Smart Tools for Business Intelligence: Geographic Information Systems

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The term of Business Intelligence was used as early as September 1996, when a Gartner Group report said: "*By 2000, Information Democracy will emerge in forward-thinking enterprises, with Business Intelligence information and applications available broadly to employees, consultants, customers, suppliers, and the public. The key to thriving in a competitive marketplace is staying ahead of the competition. Making sound business decisions based on accurate and current information takes more than intuition. Data analysis, reporting, and query tools can help business users wade through a sea of data to synthesize valuable information from it - today these tools collectively fall into a category called "Business Intelligence.*" It is important to mention that Business Intelligence (BI) is not a single application. It consists of a series of components that interact behind the scenes to extract electronic data, assemble it, analyze it and display it in a form that is easy to work with and understand. These components include: *a database; an ETL (E*xtract, *T*ransform and *L*oad data*); analytic tools; reporting/querying tools; training.*

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1 Business Intelligence vs. Geographic Information System

1.1. What is Business Intelligence?

Business Intelligence (BI) is a process for increasing the competitive advantage of a business by intelligent use of available data in decision-making. The five key stages of BI are:

Data Sourcing. BI is about extracting information from multiple sources of data. The data is heterogeneous: text documents; photographs and images; sounds; formatted tables; web pages and URL lists. The key to data sourcing is to obtain the information in electronic form.

Data Analysis. BI is about synthesizing useful knowledge from collections of data. It is about estimating current trends, integrating and summarising disparate information, validating models of understanding, and predicting missing information or future trends. This process of data analysis is also called data mining or knowledge discovery (Ionita, A., 2005a).

Situation Awareness. BI is about filtering out the irrelevant information, and setting the remaining information in the context of the business and its environment. The user needs the key items of information relevant to his or her needs, and summaries that are syntheses of all the relevant data (market forces, government policy etc.). Situation awareness is the grasp of the context in which to understand and make decisions. Algorithms for situation awareness provide such syntheses automatically.

Risk Assessment. BI is about discovering what plausible actions might be taken, or decisions made, at different times. It is about helping the companies weigh up the current and future risk, cost or benefit of taking one action over another, or making one decision versus another. It is about inferring and summarising best options or choices of a company.

Decision Support. BI is about using information wisely. It aims to provide warning the company of important events, such as takeovers, market changes, and poor staff performance, so that it can take preventative steps. It presents the information needed by companies, when they need it.

1.2. What is Geographic Information System?

A Geographic Information System (GIS) is a tool for linking attribute databases with digital maps. But GIS is really much more than this simple definition would imply. In fact,

several definitions of GIS have been proposed, each of which suggest that GIS is much more than merely an electronic mapping tool (Mennecke, B.E. 1997). Something that is common to most of these definitions is the notion that GIS not only provide users with an array of tools for managing and linking attribute and spatial data, but they also provide users with advanced modeling functions, tools for design and planning, and advanced imaging capabilities. While many of these capabilities also exist in other types of systems, such as visualization and virtual reality systems, GIS are unique because of their emphasis on providing users with a representation of objects in a cartographically-accurate spatial system and on supporting analysis and decision-making. A Decision Support System (DSS) includes various subsystems including data management, model management, knowledge management subsystem, and dialog management subsystems. A GIS includes similar subsystems, albeit subsystems which are spatially enabled. Similarly, a GIS must have a model manager that includes the typical functions, models, and statistical operations present in a DSS, but it also must provide the user with spatial models and capabilities that can be used to perform spatial modeling and spatial statistical calculations. To help the user manage the complexity involved in integrating these models with attribute and spatial data, several developers have incorporated knowledge management facilities within GIS (Leung and Leung 1993a, 1993b; Skidmore *at. al.* 1991; Smith and Yiang 1991; Wu *et al*. 1988). Finally, a GIS has a dialog management subsystem that enables users to query and output attribute data, but it also includes spatial query and output capabilities. For example, a typical aspatial DSS will include a data management subsystem designed to manage textual or, in some cases, object-oriented data. A GIS must not only be able to manage these types of data, but also manage and integrate spatial. Using such a framework it becomes clear that GIS include all of the features that are in a DSS; however, they also include several other components[1]**.** The four GIS functions are: *spatial imaging; database management; decision modeling; design and planning.*

2. GIS as extension for BI

Each of the functions of BI and GIS suggest that is necessary to tacking into account four research areas: ***human resources, data management, decision-making and collaboration,*** **and** ***planning systems*** (Ionita, A., 2005b)**.**.

