Demand Estimation of Proposed Bus Rapid Route in Al Kut City

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ABSTRACT. Public transit in the city of Al-Kut faces great challenges due to the weakness of the local government abilities in providing adequate conditions for public transport such as wide vehicles, comfortable seats, and other environmentally friendly means of transport that are almost non-use in the city of Kut, where the dependence is heavily on Mini Bus (Kia) and a medium-sized bus, most of which are old, do not operate in an integrated way, compete with each other for the passengers, reduce the flexibility of movement. This study attempts to estimate the demand for the proposed bus rapid route in the city of al Kut as a modern public transport that can contribute to reducing congestion in the city. In this study, the demand for the current public transport network lines in the city was studied, which are 12 lines using boarding / alighting values to determine passenger loads and assess flow on each route in the transportation network using the origin-destination (OD) data from on/off data, then repeat the application on the BRT route, this was done using assignment model in TransCAD software, where the results showed an estimated value for passenger demand on BRT route about 7,616 passengers/hour, which is equivalent to 40.12 % of the transport lines service.

Keywords: Bus Rapid Transit BRT, TransCAD, gravity model, Transit Assignment.

1. General Introduction

Bus Rapid Transit (BRT) is a fast mode of public transportation that uses a rubber-tired vehicle to convey passengers from one station to another inside a network of bus lanes, which provides fast, comfortable, and low-cost urban mobility with a modern, efficient service for public transport users through which buses of large capacity are used on dedicated roads and provide a high level of services compared to the regular bus line. It plays a pioneering role in transforming public transportation within cities into a situation in which it becomes the preferred mode of transportation for the majority of the population and can make a significant contribution to the growth of the city more effectively [1].

To provide an active city transportation system, public transport by building good transport links must be controlled. Bus rapid transit (BRT), Light Rail Transit LRT, tram, Metro, are modern public mass transit designed to find the solution for congestion in all global cities [2]. BRT was commonly considered as one of the most widespread public transport revolutions in recent decades. This is due to bus rapid transportation...
being a mass transit option that has significant merits in terms of carrying out advantages and its enormous ability to ultimately benefit from a variety of routes chosen for the urban environment. Support the view that BRT is a fast-widespread mode of transport worldwide due to 1) low cost, 2) flexibility of operation, 3) quick implementation, 4) high performance (e.g. reliability/speed) [3]. In countries that witness a diversity of public transport, there is a wide discussion about the differences in demand between buses and railways for public transport. Rail networks are comfortable and desirable, but the bus network can reach more destinations, provide more coverage, comprehensive and direct across the region, this leads to attracting more passengers and that the demand for the quality of public transport varies according to the type of services and income [4]. Asmael and Waheed [5] studied estimating the demand for buses as a means of public transport in the city of Baghdad using the gravity model, the public transportation system was picked because it provides active use of limited resources, energy, and land. The study specifies the demand for public bus roadways by creating a model with boarding/alighting values and allocating these demand values to the bus network. To obtain the necessary data, five public routes were chosen. For each specified route, ride checks and point checks surveys were conducted. The study's findings included a generic demand allocated to the selected bus routes, load factor, dwell time and headway. Routes R1 and R3 have been identified as having the highest travel demand, necessitating special studies to improve bus performance and transportation. Dolee and Krupa [6] determined the optimal path length for the VTCOS bus identified path, ridership capacity, total journey, and embarkation and disembarkation passenger surveys. Useful tools like road network links, shortest paths, O-D arrays, are provided by Trans Cad software. This research showed that some Anand city roads have very low passengers, and the proposed roads 2 and 7 in the study area, are more reliable and suitable for the public transportation system. Huang et al [7] proposed a methodology for OD matrix estimation using GPS and smart card data. The data was analyzed based on the bus arrival time by creating a density-based clustering algorithm and a time-correction strategy. The results showed that the proposed methodology obtained an accuracy of more than 90% through the field survey conducted in Suzhou China with a 100% sample rate. Passenger estimation is a critical step in planning a new transit route and this study is the first of its kind in the Iraq region.

