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RESEARCH ARTICLE

Moving Vehicle Method to Calculate Traffic Flow Characteristics for Erbil 60m Ring Road

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ABSTRACT

Traffic flow characteristics are important factors in the planning and management of highway facilities. Such information is not available in systematic form of the city of Erbil, so this study aims to obtain required data on flow, speed and density accordingly to find the relationship between these three parameters. Travel time, travel speed and flow due to traffic interaction data are also needed to evaluate the existing levels of service which is necessary for transportation planning and economic analysis, to be done in this field. This study uses the directional distribution of several selected road sections in the city of Erbil to give a complete picture of traffic flow in terms of size, daily and hourly variabilities. It was for this purpose that 60m ring road in Erbil city was chosen. To evaluate the data, software such as (Microsoft Excel, SPSS) were used in-order to develop relationships among each pair of flow type variables (density, speed and flow).

Measuring strength of the relationships between speed-density, flow-density and speed-flow should be done. The relation between traffic flows data was found by the R^2 is applied for all models. The strength of relationships among speed-density, flow-density and speed-flow should be measured. The relation between traffic flows data was found by the R^2 is applied for all modes.

The maximum flow rate in Section 9 is over 9000 pc/hr but range of flow is equal to 7605 pc/hr and range of space mean speed is it among 20 and 55 km/hr at peak hour and highest range of density is among 40 and 160 pc/km.

Keywords: speed, flow, density, traffic flow relationship.

1. INTRODUCTION

The originally proposed "moving observer method" is used to simultaneously estimate the average traffic flow and the average travel time of traffic from measurements by vehicles traveling against the flow in uncrowded conditions (TRB, 1975). The strength of this method seems to be the ability to estimate average traffic parameters over time from measurements along the highway, rather than taking measurements at a single point. Nevertheless, these calculations are performed without determining the instantaneous speed distribution, which means that the three assumptions hold. All vehicle speeds remain constant along the section. Any group of a passive and an active overtaking provides a null contribution to it, which is equivalent.

The development of the city of Erbil over the last 21 years in field of commercial, residential, industrial, and agricultural, that are directly related to economic development, have produced complex highway traffic models causing urban congestion and accident problems. The number of residents and vehicles changes over time. The city's road network consists primarily of ring roads and radial roads. As previously mentioned, the city of Erbil's network has radial roads connected to the ring roads. Moreover, the demand for automobiles is increasing due to the increase in population accompanying economic development over the past 20 years. It is necessary to be understood that the relationships between traffic speeds, flow and density are proved to be important factors in designing road facilities, transportation planning and control.

It should be noted that today, in the Kurdistan Reign specially in Erbil, there are many problems concerning the traffic flow pattern. The relationship between traffic flow parameters (speed-flow, speed-density and flow-density) has emerged as an important issue affecting the highway design and planning process. Ignoring these relationships can lead to serious transportation policy problems, delays in staff, and diminished public awareness.

Traffic flows are highly dependent on the city's land using activities and their impact on traffic operations, thus this survey is useful for the following reasons:

1.To study the existence traffic flow (speed, flow and

density).

2.Determine capacity of road.

3.Measuring travel time and delay.

4. Determine if a speeding complaint is valid.

The above points provide recommendations for better planning of traffic operations on urban roads based on established models (Dhamaniyaa and Chandra, 2013).

2. PROCEDURE FOR PAPER SUBMISSION

2.1. Introduction

The rapid progress of urbanization, especially the growth of vehicles in urban areas, has a huge impact on the transportation sector. The impact of urbanization is clearly significant from the perspective of traffic congestion, delays, traffic safety, pollution and transportation efficiency.

as the national population is increasing, the demand for vehicle of all types is also increasing, e.g. car and motor cycles for personal use, heavy vehicles for goods transport in the lack of public transportation. Effectively solving the problem of congestion means not only adding new lanes (capacity) to the road system, but also finding ways to improve existing roads.

Traffic is a sign of mobility and a dynamic economy. However, excessive overload can have undesired consequences. It comes at a cost to the community and the economy.

2.2. Site Selection

The field survey was carried out to collect the data on the selected major ring road (60m road) in Kurdistan-Erbil, to count the traffic flow; the moving vehicle method was used. The selected road was covered with highly traffic flow by composition of different types of vehicles namely car, bus, truck, motor cycle and van. The 60m ring and radial roads characterized by interrupted traffic due to poor management about parking, turning, and mobility. Besides the rising of the population with economic development in the last ten years, lead to increase demand on using passenger cars.

Vehicle speed on 60m road is limited to 60kph in all the sections on the ring road, which is 12 km length, vehicles can enter into the road in several other links. Traffic flow study was carried out to obtain a series of information about forms of data, such as vehicle types in the city and special equipment to collect traffic movement such as speed, flow and density. All the data were collected under good weather conditions during the study period. Table 1 and 2 show the name of locations and code of each direction.

Traffic engineering, has to carry out surveys frequently and may be required to collect many different forms of data. In some cases, the traffic engineer can use special equipment to measure some quantities of traffic, such as speed and flow but in many instances, survey must be conducted using manual methods.

In this study there is a 7 types of vehicles were selected during data collection process as follows: Passenger car (up to 5 passengers), Pick up, Motorcycle (more than 2 passengers), Van (more than 16 passengers), Bus (more than 24 passengers), Bus (more than 24 passengers) and Truck (Bafreen and Delvin, 2022).

Procedure for Traffic Data Collection (Flow, Speed, and Travel Time, measurement by Using MVM Method) was followed.

In this test car survey, one driver and four observers were engaged in the process, the driver tried to drive with average speed specified for each section (normal speed), in order to keep the balance between the overtaking vehicle and the overtaking vehicle by the test car, the length of the section is also recorded using the vehicle counter. The process was repeated for eight runs in each section. The first observer records the number of vehicles traveling in the opposite direction while the test car is traveling with flow.

