THE ROLE OF GIS IN DOCUMENTING BAHRAIN'S HISTORIC CITIES

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Abstract. Geographic information systems have long been established as useful tools for urban planning. The aim of this study is to put forward applications of GIS (Geographic Information Systems) to urban conservation in cities with architectural heritage. The study presents a specific database design to be integrated within a GIS, and the methodology of gathering data for such a database.

This study concerns Bahrain's architectural heritage, which includes many significant historic buildings as well as an overall traditional character of Bahrain's old towns. This heritage is endangered due to extensive new urban development and the general neglect over the past decades. The study also describes an experimental database that is implemented for documenting the urban character of the old towns of Manama and Muharraq. This database was tested during a partial visual survey of Manama. It is hoped that this database will be the nucleus of a long-term process of urban conservation in the Kingdom of Bahrain.

The work described here is part of a larger study conducted by the UNDP (United Nations Development Program) and the municipal government in Bahrain. A group of international experts in urban planning, urban design, and historic preservation also presented their own specific recommendations. The author of this paper was responsible for designing the GIS that helps in documenting the historic cities of Bahrain.

This report proposes the development of a geographic information system for urban conservation planning. The system supports planning specialists and decision makers in their areas of work, such as the creation of urban conservation zones and redevelopment strategies. The system documents existing structures and their present conditions in order to assist in decisions regarding their preservation, restoration, and possible reuse. Such a system will also help the municipalities in regular heritage management tasks.

1. Introduction

The government of Bahrain and the municipalities of the old towns of Bahrain need a database designed to support decisions about urban conservation. A previous governmental attempt at creating a GIS-based record of architectural heritage exists. This attempt produced an incomplete and scattered record of some buildings that were deemed significant by the individual surveyors. Such a record cannot be used efficiently for planning and zoning purposes, in part because it does not provide any information about the surroundings of the significant buildings.

On the other hand, there is a general-purpose GIS developed by the government of Bahrain that is mainly designed and used for fiscal purposes, such as tax and fee collection. This system is useful as a starting point for mapping the urban fabric, but it cannot be relied upon exclusively for conservation planning due to the lack of some crucial data related to the character and condition of the built environment.

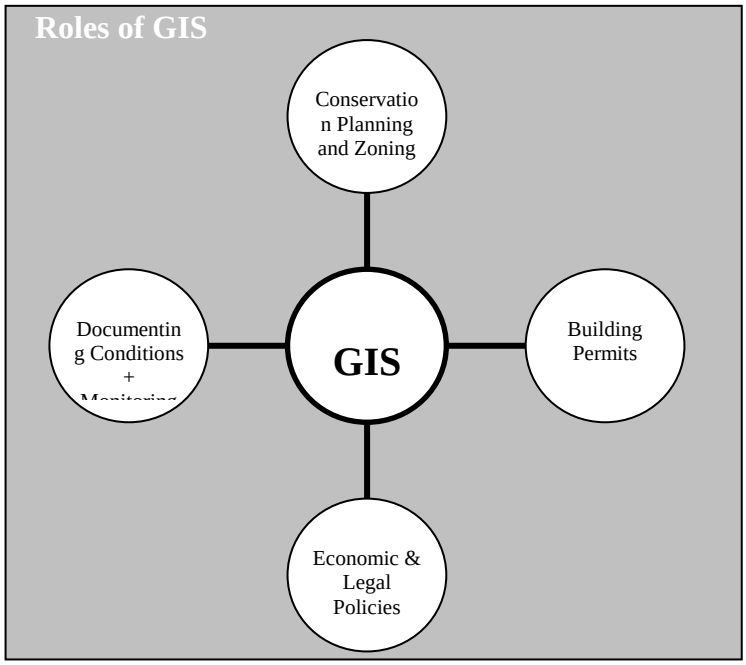
This study proposes the development of a database of all buildings within the historic district. A field survey would generate data for this database, which would be linked to the existing GIS and used for storing and exploring information about the urban conservation zones of Bahrain. This will facilitate the use of the database in an array of application, such as urban planning and zoning tasks, investment and tourism planning, architectural studies and research, and Web publication for facilitating public access to information.

Several projects of this type have been attempted around the world and documented in proceedings of symposia of the International Committee for Architectural Photogrammetry (CIPA), which is one of the international committees of International Council on Monuments and Sites (ICOMOS). The CIPA Working Group II for "Documentation and Information Management" promotes publication of GIS-related papers (for example, Bilgin, 2003; Boriani et al, 2005; Erdem et al, 2003; and Nayci et al, 2003). These proceedings are available on the Web (http://cipa.icomos.org/).

