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GIS and its Applications in Business⌗

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Abstract

Economic recessions around the world are forcing organizations to rethink how they operate. Many of them are realizing that they need to find smart ways to do their business using in-house resources. Many organizations have come up to invest in geographic information systems (GIS), as a solution that can help them to overcome their operational challenges and improve profitability.

The purpose of this paper is to show how Geographic Information Systems can be used to support business. Recent developments indicate that the GIS process has reached at least a number of business activities. GIS use ranges from 'just viewing' to analyzing complicated processes. This paper outlines how we can use GIS for decision support system (DSS), marketing research, and targeting customers. Three main levels on which GIS can be used: operational, management (tactical), and strategic. Nowadays, GIS applies more analytical operations within a business environment. We can identify retail sites, conduct competitor analysis, and calculate current and future shopping trips. All models operate within a GIS environment. I will discuss the GIS application in business, and its benefits to help managers to support their decision making, which will enable them to meet the organization targets.

Keywords: GIS, Business, Technology, Information System, Demand, Decision Support System (DSS).

1- Introduction

During the last years, GIS became more popular. A wide range of disciplines are becoming aware of the benefits that GIS offers them. GIS can do many things for business, for instance, GIS can visualize, manage, and analyze any business asset (employees, customers, and facilities, all the way to the supply chain network). To emphasize this, ESRI has more than 300,000 customers who are using GIS software for years around the world *(Esri, 2011)*. This technology allows companies to do their work in better ways and support their decision.

Recently, a number of 'GIS in Business' conferences in the USA and Europe, have demonstrated the growing interest in GIS applications among business people. Because business is covering wide range of activities such as financing, transport, industry, utilities, or marketing, we have to note that, not all activities will be equally in using the GIS technology. The use of GIS technology is different from organization to another, and even different within one organization. For example, employees in operational activities will need another kind of GIS functionality than those involved in decision making (*Toppen & Wapenaar, 1994).*

GIS use sophisticated technology to analyze the market in terms of demand (consumers) and supply (shops/ shopping centers) *(Esri, 2011)*. Few years ago, the use of GIS was limited to mapping the results of marketing research. But nowadays, the facility of a GIS is still important for retail marketing with more analytical operations are performed within a GIS environment. Some examples are the identification of retail sites, and competitor analysis. For most of these operations, new tools had to be implemented within existing GIS software.

The objective of this paper is to explain the spread of using GIS technology in general. And elaborate the use of GIS in business with concentration on marketing activities and the use of GIS for DSS.

2- What GIS can do for business:

Business has traditionally focused in some questions such as what (to produce), how (materials and technology), why (strategy), neglecting the question of where (to locate and find customer). Managers sometimes use their geographical knowledge to decide

where to locate. This knowledge can help if we are making our business in a small area, but when operating in a global economy, managers are unable to hold all required geographical knowledge. So, more technical approach is required *(Grimshaw, 2000).*

One of the best advantages that GIS offers to the business is that it helps in making location strategy about "where" to locate facilities, or "where" to target new customers. The "where" strategy gives the organization competitive advantage and gives the organization ability to compete with others. Location data can be powerful tools for retail businesses who are looking for a particular customer segment, as well as, for manufacturers who are trying to decide which retailers will be most able to move their products *(Stanchak, 2011)*. GIS also gives the organizations the ability to coordinate geographically, and use collaborative applications such as shared databases, shared applications, work flow management, and project management to support people working together in distributed locations *(Grimshaw, 2000)*. One more thing GIS can do for business is about the distribution of the product. This gives the organizations the ability to decide where to locate their goods and services, and then get a huge market share, also they can predict the future consumption of their products.

Many things that GIS can do for business, and the future is heavy by a lot of improvements in this section. We will see more opportunities that GIS can offer to business in the remaining parts of this paper.