2. Study Area.

The city of Al-Kut is the study area, the center of Wasit Governorate which it located between latitudes (32°21/32°/34/) north and longitudes (45°54/45°45/) in an important site on the Tigris River which surrounds the center of the city from three sides. Two branches branch off from the river (Al-Gharaf and Al-Dujaili), close to the north of the city, as shown in Figure (1), as for the spatial location and its relationship with the neighboring regions. The city of Kut is linked to Baghdad, as it is about (180) km away from it, and is distinguished by its middle location between the main cities surrounding it, with an average distance of approximately 220 km from Amara, Nasiriyah to the south, Diwaniyah, and Hellah to the west which this location made it a city with a variety of regional relations. The location city on the road network that connects Baghdad and the southern governorates, especially Basra a port, gave the city a distinctive status in commercial exchange and stimulated commercial movement within it, and also led to the city’s growth industrially and commercially.
3. Data collection

The evaluation of the demand on the routes of the public transport network in the city of Al Kut was based on collecting the necessary field data and calculating the number of current passengers for each route based on two survey methods mentioned below:

3.1 Ride Check Survey

The ride check survey technique was used, and it is one of the techniques used to know the number of passengers on board the bus by calculating the number of passengers boarding and alighting for each stop and along the route, as this survey offers an actual service path, demand, number of stops. The survey and data collection was conducted during the trip of the public transport vehicle on each route, and to obtain more accurate data, another observer was called in, and sitting at the end of the car to control a clear view, for counting boarding and alighting of the passengers at each stop, and the reconnaissance was conducted to survey the ride check for working day at peak hour from 7-8 Morning and on typical days for each route.

3.2 Point Check Survey

It is a technique used to determine the passenger load of all vehicles passing at a specific point along the transit route. This survey is effectively used in developing service schedules. The survey was performed by standing at the maximum loading point along each path that is not shared with other transmission lines. This was determined through the results of the ride check survey that represents the entrance to the point check survey.

Table 1. and Figure .2 show the public transport lines in the city of Kut for data collection.

| Table 1. Public Routes in Al Kut city. |
| Route Name                              | Route symbol |
|-----------------------------------------|--------------|
| Al Anwar                                | RA1          |
| Al Falaheya                             | RF2          |
| Al Hawraa                               | RH3          |
| Al Iza                                  | RI4          |
| Aljehad 1 – Al Shabab Center            | RJS6         |
| Aljehad 2                               | RJS6         |
| Al Khajeya                              | RKH7         |
| Al Sewada                               | RSEW8        |
| Al Shuhadaa                             | RSH9         |
| Al Zahraa                               | RZ10         |
| Al Maymoon                              | RM11         |
| Damook                                  | RD12         |

Figure 2. Public Routes in Al Kut city.
4. Work Methodology

The optimum BRT route in Al Kut city was selected based on many criteria as explained by Balket and Asmael, 2021[8,9]. The demand for the proposed Rapid Bus Route was estimated by studying the demand for the lines of the existing public transport network in the city using boarding / alighting values. Determine passenger loads and assess flows on each route in the transportation network and then repeat the application on the BRT track. The network was analyzed and results were obtained using TransCAD software (version 4.5).

4.1 Generation origin-destination matrix based on the gravity model

Traditional transit models require the collection of big data to forecast the demand for public transport, as it requires expensive surveys and the collection of specific data for the road and public transport networks. The created models do not give an accurate forecast of transit demand. A simple and inexpensive method must be used to forecast transit demand. The use of Origin-Destination data from on/off data can identify assignment flows and passenger loads on the transport network. If the number of transit trips at a particular station is known, it is possible to determine the origin for each destination trip. This is done by using the gravity model, where the distance between regions and the number of trips to and from the stations is used to estimate the number of trips between the stations. OD matrix indicates the number of passengers traveling between each point of origin and destination. Figure (3) illustrates OD matrix results based on the gravity model for each public route in Al Kut city.

![Generation OD Matrix for AL Anwar route.](image1)

![Generation OD Matrix for AL Falaheya route.](image2)

![Generation OD Matrix for AL Hawraa route.](image3)

![Generation OD Matrix for Al Iza route.](image4)
Generation OD Matrix for AL Jehad2 route.

Generation OD Matrix for AL Jehad1 (al shabab center)

Generation OD Matrix for AL Khajeya route.

Generation OD Matrix for AL Maymoon route.

