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Making Infrastructure data base using GIS applications – Baniwalid bridges

Abdelrazag Faraj Emhemed[1], Khadeejah Abdulsalam Mohammed[2],

[1]The Libyan Centre for Engineering and Information Technology, Baniwalid, Libya.

[2]Department of Geography, Faculty of Art, Baniwalid University.

*Resqe2010@gmail.com

Abstract: A GIS is a computer system that helps users collect, process, edit, manage, share, analyze, and visualize large amounts of data to understand spatial relationships, patterns, and trends. Moreover, because GIS provides the tools needed to create and analyze data related to infrastructure development and management, it allows managing and sharing data and converting it into easily understandable reports, which helps in developing strategies for sustainable development. In this paper, a database for bridges was created within the city of Baniwalid as a first stage to benefit from the applications of GIS in the infrastructure by feeding the open source platform (OpenStreetMap) through the phone application (CartaView), And the ArcGIS application to create an integrated database about concrete bridges in the city in order to archive all geographical and engineering information and maintenance dates. The structural condition of the bridges was also evaluated by visual inspection and all damages was mentioned. Through the use of mobile and computer applications and open platforms for GIS, a giant database can be created to be used in all future plans for the maintenance and development of infrastructure within the city.

Keywords: GIS, Karta view, Openstreetmap, Infrastructure, Bridges, and Baniwalid.

I.Introduction:

Geographic Information System (GIS) is a system for mapping and analyzing any object on earth. It is a way of gathering, storing, and managing any type of data with spatial components. GIS data are usually stored in more than one layer. This is the fundamental aspect of GIS, and working with layers of geographical information is generally known as data integration. GIS technology integrates powerful database capabilities with unique visual

perspective of a good old fashioned-map. This makes GIS unique among various information collection systems[1]. This study is conducted in Bnaiwalid, Libya with the objective to explore the potential of GIS in capturing, storing, updating, retrieving, displaying and printing data to facilitate Concrete bridges database management. This infrastructure data base is built effectively within the district by using the applications of ArcView software, Carta view application and Openstreetmap website. This case study area (Bani Walid) is a city in Libya with a population of 103200 inhabitants and an area of 19710 km2, positioned at 31˚, 20'N latitude and 14˚, 35'E longitude respectively. Bani Walid is located in Northwest Libya in the Misurata District and has borders with Tarhuna and Msalata municipalities in North, Misratah in Northeast, Sirt in the East, Mizdah in West and Gharyan in Northwest respectively as shown in (Figure 1) [2].

Figure 1: Baniwalid city location.

II.Research objectives:

There is no any descriptive or engineering data about these bridges, the dates of maintenance are vague and unclear, and there is no previous database of infrastructure within the city.

Research objectives:

- Inventory of the main bridges within the city.
- Performing visual examinations and assessments.
- Collecting data from previous reports, research and tests on these bridges.
- Preparing an integrated database about bridges, including location, engineering dimensions, visual assessment, type of maintenance required, etc.
- Entering the database for the GIS program (Arc Gis) to facilitate access and update it in the future.

III.Methodology:

The start of work will be through the Carta View application to carry out street level imagery and feed the OpenStreetMap platform. Carrying out visual inspections and field visits to bridges, so start making the bridges database in Arc-gis.

Karta view:

Karta View is a project to collect crowdsourced street-level photographs for improving OpenStreetMap. Contributors gather imagery with their smartphones using an Android or iOS app. It is also possible to upload images captured with other cameras. The Kartaview app supports using an OBD-II dongle plugged into the vehicle; in concert with the mobile device's GPS, Kartaview can derive more accurate image locations. The app also recognizes and processes street signs in real time while capturing imagery. OpenStreetMap editors can access KartaView images using the ID editor or JOSM plugin [3]. The program performs ground-imaging operations by hanging it inside the car and driving on the road network to photograph it and as shown in figure (2).

Figure 2: hanging on the mobile and start tracking the routes [3].

OpenStreetMap:

A community of mappers that contribute and maintain data about roads, trails, cafés, railway stations, and much more, all over the world, builds OpenStreetMap. OpenStreetMap emphasizes local knowledge. Contributors use aerial imagery, GPS devices, and low-tech field maps to verify that OSM is accurate and up to date.

