Online access @ www.publishingindia.com

Geographic Information Systems: A Decision Support Tool for Business

Meenakshi Handa[1]
Anupma Vohra[2]

Abstract

Geographical Information Systems (GIS) are an extremely useful tool for analysis and decision-making in a wide variety of situations. Geography is important to business, irrespective of the type of industry. Organisations are increasingly becoming aware of the vast amount of locational data already available with them and are exploring how to leverage this. This paper underscores the importance of spatial data and the need for organizations to integrate this into their decision-making. It examines the potential of GIS in business applications and provides an overview of business activities where GIS can be employed as a decision support tool. The various stages of the strategic planning process as well as business operations including market analysis, segmentation, positioning, supply chain operations, pricing, promotions and sales management can benefit from the application of GIS. The major hurdles in the application of GIS as a business tool, especially in the Indian context have to do with the availability, accuracy and currency of spatial data and low familiarity with the potential of GIS. The paper further makes a case for the introduction of GIS education in business school curricula to increase its understanding and adoption by business decision makers.

Keywords: Spatial imaging and analysis, Thematic maps, Data visualization, Spatial Decision Support Systems, Location based services

[1] *Reader, University School of Management Studies, GGS Indraprastha University, Delhi.*

[2] *Associate Professor, Faculty of Management Studies, University of Delhi, Delhi*

Introduction

Geographic Information Systems are computer-based tools that enable mapping and spatial analysis of the earth's features and events. Features of the earth's surface are linked to a map grid coordinate system and recorded in the computer. These map features can be presented or plotted in any combination and on almost any scale and the spatial relationship between the features analysed. GIS can manage data from several sources and link it to a geographic base. GIS data structure consists of stacked layers of maps, each layer representing a unique phenomenon (Figure 1). Thus, a map of street networks can be superimposed on a topographical map, which is followed by a layer representing sales territories. The bottom layer carries the grid of locational reference systems (e.g. latitudes and longitudes). These multiple layers of thematic maps can be used to better analyse and understand data held in an organization's database. Unexpected patterns may be identified with a layer of customer demographic information that may not be discernible from data in the form of tables and text.

Appropriate use of symbols, colours, and legend classifications can enhance the visual display of the data. GIS help in the structuring and imaging of data and enable the visualization of data in new ways and thus helps in revealing concealed relationships and trends GIS are thus a powerful technology for the storage, analysis and visualization of data with the ability to combine information and mapping systems as analytical and modelling tools.

GIS is an integrating technology in that it has borrowed from several different disciplines such as Geography, Photogrammetry, Cartography, Computer Science, Remote Sensing, Statistics, Engineering, Social Sciences, and Natural Sciences. GIS is being used in activities such as oil and gas exploration, laying of pipe lines and storage of oil and gas, metrology, forestry, pollution control and environmental studies, and by police / security agencies. It is also employed for census work, utilities, urban planning, crop management, water resources management defence and business. It is being employed for managing property records, tax assessment, traffic

management, roadway projects, telecommunications, epidemiology, disease control etc. In the main, the use of GIS in the past has been by the government and the public sector.

The application of GIS in business has been rising in recent year, as its power as a tool to enhance the quality of managerial decision-making is increasingly being appreciated The improvement in computing technology and the accompanying cost reductions have a strong bearing on the adoption of GIS by business. Presenting the application of GIS in the telecommunication industry, Subramanium and Narayan (2006) express the view that GIS has transformed from a single department application to a company-wide endeavour, allowing telecoms to enhance a variety of applications ranging from engineering, workforce management, customer relationship management, and location-based services to advanced analysis on wave propagation. According to Richards (2006) the effective use of geographical data underpins many vital business and governmental decisions in marketing, distribution, sales, planning, environmental protection, security and service provision.

This paper highlights the broad range of applications of GIS as a decision-support tool by business organizations. The current domestic market for GIS in the country is an estimated Rs. 797 Crores and is expected to grow to Rs. 1,800 Crores by 2010 (Times of India, 2007). However, as discussed later, there are several challenges, which need to be addressed, if the potential of GIS is to be realized by business.

