GEOGRAPHIC INFORMATION SYSTEMS: A TECHNOLOGY FOR BUSINESS DECISION-MAKING

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Abstract

Geographic Information Systems (GIS) is a powerful technology that allows for spatial and statistical analysis of many issues that are pertinent to business decision-making. In particular, GIS can facilitate unit location in relation to local and regional demographics, allocation of sales territories given a spatially distributed client or customer base, and optimal location of distribution facilities or design of delivery routes. With respect to competition between potential units and existing units of the same or competing companies, GIS is being incorporated into the decision making process by a number of international retailers. This paper provides insights into the ways in which GIS can be employed by many businesses and discusses current and potential analysis methods and their strengths and limitations. Sources of additional information related to GIS are also provided for those wishing to learn more about the technology. Overall, GIS offers businesses a powerful tool for analysis of a range of crucial issues. Increasing use of this technology is to be expected and dissemination of information related to GIS is desirable in order to promote adoption and appropriate use of GIS by the business community.

1.Introduction

Geographic Information Systems (GIS) is a term applied to a suite of computer programs designed to facilitate input, storage, manipulation, and analysis of spatial data and related attribute data and production of maps, reports and statistical output (Burough 1986). GIS have been in use since the mid 1960's (Tomlinson, Calkins, and Marble 1976). The most common applications of this technology have been in natural resource management (by forestry and water resources management agencies), in infrastructure and facilities management, in land records management, and by property appraisal districts. More recently, many public utilities and municipal governments have embraced the technology (Goodchild 1991; Estes 1995). GIS is being applied in thousands of disparate ways, from mapping crime incident locations to tracking nuclear submarines (GIS World 1996).

Applications in business decision-making and market research have been recent phenomena. According to Goodchild (1991, p. 3), "Given the importance of location in marketing, it is perhaps surprising that there has been so little discussion of GIS in the market research literature." Previously, much of the analysis was conducted by large organizations and specialized consulting firms, which developed the specialty term *geodemographics* (i.e., combining geographic and demographic analysis for market research). The availability of lower cost software and vastly more powerful and inexpensive hardware has prompted increased application of GIS by smaller firms worldwide. In the U.S., these factors coupled with availability of standardized nationwide data and improved methods for building GIS data bases, particularly geo-coding the spatial locations of customers, has led to a proliferation of GIS use in business applications. Presently, two distinct groups primarily use GIS. On one hand, large organizations (e.g., McDonald's, Texaco, Ford Motor Company, Coca-Cola, Ace Hardware Corporation, and Gold's Gym Inc.) are using GIS to study optimal location of outlets and allocation of territories to distributors and help improve marketing, customer service, and manage their assets. Conversely, specialized consulting firms (e.g., Thompson & Associates and Business Location Research) conduct GIS-based analyses for all large, medium, and small enterprises (Rando 1998). Most types of analyses utilize the spatial and database analysis capabilities standard in commonly used GIS packages. However, the analysis may also employ data specifically gathered for the study and/or use of specialized algorithms programmed into the GIS.

2. GIS Data & Spatial Analysis Tools

The availability of the data, developed by the U.S. Census Bureau, has been a particularly important factor in GIS proliferation and adoption by businesses in the U.S. (Martin 1996; *www.census.gov/geo/www/TIGER/index.html*). The Topologically Integrated Geographic Encoding and Referencing System (TIGER) data set is used with commercial PC-based GIS packages (e.g., MapInfo and ARCVIEW), in business location analysis, in territory allocation studies, in efforts to identify target populations for facility location, in market segmentation studies, in advertising, and in targeting direct mail (ESRI 1997; Francica 1997). The TIGER data set relates census demographics (e.g., age, income, and education) with geographic subdivision boundaries (e.g., zip code zones, census tracts, county and city boundaries). TIGER also contains all

streets in the U.S. with address ranges and a topological structure that facilitates "geo-coding" of customer (or any other) street address. Geocoding is the term that refers to taking a text street address and converting it into a geographic coordinate that can then be displayed as a feature (typically a point symbol) at the corresponding location in the GIS. PC-based GIS packages, some of which cost as little as US$250, along with easy to access data of Metropolitan Statistical Areas (MSAs) and/or counties on CD-ROMs, low cost plotters, and computers, have rendered GIS-based spatial analysis a financially feasible approach for any size business.

