Optimum Bridge Site Selection using Network Analysis Tool (Al Muwaffaqiyah Bridge in Iraq as A case Study)

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Abstract

The main objective of this research is to select the best site for the establishment of a new bridge on the Al Gharraf river within the limits of the Al Muwaffaqiyah region. Al Muwaffaqiyah region is located in Wasit province in Iraq. The study area is divided into multiple zones. Three alternatives are proposed to construct the bridge site. The best one is selected using network analyst tool of ArcGIS software depending on the largest number of routes passing between zones. The route link between both sides of Al Gharraf river in Al Muwaffaqiyah region is one of the important projects in the city. The project will provide a new crossing point on Al Gharraf river. The proposed route will contribute to reduce traffic congestion depending on the foundations of planning and traffic so that gives the desired result of this project in terms of the location and importance of economic feasibility.

Keywords: Network Analyst, Site Selection, Traffic Congestion, Route location, Travel Time.

Introduction

Wasit province in Iraq is seeking to develop the basic services offered to its citizens. These basic services is to improve the transport networks on the mind of the biggest problems of maintaining services. The improvement of the transportation networks is a natural consequence of the growth of the province and the breadth of its architecture and the emergence of new growth areas as well as increase the number of population and the increase of vehicles. The purpose of the study is the choice of the construction site of a bridge on Al Gharraf river in Al Muwaffaqiyah region in Wasit province.

An alternative performance measure is travel time, useful for indicating when high-speed service (such as limited-stop or express service) should be considered between two locations. Since travel time varies with the size of a community and the amount of traffic congestion (for transit modes operating in mixed traffic), travel time is not suitable as a service measure without defining different categories of city sizes (HCM, 2000).

Urban planners have always aimed at optimizing the road network design to meet transportation cost, safety, land use, aesthetic and environmental considerations. With the rapid growth in traffic patterns and space utilization, there is a growing need for a tool to design and evaluate urban road networks (Nagar and Tawfik, 2007).

Geographic Information System (GIS) can quickly analyze and display a route from a station location to the emergency call. This route (depending on the...
sophistication of the street file) may be the shortest path (distance) or the quickest path (depending on time of day and traffic patterns) (ESRI, 2006).

A GIS can be a useful tool for determining emergency vehicle response routing, and the application of dynamic variables like historical traffic count data can help emergency response vehicles to avoid traffic congestion and improve response times (Michael, 2014).

**Objective**

- The optimum site selection for a new bridge in Al Muwaffaqiyah region is the principle objective of this study. The route is proposed using network analyst tool of ArcGIS software.
- The study is focused on the traffic coming from the eastern side of Al Gharraf river to the west side and vice versa. The factors affecting the traffic and transport inventory components are determined in order to minimize the traffic congestion within the region.
- The nature and degree of transportation system is linked to the concept of easy access. The more improved accessibility increases trips breed. It can add that the flights affected by breed comfort, safety and convenience offered by the road network and transportation systems and that its arguments. The citizens exercise their activities in areas where easy access is achieved.

**Study Area and Landuses**

The study area is Al Muwaffaqiyah region. Al Muwaffaqiyah region is located in Wasit province in south region of Iraq. The study area is about four square kilometers. It is divided by the length of Al Gharraf river approximately (1.35 km) and the basin area of nearly (158000 square meters). The west side is the oldest than the eastern side of the area where most of the east side buildings were created after 2003. The boundary of study area is illustrated in Figure (1).

Al Muwaffaqiyah region is the most important areas in Wasit province. It has a densely populated and dense transport networks as a result of its privileged position and the diversity of the nature of land use. The region containing multiple uses as shown in Figure (2). The multiplicity of land uses will generate different types of trips. There are four main entrances of the study as shown in Figure (2). These are as follows:

- Route of Al Muwaffaqiyah – Kut, which is located north of Al Muwaffaqiyah region in the western side of Al Gharraf river.
- Outgoing way towards Kut – Nasiriya, which is located east of Al Muwaffaqiyah region in the eastern side of Al Gharraf river.
- Route of Al Muwaffaqiyah – Diwaniyah, which is located west of Al Muwaffaqiyah region in the western side of Al Gharraf river.
- Route of Al Muwaffaqiyah – Al-Hay, which is located south of Al Muwaffaqiyah region in the western side of Al Gharraf river.
Figure 1. Study Area in Al Muwaffaqiyah.

Figure 2. Landuses and Entrances in Al Muwaffaqiyah Region.

Methodology for Bridge Site Determination

The location of bridge site is determined using network analyst tool of ArcGIS software. Figure (3) shows the basis map of Al Muwaffaqiyah region which has been prepared by ArcGIS ArcMap program. Three alternatives are proposed to construct the bridge site.