Bridges within the city:

Work has been done on three main bridges inside the city, namely:

- **Baniwalid main bridge in the city center:**

The Baniwalid Bridge is located at the entrance of the city. This bridge was implemented during the seventies of the last century and was opened to traffic in the eighties. It considered the main artery for traffic, linking the two sides of the city. Its length is about 500m, and its width is 20m. It has two directions; each direction is 8 meters wide. A median berth and on each side a berth for pedestrian movement. The construction system of the bridge consists of 31 average spans, each of which is 14.5 meters long, and each span consists of 18 pre-stressed beams, with a height of 0.72 meters and a width of 1.00 meters [4].

Figure 3: Baniwalid Main Bridge [4].

- **Western Bridge in the Noura tribe:**

The bridge is located west of the city of Baniwalid, and connects the northern and southern banks of the valley. The Romanian Contractex Company established this bridge in 1984 [5]. This bridge is considered the nerve centre of the western region of the city as it connects a number of residential communities to each other. It is considered one of the reinforced concrete bridges poured on the site. It is 180 meters long, 10 meters wide, and contains 100 cylindrical holes with a diameter of 1 meter. As shown in the figure (4).

Figure 4: Western Bridge [5].

- **East Bridge in the Isahga tribe:**

As the same of the last bridge, this bridge is 180 meters long, 10 meters wide, and contains 100 cylindrical holes with a diameter of 1 meter, The Romanian Contractex Company established this bridge in 1984 [5]**.**

IV.Infrastructure Database:

Street Level Imagery:

The first step to build the infrastructure database is tracking the bridges with Karta View application to take pictures and obtain some geometric information. Figures 5, 6 and 7 show the results,

which make data ready to be modified in OpenStreetMap.

Figure 5: The main bridge.

Figure 6: The east Bridge in the Isahga tribe

Figure 7: The western Bridge in the Noura tribe.

Figures 5, 6 and 7 show Karta View routs, the purple dots represent the location of the photos

and you can show and download any pictures just by clicking on the purple. Yet this option gives you advantage to input the information to OpenStreetMap platform.

OpenStreetMap Platform:

After the bridges information were uploaded by Karta View, the next step is start modifying the Information and data on the OpenStreetMap website to get a shape file for the bridges, as shown in the figure 8.

Figure 8: Editing the main bridge information on OSM platform.

In OpenStreetMap.org/edit and as an open source platform, any one could edit and make use of the information. So after selecting Karta View pictures as overlay layer, the whole information of bridges (location, coordinates, length, width, lanes, type, date of construction, Etc.) will be ready to input and download as a shape file later.

Collecting Information:

In this step, Bridges are coded to facilitate data entry as follows:

Table 1: Bridges Codes.

Bridge	Code
Baniwalid main bridge	BC01
Western Bridge	BC02
Eastern Bridge	BC03

- ✓ **Geographical and engineering data**:

Geograohic and engineering data about bridges were gathered from Google map pro and reports and some of the references that were mitioned at the end of this paper and it shows up in table 2.

Table 2: Geographical and engineering data.

Bridge	Code	Coordinate		Type	length	width
		N	E			
the main bridge	BC01	31°45'38.2"	14°01'02.2"	precast concrete	500m	20m
Western Bridge	BC02	31°45'31.1"	13°57'23.0"	Cast-in-Site Concrete	180m	10m
Eastern Bridge	BC03	31°48'52.5"	14°04'54.9"	Cast-in-Site Concrete	180m	10m

- ✓ **Visual inspection data**:

Table 3: Visual inspection result.

Bridge / Element	BC01	BC02	BC03
Traffic	High	medium	low
Asphalt	Cracks – Ex. cracks- Rutting	Cracks	Cracks-Rutting
Abutments	disintegration of concrete cover + Steel rust + Cracks	disintegration of concrete cover + Steel rust + Cracks	disintegration of concrete cover- Steel rust + Cracks
Rubber pillows	corrosion	-	-
Bridge foundations	soil erosion + Cracks	soil erosion + Cracks	soil erosion + Cracks
Expansion joints	Need maintenance	Need maintenance	Need maintenance
Sidewalks	Almost good	-	-
Protection fence	Need maintenance	Need maintenance	Need maintenance
Approach slab	horizontal creep	No approach slab	No approach slab
drainage channels	Need maintenance	Need maintenance	Need maintenance
In general (1-9)	5	6	5

- ✓ **Destructive and non-destructive tests for concrete**:

There is little information about the tests and as it appears in the table 4.

