

## Delay – Cost Analysis For a Section Of Baghdad – Kirkuk Highway

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### Abstract

*This study aims to analyzing the delay – cost for a section of Baghdad - Kirkuk highway; this section (16 km length) has a lane width of 10 ft and shoulder width of 4 ft in each direction. The study results show that the average traffic delay for the studied section is (3 minute). The cost resulting from this delay for passengers and freights which had a negative effect on the Gross National Product [G.N.P] is (390,003,982 I.D./year).*

**Key words:** Delay – cost, Baghdad – Kirkuk highway

### الخلاصة:

*تهدف هذه الدراسة إلى تحليل كلفة التأخير لمقطع من طريق بغداد – كركوك، هذا المقطع (16 km) له ممر واحد بعرض (10) قدم وأكتاف بعرض (4) قدم في كل اتجاه. أظهرت نتائج الدراسة أن معدل التأخير المروري للمقطع المدروس هو (3 دقائق). الكلفة الناتجة عن هذا التأخير للمسافرين والبضائع والتي لها تأثير سلبي على الناتج الإجمالي القومي تبلغ (390,003,982 دينار عراقي).*

### Introduction

Traffic congestion is classified into non-recurrent and recurrent congestion by their periodical and location features. Since the unbalance of travel demand and transportation supply causes the recurrent congestion, it usually occurs in similar time of day and sections of roadways. Hence, the recurrent congestion is predictable so that it can be removed permanently even though it requires large-scale investment (e.g., improvement of infrastructure or/and reduction of travel demand). Hence, it is a very important issue how to manage non-recurrent traffic congestion to minimize the economic loss and traffic delay on the highways (1).

The underlying basis for assigning a monetary value of travel time is that time not spent in travel can be used for other activities having economic value (2), so as the cost of the delay time. In the case of

work travel, a reasonable estimate of the value of time for the work trips can be related to the traveler's wage, about 50 percent of the *before tax wage rate* (3) for other trip purposes, the value of travel time less obvious (4 & 5).

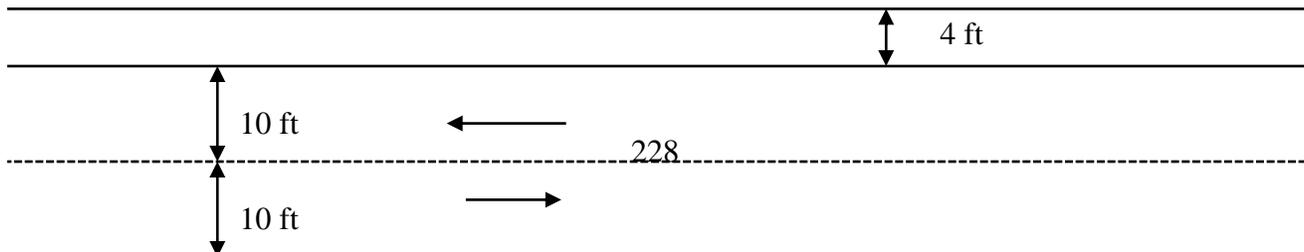
## Benefit of study

The data obtained from travel time and delay studies may be used in any one of the following traffic engineering tasks (6):

1. Determine the efficiency of the route which considers its ability to carry traffic.
2. Identify of locations with relatively high delays and the causes for those delays.
3. Performance of before-and-after studies to evaluate the effectiveness of traffic operation improvements.
4. Determine the relative efficiency of a route by developing sufficiency ratings of congestion indices.
5. Determine the travel times of specific links for use in a trip assignment models.
6. Compilation of travel time data that may be used in trend studies to evaluate the changes in efficiency and level of service with time.
7. Performance of economic studies in the evaluation of traffic operation alternatives to reduce travel time.

## Study site

To carry out this study, a section of Baghdad - Kirkuk highway had been selected. The study section (16 km length) begins from Daquke check-point, it has a lane width of 10 ft and shoulder width of 4 ft in each direction, as shown in figure (1). Pictures (1 & 2) show the study section and its surrounding area.



