GOVERNMENT OF PAKISTAN
PLANNING AND DEVELOPMENT DIVISION
NATIONAL TRANSPORT RESEARCH CENTRE

SURVEY OF BUS SERVICES FOR ISLAMABAD SECRETARIAT

NTRC-26

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INTRODUCTION

The provision of efficient transport services in urban areas has become a problem of serious magnitude in all the larger cities of Pakistan and the twin cities of Rawalpindi and Islamabad are no exception. Inspite of excessive over-loading of all public service vehicles, bus-stops remain desparately over-crowded with long lines of commuters. The gravity of the problem and its complexity are likely to increase with increase in size of the two cities which are growing rapidly. The problem therefore needs more attention than has hitherto been paid.

The first step is solving any problem is to know the facts. However, very little information has been documented on the availability of transport services and how far the available services are being utilized efficiently in Rawalpindi - Islamabad area and in other cities as well. In order to highlight significant aspects of the problem, a survey of Bus Services to and from Islamabad Secretariat was carried out. The survey mainly covered availability and regularity of bus services. The utilization ob buses was also partly examined. The results of the survey are presented in this Report.

Before describing the results, it would be in order to give an overall view of transport pattern for those who may not be familiar with the area.

THE TRANSPORT PATTERN

Although the Federal Government offices are spread all over Islambad and Rawalpindi, the main secretariat complex is located in the north eastern corner of Islamabad. Employees from all parts of Islamabad and Rawalpindi commute there. The main modes of transport are bus, wagon and personal vehicles including car, motor cycles, pedal cycles and walk. The local Bus Services are provided by the Punjab Urban Transport Corporation (PUTC) commonly known as GTS (Government Transport Service). A sizeable number of wagons also operate in the area under private ownership.

The proportion of traffic carried by different modes is not known. However, an earlier survey(1) indicated that wagons and buses provide almost equal capacity between Rawalpindi and Islamabad. Wagons ply on main routes where they compete with buses. However, buses are the only means of transport at places where wagons do not operate and generally carry people of low income groups. Hence the operation of bus services is a matter of significant importance for public policy.

SCOPE AND COVERAGE:

The availability of bus services can be looked in two days. One is availability over space, i.e. the accessability of different areas or the spatial distribution of bus routes. The other is availability over time, i.e. the frequency of services at a given place. Although these two aspects are

(1) Traffic Survey of Islamabad Highway, National Transport Research Centre, Planning & Development Division, Islamabad.

inter-related and the one is not less important than the other, the object of our investigation is the second aspect, namely; availability of bus services at a particular place. The area covered may not be representative for other places, the results can nevertheless be viewed as an indication of existing conditions. Similar exercises can be carried out for other places for more concrete information for specific areas.

One of the important aspects examined in detail in this report is the regularity of services. This is one of the main determinants of quality and is important both for users and operators. If the service is regular and users are sure that there will be a bus every ten minutes, they can wait patiently. In case intervals are longer, they can plan their trips according to bus timings to minimise waiting times. On the other hand if the service is not regular, no-body will be sure as to when the next bus can be expected and they will divert to other modes particularly to wagons which are effectively competing with buses on the main traffic routes. The regularity thus effects patronage as well as revenues.

The regularity of bus services means operation of buses at evenly spaced and pre-determined intervals. This is quite a difficult job in urban areas. The main reasons are that buses are usually held up in congested areas and get close to each other. Besides, the variation in the number of passengers boarding and alighting at different stops also effect the schedule. For these reasons, some bunching and delays are unavoidable. Nevertheless, their analysis is essential for making improvements in the services.

THE DATA

The data for this study was collected through a short survey of bus arrivals near Islamabad Secretariat. The registration numbers of buses arriving at the Bus Stop located on Market Road near Super Market from both direction were noted with the exact time of arrival in minutes. This was supplemented by information on time spent by buses in running and at stops which was collected separately by an observer actually travelling in the buses. The times spent at stops were recorded in seconds by stop watch. The above information enabled the compilation of frequencies, intervals, turn round times, running times, time spent at stops and terminals, etc. and formed basis for analysis.

The survey of Bus arrival times was carried out in the month of August, 1978 for one day during day-light only from 7.00 A.M. to 5 P.M. This covered both the morning and afternoon peaks. Subsequent observations concerning bus running times were made later during October, 1978.

The original data of this study concerning bus arrival times is capable of being analysed in several ways and has therefore been reporduced in Annexure-I for other researchers. who may like to do further analysis. The bus arrivals have also been plotted on the accompanying graph (Annexure II) which provide a visual expression of frequencies and intervals over time.

ROUTES OBSERVED:

A brief description of routes served by buses observed at the survey point is given below:

(i) Description of Bus Routes

S.No.	Route Served
1	Railway Station - Pakistan Secretariat via Murree Road, Aabpara, Lalquarter.
2	Airport - Secretariat via Saddar, Aabpara, Lalquarter.
5	Check Post 22 - Secretariat via Pindora, I-9, G-8, G-7, Sitara Market, Melody Cinema.
6	Lalkurti - F-8/2 via Saddar, College Chowk, Faizabad, Aabpara, Lalquarter, Super Market.
8	Railway Station - Secretariat via Saddar, Pindora,G-8, F-7, Super Market
9	Dhok Saidan - Secretariat via Check Post 22, Saddar, Faizabad, Zero Point, G-7/2, Lalquarter, Super Market.
16	G-9/2 - Nurpur via Aabpara, Lalquarter, Super Market, F-7/2, Zafar Chowk.
17	Saddar - Nurpur Shahan via I/9, G-8, Zero Point, G-7/2, Melody Cinema, Aabpara.
30	Lalkurti - Secretariat via Check Post 22, Saddar,Faizabad,Zero Point, G-7/2, Lalquarter, Super Market.

Routes 1 and 30 are Express having fewer stops on the way and minimum fare one stage higher than ordinary. All other routes are ordinary.

Further details concerning route lengths and inter stop distances in respect of Routes 1, 5, 9 and 30 visiting Secretariat are given at Annexure-III.

In subsequent analysis, Routes where frequency of services is small are combined under the category of "Others".

NO. OF BUS SERVICES

During survey hours (7 AM to 5 PM), 187 buses passed the observation point in one direction and 174 in the other. The route wise details are given below:

(ii) No. of Bus Services of different routes

Route	Directions		
	Up*	Down#	Both
1	72	65	137
5	21	19	40
6	16	18	34
9	26	28	54
16	12	13	25
30	20	20	40
Others	15	16	28
Total:	182	176	358

* To Secretariat
\# From Secretariat

The difference of 6 buses in two directions may be due to time lag or diversion of certain buses to routes not passing the observation point.

The largest number of buses were on route No.1, which accounts for more than half the buses visiting the Secretariat. This is followed by Route 9, 5, 30, 6 and 16.

HOURLY VARIATION:

There is considerable variation in the number of buses visiting Secretariat at different hours of the day as shown below:

(iii) Hourly Frequency of buses visiting Secretariat — Average of two directions (Routes 1, 5, 9 & 30 only)

Hour	No.of Buses
0700	18
0800	15
0900	13
1000	14
1100	12
1200	10
1300	8
1400	12
1500	10
1600	11
1700	12
Average	12

Further details giving variation for main Routes individually in two directions separately are contained in Annexure-IV.