Outside the U.S., national geo-demographic and infrastructure data sets are available for many developed countries including Australia, Austria, Canada,, France, Germany, Holland, Norway, Sweden, Singapore and the United Kingdom. For example in Switzerland geodemographic data is available for 100 meter grids for the entire country this data is referred to as GEOSTAT and is produced by the Federal Office of Statistics (Din , 1996) In the United Kingdom, Germany and other northern European countries less precise geo-demographic data is available but links between the infrastructure and cadastral GIS being developed in many countries and census data is evolving. Outside these areas, availability of geo-demographic data sets is sporadic, although the United Nations is working through UNESCO to assemble available data worldwide as part of the Global Resource Information Database (GRID) Project (GIS World, 1996).

View and Query

Examples of standard spatial analysis functions used in the study of business application include, at the most basic level, spatially driven *view and query* of locations coupled with analysis of associated *attribute* (descriptive and statistical) data. For example, a map of a portion of a MSA with major features and transportation routes (typically surface streets possibly categorized with data on traffic densities) would be viewed along with the locations of all restaurants. The GIS data would be queried to identify all fast food outlets serving hamburgers and these would be highlighted, typically by changing the color with which they were represented. All related attribute data (such as sales) for the selected restaurants would be available for further query and analysis. A common use of the view and query function is to help understand the geographic extent and spatial factors affecting trade areas (Patterson 1997).

Buffer-zone Generation

A more sophisticated analysis would employ the *buffer zone generation* function in the GIS to create a *region of interest* (i.e., a zone extending a specified distance from a feature or features of interest). All features falling within this region of interest would then be identified. Both features (units) within the zone or outside the zone can be easily determined. For example, a buffer zone five miles in radius could be generated around all dry cleaning establishments within a region. The areas not currently within five miles of a dry cleaner would be readily identified. Thus, potentially under served areas could be identified. The simple case of a circle with a given radius extending out from a point feature representing a unit location can be easily generated. A more sophisticated buffer zone can also be generated by either using city-block distances ("Manhattan" distance) or travel times to determine all areas within 20 minutes of a given set of features rather than a simple fixed distance. The latter variation requires that data on average speeds and connectivity of streets (e.g., the existence of one-way streets and non-connecting overpasses) be present in the representation of the street network stored in the GIS (DeMers 1997). A variant of buffer zone generation has been incorporated into the latest release of the ARCVIEW Business Analyst module from ESRI. This function takes scattered customer location data and generates a statistically derived envelope that encloses a user-specified proportion of all probable customers. This shrink-wrapped polygon, which indicates the trade areas from which most customers are likely to come, can facilitate advertising and locational decisions (ESRI, 1999).

Polygon Overlay

Another important standard function of commercial GIS packages is *polygon overlay*. In this function, data about a variety of themes is stored in separate co-registered layers (sometimes referred to as *levels, coverages*, or *themes*). These layers can be overlaid and the intersection and proximity of features in one layer can be compared with the corresponding feature in other layers. A typical example would involve a GIS that contained transportation information, location of an actual store, proposed locations for a new store, and demographic data of the region, each stored in separate layers (i.e., four layers in total). As illustrated in the pervious example, store locations (points) could be overlaid on the street network (lines), which could be overlaid by the polygonal areas representing census tracts, block groups, or zip code zones. Analysis of the combined data would then be feasible. For example, the average income of the residents in all census tracts through which the arterial street passing by the location of an existing unit could be readily determined (ESRI 1997).

