The Application of GIS Tool to the School Mapping Data Model in Jordan

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Abstract

This research paper explains the technical components associated with building school mapping. It describes the technical procedures required for effectively use of GIS tool in schools. It also gives details about where the educational planner can obtain the data and their sources for supporting decision making processes, in a form of data model. This project constitutes the design and implementation of data modelling in education. Consequently, the paper clarifies the importance of data accuracy and its association with costs. It describes the diversity of data types required at different educational administrative levels, i.e. governorate, directorates, sub districts. Finally, the paper explains in details the role of data mining and warehouses in school mapping.

Keywords: Education Decision Support System, GIS Tool, Data Model, School Mapping, Geospatial Data, Decision Making, Educational data warehouse.

Introduction

Background and Rationale and Literature Review

GIS and Planning

The trends to use Geographical Information Systems (GIS) in planning and decision making have turned GIS into a valuable visual tool that is user friendly in many fields, where information systems are applied. However, those trends have made the tool legitimate to play a central role in the planning process, and even more in supporting knowledge management and data mining. The GIS acts as an infrastructure base for building up various perspectives from different sets of information and expert information systems. Examples are countless on utilizing GIS for planning purposes, such as GIS and multi-criteria analysis for land management, flexible GIS user interfaces for creative engineering towards system integration of GIS and rule-based expert system for urban mapping and Enterprise Resource Planning. Other works put even more focus on the role of using geospatial information as a base infrastructure in designing a GIS-based computer supported collaborative system for urban planning [1-5]. The current trend in modern organization, towards flatter structures and the involvement of many stakeholder groups in solving decision problems, is based on what can be called spatial decision support systems. [6] Also, has to decide on the role, limits and development of using and institutionalizing GIS in planning and decision support systems. [7, 8]
In Jordan, like any other developing country, the need for GIS is even more unambiguous because there are more problems in urban planning, combined with the lack of strategic planning. As a result, there is need for more resources in the form of data base or managed information systems to help visualize the complication of the problem for decision support systems and decision analysis.

**Paper Organization**

This paper is organized as follows: Section 2 briefly defines GIS types of data sources, and categories of the GIS applications. Section 3 is devoted for School Mapping and data required for school mapping modelling in Jordan, namely; how to build School Mapping application, starting with description of building warehouses for: the sub district, the directorates, and the governorates, and then illustrates the work completed for the layers to build each directorate. The implementation of School Mapping Model is presented in section 4. Finally, conclusion and future works are presented in section 5.

**GIS and School Mapping**

The trend towards using GIS and school mapping to support decision making for administrations of Education in the world is becoming very important for planning purposes and is in the implementation stages in many developed and developing countries of the world. [9-13]

In some cases, building a geo-spatial database and using GIS is becoming a standard and/or a requirement for funding agencies to approve loans/grants. More details are illustrated in the workshop conducted for DFID [14].

GIS implementation presents a major role in the educational decision support process including assisting decision-makers in either expanding current schools or suggesting sites for new schools in Jordan. The design of the Educational Decision Support System (EDSS) of the Ministry of Education will combine Geospatial database and EMIS database with modelling techniques to support problem-specific semi-structured decisions while allowing the decision makers to use their experience and insight.

School mapping can be defined in different ways. It can be defined as the art and science of building geospatial databases combined with relational databases of educational, demographic, social and economic information for schools and educational directorates to support educational planners and decision makers. In order to do proper planning, the educational sector should not start any project before providing all stakeholders with a comprehensive database of all schools, pupils, teachers and related resources. Building that part of GIS layers showing school locations and other significant geographic features such as streets, city-zoning, school-directorates, sub-districts, districts, governorates and other features provides an excellent tool for planners. For example, school mapping is utilized in constructing new schools and/or renovating existing schools. [9-16]
In order to realize this objective, different requirements need to be prepared. It is crucial to recruit qualified staff and build management capacity for utilizing such technology as an ongoing process. Furthermore, the data has to be updated regularly and to be available and durable. Experts are also of major importance to train and guide as they are the link between the geospatial database and the stakeholders managing and/or using the data. Their major role is to ensure an efficient use of available data, models, developed software and basic theoretical knowledge. This would provide usable and applicable Education Decision Support Systems, and at the same time, will build the capacity of the decision makers to create alternative solutions for different problems.