It would be seen that there are, on the average, 12 buses to and from Secretariat each hour, or there is one bus every five minutes. The highest frequency is in the morning from 0700 to 0800 hours and lowest during 1300 hours. In general, the frequency declines in the middle of the day. These are off-peak hours during which operators may take rest, obtain fuel and oil, etc. This would be in line with changes in demand.

It would also be seen from the above that frequency during morning hours is higher than in the afternoon hours. This means that the problem of getting transport for going back home is more acute than in the morning for coming to office.

Looking at individual routes (Annexure IV) it would be seen that Route 1 from Railway Station to Secretariat has a frequency of more than 6 buses an hour or one bus every 10 minutes. The other three routes serving Secretariat viz. 5, 9 and 30 have a frequency of less than two buses an hour. Routes 6 and 16 having destinations at places other than Secretariat have still lower frequencies of 1.5 and 1.2 buses an hour in either direction.

The pattern in both the directions is similar though the number of buses in two directions do not balance exactly. This may be due to time lag and variation in time spent at the terminals as indicated before.

AVERAGE INTERVALS:

Frequency and interval are two different aspects of the same phenomena. We can either say that there are six buses an hour or there is one bus every ten minutes. Accordingly, the frequencies described above have been expressed.

intervals as follows:

(iv) Frequencies and Intervals:

Route	Average Hourly Frequency	Average Interval (Minutes)
1	6.0	10
5	1.8	33
6	1.4	40
9	2.5	25
16	1.6	50
30	1.8	33

The above intervals have been calculated by dividing the total survey time by the number of bus services recorded. It is evident that Route 1 has the shortest interval of 10 minutes. This is followed by Route 9 with interval of 25 minutes, Routes 5 and 30 have intervals of 33 minutes each. These four routes combined, all visiting the secretariat, have an interval of 5 minutes. Routes 6 and 16 have longer intervals of 40 and 50 minutes. Other routes not analysed here had still longer intervals.

DISTRIBUTION OF INTERVALS:

As indicated before, bus schedules in urban areas are often disturbed due to bunchings and delays at stops. The intervals are therefore likely to vary from one another. The extent of variation can be examined by considering the distribution of intervals by length of time. This is shown in detail in Annexure V. A summary of the same is given

below. The accompanying graph-I also shows frequency distributions of intervals for individual routes:

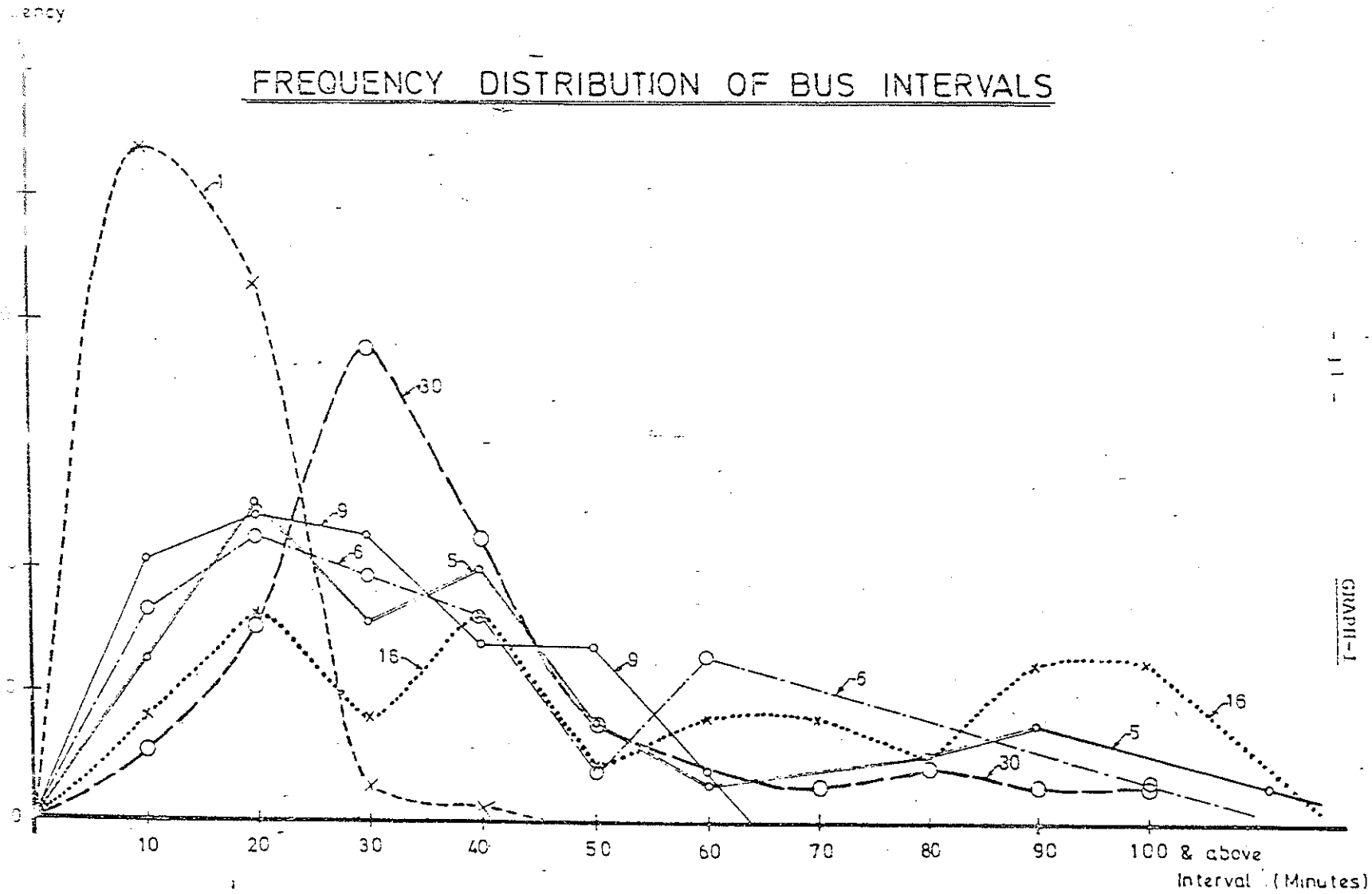
(v) Percentage Distribution of Intervals by Length of Time for different Routes (Both Directions Combined)

Route	Time (Minutes) 0-9	10-19	20-29	30-59	60 & over
	% Intervals				
1	54	42	3	1	-
5	15	24	18	28	15
6	16	22	19	32	10
9	20	24	24	30	2
16	8	16	8	28	40
30	3	20	24	32	12

As expected, Routes having higher frequency have greater proportion of intervals on lower time brackets and Routes having lower frequency have greater proportion of intervals in higher time brackets, the concentrations being around the means. For example, Route 1 having the highest frequency has 54% intervals less than 10 minutes. On the other extreme, Route 16 having average interval of 50 minutes has 40% intervals more than an hour long. Intervals on other Routes vary in between these limits.

The longest interval on Route 1 was 30 - 45 minutes. For other Routes the proportion of intervals exceeding one hour was 15% for Route 5, 10% for route 6, 2% for route 9, 40% for Route 16 and 12% for Route 30. This means that the occasions when there is no bus for an hour or so are not rare on these routes.