The second observer records the number of vehicles that have passed the test car, the third observer records the number of vehicles that have passed the test car while driving in the current direction, and the fourth observer records the stopwatch. The total travel time in each direction was measured (Wardrop,1952).

The formula is used to estimate both speeds and flows for one direction of travel. The Figure1 shows the site plan showing the location of the study area.

$$q=(X+y)/(ta+tw) \quad (1)$$

Where:

q = is the estimated flow on the road in the direction of interest.

x = is the number of vehicles traveling in the direction of interest, which are met by the survey vehicle while traveling in the opposite direction.

y = is the net number of vehicles that overtake the survey vehicle while traveling in the direction of interest (i.e. those passing minus those overtaken)

ta = is the travel time taken for the trip against the a stream

t_w = is the travel time for the trip with the stream, and is the estimate of mean travel time in the direction of interest.

$$t = tw – y/q \quad (2)$$

$$\text{Speed, } Us=L/t \quad (3)$$

Where:

L = length of roadway section (km)

t = mean travel time (sec)

After that calculate density by relation between speed and flow:

$$\text{Density} = q/Us \quad (4)$$

Figure 2 below shows direction of moving Vehicles methods (Pignataro,1973):

Table 1: Name of locations of the road

Section	Location and Name	Direction of Road	
		From	To
1	60-m Ring Road (Kurdistan Road)	Akram mantic	Franso Hariri
		Franso Hariri	Akram mantic
2		Franso Hariri	Qarachough
		Qarachough	Franso Hariri
3		Qarachough	Kandenawa
		Kandenawa	Qarachough
4		Kandenawa	Layla qasim
		Layla qasim	Kandenawa
5		Layla qasim	Chwar chra
		Chwar chra	Layla qasim
6		Chwar chra	Parliament
		Parliament	Chwar chra
7		parliament	Fransaismetran
		Fransaismetran	parliament
8		Fransaismetran	Khanzadi soran
		Khanzadi soran	Fransaismetran
9		Khanzadi soran	Ezzadin faizi
		Ezzadin faizi	Khanzadi soran
10		Ezzadin faizi	Gad gross

Figure 1: Site plan showing the location of the study area

Table 2: Name of direction and code each side

Direction of Road		
From	To	Code Number
Akram mantic	Franso Hariri	1-2
Franso Hariri	Akram mantic	2-1
Qarachough	Franso Hariri	4-3
Qarachough	Kandenawa	5-6
Kandenawa	Qarachough	6-5
Kandenawa	Layla qasim	7-8
Layla qasim	Kandenawa	8-7
Layla qasim	Chwar chra	9-10
Chwar chra	Layla qasim	10-9
Chwar chra	Parliament	11-12
Parliament	Chwar chra	12-11
parliament	Fransaismetran	13-14
Fransaismetran	parliament	14-13
Fransaismetran	Khanzadi soran	15-16
Khanzadi soran	Fransaismetran	16-15
Khanzadi soran	Ezzadin faizi	17-18
Ezzadin faizi	Khanzadi soran	18-17
Ezzadin faizi	Gad gross	19-20

The minimum number of test runs can be determined by equation (5).

$$Ns = (Z*S/d)^2 \quad (5)$$

Where:

Ns = minimum sample size

Z = number of standard deviations corresponding to …….

S = standard deviation

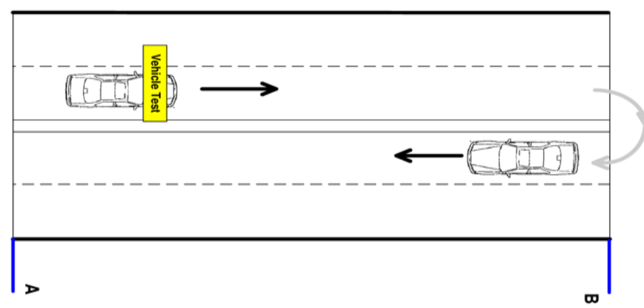


Figure 2: Shows method of moving vehicles methods working in field

d = limit of acceptable error in the average speed estimate

$Ns = (5*1.96/5)^2 = 4$ runs

Number of runs was equal to 4 runs, in this case and for this study 8 runs for each direction was taken according to a relationship study done by (box, 1976), also standard deviation equals to 5 in (Ali, 1989).

Many institutions carry out the maximum number of practical test vehicle trips (typically 3-6 runs), taking into account the available data collection budget. (FHWA, 1998) (Garber,2003) Sample of data for this operation for example for one section is shown in Table (3).

Table 3: Moving vehicle method data sheet of speed - flow – density, section (9-10), time period: evening

Run	Flow, pc/hr	Speed,	Density, pc/km
1	3593	43	83.558
2	4015	45	89.222
3	2207	42	52.547
4	2592	45	57.600
5	3532	52	67.923
6	2985	43	69.418
7	2484	46	54
8	3248	43	75.534

2.3. Development of Statistical Relationships among Speed, Flow and Density

package for the social sciences (SPSS) software was used to establish relationships between traffic parameters such as speed, flow rate, density then it was used to evaluate and analyze data. The models that were developed for all types of data were of the following forms (Greenshield, 1935) and (Greenberg, 1959):

1.Linear or (Green shields model)
2.Logarithmic or (Greenberg model)
3. Exponential or (Underwood model)

3. RESULTS and DISCUSSION

This study discusses the obtained results from various traffic flow parameters included in the survey findings. This section collects, analyzes, and describes detailed data. Detailed analysis of velocities and flows directly obtained from on-site observations, is present, as well.

The resulting traffic flow density was calculated from the measured velocities and flow rates. Speed-Density, Flow-Density, and Speed-Flow relationships have been established. The purpose of this study is to compare the results obtained from the site studies for traffic flow characteristics recorded in this research such as:

1.Travel speed and travel time for all sections in the study locations.
2.Speed-flow-density relationships for all sections in the study are performance of curve fittings using least square statistical models.

