

Application of Geographic Information System (GIS) in Education

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ABSTRACT

Information technologies (IT) are developing very rapidly in today's world. Geographic Information System (GIS) is one the technologies that evolves to allow people to solve many geographic problems quickly, effectively and easily with the abilities to make analysis, especially location analysis in combination with traditional database systems. Education is one of the fundamental elements of a nation and it can contain several elements including issues that are geographic. The purpose of this paper is to show the applicability of GIS in education facilities, where each educational unit has easy access to the common database. The system is constructed for schools in Old Tbilisi District, in Tbilisi, Georgia and different analyses related to education were performed.

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Introduction

In particular, among developing countries, the correlation between adults with higher levels of educational attainment, and individual earnings, employment opportunity in the urban labor markets and agricultural productivity is significantly positive. Education affects developments through various dimensions of cognitive competence: literacy (reading and writing), numeric, modernity and problem solving behaviors (Lockheed & Verspoor, 1991). Hence, education is so important and it should be supported by proper planning and improved facilities that will enable information technology integration that will lead to easy information analysis.

Information technology is wide in scope and proper use and integration will make the solution to some problems easier. Many problems exist in educational administration today and there are many applications of information technology to assist in solving the problems. The focus of this Geographic Information System (GIS) paper is to emphasize the use or application of GIS in Education by determining education district, create a school mapping, where school

can be established and help decision makers to solve problems which are related to locations / geography in education easily and quickly. Generally, the areas of relevance will include the capacity of schools, schools' regional distribution, number of students, and number of teachers, number of schools, Gender issues, and simple statistical calculation within and between schools/district. GIS is mainly used for analyses, which, in developing countries, only few GIS projects are successfully applied and utilized for decision-making. (Makino & Watanabe, The application of GIS to the school mapping in Bangkok, 2002).

There are 2430 general education schools (National Statistic Office of Georgia, 2011). This research data focus on schools in Old Tbilisi District in Tbilisi. All the schools in Tbilisi are available on the map in the Governor's office website, however this school maps unfortunately is not synchronized with the data of Ministry of Education and Science of Georgia. There are some statistical data for schools with the Ministry of Education and Science of Georgia. These are how many schools there are in Georgia, the capacity of each school, the number of students in Georgia, distribution of schools in Georgia, physical condition of schools Minister of Education in Georgia analyses these data but not geographically. Another accomplishment of this paper is integrating schools' data to GIS and analyses the data visually on the map.

GIS as a Tool in Education

Geographic Information System is a discipline for capturing, storing, analyzing, managing and presenting data and associated attributes, which are spatially referenced, to Earth. Geographic Information System is to analyze object and event on the earth and visualize them with real coordinates on the map. In another definition of GIS, it is abbreviation of three words:

Geography + Information + System. Geography relates to all the features and process that occur on the surface of the earth. Information is the hearth of GIS, where vast amount of data are stored and analyzed (Audet & Ludwig, 2000, p. 6). Therefore, GIS makes geographic analysis and location analysis easier, so users of GIS application increases and the scope expands. The trend towards using GIS and school mapping to support decision making for Ministries of Education and educational facilities are becoming very important for planning purposes. GIS is in the implementation stages in many developed countries of the world, and in the developing countries. (Yoko, Watanabe 2002) have decided that GIS is a very useful tool to analyze the school-planning situation. Besides the simplification of educational administration, and expansion of compulsory education, enforcing the clear school planning policies, and creating the digital database that can be used in GIS, will have more positive influence on improving school services and qualities for the current and future children.

Among the possibilities for GIS to improve education micro planning, the following are identified by (DeGrauwe, 2002):

1. GIS helps make the presentation of data more attractive than traditional static maps.
2. Projecting tabular data onto maps helps in recognizing "unexpected" situations which, now noticed, call for closer examination.
3. Through considering geographical (spatial) factors, the analysis becomes "finer" and more precise, increasing the likelihood that ensuing strategies will be more pertinent.
4. More flexible assistance can be provided in prospective planning at multiple levels or units of analysis: national, regional, provincial/district, and local.

