Every GIS application is in need of support of geospatial data management framework that can handle the information used to support the application. A geodatabase can be a set of shapefiles, CAD files, html web pages, tabular spread sheets etc. Geodatabases are very important and are strongly emphasized because of the fact that the accuracy of any tool of GIS can never be better than the accuracy of the GIS data. This means that the accuracy of GIS operations directly depends upon the data used. If the data is correct and accurate the results will be more accurate and vice versa.

1.7 Statement of Problem

There is a lot of revenue followed by rapid growth and fierce competition in FMCG sector which leads to ever changing business dynamics and grim challenges. In a fast growing and competitive environment one needs to have state of the art technologies in order to compete with competitors and better manage business. Following are some of the challenges that have addressed in this study

- Keeping track of potential market/customers in a fast urban growth environment by spatially visualizing and analyzing data
- Making a well distributed warehouse network for maximum area coverage.
- Timely, efficiently and economically managing delivery dispatch.

1.8 Purpose of study

FMCG industries in Pakistan ranges from some of the world's biggest companies to medium sized local companies followed by small FMCG industries that specifically targets rural areas. FMCG industry giants like Procter and Gambel, Uniliver, Nestle, Pepsi etc. are some of latest technology for enriching and enhancing their company's business intelligence in order to keep pace with changing business dynamics. Medium sized companies are using technology for inventory purposes only. Neither of the FMCG industry large or medium enterprise have spatial intelligence in their business intelligence systems. With geo-business intelligence spatial data can be quickly captured and converted into decisions. Every location has a large amount of information; GeoBI makes this information visible and accessible. Thus, this study tries to integrate spatial intelligence in their business by addressing key issues faced by FMCG industry.

1.9 Rationale

GIS has not yet become very popular among business community especially among FMCG business community of Pakistan. One of the major reason behind it lies in the fact that most GIS application are highly sophisticated and requires specialized knowledge or at least significant familiarity with GIS and its methods whereas major business community of Pakistan have not got this knowledge. This study tries to bridge the gap between FMCG industry and GIS research. In developed countries, fleet intelligence and geovisualization have become an integral part of FMCG companies. Keeping it simple, easy to understand and user friendly, this study targets key issues in FMCG sector while providing optimal solutions using GIS and WebGIS.

1.10 Objective

Following are the main objectives of this project:

- To provide Geo-visualization capability for viewing FMCG distribution networks and other statistical information on maps.
- To develop SDSS for potential sites selection for new warehouses and their network optimization.
- To design and optimize economically efficient routes for delivery dispatch.

1.11 Background

1.11.1 Site Selection

Site selection is a process of selecting a suitable location or place for any business. For example selection of site for a warehouse, retail store etc. Site selection is one of the elementary decisions in the start-up, extension or relocation for all kind of businesses (Rikalovic et al., 2014). Selection of a retail site is long term investment (Erbıyık et al., 2012). For any business, site selection is a critical part in expanding and also for newcomers; it could be very expensive process if the store fails. For the site-location analysis ArcGIS 9.1 (Arc Info) and Spatial Analyst are the basic tools (Pearson, 2007).

Selection of a site for the warehouse based on customer density, distribution cost, and possible store size, parking facilities, competitors' location, product requirements, transportation type and the sales level (Vlachopoulou et al., 2001). Site selection for retail store based on distance from retail store, traffic jam, plan feature, demand potential, surroundings, market

magnetism, customer attraction, economy, competition, and customer traffic (Erbıyık et al., 2012).

Warehouse site selection usually affected by qualitative and quantitative (Distribution price tag, Warehouse management cost etc.) criterion. Geographical Information System (GIS) and Decision Support System (DSS) are the very important for the evaluation of a warehouse site evaluation and we need to integrate GIS and DSS. To integrate GIS and DSS three tools ArcView3, MapOject, and Visual Basics can be used (Vlachopoulou et al., 2001). Arc View 3 is used to visualize, analyze and explore the spatial data. Arc View can easily load tabular data such as database files. Map object is used to load maps in application and mange loaded map with the tabular data of database. Visual Basic is used to combine MapOject and Arc View 3.

As site selection is the multi criteria decision making (MCDM) problem because we select a site from different available sites on the basis of different criterion. Analytical Hierarchical Process (AHP) is an MCDM approach which was introduced by Satty. In AHP technique we assign different ranks to all criterions on the basis of their relative importance (Triantaphyllou and Mann 1995). Finally on the basis of assigned ranks best site can be selected using AHP. AHP is used for the site selection for the milk production industry in Turkey (Erbıyık et al., 2012).

Ahmad et al., (2004) developed a decision support system (DSS) which is used to select different sites for residential housing development. Their application takes input i.e. source data (Parcel data, Land deal data etc.) then converts all the data into one format and stores in into database. After transformation of data they defined different criterion (land price, geography etc.) and used online analytical process (OLAP) analysis which reflects the real life scenarios by changing some values in the criteria matrix. Finally at the end DSS application execute and best

suitable sites are selected for the clients. Chopra, (2003) describes the distribution chain supply network. In his paper he describes factors that influence our choice to establish a new warehouse and distribution network of a company. Each factor was analyzed according to their relative strengths and weaknesses.

1.11.2 Fleet Intelligence

Fleet intelligence is a system which helps industry to manage vehicle fleet (temperature of the vehicles, position of vehicles, vehicle routing etc.) efficiently through smart allocation of resources (Thong at al., 2007).

Fleet intelligence system is a fast growing business. Advance fleet intelligence incorporates the influence of global positioning system (GPS) and global system for mobile communications (GSM) techniques. Users can observe and track the real time physical locations and conditions of their automobiles using general packet radio services (GPRS) and short text messages (SMS) (Thong at al., 2007).

1.11.3 Spatial data mining

Spatial data mining is used for extraction of data from data warehouse and extracted data is used for analysis by On-Line Analytical Processing (OLAP) and Spatial On-Line Analytical Processing (SOLAP) technique.

OLAP (On-Line Analytical Processing) is a data warehouse and client tool which is used to access, visualize, and analyze the integrated, aggregated and summarized data from the data warehouse (Rivest et Al., 2005). Spatial On-Line Analytical Processing (SOLAP) is a tool which is defined “as a type of software that permits quick and easy navigation within spatial databases and that offers many levels of information granularity, many themes and many display modes synchronized or not: maps, tables and diagrams” (Bédard et al.,2001).

Spatial data mining has extended roots in both conventional spatial analysis fields (such as spatial statistics and exploratory data analysis) and various data mining fields in statistics and computer science (such as clustering, classification, information visualization and visual analytics) (Mennis and Gou, 2009).

GIS has played very important role in enterprise business and decision making since 1990s but it remains isolated island. Therefore we need a business model which incorporates GIS with enterprise business application transparent, effective and efficient based on service intelligence agents (SIA) (Yang et al, 2012).

1.11.4 Geo-Business Intelligence

Business Intelligence (BI) and Geo Business Intelligence (Geo-BI) both are used conventionally to deal with data from a single organization with the goal of increasing profit and enhancement of performance (Wickramasuriya et al., 2013). Ren at al., (2010) defined business intelligent analysis system as, it is a process to accumulate, manage and analyze the commercial information, whose goal is to raise all levels' decision makers' ability to obtain knowledge and intuitions and thus to promote them make best decisions for the company.

Business Intelligence (BI) could be defined as "the applications, infrastructure and tools, and best practices that enable access and analysis of information to improve and optimize decisions and performance (Wickramasuriya et al., 2013). Business intelligence (BI) systems provide the capability to inspect business information in order to maintain and advance management decision making across a extensive range of business behavior (Elbashir et al., 2008).

Business Intelligence (BI) solutions are actually OLAP systems, which provide a unique skill to interactively explore the data warehouse (Rivest et Al., 2005). Basically there are two

tactics to BI: managerial and technical. The managerial tactic concerns the way BI generates knowledge required to make calculated decisions using assembled data, while the technical tactic is seen as the tools and methods required to provision of decision making (Wickramasuriya et al., 2013).

Geo Business Intelligence or Location Intelligence is a group of technologies that combines GIS or Geo-Location and Business Intelligence (BI) and used to execute DSS with the purpose to improve the effectiveness of business behavior in service environment (Angelaccio et al., 2013).

Chapter 2

MATERIALS AND METHODS

2.1 Study Area

Based upon the availability of data, vicinity, business dynamics and development Federal Capital of Pakistan, Islamabad was chosen as the study area. Islamabad is one of the most planned city of Pakistan. It has an area of 908.32km^2 with an approximate population of 805,235. Islamabad is located at 33.43°N 73.04°E at the northern edge of the Potwar Plateau and at the foot of the Margalla Hills in Islamabad Capital Territory. The area of the city is approximately 906 square kilometers. Geologically the area is uneven with elevation ranging from 1604 meters to 457 meters. Most of sectors are already developed along with handsome number of sectors still under development which creates a lot of opportunities for growing and new businesses. Most of the areas have road accessibility which makes mass movement easier and fiercer as well. Map of study area is shown in fig 3.1.

2.2 DATA COLLECTION & PREPARATION

2.2.1 Road Network:

First and most important dataset in our project is road network for that we got data from Open Streets Maps (OSM). OSM is an open source project in which participants from all around the world are allowed to contribute. Anyone can freely download and reuse that data. OSM usually provide data in xml format. Quantum GIS (QGIS) can convert OSM data into shape file with the help of Open Street Map Plugin. Road network is a necessary element for the development of fleet intelligence and site selection tools.