3.1. Speed-Flow-Density Relationships

Traffic flow parameter theory is one of the most important points to enable engineers or planners to establish the relationship between traffic flow, density, and traffic speed for selected level of service, type of roads based on the data collected in field (Hari, and Ramachandra, 2018).

Regression analysis is the area of statistics that is used to examine the relationship between a quantitative response variable and one or more explanatory variables for deferent models such as (linear, logarithm, exponential). The best fit models obtained between traffic flows characteristics were as shown in Table 4 and worst cause shown in Table 5 (Mararo, 2016). Figure3 showns the highest flow rate in section 3 but the range of flow equal to 7605 pc/hr and range of speed between (20-55) km/hr at peak hour shown in figure4. The highest range of density between (40-160) pc/km is illustrated in figure5.

Table 4: Best fit models

Relationships	R^2	Model
Speed-Density	0.7411	Underwood
Flow-Density	0.9972	Greenshield
Speed-Flow	0.6017	Greenberg

Table 5: Best fit models

Relationships	R^2	Model
Speed-Density	0.00002	Greenberg
Flow-Density	0.000004	Greenberg
Speed-Flow	0.0029	Greenshield

3.1.1Speed-Density Relationship

As illustrated earlier, different models were tested with data in collected in site to identify which model best fits for the data. This step of procedure has been taken with the use of regression analysis (Highway Capacity Manual, 1985). In this project, the speed-density relationships were chosen because it is mathematically easy to handle and establish. Other relationships, flow - density and speed- flow, can be used in equilibrium equation (Pandya, 2015).

The data is analyzed by regression adopting different hypotheses is mention below:

Consider the most appropriate model in this section (20-19) in the morning; the Exponential the value of R^2 value was equal to 0.7411 which is high value. Second best fit in section (20-19) morning, the value of R^2 value was equal to 0.7352 Logarithmic high values.

In this stud, the lower value in section (18-17) in morning the R^2 value was equal to 0.00002 Logarithmic and in second section (18-17) morning R^2 0.00004 Exponential, Also, it is generally expected that the R^2 value will be lower on urban roads. The reason for this case is the effect of consistence of the traffic stream for these sections on having high percentage of heavy vehicles such as bus and stoppage of taxies on sides of the road side, side parking, distance between turnings and pedestrians.

Moving vehicle method, the high value of R^2 in this method in section (9-10) evening is equal to 0.0168 the Greenberg model. In general, the free flow speed in speed-flow-density relationships on 60m-ring and some connected radial roads is lower than location study in Erbil city because of the difference about geometric of roads. Roads of Erbil made over pass, under pass, wider lanes and longer distance between intersections or over or under passes.

3.1.2. Flow-Density Relationships

The flow-density relationships are used to find the traffic parameters of a roadway. The flow and capacity which happens at this point is the optimum flow and optimum density.

The relation between the density and the corresponding flow on a given stretch of road is referred to as one of the fundamental diagrams of traffic flow. Some characteristics of an ideal flow-density relationship is listed below:

When more and more vehicles are added, it reaches a situation where vehicles can't move. This is referred to as the jam density or the maximum density. At jam density, flow will be zero because the vehicles are not moving. There will be some density between zero density and jam density, when the flow is maximum.

The relationship is normally represented by a parabolic curve as shown in figure 3. The most appropriate model for this study is the section (14-13), morning is the Linear relationship the value of R^2 value was equal to 0.9972 which is very high value and the second best fit in section (14-13) morning, the high value of R^2 equal to 0.9826 was the Logarithmic relationship.

Moreover, the lower value in section (18-17) evening the R^2 value was equal to 0.000004 Logarithmic and second section

(18-17) evening R^2 value was equal to 0.0017 Exponential, also parameter of traffic flows in these sections, the reason for such case is that the buses and taxis are affected by many issues and are generally expected to have lower R^2 values on urban roads, taxi stop side, side parking, distance between turning and pedestrian. The highest flow for each section is shown in figure3.

The high value of R^2 was obtained from moving vehicle observer in section (9-10) evening which is equal to 0.8192 the Greenberg model.

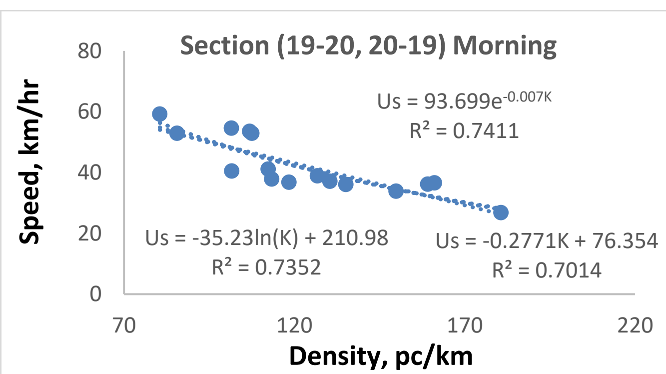
3.1.3. Speed-Flow Relationships

Speed-flow relationships are used to find the speed at which the optimum flow happens.

Consider the most appropriate model in the section (15-16) morning with the Logarithmic value of R^2 was equal to 0.6017 and the second best relationship was in section (15-16) morning with the value of R^2 was equal to 0.5618 of the Exponential relation.

On the other hand, the lower value was in section (17-18) morning as the R^2 value was equal to 0.0029 Linear and second section (17-18) morning R^2 value was equal to 0.0046 using Logarithmic best relationship. In addition, many problems affect traffic flow in these sections, such as high percentage of buses, so it is generally expected that R^2 will be low on urban roads and taxi stop side, side parking, distance between turning and pedestrians. The high value of R^2 in this method was in section (9-10) morning which was equal to 0.0443 using the Greenberg model.

The lower value of speed in section three was equal to 20km/hr, and the upper speed in section seven was equal to 55 km/hr this value depends on (turning, mobility and derivers) all of them have negative effects on the result.