3- GIS & Organization:

The early concerns about the application of information technology were focused on the technology issue rather than the information issue. Figure 1 (a) shows the two traditional perspectives of GIS technology (T) and application (A). To deliver the applications for GIS Technology needed by the organization, there must be two additional perspectives, information system (IS), and organization (O). The shift from the model shown in figure 1 (a) to that shown in figure 1 (b) represents a paradigm shift in thinking of GIS community. Many organizations have been invested in a technology and application model. Technology is a foundation stone of the pyramid,

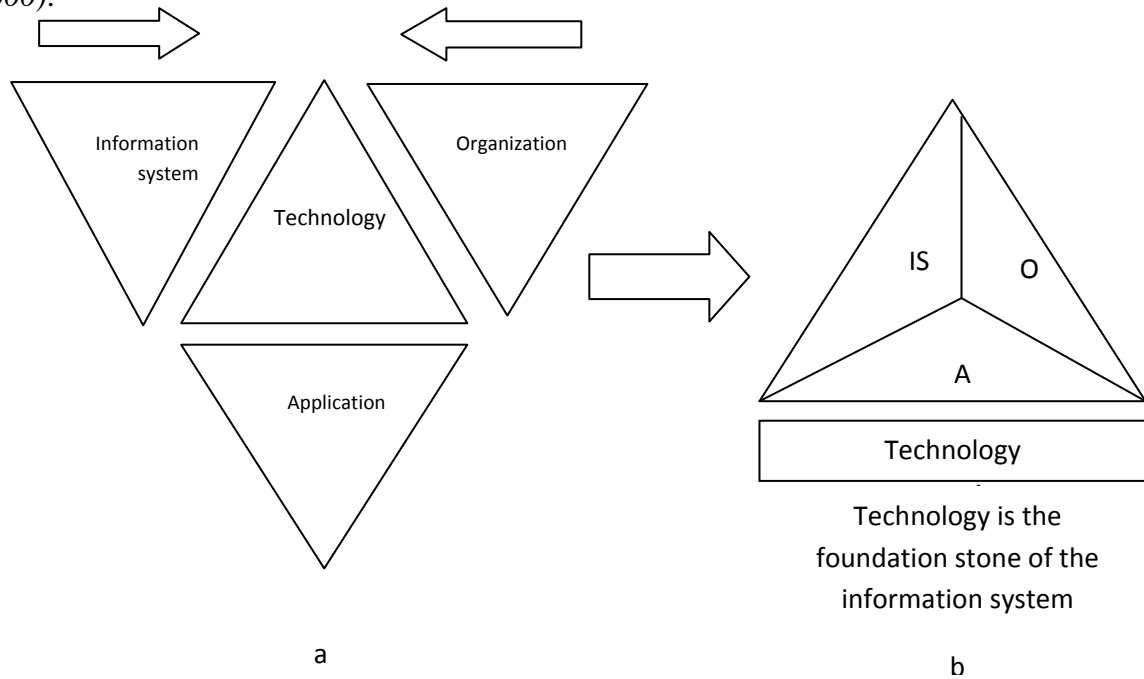and greater attention must be given to GIS in its organizational setting *(Grimshaw, 2000).*

Figure 1   Building the GIS pyramid

(Grimshaw, 2000).

To be successful the technology assessment must be combined with business planning process not just in the information planning cycle. So, more organization will be able to bring GIS technological opportunity into business to make a significant impact on profit. Many organizations are considered GIS as a part of the organization's information management strategy.

Figure 2 shows the basic business and how they are relating to the three main processes in businesses which are information, systems, and technology. This is a useful framework for looking in detailed at GIS and how it applied in management strategies. During the next years, business will confront with some challenges to maintain market share. This will cause GIS to rise to dominate as an important tool for strategic planning. In the future, GIS technology will be more sophisticated, and its application will move from achieving efficiency to achieving strategic benefits.
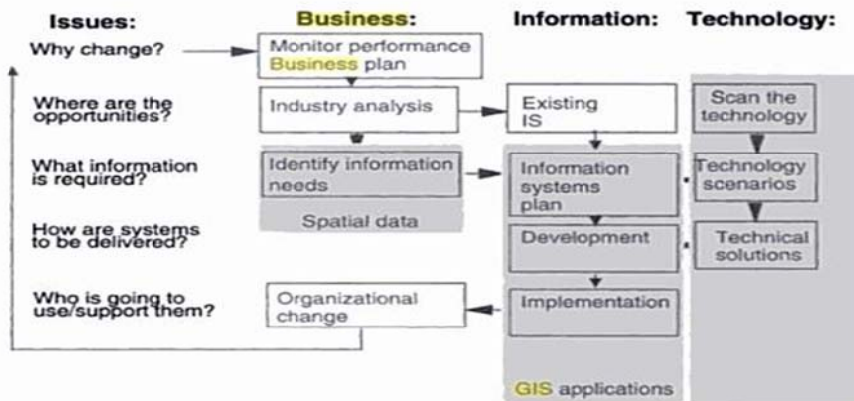
Figure 2 GIS in the Organization *(Grimshaw, 2000).*

Moreover, GIS can support high level decision making, and help the organization to survive from a competitive pressure. Two main areas in which GIS can play a key tool and have a strong impact in business strategies: competitor analysis, and branch rationalization *(Grimshaw, 2000).* In addition, GIS applications are currently supporting decision making in functional areas such as marketing, they enhance the efficiency and the productivity of these areas. Managers are looking for real business reasons for justifying in GIS investment.