GRAPH-I


FREQUENCY DISTRIBUTION OF BUS INTERVALS
1
30
9
6
5
16
9
6
16
5
30
0
10
20
30
40
50
60
70
80
90
100 & above
Interval (Minutes)

PROPORTION OF INTERVALS AROUND AVERAGE

The variations in intervals indicated above are partly based on absolute values of time which vary partly due to differences in scheduled frequencies and partly due to the lack of regularity in operations. The later aspect will be better reflected if the variations are considered in relative terms. This is shown in table (vi) which indicates proportion of intervals within ± 10% and ± 20% of average for different routes:

(vi) Proportion of Intervals Around Mean

Route	% of Interval	
	+10%	+20%
1	17	29
5	15	25
6	10	23
9	13	28
16	8	16
30	18	25

It would be seen that buses of route 30 having 18% of intervals within ± 10% of average. This is followed by Route 1 (17%), Route 5 (15%), Route 9 (13%), Route 6(10%) and Route 16(8%), respectively. If the extent of deviation

from the mean is increased from ± 10% to ± 20% of average, the top position will be occupied by Route 1 (29%) followed by Route 9 (28%) and Routes 5 and 30 (both 25%), Route 6 (23%) and Route 16 (16%). Route 30 and 1 are more regular than others having largest proportion of intervals within ± 10% and ± 20% average, respectively. Route 16 appears to be the least regular having lowest proportion of intervals within 10% and 20% of mean.

SKEWNESS OF DISTRIBUTION:

The irregularity of intervals can also be seen from the skewness of distribution. If intervals are evenly spread, the arithmatic mean (average) will be in the centre of the series and will be equal to median (central value). The distribution will be symmetrical. If some of the observations are exceptionally high or low, the mean will be pulled away from the median towards the extreme values, will be smaller or larger than median and the resulting distribution will be skewed negatively (towards the left) or positively (towards the right) depending upon whether more extreme values are on the lower or upper end of the distribution. The difference between

the mean and the median indicates the direction and degree of skewness, which in turn indicates the extent of extreme values on either side of the mean. This can be seen from Table (vii) below:

(vii) Skewness of Bus Intervals*

Route	Mean	Median	Difference No.	% of mean
1	10	8	2	20
5	33	24	9	27
6	40	25	15	37
9	25	22	3	12
16	50	43	7	14
30	33	23	10	30

It would be seen that in all cases arithmatic mean is higher than median, the difference ranges between 12 and 30 percent of the mean. The accompanying graph also indicates that the distribution is markedly skewed to the right. The conclusion is that some exceptionally longer intervals have increased the average length. The elimination of such intervals will reduce the average and improve the regularity.

The values derieved above can be used for measuring changes over time or for comparison with other places.

*The proper statistical measure of skewness is:

$$\text{Skewness} = \frac{3\ (\text{mean} - \text{median})}{\text{Standard deviation}}$$

The application of this formula to our data has provided the following results:

Route No.	Skewness $3(\bar{x} - \text{median})/n$
1	1.1
5	1.5
6	1.5
9	0.6
16	0.9
30	1.6

STATISTICAL MEASURES OF VARIANCE

Still better measures of regularity are provided by more formal statistical analysis of variance contained in Annexure VI. Its main features are however briefly described in the following paragraphs:

MEAN VARIANCES:

The mean variance is the arithmatic mean of variances from the mean, both negative and positive. It is arrived at by adding the variations in both directions and dividing by the number of observations. Formally, it is defined as $\bar{V} = \frac{\Sigma(1x - \bar{x}1)}{N}$. The mean variance has been found between 64% and 71% of average interval. Details of individual routes are shown below:

(viii) Mean Variances as % of average interval:

Route	Direction	
	Up*	DOWN#
1	55	44
5	69	57
6	58	59
9	51	51
16	63	54
30	40	45
1, 5, 9 and 30 combined.	71	64

* To Secretariat

\# From Secretariat

Here again, Route 30 having lowest value of 40% appears to be the most regular. It would also be seen that in the upward direction (to Secretariat) the mean variance is between 40% and 71% of average while in the reverse direction, range gets narrow (between 44 and 64%). It seems buses correct part of their irregularity by adjusting their stay at the terminal.

CO-EFFICIENT OF VARIATION:

Similar to mean variance, the co-efficient of variation is the ratio of standard deviation to mean[2]. The standard deviation is the root of sums of squares of deviations from the mean divided by the number of observations. Mathematically it is defined as : $\sigma = \sqrt{\Sigma (x - \bar{x}^2/n}$. When expressed as ratio to mean, it gives co-efficient of variation. The values of this co-efficient for our data have ranged between 54 and 92 percent. Details for individual routes are shown below:

(ix) Co-efficient of variations of bus intervals

Route	Direction	
	Up	DOWN
1	65	54
5	76	72
6	92	98
9	61	56
16	73	60
30	50	64
1, 5, 9, and 30 combined	90	79

* The difference between the mean variance and standard deviation may be noted. The former is the average of deviations from mean with ignored signs while in the later case deviations are first squared to eliminate negative signs, divided by the number of observations and then root is taken.

The co-efficient of variation are higher than the mean variance as a ratio of average interval and confirm the earlier results. The values in the upward direction (to Secretariat) are also higher than in the other direction as before indicating that disturbances in schedules are partly offset by adjustments in intervals at the Secretariat end.

WAITING TIME PROBABILITIES

Passengers are normally interested to know as to what are the chances of getting a bus after a given waiting time or what is the most probable waiting time for getting a bus of a certain route? The answer will be given by mathematical probabilities of getting a bus after a certain time which will be in proportion to time coveeed by intervals of varying lengths. The following example will make the relationship between interval and waiting time clear:

(x) Example of relationship between Interval and Waiting Time

Interval Minutes	Frequency	Time Covered Minutes	Time as % of total	Cumulative Frequency
1.	2.	3.	4.	5.
5	3	15	25	25
10	2	20	33	58
25	1	25	42	100
Total:	6	60	100	-

In the above example, there are six bus services of which 3 are at an interval of 5 minutes each 2 at an interval of 10 minutes each and one at an interval of

25 minutes. The time covered by 3 buses with 5 minutes interval is 15 minutes which is ¼th of total. The probability of getting a bus with 5 minutes interval will be 25%, within 10 minutes 58% and within 25 minutes 100% i.e. equal to cummulative frequency in Col. 5.