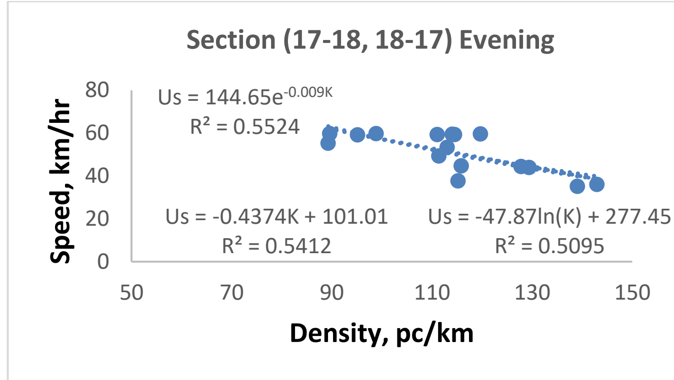
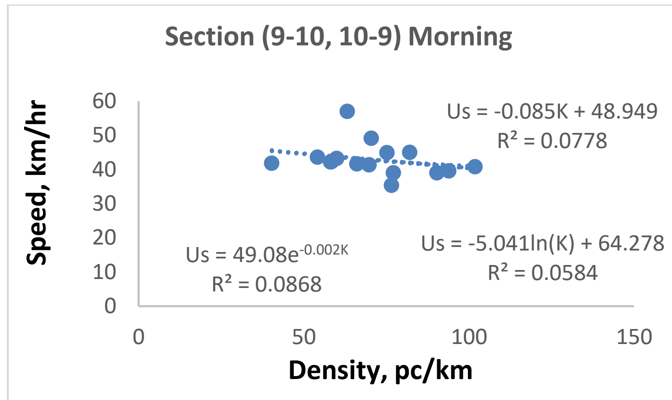


Figure 4: Best Cause Relationships between Speed-Density



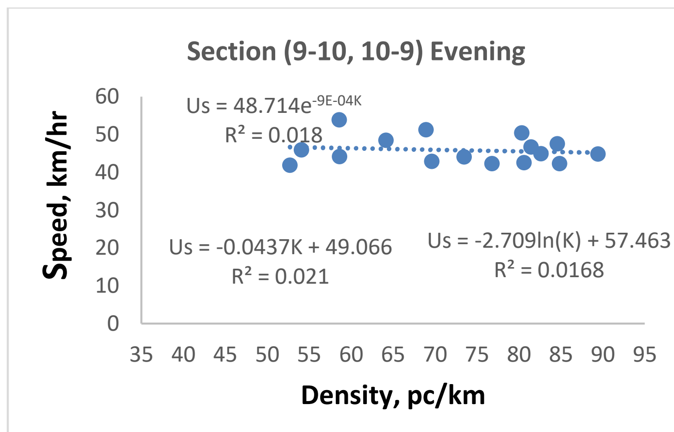
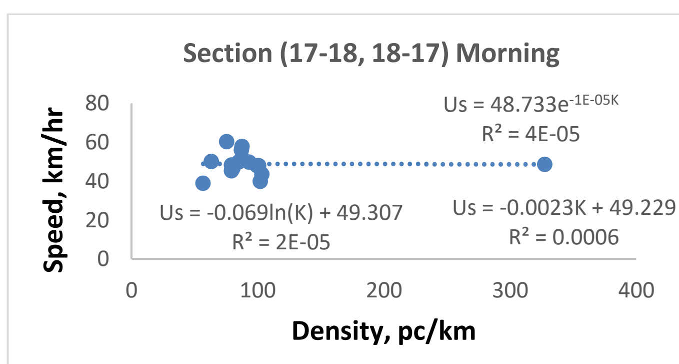
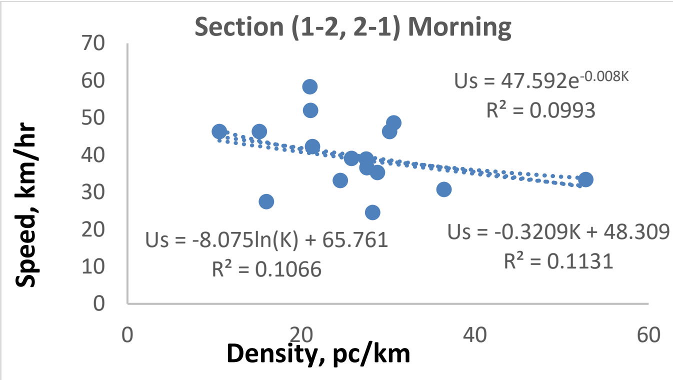


Figure 5: Worst Cause Relationships between Speed-Density





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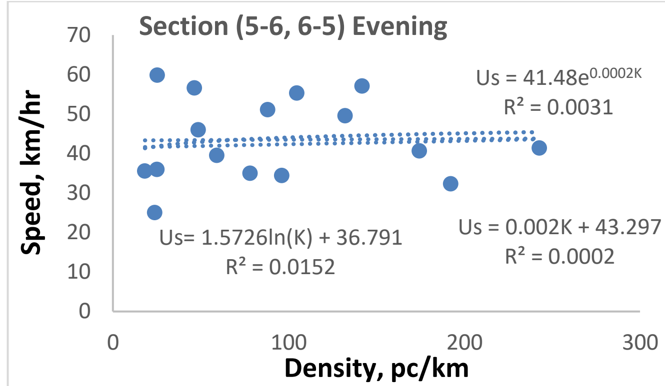