Applications of GIS in Business

GIS make it possible to analyse a wide variety of business information in terms of a location perspective. It can be used by any organization, which has activities, or interests spread over a geographic area. Geography is important to marketing as both supply and demand have space implications, and therefore cost dimensions for business. Consumer goods marketers, retail organizations, financial services, tourism enterprises, hospitality services, hospitals, insurance companies, distribution and logistics services and other business organizations can use GIS for improving decision-making in a wide range of spheres (Table 1).

A Spatial Decision Support System (SDSS) is an extension of GIS and refers to the GIS developed to aid the decision making process by providing both the spatial data and the tools for its analysis Mennecke (2001) classifies the activities performed by GIS into four functions: (a) *Spatial imaging:* GIS ability to represent displays of spatially defined data and information (b) *Database management:* ability of GIS to store, manipulate, and provide access to data (c) Decision *modelling*: capability of GIS to be used to extend support for analysis and decision making and (d) D*esign and planning*: the potential of GIS to create, design, and plan. These functions of GIS can be applied to support decision-making in business operations. The following sections present a view of the broad range of applications of GIS in business.

GIS for Market Analysis, Segmentation, Targeting and Positioning

Demographic information about customers displayed with reference to spatial distribution, enables a better understanding of the requirements of people living in different neighbourhoods or city areas. This can be further supported with psychographic profiling or purchase and consumption patterns for specific products, thereby improving the choice of target markets and development of marketing efforts. For example, information about the location of heavy users of a product category, company's own brand, and competitors' brands can guide the focus of marketing activities.

Tapestry (ESRI 2009) is a geodemographic market segmentation system that classifies U.S. neighbourhoods into 65 market segments wherein neighbourhoods with the most similar features are grouped together, while neighbourhoods showing differing characteristics are separated. Cluster analysis is the basic approach used to create the market segmentation system. The 65 segments are further combined into 12 LifeMode groups based on lifestyle and life stage. Another method of combining the 65 segments based on the segments' geographic and physical features such as population density, size of city, location relative to a metropolitan area, and whether they are part of the economic and social center of a metropolitan area results in 11 Urbanization groups.

Lee and Fukui (2003) studied the relevance between market characteristics of the area and location of branches of five major banks in Tokyo. The study found a relationship between locations of the five banks and the demographic profile of the area and came to the conclusion that most of the banks studied had similar locational tendencies. Biswas (2006) reports on a software being developed by research agency ORG-Marg which will integrate the retailer profile, consumer demographics and consumption pattern databases with a geographic mapping system. This would result in a user-friendly Windows-based system that will put data, analysis, mapping and segmentation functionally on the desk of the marketing decision maker. Fan and Zhang (2009) undertook a study that incorporates spatial predicates describing the spatial relationships between customer locations and surrounding objects into customer attributes. They propose a new filtration algorithm that can select more relevant predicates from the huge amounts of spatial predicates than existing filtration algorithms. Next, as spatial predicates basically involve some uncertainties, a rough set-based spatial data classification algorithm was was developed to handle the uncertainties and therefore provide effective spatial data classification. Zhao (2000) reports on a technique based on rank correlation for analysing the relationship between the distribution of customers of motor vehicles and their background demographic characteristics with the help of GIS.

GIS to Guide Promotion

GIS can be used to study the reach of various media such as national and local newspapers and magazines etc. and to obtain a clearer picture of the extent to which various media vehicles are reaching out to different customer segments. Advertising budgets can be allocated for different regions based on growth targets in those regions, competitor promotional efforts, extent of untapped markets etc. Outdoor advertising companies can use GIS for representing demographic and other information about various locations.

In a paper entitled "GIS for Customer and Market Analytics", ESRI (2007), presents the case of Lamar Advertising, one of the largest outdoor advertising agencies in the United States, which used ArcWeb Services to develop multiple location maps for one proposal, incorporate demographic maps and help distinguish different advertising panels displayed on the map.

Direct mail firms use GIS to identify households that are likely to be more open to the products marketed by them (Korte, G. B. (2001). Cox Direct, a subsidiary of U.S.-based Cox Enterprises undertakes cooperative advertising for fast-moving consumer products, where multiple advertisers share the costs of the mailing, to over 30 million households several times a year. The address database available with the company is segmented based on demographic information (marital status, family size and age, income, education etc.) of members obtained from the U.S. Census Bureau. Clients prepare profiles of ideal customers with help from Cox Direct analysts. Addresses that best match these profiles are then identified for the purpose of direct mailing. IKEA employs geo-demographics to identify suitable areas for its catalogue distribution.

