1.

Introduction

Cargo transportation has become one of the most important activities in regional and urban planning due to the impact of freight transportation and distribution on roads and the performance of the economy. Freight transportation systems that are efficient are linked to reduced costs of goods transport to and from logistical facilities. Understanding the assembly pattern of the truck's trip ends (production and attractions) can aid in the optimal placement of such facilities in space [1]. In recent years, Baghdad's car ownership rate has risen by 5.5 percent since 2003, before stabilizing at 3.5 percent in 2006 [2]. The rapid rise of private vehicles contrasts with the rapid growth of truckers, which is worsening the situation in Baghdad's general province [3]. In practice, developing a model from field data is difficult since many of the phenomena are non-linear and/or overlap, or the model is difficult to construct [4]. The difficulty of reproducing data from a field survey is a common one for transportation engineers. It's crucial to create a trucking model so you can evaluate the existing situation and recommend a different path to the research area [4]. Baghdad, like many other Iraqi cities, has to release comprehensive transportation planning studies. Especially when it comes to moving products. As a result, the goal of this study is to build a map that depicts the apparent behavior of transportation and to propose a new route for the study region as a remedy to the current road. This research aims to evaluate the cargo transportation system for Jisr Diyala area in the city of Baghdad by
applying the transportation planning process using geographic information systems (GIS), as well as to investigate the existing problems and obstacles. This research aims to examine the study area's path for the largest commercial area (Al Shorja) and propose alternative options.

2. Case Study

Jisr Diyala, an Iraqi district located to the southeast in Baghdad and at the meeting point of the Diyala River with the Tigris River and famous for its wonderful orchards on the banks of the Diyala River, from which it took its name, and it is one of the relatively quiet cities with a population of about 157 thousand in 2014 [5]. It is about 17 km from the center of Baghdad, and it was until the end of the eighties of the last century administratively subordinate to the Rusafa district, but the previous regime created the Mada'ain Salman Pak district and made it a subordinate to this district, which is more than 15 km away from it [6].

3. Data Collection

The data for the study area were collected from a manual survey due to the lack of sufficient data in the governorate of Baghdad and the difficulty in obtaining it completely from the concerned authorities. As a result, the survey was carried out manually at the governorate's entry (Jisr Diyala). Remote control gadgets have not been allowed for usage due to security concerns in the country. The Commercial Vehicles Survey (CVS) of the Ministry of Transportation / Public Land Transport Company was another dataset used in the investigation. The CVS is a truck drivers survey done at the Jisr Diyala entry to collect thorough information on truck and cargo transportation on the province's principal routes and highways. The questionnaire comprised the origin and destination of the trip, the challenges, and the most essential thing about the questionnaire was the size of the truck per hour on February 24-2020, as indicated in the questionnaire, Figure 2.
The questionnaire was approved according to the decision-makers.

Figure 2. Questionnaire Form.

The surveys were carried as follows:

- Interviews with drivers as they enter the city.
- The trip's objective. Users of the road face traffic congestion issues.
- The point of departure and arrival for tours via the city core.
- Rest stops for trucks (area and location).

As collecting data from the entrances and exits was challenging due to security concerns, the data collection period was separated into two hours in the morning and two hours in the evening to collect the products transit requests used in this study, as shown in figure 3.
4. Methodology

1. Building a geographical database for the road network of Baghdad city using ARC GIS software. By drawing a shapefile for the study area and determining its geographical location from the city of Baghdad for the ability to analyze it.

2. Creating a truck traffic database that includes the following information: Survey of the mobility of vehicles (knowledge of the origin and destination within the governorate through a questionnaire).

3. Counting the trucks and the demand for trucks on the internal road network from Jisr Diyala entrance through the survey during the specified period for the study.

4. Analyzing the current situation of transporting goods on roads from the study area to inside Baghdad to the Shorja area, based on manual surveys and traffic counts with GIS using spatial analysis (the best route).

5. Find solutions to the current problem by proposing a new road to be a lane for trucks only and the current path for small vehicles to reduce the traffic burden on the entrance.

5. Result and Discussion

5.1 Sample Size Calculation
Determining the size of the interviewed people is necessary because it is impractical to interview all residents in the study area. The following equation can be used to find the sample size [7]:

\[ S = S_f \times T_n \]

Where: S is present the Sample Size
Sf is present the recommended sample size factor
Tn is present the total number of H.V (Heavy Vehicles)

Therefore, sampling procedures depend on the total number of Heavy Vehicles in the study area. Then it must be compared with the recommended sample size is 1/5 which represents the minimum and recommended sample size, according to the Standard of bureau for sample size selection, as shown in table 1.
Table 1. Standard of bureau for sample size selection [7].

| The population of the study area | Minimum | Recommended |
|----------------------------------|---------|-------------|
| Under 50,000                     | 1 in 10 | 1 in 5      |
| 50,000-150,000                   | 1 in 20 | 1 in 8      |
| 150,000-300,000                  | 1 in 35 | 1 in 10     |
| 300,000-500,000                  | 1 in 50 | 1 in 15     |
| 500,000-1,000,000                | 1 in 70 | 1 in 20     |
| Over 1,000,000                   | 1 in 100 | 1 in 25    |

The size of the study sample for vehicles entering Baghdad from Jisr Diyala entrance on Monday is 140 vehicles per hour for the first hour of study time (11-12 am), and 90 vehicles per hour for the second hour of study time (9-10 pm).

