An e-Enrollment Model for Public Schools in Developing Countries Using GIS

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Key words: GIM, spatial planning, school, automatic student registration, Turkey

SUMMARY

Today, GIS is an efficient tool to tackle with many issues. The matters based on geographical information like determination of school catchments areas, the routes for school service buses, and Automatic Student Registration (ASR) are not a problem anymore with GIS in education sector. But deficiencies in residential address infrastructure, graphic and non-graphic data problems, and school capacity issues are the most important difficulties for ASR especially in developing countries. Geographical Information Systems (GIS) mapping procedures are used widely in ASR process. Furthermore, this is very important tool for determination of school catchments areas and route of school service buses.

The researches have shown that deficiency of GIS mapping procedures in developing countries is an important issue in school site management. In these countries, school catchments areas are mostly not determined, because address information have not enough accuracy with up-to-date, and routes for school buses are not so efficient. In this study, firstly, student registration processes are examined and system requirements are defined. In accordance, a prototype model was developed for Turkey where there are 36.712 public primary and secondary schools. Using this model, applications were carried out with actual data. This model include several graphic data layers as roads, buildings, school locations, administrative boundaries, and non-graphic layers as street numbers, residential addresses and school capacities. As a result, students had an opportunity to enroll the nearest school via internet using address information while school buses have been managed efficiently by minimizing costs with GIS functions.

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1. INTRODUCTION

In education systems of developing countries, there are a lot of problems such as determination of school catchments areas, automatic allocation of the students in those areas, excess of capacity and route costs of school buses (Yıldırım et all, 2004). These are technically complex problems which arise from lack of up-to-date and real address data, demographic data, and census data in determination of boundaries of school catchments areas. The main issue is that there is no digital infrastructure as digital base maps, information technologies and geographic/spatial coverages in cities. Also, determination of routes of school buses optimally is not possible, because of inefficiency of road information, and address based information systems. Presently, in information age, these issues can be relieved by GIS which differs from image processing and computer assisted design (CAD) packages by its capability of analyzing geographically referenced data, has been widely used in urban planning and resource management since the 1960s (Yomralioglu, 2002). In the last five years or so, public education administrators began to explore the application of GIS in facilities management in developing countries. GIS generally facilitate preparation, interpretation, and presentation of spatial data. Each entity of spatial data has attribute(s), location, and possibly geometric and topological properties. Some school administrators may use a GIS simply to produce a paper map, on which they visually analysis the locations of schools and the distribution of students, and draw possible districting patterns.

The remainder of this paper is organized as follows. The next section reviews the relevant literature and summarizes typical properties of ASR. Then, it is introduced an ASR model that explicitly accounts for those criteria. The results are presented in the fourth section, where the implementation of the model is described by GIS software, and it is tested with actual data sets of Trabzon City in Turkey. Concluding remarks are presented in the last section.

The main steps of the study include;

- building up the digital coverages of the city (base maps, zoning plans, topography, etc);
- forming attributes of the coverages;
- determination of school catchment areas based on maximum walking distance and age distribution of students by GIS techniques;
- building up ASR by GIS techniques;
- optimization the routes of school buses based on residences of the students using network analysis techniques in GIS.

2. LITERATURE REVIEW

ASR issues in Turkey; School catchment areas are determined manually by the commissions of Directorates of National Education during the enrollment period in Turkey (TC Official Gazette 25212, 2003). Therefore, school catchment areas are not determined accurately because of lack of base maps, up-to-date information and GIS. Also, walking distances from student houses to schools are not calculated appropriately (Figure 1). So, students are faced with walking to further schools or taking school buses.

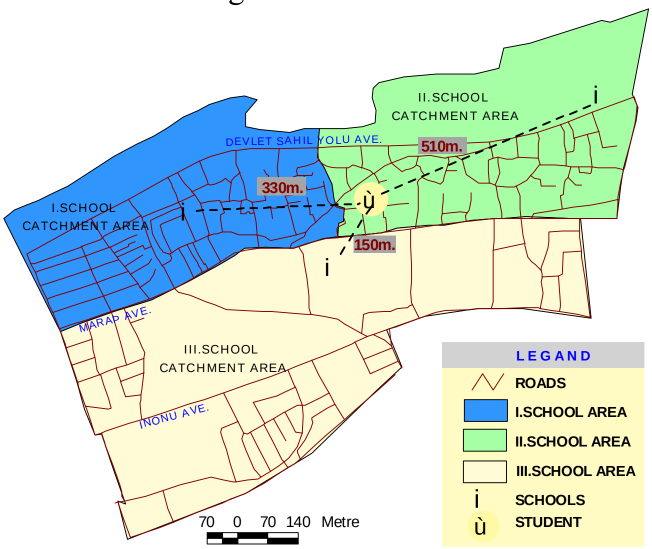


Figure 1. Distance issues for allocation to school according to existing

School Site Management and ASR Using GIS; With the help of either census or county road information, each student in the school district can be accurately mapped with GIS. A current student database is taken from the district's student information system, and students are mapped in GIS by a process called geo-coding. The address of each individual student is matched with addresses in the county or census road file. This results in a point on the map for each student. Once students are in GIS format, they can be analyzed and displayed in several ways (Matt, 2005; Armstrong et all, 1993; Bruno, 1996; Caro et all, 2004; Yıldırım et all, 2004; Pearce, 2000; Jensen, 2002; Schlosser, 1998; Zuppo and Fonseca, 1994).