Trade Area Determination

The demographics of areas within a specified distance or travel time or the demographics of under-served areas, could be analyzed and statistically tabulated. For example, the average income for all census block groups within five miles of a dozen potential locations that are currently under served by competing stores, could be readily identified. Demographic data can also be analyzed in a step-wise fashion by adding additional polygons to a region of interest by linking contiguous areas together. Thus, an area within a travel time of given region of a community can be constructed and the demographics of the areas constituting this new zone can be combined and analyzed. For example, a region containing 200,000 people can be assembled that is approximately 45 minutes from a potential store location. The demographics of this zone (which may

contain many tracts) can then be analyzed. It is even possible to allocate population within a census tract or zip code of an area falling within a zone and outside a zone. Because TIGER data is available for the entire U.S., the limitations of using data solely associated with MSAs can be overcome and new regional groupings can be created that cross state boundaries and take into account economic, cultural, social, physiographic issues and/or incorporate larger or smaller trade areas. For example, a region composed of Dallas, Houston, Austin, and San Antonio, could be created and then analyzed as a whole (i.e., target market). Smaller trade areas that occupy less than a whole census tract or cut across census tract boundaries can also be assembled. This can be accomplished by using block group and even block level data or by assuming an average population density and performing the allocation based on the portioning of the area of the tract falling inside and outside the prescribed zone(s) (Faintich 1996).

Determination of trade areas is one of the most promising business applications of GIS. By mapping customer locations, the spatial distribution of customers can be determined. Furthermore, by analysis of the related attribute data dealing with buying patterns, magnitude of sales, and customer demographics, it is possible to develop profiles of the characteristics of customers and help define existing trade areas. Once trade areas have been delineated and characterized, they can be examined to determine marketing and service delivery strategies. For example, if most customers come from a particular community, then promotional efforts can be better targeted on maintaining the locality and increasing the penetration into this community. Conversely, the information about the dominance of one community or geographic area in accounting for current customers could indicate that to expand, marketing efforts should be targeted at customers in surrounding communities. The decision of which interpretation to select in this case could be guided by analyzing the demographics of each community or region with TIGER data. If the demographic data indicate that the existing community has relatively few new potential customers, then expansion will require catering to more far-flung customers. Alternatively, if analysis of the demographic data shows that there are many new potential customers within the community from which most current customers are drawn, then further efforts within that more spatially limited area will likely be more effective (Patterson 1997).

Trade area delineation can also help firms understand the distances their customers are willing to travel, which can help firms decide whether to grow market share by either (1) running some type of promotional activity or the like to lure additional customers, or (2) opening a new unit. Understanding the trade area is also important for firms that deliver services to their customers. If the bulk of customers are within a limited distance of the firm's office, then abandoning efforts to cater to the few outlying customers may be cost effective because travel times to render service to these customers are frequently not recovered in higher fees. Conversely, if despite limited efforts to target an outlying group of customers, significant business is obtained from this distant area, then additional promotional efforts and/or establishment of a unit or service dispatch location closer to these customers may be warranted. Regardless, knowing the spatial extent of customers, the attributes of customers, and the demographics of the region, can help to target marketing efforts and streamline the delivery of services (Thrall 1996).

The demographic data available from the U.S. Census Bureau or corresponding governmental entities in other countries can be supplemented with information on customer profiles, purchasing habits, or other customer specific data. For example, many large retailers (e.g., Radio Shack, Toys "R" Us, and Service Merchandise) track the zip codes (mailing zones) and/or telephone numbers of all customers and map this with information on store locations and demographics of the areas from which their customers are drawn. Databases on consumer credit, business locations and characteristics, and consumer buying patterns and preferences are also available. These databases are frequently linked and analyzed using GIS (Thrall and Del Valle 1996).