On Wednesday, the morning sample was 70 vehicles per hour, and the evening sample was 80 vehicles per hour. This calculator can be used to figure out how many persons to interview in order to acquire findings that accurately reflect the target demographic. It’s also feasible to determine the precision level of an existing sample (Higgins, 2001). Although larger sample sizes reduce sampling error, they do so at a slower rate. Sample size can be calculated using a variety of statistical formulas. Calculating the sample size for categorical data can be done in a variety of ways, using a variety of formulas [8]. Show result in table 2.

Table 2. Shows Heavy Vehicles distribution according to sample size for days in Morning Period

| Period   | Days   | Sample Size Mon. | Sample Size Wed. |
|----------|--------|------------------|------------------|
| Morning  | 140    | 70               | 28               |
|          |        |                  | 14               |
| Evening  | 90     | 80               | 18               |
|          |        |                  | 16               |

* N= total number of heavy vehicles.

5.2 Baghdad Truck Demand

Data were collected on two days (Monday and Wednesday) and for the two morning periods at 10-11 and 11-12 hours, and the evening at 8-9 and 9-10 hours. Figure (4) shows the flow of demand for trucks and the difference between the morning and evening shifts. And he chose the highest hour from each period, and the results were as shown in figure 4.
As for the analysis of the results of each question from the questionnaire, it was determined by percentages from the total questionnaires at the entrance, table 3 shows the percentage of each choice.

Table 3. The percentage of Answers for the Analysis Questionnaire.

| Question 1: the type of vehicle? | 0.23 | 0.77 |
|----------------------------------|------|------|
| A- Governmental                  |      |      |
| B- Non-Governmental              |      |      |

| Question 2: The type of goods?   | 0.25 | 0.32 | 0.11 | 0.16 | 0.16 |
|----------------------------------|------|------|------|------|------|
| A- Food                          |      |      |      |      |      |
| B- Construction                  |      |      |      |      |      |
| C- Electric                      |      |      |      |      |      |
| D- Oil Products                  |      |      |      |      |      |
| E- Other goods                   |      |      |      |      |      |

| Question 3: Speed of vehicle (Km/Hr)? | Average (80-85) km/hr |
|---------------------------------------|-----------------------|
|                                       |                       |

| Question 4: The number of axles for vehicles? | 0.08 | 0.19 | 0.21 | 0.52 |
|-----------------------------------------------|------|------|------|------|
| A- 2 axle                                     |      |      |      |      |
| B- 3 axle                                     |      |      |      |      |
| C- 4 axle                                     |      |      |      |      |
| D- More 4 axle                                |      |      |      |      |

| Question 5: Payload Weight (ton)?             |      |      |      |      |
|-----------------------------------------------|------|------|------|------|
Average (35-40) Ton

Question 5: The time period taken for entry?

Between two hours or more, and sometimes 15 minutes or less for government vehicles, and up to a full day for non-governmental vehicles when traffic is very crowded and the time period changes according to the burden of security measures, including inspection and sonar (scanning).

Question 6: The most appropriate period for road users to enter?

- A - (6-8) AM 0.30
- B - (10 AM - 6 PM) 0.09
- C - (6-12) PM 0.61

5.3 Building Geodatabase of Freight Network System in GIS

Building a transport network in geographic information systems (GIS) requires a satellite image. The work is based on the preparation of a satellite image accuracy of 60cm. The GIS technology was not included in the data scanning, but to determine the directions and locations of the study area [9]. The grid was constructed in stages. The first stage included description features, which provide information about roads (length, width, number of lanes, speed limit, capacity, and so on), and the rest came from observation and measurement, which are crucial in path analysis to determine the best path location and include a features table. A road network's most important characteristics are its measured length, speed (km per hour), road width and direction, and the number of lanes. The database needs to be accompanied by the traffic volume of passenger cars, and these data taken for the years 2016, 2018, and 2020 have been relied upon for several intersections to maintain an integrated network. [10], [11] and [12]. The importance of obtaining the areas of origin and destination, the largest destination for trucks has been identified, and it is located in the center of the governorate, which is the area of Al Shorja, for conducting the analysis.

5.4 Freight Network Analysis using GIS

Building network analysis is required when the geodatabase has been prepared for analysis. After determining the original entrance to Jisr Diyala and the single destination, Shorja, in version 10.7 of the GIS application, the route of the trucks was examined based on the dependent variables (duration) and other non-dependent features (traffic volume, road capacity, speed, and others). The data is evaluated and crucial results are created for academics and users after entering it into the GIS and identifying it and its properties. The business locations served by Jisr Diyala's entry matrix are assessed based on which are the closest and most frequently used by drivers. Six commercial zones will be chosen depending on a variety of factors (distance, type of goods, time, etc.).