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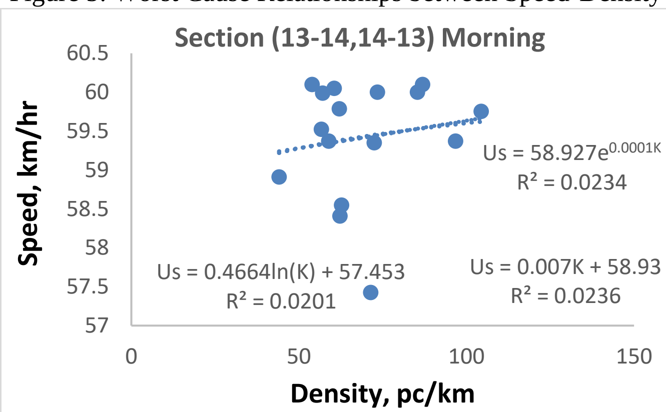
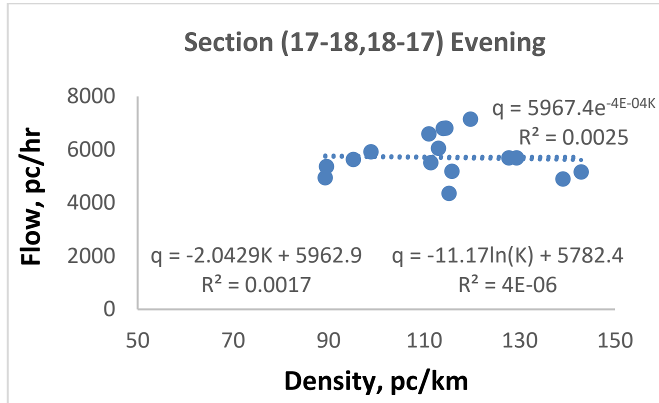




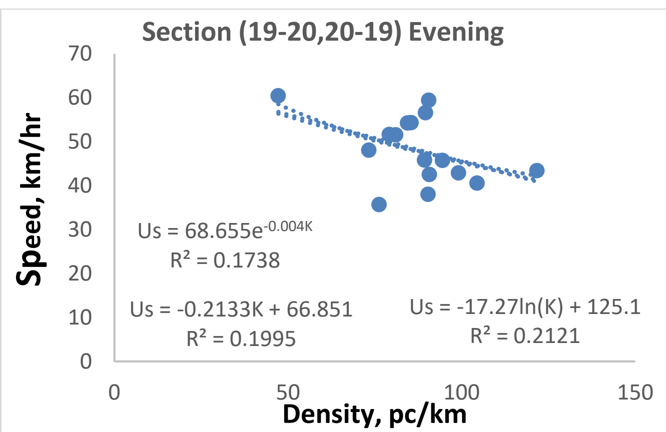


Figure 5: Worst Cause Relationships between Speed-Density

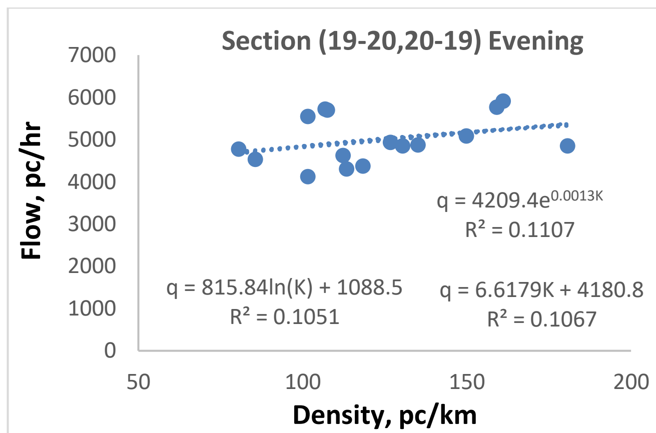
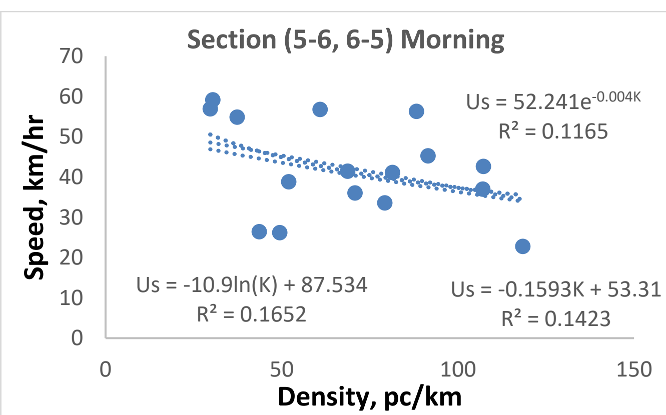


Figure 6: Worst Case Relationships between Flow-Density



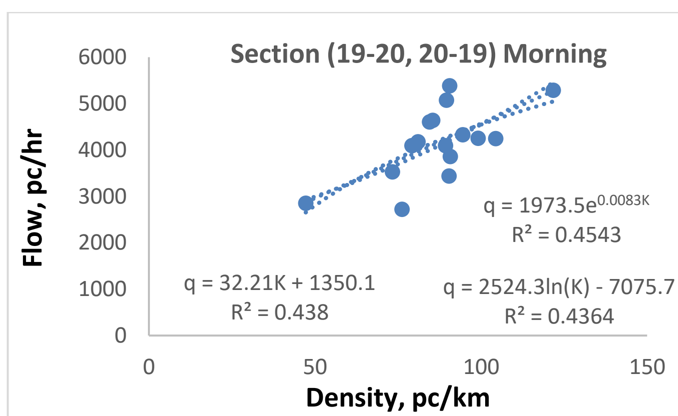
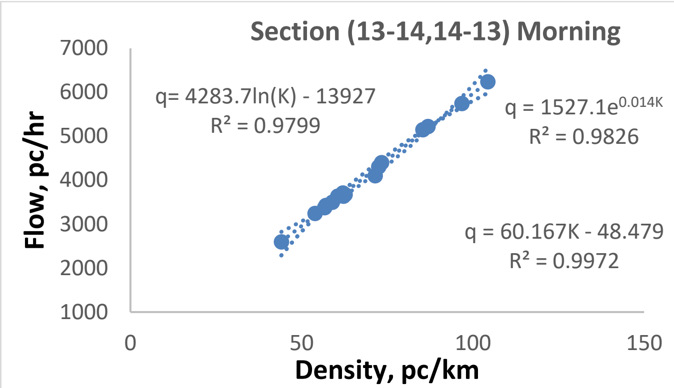