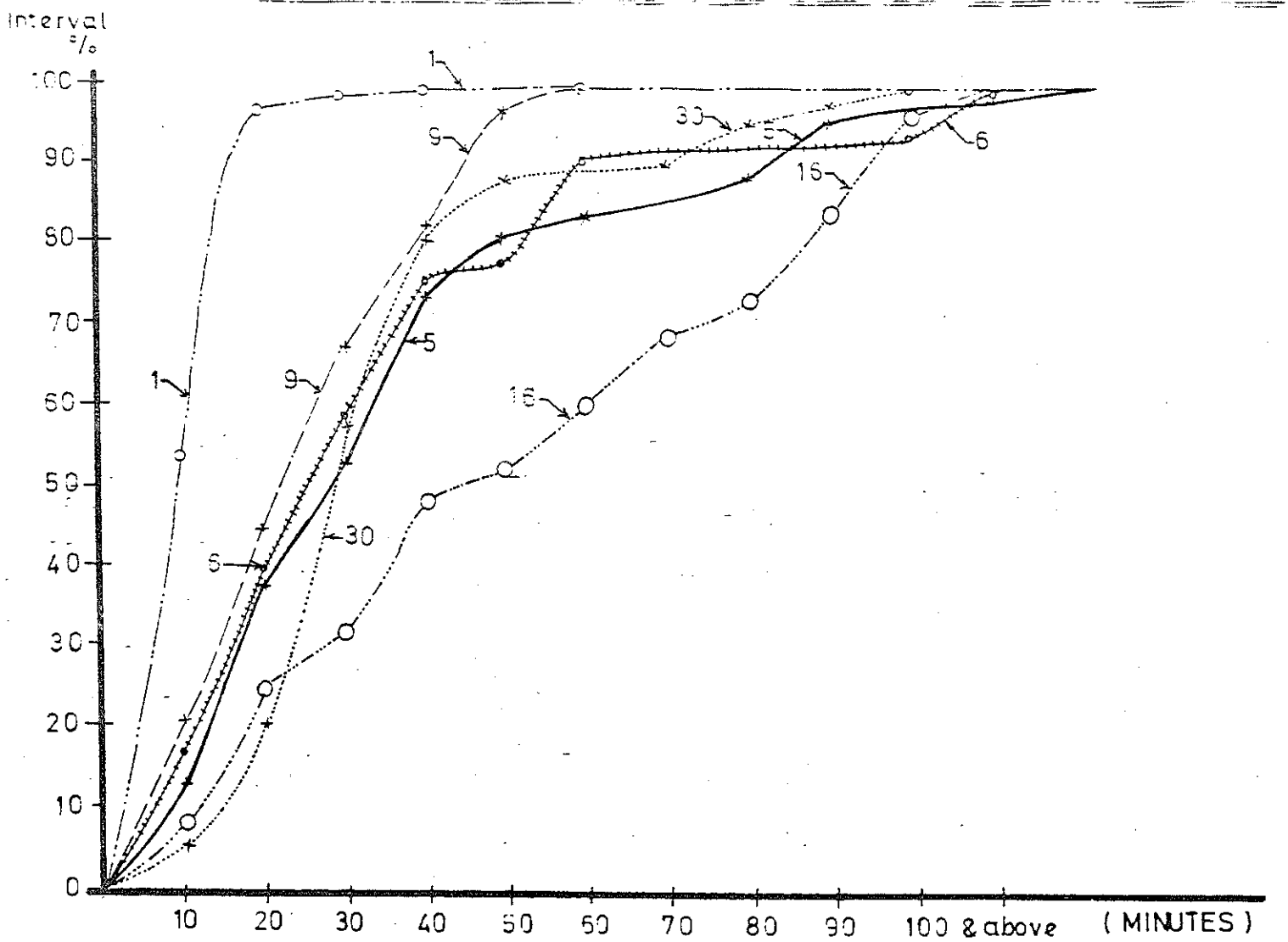
Such frequencies of intervals of individual bus routes have been calculated in Annexure VII and plotted on the accompanying graph II. On the basis of these frequencies, probabilities of getting a bus at given waiting times for different routes are shown below:

(xi) Probabilities of getting bus at different waiting times (Percentage Points)

Waiting Time Minutes	Routes/Probabilities(Percent)					
	1	5	6	9	16	30
5	5	-	-	-	-	-
10	29	2	2	5	-	1
15	58	6	3	13	3	1
20	90	13	12	19	4	1
25	95	25	16	27	6	33
30	98	27	25	42	8	66
45	100	57	43	73	22	69
60	100	65	63	100	20	100
& over	100	100	100	100	100	100

It will be seen from the above, that chances of getting a bus of Route 1 at 5 minutes waiting time are 5%, at 10 minutes waiting time 29%, 15 minutes waiting time, 58% and so on. For other routes, the chances of getting a bus at 15 minutes waiting time are 6% for Route 5, 3% for Route 6 and 16, 13% for Route 9,

CUMULATIVE FREQUENCY OF BUS INTERVALS



and 1% for Route 30. At 30 minutes waiting time, the chances are 98% for Route 1, 27% for Route 5, 25% for Route 6, 42% for Route 9, 8% for Route 16 and 66% for Route 30. The greater the regularity of services, the higher will be the concentration of probabilities around average interval, as in the case of Route 30 where the chances of getting a bus upto 20 minutes waiting time is only 9% as compared to 12, 13 and 19% for Routes 6, 5, and 9 which have similar average intervals. The maximum frequencies of Route 90 are concentrated around 20-30 minutes (55%).

If we take probabilities of getting a bus as independent variable, the waiting times for different routes will be as follows:

(xii) Waiting Time at Different Probabilities:

Probability %	Waiting Times(Minutes) for Routes					
	1	5	6	9	16	30
50	12	39	50	30	80	34
60	14	46	55	36	86	36
70	15	71	95	40	90	47
80	17	80	133	46	93	71
90	19	88	161	49	97	76
100	32	105	164	55	135	96

From this table it is obvious that there is only 50% chances of getting a bus within maximum waiting time of 12 minutes for Route 1, within 30 minutes for Route 9, within 34 minutes for Route 30, within 39 minutes for Route 5, within 50 minutes for Route 6, and within 80 minutes for Route 16. Similarly, maximum waiting time for other probabilities can be read.

UTILIZATION OF VEHICLES:

In addition to frequencies and intervals analysed above, the utilization of vehicles was also examined, This included round trip times, running and stopping times, rests at terminals etc. These are described in the following paragraphs:

ROUND TRIP TIME:

The round trip time is defined as the time taken by a bus to make a complete round trip including the time spent at stops and terminals. It was possible to calculate the same by using license plate method i.e. occurrance of the same bus number at different times at the same stop.

The average round trip times thus estimated for individual routes are given below:

(xiii) Round Trip Times:

Route No.	No. of Obs.	Av. Round Trip Time (Minutes)
1	34	141
5	4	188
9	14	178
16	6	122
30	11	162

The number of observations given above are less than the number of services for these routes. This is partly due to time lag. The bus numbers noted during the last trip time would not re-appear. Besides, the extreme values have also been ignored. In addition, the fact that buses can change route numbers complicated the measurement of round trip time.

For routes other than those given above, the number of observations were not sufficient to give a stable average. These have not therefore been analysed.

DISTRIBUTION OF ROUND TRIP TIMES:

The variations in round trip time were further examined for route number 1 for which sufficient observations were available. It was found that 73% of buses had round trip times within 10 minutes plus and minus of average time. The distribution of buses by time of interval is shown below:

(xiv) Distribution of round trip times (Route 1 only)

Time (Minutes)	No.	%
Upto 130	5	15
130-139	13	38
140-149	12	35
150-159	3	9
190-199	1	3
Total:	34	100

The distribution for other routes has not been made as the number of observations was small. It would be interesting to obtain more observations for other routes and to determine their round trip times.

VARIATION BY TIME OF THE DAY:

Travel times normally increase during rush hours as the roads are congested and consequently speeds are reduced and it takes more time for boarding and alighting the vehicle when it is fully packed. However, examination of variations in round trip time indicated that, contrary to expectation, the actual round trip times during morning and evening peak hours were less than

during the off-peak hours as shown below:

(xv) Round Trip Times by time of the day

Time of day	No. of Obs.	Av. Round Trip Time
0700-0959	5	141 Minutes
1000-1359	15	147 "
1400-1559	6	140 "
1600-1759	7	130 "

The round trip time during morning and afternoon peak is 141 and 140 minutes as compared to 147 minutes during off-peak interval. However, the round trip time in evening (1600 and 1700 hours) is lower than afternoon peaks. The reasons are not quite dear. Further investigation is called for.