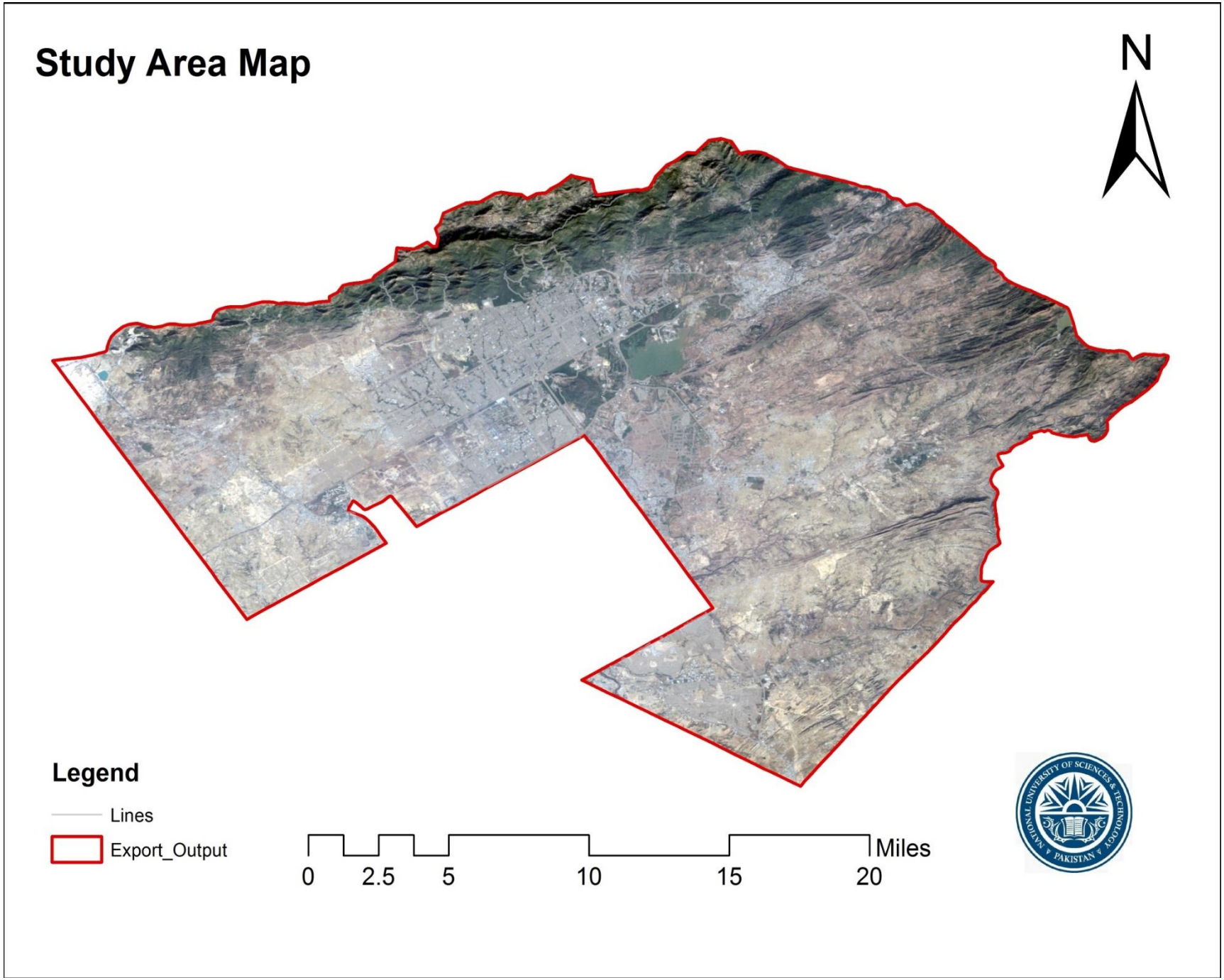


Figure 2. 1 Study area map

2.2.2 Topological Corrections

Our main focus in this project is to provide routing solution to the end user therefore we cannot afford to have topological errors in our dataset. One of the drawback of using data obtained from OSM is that it cannot be used directly for routing and shortest path analysis because it has topological error like dangling nodes, pseudo nodes and direction of lines. To remove these topological errors, we build topology by using topological rules MUST NOT HAVE DANGLES, MUST NOT INTERSECT ad MUST NOT HAVE PSEUDO NODES.

2.2.2.1 Must Not Have Dangles

An endpoint which is not connected to another line is called a dangle. Sometimes road lines are not properly connected i.e. there is some gap left between two arcs called *undershoot* and sometimes one arc is overextended known as *overshoot (figure 2.2)*, which creates serious problem for routing function and therefore it needs to be corrected (ZiTan Chen,2008).

2.2.2.2 Must Not Intersect

This rule is to ensure that at intersection node there is no overhear bridge or underpass, if there is any then this is a topological error and must be removed as shown in figure 2.3.(Pantelias et al 2008)

2.2.2.3 Must Not Have Pseudo Nodes

If a node is connecting end points of same arc then it is a pseudo node and must be removed as shown in figure 2.4 .(Zope-Chaudhari and Venkatachalam ,2012).

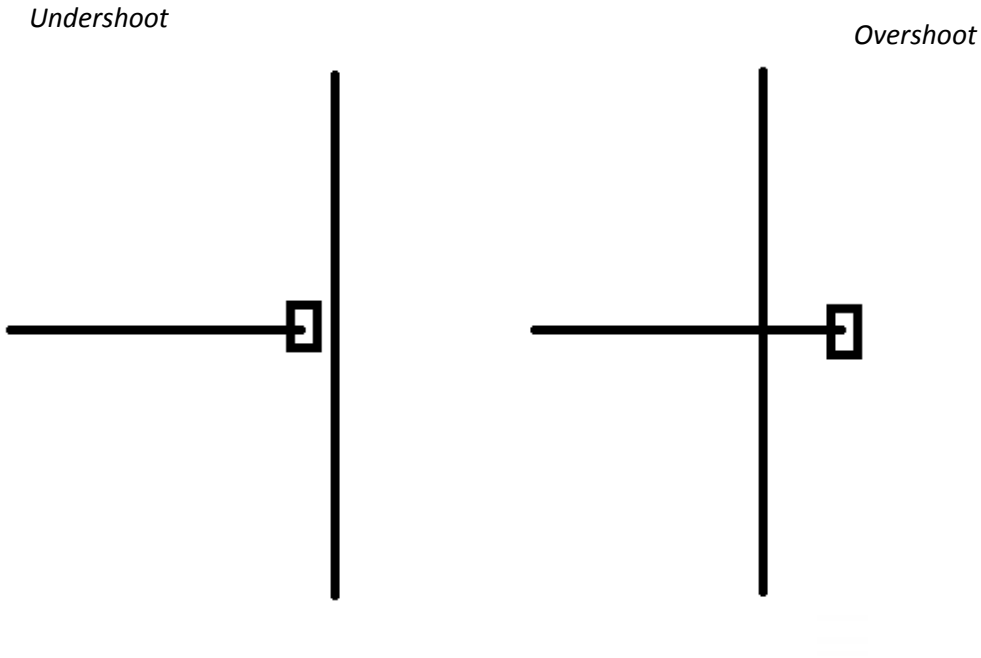


Figure 2. 2 Must Not Have Dangles

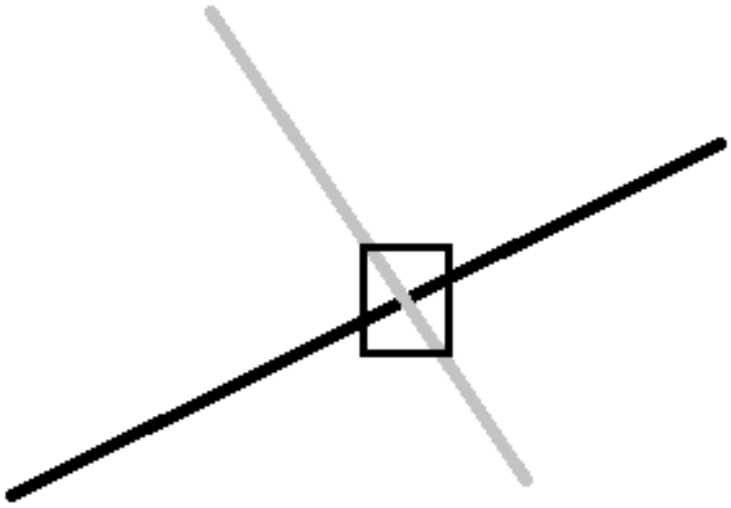


Figure 2. 3 Must Not Intersect

Before Removal

After removal

Figure 2. 4 Must Not Have Pseudo Nodes

2.2.3 Routing parameters

After removing errors next step is to add routing parameters like *source, target, direction, length, and speed limit* which are required to perform different routing functions like shortest and fastest route between two points. For source and direction to from parameters were added in the attribute information. Length of road segment was calculated using geometry calculator in ArcMap editor tool bar. For speed limits, local traffic rules set by Islamabad traffic police were used.

2.2.4 Business Data

2.2.4.1 Target Company

Our target company for this project is Anhaar Foods, they provide dairy products which includes milk, yogurt and Desi Ghee. Their milk product comes in three forms whole milk, low fat milk and full cream milk. Yogurt also comes in two form plain yogurt and sweet yogurt. Anhaar is a Lahore based company. Their products comes on truck from Lahore to Islamabad on daily bases. Therefore adding fleet intelligence could enhance their performance and can reduce expenditures. Besides, geovisualization tool would help them viewing their across the city and predict future trends spatially. Since, they do not have any warehouse in Islamabad this study can help them in choosing best suitable location for their new warehouse in Islamabad.

2.2.4.2 Data Collection

A special form was designed for field survey .Other than the GPS coordinates part this form was filled by the owner/shopkeeper. Figure 2.5a and 2.5b shows the form designed for this purpose. This form fulfilled two purposes

a) XY Coordinates Of shops

b) Total Worth of Anhaar Products sold

SALES SURVEY

Date:_____

NAME OF SHOP/STORE:_____

_____

ADDRESS:_____

_____

SHOP OWNER:_____

GPS Coordinates(to be filled by survey management)

x	
y	

Available Anhaar Products:

Anhaar Whole Milk	
Anhaar Full Cream Milk	
Anhaar Low Fat Milk	
Daily Dairy	
Yogurt Plain & Sweet	
Anhaar Desi Ghee	

Sales Of Anhaar Products:

Anhaar Whole Milk	
Anhaar Full Cream Milk	
Anhaar Low Fat Milk	
Daily Dairy	

Figure 2. 5a Sales Survey Form

Figure 2. 5b Sales Survey Form

Yogurt Plain & Sweet	
Anhaar Desi Ghee	

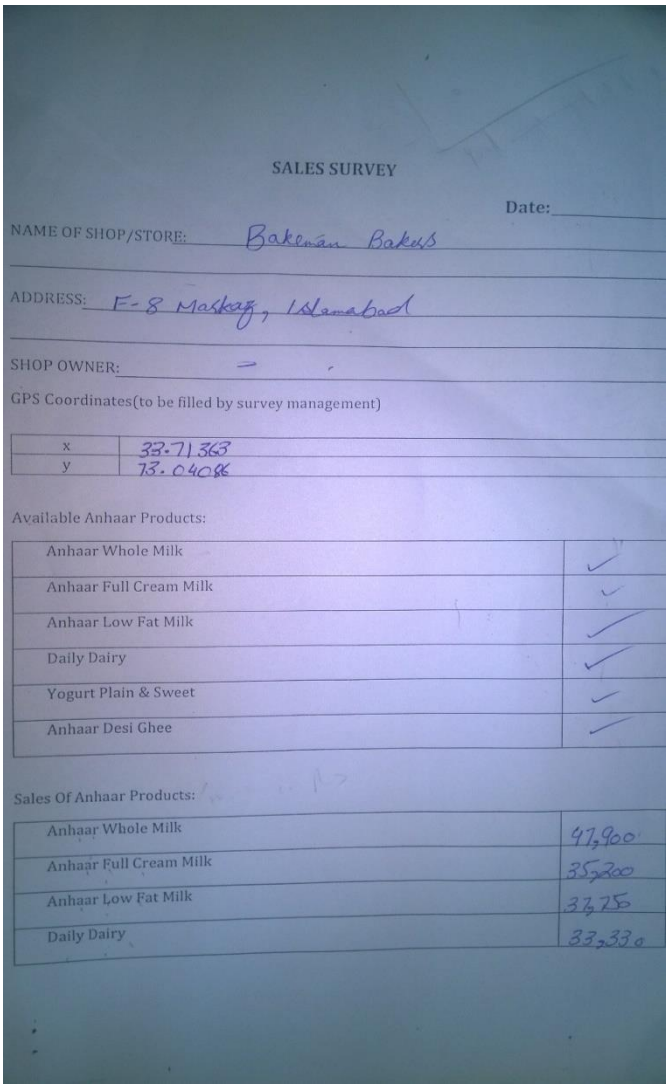
TIME OF DELIVERY: _____

SURVEY SUBMITTED BY

SIGN: _____

SURVEY SUBMITTED BY

SIGN: _____



SALES SURVEY

Date: _____

NAME OF SHOP/STORE: Bakman Bakers

ADDRESS: F-8 Markaz, Islamabad

SHOP OWNER: –

GPS Coordinates(to be filled by survey management)