Table 4: Date and type of tests.

Test / Bridge	BC01	BC02	BC03
Penetration Tests on Concrete	YES (2016)	NO	NO
Rebound Hammer Method	YES (2016)	YES (2013)	YES (2013)
Pull-Out Tests on Concrete	YES (2016)	Unknown	Unknown
Dynamic Non Destructive Test	YES (2016)	Unknown	Unknown
Radioactive Methods of NDT	YES (2016)	Unknown	Unknown

Concrete Maturity Testing	YES (2016)	Unknown	Unknown
Coring	YES (2016)	Unknown	YES (2013)
Moisture Testing	YES (2016)	Unknown	Unknown
Rebar Locators and Cover meters	YES (2016)	Unknown	Unknown
Concrete Crack Monitors	YES (2016)	Unknown	Unknown

Arc GIS (Geo-Database):

After collecting the data about the bridges as they appear in the tables above, and completing the street level imagery work in the Kartaview application, and editing the data for the OpenStreetMap platform to obtain an updated shapefile, The authors moved on to the last stage, which is to create a Geo-database in the ArcGIS 10.2 program, and as shown in the figures (9), (10).

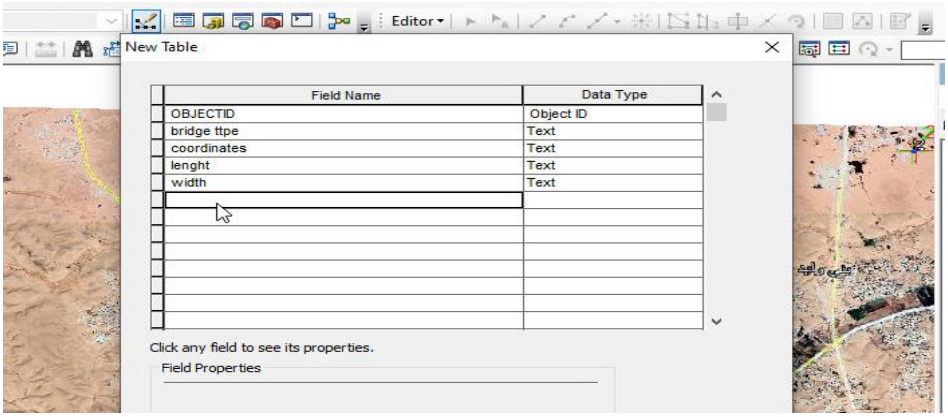


Figure 9: Bridges geodatabase in Arc GIS 10.2.