The purpose of the proposed geographic information system is to:

- Support planning specialists and decision makers in their areas of work, such as the creation of urban conservation zones and redevelopment strategies.
- Document existing structures and their condition in order to assist in decisions regarding their preservation, restoration, and possible reuse.
- Document demolished and ruined structures in order to aid in their rebuilding or redevelopment as determined by the historic preservation specialists.
- Provide documentation to support various financial and judicial initiatives.
- Help the municipalities in managing building permits within the historic zones.
- Monitor any unsupervised changes to the historic built fabric.

- Promote public awareness about the historic cities of Bahrain through publication of maps in print and Web formats.



2. Database Design

A "real" database takes months to design, develop, and test. Given the short period that was available for this task, the database design that was achieved is experimental in nature and cannot be treated as a final product that is deployable across governmental institutions. For example, no formal gathering of requirements was attempted; i.e., it is not known exactly how the database will be used. Without this knowledge, the consultant is forced to come up with a design that can satisfy the immediate needs of the project and one that can be implemented in the given amount of time.

A preliminary database was implemented during the second work phase to serve as an early model for a GIS. This database, like any other software system, needs to be continuously tested and refined as it is being inhabited with data and maintained by specialists.

A regular forms-based database entry and retrieval system was developed. It permits the storage of different types of information about buildings and properties. Each building is given a unique identification number used to link entries in the database tables with the building's

location on the map (see *Figure 1*). This permits the use of the database for planning and zoning as well as for producing different kinds of maps.

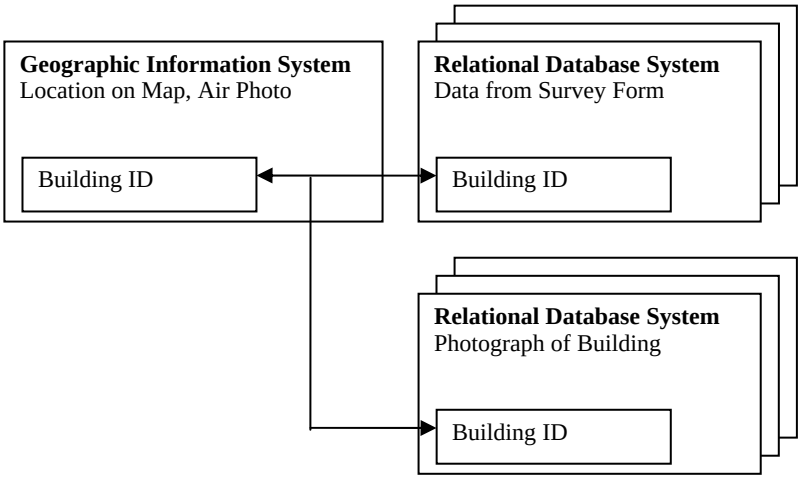


Figure 1. Diagram showing conceptual design of the proposed database system.

The following tasks were completed during the UNDP mission:

- Setup of an experimental database.
- Testing the database with the field survey that was proposed by the zoning and conservation consultants.
- Entering survey data into the database.
- Training government employees to continue adding data into the database after the consultants have left.

Implementations:

- Members of the mission's team designed a prototype GIS that can serve as the basis for a conservation planning system. This prototype is composed of a new map and a related database system. The consultants have also designed a sequence of field data collection, followed by data entry into the database system. This sequence has been tested in the field on a group of parcels in Manama.
- The system is composed of GIS maps of buildings and properties. The maps are linked to other tables and data, such as photos of buildings and other types of related documents like deeds, etc.
- The system is to be inhabited by data collected through a purposely designed survey form.
- Initially, there will be a need for increased human resources in order to build the system, collect data, and inhabit the system with data. However, on the long run, fewer resources can suffice to maintain it.

3. Information Needed

Different kinds of information are needed for the design and development of the conservation planning GIS:

- A clear idea about the different cases in which the database will be used. For example, the kinds of queries and searches that will be conducted. More generally, what different uses and applications of the database can be foreseen?
- Better maps and geographic data of the study area. Due to budgetary and social constraints, there seems to be a problem with updating the cadastral survey. Many properties are not delineated in the base map. This may hinder the progress of data collection and analysis, especially when it comes to zoning and urban design. In such studies, there needs to be a clear distinction between public and private land, as well as a clear outline of open space.
- Census reports for the two urban conservation zones. The Planning Department at the MOMAA (Ministry of Municipalities Affairs and Agriculture) has provided some of this data but it is incomplete and needs to be related to the GIS maps.