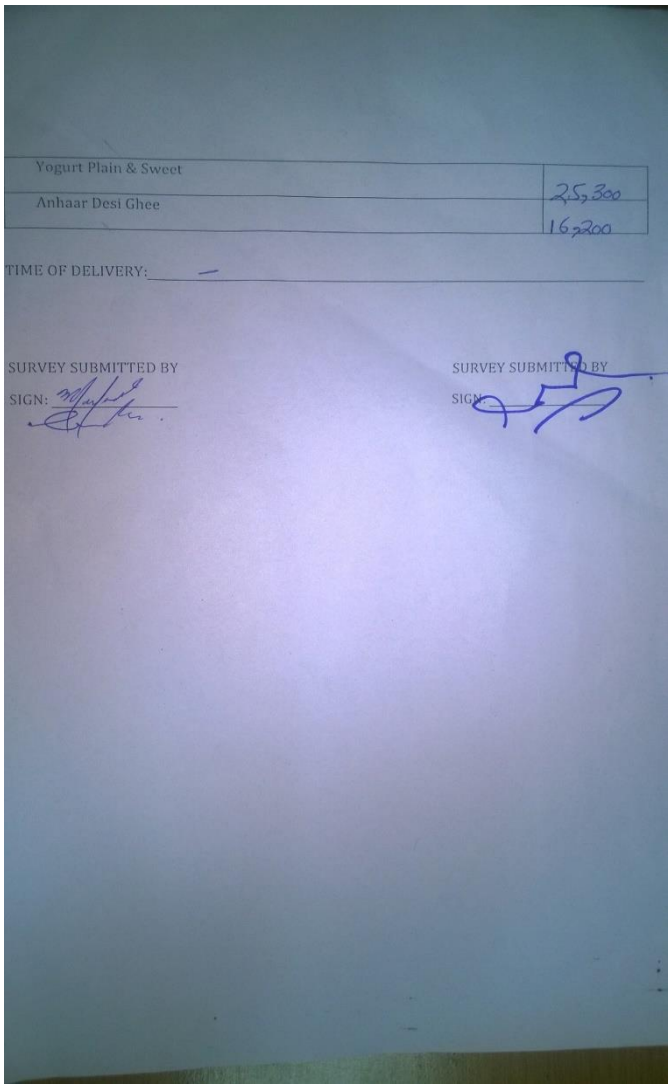
x	33.71363
y	73.04086

Available Anhaar Products:

Anhaar Whole Milk	✓
Anhaar Full Cream Milk	✓
Anhaar Low Fat Milk	✓
Daily Dairy	✓
Yogurt Plain & Sweet	✓
Anhaar Desi Ghee	✓

Sales Of Anhaar Products:

Anhaar Whole Milk	47,900
Anhaar Full Cream Milk	35,200
Anhaar Low Fat Milk	33,75
Daily Dairy	33,330



Yogurt Plain & Sweet	25,300
Anhaar Desi Ghee	16,200

TIME OF DELIVERY: –

SURVEY SUBMITTED BY

SIGN:

SURVEY SUBMITTED BY

SIGN:

A GPS device was used to store location of shops where Anhaar products are available. In addition to coordinates, a questionnaire was filled by owner/shopkeeper which acquired information like shop name, address, quantities of different Anhaar products sold etc. Afterwards, location data and attribute data were separated and formatted for further processing.

2.2.4.3 Analogue to digital conversion

The xy coordinates are put into a location GDB whereas business data is put into attribute GDB. Afterwards, the data collected from field was added to excel sheet, the data from excel was then exported to .csv format, eventually imported in arcgis to create point data shapefile for Anhaar.

2.3 Methodology

This web based system will consist of visualization part and SDSS for that we are using general three tier Web GIS application architecture as shown in figure 2.6 which include *client, server and client tier*. Although all of them can be deployed on a same machine but logically they remain three separate layers and usually it is preferred to keep them physically separate as well.

Main advantage of dividing these tier is that it becomes easier in terms of up gradation i.e. any of them can be upgraded or scaled up without disturbing the other two. Secondly each tier can be secured differently according to the security requirement and this architecture also provide easy management because it groups things together by functionality which make it easily understandable and manageable

2.3.1 Data Tier

Once, the dataset was prepared, it resided in the data repository from where it is ready to be published as a GIS web service (resource) over internet or local area network (LAN) .Benefit

of using GIS service over internet is that user is not required to install any specialized GIS software

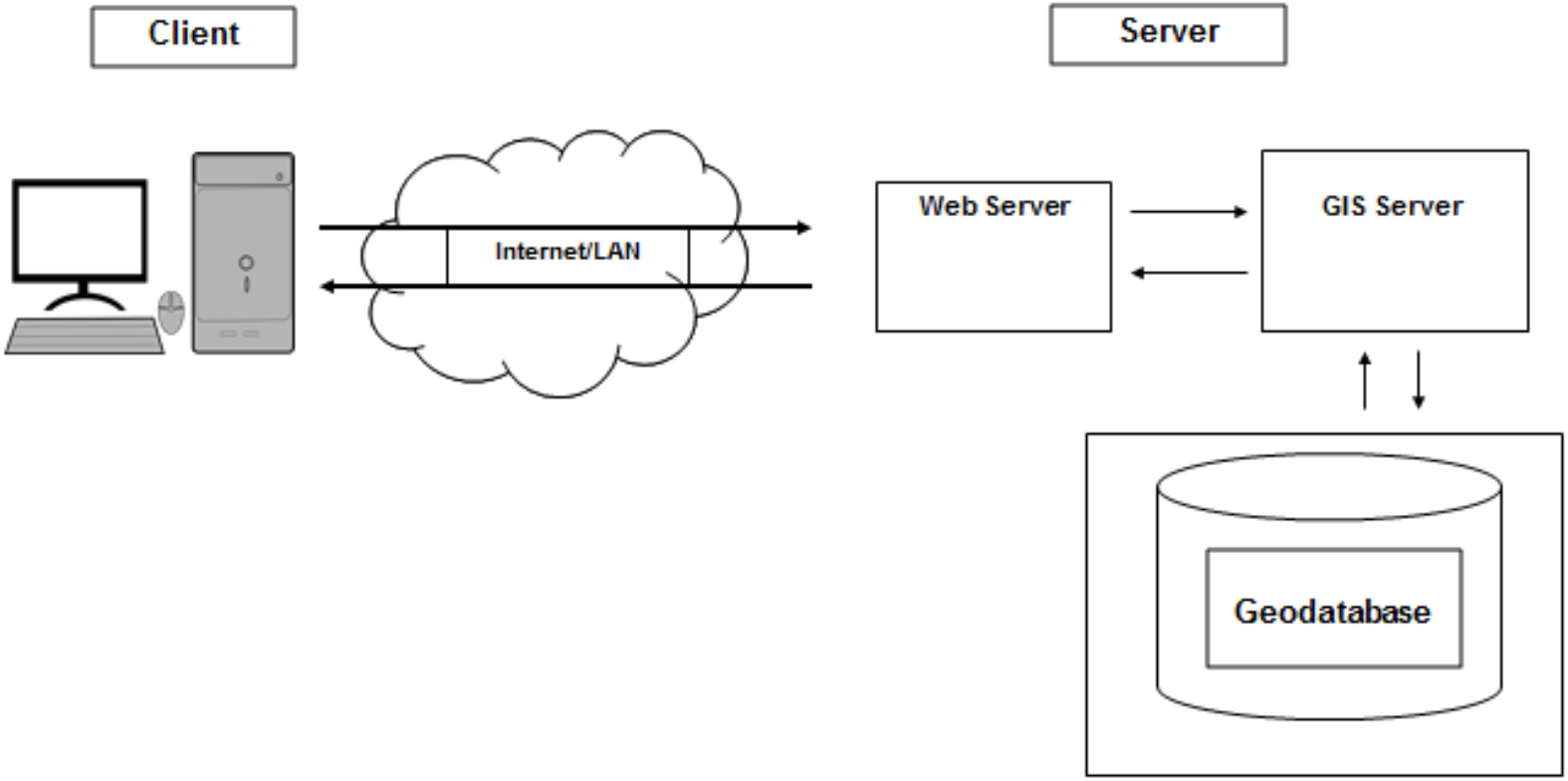


Figure 2. 6 Web GIS Application architecture

only web browser is enough to consume services or custom web application can also be made to do the same.

2.3.2 Server

ArcGIS services and capabilities are listed in the table 2.1 and table 2.2.

Table 2. 1 GIS Services and their corresponding GIS Resources

Service type	Required GIS resource
Map service	Map document (.mxd)
Geodata service	File geodatabase or database file connection
Geoprocessing service	Geoprocessing result from ***Results*** window in ArcGIS for Desktop
Search service	Folders and geodatabases of GIS content that you want to search

Table 2. 2 Capabilities of GIS services

Capability	What it does	Required Services
Feature Access	Provides access to vector features in a map.	Map services
Geocoding	Provides access to an address locator. This capability is always enabled when you publish a geocode service.	Geocode services
Geodata	Provides access to the contents of a geodatabase for data query, extraction, and replication. This capability is always enabled when you publish a geodata service.	Geodata services
Geoprocessing	Provides access to geoprocessing models. This capability is always enabled when you publish a geoprocessing service.	Geoprocessing services
KML	Uses a map document to create Keyhole Markup Language (KML) features.	Map services
Mapping	Provides access to the contents of a map, such as the layers and their underlying attributes. This capability is always enabled when you publish a map service.	Map services
Network Analysis	Solves transportation network analysis problems using the ArcGIS Network Analyst extension.	Map services
WFS	Creates a service compliant with the OGC Web Feature Service (WFS) specification.	Map services, geodata services
WMS	Creates a service compliant with the OGC Web Map Service (WMS) specification.	Map services, image services

ArcGIS Server allows to share your GIS resources across an enterprise and across the Web. ArcGIS server communicate with client through common web service SOAP and REST. Additionally it allows to limit user's access to different services according to their role in the organization. This project uses REST services which are to be consumed in a browser.

2.3.3 Client /Presentation tier

End user interacts with the system through this layer and we can use ArcGIS viewer for flex here because it is a ready to use web application but we will be use ArcGIS API for flex because as we need to add our own build and customized tools for web application.

Beside we have to customize widgets to communicate with GIS Server for each module. Customization in easier than making widget from scratch.

User interface will be designed with the help of *flex, which is an open source GUI framework for developing rich GUI.* Flex works across all desktop browsers therefore end user just need to have a web browser with flash player plugin.

2.3.4 Detailed work flow

Detailed work flow for the whole process is shown in the figure 2.7.

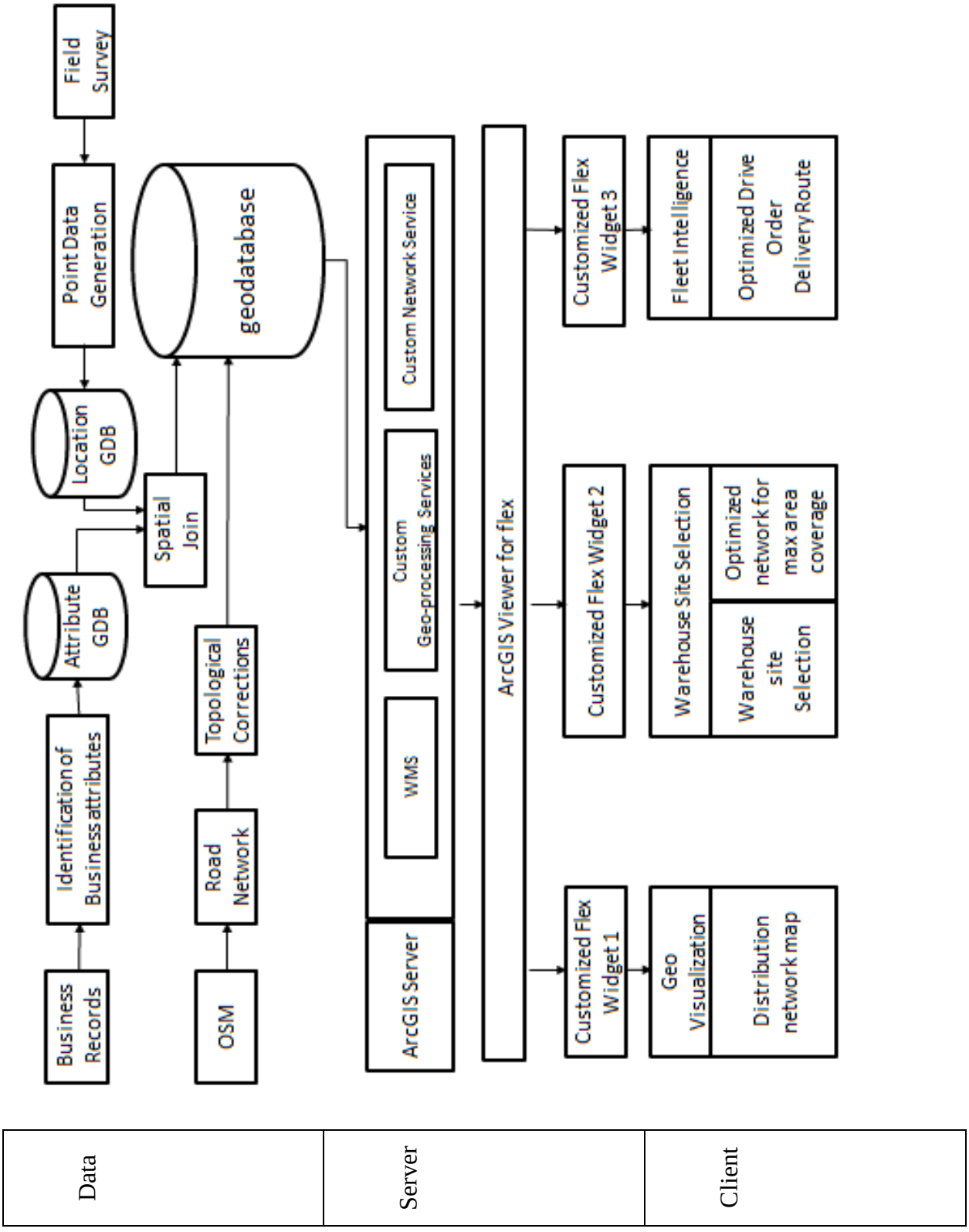


Figure 2. 7 Flow Chart

2.3.5 Web base services

Any GIS data available on web and represented through Uniform Resource Locater (URL) that is already published on server. To publish GIS service there are some steps that must be followed.