***Fig. 1 Typical Layout of the Study Section on Daquk-Kirkuk Highway***

### **Traffic survey**

Traffic volume survey was obtained to accomplish this study, traffic volume was carried out to specify the peak hour in which the maximum delay will be occur. Manual count method was used to calculate traffic volume from 7:00 a.m. to 12:00 p.m. (peak period in rural highways, sultan) for three days (Mon, Tues & Wed) from 5/4/2010 to 7/4/2010, as shown in table (1). Then represent these volumes in Figure (2) to show the peak hour, the figure shows that the peak hour from (8 – 9 a.m.).

Average Annual Daily Traffic (AADT) for the study section would be determined by assuming that the peak hour is equal to the Design Hour Volume (DHV), and then AADT was computed from the following equation for each type of vehicles as shown in table (2):

$$DHV = AADT * K$$

Where:

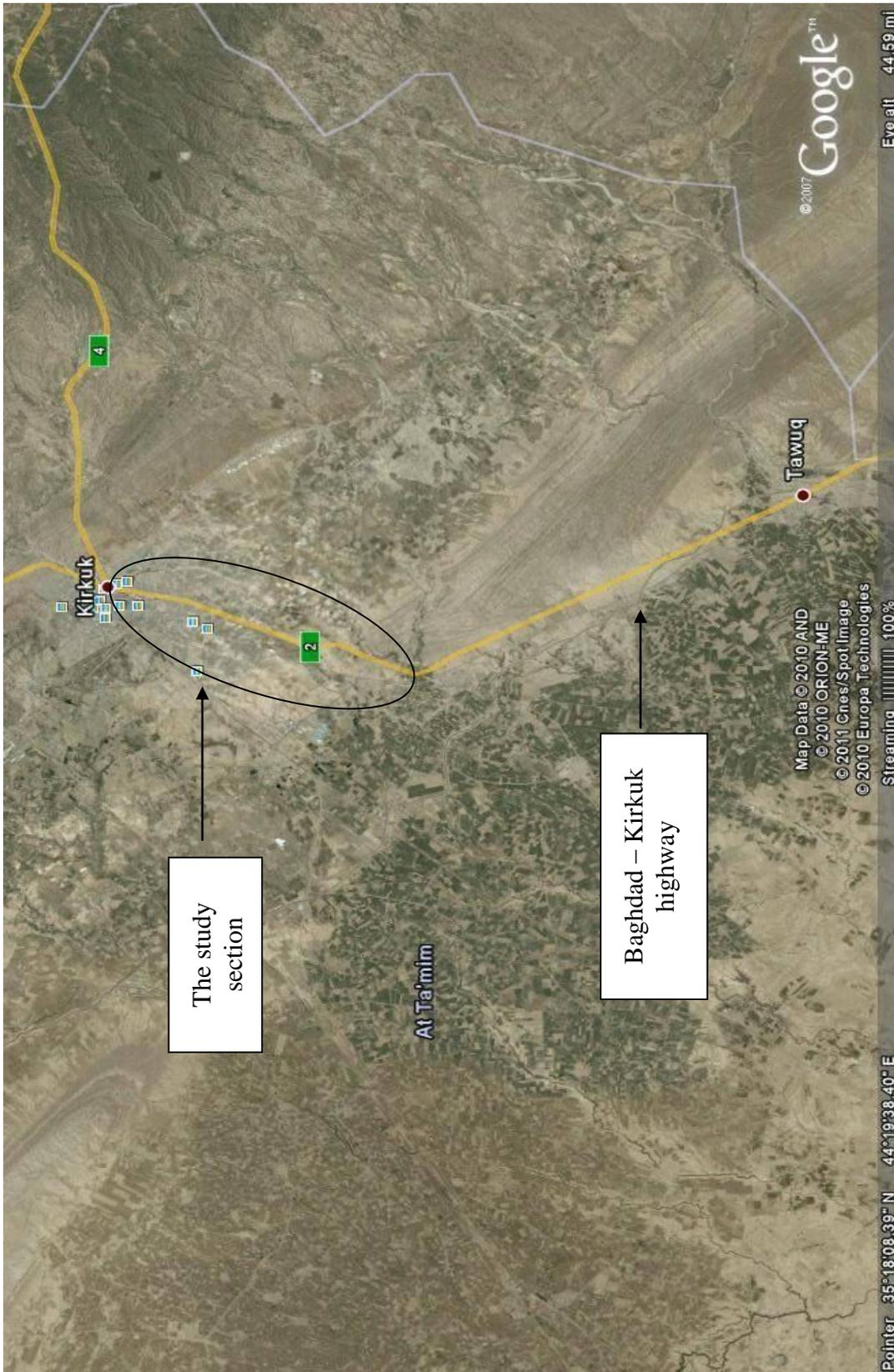
DHV = Design Hour Volume (vph)

