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Traffic Characteristics and Spot Speed Analysis in Urban Roads.

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TRAFFIC CHARACTERISTICS AND SPOT SPEED ANALYSIS IN URBAN ROADS

" خصائص المرور وتحليل السرعة اللحظية على الطرق الحضرية "

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الملخص العربي

يهدف البحث إلى التعرف على خصائص المرور وتحليل السرعة اللحظية بالطرق الحضرية لكونها أحد الخصائص الرئيسية للمرور والتى يعتمد عليها فى تطبيقات مختلفة مثل التصميم الهندسى للطرق وتحديد مقدار السرعة القصوى والمتوسطة وكذلك تحليل الحوادث المرورية . وقد إعتمد البحث فى ذلك على حصر المرور عند قطاع من الطريق يقع بين تقاطع مصطفى كامل وتقاطع سعد باشا بمحور شارع الحرية بمدينة الفيوم ، وذلك خلال ساعات الذروة الصباحية من الساعة ٨ صباحا وحتى الساعة ١١ صباحا وكذلك تسجيل السرعة اللحظية للأنواع المختلفة من العربات عند نفس القطاع من المحور وذلك بإستخدام العربة المتحركة . ولقد اكتفى البحث بدراسة العربات الخاصة والسرفيس وعربات النقل على أن تكون النتائج الإحصائية فى حدود ثقة ٩٥٪ ، حيث أن حجم العينة الخاصة أوضحت أن الأتوبيسات والبيك أب غير كافيه من الناحية الإحصائية . وبمغايرة نموذج التوزيع للمعتدل للعربات الخاصة والسرفيس والنقل بإستخدام اسلوب Chi-Square أظهر البحث أن متوسط السرعة للعربات الخاصة والسرفيس والنقل والتى تستخدم محور شارع الحرية بمدينة الفيوم فى اتجاه تقاطع مصطفى كامل - سعد باشا كانت على التوالى ٣٤ كم/ساعة ، ٣٣ كم/ ساعة ، ٢٨ كم/ساعة وفى الإتجاه الأخر كانت متوسطة السرعة ٣٣,٥ كم/ ساعة ، ٣٣,٥ كم/ساعة ، ٢٩ كم/ساعة لنفس الأنواع من العربات على التوالى .

وفى نهاية البحث تم إستنتاج أن حدود السرعة القصوى لشارع الحرية منخفض مما يلزم معه إجراء التحسينات اللازمة لرفع مستوى الخدمة على هذا المحور وبالتالى تحسين السرعة عليه وعلى المحاور الحضرية المماثلة .

Abstract

The main objective of this paper is to describe the traffic Characteristics and analysis of spot speed of vehicles using urban roads . Some urban roads in Fayoum City in Egypt are taken as case study.

This research work was based on the traffic count and spot speed data was collected by using of moving car method through peak period. This speed is used to estimate the speed distribution of the traffic stream under the prevailing conditious. The speed distributions obtained have many applications such as study of speed trends, estimate maximum, minimum and average speed limits, geometric design elements, and aecident analysis. The analysis of data collected showed the following results :

1. The estimated values of traffic congestion index are 0.91, and 0.81 for Mostafa Kamel / Saed Basha direction and Saed Basha / Mostafa Kamel direction respectively.

2. The average speed values of different vehicle types using Horia street are 34 km/hr, 33 km/hr and 28 km/hr for Mostafa Kamel / Saed Basha direction for passenger cars, microbuses, and trucks . For the other direction the values are 33,5 km/hr, 33,5 km/hr, and 29 km/hr for the same vehicle types respectively.

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3. Spot speed distributions for different vehicle types are yielded to normal distribution and are fitted by using Chi-Square test .

4. Low spot speeds registered for the study street must draw the attention to improve the driving and geometric conditions on this street .