RUNNING AND STOPPING TIMES

The round trip time includes running and stopping times which depend upon the type and length of route, and frequency and duration of stops on the way. How many stops a bus makes en-route and how much time is spent in running at stops was examined for the four main routes. An observer travelled in buses and recorded time of arrival at different stops and also the time a bus stayed at each stop. The latter time was measured by stop watch in seconds. The results are presented in Annexure-VIII. A summary of the same is given below:

(xvi) Running and Stopping Times for one way trips

Route	Trip Time (Minutes)	No.of stops	Time per Stop(sc)	Total Stopping Time (Minutes)	Running Rime
1	60	30	32	16	44
5	89	46	32	25	64
9	65	33	36	20	45
30	62	29	32	15	47

The route numbers 1, 9 and 30 are similar in length and mostly overlaping. Route 1 and 30 are Express - supposed to have fewer stops than others while route 9 is non-express. Nevertheless, the difference in the trip time and number of stops enroute is not significant. Route 5 is lengthy and circultous. Its trips time is longest of all, the number of stops are about 50% more and so is the total time spent in running and at stops.

LENGTH OF STOPS:

The distribution of stops by length of time indicates that about 42% of stops are shorter than 20 seconds, 34% between 21-40 seconds, 13% between 41-60 seconds and about 10% are more than one minute long. Route-wise details are given below:

(xvii) Distribution of stops by length of time (seconds) for individual routes:

Route	Upto 20	21 - 40	41 - 60	61 & over
1	40	34	13	11
5	47	31	11	9
9	35	35	20	10
30	40	35	13	7
Average	42	34	14	10

The above stops include stops at signals, the number of which ranged between 5 and 7 and the average time was 24 seconds as shown below:

(xviii) Stops at Signals:

Route	No.of stops	Time per stop(sc)
1	6-7	24
30	5-6	25
5	5-6	24
Average	6	24

It will be seen that average stopping time at signals(24 seconds)

is less than the average for all stops (32 seconds).

TIME SPENT AT THE TERMINALS:

The difference between the round trip times and trip time (time spent to travel from one end to the other) gives the time spent at the terminals. This has been calculated as below:-

(xix) Time Spent at Terminals:

Route	Round Trip Time(Minutes)	Trip Time*	Time Spent at terminals
1	141	120	21 Minutes
5	188	178	10 "
9	179	130	49 "
30	162	123	39 "

*Including time spent in running and on the stops.

It would be seen that buses of Route 1 spend 21 minutes at terminals while buses of Route 30 spend 39 minutes and of Route 9 enjoy 49 minutes. The difference in round trip time is therefore mainly due to higher time at terminals.

It is not clear as to why buses of routes 9 and 30 enjoy relatively higher free times at terminals. As the trip times are not much different, these need not be any significant difference in times spent at terminals. The management may perhaps like to review the round trip times in the light of above findings in order to improve utilization of buses. The time spent at the terminals by Route 5 is exceptionally low. This seems to be a sampling error and needs further verification.

The times spent at terminals were further verified by estimating the time spent at the Secretariat end. The original data provided time at which a bus passed screening station towards Secretariat and the time it returned. This included time involved in travelling to and from Secretariat and time spent at the terminal. The time spent by buses in running between the observation point and the terminal was estimated by an observer travelling in the bus. This time was found 4 minutes and there was no significant variation. Deducting this time from the time taken to return to observation point from Secretariat side, the time spent at the secretariat terminal has been estimated as below:

(xx) Time spent at Secretariat Terminal:

Route	No.of Obs.	Average time(Minutes)
1	60	12
5	16	15
9	25	15
30	18	20

This is about half the time for both terminals for Routes 1. For routes 9 and 30, it is less than half. It is possible that the time spent at the other end is more than half. For Route 5, the time spent at the Secretariat Terminal is more than total time estimated for both terminals in table (xix). This discrepancy seems due to sampling error. Perhaps more observations would be needed for this Route.

The times spent at terminals need further examination in more detail, e.g. analysis of terminal times by time of the day, etc. This was not possible due to small number of observations. More observations may be called for particularly for Route 5 to remove inconsistencies and to firm up the results for other routes.

Routes not considered above had their terminals at places other than the Secretariat and the stopping time of buses at these ends was not examined.

CONCLUSION:

This study has made a begining in the documentation of Urban Transport operation which is of significant concern for planners, operators and users equally. It has brought into sharper focus such important aspects of urban transport as availability and regularity of bus services. The indicators of regularity developed here will provide basis for measuring changes in efficiency as a result of changes in operating policies in the future. Some areas of improvement have also been pointed out.

This study has covered a limited area including services to and from Islamabad Secretariat. It would be fruitful if similar studies for other areas of the city and other bus routes are also carried out.

Annexure-I

Bus Arrival Times (Hours Minutes)

Direction : F-6-1 to Secretariat

Route 1

0712
0715
0716
0724
0729
0745
0748
0757

0807
0815
0830
0835
0842
0842
0855

0901
0914
0930
0932
0943
0948
0948

1006
1012
1015
1022
1033
1034
1039
1055

1105
1124
1125
1138
1147
1153
1153

1210
1214
1221
1224
1231
1251

1306
1321
1325
1340
1349

1412
1421
1422
1440
1450

1513
1520
1529
1532
1550

1605
1620
1635
1637
1639
1646
1655

1706
1720
1723
1723
1726
1750
72

Route 2

0730
1118
1304
1341
1443
1529
1537
1703
8

Route 5

0710
1721
1723
1745
1818

0904
0920
0920

1013
1049

1113
1152
1225
1348
1455
1504
1525
1652
1655
1719
1754
21

Route 6

0741
0748
0813
0840
0918
0940
1035
1054
1333
1408
1443
1445
1620
1637
1705
1741
16

Route 8

1020
1735
2

Route 9

0700
0714
0733
0738
0745
0813
0820
0847

0909
0944
0955

1044
1055
1059
1130
1216
1245
1356
1428
1450
1510
1605
1616
1645
1715
26

Route 16

0750
0921
0955
1136
1150
1323
1356
1359

1602
1622
1656
1739
12

Route 17

0710
1

Route 22

0726
0759
0830
1428
4

Route 30

0731
0757
0830
0844
0854
0925
0940

1042
1058
1120
1154
1218
1329
1347

1421
1504
1617
1634
1654
1717
20

Grant Total: 182

Annexure-I (Contd.)