According to (Hite J., 2004) school mapping as a technical exercise has become a relatively normalized and institutionalized practice in education's micro planning. More than simply being a tabular, graphical or cartographical representation of a particular space or place, school mapping involves the consideration and inclusion of various forms of technical data that impact and populate the physical and social context of analysis. As a process that produces specific functional products, school mapping is fundamentally an educational micro planning effort focused on increasing school resource efficiency and equity (Caillods, 1983).

Another use of GIS in Education involves combining statistical inferences to geographic information. Statistics in education might be used with GIS to present a clear picture of educational facilities and activities. Ratio of students to teacher, number of students in a class and student density in school, schools distribution in a district to find lack of schools and in time processing education facilities and so on. GIS might be used for supporting educational decisions by senior administration and how to use statistic for this system. Some approaches in GIS that might be used for education facilities and policy with statistical inferences in the districts of Izmir (Temiz, 2007) where discussed.

School Location Analysis Using GIS

There are 2 main types of schools in Old Tbilisi District. These are public school and private schools. First, it is necessary to collect data on schools then create a database based on the collected data. GIS Data needs spatial data to integrate to GIS system. Location of Schools takes location geographically so school coordinate helps us to integrate data to GIS system. Name of this feature is called a Geocode. Geocoding is the process of transforming a description of a location - such as a pair of coordinates, an address, or a name of a place - to a location on the earth's surface. You can geocode by entering one location description at a time or by providing many of them at once in a table. The resulting locations are output as geographic features with attributes, which can be used for mapping or spatial analysis. In figure 1 it shows map of school in Old Tbilisi District in Tbilisi.

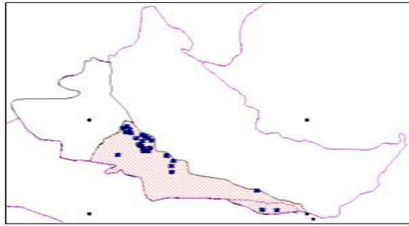


Figure 1: Map of Schools in Old Tbilisi District

A thematic map is a type of map or chart especially designed to show a particular theme connected with a specific geographic area. These maps can portray physical, social, political, cultural, economic, sociological, agricultural, or any other aspects of a city, state, region, nation, or continent (Library of University of Washington, 2008). Thematic maps are great techniques that may be used for education and school analysis. Also thematic maps can be used with statistical method which represents data with pie chart diagram. Any kind of ratio comparison used can be visualized with map. Below figure is a good example for using the thematic map with pie chart. This example illustrates ratio of boys to girls in school. This is a fragmentation of some schools in Old Tbilisi District. Size of pie chart is proportional to the number of students in a school.

Another useful technique is using a buffer zone which informs us about the coverage area of a particular school. This technique is used to decide correct school location based on residence zone, school related problems. For an example, is there any problem or not between school building and other buildings? What is the distance of petrol station from school buildings as it should be minimum 100m? Buffer analysis techniques were used in order to solve such related problems. In first analysis buffer size is selected as 500m to see distribution of schools in map. In figure 3 it is shown that density of organized schools cover approximately whole residence zone. It is also important to know demographic situation in the school coverage area for decision support by reading this map correctly.

Another significant point is to change scale of the map for specific school analysis. This technique is applied distance between petrol station and school. Based on European Union standards the distance from school to petrol station must be minimum 100m due to the fact that petrol stations are risky and dangerous for schools and residence zones. A model has been made for it. Petrol Station is represented by P and building of school is represented by S and it is formulized as follows:

$$|P - S| > 100.$$

Public School No 72 is a good example of this problem. There are 3 petrol stations near this school and they can be risky for the school. In below figure petrol stations are shown by red colored pins and school is illustrated by a column building. A buffer of 100m is drawn focusing on school location. It is observed that two petrol stations are in the coverage area of the buffer. It may result in a risky situation.

As shown in Figure 4 this petrol station is risky to the school and Public School No 20 also has the same problem like this. Appealingly, buffer is a technique that is useful for school zone analysis and probable future problems can be foreseen easily.