GIS can be employed for territory design, territory allocation and sales route planning. It can help to improve coverage of a territory and reduce the amount of time spent in travelling by salespersons while increasing the time spent with customers. Kuehn et al (1994) present a case study of how the overlay of customer locations with sales territory enables redesign of territories and thereby reveals the potential for major economies.

GIS and Location Based Services

Location Based Services (LBS) refer to services that use the capacity to determine and transmit the geographic location of an entity with the use of a mobile communication network. Several applications of LBS have been identified – some of which have been already implemented while work in the direction of implementing others is underway. Using LBS, a vehicle driver can identify the shortest route from his current location to a proposed destination. The best route to be taken so as to avoid traffic congestion can also be identified. A person could identify the location of restaurants serving certain kinds of cuisine and within a specified price band within a certain kilometre radius of his /her current location. The initiative of the location-based service could also stem from the marketer. When a potential customer comes within a certain radius of the service location, for example a restaurant or retail outlet, he/she may be sent a promotional message. Because of privacy issues, the customer must give permission, usually through subscription, for such messages. Similarly a travel and tourism service could use LBS to transmit information about each site that a tourist approaches and the message could be phased according to the part of the site where the tourist is currently.

Cheng et al (2005) view the architecture of the GIS as founded on the concept of a network consisting of a set of points (nodes) and a set of arcs where each branch connects a pair of nodes. A path in a

network is a sequence of connected arcs on condition that no node is repeated. If the exact distance in each arc is available, the total distance for each of the paths can be calculated. The GIS will identify the shortest path from one point to another by (a) locating the nodes in a map, (b) measuring the distance of each arc, (c) measuring the distance of each path by combining the distances of the connected arcs for each path, and (d) making a comparison of the paths to identify the shortest path.

In its paper entitled "GIS for Customer and Market Analytics", ESRI (2007), present the case of the American Suzuki Motor Corporation (ASMC) using the ArcWeb Services. ASMC's dealer locations can be identified on the company's website. When a visitor to the website types in a Zip code the service returns a list of the company's dealers within a 50-mile radius. Dynamic map displays and driving directions are also provided

Use of GIS by Insurance Firms

Insurance firms employ GIS in several areas such as predicting and modelling catastrophes, avoiding concentration of policies in high-risk areas, determining the amount of risk through reinsurance and helping in the pricing of policies. GIS is used for studying earthquake-prone areas, flood-prone areas and other such natural risk factors. Similarly, analysis can be made in terms of accident frequencies, crime rates, etc. These analyses are used for calculating the risk of insurance. According to Morton (2002), there is frequently a relationship between spatial location and insurance risk and the insurance sector needs to make greater use of spatial analysis techniques.

Osmet (2007) reports on Royal & SunAlliance's, pioneering integration of ArcGIS Desktop and ArcGIS Server technology with core business processes. The company is using GIS technology for validation and geocoding, to make peril risk assessments, and to support risk accumulation management. As a first in the Indian insurance industry, ICICI Lombard has used GIS for risk management. Identification of areas with high population density, a large concentration of rented property and demographic profiling based on census data can help insurers in decisions regarding underwriting of

property for fire, burglary and other types of insurance through predictive modelling (Mishra, S. (2006)).

GIS in Retail Management

As underscored in a report by Infiniti Research Limited (2009) with the availability of GIS, geo-marketing is increasingly becoming a basic part for the decision making process for retailers. Organizations are beginning to use GIS software to match their marketing efforts with the needs of specific sets of customers; thus, maximizing the effectiveness of sales. Some of the several uses of GIS in retail management are presented below:

Trade area analysis: GIS is used to identify the primary trade area, secondary trade area and fringe area from where a particular market/ shopping centre/outlet draws its customers. Greene and Stager (2005) present the results of a case study, which demonstrates the use of GIS for the application of Huff's probability model for approximating the attendance of three popular opera houses in Chicago, USA. The authors developed probability contours estimating the likelihood of a opera house drawing customers from a specific area. The study used the seating capacity of the opera houses as an attraction index. More refined parameters for attraction could be developed using the quality of performance, the price of a seat etc. In a study reported by Murad (2009) the Al-Hijaz shopping centre in the northern region of Jeddah was chosen for the analysis of its retail customers. ArcGIS software was used for data processing by the retail planners of this centre in evaluating the current retail market and identifying the possibilities for expansion. Several GIS functions and tools, such as address geocoding, feature query and identification, proximity and overlay analysis, were used.