AADT = Average Annual Daily Traffic (vpd)

K = percentage of Design Hour Volume of 24-hr = 0.15 for rural highways (7).



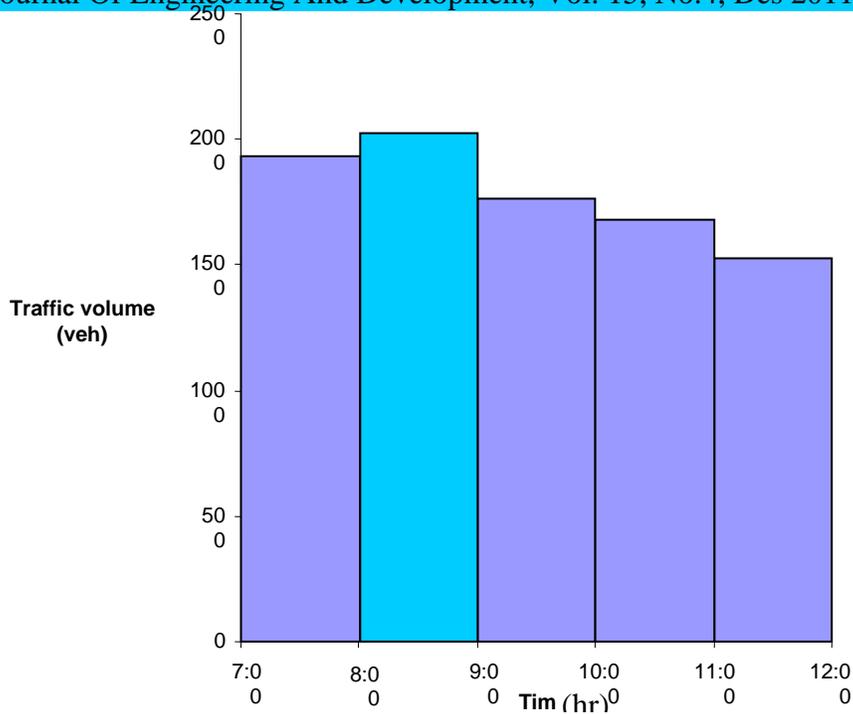
Picture. 1 The Surrounding Area of the Study Section



**Picture. 2 The study section (16 km length)**

	Time	7:00 – 8:00	8:00 – 9:00	9:00 – 10:00	10:00 – 11:00	11:00 – 12:00
5/4/2010	Passenger car	1574	1638	1504	1377	1351
	Minibus	178	194	173	130	134
	bus	62	76	57	38	44
6/4/2010	trucks	80	90	76	56	60
	Passenger car	1624	1663	1514	1443	1358
	minibus	173	195	139	133	96
7/4/2010	bus	58	78	46	43	28
	trucks	73	91	62	59	41
	Passenger car	1644	1627	1537	1593	1493
Average	minibus	174	202	159	162	145
	bus	60	83	44	48	36
	trucks	78	95	67	70	61
Total average volume (veh/hr)	Passenger car	1614	1642	1518	1471	1400
	minibus	175	197	157	141	125
	bus	60	79	49	43	36
	trucks	77	92	68	61	54
		1926	2010	1792	1716	1615