Advanced Approaches

More sophisticated types of GIS analysis depend on the use of specialized applications software capable of *network analysis* and/or *spatial optimization*. The former type of analysis typically involves finding the shortest path through an interconnected network, usually representing streets. The network analysis software can account for travel times, capacities, and information on volume of travel on a given transportation artery (Lupien 1987). Network modeling has been used along with GIS to route delivery vehicles (e.g., FedEx, UPS), buses (e.g., transit districts, Independent School Districts), garbage trucks, emergency response routing of fire trucks, ambulances and police cars.

Business applications of network analysis/routing models are increasing dramatically, particularly for trucking and delivery of in-home services (Dinkler 1997). Networking software can be used to determine the aggregate travel time for all persons living within a sales territory or trade area defined by a distance or by the boundaries of a city or region to a potential retail outlet. For example, Sears, Roebuck and Co. uses GIS along with network modeling to route and coordinate home repair and appliance installation services. The Sears application has recently been incorporated in a routing analysis product by ESRI for use with ARCVIEW and ARCVIEW business analyst products.

Spatial optimization is a special form of the mathematical optimization technique employed in the operations research context for decades. Typically, spatial optimization relies on GIS with imbedded algorithms (e.g., the simplex algorithms) to optimally locate facilities and/or allocate territories given an objective function and constraint(s) that can be weighted. This approach has been extensively used to locate infrastructure (e.g., roads, pipelines) or facilities (e.g., substations, road maintenance centers) or manage the extraction of natural resources. Business applications of GIS linked to spatial optimization programs for location/allocation analysis has been available for over a decade. These applications have been

increasing, particularly for large retail outlets (e.g., Wal-Mart, Home Depot) (Goodchild 1984). Because spatial optimization is complex and requires much site-specific data, it is rarely used in current business applications, although the potential for this approach–for example, in selecting among multiple potential locations for a unit, given a variety of factors–is high.

Geocoding

In order to identify the location of customers patronizing a given business, various methods are available. If a database of mailing addresses is available those can be geo-coded. If phone numbers are available, digital information on dialing zone boundaries are frequently available although they are likely to be somewhat costly.

Another alternative for businesses with many casual customers or those dealing in cash transactions in part or in whole is to use a survey instrument. Frequently these surveys also ask questions about buying habits and preferences. It is also possible to relate the survey response to a particular purchase (which may or may not be representative of more general buying activity). Eliciting customer names and addresses can be problematic however. Frequently customers are reluctant to divulge what they regard as private information in a voluntary survey.

Geocoding street addresses and interpolating locations from beginning and ending address ranges is problematic in rural areas and time consuming. Geocoding customer information by zip codes or telephone numbers is of limited accuracy since the zones may contain several thousand residents. Use of a regular grid to locate customers is an option that is used is survey driven customer mapping. Interestingly it is also an option in Switzerland, which has demographic data or a national 100-meter grid. This allows Swiss market researchers to determine characteristics such as primary language for each 100-meter cell or group of cells in the entire nation, no other nation has such a precise geo-demographic data set. An alternative frequently used in GIS studies is to supply the customer with a map which has a grid overlay and have the survey respondent indicate which grid cell they live and/or work in. This grid map has the advantage that Geocoding this data is very easy. This approach is extensively used in the fast food franchising industry because most customers are casual and often employ cash and also because the vast majority of customers have only traveled a short distance to purchase their meal. A hierarchy of the distances customers are generally willing to travel to obtain various types of fast food has even been derived by GIS analysts working for the fast food industry (people will travel much farther to get a pizza than a hamburger) (Orton, 1998).