Direction : Secretariat to F-6-1

Route 1

0705
0711
0725
0732
0738
0747
0749

0804
0810
0819
0829
0838
0846
0848
0859

0911
0919
0926
0938
0944
0957

1005
1008
1011
1023
1031
1037
1041
1059

1114
1127
1140
1157

1207
1239
1259
. .
1306
1334
1336
1352

1403
1416
1431
1440
1455
1459

1507
1509
1525
1537
1541
1553

1609
1627
1635
1648

1705
1708
1716
1719
1732
1742
1750
1753
65

Route 2

0737
0858
0925
1126
1312
1537
1613
1721
8

Route 5

0729
0740
0752
0833
0944

1024
1042
1105
1139
1218
1252
1420
1427
1442
1505
1523
1536
1721
1739
19

Route 6

0707
0725
0819
1837

0902
0913
1008
1033

1123
1124
1408
1424
1431
1446
1519
1715
1727
1749
18

Route 9

0715
0724
0727
0757

0807
0827
0834
0837

0902
0942
1007
1024

1112
1122
1140
1203
1242
1310
1355

1435
1440
1453
1507
1537

1625
1633
1713
1739
28

Route 16

0757
0814
0914
1042
1118
1243
1254
1422
1525
1642
1717
1717
1727
13

Route 22

1502
1

Route 26

1501
1

Route 29

0737
1

No. un-known

0916
1217
2

Route 30

0708
0741
0817
0838
0853
0935
0956

1019
1106
1128
1150

1225
1246
1422
1443
1519

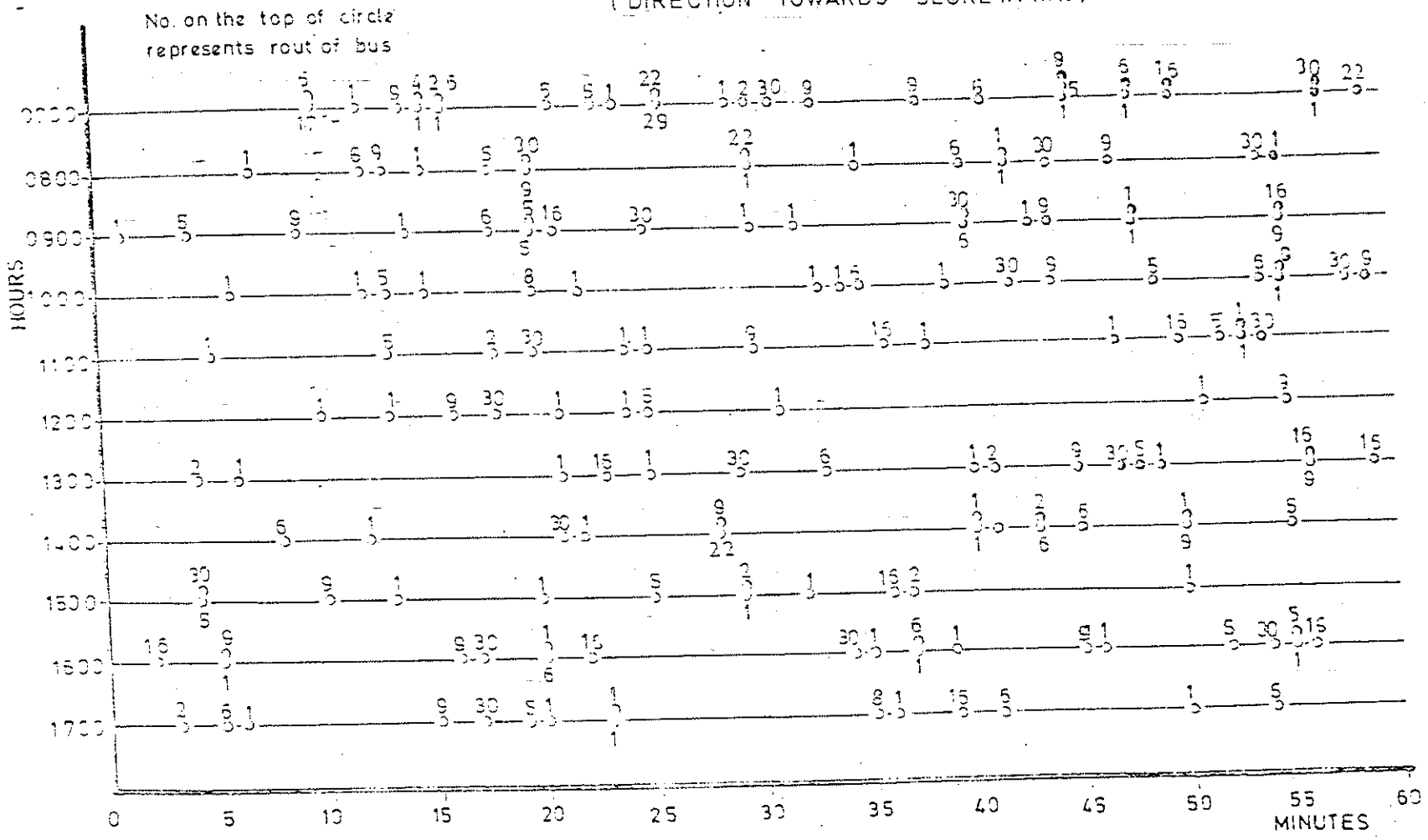
1645
1700
1723
1753
20

Grant Total: 176

Annexure-II

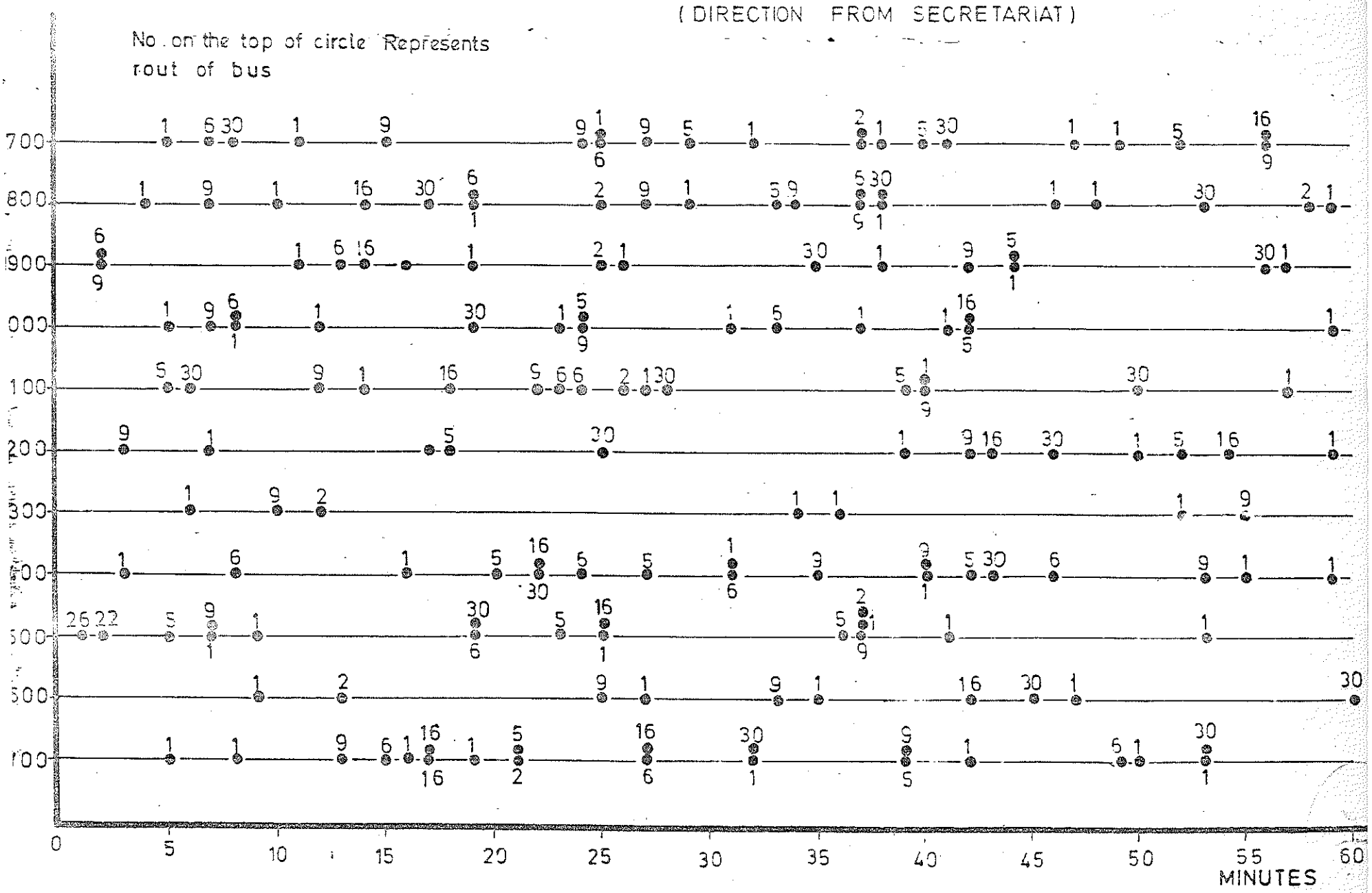
ARRIVAL OF BUSES AT F-6/1 STOP

(DIRECTION TOWARDS SECRETARIAT)



ARRIVAL OF BUSES AT F-6/1 STOP

(DIRECTION FROM SECRETARIAT)



Annexure-III

Description of main Bus Routes

Route No.1

Name of Stop	Distance from origin
Railway Station	0
National Bank	0.7
Saddar G.T.S.	1.1
Marhir Chowk	1.9
Liaquat Bagh	2.3
Committee Chowk	2.8
Waris Khan	3.3
Central Hospital	3.9
Rahamanabad	4.7
Passport Office	5.1
Faizabad	6.5
Zero Point	9.4
C.D.A. Store	10.5
Aabpara	11.1
Melody Chowk	11.6
G-6/1-2	12.1
Lallquarter	12.6
Polyclinic	13.1
F-6-1	13.8
Secretariat	14.9

Route No. 9

Chaungi No. 22	0
R.A. Bazar	0.4
G.P.O.	1.0
G.T.S. Stop	1.3
Marhir Chowk	2.1
Liaqat Bagh	2.5
Committee Chowk	3.0
Teli Mohallah	3.3
Waris Khan	3.6
Central Hospital	4.2
Chandni Chowk	4.5
Rahamanabad	5.0
Passport Office	5.3
Shamsabad	5.9

Route No. 9

Name of Stop	Distance from origin
Faizabad	6.7
Zero Point	9.4
Bank Colony	10.0
G-7-2 School	10.5
Lallquarter	11.7
Polyclinic	12.3
F-6-1	12.9
Ayub Chowk	13.4
Secretariat	14.0

Route No. 5

Chungi No. 22	0
G.P.O. Saddar	1.0
G.T.S. Station	1.2
Marhir Chowk	2.0
Liaqat Bagh	2.4
Committee Chowk	2.9
Waris Khan	3.4
Banni Chowk	3.7
Asghar Mall	4.2
Hydari Chowk	4.6
Siddique Chowk	5.2
Gulzar Hotel	5.5
Pindora	5.9
Sector I/9	7.3
College No. 2	8.8
Peshawar Turn	9.9
F.I.A. School	10.3
T&T Colony	11.1
Zero Point	11.5
G-7-2 School	12.3
G-7-2	12.7