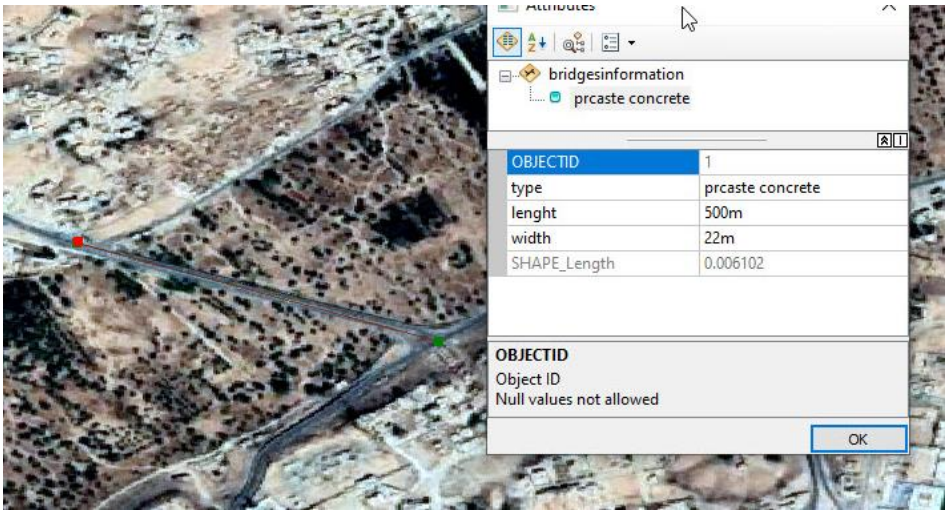
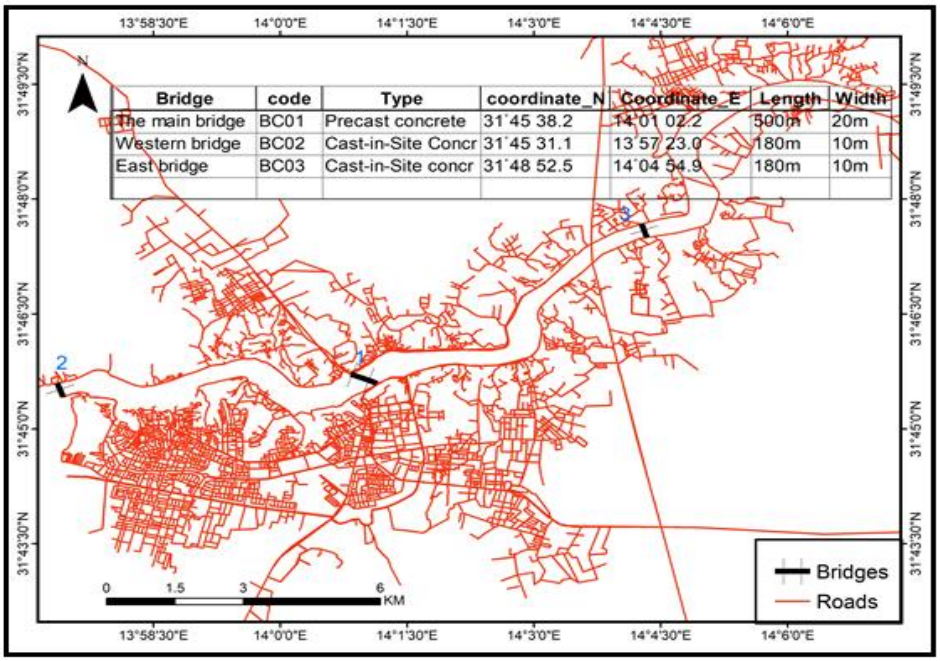


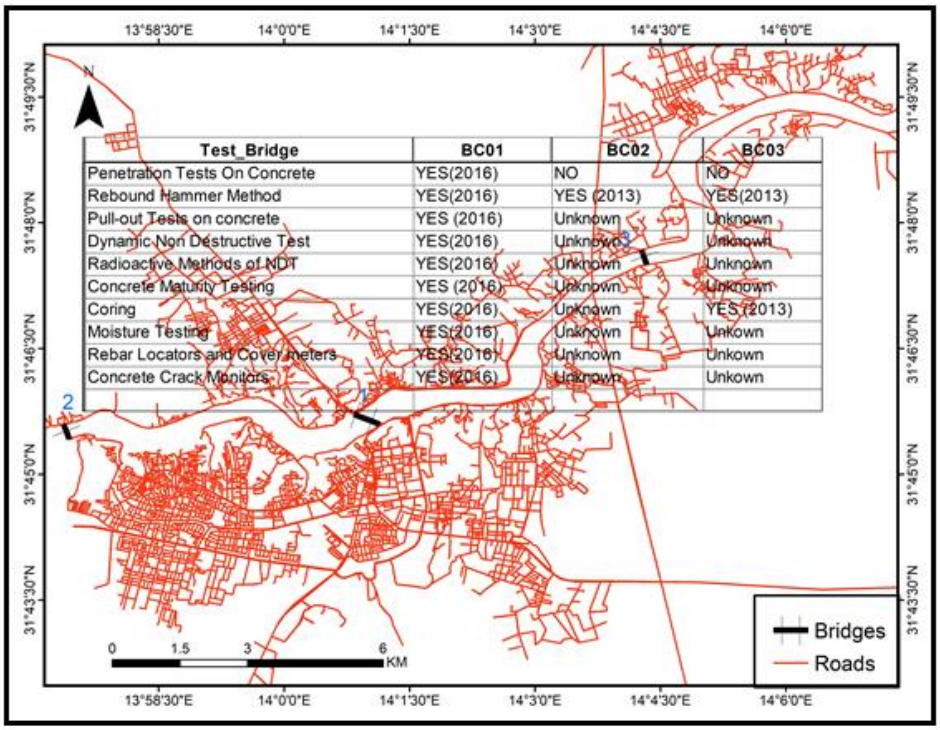
Figure 10: A bridge geometric information.