Generation OD Matrix for AL Sewada route.

Generation OD Matrix for AL Shuhadaa route.
4.2 Transit Assignment model

The transit Assignment model uploads transit passengers on a specific transit network to represent passenger loads and the level of service. It is a basic evaluation and analysis tool at the planning and operational levels.

The Transit Assignment process relates to how the flows are distributed over the transit routes in a particular transit network for specific travel demand in an OD matrix. The performance of the transport system is determined through the interaction between the demand for travel and transport network supply. Therefore, any assignment model is the assignment of route selection. The shortest path method was utilized for trip assignment because the tracks are designated for public transport buses in the city, following Figure 4. illustrates a trip assignment for all routes in al Kut city during peak hour.

4.3 Bus Rapid Transit Assignment
The basic requirement in designing effective public transport systems is by collecting data related to passenger movements in the matrix of origin and destination. This matrix is a table showing passenger movement between areas of origin and destination areas and estimating passenger movement patterns on transport systems.

Bus rapid transit path was drawn in route system layer, stopping points shared with other public transport lines on the route were identified and their data were entered see Figure 5. Then the previous steps in the analysis were applied by extracting an OD matrix in Figure 6. depending on the gravity model and the field attribute (ridership count) and finally, transit assignment model was used to get BRT route load profile analysis shown in Figure 7. and the Figure 8. represented final load profile analysis for public transport and BRT Route in al kut city.

Figure 5. Bus rapid transit route.

Figure 6. Generation O D Matrix for BRT Route.
5. Results.

The following appear data results of this work Methodology:

5.1 Determination of Demand for bus rapid transit route

Table 2 (below) represent the demand for bus rapid transit route.

Table 2. The demand For Bus Rapid Transit Route.
### Table 1

| Number of Shared Stop | Demand (Pass/hr.) | Number of Shared Stop | Demand (Pass/hr.) | Number of Shared Stop | Demand (Pass/hr.) |
|-----------------------|-------------------|-----------------------|-------------------|-----------------------|-------------------|
| 1.                    | 480               | 15.                   | 106               | 29.                   | 230               |
| 2.                    | 232               | 16.                   | 75                | 30.                   | 250               |
| 3.                    | 84                | 17.                   | 60                | 31.                   | 270               |
| 4.                    | 60                | 18.                   | 136               | 32.                   | 240               |
| 5.                    | 400               | 19.                   | 153               | 33.                   | 220               |
| 6.                    | 480               | 20.                   | 119               | 34.                   | 180               |
| 7.                    | 280               | 21.                   | 86                | 35.                   | 160               |
| 8.                    | 169               | 22.                   | 450               | 36.                   | 130               |
| 9.                    | 117               | 23.                   | 405               | 37.                   | 110               |
| 10.                   | 189               | 24.                   | 315               | 38.                   | 70                |
| 11.                   | 162               | 25.                   | 225               | 39.                   | 60                |
| 12.                   | 165               | 26.                   | 153               | 40.                   | 50                |
| 13.                   | 120               | 27.                   | 106               | 41.                   | 40                |
| 14.                   | 105               | 28.                   | 210               |                        |                   |
| **Sum**               | **7616**          |                       |                   |                       |                   |

### 5.2 Boarding and alighting profile analysis

Figure (9) below displays the results of boarding/alighting count from Shared Stops on the BRT route.

![Boarding and Alighting of BRT Route Shared Stops](image)

**Figure 9.** Boarding and Alighting of BRT Route Shared Stops.

### 6. Conclusion
The results of evaluating the demand for transport network lines in the city of Kut under operational conditions and transit allocation models showed that most of the routes have a low load and that the boarding and alighting of passengers were not high among all pairs of stations along the buses line. After adding the BRT route and predicting passenger demand is about 7616 pass/hour, which is equivalent to 40.12 % of the transport lines service, it can contribute to improving the current transportation service, since the use of modern buses in this system encourages citizens to ride on the one hand. And the use of the routes system may reduce congestion in the streets located in the city center on the other hand. Passenger analysis provides a significant role in representing transit services and the boarding and alighting data for ridership’s can offer useful information for planners to define the bus demand for each public road and displays the current level of service activity and performance.

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