The best motion paths for transmission between parts of the study area are selected relative to the alternatives of the bridge site. The study area of Al Muwaffaqiyah is divided into eleven zones. The origin and destination of zones determine the lengths of routes to move. The time required for transmission is calculated depending on the speed of movement rate. The best path is found by comparing the times over to move for each route (at least for so). The selected path ensures faster transmission and less expensive with fuel exchange and pollution. Figure (4) shows the zones of study area.
The main road network of the Al Muwaffaqiyah region is drawn according to the information available from the competent authorities of roads office in Kut in Iraq and the basic map of the city. The speed of each path is determined from the information provided by roads office in Kut. The speed rates are ranged between 40 km per hour for the paths that pass through the city center and 65 km per hour for paths that do not pass through the center. The route networks in Al Muwaffaqiyah region are displayed in ArcGIS ArcMap program as illustrated in Figure (5).

Figure 3 Base Map and Proposed Alternatives in ArcGIS Software

Figure 4 Al Muwaffaqiyah Zones
Thirty routes pass through zones as illustrated in Figures 6 through 35.

Figure 6  Route Number 1 From Zone 1 to Zone 7

Figure 7  Route Number 2 From Zone 1 to Zone 8
Figure 8  Route Number 3 From Zone 1 to Zone 9

Figure 9  Route Number 4 From Zone 1 to Zone 10

Figure 10  Route Number 5 From Zone 1 to Zone 11
Figure 11 Route Number 6 From Zone 2 to Zone 7

Figure 12 Route Number 7 From Zone 2 to Zone 8.

Figure 13 Route Number 8 From Zone 2 to Zone 9.
Figure 14 Route Number 9 From Zone 2 to Zone 10.

Figure 15 Route Number 10 From Zone 2 to Zone 11.

Figure 16 Route Number 11 From Zone 3 to Zone 7.
Figure 17  Route Number 12 From Zone 3 to Zone 8.

Figure 18  Route Number 13 From Zone 3 to Zone 9.

Figure 19  Route Number 14 From Zone 3 to Zone 10.
Figure 20  Route Number 15 From Zone 3 to Zone 11.

Figure 21  Route Number 16 From Zone 4 to Zone 7.

Figure 22  Route Number 17 From Zone 4 to Zone 8.
Figure 23  Route Number 18 From Zone 4 to Zone 9.

Figure 24  Route Number 19 From Zone 4 to Zone 10.

Figure 25  Route Number 20 From Zone 4 to Zone 11.
Figure 26  Route Number 21 From Zone 5 to Zone 7.

Figure 27  Route Number 22 From Zone 5 to Zone 8.

Figure 28  Route Number 23 From Zone 5 to Zone 9.
Figure 29  Route Number 24 From Zone 5 to Zone 10.

Figure 30  Route Number 25 From Zone 5 to Zone 11.

Figure 31  Route Number 26 From Zone 6 to Zone 7.
Figure 32  Route Number 27 From Zone 6 to Zone 8.

Figure 33  Route Number 28 From Zone 6 to Zone 9.

Figure 34  Route Number 29 From Zone 6 to Zone 10.
Results Analysis
The travel time between zones is determined by ArcGIS software ver.9.3. Table (1) shows the routes which are chosen by network analyst tool of ArcGIS software during the passage of the proposed alternatives. These routes are used to count the number of times tracks passing through one alternative as shown in the Table (2). Table (2) shows that the alternative number one is the best because it has the largest number of routes passing through it.

Table 1 Travel Time to Pass from Zone to Zone

<table>
<thead>
<tr>
<th>From zone</th>
<th>To zone</th>
<th>proposal</th>
<th>Program Time (seconds)*</th>
<th>Factored time (minutes)**</th>
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</table>
Time given by ArcGIS software and it is calculated from the origin point to the destination point without any interruption or delay.

** Time required to move between zones after the addition of stops and delays.

**Table 2** Number of Routes Passanger in the Proposed Alternatives

<table>
<thead>
<tr>
<th>Alternatives for Bridge Location</th>
<th>Routes Passanger from Alternatives</th>
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<tr>
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<td>2</td>
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<tr>
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**Conclusions**

From this study we can conclude the following:

- Network analyst of ArcGIS software is a powerful tool for bridge site determination.
- The construction of new bridge will contribute to reduce traffic congestion.
- The bridge location links both sides of Al Gharraf river in Al Muwaffaqiyah region which provides faster transmission and least cost.
- The use of geographic information system facilitates the analysis of routes between different origins and destinations.
- ArcGIS software addresses these route automatically and gives the criteria for the best alternative according to times and distances. It has the ability to deal with multiple plans and maps.

**References**


Highway Capacity Manual, 2000, Transportation Research Board, National Research Council, National Academy of Sciences, United States of America, HCM.