Figure 2: Coverage Area of School Zone in Old Tbilisi District

Using SQL Queries

Most of the actions necessary to retrieve information from a database are done with Structured Query Language (SQL) statements. SQL can be divided into two parts: The Data Manipulation Language (DML) and Data Definition Language (DDL). The query and update commands from the DML part of SQL is;

- SELECT - Extracts data from a database
- WHERE - Extracts only those records that fulfill a specified criterion
- AND - Displays a record if both the first condition and the second condition is true
- OR - Displays a record if either the first condition or second condition or second condition is true.
- ORDER BY- is used to sort the result set by a specified column

- Select Statement: This statement used to select data from a database. The result is stored in a result table, called the result set.
- SELECT column name or column names
- FROM table name or table names
- Where Clause: This clause is used to extract only those records that fulfill a specified criterion.
- SELECT column name or column names
- FROM table name or table names
- WHERE column name and operator value
- AND Operator: This operator displays a record both the first condition and the second condition is true.
- §SELECT column name or column names
- FROM table name or table names
- WHERE criteria 1 AND criteria 2
- OR Operator: This operator displays a record if either the first condition or the second condition is true.
- SELECT column name or column names
- FROM table name or table names
- WHERE criteria 1 OR criteria 2
- Order By - This keyword is used to sort the result-set by a specified column
- SELECT column name or column names FROM table name or table names
- ORDER BY column name or column names ASC|DESC

It is a good example of using SQL with thematic map is applied to Private Schools in Old Tbilisi. Data of private schools are used in different table but with the same data structure of public schools. Analysis of private schools is based on conditions such as having conference halls, sports saloons, sports fields and canteens. Following

query is applied to learn the situation
SELECT School_Name

- FROM Private School
- WHERE Sport_Salon__Yes_1_No_0_=1 and Sport_ Field_Yes_1_No_0= 1 and Conference_Salon_Yes_1_ No_0 = 1 and Canteen_Yes_1_No_0 = 1

GIS system gives results as maps and/or tables. As shown in figure 5 query and thematic map are combined. According to query results, number of students and number of teachers whose schools are eligible for the query are represented by thematic map which is supported by statistical method. Number of teachers is represented by red color and that of students is represented by green color. With the query based on our criteria, GIS system has ability to produce list of schools.

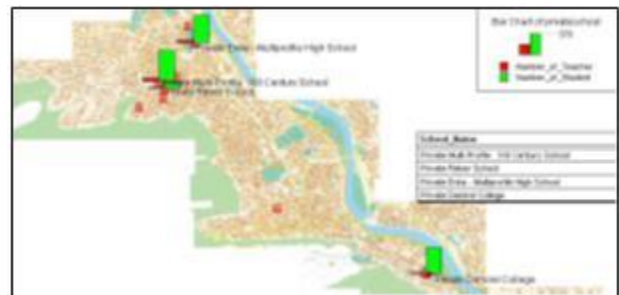


Figure 3: Analyses of Private Schools in Old Tbilisi District

Conclusion and Recommendation

A database is created based on administration management system in Georgia and this database is dynamic and it can be developed. Many administration units can easily utilize it. Management of Georgia is divided into districts. Each educational district is managed by Research Center, and each research center can see data from the other districts and can see educational situations in its own district.

This gives many advantages to administrators of education. They can see clear picture of education overview, they will have same database structure and by this way database structure is standardized across district. Whenever data are to be viewed, they can be easily visualized. An-other advantage is easy comparison of data with others.

GIS can visualize data with different size of scales so it can show exact problem with analysis. Some relations can be shown on the map and they can be categorized. If there is need to see the situation of education in general in Georgia, databases can be combined with query to give combined analyses of the pictures of education.

This model is applied to Old Tbilisi District in Tbilisi and Center of Old Tbilisi and it might be applied all districts in Georgia. Managers can determine and solve the problems fast, effectively and correctly for educational facilities. This system can be used for other ministries and local authorities.

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