Site analysis*:* Location decisions can be facilitated as various site options can be evaluated with regard to their socio-economic statistics for the potential they offer. Marks and Spencer, the British retailer, has been employing GIS for gravity modelling and for evaluating new retail locations (Sherwood-Bryan, N. (1994)). A number of fast-food chains such as the U.S.-based Burger King have been using GIS for the appointment of franchisees and demographic profiling (Battista, C.

(1995)). Information about areas where a retail stores' customers live can be used to identify other "analogous" neighbourhoods.

Cheng et al(2005) demonstrate the use of a GIS in the selection of the location for a shopping mall. Spatial (geographical) and non-spatial (market-oriented) data is combined to construct visualized information that can be easily understood and analyzed by decision makers. Queries are then created to find optimal solutions for four location problems: minimum distance, maximum demand coverage, maximum incomes coverage, and optimal centre. Cheng et al (2005) developed five basic layers for project: (i) a map of the city (ii) a layer representing the average monthly demand information covered in areas. (iii) a layer representing the household incomes information. (iv) a layer covering the potential sites of the super mall. (v) a layer indicating locations for eight existing super malls, which were selected based on four criteria: number of shops, variety of shops (degree of functionality), rental fee, and number of shoppers (daily average).

Retail loyalty programmes*:* Data from loyalty programmes can be linked to geo-demographic and lifestyle data and other aspects of consumer behaviour. Allaway et al (2005) report on the insights provided by the spatial analysis of the adoption of a retail loyalty program. The study found a relationship between the likelihood of adoption and the distance between the store and the place of residence, as well as proximity to consumers who were Innovators- had adopted the program within the first two days- and distance from billboards. Distinct spatial diffusion stages with regard to adoption of an innovation by consumers were identified. McDonald's and other fast-food chains use GIS to plan for and locate new franchises as well as company owned stores.

GIS in Logistics and Vehicle Routing Applications

A number of specific GIS tools are available in the area of transportation, logistics, and vehicle routing. These tools include vehicle routing and navigation systems, intelligent vehicle highway systems and dispatch systems. Global Positioning Systems are being used for route analysis and for identifying the location of trucks in real time. For example, ESRI's ArcLogistics Route has a routing and manifest generation capability, which makes it possible to generate a route keeping various parameters such as time, travel distance, drop-off schedules in view. Other factors that can be included in drawing up routing plan are vehicle capacity, vehicle fixed and running costs, varying requirements of volume and frequency of replenishment of different outlets. Similarly, with the availability of real time traffic

monitoring systems, it would be possible to modify the appropriate route to be taken by the vehicle. The United States Parcel Services, for example, is using GPS to monitor the movement of fleet vehicles. Similarly, Federal Express employs GIS for tracking packages along their routes.

Application of GIS for by Banks

First Magnus of U.S.A. has used its understanding of the relationship between geography and business growth to provide better service to its customers (Gaylord, 2007). For example, First Magnus, set the goal of providing branches and/or satellites within a 10-minute driving distance from the primary population areas in a city. It also wanted to identify branches that generated most of its business from customers located beyond a 10-minute driving distance.. ESRI BusinessMAP was used. After a geocoding of its branches, a drive-time zone showing the number of households that can visit each branch with in a certain time (e.g. 5 or 10 minutes) was created. Loans were then geocoded on the basis of their property address, thereby enabling management to visualize how branches are located with respect to these addresses and to identify areas that were not included in any of the branches' drive-time regions. Maps displaying loan originations, location of alternate branches in the area, and housing density provided the justification for closing high-cost but low-volume branches.

Panigrahi et al (2003) report a case study illustrating the use of GIS in the banking sector. A zonal and road network map of Chennai city was prepared and the banks various branches and ATMs were located. The addresses of the bank’s customers, classified as loanees or account holders were geocoded. The subsequent analysis was used by the concerned bank to locate current defaulters, identify areas which had a concentration of certain types of defaulters and develop a route plan for collection officers that presented the shortest distance through which maximum number of defaulters could be visited. GIS could be employed to identify suitable locations for ATMS and collection boxes, develop demographic profiles of the different types of defaulters and use these analyses to identify potential defaulters.