Determination of School Catchment Areas; To resolve school redistricting problem a lot of solutions have been proposed and many mathematic models have been designed by researches like Sutcliffe et all, Clarke and Surkis, McKeown and Workman, Jennergren and Obel, Bovet, Bruno and Anderson, Schoepfle and Church, Ferland and Guennette, Taylor et all, and Lemberg and Church. Student attendance boundaries are also converted from hard-copy maps into GIS format. This helps determine how home schools are serving their neighboring populations. Various analyses are performed with attendance boundaries, such as the number of students who live in the attendance boundary vs. students who attend the home school, as well as the number of students who live outside the attendance boundary and attend within it. The final goal is to see if attendance boundaries are working or need to be changed (Matt, 2005).

Route Optimization of the School Buses; Any system of interconnected linear features, sets of roads, railway, rivers, pipelines, telephone and electric lines, is a network. Queries and analysis done on these systems for optimum decisions are named as network analysis in GIS (Yomralioglu, 2002). To make optimize for school buses and reduce cost are enabled with network analysis based applications. In this context, there are a lot of studies about route optimization of school buses.. (Derekenaris et all, 2001; Kerry, 2001; Anthony, 200; Andres, 2004; Marlon et all, 2005; Handa et all, 2007)

3. AUTOMATIC STUDENT REGISTRATION (ASR) MODEL

The ASR model is based on GIS, relational databases and address information system. The main components of the model that allows to capture, store, update, analyze and display all forms of geographic information are hardware, software and spatial data. Also, this model includes updating procedures, data sharing rules, and other related data. ASR model is an important part of school site management (Figure 2).