The use of a grid map to geo-code customer locations is only one option. To geo-code customer locations, zip code information or street address information can be used with built-in utilities in most commercial GIS packages (Culpepper and Johnson 1998). However, zip code zones are too large for studies of fast-food customers, as these zones may contain entire communities. Instead, zip code plus four data can be used to track such customers (e.g., mail order customers and business from other firms) (Wendelken, 1996). Unfortunately, most consumers are generally ignorant of this more specific information, just as they are ignorant of their census track or residential block group. Street addresses can be readily geo-coded, using TIGER data, with tools built into all commercial GIS packages (Johnson 1998). However, customers' locations are determined/approximated by interpolation, using the beginning and ending street address for each block. Thus, in rural areas where blocks are long and population density is not uniform, this method is inaccurate. A host of other problems affect geo-coding street addresses, including that street addresses may not be readily divulged by casual customers, geo-coding of street addresses is problematic in rapidly growing areas, and addresses are more laborious to keypunch than grid coordinates (Lam 1983). Therefore, as a practical matter, either a zip code, a phone number code, or a grid map coordinate, is likely to be more convenient for geo-coding.

3. Management Of GIS

GIS poses an unusual problem for business information systems professionals. In general, these professionals have had little or no exposure to the technology in universities, trade schools, or in their previous professional careers. Certain aspects of GIS such as the management of attribute data and/or creation of relational data base schema that are then linked to the geographic elements of the GIS poses no particular challenge. However, concepts such as coordinate systems map projections, scale orientation, and the whole field of cartographic design is *terra incognito* to a typical CEO or information systems professional. Likewise, many of the spatial analysis functions in GIS are not feasible in any other system and hence pose a difficult learning curve. Thus, the process of development and implementation of GIS in many organizations can suffer if it is treated as just another database application. Partially as a consequence, many organizations end up positioning GIS as a separate function within the organizational structure. In many other organizations, someone such as a market researcher, develops an aptitude for the use of the technology and may end up becoming a *de facto* GIS analyst (Montgomery , 1989). The overall process of planning, executing, and controlling GIS is relatively straightforward, as long as a digital base map structured to allow geo-coding of customer addresses exists. Frequently specialized consulting firms are available that can build this base-map if it is absent. Acquisition of appropriate hardware and software depends of the scale of the application, but for a fully functional system an investment of less than US$10,000 is sufficient. Personnel selection and training poses a larger challenge for many organizations. A frequent mistake is to assume that GIS is a clerical function and attempt to retrain existing data entry staff. This rarely works, as this is not simply a spreadsheet with a slightly different flavor. A prudent alternative is to recruit one or more of the increasing crop of college graduates from the earth and environmental science disciplines and then imparting the necessary business related knowledge, skills, and abilities. Alternatively, many engineers and technical staff that have been sidelined due to changes in technology can often be retrained using a combination of classes in the technology from local universities/colleges and/or vendor provided training. Vendor provided training is

highly specific to that vendor's product and will generally not cover applications related to the particular firm. Therefore, significant time working with the software and knowledge of the firms unique needs should be anticipated in addition to the vendor provided classes (NCGIA, 1989). Recently the Internet has been a good source of training materials also.

4. Business Application Of GIS By Multi-National Corporations

While many Multi-National Corporations (MNCs) have been long-term users of GIS, nevertheless they are probably behind national and state governments. One industry that has been in the forefront of GIS adoption is the public utility companies. Both mapping and management of built infrastructure often referred to under the rubric of AM/FM (Automated Mapping/Facilities Management) has been a mainstay of the electrical and to a lesser extent the natural gas and water supply utility companies for over a decade. For example, Reliant Energy of Houston Texas, Sidney Power in Australia, and Ontario Hydro in Canada use GIS technology to maintain data on location, capacity, expansion, connectivity, and maintenance of facilities (ESRI, 1995). For example, Seattle Power generates maps of all customer outages, following storm events to help locate line breaks and most rapidly re-establish power. Being able to identify the characteristics of every transformer, switch, etc. and to check to see if that component is in inventory prior to dispatching a service crew saves time, effort, and greatly speeds recovery from major disruptions such as hurricanes or ice storms (Lang, 1989).