GIS and School Mapping in Jordan

This paper focuses on a remarkable and demanding project in Jordan catering for educational reform. Jordan is a fast developing country which is in the transition process of evolving in an era of technology and knowledge economy reform. The know-how and implementation strategies within this area form a part of our continuous search for improving our practices and quality of life. In fact, the Ministry of Education prepared in 2002 a major educational reform proposal to be approved and launched it in year 2003; it was titled “Education Reform for Knowledge Economy Project” (ERfKE), which represents a landmark step in the progress of change in education in Jordan. This project consists of the following five components:

- Component One: Establishment of a National School-based Development System
- Component Two: Monitoring & Evaluation and Organizational Development
- Component Three: Development of Teaching and Learning
- Component Four: Development of Special Focus Program Development
- Component Five: Improvement of Physical Learning Environments

Components one, two and five are relevant to this study. [17, 18]

During our literature review that included ERfKE project, we perceived that the funding agencies and donors required that it had to be backed up with an on-ground feasibility study based on school mapping intelligent recommendations as a precondition to secure funding for ERfKE proposal. At that time, it is required to build proper geospatial database within six months for the first phase to be approved. However, the used statistical data was an old one, not suitable for this exercise and based on 1999/2000. Moreover, the exercise was inefficient and the planners did not adopt its results for various drawbacks including: the considered data were too old, the employed application software was extremely complex and was not suitable for the exercise, and finally the staff had received limited training.
Research Question

This research is aimed at the application of GIS Tool to the School Mapping. The study attempts to answer the following research questions:

1. How can school mapping assist/support educational planners and decision makers?
2. What can be the contribution of GIS be in this regard?
3. Is the quantity and quality of data at present enough to develop maps which are helpful to educational planners and data modelling for decision-makers?

Objectives

The Overall Objective is to establish a reliable GIS database for school mapping data modelling which can be used for effective education planning and appropriate decision making. On the other hand, the Specific objectives of this research are to illustrate different steps of developing GIS for school mapping in order to:

- Collect spatial data on all education facilities and other adjacent facilities
- Enter the spatial information on the GIS software platform
- Link each school to corresponding education statistics and indicators databases
- Establish a digitized Education GIS database.

Methodology

This project suggests quantitative and qualitative methods to achieve its objectives in building school mapping. The quantitative part involves the collection and analysis of statistical, geo-spatial data related to education from the MoE policies, strategies, related projects such as Jordan Education Initiative (JEI), National Broadband Network (NBN), and the MoE’s databases application supporting the Ministries processes toward planning as well as the Ministries’ vision and mission. For school mapping purposes, it was vital to minimize the time and cost; and so, many public and private organizations using GIS were consulted to reuse their assets. Comprehensive need assessment was conducted using employing interviews, focus groups, and future indicators in the strategic plan and ERfKE II. This assessment particularly, involves the collection and/or acquisition of educational, spatial and attribute data in order to achieve the goal of this paper in building data model for school mapping. Consequently, based on the data model developed above, this project can achieve the following, discussed in a separated research:

- Visualization and diagnosis of local schooling conditions;
- Projection of needs;
- Proposal for reorganization of the school network based on a set of norms and standards.
Part of the data sources were geo-spatial data, obtained from existing databases and maps. The other part was statistical data on education, obtained from the Educational Management Information System (EMIS).

**GIS in Education in Jordan**

**Core Basic Definitions**

Geographic Information System (GIS) is defined as an information system that is used to input, store, retrieve, manipulate, analyze and output geographically referenced data or geospatial data, in order to support decision making for planning and management of land use, natural resources, environment, transportation, urban facilities, social service and other administrative records[19].