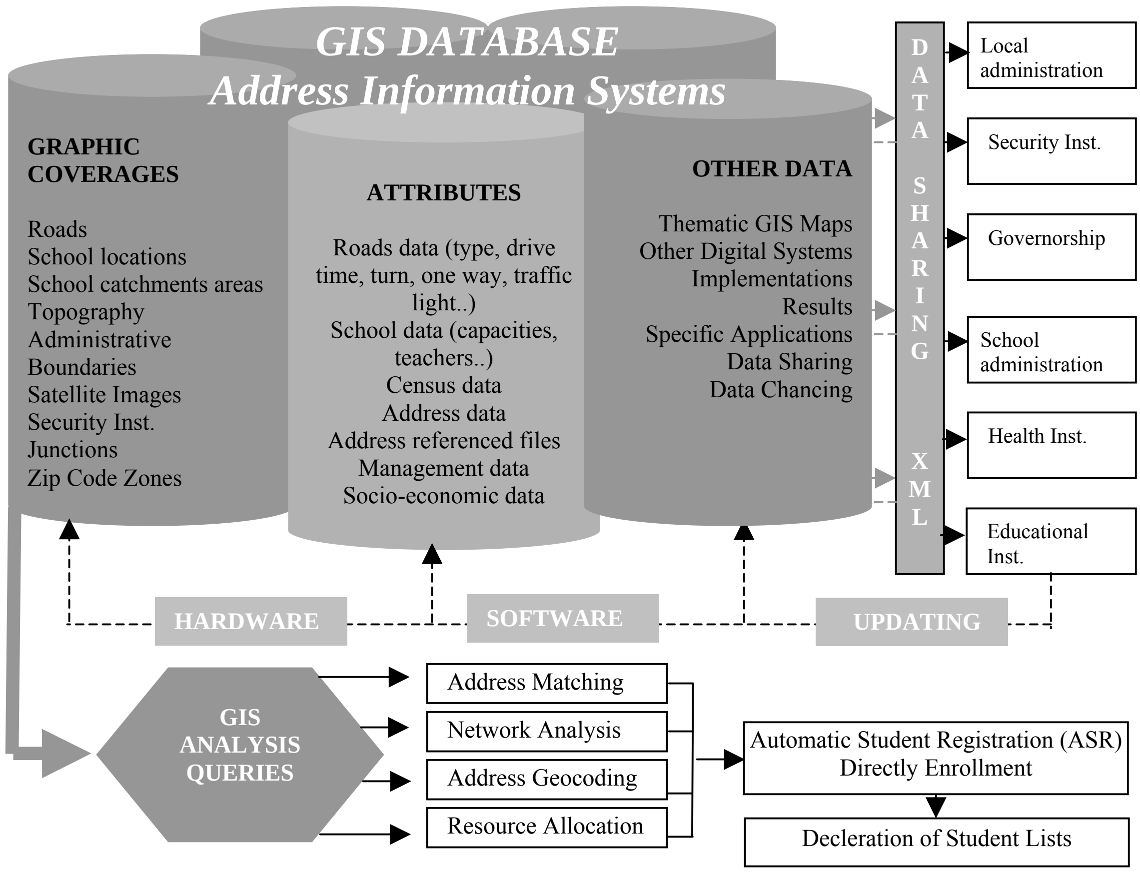


Figure 2. The Proposed Model for Automatic Student Registration (ASR)

4. SYSTEM IMPLEMENTATION

4.1. Study Area

The selected area for this study is in the city of Trabzon where is located on the Black Sea coast of Turkey (Figure 3). There are approximately 59,723 students who are attending to 74 elementary and 25 secondary schools in Trabzon city. The city has road network of 596 km, 3 boulevards, 125 avenues, and 1300 streets.

Figure 3. Study Area in Trabzon, Turkey

4.2. Components

Address Information Systems (AIS); When considered technologic innovations, it seems that building an address inventory system with classical methods, updating, querying, and realizing required analysis are not possible. In this respect, there is a systematic approach in school site management. This is a good addressing system which has always been important for systematically recording school or student information and effectively route of school buses (Lilian et al, 2000). AIS in which following, querying and displaying of numerating processes are realized in school site management applications. These applications show that, AIS including address data and address databases have to contribute to automatic student registration and route of school buses (Figure 4).

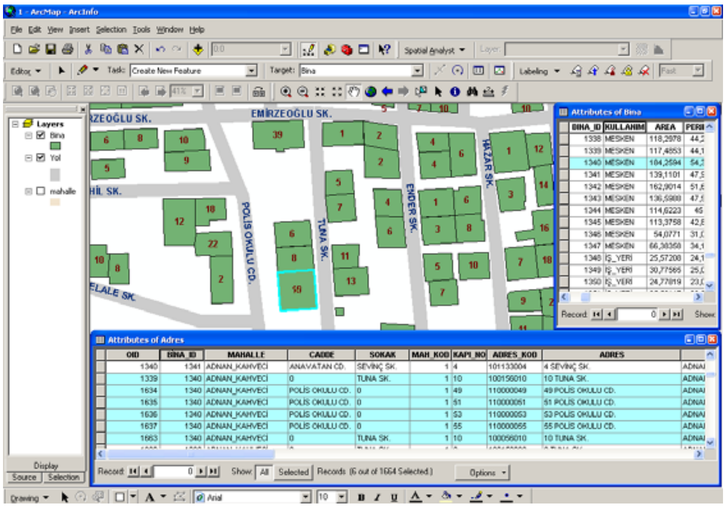


Figure 4. Address based information system for Trabzon City

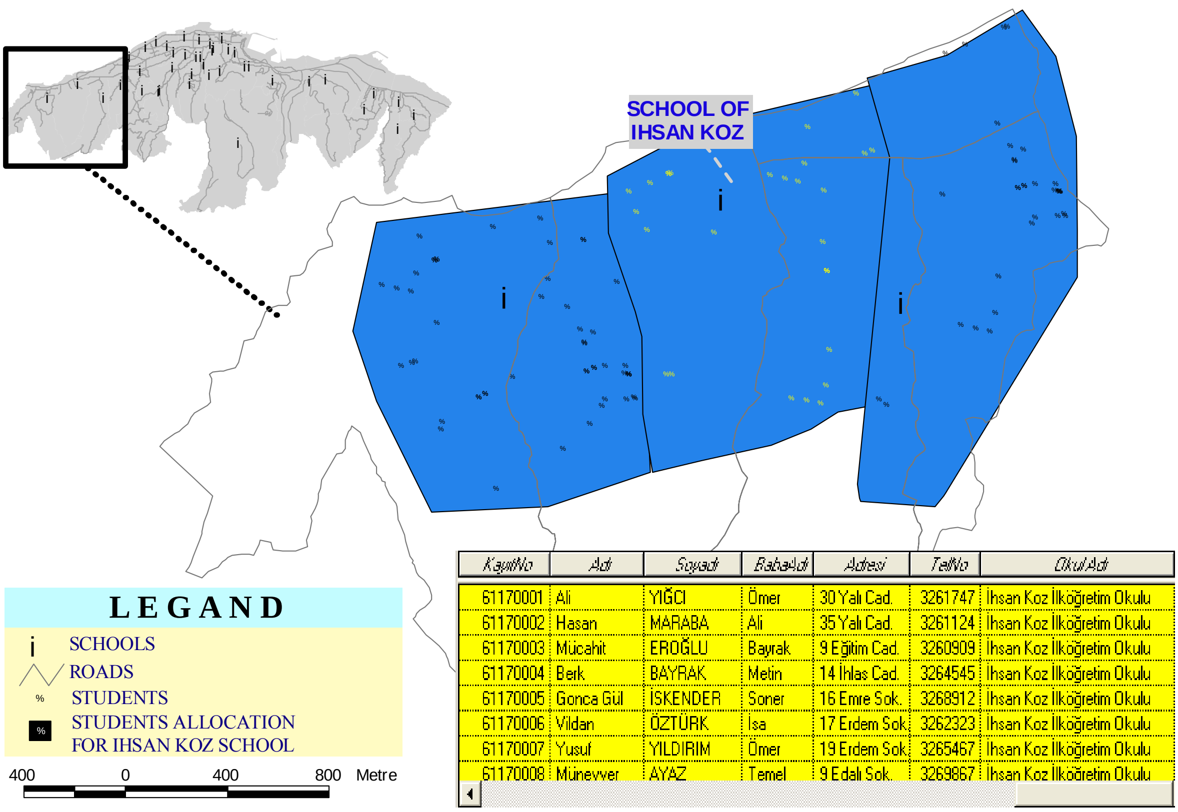
Digital Maps; The digital maps include graphical data as road networks, school locations, administrative boundaries, and buildings. These graphical data and their attributes are shown in the Table 1.