2.3.5.1 Authoring Service

Authorizing a service can be easily performed in ArcGIS desktop. For this study, ArcGIS desktop 10.2 was used. Required operational layers and datasets are made in ArcMap, later which are to be published on GIS server. Figure 2.8 below shows the step required for authoring services in ArcGIS desktop.

2.3.5.2 Publishing service

After the completion of authoring step, layers are ready for publishing as web based GIS services. ArcGIS server 10.2 is used in this study for further usage to make them useable for web based activities.

Figure 2.9 shows service ready for publishing and also shows the procedure to publish a map services. Before publishing services the connection to Arc GIS Server must be already done through Arc Catalog or ArcGIS Server Manager. This is an important step for sharing the resources to ArcGIS Server, before publishing services ArcGIS Server must be installed on the system and connection must be made before publishing the services through Arc Catalog or ArcGIS Server Manager. The metadata of each layer is provided in this step. The input output parameters for Geo processing services is also added in this step. Once done each service is checked for errors and warnings whether this process can be published and can then be utilized successfully. Figure 2.10 represents the connections and the directory where the web service must be placed is shown in the here.

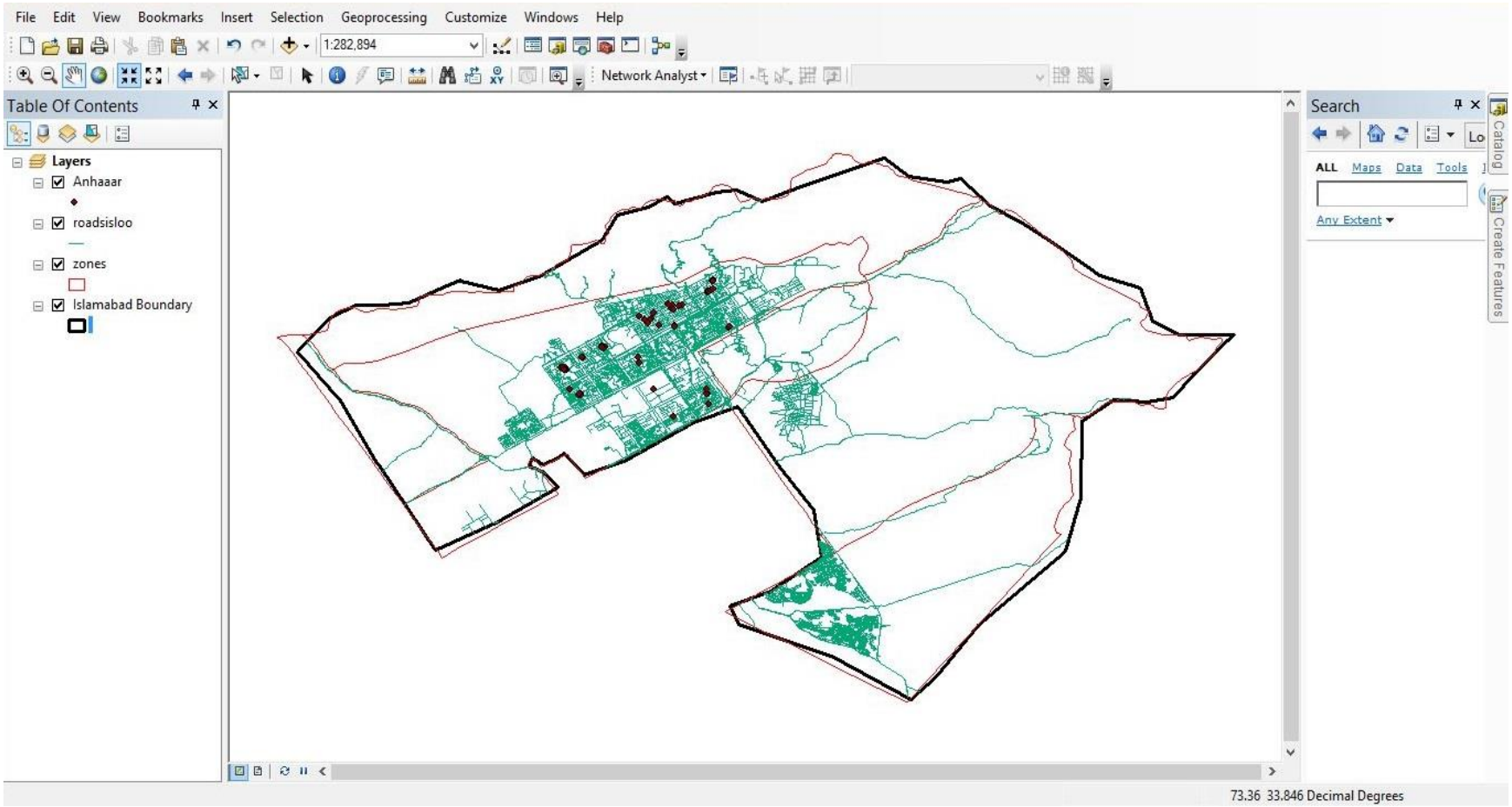
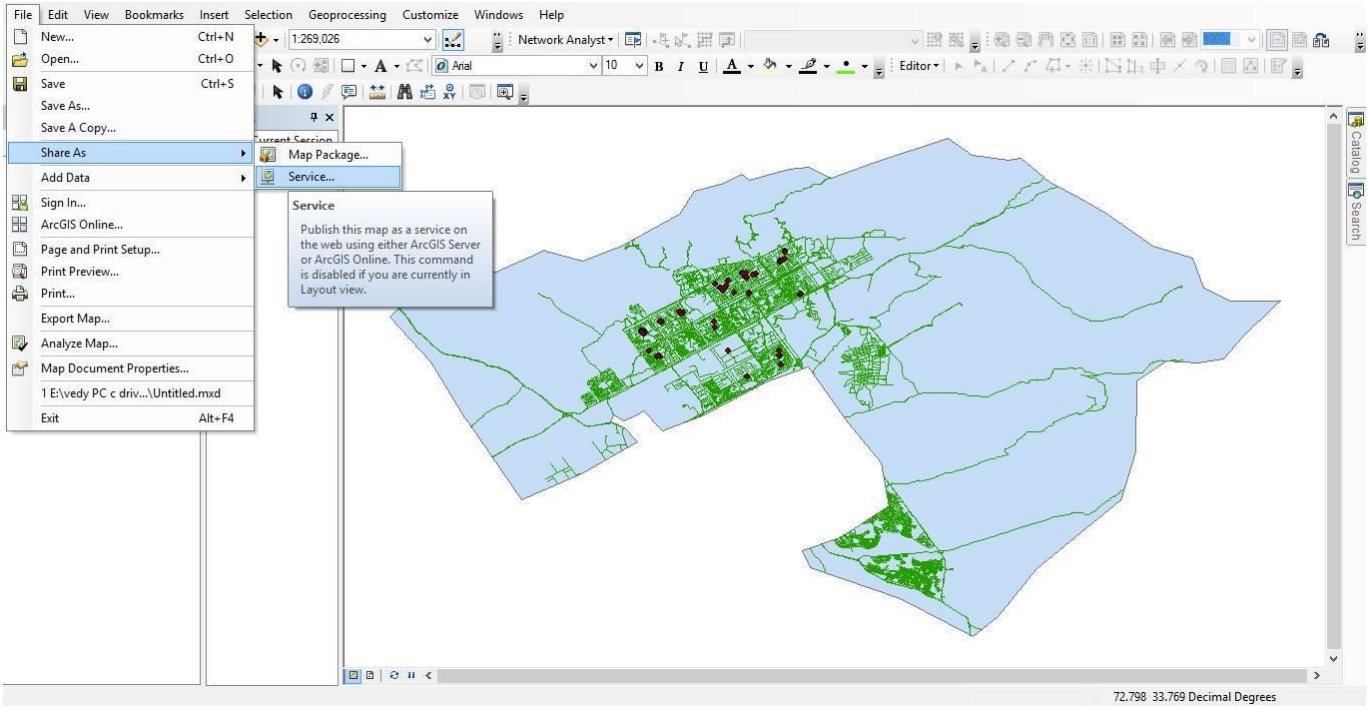