GIS for Study of Labour Markets

GIS can be used to analyse the composition of the labour market in a specific geographic region. Greene and Stager (2005) have presented a case study of the application of GIS to analysing an urban market's industrial specialization in USA. The authors use the concept of a *location quotient* to indicate the share of employment in a specific industry in a particular sub-area as a percentage of the share of employment in the same industry in a larger region. The study found that, with a few exceptions, manufacturing and professional services tend to complement each other- that is, in sub-areas where one has higher concentration, the other has lower concentration. Forstall and Greene (1999) had found similar results. Insights such as these would be useful to organizations in assessing availability and cost of labour and thus as factor in evaluating location alternatives.

GIS for Rural Marketing

GIS is being used for planning and implementation of rural marketing efforts at various levels. Amanna and Raina (2003) report on GIS application for rural marketing and sales in India. GIS facilitates the identification of uncovered markets, charting route plans for delivery to wholesale/retail outlets development of campaigns based on available road information and demographic data and ensuring the coverage of congregations such as mandis, *haats* and *melas*. The application comprises of three modules: Market Analysis which is aimed at identification of potential markets, Route Design aimed at route planning for maximizing coverage, and Data Updating for future expansion. The MICA Rural Market Ratings is a marketing tool developed by the Mudra Institute of Communications, Ahmedabad in collaboration with ML Infomap Pvt. Ltd. (Lahiri, M. (2006)). This includes maps which indicate the rural market potential of all districts in India and also provides information such as location of rural *haats*, *mandis* etc.

Hurdles in GIS Use in India

The application of GIS by business organizations in India is on the increase. However, a number of issues need to be addressed to enable

more widespread and effective utilization of GIS in the Indian context. According to Preethi (2007), India has not been able to capitalize on the developments in spatial analysis as compared to other countries. It is mainly the dearth of sufficient and clear geographic data, which is holding the industry back, even as the demand is on the increase.

Problem with the Address System in India

There is no uniform pattern of address formation in the country. Each city, town, or locality has its own method of formulating addresses, most of which are not compatible with international address matching tools.

Availability, Accuracy and Currency of Spatial Data

A typical GIS application may rely on data from several sources. In India, a number of agencies are involved in primary data creation used in GIS such as national mapping agencies like Survey of India, National Bureau of Soil Survey & Land Use Planning, Geological Survey of India and Forest Survey of India. Also involved are agencies providing satellite data, such as NRSA, Space Imaging, and Earth Watch. Issues such as non-availability of digital data from Survey of India (SOI), legal implication related to SOI map digitisation and non-availability of maps on scale larger than 1:25,000 in a number of cases have been mentioned as problems related to creation of GIS applications in India (Munshi, K., 2000). A related issue is that of accuracy and currency of data. The available data may have not been updated since some time and as a result, developments such as new roads and buildings may not have been included.

However, the imminent clearance of about 4,800 maps by the Government of India so that they would be available in the public domain is a major step in the direction of enhanced data availability. According to Rao (2007), Survey of India is now able to complete the process of updating of maps in keeping with ground reality. In February 2007, the Defence Ministry of India has cleared about 1,600 Survey of India maps. Within the span of the forthcoming five years, a large part of the country will be mapped in 1:10,000 scale. Data on forests, ground water, roads, population characteristics and municipal

plans will be superimposed on these maps as also data available on rainfall, crop patterns and flooding. This ambitious project will be undertaken by the National Spatial Data Infrastructure Mission, which will serve as an online database to maintain such data layers and base maps. Public-private partnerships will be used for commercial applications.

Availability of General Business Data

The lack of availability of general business data such as demographic and consumption patterns for various products is also a challenge. The wider availability of census data including it geographic dimensions would contribute immensely towards furthering the application of GIS for marketing and business purposes. Detailed maps and data such as consumer demographics at the micro level, household ownership of durable goods such as cars, consumption patterns at the household level etc. need to be developed.