MNCs that are long time GIS users are those in the extractive industries such as energy exploration and production, mining, and forest products. For example, Royal Dutch Shell is using GIS in a myriad of areas from helping to provide base maps for display of seismic data, to maintaining inventory on location and characteristics of drilling rigs and oil and gas leases, and to study of gas station locations in relation to traffic volumes. Other Applications at Shell include, environmental restoration projects in Nigeria, development of the land-base, well locations, and pipeline routes (GIS World Magazine, 1990). Extractive industries using GIS include, forest product companies such as Champion International, International Paper, Louisiana Pacific, and International Paper and Northern Paper (Berry, 1991). These firms use GIS to maintain data on their land-holdings and optimize timber harvesting. At the same time, GIS allows the timber comp any's to minimize the negative environmental impacts of haul roads and erosion from harvest areas. Polygon overlay of layers of slope, soil, and stand information can be used to limit harvesting in areas subject to high rates of erosion. Likewise, buffer-zone generation can be used to designate areas near roads or streams to be left undisturbed as buffer strips. Use of Global Position System (GPS) technology in conjunction with GIS greatly facilitates determination of the correspondence between zones determined with GIS and actual locations on the ground in remote areas. Another perhaps somewhat surprising advantage of GIS for forestry and other extractive industries is that by clearly delineating areas that are protected or may have less valuable resources present, payments of property taxes, leasing fees and/or royalties can be dramatically reduced. Detailed study using digital aerial photography, GIS, and GPS can clearly delineate the presence of lower value hardwoods in many properties formerly classified as uniformly high value timber. This data, when coupled with information on buffer strips left along streams and areas where slope precludes harvesting can when presented to taxing authorities result in assessed values and hence lower taxes (Addy, 1999). For this and similar extractive industries, similar scenarios result in the GIS system easily recovering both capital and operating costs.

Although large corporations beyond large public utilities and extractive industries have in general been slower to embrace the technology, many examples from every industry sector exist. In the transportation, trucking, and package delivery field, GIS has been used to determine more optimal routing. For example, FedEx uses GIS to continuously determine optimal routes to most efficiently make all required deliveries. Both Coca-Cola and Pepsi-Cola are employing GIS in to rationalize delivery systems (Coca-cola, 1998). Soft-drink distributors, faced with major delivery bottlenecks, have increasingly turned to GIS to both select optimal routes to reach their customers and also to locate bottling plants.

Large manufacturers are also faced with distribution issues particularly as the growth of the global economy, outsourcing, strategic alliances, and just in time inventory systems has altered the production landscape. Therefore, choosing the best location for a major facility such as a semiconductor plant or an automobile assembly facility becomes of critical importance. For example, The South Carolina Development Board in conjunction with BMW selected Spartanburg S.C. as the site of BMW assembly plant (ESRI,, 1993). Additional manufactures that have used GIS to study and select plant locations include INTEL and DuPont.

GIS can be used to select facility location based on infrastructure and distribution factors but demographics and customer characteristics may also play an important role. Columbia HCA, the largest health care provider in the U.S., uses GIS to study the demographics of the markets in which it is acquiring health care facilities (typically hospitals). It studies such factors as travel times, income, age, locations of private practice physicians, pharmacies, and nursing homes. These latter types of information are used to develop networks of participating physicians. Determination of the market area requires geo-coding data from patient records and comparing that information with the geo-demographics of the area from TIGER (Hecht, 1994)

Another group of firms interested in information on doctors and patients are the pharmaceutical companies. They however have primarily used GIS to allocate territories among salespersons. Most prescription pharmaceutical drugs are sold through highly paid sales representatives who compete vigorously for clients. However, as client lists grow, the area covered by any given salesperson may not be optimal in terms of travel times and costs. GIS can be used to geo-code clients and compare those locations with demographic information or locations of doctors or pharmacies. This in turn can be used to see

if certain markets are being under-served while others are over-served. Ultimately sales territories that optimize allocation of territories among the multiple salespersons while including scope for addition of new clients can be achieved (ESRI, 1997).