Table. 1 Traffic Volume Survey



**Fig. 2 Traffic Volume of the Study Section (7:00 a.m. – 12:00 p.m.)**

**Table. 2 AADT Determination for each Type of Vehicle**

Vehicle type	Peak hour volume (DHV) (vph)	K	AADT (vpd)
Passenger cars	1624	0.15	10947
Minibus	197	0.15	1313
Buses	79	0.15	527
Trucks	92	0.15	613

### Travel time and delay studies

A travel time study determines the amount of time required to travel from one point to another on a given route. In conducting such a study, information may also be collected on the locations, durations and causes of delays. When this is done, the study is known as a Travel time and delay study. Data obtained from travel time and delay studies give a good indication of the level of service on the study section. These data also aid the traffic engineer in identifying problem locations, which may require special attention in order to improve the overall flow of traffic on the route (6).

## Definitions of terms related to time and delay studies

The terms commonly used in travel time and delay studies are (6):

- Travel time: is the time taken by a vehicle to traverse a given section of a highway.
- Delay: is the time lost by a vehicle due to causes beyond the control of the driver.
- Travel-time delay: is the difference between the actual travel time and the travel time that will be obtained by assuming that a vehicle traverses the study section at an average speed equal to that for an uncongested traffic flow on the section being studied.
- Ideal travel time: it is the time result from dividing the speed limit on the length of the study section.

## Types of delay

Delay can be divided into two types these are:

1. Stopped delay: it is the stopping time during driving caused by control devices such as traffic signals or the impedance that may exist; it can be measured by stop watch.
2. Congestion delay: it is the delay caused by slowing down effect of slow moving of heavy vehicles, overloading intersection, inadequate carriageway width, parked vehicle, crowded pavement and similar factors (8).

In present research, on the study section (two-lane highway) the delay results from slow moving of heavy vehicles (congestion delay), which causes formation of platoons, therefore, passing opportunities will decrease because of depending on gaps in the opposite direction. The ownerships can not drive at their desired speed. This reduction in speed will causes the difference between travel time and ideal travel time.

## Methods of conducting travel time and delay studies

Several methods have been used to conduct travel time and delay studies. These methods can be grouped into two general categories:

1. those using a test vehicle: this category involves three possible techniques:
  - Floating-car technique.
  - Average-speed technique.
  - Moving-vehicle technique.

2. those not requiring a test vehicle: this category involves two possible techniques:

- License-plate observations method.
- Interviews method.

The travel time data for the study section is collected using floating-car technique.

## Floating-car technique

In this method, the test car is driven by an observer along the test section so that the test car “floats” with the traffic. The driver of the test vehicle attempts to pass as many vehicles as those that pass his test vehicle. The time taken to traverse the study section is recorded. This is repeated, and the average time is recorded as the travel time (6).

## Analysis of travel time and delay studies

Travel time data is collected using floating-car technique. Travel time (the time required to traverse the study section) is recorded for thirty runs in peak hour (8:00 to 9:00 figure. 2) for periods (3/5/2010 – 5/5/2010, 10/5/2010 – 12/5/2010 & 17/5/2010 – 18/5/2010), as shown in table (3). In rural areas there is a pronounced peak which occurs in the 7:00 to 12: 00 A.M. interval (9). Average travel time (15 min from table. 2) is considered to compare with ideal travel time which is calculated depending on speed limit for the study section (80 km/h from AASHTO (7)), thus, ideal travel time is compute from the following equation;

$$\begin{aligned}\text{Ideal travel time} &= \text{distance/speed limit} \\ &= 16 \text{ (km)}/80 \text{ (km/h)} \\ &= 0.2 \text{ hour} = 12 \text{ min}\end{aligned}$$

Segment delay is the difference between observed travel time and calculated ideal travel time, then:

$$\text{Delay} = 15 - 12 = 3 \text{ min}$$

As a result of this delay, the level of service for the study section is (E), it was obtained by using highway capacity system computer program (HCS, 2000). This level represents critical flow and need a treatment.