The database contains descriptive information for bridges such as length, width, type of concrete, coordinates, data on visual inspection results, and dates and types of previous tests as shown in figures (11), (12), (13).



Bridge	code	Type	coordinate_N	Coordinate_E	Length	Width
The main bridge	BC01	Precast concrete	31°45 38.2	14°01 02.2	500m	20m
Western bridge	BC02	Cast-in-Site Concr	31°45 31.1	13°57 23.0	180m	10m
East bridge	BC03	Cast-in-Site concr	31°48 52.5	14°04 54.9	180m	10m

Figure 11: geometric information.



Test_Bridge	BC01	BC02	BC03
Penetration Tests On Concrete	YES(2016)	NO	NO
Rebound Hammer Method	YES(2016)	YES (2013)	YES(2013)
Pull-out Tests on concrete	YES (2016)	Unknown	Unknown
Dynamic Non Destructive Test	YES(2016)	Unknown	Unknown
Radioactive Methods of NDT	YES(2016)	Unknown	Unknown
Concrete Maturity Testing	YES (2016)	Unknown	Unknown
Coring	YES(2016)	Unknown	YES (2013)
Moisture Testing	YES(2016)	Unknown	Unkown
Rebar Locators and Cover meters	YES(2016)	Unknown	Unkown
Concrete Crack Monitors	YES(2016)	Unknown	Unkown

Figure 12: tests information.

V.Conclusions:

A database was created for important concrete bridges in the city of Bani Walid as a stage of creating a database for the inductive structure of the city. The steps are as shown in the diagram in Figure (13).

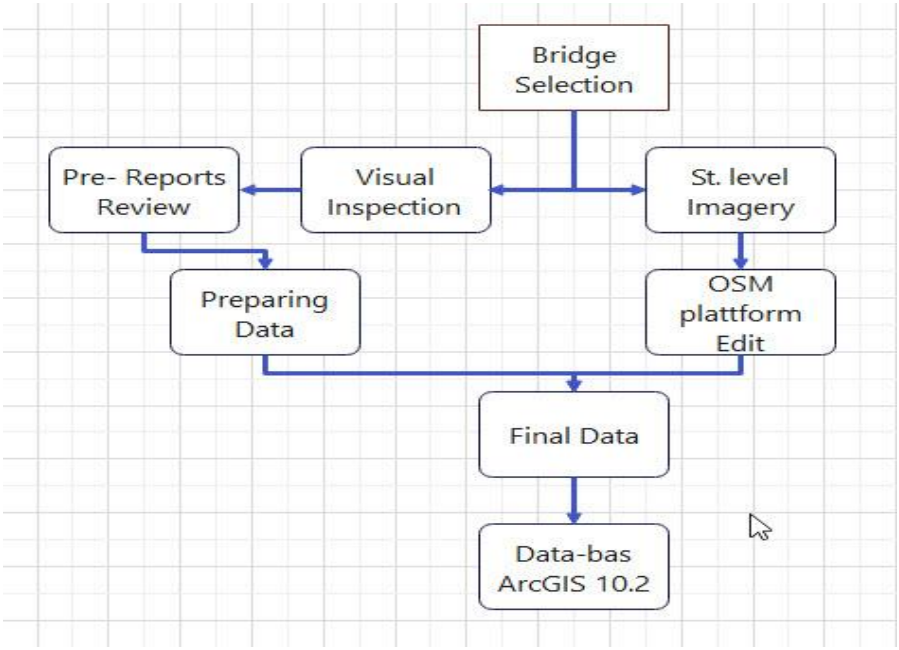


Figure 13: Action steps chart

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VI.Recommendations:

It is recommended to develop this study and adding all the data about concrete bridges. It also recommends adding secondary bridges and culverts, and then roads to develop the database to contain all the details of the infrastructure within the city to rely on instead of paper data, which are frequently lost and damaged.

References:

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