Sittara Market	13.3
G-7-4	13.5
G-6/1-2	14.1
G-6-1	14.4

Route No.5

Name of stop	Distance from origin
G.P.O.Islamabad	15.0
Polyclinic	15.2
F-6-1	15.8
Secretariat	16.9

Route No. 30

Chungi No. 22	0
G.P.O.Saddar	1.0
G.T.S. Stop	1.3
Marhir Chowk	2.1
Liaqat Bagh	2.5
Committee Chowk	3.0
Waris Khan	3.6
Central Hospital	4.2
Rahmanabad	5.0
Passport Office	5.3
Faizabad	6.7
Zero Point	9.4
Bank Colony	10.0
G-7-2 School	10.9
Lallquarter	11.7
Polyclinic	12.3
F-6-1	12.9
Ayub Chowk	13.4
Secretariat	14.0

Annexure - IV

Frequency of Bus Services by Route and Hour - No.of Buses each Hour

F-6-1 to Secretariat:

Hour	Route Nos. 1	5	9	30	Total	Average Interval (Minutes)	6	16
0700	8	4	5	2	19	3.16	2	1
0800	7	1	3	3	14	4.62	2	-
0900	7	3	3	2	15	4.00	2	2
1000	8	2	3	2	15	4.00	2	-
1100	7	2	1	2	12	5.00	-	2
1200	6	1	2	1	10	6.00	-	-
1300	5	1	2	2	10	6.00	1	3
1400	6	1	2	1	10	5.45	3	-
1500	5	2	1	1	9	6.67	-	1
1600	7	2	3	3	13	4.00	2	3
1700	6	2	1	1	10	6.00	2	1
Total:	72	21	26	20	137	4.75	16	13
Average:	6.5	2.0	2.4	1.8	12.6	-	1.5	1.2

From Secretariat to F-6-1:

Hour	Route Nos. 1	5	9	30	Total	Average Interval (Minutes)	6	16
0700	7	3	4	2	16	3.75	2	1
0800	8	1	4	3	16	3.75	2	1
0900	6	1	2	2	11	5.45	2	1
1000	8	2	2	1	13	4.62	2	1
1100	4	2	3	3	12	5.00	2	1
1200	4	2	2	2	10	6.00	-	2
1300	4	0	2	-	6	10.00	-	-
1400	6	3	3	2	14	4.29	4	1
1500	6	3	2	1	12	5.00	1	1
1600	4	-	2	1	7	8.57	-	1
1700	8	2	2	3	15	4.00	3	3
Total:	65	19	28	20	132	5.04	18	13
Average :	6	1.7	2.5	1.8	11.8	-	1.6	1.2

Annexure-V

Distribution of Intervals by Length of Time

Interval Minutes	Route 1	5	9	30	Total	6	16
				F-6-1 to Secretariat			
0-4	20	4	2	-	77	1	1
5-9	20	1	3	-	42	1	-
10-14	14	2	5	2	14	-	1
15-19	15	1	1	4	5	2	-
20-24	3	4	3	4	1	2	1
25-29	-	-	4	1	-	2	1
30-40	-	4	4	6	-	5	3
45-59	-	2	3	-	-	1	1
60 & Over	-	3	1	3	-	2	4
Total:	72	21	26	20	139	16	12
				Secretariat to F-6/1			
0-4	12	-	2	-	77	1	1
5-9	22	1	4	1	37	2	-
10-14	18	3	4	-	13	2	2
15-19	11	4	3	2	4	4	1
20-24	-	2	2	8	1	1	1
25-29	1	1	4	-	-	2	-
30-44	1	5	6	5	-	1	2
45-59	-	-	3	2	-	3	1
60 & Over	-	3	-	2	-	2	6
Total:	65	19	28	20	132	18	13
				Both Directions			
0-4	32	4	4	-	154	2	2
5-9	42	2	7	1	79	3	-
10-14	32	5	9	2	27	2	3
15-19	26	5	4	6	9	6	1
20-24	3	6	5	12	2	3	1
25-29	1	1	8	1	-	4	1
30-44	1	9	10	11	-	6	5
45-59	-	2	6	2	-	4	2
60 & over	-	6	1	5	-	4	10
Total:	137	40	54	40	271	34	25
				% Both Directions			
0-4	23	10	7	-	57	6	8
5-9	31	5	13	3	29	10	-
10-14	23	12	17	5	10	3	12
15-19	19	12	7	15	3	19	4
20-24	2	15	9	30	1	6	4
25-29	1	3	15	3	-	13	4
30-44	1	23	19	27	-	19	20
45-59	-	5	11	5	-	13	10
60 & over	-	15	2	12	-	10	40
Total:	100	100	100	100	100	100	100