4. Available Information

In general, governmental data in Bahrain is hard to obtain. There is no clearing house or Web access to geographic and other data. Nevertheless, MOMAA officials were very helpful in providing contacts. The following sources of maps and relevant data were identified:

- MOMAA's Information Systems Department maintains a remarkable GIS that includes map layers of several themes that are designed for building permits and taxation purposes.
- High-quality digital images from recent air photos and satellite images were provided. Historic air photos from various years during the 20th century were also available. These photos are rectified to match the projection of municipal maps.
- MOMAA has also developed various GIS applications used by many departments in the ministry and by the municipalities for permits and other urban land management functions.
- The Planning Department at the MOMAA has census data for the years 1981, 1991, and 2001.
- Other potential sources of data include the Department of Properties at the MOMAA, the Ministry of Housing, the Surveying Authority, and the Ministry of Information, especially the Restoration Department and the National Museum.

5. Field Survey

An inventory of the buildings and open spaces in the historic centers of Manama and Muharraq was proposed by the conservation and preservation consultants. The complete inventory must be performed through an extensive field survey covering the proposed protection perimeters and buffer zones.

A specially designed form for data collection was designed by the consultants concerned with conservation zoning and preservation in collaboration with the author (see survey form in *Figure 2*). The design and revision of this survey form involved several cycles of modification, during which the form was tested on actual areas in Manama.

The survey form is divided into several sections:

- The top section designates an ID for the building along with its address and other administrative data.
- The "property ownership and uses" section documents the building and land use.
- The "Building Details" section records several aspects of the construction of the building and its occupants, such as the building typology, height, number of floors, and construction system.
- The "Buildings of Architectural Significance" section is filled only when a significant building is encountered. It records, in detail, the historic elements in the architecture of the building, such as wind towers, traditional balconies and doors, etc.
- The final section is to be filled by the conservation and preservation experts, who decide on the possible type of intervention for each building. There are three categories of intervention: preservation, new construction, and demolition.

The field survey began with groups of surveyors employed by the MOMAA during our mission. Before the beginning of the field survey, our team of consultants instructed them on the inventory objectives, the survey forms, and the techniques to be used.

For a few days, the surveyors worked together with the consultants, receiving further training on the ground and then performing the survey. This resulted in completing the inventory for a small area in Manama. In parallel with the test field survey the following operations were carried out by the team of consultants and the survey supervisors:

- a) Updating and preparation of base maps in preparation for data entry.
- b) Downloading and renumbering of the photos of the surveyed buildings.
- c) Beginning of the data entry into the GIS.

The tasks involving the GIS were completed in the following weeks by the team of consultants. These tasks included redrawing parts of the maps where the building boundaries were not available from the municipal GIS. In addition each building was given a unique ID that comes from the survey

form. After this, the survey form data is entered into the database system and a link between the GIS and the database tables is established.