The banking and insurance industry has recently begun to embrace GIS technology. For example, Chase Manhattan Bank of New York and Wells Fargo Bank of San Francisco are using GIS for two primary purposes. First, to determine the market areas and customer demographics in terms of direct advertising efforts. Second, to determine branch locations and to a lesser extent services and hours of operation for bank branches. Conversely banks are also using GIS to comply with several regulations that prohibit discrimination in lending (i.e., The Community Reinvestment Act, The Home Mortgage Lending Act). In many cases the bank are outsourcing the analysis to any of one of a dozen consulting firms who have standardized their procedures to the point where they will conduct analysis on data sets sent to them over the Internet at a set rate of so many cents per geo-coded and analyzed loan in the bank's portfolio.

The insurance industry is using GIS to study the spatial distribution of customer claims and to a lesser extent is looking at intrinsic spatial factors such as proximity to hurricane prone areas and earthquake faults. This data is being used to adjust premiums both to reflect historical patterns of loss and also to predict areas that may in the future incur large losses due to natural disasters. The increasing availability of data on crime locations and attributes is allowing some U.S. insurance firms to adjust rates for property and auto insurance to reflect overall crime patterns in the community. Since several countries, notably Canada and Great Britain, are in the forefront of using GIS in crime mapping, the potential for the insurance industry to tap into this data source in those countries is significant.

5. Business Application Of GIS In Small And Medium Enterprises

While large firms operating in a range of ownership formats have increasingly embraced GIS for both strategic and tactical planning purposes, many Small and Medium Enterprises (SMEs) are just starting to adopt GIS. In contrast to some larger firms that began to utilize GIS in the late 1980's (Goodchild 1991). One particular area where GIS is efficacious is the analysis of customer demographics, a type of analysis that is crucial to relationship marketing. Relationships and understanding of the unique characteristics of customers is a sustainable competitive advantage many SMEs have over their larger competitors. Therefore, using available tools to further strengthen relationship-based marketing is an essential strategy to remain competitive. Nevertheless, SMEs have not extensively used GIS for marketing or other business-related purposes. The limited use or lack of use of this technology by SMEs is no longer due to financial and technological limitations, but rather a result of limited dissemination of information about the technology.

Users in SME's have adopted the technology later than users with applications involving infrastructure and natural resources management by as much as two decades (Tomlinson, Calkin, and Marble 1976). Some SMEs that could benefit from GIS include firms whose delivery of services involves substantial expenditures for travel and whose travel time to customers or client locations is a significant cost factor; for example, pest control, landscaping services, home repair firms, in-home health care providers, florists, and some restaurants. All of these firms could benefit from analysis of customer locations in relation to routes, traffic patterns, and firm locations. Most SMEs currently using GIS are firms in fields such as surveying, landscape architecture, urban planning, and market research. These firms use GIS as a primary part of their business rather than as a tool to determine how to improve distribution and promotion of a product or service. Nevertheless, there are several exceptions.

- An advertising and printing firm specializing in direct mail of political and commercial materials. This three-person firm uses TIGER data along with customer information from mailing lists. In particular, demographic information of registered voters and their voting patterns are used to selectively target direct mail by zip code to potential voters.

- An adventure travel firm tracks its worldwide customer locations with GIS and maintains a web site that uses web-based GIS server technology to allow customers to view a map of potential vacation areas and query attribute data and view video clips over the Internet.

- A commercial real-estate leasing firm employs GIS to identify suitable rental locations for its clientele, which are primarily professional corporations. The GIS stores TIGER-based street maps of the surrounding area surrounding rental properties and aerial photographs of the area, and facilitates demographic analysis of the types of customers in proximity to each rental property.

- A manufacturer of customized titanium golf clubs uses detailed demographic data and customer databases and industry information about golf pro-shops to target advertising and marketing efforts at a selective affluent clientele.