Figure 2. 8 Authoring Services



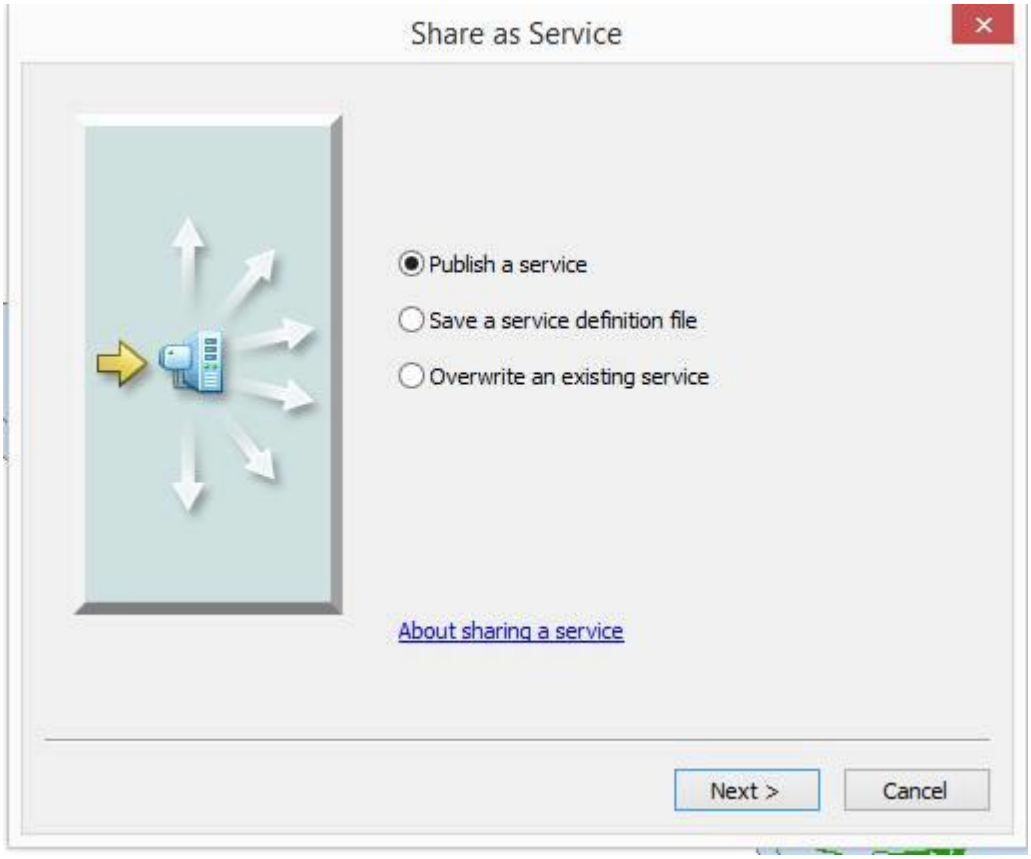


Figure 2. 9 Publishing Service

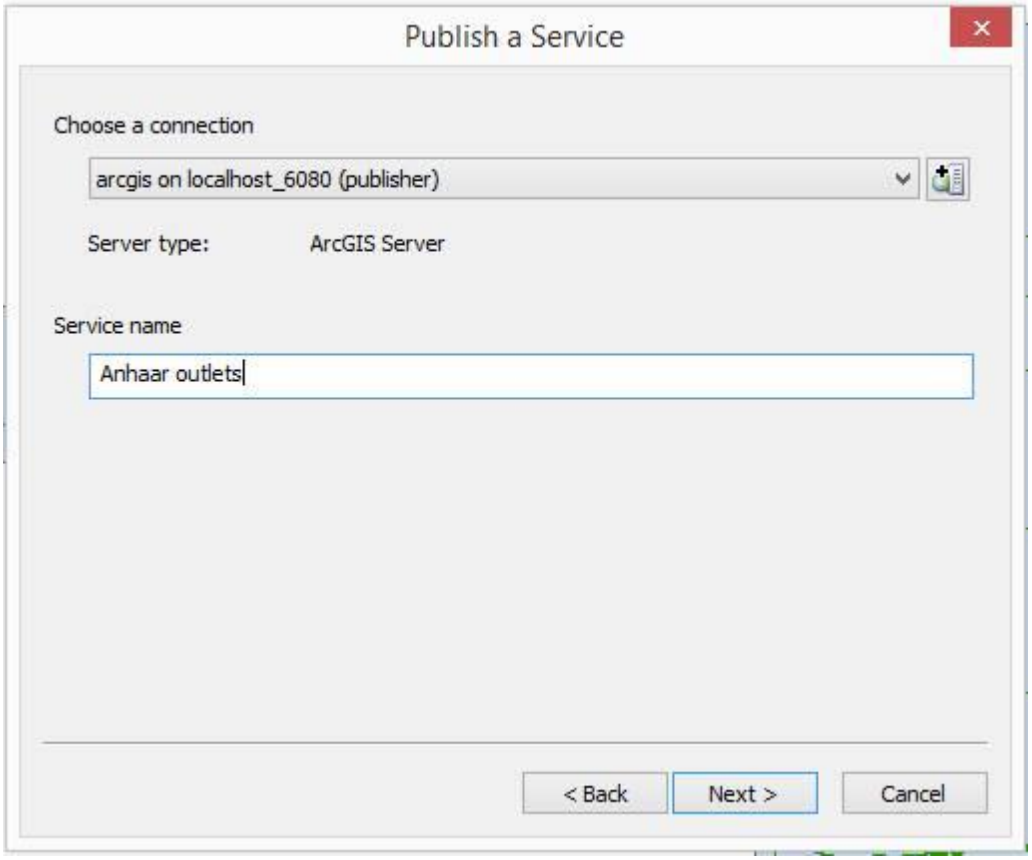


Figure 2. 10 Publishing service its connection and directory

2.3.5.3 Utilizing service

When a layer or dataset is published, it is available for further utilization through a browser using URL as shown in Figure 2.11. It shows the service name, URL, and other information. Each layer is represented by a unique ID, which starts from zero. First layer have an id zero and so on.

2.3.6 Geovisualiztion

Two datasets have been published as web services which includes road network and location of Anhaar products outlets. Attribute data associated with each outlet, collected through survey has been displayed and summarized using charts and sql query. Specialized flex widgets have been made for this purpose.

2.3.7 Site Selection for new warehouse

For site selection, model builder is used to build the model for multi criteria decision analysis. Following criteria are used in this model as input parameters

- Digital elevation model (DEM)
- Landuse Map
- Euclidian distance from existing shops (Mean Center)
- Road Accessibility
- Zonal distribution map of Islamabad

Maximum weight is assigned to mean Euclidian distance from existing shop i.e. mean center and road accessibility. Landuse map is used to make sure that proposed site should be in a commercial area or close to commercial area and not in some green or vegetation cover land. DEM criteria makes sure warehouse lies in a flat terrain and not close to water bodies that makes

it less prone to flood hazard. Figure 2.12 gives ad detailed view of working of this site selection model.

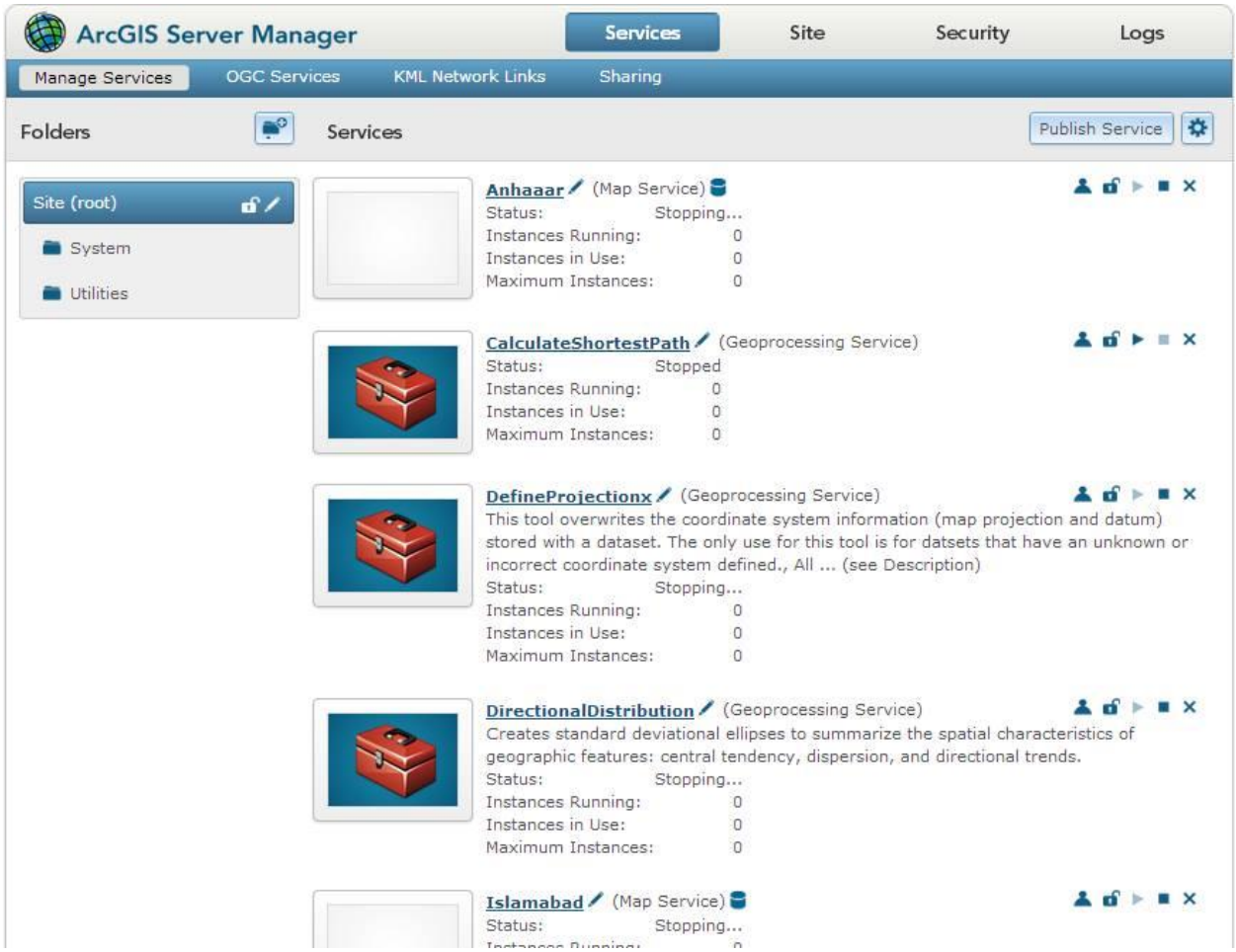


Figure 2. 11 Services available for utilization

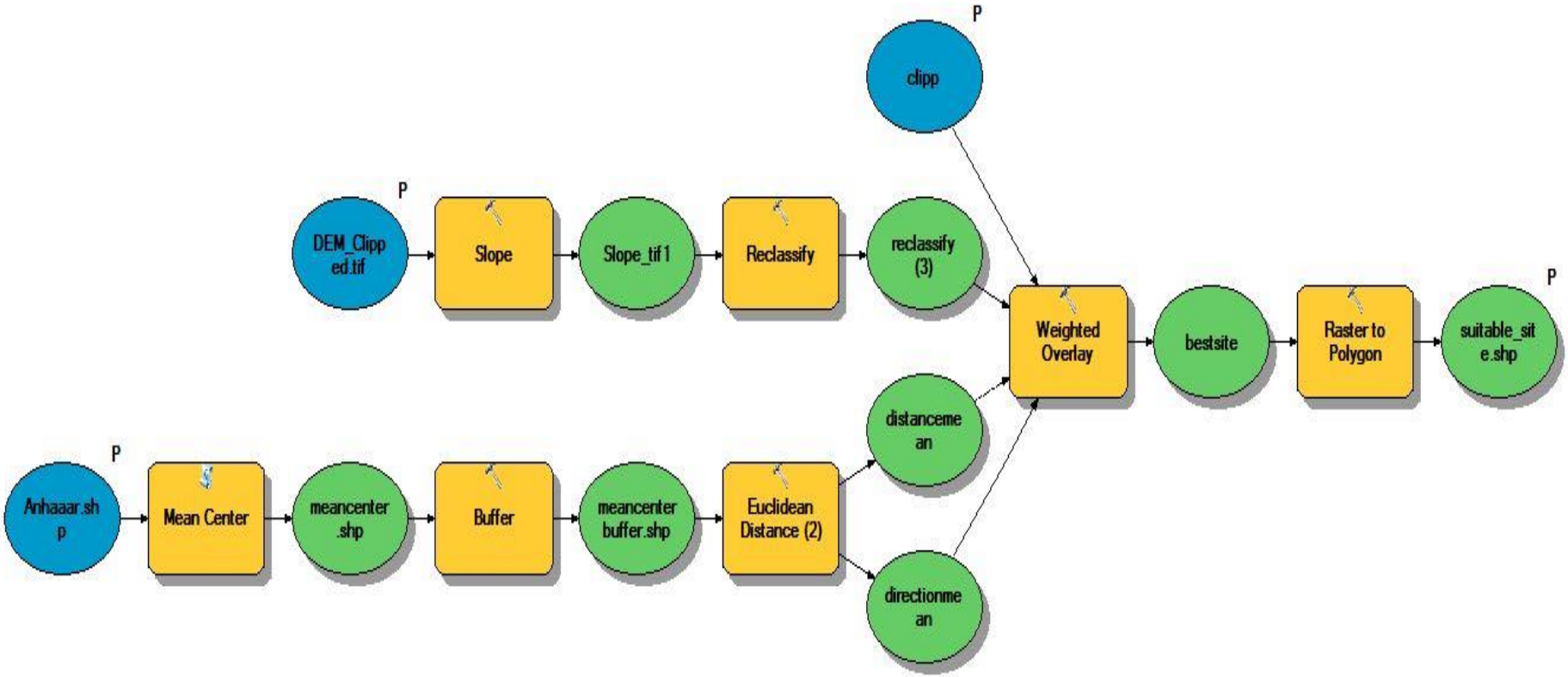


Figure 2. 12 Detailed overview of warehouse site selection

2.3.8 Fleet Intelligence

As it has been mentioned, target Company chosen for this study is a Lahore based company. Its products are transported from Lahore to Islamabad on daily basis. The vehicle makes its entry in Islamabad from the same route i.e. Islamabad motorway and supply goods to all outlets. This creates a travelling salesman problem (TSP), where shortest distance between two points as well as order of distribution plays a key role in minimizing distance and fuel consumption. ArcGIS Network Analyst's vehicle routing extension has been used for this purpose. Along with network routable road network, route service is also published. Using route service, the functionality to find the best sequence order with respect to distance is added to application.