4- The Diffusion of GIS Technology:

The Diffusion of the use of GIS technology is dependent on the degree to which it is seen as a mature development. There are few factors are important in determining the maturity of GIS technology. The first factor is the degree to which the functionality offered by a GIS corresponds to the operations demanded of it. This relates to the debate on whether GIS is still technology-driven or has shifted into a user-driven technology. This reflects the gap between what the user needs and what GIS software can offer. For example, we cannot put GIS software in the same category as word processing software. The different types of GIS applications require highly specified utilities that cannot be covered by one single software package.

The second factor is the extent to which the software is easy to use. In other words, are the GIS users being able to use the software without help. In recent years, many kinds of tools have been added to the GIS software, which allowing users to build their own dedicated interface.

The third factor is the importance of investments in both software and hardware. The availability of much GIS software on PCs and the low price of hardware (both PC and

work stations), indicate that the cost of hardware and software is no longer an obstacle (*Toppen & Wapenaar, 1994).*

The fourth factor is the Education and awareness about GIS. The number of people who have been or are becoming educated in GIS is growing. The issue is more a matter of quality than of quantity. Does the type of GIS skills and the type of GIS knowledge acquired at universities, colleges, and in all kind of courses suit the demand?

The fifth factor is the data problem. This is a main issue because it slows down the diffusion of GIS use. Data investments are high. And problems related to availability, costs, standards, accuracy, and legal liability are far from being solved. Because of data collecting activities by governments and the private sector, the availability of data is not the acute problem anymore. Instead, the cost of data is now the decisive factor preventing the possibility to use geographical information. It is expected that the data issue will remain the key factor in business success in the coming years (*Toppen & Wapenaar, 1994).* As a result of these factors, there are differences in the degree to which GIS is applied between organizations and even within organization. We will describe a general view on how the diffusion process takes place.

4-1 Differences between Organizations:

The ability to invest a lot of money in necessary GIS software and hardware was essential by that time. The software was not easy as it is today; thus, there was a permanent need for technical assistance. So, the larger governmental agencies, and universities were able to invest in GIS technology, as long as the benefits of GIS were made clear. At that time, the first reason to invest in GIS technology was to speed up the map production. After that, other GIS functions become important. Then, GIS became available to other departments within a governmental organization. In the footsteps of government and universities, the investment of the GIS technology became evident within smaller governmental organizations and large business firms. The availability of GIS software for PCs and user interfaces has encouraged the spread of using GIS technology. Another reason that increased the use of GIS technology in small business is the availability of data. The use of GIS technology has become widespread, as a result of the possibility of organizations to buy digital maps and socioeconomic data. All kinds of boundary files are becoming popular. And the

most popular ones are the postal code maps, which allow for detailed mapping and analysis (*Toppen & Wapenaar, 1994).*

4-2 Differences within Organizations:

The reason of why the organization adopted GIS technology is different from organization to other, and even different within one organization. Within an organization, GIS pioneers often have a difficulty to persuade others of the usefulness of GIS. Of course, the cost-benefit issue plays a decisive role. While being both a productive and a persuasive tool, and mapping was the major GIS activity. Once GIS was adopted, it was used for all kinds of analytical purposes. Only when the full potential of GIS has been demonstrated is it likely that other applications will be used successfully within the same *(Toppen & Wapenaar, 1994).*

5- GIS in Business:

The use of GIS comes from the need to maintain spatial database and from the need of mapping. GIS application for business is a tool to support management decisions, and most of managers use GIS to demonstrate unrecognized patterns in their data. For example, the knowing where existing and potential markets are is crucial to any business *(Toppen & Wapenaar, 1994).* Three main levels on which GIS applications can be applied in business: operational, management (tactical), and strategic.