Awareness and Training for GIS

The human aspect of GIS has to be given due attention. The ultimate users of this decision-support tool need to be trained to understand GIS and its potential. Even the most advanced technology needs people to understand and use it. For a business organization to use GIS for its specific decision-making, it may be necessary to make customized inputs to a general database. Acquisition of customized data would involve costs and it is necessary that the decision makers can understand the potential contribution of GIS to their business.

Introduction of GIS education in business school curricula would help to familiarize a large number of business students with the concept of spatial analysis and the tools available. The first step would be making the hardware, software and mapping data available in the business schools and training the faculty on GIS application and usage. As evident from the above discussion, GIS can be used in a range of areas including marketing, finance, economics, and management information systems. The business school faculty would be encouraged to include spatial analysis in their study. This would promote academic research in the various aspects of GIS implementation, management

and impact. The faculty, in turn, would be able to convey the benefits, usage and training for GIS to business students. For example, user-friendly software is available which enables students to undertake basic marketing projects by applying their own data. During their careers in the corporate world, these students would be able to understand and apply relevant spatial analysis in their sphere of activity. This should contribute in a significant measure to the adoption of spatial thinking by business. Business schools could also collaborate with industry to organize workshops to impart awareness and/or training for executives and managers.

Conclusion

Business organizations can benefit tremendously from geo-referencing their decision-making processes. This paper has highlighted areas where GIS can be used to improve business plans and operations. Organizations need to establish a plan of action for integrating spatial data analysis into their activities. Based on the size of operations and financial resources available, a budget and personnel would have to be devoted towards this end. Appropriate training at various levels within the organization would be required. There is also a call to the various agencies involved to work towards improving the availability, accuracy and currency of spatial data. As GIS finds new applications in business and its usage increases, this will support further research and innovation in the area, thereby fuelling a virtuous cycle. The introduction of GIS education in business school curricula and increase in scholarly research in the area would contribute to the appreciation and adoption of GIS by business decision-makers.

References

Amanna, V. and Raina, S. (2003) "GIS for Rural Marketing." www.*GISdevelopment.net*.

Allaway, A. W., Murphy, L. D. and Berkowitz, D. K. (2005), "The Geographical Edge: Spatial Analysis of Retail Loyalty Program Adoption." James B. Pick (Ed.) *GIS in Business*, Idea Group Publishing, Hershey PA, pp 260-277.

Bradford, G. (1995), "Targeting Technology". *Admap*, January, pp 32-4.

Battista, C**.** (1995) "Competition in the Food Chain." *Business Geographics*, 33, pp 32-34.

Biswas, A (2006), "Geo market segmentation and GIS", *www.gisdevelopment.net/application/ business/i index.htm* .

Cheng, E.D.W.,Li , H. and Yu, L.(2005), "A GIS Approach to Shopping Mall Location Selection", http://www.sciencedirect.com/science_ob=ArticleURL&_udi

ESRI (2007), " GIS for Customer and Market Analytics", February, http://www.esri.com/showcase/ best-practices/index.html.

ESRI White Paper (2009), 2009 Methodology Statement: ESRI® Data—Tapestry™ Segmentation for Block Groups and ZIP+4s, http://www.esri.com/library/whitepapers/pdfs/esri-data-tapestry-segmentation.pdf

Fan, B. And Zhang, P. (2009) Spatially Enabled Customer Segmentation Using a Data Classification Method with Uncertain Predicates, *Decision Support Systems* Volume 47 , Issue 4 November, pp 343-353

Forstall, R. L., and Greene R.P. (1997), "Defining Job Concentrations: The Los Angles Case." *Urban Geography*, 18, pp 705-739.

Gaylord, M. (2007), http://www.esri.com/news/arcwatch/0507/first-magnus.html

Greene, Richard P and Stager, John C. (2005),"Techniques and Methods of GIS for Business." in James B. Pick Edited *GIS in Business*, Idea Group Publishing, pp 37-55.

Goodchild, M.F. (1991), "Geographic Information Systems." *Journal of Retailing*, Spring, Vol. 67 No 1, pp 3-15.

Infiniti Research Limited (2009) *Geographic Information System (GIS) Market in Retail Sector 2008-2012,*

Jones, K., and Pearce, M. (1999) "The Geography of Markets: Spatial Analysis for Retailers." *Ivey Business Journal*, March/ April, pp 66-70.