Human Resources Because of the visual nature of GIS, issues related to the nature of the task, the visual layout and presentation of the display, and the cognitive processes that these issues affect in the user are all critical considerations in the use and management of GIS. A rich literature on human factors exists and can be applied to GIS (Medyckyj-Scott and Hearnshaw 1993) and BI. Bertin (1983) proposed taxonomy of graphical representations of data that is useful for GIS human factors research. Bertin's research described the efficiency of human processing associated with over 100 types of graphical displays of tabular information[2]. Fundamental to the user interface and graphical displays is the consideration of the physical characteristics of the system. Issues such as the layout of features on the screen, the color and saturation of display objects, the number and type of display objects used, the nature of the input and output devices, and the arrangement of the physical components of the system all have important impacts on the way people interact with the technology (Benbasat *at. al.* 1986; Turk 1993). In this context, businesses seeking to successfully integrate GIS into their organization must be given guidance concerning how to properly

[1] A DSS model has been used as the basis for defining GIS components because most of today's GIS systems incorporate the components present in a DSS. Densham (1991) used the term *spatial decision support system* (SDSS) to describe a system that *"… normally is implemented for a limited problem domain. The database integrates a variety of spatial and non-spatial data and facilitates the use of analytical and statistical modeling techniques. A graphical interface conveys information, including the results of analyses, to decision makers in a variety of forms. Finally, the system both adapts to the decision maker's style of problem solving and is easily modified to include new capabilities".*

[2] Many of the graphical constructions described by Bertin were maps and map derivatives

train users as well as how to configure the layout and display of their systems for optimal use (Turk 1993). With the broad scope of applications that GIS may be used for, it is also important to consider task characteristics when studying human factors in GIS (Nyerges 1993). A task framework is needed to provide a better understanding where GIS should be used and how it should be applied to solve business problems (Nyerges 1993; Turk 1993). For example, an important question for business users of GIS is whether some of the tasks for which they use GIS are fundamentally different from the tasks of other users (e.g., economic planners or managers in local government). Another important issue in human resources research relates to the cognitive characteristics of BI and GIS users (Mark 1993; Turk 1993). For example, Crossland *et al.* (1993) considered spatial cognition and need for cognition as they relate to decision-making performance in spatial problem solving. They found that differences in individual spatial cognitive abilities had important impacts on decision maker effectiveness and efficiency. A better understanding of these factors will clearly benefit business users because user effectiveness will have important impacts on acceptance and the requirements association with training users to properly apply GIS to business problems (Hearnshaw 1993).

Data Management. Considerable attention has been paid to various issues associated with acquiring, managing, and using GIS attribute and spatial data. Likewise, the integration of enterprise-wide geographic technologies into data warehouse applications will require unique procedures for capturing and managing these large, multidimensional databases. By enabling data warehouse applications to leverage geographical relationships, geographic technologies can be used to create, improve, or enable processes in a variety of ways that were impractical or difficult using other, non-spatial technologies.

Decision Making and Collaboration. Often GIS are used only as a tool to query a database or as a vehicle for displaying maps and spatial imagery. In this context, GIS represents an important enhancement to traditional database management systems and presentation graphics tools because it provides the decision maker with a powerful way to organize, retrieve, and display databased on its spatial characteristics. However, as noted above, GIS can also be employed as a tool to support more sophisticated manipulations and analyses of data. Furthermore, as is the case with other information systems, many decisions supported by GIS are actually made in or by groups of people working collaboratively (Campbell and Masser 1996). For example, some organizations have integrated GIS into group conference facilities. Graphic manipulation tools for GIS that would allow users that are geographically dispersed to share maps, data, and other information would provide a powerful environment for decision making and collaboration.

Planning and Project Management. Among the GIS functions shown in Figure 2, the planning and design function is one of the best developed and best understood. GIS and related technologies might, for example, be useful for representing conceptual models of new or revised business or task processes. The ability of GIS to represent data in multiple layers may be useful in enhancing the capabilities of current technologies.

3. Conclusions

GIS is important in business intelligence because most business problems include significant spatial components and GIS enables decision makers to leverage their spatial data resources more effectively. CRM[3], ERP[4], SCM[5], and more others are acronyms for some solutions designed to extract and analyze information from data warehouses and allow decision-makers to perform at a higher level of efficiency. But data on it's own has no value. Without simple visual ways to integrate, display and analyse, it is possible to end up with massive amounts of data but no information. In our point of view, the geo-

[3] CRP = Customer Relationship Management
[4] ERP = Enterprise Resources Planning
[5] SCM = Supply Chain Management

spatial data and maps managed within an enterprise GIS represent a kind of common "language" that is understood within and across organizational boundaries. This "language" has the power to weave together and integrate traditionally disparate business functions. Each of these diverse functions is ultimately dependent upon the location and spatial relationships between real property, assets, and people.

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