Operational GIS applications include the use of GIS functions to monitor the provision of goods for retail net. As a result of this, GIS will be used to support day - to-day routine activities. Tactical (management) applications provide information that needed to support decision making. These applications are always used by middle management. on the other hand, Decision making requires the combination of all kinds of data relevant to the decision, and GIS will offer the combination of spatial data such as, information about where existing and potential market, and where the location of competitors, and this will help to decide where to locate to new retail outlet. Strategic GIS applications are used by senior management. These applications have to provide them with the specific information they need to make strategic decisions. GIS applications will support the senior manager in his strategic decision-making by the mapping facility. for instance, Issues that might concern the senior manager are where to invest or which new products to put on the market.

This threefold classification is just one way to classify GIS application in business. But it emphasizes an important point, which is each level within an organization and each kind of activity requires a different kind of GIS. In general, operational GIS applications were to be implemented first in an organization for three purposes, it was easy to show that how GIS could help save money, operational use of GIS also stimulated the awareness of GIS within an organization, and it enabled the tactical use of GIS.

Nowadays, there is much effort to apply GIS to tactical issues. It is important to gather and integrate internal and external information, for an optimal decision making. The degree to which senior managers will be using GIS to query spatial information for their strategic decisions will depend on how successful the operational and tactical GIS applications have been in his organization.

5-1 GIS for Marketing:

Bringing GIS into marketing planning helps you to understand and respond to both customer and market. GIS technology allows you to segment the market and reach your existing and potential customers to improve retention and find new opportunities. Marketing is one of the most business sectors that apply GIS. Location data can be powerful tools for retail businesses who are looking for a particular customer segment, as well as, for manufacturers who are trying to decide which retailers will be most able to move their products *(Stanchak, 2011)*. In general, marketing is a question of demand (customers) and supply (retail outlets, shopping centers). Both demand and supply are easy to pinpoint to a geographical location. Therefore, these factors are interesting to analyze with the help of a GIS applications. The marketing field has been developed from mass marketing to niche marketing. This development has made a new approach to the necessity of marketing analysis. All kinds of market segmentation techniques have been developed to define and reach the target group of customers. Interest in the applications of GIS for marketing analysis is growing. It should be noted, that this interest is not focused on GIS per se. Instead, people see GIS as a way to handle spatial information.

There are many kinds of GIS applications for marketing research. GIS can help to answer a number of marketing questions, such as:
Where are my customers located?

What are their characteristics (market segmentation, classification of residential areas)?

Where are my competitors located?

What is the potential turnover in a region for my product? What market share can I expect?

Where should I locate my new branch? Should I expand an existing branch?

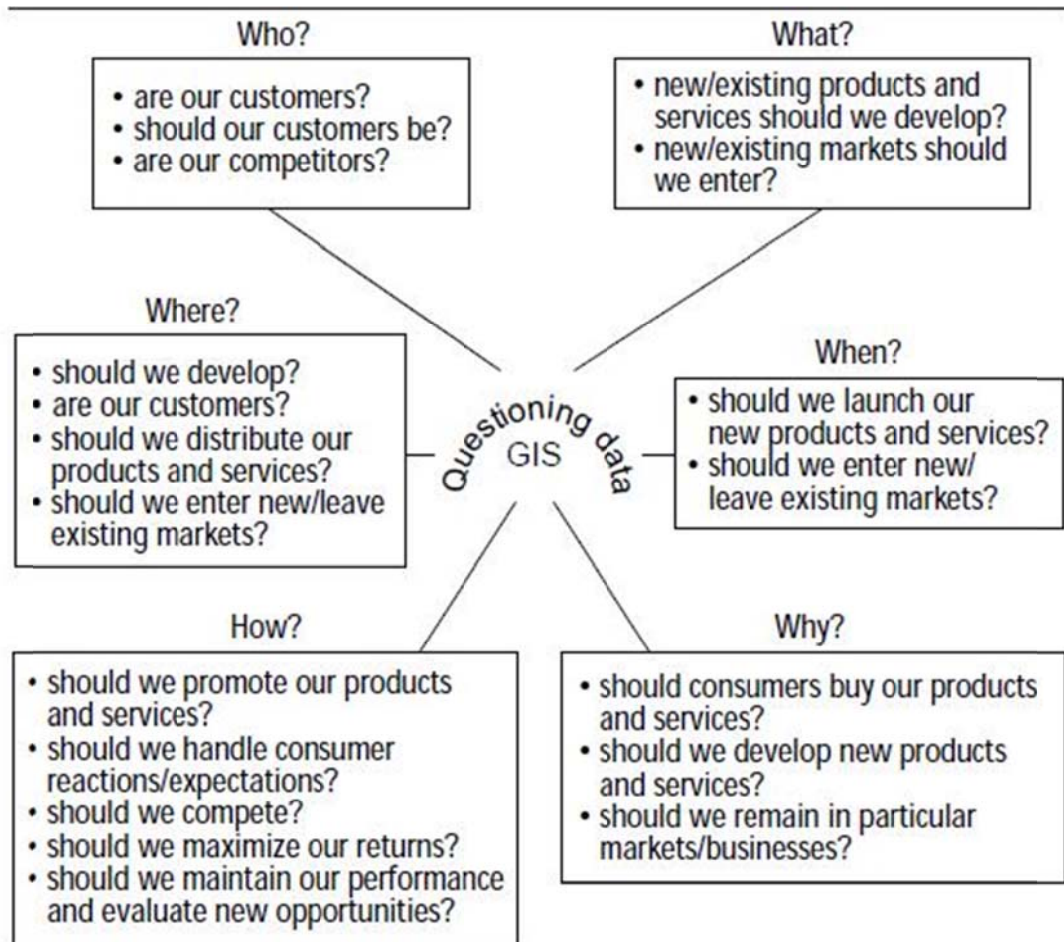How should I promote my product? Where and how should I advertise?