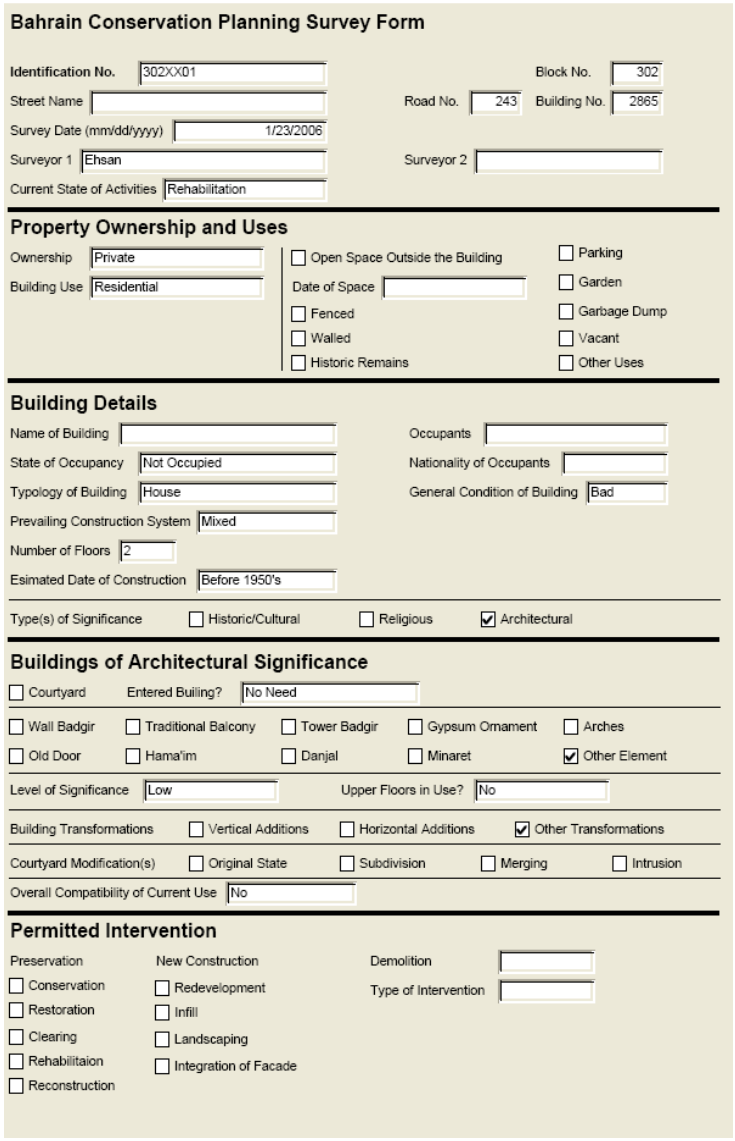


Figure 2. Screen capture of the data entry form.

Figure 3. Example of a map where surveyors have outlined and numbered some buildings.

6. Sample GIS Output

In order to illustrate the usefulness of the field survey and the collected data, several thematic maps for the surveyed area were generated and incorporated in the following pages. Each of these maps is generated from the system with simple GIS commands that color each building according to its attributes in the database table.

Figure 4. Building use map showing the infiltration of various commercial uses into the residential fabric.

Figure 5. Building condition map showing many building in bad condition (cyan) and a single ruin (blue).

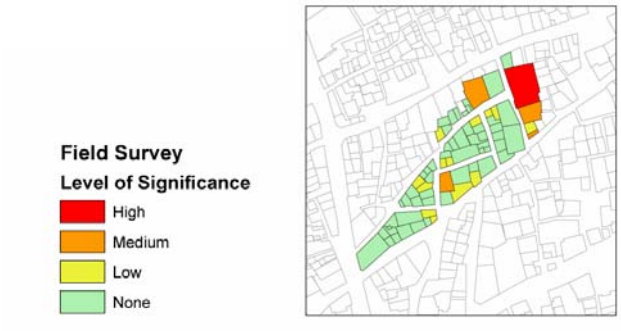


Figure 6. Map showing a single high significance building in the surveyed area (red) and a few of medium significance (orange).

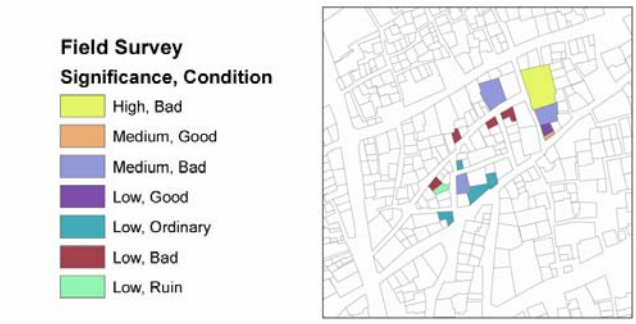


Figure 7. Map showing a combination of two attributes that is useful for decision making, such as choosing buildings for restoration projects.

7. Summary

There is an urgent need for a geographic database designed to support decisions about urban conservation in Bahrain. The purpose of the proposed system is to support planning specialists and decision makers, in their areas of work, such as the creation of urban conservation zones and redevelopment strategies. The system can also be used to document existing structures and their present conditions in order to assist in decisions regarding their preservation, restoration, and possible reuse. It is also crucial for monitoring any changes to the historic built fabric.

I have described a prototype system that can serve as the basis for this conservation planning system. The consultants have also designed a sequence of field data collection, followed by data entry into the system.

- The system is to be inhabited by data collected through a purposely designed survey form.
- The proposed GIS may be hosted by the MOMAA and accessed remotely by all municipalities.
- Initially, there will be a need for increased human resources in order to build the system and inhabit it with data.
- The system needs to be linked to existing governmental GIS.
- In the case of significant buildings, the system must provide links to complete building documentation.
- The proposed system needs to be continually refined as the needs change.

I have also described the experimental database that was tested during a partial visual survey of Manama. The survey was designed and conducted with the zoning and preservation consultants. It is hoped that this database will be the nucleus of a long-term process of urban conservation in the Kingdom of Bahrain.

Acknowledgements

This report summarizes my findings and recommendations resulting from two work phases as IT Consultant on the "Capacity Building for Enhancement of Urban Governance" project, undertaken by the UNDP/Bahrain and the Ministry of Municipalities Affairs and Agriculture. The first work phase was from 16 November till 25 November 2005, while the second work phase was from 16 January till 2 February 2006.

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