Figure 6: Worst Case Relationships between Flow-Density



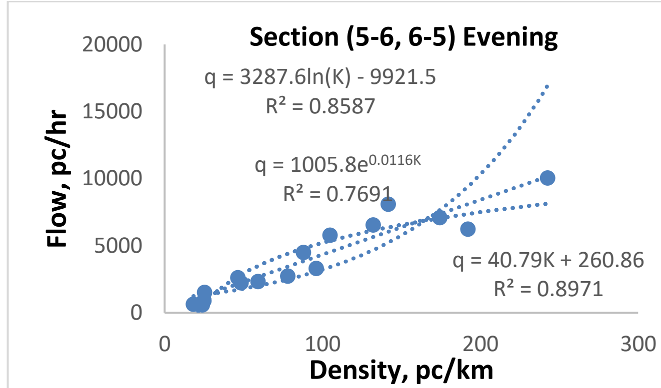
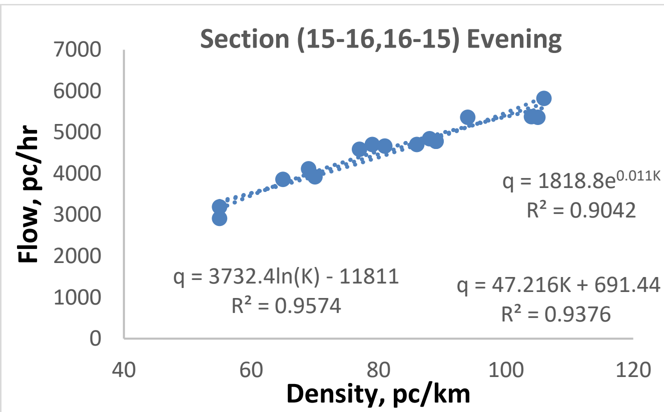
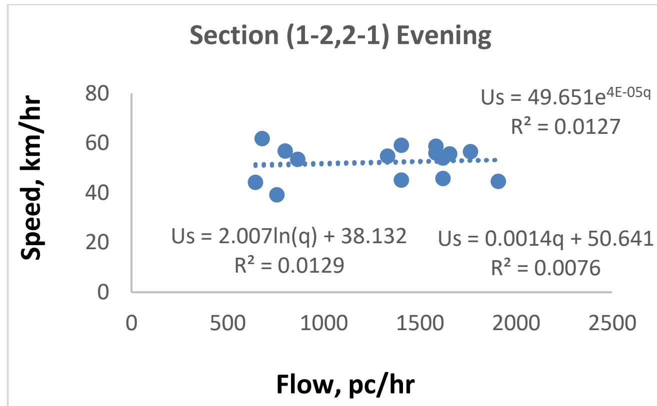
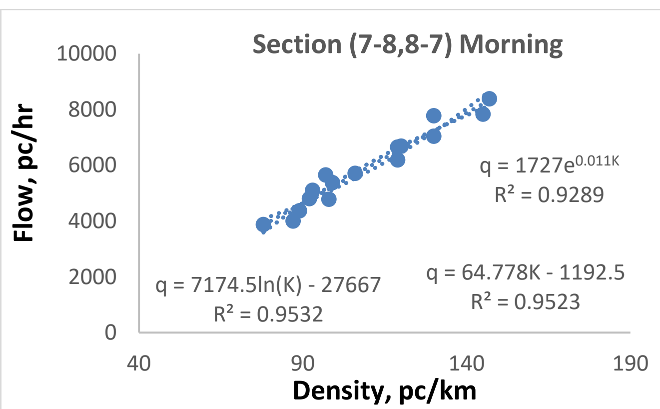


Figure 7: Best Case Relationships between Flow-Density







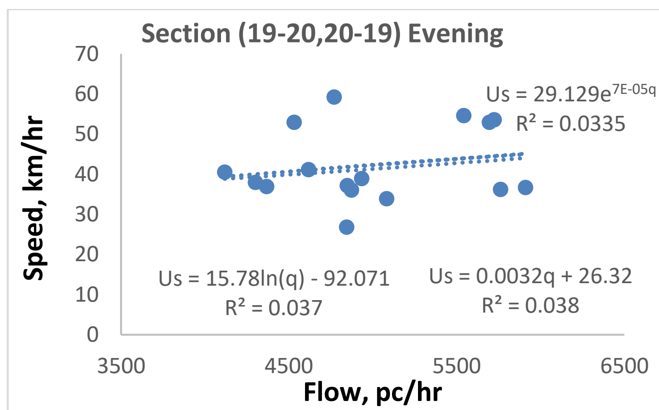
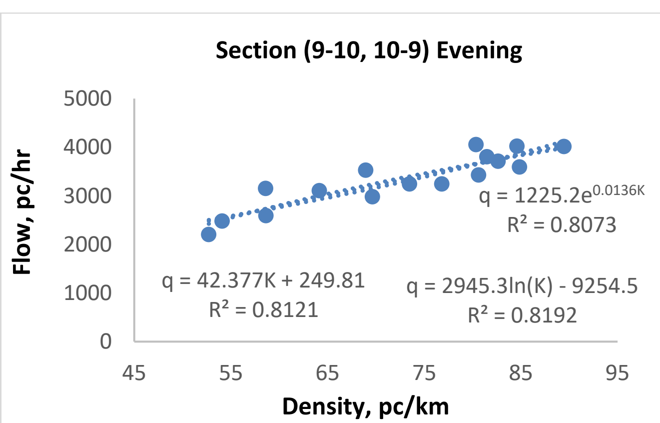
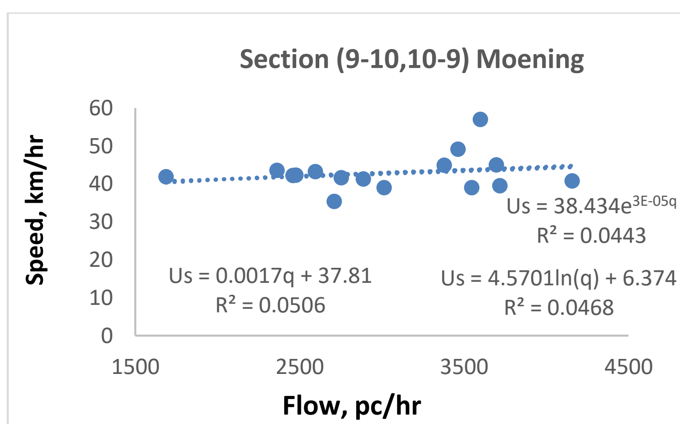