Who?
- are our customers?
- should our customers be?
- are our competitors?

What?
- new/existing products and services should we develop?
- new/existing markets should we enter?

Where?
- should we develop?
- are our customers?
- should we distribute our products and services?
- should we enter new/leave existing markets?

When?
- should we launch our new products and services?
- should we enter new/ leave existing markets?

How?
- should we promote our products and services?
- should we handle consumer reactions/expectations?
- should we compete?
- should we maximize our returns?
- should we maintain our performance and evaluate new opportunities?

Why?
- should consumers buy our products and services?
- should we develop new products and services?
- should we remain in particular markets/businesses?

Questioning data GIS

Figure 3 GIS in Marketing *(Clarke. L, Rowley. J, 1995)*

The main purpose of using GIS applications in marketing research is for mapping. This mapping facility is crucial in persuading people of the potentials of GIS. They found the information that presented in maps was much easier to interpret. When the locations of distributors, customers, and competitors were mapped, users had their first spatial view of their data. Gradually, more attention has been given to analyze the relation between supply (business activities) and demand (customers, geo

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demographic data). Also, GIS offer tools to analyze and map the business expenditures (*Toppen & Wapenaar, 1994).*

In recent years, much effort has been done to create detailed spatial databases. For this purpose, postal code maps are becoming more popular. There is a use of number of postal code areas as an entity for research. Most important advantages of the postal code system:

Coverage a whole country.

Is maintained by one organization.

Is linked to the mailing address.

Is linked to the 'perceived structure of geography', such as buildings and streets

Provides a fixed hierarchy of areas.

Is easy to handle by computer (in a GIS).

The capability to deal with postal code information within a GIS environment is now one of the key factors of a successful role in marketing research. In the Netherlands much effort has been done to make neighborhood maps and block maps. Block maps are based on a detailed road network; each block is specified by its surrounding road segments.

5-2 GIS for DSS:

The most common reason that enables business to investment in GIS is the belief that it improves decision making. Many studies have found that using GIS maps result in more accurate and faster decisions than using paper maps *(Alan. R, Traci. A, 2000).*

The growth in the importance of (DSS) has taken place against a background of rapidly changing computer technology. The introduction of widely available personal computers and their one hundred fold increase in performance has facilitated the development of a wide range of DSS applications (Keenan. P, 1995). Many areas of DSS application are concerned with geographic data. Recent DSS textbooks are including GIS as a component of management support systems. GIS related research is beginning to make an appearance at conferences associated with DSS. For example a recent paper by Crossland and Wynne (1994) presented empirical evidence of the usefulness of a spatial approach to decision making. This paper was presented at the Hawaii International Conference on System Sciences, a conference associated with DSS rather than GIS based application (Keenan. P, 1995).