Annexure - VI

Analysis of Variance of Bus Intervals

Direction	Route	No.of Obs.	Mean Interval	Mean Variance (1)	Mean Variance as % of mean	Standard Deviation (2)	Co-efficient of Variation (3)
UP	1	72	9.2	5.1	55	6.0	65
F-6-1 to Secretariat	5	21	31.4	21.7	69	23.9	76
	9	26	25.4	13.0	51	15.5	61
	30	20	32.0	13.0	40	16.6	50
	Above combined	139	4.75	3.36	71	4.7	90
	6	16	40.0	23.7	58	37.0	92
	16	12	54	34.0	63	39.2	73
DOWN	1	65	10.2	4.4	44	5.6	54
Sectt. to F-6-1	5	19	34.7	19.3	57	25.2	72
	9	28	23.6	12.0	51	13.3	56
	30	20	33.0	15.0	45	21.2	64
	Above combined	132	5.0	3.2	64	3.9	79
	6	18	38.82	23.0	59	38.09	98.00
	16	13	51	27.8	54	30.7	60.00

(1) Mean Variance $= \frac{(x - \bar{x})}{n}$

(2) Standard Deviation $= = \sqrt{\frac{\Sigma (x - \bar{x})^2}{n}}$

(3) Co-efficient of variation $= \frac{\sigma}{\bar{x}}$

Annexure-VII

Cumulative Frequency of time covered by Intervals of varying lengths

Route No. 1

INTERVAL x	Frequency f	Cumulative Frequency fx	(%)
0	6	0	0.36
1	4	4	0.65
2	7	18	1.65
3	11	51	4.03
4	5	71	5.48
5	4	91	6.91
6	8	139	10.37
7	8	195	14.41
8	10	275	20.17
9	11	374	27.31
10	6	434	31.63
11	6	500	38.4
12	7	584	44.8
13	10	714	54.8
14	3	756	58.0
15	11	921	70.7
16	6	1017	78.1
17	3	1068	82.0
18	5	1158	88.9
19	1	1177	90.3
20	1	1197	91.9
23	2	1243	95.4
28	1	1271	97.5
32	1	1303	100.0
Total:	137	-	-

Route No. 5

INTERVAL x	Frequency f	Cumulative frequency fx	(%)
0	1	0	0
2	1	2	0.2
3	1	5	0.4
7	1	12	1.0
9	1	21	1.7
10	1	31	2.5
11	2	53	4.3
12	1	65	5.3
13	1	78	6.4
15	1	93	7.6
16	1	109	8.9
18	3	163	13.3
21	1	184	15.0
22	1	206	16.8
23	2	252	20.6
24	2	300	24.5
29	1	329	26.9
33	2	395	32.7
34	2	463	37.8
35	1	498	40.7
36	1	534	43.6
39	2	612	50.0
40	1	652	53.3
41	1	693	56.6
46	1	739	60.4
53	1	792	64.7
71	1	863	70.5
77	1	940	76.8
83	1	1023	83.6
87	1	1031	84.2
88	1	1119	91.4
105	1	1224	100.0
Total:	40	-	-

Annexure - VII(Contd.)

Route No. 6

INTERVAL x	Frequency f	Cumulative Frequency fx	(%)
1	1	1	0.08
2	1	3	0.23
7	3	24	1.87
11	1	35	2.00
12	1	47	3.66
15	2	77	6.00
16	1	93	7.25
18	2	129	10.05
19	1	148	11.53
22	2	192	14.96
24	1	216	16.83
25	2	266	20.73
28	2	322	25.09
33	1	355	27.67
35	2	420	32.74
36	1	456	35.54
38	1	494	38.50
41	1	535	41.70
50	1	585	45.60
54	1	639	49.80
55	2	749	58.38
95	1	844	65.78
116	1	960	74.82
159	1	1119	87.23
164	1	1283	100.00
Total:	34	-	-

Route No. 9

INTERVAL x	Frequency f	Cumulative Frequency fx	(%)
0	1	0	0
3	2	6	0.48
4	1	10	0.79
5	2	20	1.59
7	3	41	3.27
8	1	49	3.91
9	1	58	4.62
10	2	78	6.22
11	4	122	9.37
13	1	135	10.76
14	2	163	12.99
15	1	178	14.19
17	1	195	15.55
18	1	213	16.98
19	1	232	18.5
20	2	272	21.69
22	2	316	25.2
23	1	339	27.03
25	2	389	31.02
26	1	415	33.09
27	1	442	35.24
28	2	498	39.71
29	1	527	42.02
30	3	617	49.2
31	1	648	51.67
32	1	680	54.22
35	1	715	57.02
39	2	793	63.24
40	3	913	72.8
45	1	958	76.39
46	1	1004	80.06
48	2	1100	87.72
49	1	1149	91.62
50	1	1199	95.61
55	1	1254	100.00
Total:	54	-	-

Annexure - VII(Contd.)

Route No. 16				Route No. 30			
INTERVAL	Frequency	Cumulative Frequency		INTERVAL	Frequency	Cumulative Frequency	
x	f	xf	(%)	x	f	xf	(%)
0	1	0	0	8	1	8	0.63
3	1	3	0.23	10	1	18	1.42
10	1	13	1.02	15	3	63	4.96
11	1	24	1.89	16	1	79	6.22
14	1	38	3.0	17	1	96	7.56
17	1	55	5.34	18	1	114	8.97
20	1	75	5.92	20	1	134	10.55
26	1	101	7.98	21	5	239	18.82
33	1	134	10.58	22	3	305	24.01
34	1	168	13.27	23	3	374	29.45
35	1	203	16.03	24	2	422	33.23
36	1	239	18.88	26	1	448	35.27
43	1	282	22.27	31	2	510	40.16
50	1	232	26.22	32	1	542	42.67
57	1	389	30.72	33	1	575	45.27
60	1	449	35.47	34	2	643	50.62
63	1	512	40.44	35	1	678	53.38
77	1	589	46.52	36	2	750	59.05
85	1	674	53.23	42	1	792	62.36
88	2	850	67.14	43	1	835	65.75
91	1	941	74.33	47	1	882	69.44
93	1	1034	81.67	62	1	944	74.33
97	1	1131	89.33	71	1	1015	79.92
135	1	1266	100.00	73	1	1088	85.92
				86	1	1174	92.44
Total:	25	-	-	96	1	1270	100.00
				Total:	40	-	-