Chapter 3

RESULTS AND DISCUSSION

All the above mentioned capabilities are provided to the user through a browser based easy to use interactive interface. Adding above mentioned capabilities to the system yielded different results which have explained and discussed below

3.1 Presentation tier / client side view

End user can view this application through Uniform Resources Locater (URL). Figure 3.1 shows the front view of the application.

3.2 Base layers and Operational layers

These are two layers type shown, one base layer and other operational layer. All the visualization, analysis and summarization is done on operational layer. Base Map acts like a container on which operational layers are over laid; it might be Google layer, satellite imagery. There are different types of base maps but at a time only one can be active, as shown in Figure 3.2.

Operational layers are layer which are over laid on base map or these are layers on which any operation can be performed on it. More than one operational layer can be active at any time. Transparency of the operational layers can be increased or decreased according to the requirements. The sequence of the layers can be moved up and down accordingly. Figure 3.3 shows operational layers which includes Anhaar outlets layer, road network layer and Islamabad boundary layer serve here as an operational layers and results of some operation as layer.

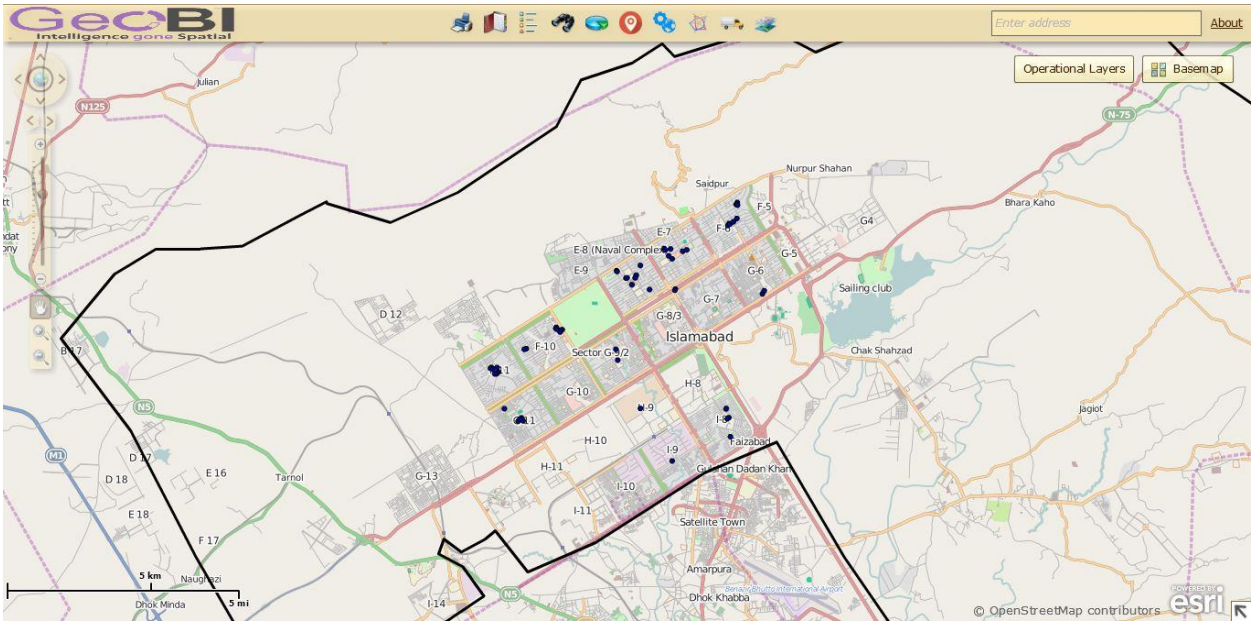


Figure 3. 1 Front view of Application

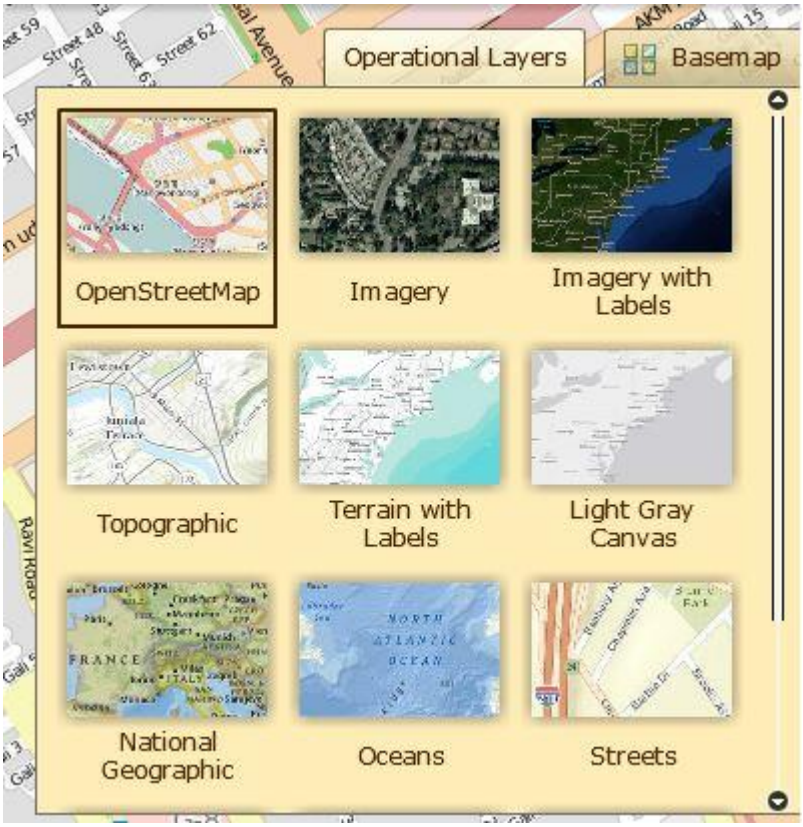


Figure 3. 3 Base Maps

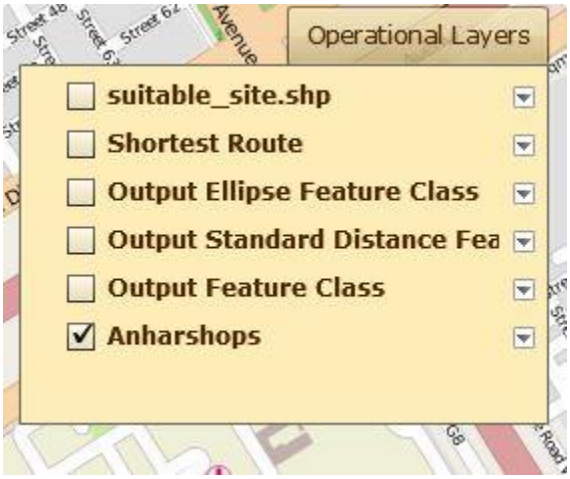


Figure 3. 2 Operational Layers

3.3 Search Widget

Search widget is developed to make search easily and quickly. Two sort of searching is provided in application. First of all select the required layer for which some searching operation is performed. One type of search is to select geometry and select the any sub section of area in study area, for this type of search first of all select the required layer, then select the geometry type for search it might be circle, rectangle or single point feature for selection, after that select any subarea or area of interest in study area and look for the Anhaar outlets and their information, it will show you all Anhaar outlet location along with their attribute information as

well sot that the end user can further dig down deep into information and analysis. The result is shown in new window having all detail such as total sales in previous month or sale of a particular Anhaar product.

The other type of search is search by attribute, a user must write the attribute i.e. name of the outlet/shop and the search will show the output results. The result will be shown on the screen to the user. Window having the attribute information and there symbol changes, the individual result can be seen in details. Figure 3.4 shows the search by name widget, one can search for any of the outlet by entering name. Figure 3.5 shows the widget for search by location, for searching any feature 1st select the layer form which feature to be searched, then select the searching types i.e. to search by geometry. Figure 3.6 shows the result of search widget, of search area its show all the attributes and its details in a tabular as well as summarized in pie chart form as well. Another search has also been provided which deals with search by sql query. In this type of search one can go for search queries like select those outlets where sale of Anhaar products is greater than two lakh.