There is general agreement that Decision Support Systems (DSS) focus on decisions and on supporting decisions rather than replacing the user's decision making process. There is also a general agreement in the definitions of (DSS) that both database and model component are usually required to fully support decisions *(Keenan. P, 1995).*

Spatial Decision Support System (SDSS) can be seen as an important subset of (DSS). The potential of (SDSS) for growth has been facilitated by technological developments. The availability of appropriate inexpensive technology for treating and dealing with spatial data enables SDSS applications to be created. The benefits of using GIS based systems for decision making are increasingly recognized. So, SDSSs is identified as a growth area in the application of GIS technology. However the value of SDSS is not determined by its innovative use of technology. Instead the contribution of these applications will be determined by the need for a spatial component in decision making.

For GIS to support decision making they must be viewed as spatial decision support systems (SDSSs). These can be defined as: interactive computer-based systems that help decision makers to utilize the data and models in the solution of unstructured problems *(Clarke. L, Rowley. J, 1995).* A computer based system to solve the retail location problem should take the form of DSS which handles spatial information, or a spatial decision support system SDSS.

In general, the characteristics of DSS are recognized as the following:

  * Help decision makers in their decision processes for unstructured or semi-structured problems.

  * Improve the effectiveness rather than just the efficiency of decision making.

  * Combine the use of models or analytical techniques with data-access functions.

  * Concentrate on features which lead to easy, interactive use by inexperienced users.

  * Include general solution strategies such as intuitive approaches, trial-and-error procedures and subjective judgments.

A DSS is designed to support decision makers in an unstructured or semi-structured situation where the problem is complex and cannot be solved by human analysis. DSSs typically use models to allow "what-if" analyses and use the data stored in a database management system. Good database management facilities make the DSSs powerful. Finally, the developments of GIS allow decision makers incorporate a

spatial dimension in their decision making. This spatial dimension is an important feature of many areas of DSS application.

6- Case Study: Improves Accuracy of Real State, California:

Background

Apt Market Research of Costa Mesa, California, provides market analysis and consulting services for many types of apartment developments, specializing in affordable rental housing and age-restricted apartments for seniors. Each year, the firm conducts about 50 to 60 market studies or consulting assignments for builders, developers, lenders, investors, and municipalities, primarily in California and the Southwest. To date, Apt Market Research has performed nearly 600 studies for properties in submarkets in California and 25 other states. The value of apartment communities subsequently constructed exceeds $2.5 billion.

The Challenge

Apartment developments are representing investments between $25 million to $30 million. Apt Market Research knew that to provide valuable market studies to potential customers, it needed to incorporate the most possible accurate geographic and demographic data. "The accuracy of our market studies and their acceptance by decision makers depend on our building conclusions with solid data," says Annie Gerard, principal *(ESRI Business Analyst Online, 2010).* Apt Market Research needed to find a company that provides accurate, reliable demographic estimates based on proven, trusted data methodologies. The data needed to be verifiable against anomalies such as fewer residents identified by local sources, or published data that showed far more or fewer housing units than were documented in local building permit data. Apt Market Research also wanted the provider's staff to be expert in demographic forecasting and technology; simple-to-use software with flexible exporting file formats was a must.
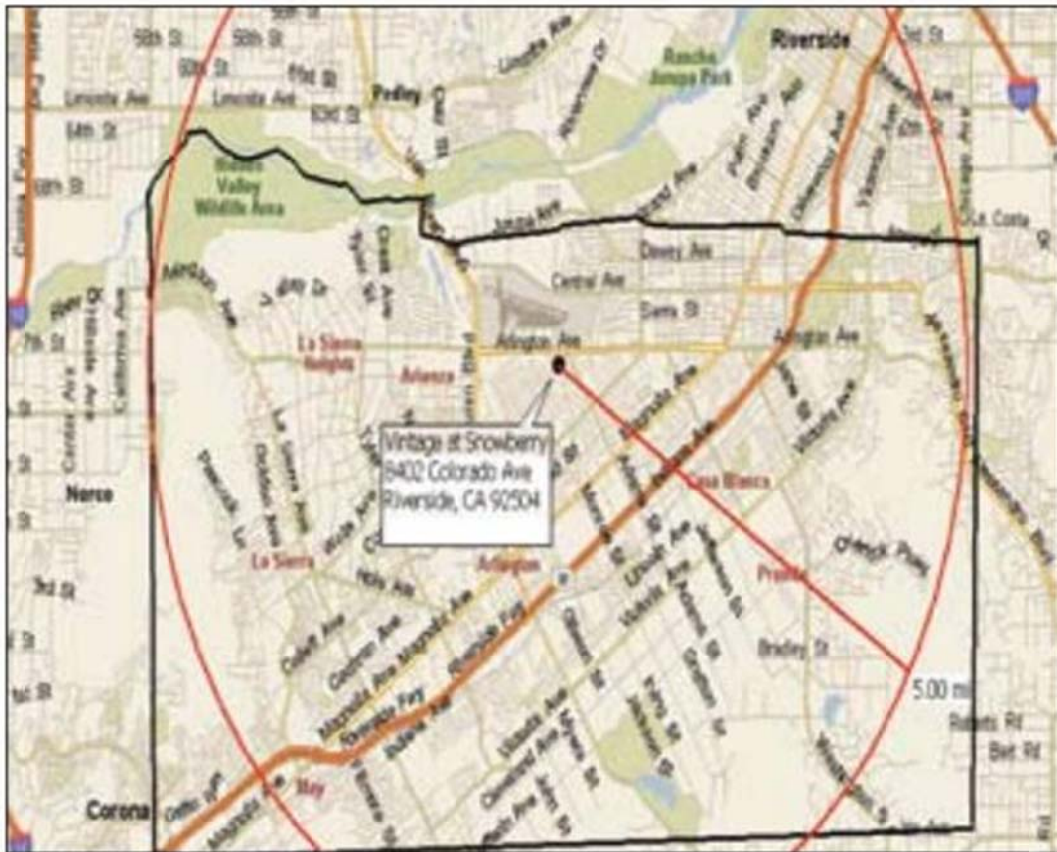
Apt Market Research used ESRI Business Analyst Online to create a custom market area around a site in Riverside, California.