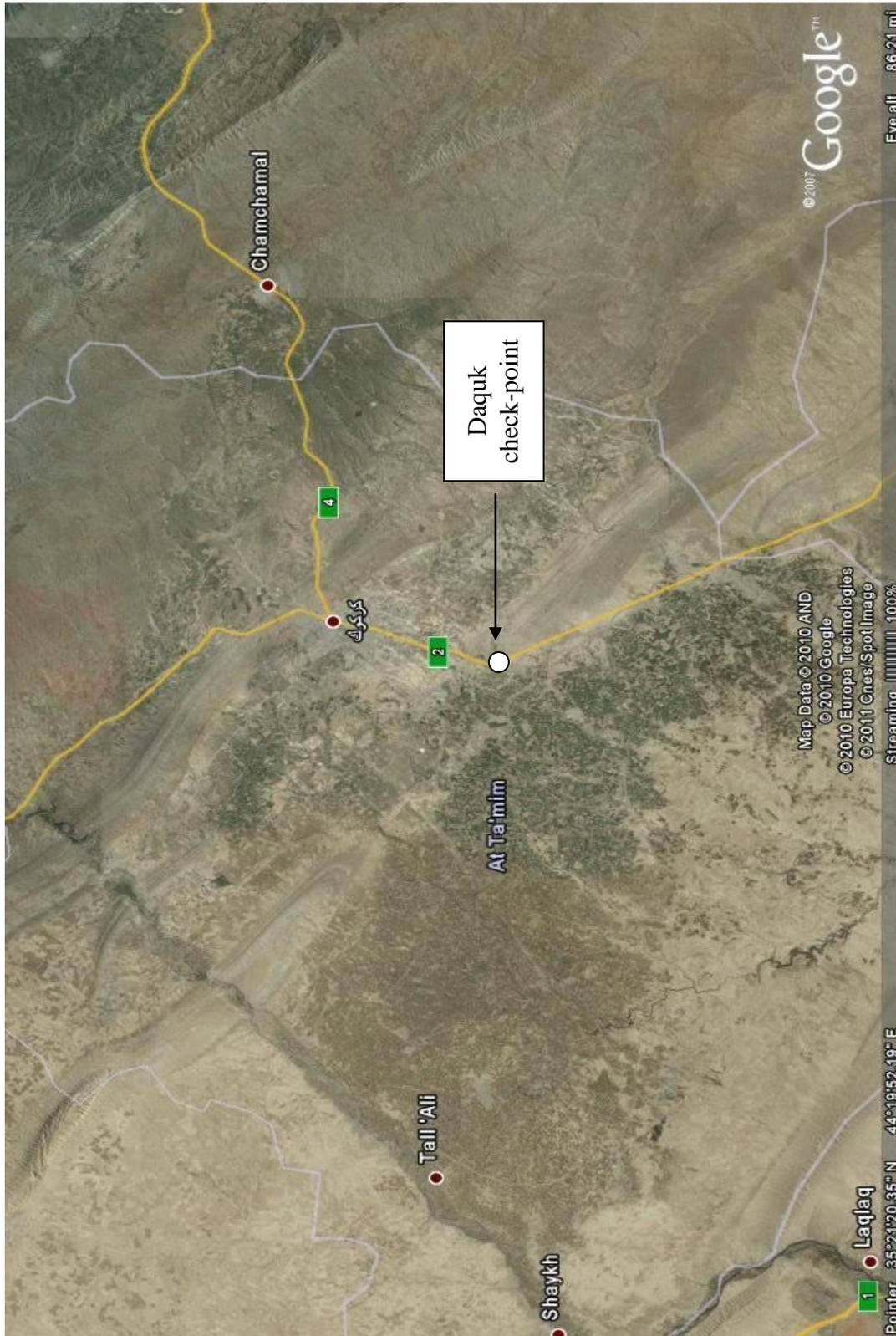
**Table. 3 Travel time data**

Run No.	Date	Travel time (min)	Run No.	Date	Travel time (min)
1	3/5/2010	14.5	17	11/5/2010	12.5
2		15.5	18		14
3		16	19		14.25
4		14.25	20		15.5
5	4/5/2010	14.75	21	12/5/2010	16
6		13.5	22		16.5
7		14.25	23		16
8		15.5	24		15.25
9	5/5/2010	15	25	17/5/2010	13.5
10		17.25	26		15.25
11		15.5	27		15.25
12		14	28		15.75
13	10/5/2010	13.75	29	18/5/2010	14
14		14	30		16.25
15		15			<b>Av. = 14.9 ≈ 15 min</b>
16		14.5			