Table 1. Graphic and non graphic data

COVERAGES	**ATTRIBUTES**
ROAD	shape, road_name, R_F_add, R_T_add, L_F_add, L_T_add, Length, road_type, L_zip_code, R_zip_code, Av_speed_time_drive_time, oneway, cevering, F_junction, T_Junction
TURNTABLE	Junction_no, F_arc_no, T_arc_no, time, cost
BUILDINGS	Shape (Şekil), Alan, Cevre, Bina_, Bina_id, **Adres_Kod**
ADDRESS	Build_id, district, street, avenue, boulevard, build_number, zip_code, address, address_code
SCHOOL	Shape, area, perimeter, address_kode, education_id, name, student, teachers, type, type_code, tel, faz, note

4.3 Scenario

The system was tested for three school catchment areas in Trabzon city. In the result of this scenario, the schools that the students have to be registered were determined (Figure 5).



KayitNo	Adi	Soyadi	BabaAdi	Adresi	TelNo	OkulAdi
61170001	Ali	YIĞCI	Ömer	30 Yalı Cad.	3261747	İhsan Koz İlköğretim Okulu
61170002	Hasan	MARABA	Ali	35 Yalı Cad.	3261124	İhsan Koz İlköğretim Okulu
61170003	Mücahit	EROĞLU	Bayrak	9 Eğitim Cad.	3260909	İhsan Koz İlköğretim Okulu
61170004	Berk	BAYRAK	Metin	14 İhlas Cad.	3264545	İhsan Koz İlköğretim Okulu
61170005	Gonca Gül	İSKENDER	Soner	16 Emre Sok.	3268912	İhsan Koz İlköğretim Okulu
61170006	Vildan	ÖZTÜRK	İsa	17 Erdem Sok.	3262323	İhsan Koz İlköğretim Okulu
61170007	Yusuf	YILDIRIM	Ömer	19 Erdem Sok.	3265467	İhsan Koz İlköğretim Okulu
61170008	Münevver	AYAZ	Temel	9 Edalı Sok.	3269867	İhsan Koz İlköğretim Okulu

Figure 5. Result of the e-enrollment system

5. CONCLUSIONS

In this paper, an interactive e-enrollment model is proposed to solve the problems in determination of school redistricting and school buses route. It is seen that, the visual representation of geographical data has widespread application in educational policy analysis and school site management and GIS has proven to be an extremely effective and efficient tool to solve these problems. Also, the visualization of socio-economic, cultural, and demographic information in a geo-space provides the school site administrator and educational policy analyst with a powerful visual technique for school site management.

In this study, GIS assisted an e-enrollment model was realized for 74 elementary and 25 secondary schools and for 59,723 students in the City of Trabzon, in Turkey. This model was designed based on “maximum walking distance” for students. This study has shown that, however, digital data of cities have to be prepared firstly for school site management. Another important component is address data in school site management.

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BIOGRAPHICAL NOTES

Volkan Yildirim graduated from the Department of Geodesy and Photogrammetry Engineering at Karadeniz Technical University (KTU) in 1999. He received his MScE degree with thesis entitled "Address Information System Design and Application: Trabzon City Case Study" in August 2003. He is studying on his PhD thesis. His research interests are networks in GIS and address information systems.

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