Figure 4 Create market areas *(ESRI Business Analyst Online, 2010)*

Apt Market Research executives wanted to avoid data forecasts that were too high or too low. "Counts that are too high could result in overestimated demand and could potentially result in a slow lease-up, with negative financial consequences," explains Gerard. "Numbers that are too low tend to underestimate the market potential, possibly leading to overly conservative conclusions on supportable project scale, rents, or other factors that also negatively impact the bottom line" *(ESRI Business Analyst Online, 2010).*

The challenges that the company face are:

* finding accurate demographic and geographic data.

* Establishing a relationship with a technology provider with staff expertise in data.

* Exporting data in various formats.

The Solution

ESRI recommended Business Analyst Online, which provides on-demand reporting, mapping and flexible file format capabilities. Using Esri online service enabled Apt Market Research to easily and inexpensively improve market area boundaries and analyze different iterations as necessary. Gerard says "The user defined geographic functionality that Business Analyst Online lets us match the data to the market area, not vice versa. The ability to define a custom study area by simply clicking on a map is a feature we especially value" (_ESRI Business Analyst Online, 2010)._ To solve data exporting requirements, the Excel export feature in Business Analyst Online was integrated with the company's demand model. The Information from reports such as the Market Profile and Housing Profile from Business Analyst Online was exported into a template that populates graphs and comparative charts that correspond to filters in the company's demand modeling. This capability provides automatic, precise access to demographic characteristics and in-depth market information.