1. Introduction

The traffic flow characteristics and spot speed measures are very important to study in order to know the individual speeds of vehicles passing at a given point on a road or a street [1]. These individual speeds are used to estimate the speed distribution of the traffic stream under the prevailing conditions [2]. The speed distributions obtained have many applications. They are :

- Study of speed trends,
- Establish maximum and minimum speed limits,
- Accident analysis, and
- Geometric design.

Some previous studies of speed characteristics can be described as follows : Measurements of speed / flow relations on recreational roads during the summer of 1973 have been studied for traffic on improved and unimproved sections of A66 Penrith Cockermouth road in U.K. [3,4].

In Egypt, the spot speed characteristics on Egyptian rural highways are studied and evaluated [2]. In addition, the measurements of average running speed of Orouba street and traffic flow characteristics in Heliopolis area have been studied [5]. Also, the spot speed characteristics for vehicles using urban street in Sana'a city in Republic of Yemen are studied [6].

The primary objective of this paper is to investigate the variation of vehicle speed around the speed limit, especially in urban streets. Also, the traffic flow behaviours which gives traffic safety should be described. Fayoum city in Egypt taken as case study.

2. The Surveys

2.1. General

In this research work, the classified count of traffic flow was Carried out on Horie street in Fayoum City between Mostafa Kamel interseetion and Saed Basha intersection (as shown in Fig.1.) between 8.00 a.m. and 11.00 a.m., on tuesday, April 7th , 1998. Also, the spot speed at the same section traffic count was measured through 8.00 a.m. till 10.00 a.m. for both directions of study street.

The selection of this location of survey was made on the following bases:

- to eater for different environmental operating conditions, and
- this site has a medium traffic volumes in order to avoid excessive vehicle interaetions.