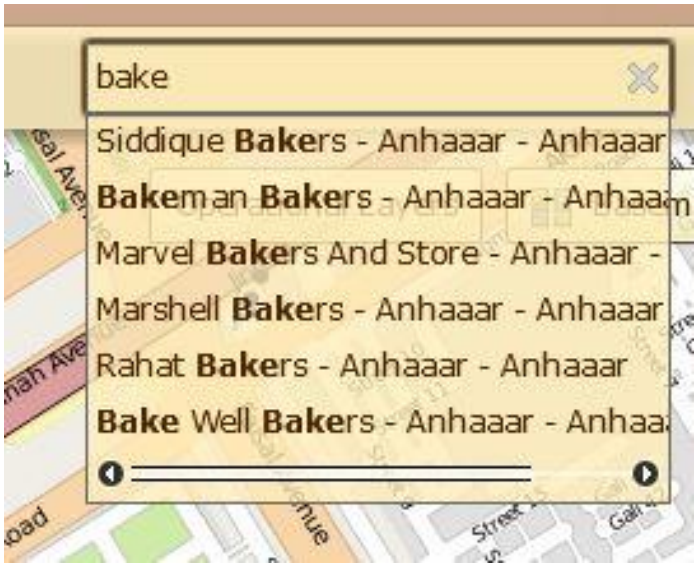


Figure 3. 4 Search by Name attribute

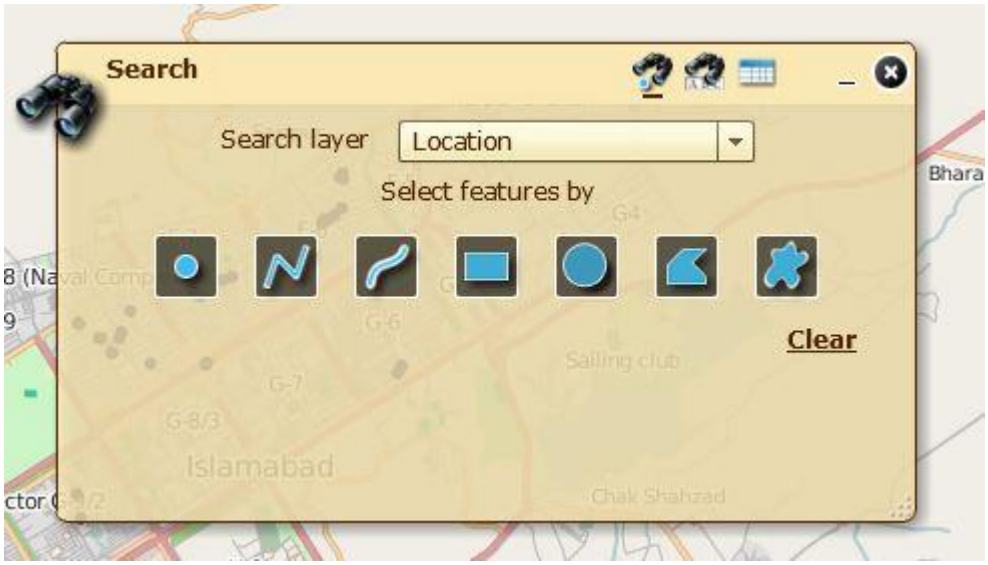


Figure 3. 5 Search by location

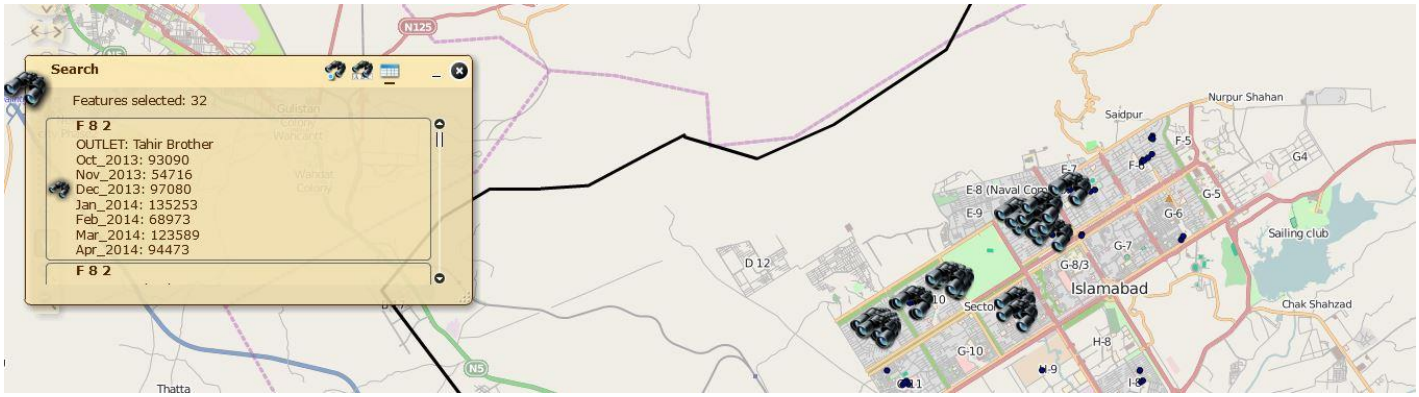


Figure 3. 6 Results of search by location query

3.4 Mean Center

This widget has been designed to identify the geographic center (or the center of concentration) for a set of features which in this case are the outlets of Anhaar Foods. This widget takes the location of all outlets of Anhaar from Anhaar outlets layers and calculate their geographic center. This tool can serve as an alternative for warehouse site selection. It can also be used to counter check the results from warehouse site selection widget. Ideally, both mean center and proposed site for new warehouse should be close to each other. Figure 3.7 shows the general architecture for mean center and fig 3.8 shows the mean center widget interface and figure 3.9 shows the results of mean center widget calculated form Anhaar outlets.

3.5 Directional Distribution

A common way of measuring the trend for a set of points is to calculate the standard distance separately along x and y directions. These two parameters define the axes of an ellipse encompassing the distribution of features. The ellipse is referred to as the standard deviational ellipse, since the method calculates the standard deviation of the x-coordinates and y-coordinates from the mean center to define the axes of the ellipse. The ellipse allows you to see if the distribution of features is elongated and hence has a particular orientation. Figure 3.10 shows the general flow and input output for directional distribution.

Although one can get a sense about the orientation of data by drawing features on map, calculating the standard deviational ellipse makes the trend even clearer. Standard deviational ellipse is calculated using either the locations of the features or the locations influenced by an attribute value associated with the features. The latter is termed a weighted standard deviational ellipse.

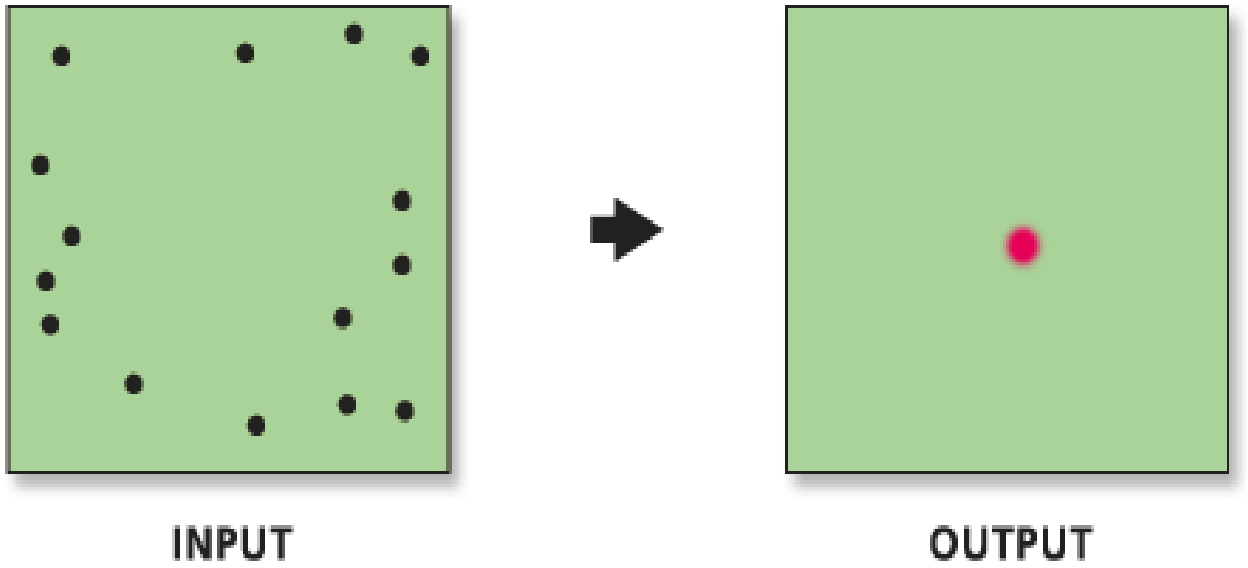


Figure 3. 7 general architecture for Mean Center

Figure 3. 8 Interface of Mean Center

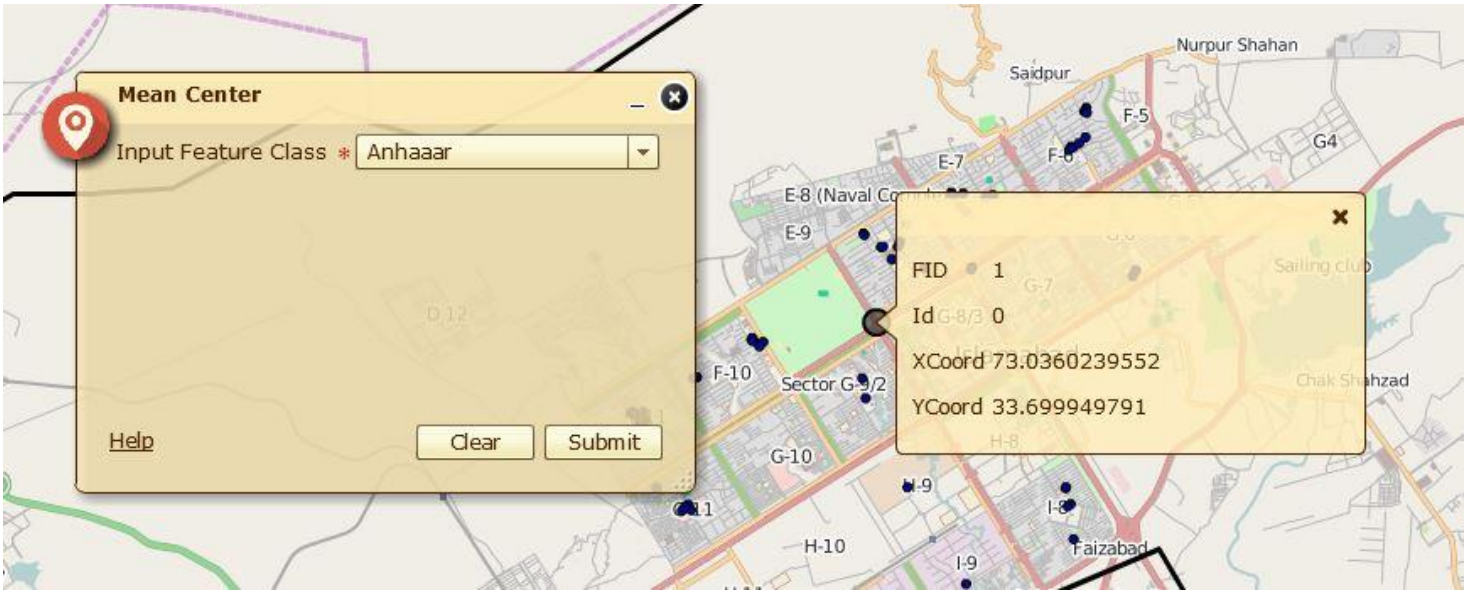


Figure 3. 9 Result of Mean Center widget

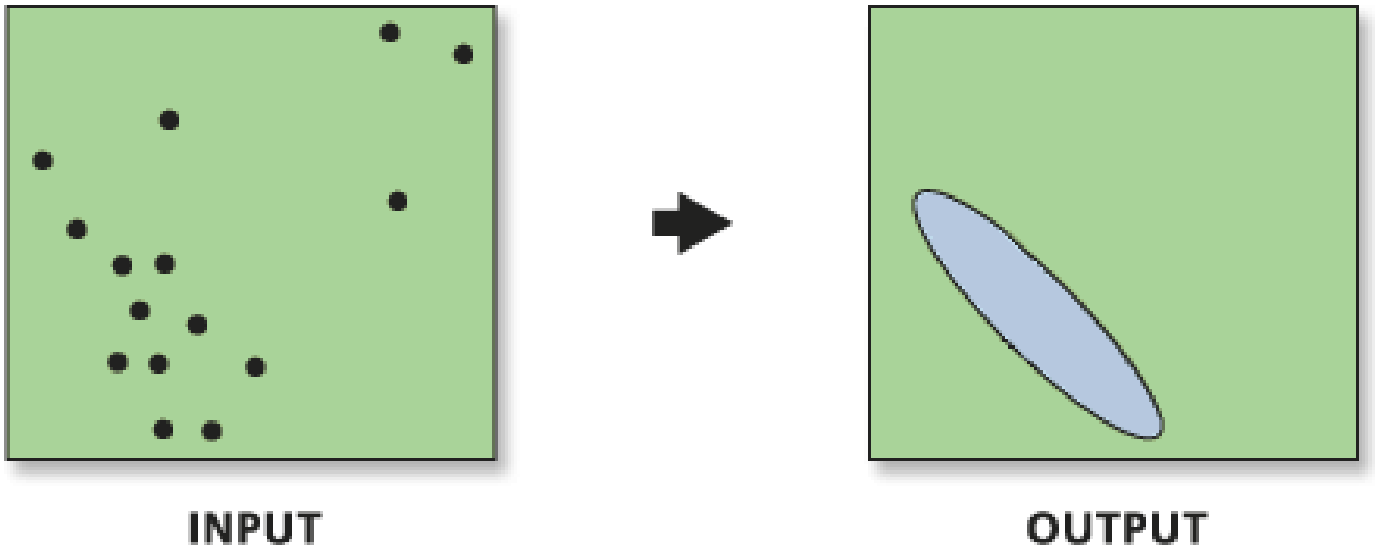


Figure 3. 10 General architecture for directional distribution algorithm

In this study, weighted standard deviational ellipse has been calculated using a case field parameter of sale associated with location of Anhaar outlets. Figure 3.11 shows the interface of distribution widget. Figure 3.12 shows the output of directional distribution widget for Anhaar outlets based on their sales.