The Result

By integrating demographic data, such as household growth, housing values, and tenure, generated from Business Analyst Online Apt Market Research significantly increase its efficiency and improved the quality of its market studies. For this purpose, Gerard emphasizes, "Being able to easily access accurate demographic data from Business Analyst Online lets us spend much more time performing the actual analysis work". The company now feels confident by knowing that the demographic data used in the studies is providing valid and reliable conclusions for multimillion-dollar real estate developments. Since APT Market Research Company selected ESRI as a provider for the data that they need, the capacity and revenues of the APT have increased between 20 and 25 percent (_ESRI Business Analyst Online, 2010)._
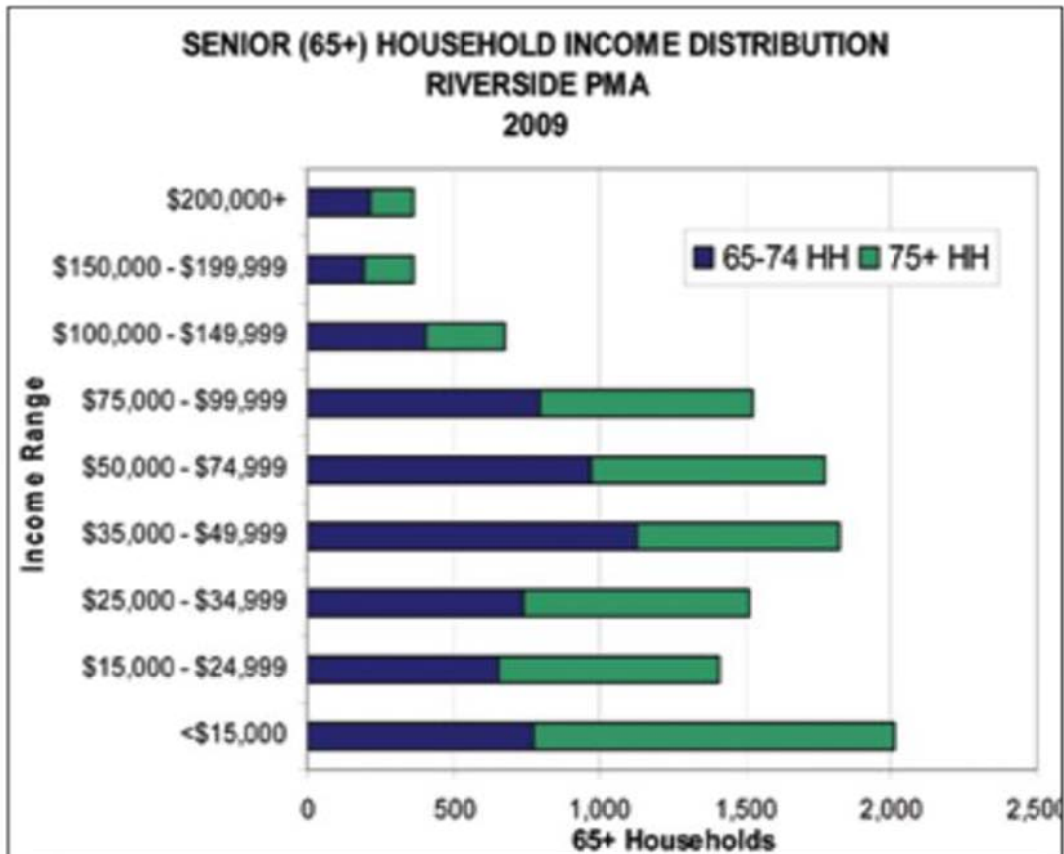
The company used the Excel export function in Business Analyst Online to design an automatic demand model that incorporated demographic data from report templates to quickly produce accurate charts for market studies.

Figure 5 Exporting data (*ESRI Business Analyst Online, 2010)*

We can summarize the results of the APT after using ESRI data in these points:

* Increase revenue by 25%.

* Improve quality and accuracy of conclusion recommendation.

* Streamlined report production and saving 2–4 hours per study.

* Reduce data entry and errors.

7- Discussion:

Geographic information systems (GIS) provide a solution that can help organizations to overcome their operational challenges and improve profitability. GIS has the ability to analyze business asset and support decision makers by using sophisticated technologies. Three main levels on which GIS can be used: operational, management (tactical), and strategic. Moreover, GIS is a great tool for decision support system

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(DSS), marketing research, and targeting customers. We have to know that the use of GIS technology is different from organization to another, and even different within one organization. Two main parts that GIS can play a key role in business; first one is the marketing strategies. It helps in making location strategy about "where" to locate your facilities, or "where" to target new customers. Also, it helps you to understand and respond to both customer and market. Second one is decision support system (DSS), GIS helps managers to solve problems which are complex and cannot be solved by human analysis. GIS is using models that analyze the data, and provide outputs in terms of charts and tables, which will support manager to make the decision and solve the problem.

8- Conclusion:

Nowadays, GIS became very popular. A wide range of disciplines are becoming aware of the benefits that GIS offers them. GIS can do many things for business, for instance, GIS can visualize, manage, and analyze any business asset (employees, customers, and facilities, all the way to the supply chain network). GIS use sophisticated technology to analyze the market in terms of demand (consumers) and supply (shops/ shopping centers). GIS allows the organizations to coordinate geographically, and use collaborative applications to support people to work together in distributed locations. Nowadays, we see many companies have obtained GIS technology to make the life easy, and to take the advantage of GIS. As a result of technology development, GIS has become more sophisticated, and we expect more advance tools and intelligent procedures to be implemented by GIS in future especially in business.

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