Lee, Young Joo and Fukui, Hiromichi (2003), "Identifying the Relationship Between Area Characteristics by Social Class and Bank Branches Distribution using GIS - A Case Study of Tokyo 23 Wards" *www. GISdevelopment. net.*

Korte, George B. (2001), *The GIS Book*, 5th Ed., On Word Press, Thomson Learning. Singapore, pp 139-154.

Kuhen, Alferd A., Melone, Nancy Paule, McGuire Timothy W. and Penninti, Vivekanand R. (2004), "High-Value PC-Based GIS Applications in Business." in *Proceedings of the Twenty-Seventh Annual Hawaii Conference on System Science.*

Lahiri, M. (2006), "MICA Rural Market Ratings."
www.gisdevelopment.net/application/business/ index.htm .

Mennecke, B. E (2000), "Understanding the Role of Geographic Information Technologies in Business: Applications and Research Directions." *Journal of Geographic Analysis and Decision Analysis*, Vol. 1, No. 1, pp 44-68.

Mennecke, B. E., Crossland, M.D., and Killingsworth, B. L. (2000), "Is A Map More than A = Picture? The Role of SDSS Technology, Subject Characteristics, and Problem Complexity
on Map Reading and Problem Solving." *MIS Quarterly*, 24 (4), pp 601- 629.

Mishra, Subash (2006), "People's Data to People's Advantage- GIS Way" *GIS Development Asia Pacific,* December, Vol. 10, Issue 12, pp 22-23.

Morton, K. (2002), "Mapping not-at-Home Risks" *Canadian Insurance*, 107 (12), pp 8-10.

K. Munshi, (2000) "Consumer-driven Changes in the GIS Market" *www.gisdevelopment.net/ application/ business/index.htm* .

Murad, A. A. (2009) "Using Customers Data for Defining Retail Market Size: a GIS Approach", *International Journal of Business Information Systems,* Volume 4, Number 3 **,** pp 340-359.

Panigrahi, P K Sagar, V. P. and Rajesh, P. R. (2003), "GIS – Tool for Simplifying the Collection Management System in Banks and Financial Service Organizations." *www.gisdevelopment.net/application/business/index.htm* .

Preethi J(2007), "Mapping industry yet to mature here", Business Line, March 27,p 2.

Rao, M. Gopal (2007), *GIS Development Asia Pacific*, December, Vol. 10, Issue 12, pp 195.

Richards, J., (2006), "Making Business Sense of Geographic Information", *Computer Weekly.com,* 14 December, http://www.computerweekly.com/Articles/2006/12/14/220666/.

Sherwood-Bryan, N. (1994), "Marks and Spencer Maps it Out." *Business Geographics*, 2.3, Pp 36-37.

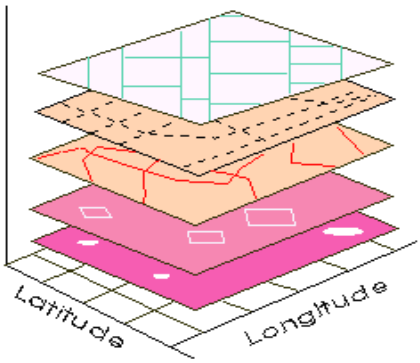
Subramanium, P, and Narayan V. L. (2006) "Applying Geographical Information Systems in Telecommunications"

http://www.infosys.com/industries/communication/white-papers/gis-paper.pdf

The Times of India (2007), *Times News Network*, 19 February, p 1.

Zhao, L., (2000), "Integrating Rank Correlation Techniques with GIS for Marketing Analysis", Paper presented at *GeoComputation 2000 Conference*.

FIGURE I: GIS- MULTIPLE LAYERS
OF THEMATIC MAPS



Sales territories
Demographic data
Census tracts
Street networks
Topography

TABLE 1: SOME APPLICATIONS OF GIS IN BUSINESS

Modelling demographic & psychographic information
Competitor analysis
Market segmentation
Analyzing parcels of land
Asset management
Risk analysis
Dealer network analysis
Territory design and sales force management
Transportation and distributor analysis
Retail, plant or warehouse location decisions
Advertising decisions
Sales promotion planning
Customer conversion and lost customer analysis
Market research planning