Figure 7: Best Case Relationships between Flow-Density

Figure 8: Worst cause Relationships between Speed-Flow





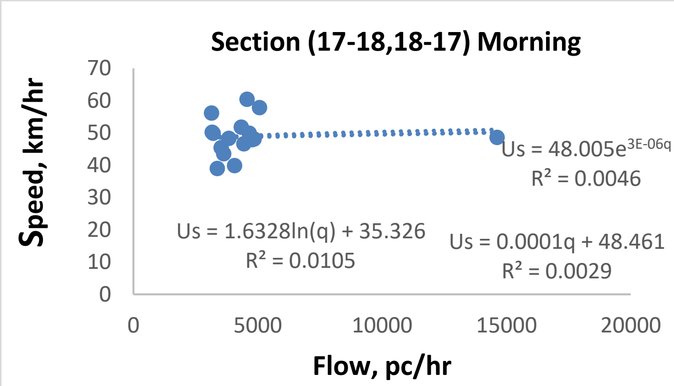
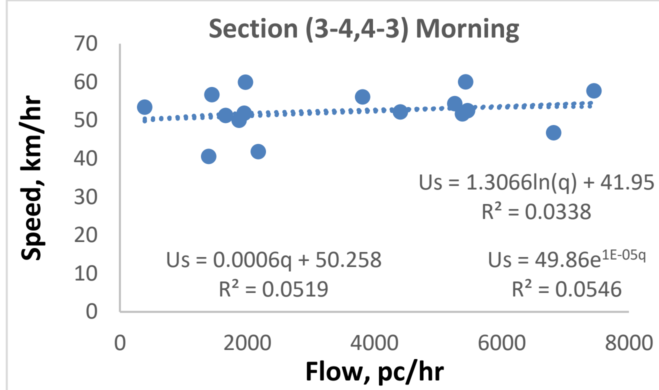


Figure 8: Worst cause Relationships between Speed-Flow



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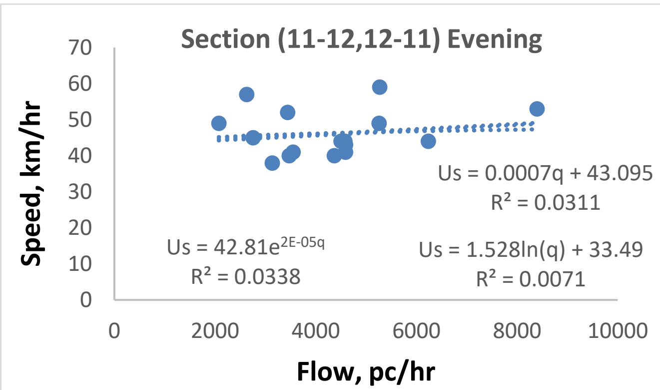