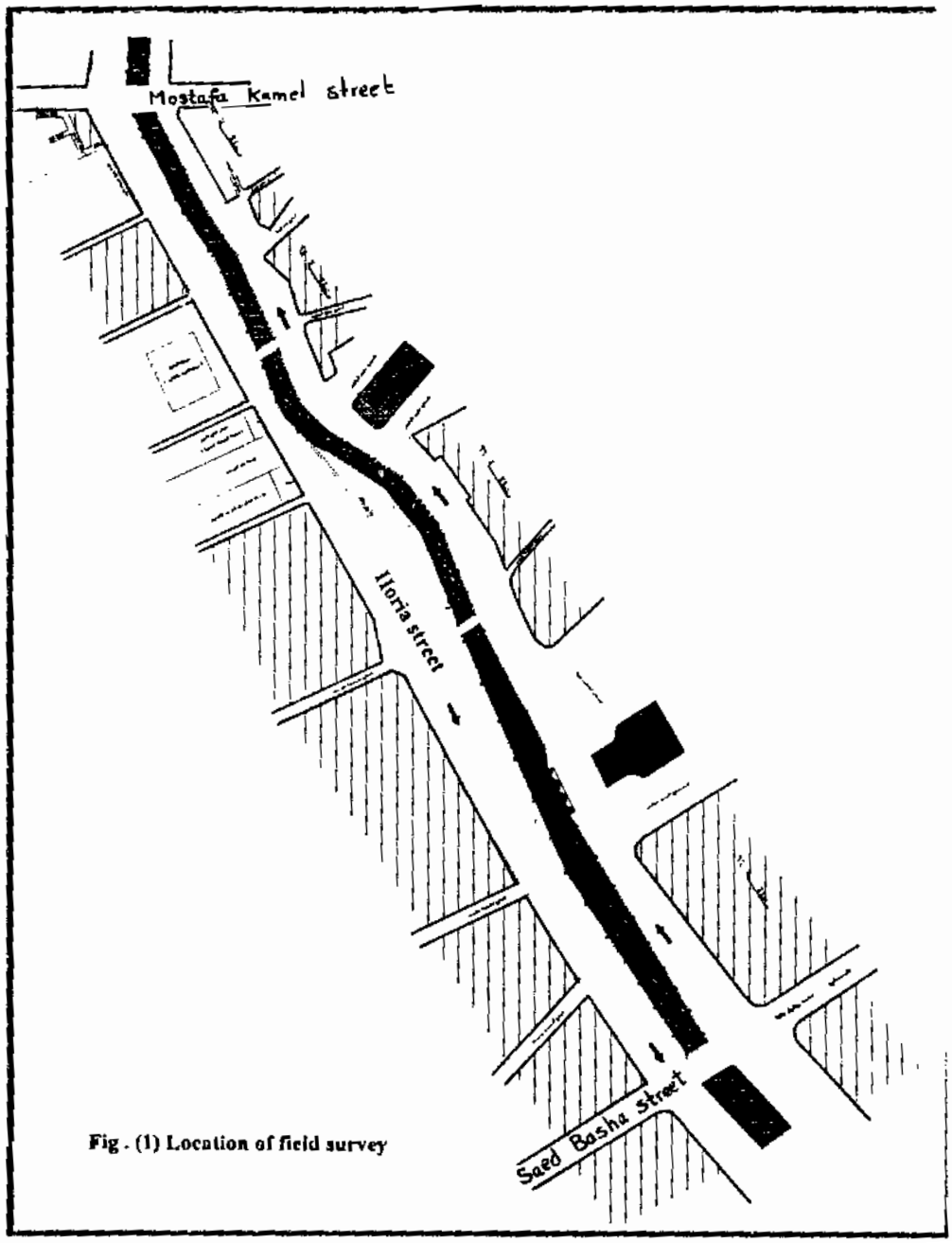

Fig. (1) Location of field survey

2.2 Vehicle type

For the purpose of this research, vehicles are classified by type as follows:

- Passenger cars including private cars, vans, jeep and taxies.
- Buses with seating capacity of 40 more,
- Microbuses with seating of 26 seats,
- Pick-up vehicles with loading capacity of 1.5 tons, and
- Trueks including light, medium, and heavy vehicles.

2.3 Sampling Requirements :

The minimum sample size required for a normally distribution population may be determined by considering the confidence intervals. The required sample size (N) is determined using the following formula [1] :

$$N = z\,\sigma^2 / e^2$$

Where :

z = a statistic value depends upon the confidence level. For 95% confidence level, z = 1.96

σ = standard deviation of the sample (in this case σ = 8.00 km/hr.)

e = permitted error in the estimate of the population mean (e = 2.00 km/hr.)

Then, the necessary sample size is computed as :

$$N = (1.96^2) \times 8^2 / 2^2 = 62$$

Table (1) shows the sample size of the different vehicle types

Table (1) Sample size for all different vehicle types

vehicle types / direction	Passengers Cars	Micro-buses	Buses	Pick.up	Trucks
Mostafa Kamel/Saed Basha	475	350	59	61	98
Saed Basha/Mostafa Kamel	390	335	48	58	88
Total	865	685	107	119	166

From table (1), the sample size of buses and pick-up vehicles were rather low, and the number of buses and pick-up vehicles should be excluded from the analysis.

3. Statistics background

In traffic engineering practice, it is necessary to evaluate a set of field measurements in order to find a meaningful interpretation of their values. In this section, a number of statistics are illustrated as defined in Ref. [2,7] :

3.1. Arithmatic Mean :

The arithmatic mean is a measure of control tendency of the data. For grouped data (as in the case of spot speeds) the arithmatic mean is determined as follows :

$$\bar{X} = \sum fi\, xi \;/\; n$$

Where xi and fi are midpoint and frequency of the i th group

3.2. Standard Deviation :

The standard deviation is a measure of spread about the mean. For grouped data, it can be determined as follows :

$$S = \sqrt{\sum fi\,(xi)^2 - \frac{1}{n}[\sum(fixi)]^2 \;/\; n}$$

3.3. The Standard Error of the Mean (SEM) :

This statistic indicates the confidence with which the sample mean may be assumed to be the actual mean of all traffic. It ean be determined as follows :

$$SEM = S / \sqrt{n-1}$$

3.4. Median :

It is the speed at which there are just as many vehicles going slower. Its value corresponds to the 50 percentile of the comulative distribution curve.