- A check-cashing firm uses TIGER data to identify areas with demographic characteristics that include a high proportion of low-income persons to determine new check cashing store locations.

Many specialized businesses have responded to the growth of demand for business application of GIS. Although most clients of such consulting firms as Channel Marketing of Texas, Decision Support Services of New York, Matrix Research of Wisconsin, and Thompson Associates of Michigan, are larger firms, SMEs increasingly use the services and expertise of these firms. For small business people short on time and capital investment, and leery of new technologies, these

consultants offer an ideal alternative. Several firms are offering GIS-based spatial analysis and database access over the Internet these include both U.S. firms and firms located in Canada, Britain, Switzerland and Australia. Various simple forms of spatial analysis and mapping are available for modest fees, included geo-coding of customer addresses. Confidentiality of customer information submitted to such sites is a major impediment to more rapid adoption of the promising technological approach.

Many SMEs conduct GIS analysis in-house or rely on consulting firms to perform GIS-based market geo-demographic analysis for a fee. However, an increasing number of firms find that local development agencies (e.g., Small Business Development Centers) or chamber of commerce can do much of the analysis at little or no cost. Sometimes governmental agencies will perform GIS-based analysis on a cost recovery basis. For example, to target telephone solicitations for replacement air conditioners, a small air conditioner sales and service firm in the College Station, Texas area uses the Brazes County appraisal district's GIS to extract information on age, value, and square footage of homes. The appraisal districts merely charges for time and materials.

In most franchise systems (e.g., restaurants, hotels and motels, printing services, convenience stores, laundry services, real estate services, and health and beauty aid), a continuous business relationship exists between the franchisor (a large firm) and the franchisee (a SME). This relationship includes everything from providing the actual product to providing marketing strategy, site selection, training, operating manuals, cooperative advertising programs, and quality control (Franchising in the Economy 1991-1993). The services provided by the franchisor to the franchisee now also include GIS based trade area and unit location analysis. Also a mandatory part of the relationship for many franchisors is a cannibalization analysis based on GIS. Many fast food franchisors use GIS to estimate the effect on sales and revenues of a proposed unit on existing units (cannibalization) (Long 1996). Many franchisors employ specialized consulting firms to conduct similar studies. For example, Thompson & Associates (a consulting firm based in Ann Arbor, Michigan), specializes in market research applications of GIS and related technologies. Dominos Pizza Inc., Chick-fil-A, Burger King Corporation, Baskin-Robbins, Long John Silvers, and Dunkin Donuts are among its clients that have extensive international franchise operations (Orton 1998).

6.Conclusion

The application of GIS by business is in its infancy. With minor modifications, many spatial analysis techniques developed and used for other applications are applicable to all businesses. As a result of lower costs, greater user friendliness, and more powerful spatial analysis capabilities, GIS software is affordable to an ever-increasing number of businesses (Goodchild 1991).

There are many sources of additional information on GIS, including the trade journal *Business Geographics* and other academic journals in Geography. Colleges and universities are a good source of information and education and training on GIS, in particular the National Center for Geographic Information and Analysis a consortium of three Universities headquartered at the University of California at Santa Barbara is an excellent source for data and publications on GIS. Associations such as the Urban and Regional Information Systems Association (URISA), as well as the vendors of GIS software, can be helpful to new and potential users. In Great Britain the Association of Geographic Information is a valuable source of assistance with GIS, while in Switzerland the Federal Office of Statistics has a rich horde of GIS data applicable to geodemographic analysis. The principal vendors of GIS software used in business applications include Mapinfo Corporation of Chicago, Illinois, The Environmental Systems Research Institute (ESRI) of Redlands, California (vendor of the ARCVIEW, ARCVIEW Business Analyst and ARC/INFO GIS), and Intergraph Corporation of Huntsville, Alabama (vendor of MGE, Geomedia, and VISTAmap).

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