5.5 Route analysis for the study area

As we mentioned previously, using the GIS program, the route analysis will be for the study area (Jisr Diyala), and for the route analysis the origin was calculated at the entrance to the Jisr Diyala and the destination is Shorja, and from it, the current route that the trucks take is clarified from the entrance entering the Jisr Diyala and then Al-Rustumiya Road until the trucks take Muhammad Al-Qasim or Qanat Al-Jaysh highway, as shown in the figure 5.
Figure 5. Map shows the current route from Jisr Diyala Entrance to Al-Wathba intersection.

Table (4) below represents the result of the analysis for the current route.

| Attribute                        | Value                  |
|----------------------------------|------------------------|
| First Stop ID                    | Jisr Diyala Entrance   |
| Last Stop ID                     | Wathba Intersection    |
| Total Distance                   | 15.80 km               |
| Speed                            | 55 km/hr               |
| Time                             | 46 minutes             |
| Traffic Vol. in Mor. (H.V)       | 145                    |
Traffic Vol. in Even. (H.V) 129
Traffic Vol. in Mor.(P.C) 3984
Traffic Vol. in Even. (P.C) 1991
Total Volume in Morning 4128
Total Volume in Evening 2119
V/C in Morning 0.52
V/C in Evening 0.27

From the characteristics of the current route, we see the problems that road users suffer, which is represented by the poor services and the bridge, which is known as Imam Ali Street, consisting of 4 lanes, which causes a large traffic momentum for not being absorbed and the bridge carries a large number of vehicles, as a result, finding a suitable solution for the route is important. A suggestion for a new route begins at Salman Pak Square, connects with Muhammad Al Qasim highway, and runs behind Al Rustumiya, avoiding traffic. It is just for truck passage and the other path for small vehicle entry. The length of the proposed road is 17.2 km. We note that the new route is approximately 1.2 km longer than the current one, but it will be more flexible to move because it is for trucks and the speed will be greater for it. According to field data, the proposed route's speed varies between 80 and 100 km/h, resulting in a travel time of 31 minutes rather than 46 minutes for the current common route for passenger cars and heavy vehicles, as shown in figure 6.
5.6 Multi-Destination Analysis
The multi-destination analysis is represented by a 1 * 11 matrix, where the entrance represents the origin and the destination represents the nearest 11 commercial centers that support this entrance in terms of speed and time to reach them, as shown in Figure 7 and Table 5.
Figure 7. The map illustrates points of origin and destination and their routes after the analysis process.
Table 5. The resulting route specifications after the analysis can be configured. O-D matrix
(Jisr Diyala–Commercial Center).

| Name | Destination Rank | Length (km) | Traffic Vol. in morning | Traffic Vol. in evening | Time (hr.) | Speed |
|------|------------------|-------------|-------------------------|-------------------------|------------|-------|
| Graphic Pick 1 - Graphic Pick 3 | 1 | 5.824 | 20.74 | 16.40 | 0.097 | 60 |
| Graphic Pick 1 - Graphic Pick 2 | 2 | 5.287 | 26.83 | 25.08 | 0.096 | 55 |
| Graphic Pick 1 - Graphic Pick 4 | 3 | 6.907 | 30.09 | 24.65 | 0.098 | 70 |
| Graphic Pick 1 - Graphic Pick 5 | 4 | 7.724 | 40.62 | 34.17 | 0.11 | 70 |
| Graphic Pick 1 - Graphic Pick 6 | 5 | 10.314 | 41.95 | 37.27 | 0.15 | 65 |
| Graphic Pick 1 - Graphic Pick 7 | 6 | 11.509 | 48.30 | 43.93 | 0.16 | 70 |
| Graphic Pick 1 - Graphic Pick 11 | 7 | 12.231 | 52.14 | 47.95 | 0.22 | 55 |
| Graphic Pick 1 - Graphic Pick 8 | 8 | 12.271 | 52.35 | 48.18 | 0.23 | 55 |
| Graphic Pick 1 - Graphic Pick 9 | 9 | 15 | 66.85 | 63.40 | 0.23 | 65 |
| Graphic Pick 1 - Graphic Pick 10 | 10 | 19.204 | 105.96 | 104.43 | 0.27 | 70 |

6. Conclusion

It was concluded from the analysis of the study area that the length of the proposed route is about 1.2 km longer than the current route, but it is more flexible in movement and speed for trucks because it is intended for trucks only. The proposed route is also characterized by the fact that it connects the route of entry for trucks directly from the entrance to the Mohammed Al-Qasim Expressway, meaning that it does not pass through any traffic penalties with small vehicles and does not enter the crowded areas, as the analysis of the proposed path shows that the new path is established in open and agricultural areas and far from the traffic momentum, which facilitates the possession of land for the construction of the path. The freight vehicles entry are characterized by a high speed of 80-100 km/h in comparison to other locations, where the trip time is decreased by 15 minutes from the current route, providing road users to achieve speed and flexibility of movement.

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