3.5. The 85th Percentile Speed :

It is the speed below which 85% of drivers operate. It is sometimes referred to as the critical speed and used as a good guide in establishing speed limits.

4. Survey results :

4.1. Traffic count results :

4.1.1. Traffic volume and directional distributions

Traffic counts were collected for 3 hours starting at 8.00 a.m. till 11.00 a.m. in April 1998 for both directions of Horie street, Fayoum city at section lies between Mostafa Kamel and Saed Basha intersections. The traffic counts and the variation in traffic volumes were used to determine the peak hour traffic volume and directional distribution factors on the street under study.

Peak hour traffic volumes in vehicles and passenger car units (p.c.u) were obtained and given in Table(2).

Table(2) Results of traffic counts

Street Direction				
	Mostafa Kamel/Saed Basha		Sade Basha/Mostafa Kamel	
Traffic Volume / Survey time	Veh./hr	P.c.u/hr	Veh./hr	P.c.u/hr
8.00 - 9.00	2215	2480	2300	2575
9.00 - 10.00	2755	3080	2450	2740
10.00 - 11.00	2620	2930	2260	2530
Peak hour traffic volume	2755	3080	2450	2740
Directional distribution %	0.49		0.51	

From table (2), directional distribution of Mostafa Kamel / Saed Basha direction 0.49 and for other direction was 0.51.

4.1.2. Traffic Composition Results :

Traffic counts were carried out in order to evaluate the amount and composition of traffic on the street under study.

Table (3) shows the number of different vehicle types and their percentages during peak hour for Horia street.

Table(3) Traffic composition and their percentages during peak hour for Horia street

Street	Traffic direction	Traffic Composition Peak hour 9-10 a.m.											
		Passenger Cars		Micro-buses		Buses		Pick-up		Trucks		Others	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Horia	Mostafa Kamel/ Saed Basha	1570	57	662	24	110	4	56	2	330	12	27	1
Horia	Saed Basha/ Mostafa Kamel	1471	60	562	23	74	3	24	1	269	11	50	2

From table (3), the results of traffic compositions during peak hour time between 9.00 a.m. and 10.00 a.m. showed the following characteristics :

1. Mostafa Kamel / Saed Basha direction: the passenger cars of this direction represent 57% of total vehicles, while the micro-buses represent 24% of total vehicles, buses represent only 4% of total vehicles, pick-up vehicles represent 2%, truck vehicles represent 12% , and only 1% of total vehicles represent others.

2. Saed Basha / Mostafa kamel direction: the traffic compositions for this direction during peak hour between 9.0 a.m. and 10.0 a.m. showed about 60%, 23%, 3%, 1%, 11% and 2% of total vehicles represent passenger cars, miero-buses, buses, pick-up, trucks and others respectively.

4.1.3. Traffic Congestion Index and Level of Service

Traffic congestion index is the ratio between traffic volume and capacity for every direction of street. Traffic volume of study road is calculated after converting counted vehicles into passenger car units by using equivalent factors of 1.0, 1.5, 2.0,3.0 and 0.5 for passenger cars and taxies, micro-buses, buses, heavy trucks, and others. Also, the capacity of study road was calculated for every direction considering the width for every direction is 12,5 m, percentage of truck was estimated for every direction, shoulder width 1.75 m for

every direction. The traffic congestion index is estimated for every direction of study road [8].

Table (4) shows the level of service and (v/c) ratio in each direction on Horia street, Fayoum city.