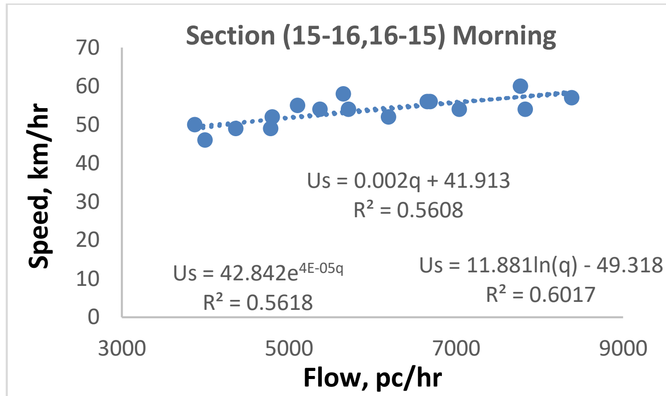

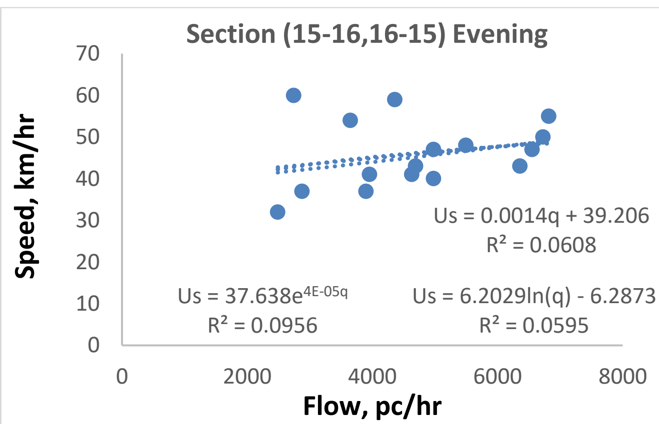

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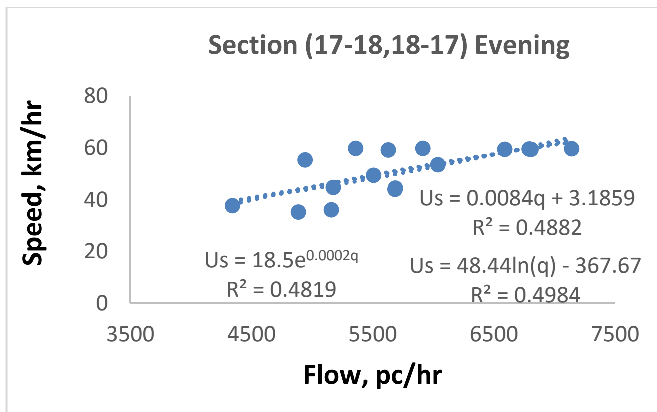
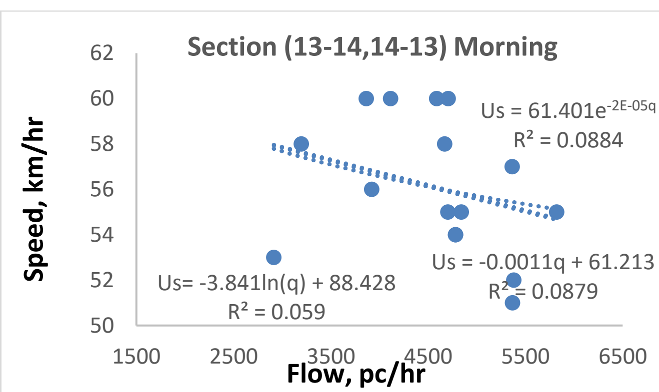


Figure 9: Best cause Relationships between Speed-Flow



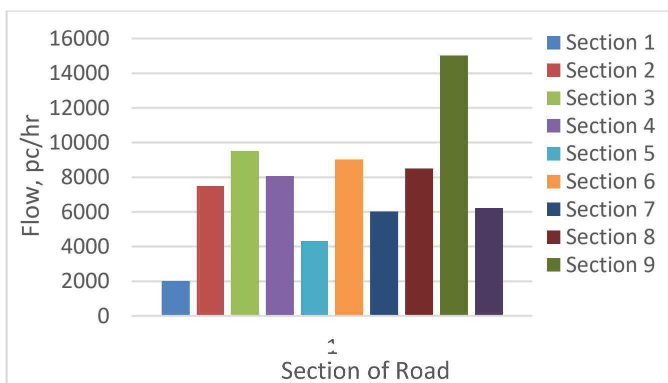


Figure 3: Highest rate of flow for each section study

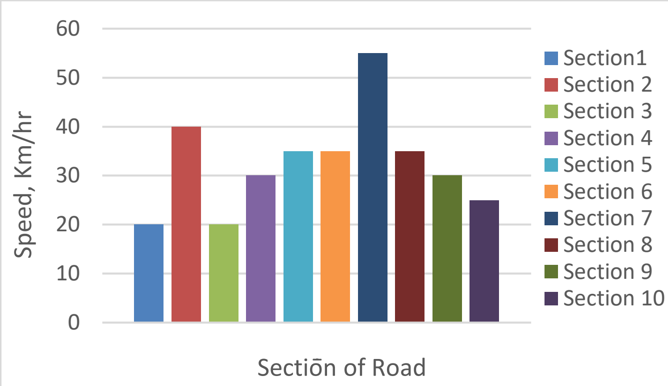


Figure 4: lowest rate of speed for each section study

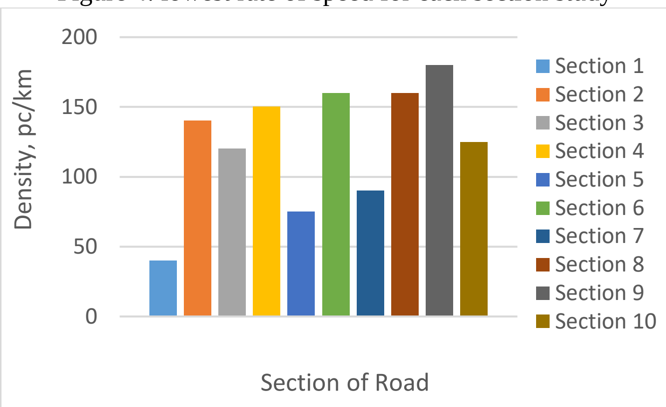


Figure 5: Highest rate of density for each section study

4. CONCLUSION

The following conclusions can be drawn from the data analysis:

1.Traffic volumes at Peak hours in the morning and evening are important for transportation engineers and planners in the design of traffic and demand levels of population to use roads. The analyses with the data suggested that the morning and evening peak periods for the Erbil city are from 8 to 10 am and 3:30 to 5:30 pm respectively. These periods were first determined as a basis for all other analyses.

2.The relation between speed-flow-density in most locations under study has poor traffic control because of parking on the side street, pedestrian, turnings movements, and bad driving behaviors.

3.Generally, methods for measured flow and speed, by MVM is efficient, practical and economic, but regarding flow, it may not be exact data because it was controlled by human-controlled which is not easy.

4.The best-fit models of speed-density-flow relationships on all road sections are as shown in the results.

5. The geometric design of the roads are note such efficient to travel safely, so it will be important to the roads to achieve more road safety. Generally, the same sections of roads do not have standard lane width such as 60-M Ring Road lane whose width is from 2.99 to 3.10m.

6. Parking of vehicles and location for taxi and/or bus stops, pedestrian movement from one side to another side, quality of pavements.

7. The results of the lower and upper value of speed-density-flow are shown by figure 3,4 and 5, but this data is used for whether complaints about speeding are valid are not, and to give recommendations based on established models to better plan traffic operations.

5. RECOMMENDATIONS

This is research based on the accomplished field work during this study. The findings and recommendations are summarized below:

1.The investigation of the basic parameters of traffic flow on roads in a city (Speed-flow-density) and various transportation costs, delays, accident rates, fuel consumption, and urban irregularities must be conducted and data should be collected in more comprehensive manner.

2.Study of vehicle parking on side streets and pedestrian movement to the left and right must be performed the controlled, delay to minimize the controlling parking of vehicles on the street and movement of pedestrians one side to another one.

3.The percentage of passenger cars is highly affecting the traffic stream in Erbil City, so it is recommended for decreasing the acceptable percentage of using the vans, mini-buses and buses because of their effect on the environment, economy, traffic control, and accomplished field work public transport system such as tram and metro.

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