Dueker defines GIS as: “A geographic Information System is a special application of information Systems where the data base consists of observations on spatially distributed features, activities or events, which are definable in space as points, lines. or areas. A geographic information system manipulates data about these points, lines, and areas to retrieve data on an add-hoc basis [20].

**GIS Data Sources**

GIS Data sources are classified into two types; primary and secondary types and can be defined as follows:

**Primary Data:** Data is measured directly by surveys, field data collection, remote sensing, digital mapping, GPS, and data obtained from existing maps, tables or other sources. Usually, one cannot observe the spatial distribution of a variable throughout a study area, without sampling, which is based on taking measurements of a subset of the features in the area that best captures the actual spatial variation. The sampling density determines the resolution of data. Samples taken at 1 km intervals, for examples, will miss variation smaller than 1 km.

**Secondary Data:** Data is obtained from existing maps, tables or other data sources. Secondary data will also include Meta-data: “data about the data”, and some information about procedures used to collect or compile the data, data lineage, accuracy and measurement standards, coding schemes. More and more ready-made digital GIS data sets become available from Government agencies such as census geography, topographic surveys and private companies.

**Sources of Geospatial Data:** There are many sources of geospatial data including, and not limited to, digitized maps, aerial photographs, satellite images, statistical reports and other related documents as presented in this project.
School Mapping

Data Required for School Mapping Modelling in Jordan

In order to build school mapping, we need geographic data which are included in layers and data warehouses/mines and their attributes. We will examine these layers in the next section (needed data) and also what layers and data are available (available data). A digitized map typically consists of various kinds of features represented in different layers. You can think of layers as a stack of transparencies, each containing specific features when combined they make up the total map. The map layer is simply named map throughout this paper. A stack of maps can form a map view. Maps stacking order is very important in obtaining the optimal visualization.

For example, layers could be land parcels, roads, water, or school locations. Each map layer can contain only one kind of feature. Figure 3 gives an illustrative example on how to arrange four distinct layers: Schools, Hydrology, Town, and Roads.

![Figure 3 layers arrangements](image)

A **data Warehouse** is the source of geographic data where the data are sorted. Each warehouse contains only one type of geographic data, obtained and managed through different specialized software platforms such as Access, MGE, FRAMME, MGE Segment Manager, ARC/INFO, Oracle, ArcView, MapInfo, MGDM, or CAD

**Data Needed**

The data needed for the school mapping and implementation consists of two types; the first set is geographic data, i.e. vector layers and data on the educational system, especially on schools. The second data set are already available through the EMIS system, e.g. in Access, Excel, oracle and other types. The needed vector layers data fields are depicted in figure 3.1.
Excel Files. EMIS Data [21]: Several data related to the educational system (including teachers, students, and so on) are linked to spatial data in school mapping.

Figure 3.1: Vector Layers Data
**Schools Data**: Most of schools data are included in EMIS as presented in figure 3.2.

**Figure 3.2**: Schools Data Available At EMIS
**Data Availability:** The following section lists a series of GIS layers, by level of the educational administration, which are already available in MoE’s data assets at this moment.

1. **Governorate.**
   - Governorate Layer (Gov).
   - Governorate Text Layer

2. **Directorates.**
   - Continuous Directorates Layer
   - Private School location for each directorate.
   - Public School location for each directorate.
   - Locations of directorates of education
   - All new sites locations
   - Directorates Text Layer
   - A separate Layer for each directorate

3. **Sub District.**
   - Sub District Layer
   - Sub District Text Layer

4. **Warehouses for each Governorate.**
   - Governorate Layer.
   - Sub District Layer.
   - Directorates layer.
   - Streets Layer.
   - New site locations layer
   - Text layer
5. Attributes:
Each layer has many attributes; they help explain these layers. The following section contains a number of layers, the most important attributes are:

### Sub District Layer
- Gov ID.
- Gov Name in English.
- Gov Name in Arabic
- Directorate ID.
- Directorate Name in English.
- Directorate Name in Arabic.
- Sub District ID.
- Sub District Name in English.
- Sub District Name in Arabic.