Table (4) Values of (v/c) ratios in Horia street, Fayoum city [9]

Street direction	Area type	Practical Capacity	(v/c) ratio	level of service
Mostafa Kamel / Saed Basha	C.B.D	880	0.91	E
Saed Basha / Mostafa Kamel	C.B.D	880	0.81	D-E

From table (4), the estimated values of (v/c) ratios are 0.91, and 0.81 for Mostafa Kamel - Saed Basha direction and Saed Basha - Mostafa Kamel direction respectively. Also, the level of service of study street is computed as level E.

4.2. Properties of speed distribution

All speed data were stored on the computer according to its type. Vehicle speeds were grooped into speed cells of a constant width of 5.0 km/hr. A series of statistical parameters such as mean, median, standard deviation, and standard errors were estimated [7].

Previous research work [2] have shown that when the data for passenger cars on level roads were assembled, the speed distribution were found to be normal. Although the normal distribution is sometimes appropriate, previous experience indicated that lognormal distribution might be of more application.

To test the validity of the normal distribution, the Chi-squared test was performed at a 5% significance level. This test is used to decide whether the true distribution (of which the collected data constitute a sample) could be identical with the normal distribution. The procedure of fitting using the Chi-squared test is detailed in Ref.[1].

Table (5) shows the spot speed data distribution for Mostafa Kamel - Saed Basha, and Saed Basha - Mostafa Kamel directions for different vehicle types.

Table (5) Spot speed data distribution for different vehicle types

Steet direction / Speed km/hr	Mostafa Kamel/Saed Basha			Saed Basha/Mostafa Kamel		
	Passenger Cars	micro-buses	trucks	Passenger Cars	micro-buses	trucks
15-20	8	4	5	6	3	3
20-25	33	31	14	27	21	12
25-30	65	50	25	49	33	21
30-35	90	82	33	82	85	32
35-40	122	98	13	108	105	12
40-45	95	55	6	77	62	5
45-50	45	22	2	32	21	2
50-55	7	6	-	4	5	1
55-60	6	2	-	3	-	-
60-65	4	-	-	2	-	-
Total	475	350	98	390	335	88

Also, Figures 2, and 3. show the spot speed frequency distribution and cumulative curves for both directions of study street as a typical examples of passenger cars distributions. In all cases, normal distributions were fitted to data of passenger cars, microbuses, truck vehicles.

4.2.1. Variation in speed distributions

Table (5) shows the average speed of vehicles passing through Mostafa Kamel - Saed Basha direction is 36.44 km/hr and standard deviation is equal to 8.20 km/hr, while the average speed of vehicles passing through other direction of street is computed as 35.90 km/hr., and standard deviation of 7.80 km/hr.

A summary of the arithmatic mean of speeds and standard deviations of different vehicle types are given in table (6) .

Table (6) Arithmatic mean and standard deviation (km/hr)

Vehicle type / Street direction	Pass. Cars		Microbuses		Trucks	
	SD	mean	SD	mean	SD	mean
Mostafa Kamel / Saed Basha	8.20	36.44	7.53	35.11	6.54	30.61
Saed Basha / Mostafa Kamel	7.80	35.90	6.76	35.90	6.67	31.25

4.2.2. Spnt Speed Statistics

Table (7) shows the fundamental statistical characteristics of spot speeds. Average and maximum speeds are calculated of every direction of study street

Table (7) Spot speed percentiles (km/hr)

Vehicle type / Street direction	Pass. Cars		Microbuses		Trucks	
	Median	85th	Median	85th	Median	85th
Mostafa Kamel / Saed Basha	34	42	33	40	28	35
Saed Basha / Mostafa Kamel	33.5	41	33.5	40.5	29	35.5

5. Conelusions

This paper showed the important of traffic count and spot speed distribution of all vehicles using urban streets. The survey results are based on traffic count and measurements of spot speed by using of moving car method through peak period.