3.6 Standard Distance

Standard distance measures the degree to which features are concentrated or dispersed around the geometric mean center. Measuring the compactness of a distribution provides a single value representing the dispersion of features around the center. The value is a distance, so the compactness can be represented on a map by a circle with radius being equal to the value. For input features having spatial pattern concentrated in the center with fewer features toward the periphery i.e. having spatial normal distribution, a one standard deviation circle polygon will cover approximately 68 percent of the features; a two standard deviation circle will contain approximately 95 percent of the features; and three standard deviations will cover approximately 99 percent of the features in the cluster. Figure 3.13 shows the interface and results of standard distance widget.

3.7 Site Selection for new warehouses

Based on defined criteria, a new site is proposed for the system that is closest to all Anhaar outlets. Currently, Anhaar do not have any warehouse in Islamabad. Proposed site for a

new warehouse could save a lot of time and fuel in supply management. Figure 3.14 shows results of site selections widget.

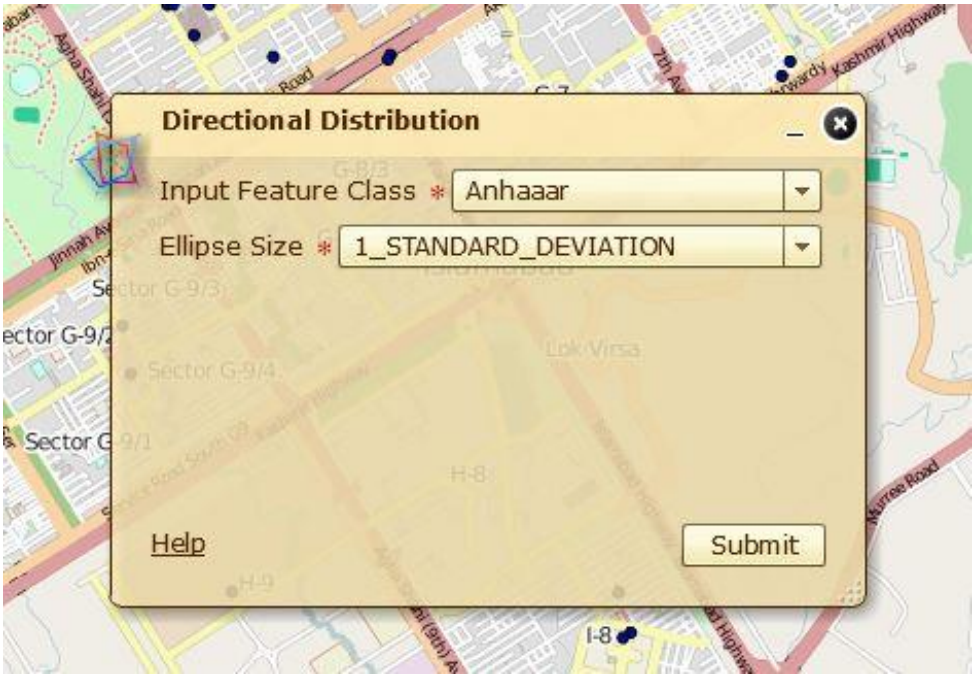


Figure 3. 11 Interface of Directional Distribution widget

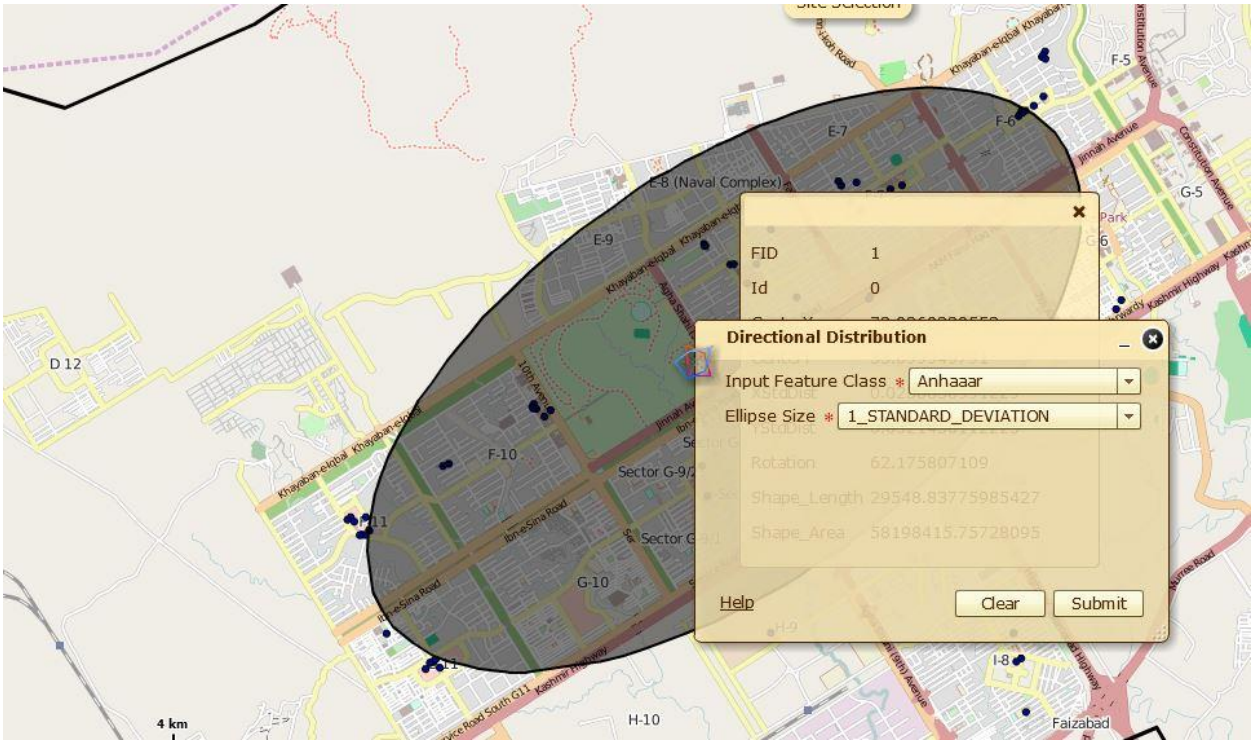


Figure 3. 12 Result of directional distribution widget

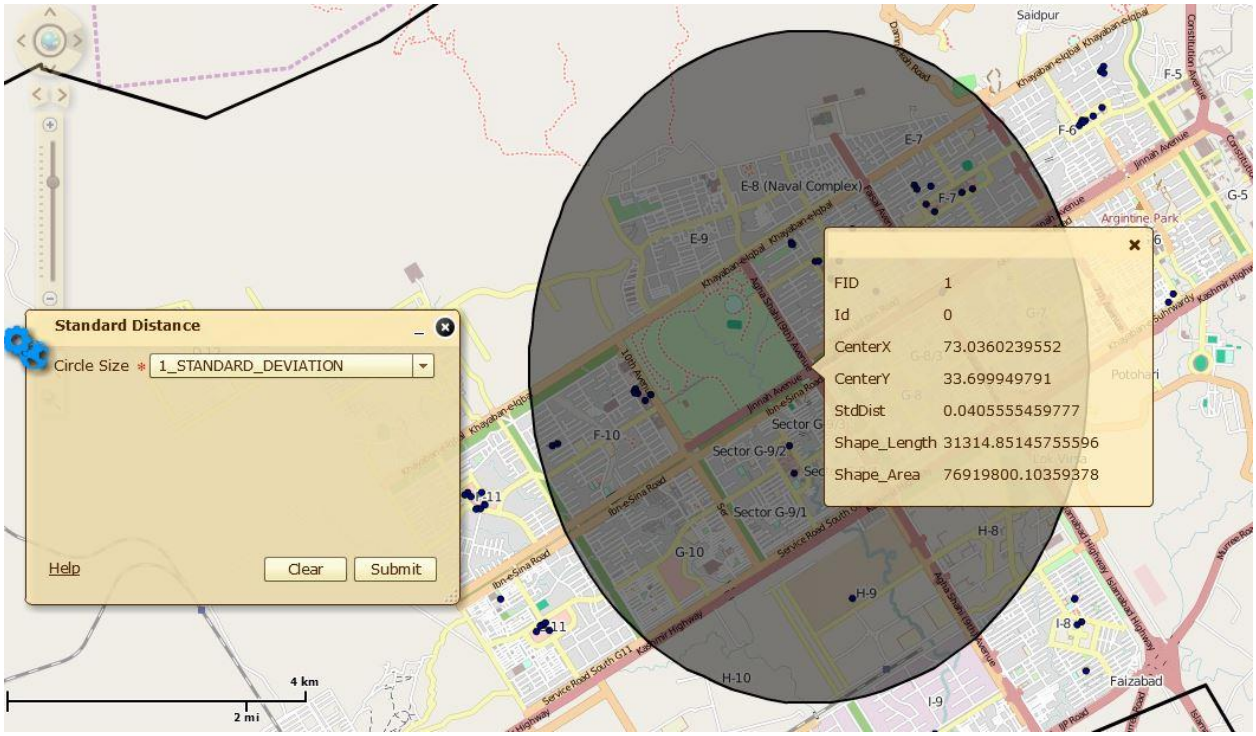


Figure 3. 13 Standard Distance widget interface and outputs

Figure 3. 14 Site selection interface and result

Chapter 4

CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

GIS has not yet become an integral part of daily business activities in Pakistan. Most of the people either do not have knowledge about positives and power of GIS or they do not want to indulge in any new technology that has not been around for a while. Most of the FMCG companies in Pakistan are unaware of location intelligence and what goods location intelligence could do them. Most medium sized FMCG companies have Microsoft excel based data entering, storing, querying and analyzing systems. However, large enterprise are a step ahead and they have their own database management systems along with data mining capabilities for business intelligence. Thus, business intelligence for most Pakistanis FMCG industry is a non-spatial term. In this way, they are ignoring one of powerful intelligence tool which has the potential to better maintain their business, minimize expenditures and exploiting the potential benefits and drawbacks of site selection. In this project, we have tried to emphasize on the importance of location intelligence/spatial intelligence and how it can be easily integrated in daily business activities for a typical FMCG company. Having successfully implemented, geobusiness intelligence techniques for an FMCG company, it can be concluded that GIS can be an integral part of FMCG sector. In fact companies should be encouraged to use geobusiness intelligence, location intelligence and GIS techniques to exploit fully their company's data and business for a strong and powerful growth in a competitive market environment.

4.2 Recommendations

The road data for this project was downloaded from open street map. Since open street map is an open source product therefore there is no authenticity or check for maintaining same level of accuracy throughout the dataset. Thus, there should a spatial data infrastructure for Pakistan by public sector organizations like survey of Pakistan etc. For road speed limit and traffic load information of different roads, National highway Authority should create road network data and make it available to general public or at least to educational institutions for learning and research purposes. In this way, a large amount of time can be saved while maintaining accuracy check.

ArcGIS server was used as GIS server in this project. However, in order to minimize cost for end-user, some open source GIS server can be used such as geoserver, mapserver, mapnik.

For site selection tool, due to unavailability of data and shortage of time, fewer variables were took under consideration. Some more variables should be considered such as sector vise distribution of population in study area, property rates etc.

This study can be extended further to a generic geographic business intelligence (geobi) that incorporates lots of preloaded with datasets like information about population, business activities in given area, land information system and property prices should be incorporated that can give user a deeper insight about market conditions and its competitors. An automated data entry device could also be for inventory purposes.

It is recommended that these sort of studies should be encouraged which emphasize on integrating GIS into daily business activities. FMCG companies should be encouraged to

practically implement such an application. It would not only make business community familiar GIS technology but also provide their business cutting edge over their competitors.

We recommend that for a step ahead in fleet intelligence, GPS device should be incorporated in vehicles in order to incorporate full time monitoring and display on map.

It is recommended that these sort of studies should be encouraged which emphasize on integrating GIS into daily business activities. FMCG companies should be encouraged to practically implement such an application. It would not only make business community familiar GIS technology but also provide their business cutting edge over their competitors.

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