### Directorate Layer
- Gov. ID.
- Gov. Name in English.
- Directorate ID.
- Directorate Name in English.
- Directorate Name in Arabic
- Gov Name in Arabic.
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**Governorate Layer.**
- Gov. ID.
- Gov Name in English.
- Gov Name in Arabic.

**Schools Layer.**
- School National ID
- School Name
- School Gender
- School Type (Public, Private)
- School Building Type (Owned, Rented)
- School Establish Year
- School Level (KG, Basic, Secondary)
- School Telephone
- Location Position (X,Y) axis
- Position Latitude, Longitude (Lat, Long)
- No of Students
- Area of Classes
- No of Teachers, Managers, Technicians etc
- Directorate
- Town, Village
- (Single, Double)Shift.
- School size (no. Of rooms))
- Authority
- Number of KG Rooms
- Number of Special Needs Rooms
- Number of Resource Rooms
When reviewing the previous layers, one can observe that there are missing ones, due to unavailable information at the MoE. There is inadequate information regarding layers which referring to Town, Village, Hydro, Contour, catchment area for students, and Population. Data relating to the street layer in addition, information regarding bus service, the number of the buses, its schedule, and the bus route, and capacity are very important to establish if children going to school in this area need to use a bus service. Without this information, it becomes more difficult to conduct a detailed and useful analysis.

Implementation of School Mapping Model

The School Map is part and parcel of the educational planning process, because the implementation of School Mapping means developing priority lists of schools, establishing optimal locations and developing recommendations for new school construction. The implementation of school mapping can be divided into many stages. [9-13]

The researchers will first examine the process which is used, within GIS, to set up the geographical data base. The first step is to identify the information that we have to establish and what information is missing before we start creating school mapping. However, in practical terms, it is sometimes impossible for a planner to have all the required layers, (all the information) due to costs implications, timing and updating, accuracy, thus the planner can only rely on the available data.

The next process which has to be developed is conducted in two stages. Firstly, building the warehouses; secondly, preparing the layers. To build those warehouses, the researchers will proceed through three steps: building sub-district warehouses, building directorate’s warehouses, building governorate warehouses.
Building many warehouse for sub district, Directorate and Governorate

**Building sub district warehouse.**

**STAGE 1**

**Step 1**

Building sub district warehouse.

**Inputs:**
- Digital data of sub districts

**Analysis**
- How to build sub District Layer

1. Attribute Query by Name.

2. Area by face to make all the layers of sub districts at the same layer.

3. Sub district Text

4. Outputs:
   - Warehouse of Sub districts.

**Figure 4.1 Sub district warehouse.**
**A. Inputs:** Digital data for sub districts.

**B. Analysis:**

1. Using **Attribute query by name** to call all the sub district layers to the same warehouse.

2. Using Area by face order, to lay out all these layers into one layer which contains: Sub Districts with Name and ID attributes.

**C. Outputs:** Warehouse for Sub Districts contains Sub Districts, and Text layers.

Building directorates warehouse. A directorete warehouse is presented in Figure 4.2
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Directorates Text.

Outputs:
Warehouse of Directorates.

Figure 4.2 A Directorate Warehouse

A. Inputs: Prepared layer of sub districts.

B. Analysis:
1. Using **attribute query by name** to limit the entire sub districts that should be at each directorate.
2. Using **Area by face** order, to lay out all these layers into one layer which contains: Directorates with Names and ID attributes.
3. Merging all sub districts that should be within one Directorate.


Also you will see for each Governorate

Building Governorate warehouse

Step 3

Inputs
Prepared data of Directorates

Analysis:
How to build Governorates layer?

1. Attribute Query by Name

2. Area by face to make all the layers of Directorates at the same layer.

3. Merge the directorates to build the boundaries of each Governorates
Figure 4.4 Governorate warehouse

A. Inputs: Prepared layer of Directorates.

B. Analysis:

1. Using attribute **query by name** to limit all the Directorates that should be at every governorate.

2. Using **Area by face** order for each governorate to lay out its directorates together, and then to lay out all the governorates into one layer, which contains: Governorate Names and ID attributes.