The main results can be concluded as follows:

a) Directional distribution of Mostafa Kamel / Saed Basha direction 0.49 and for other direction was 0.51 .

b) Traffic compositions of Mostafa Kamel - Saed Basha direction were 57%, 24%, 4%, 2%, 12% and 1% of total vehicles for passenger cars, micro-buses, buses, pick-up, trucks, and others. For the other direction the traffic compositions were 60%, 23%, 3%, 1%, 11%, and 2% for the same vehicle types respectively.

c) The estimated values of (v/c) ratios (Traffic congestion index) are 0.91, and 0.81 for Mostafa Kamel / Saed Basha direction and Saed Basha / Mostafa Kamel direction respectively.

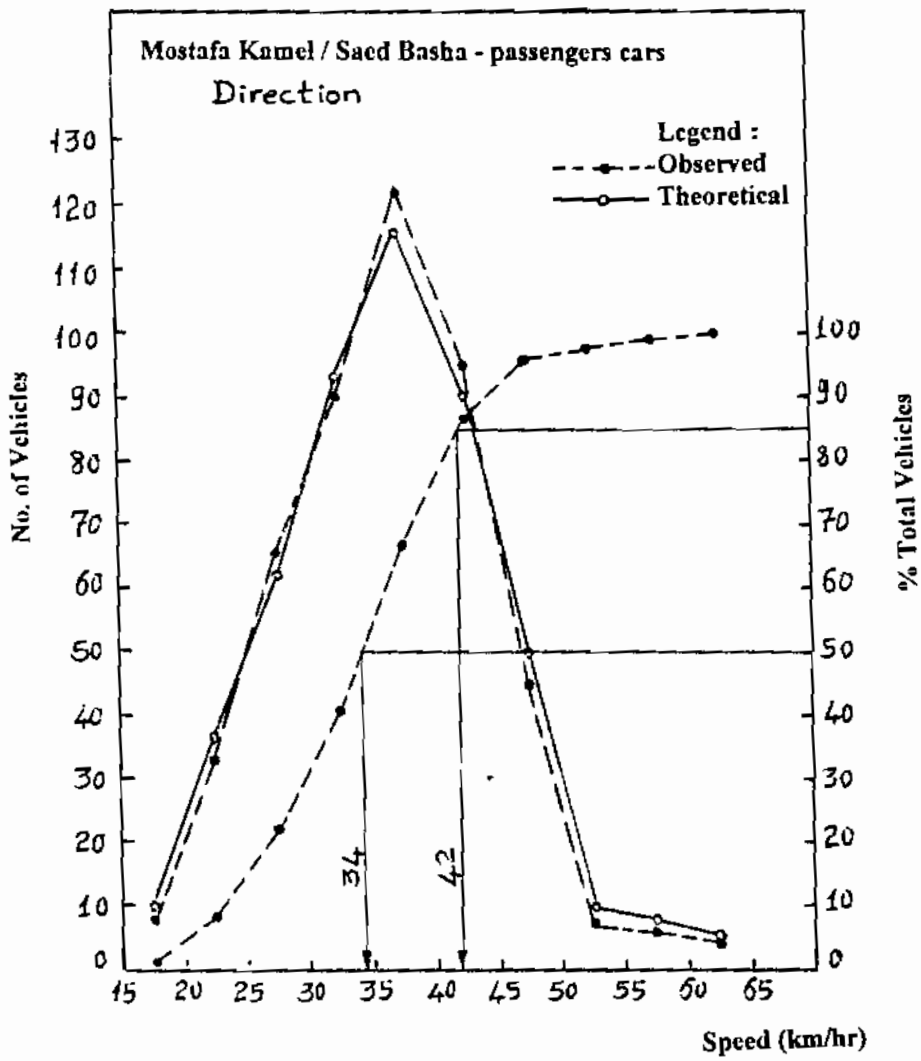

Fig. (2) Spot speed frequency and cumulative frequency distributions of passenger cars for Mostafa Kamel / Saed Basha, Horia street, Fayoum city.