### Passengers count

Daquk check-point (picture. 3) was chosen to account numbers of passengers whom was using a different types of vehicles (passenger cars, minibuses, buses & heavy trucks) at the peak period for the same three days of traffic survey (Mon, Tues & Wed) from 5/4/2010 to 7/4/2010, listed below the average number of person per each type of vehicles according to the passenger survey counts:

Passenger car : 1.5 person  
 Minibus : 10 person  
 Bus : 40 person  
 Heavy truck : 1 person



Picture. 3 Daquk Check-Point which used in Passengers Count

## Delay – Cost analysis

### 1- Passenger delay – cost analysis

There are two alternatives to evaluate the cost of delay time per person:

A- According to Iraq Transportation Master Plan (ITMP) by group of Italian companies, the year 2010 forecasting passenger time value is computed by the researchers as (1.0464 \$/hr)  $\approx$  (20.933 I.D/min) at rate (1200 I.D per 1\$).

B- According to forecasting figures for year 2010 computed by the researchers basis on 2007 Annual Statistical Abstract issued by the central organization for statistics and information technology, the passenger time value is equal to (6.817 I.D/min).

To be in the safe side, the researchers prefer to use the minimum value which is (6.817 I.D/min) as the passenger time value.

The following table shows the way to calculate the summation total passenger Delay – Cost for all type of vehicles by use of the following formula as shown in table (4):

Total Annual Passenger Delay – Cost = [AADT \* 365 \* average number of passengers per vehicle type \* delay \* personal unit cost per time]

**Table. 4 Annual passenger delay cost**

Type of vehicle	AADT * 365	Average no. of passengers per vehicle type (person)	Delay (min)	Personal unit cost per time (I.D/min) (alternative 2)	Total annual passenger Delay – Cost I.D
Passenger cars	3995655	1.5	3	6.817	122572711
Minibuses	479245	10	3	6.817	98010395
Buses	192355	40	3	6.817	157354084
Heavy tracks	223745	1	3	6.817	4575809
<b>The sum =</b>					<b>382512999</b>

The total (382512999 I.D) should be much more when using the figure fixed by the (ITMP) study and will be about (1,174,584,804 I.D)

### 2- freight Delay – Cost analysis

According to (ITMP) the freight time cost value forecasting for year 2010 is computed by the researchers as (0.0186 \$/ton.hr)  $\approx$  (0.372 I.D/ton.min) at rate (1200 I.D per 1\$).

The average loading truck weight is 30 ton (A).

Then:

$$\begin{aligned} \text{Total annual freight delay Costs} &= \text{AADT (Tucks)} * 365 * \text{Average loading truck weight} \\ &* \text{Delay} * \text{Average ton freight unit cost per time} \\ &= 613 * 365 * 30 * 3 * 0.372 \\ &= 7490983 \text{ I.D} \end{aligned}$$

Now from the items (1) & (2) above:

$$\begin{aligned} \text{The sum total Delay (passenger + freight) Cost} &= 382512999 + 7490983 \\ &= 390,003,982 \text{ I.D} \end{aligned}$$

## Conclusions and recommendations

The study results show that the average traffic delay for the study section of Baghdad – Kirkuk highway is (3 minute). The cost resulting from this delay for passenger and freights which had a negative effect on the Gross National Product [G.N.P] by (382512999 I.D./year) for passengers and (7490983 I.D./year) for freights, so the total delay costs is (390,003,982 I.D./year). There are many treatments can use to terminate or reduce the delay cost such as turnouts, paved shoulders, adding lanes ....etc. The public authorities or researchers can make a comparison study for the cost of each treatment with the delay cost.

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