3. Using merge order to merge all the directorates that should be at the same governorates, and then to merge the entire Governorate into Jordan Boundary.

C. Outputs: Warehouse for Governorates contains Governorates and Text layers. **Preparing multiple layers to each directorate Warehouse using ArcView or ArcGis Programs.**

Stage TWO:

A. Inputs: 1. Digital data of Jordan, which are Street layer.

2. Directorates layers which were prepared earlier in stage one.


C. Outputs: five layers added to each directorate warehouse (directorate border, streets, districts, sub districts, and directorate text).
Conclusions and Future Works

This paper dealt with the role of school mapping and GIS in the Hashemite Kingdom of Jordan. The research question is: “How can school mapping assist and support educational planners and decision makers by means of GIS. Initially, this paper examined the international literature regarding the role and usage of school mapping and GIS. Following on, it explained the catalytic role the school mapping project in Jordan can play as a result of the launch of ERfKE in 2002 and it extension plans for ERfKE II by the Ministry of Education reform plans.

The research has a number of objectives, where the key objective is to establish a reliable GIS Database for school mapping through building school mapping data model, which will be used for effective planning and appropriate decision making.

At the outset, GIS terms and definitions are explained. The paper explained different types of data sources used, i.e. primary and secondary data, and explained the Geospatial data terms. Moreover, the paper explained how data can be used in school mapping in Jordan and their usage in the applications of school mapping modelling, and explained the terms and functionality of layers, warehouses and attributes as well as the necessary technical terms. As the basis for the next phase, of the future research focusing on human resources capacity building necessary for successful GIS application and implementation as a tool for decision making.

Moreover, the paper described the main component of the school mapping, namely; data sources acquisition, data processing using the GIS tool, the resulting thematic maps along with accurate and relevant data and information, and their association with costs for decision making. The implementation of this research in one of the directorates is one of the research team future works. It describes the diversity of data types required at different educational administrative levels, i.e. governorates, directorates and sub districts. Finally, the paper explains in details the role of data mining and warehouses in school mapping.

Future work is based on building a public private partnership to provide the missing layers mentioned above, and to use the model in all policy research and problem solving for planning decision making.
تطبيق نظم المعلومات الجغرافية في إنشاء نموذج للخريطة المدرسية في الأردن

ريم الخرخوف

ملخص

تشرح هذه الورقة المكونات التقنية المرتبطة بإنشاء الخريطة المدرسية. فهي تصف الإجراءات الفنية اللازمة والفاعلية لاستخدام نظم المعلومات الجغرافية في التطبيقات المتعلقة بالمدارس. وتشير هذه الورقة التفاصيل للمخطط التربوي عن البيانات الضرورية الواجب الحصول عليها ومصدرها لدعم عمليات صنع القرار، في شكل نموذج البيانات. هذا الورقة ستعرض تصميم وتنفيذ نماذج البيانات في مجال التعليم، وهذه الدراسة تضيف للدراسات السابقة من نوعها في المنطقة الجانب التطبيقية. نتيجة لذلك توضح أهمية الدقة بالبيانات واتباعها مع التكاليف، كما أنها تصف أنواع البيانات المطلوبة على مختلف المستوى الإدارية (محافظة، مديرية، دوائر فرعية)، وشرح الورقة بالتخصص دور البيانات وتحليلها وتخزينها في إنشاء الخريطة المدرسية.

References


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Appendix 1. The following figures are samples generated from the implemented School Mapping application model for: governorates, sub districts, MoE and directorates of education layers.

**GOVERNORATES LAYER**

**SUB DISTRICTS LAYER**
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MOE AND DIRECTORATE OF EDUCATION LOCATION LAYER

DIRECTORATE LAYER
AMMAN DIRECTORATE LAYER

SCHOOL LOCATION LAYER