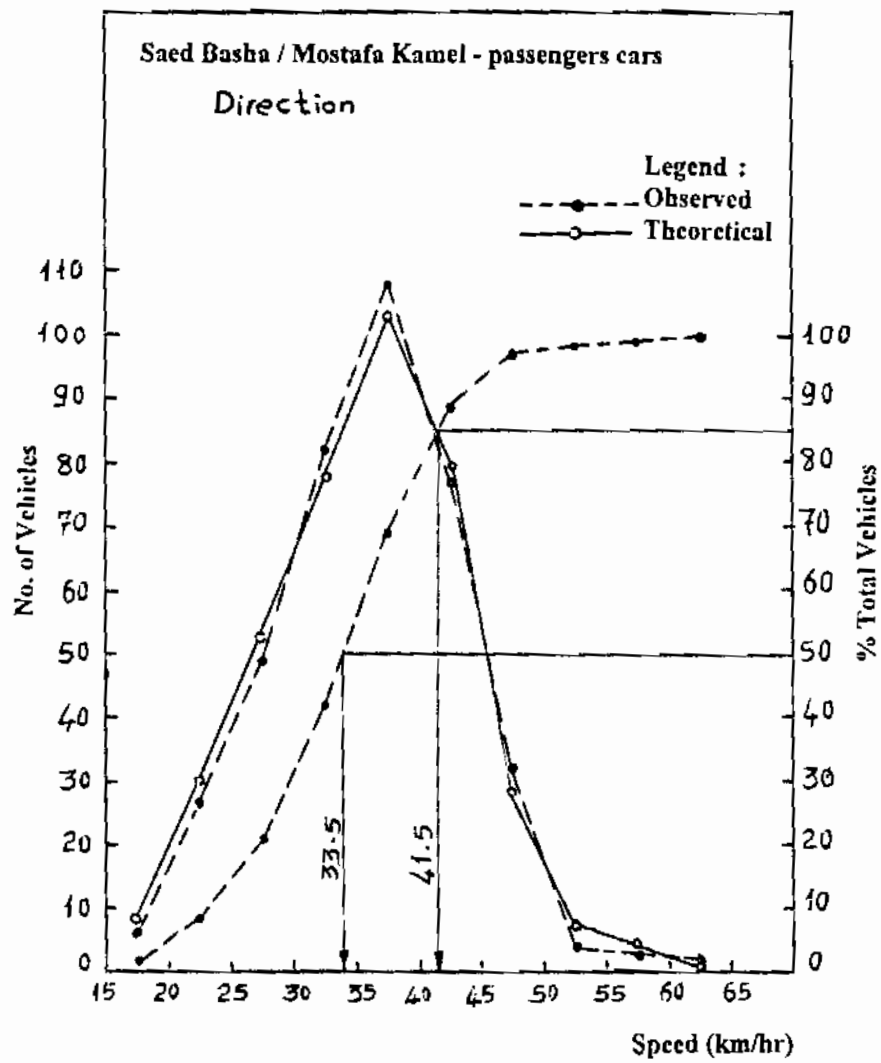

Fig. (3) Spot speed frequency and cumulative frequency distributions of passenger cars for Saed Basha / Mostafa Kamel, Horia street, Fayoum city.

d) Average speed limits of different vehicle types using Horia street, Fayoum city were 34 km/hr, 33 km/hr and 28 km/hr for passenger cars, microbuses, and trucks for Mostafa Kamel - Saed Basha direction. The same results of other direction were 33,5 km/hr, 33,5 km/hr, and 29 km/hr for the similar different vehicle types respectively.

e) Spot speed distributions of passenger cars, micro-buses, and trucks were yielded to normal probability distribution.

f) The low spot speeds registered for this study street must draw the attention to improve the driving conditions on this street and geometric design elements must be improved in accordance with ideal operating conditions. Items such as lane and shoulder widths, parking spaces and traffic control devices must be reviewed, updated and manifisted.

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