ASSESSMENT OF RESOURCE (PASSENGER-CARRYING TRANSPORTS) REQUIRED DURING PEAK PERIOD IN A PARTICULAR BUS-ROUTE OF DHAKA CITY

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DEPARTMENT OF INDUSTRIAL & PRODUCTION ENGINEERING

BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY , DHAKA

Dedicated to the memory of

my grand father

DR. M. A. HASEM.

C E R T I F I C A T E

This is to certify that this work has been carried out by the author under the supervision of Professor Dr. Md. Mizanur Rahman of Industrial & Production Engineering Department of Bangladesh University of Engineering & Technology, Dhaka, Bangladesh ; and it has not been submitted anywhere else for the award of any other degree or diploma.

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A C K N O W L E D G E M E N T S

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The author hopes for further works on this subject from the next generations .

M D . E Z H A R U L H A Q

A B S T R A C T

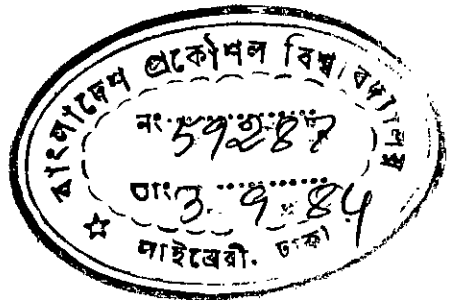
Traditionally, public transport services have been planned on the basis of managerial assessment of the quantity and location of the traffic offering. Normally such assessment would be based on experience of operating existing services, the manager's knowledge of his area, the likely origin and destination points for passenger journeys, road conditions, etc.

In the present work, an analysis of the present operating conditions of the public transport in a particular bus-route of Dhaka City has been carried out; and the resource(public transport) requirements for a smooth and comfortable journey of the city-people in their day-to-day life has been assessed.

The relation between services (supply of transports) and the demand (arrival of passengers) in different periods of the day gives an idea about the degree of requirements of services for its smooth operation.

This assessment gives an overall view of the state of the public transport systems and its conditions. Actual data were collected, analysis of which yielded results indicating that the existing public transport system of the city is in a bad shape. The problems associated with the system have not emerged from inherent shortages and the size of fleet, rather due to unplanned scheduling of the transports in the route.

This resulted in emergence of a gap between supply and demand from the passengers carrying standpoint. Scientific methods available in the field of Operations Reasearch has been used in the present work to demonstrate that better management could be achieved by use of such methods.



C O N T E N T S

F I G U R E S

T A B L E S

S Y M B O L S

λ = Arrival rate of passengers

μ = Service rate of passengers

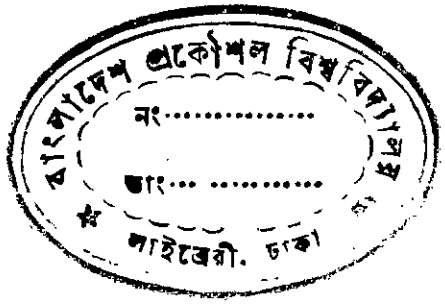
X_{ij} = The average value of c_j, for a specific time period (i) over the entire data collection period (T)

t = Time period of fifteen minutes each

c = Observed values of the variables considered

Chapter I

I N T R O D U C T I O N



CHAPTER - I

INTRODUCTION

Operations Research (OR) is the use of scientific methods to solve a problem under study which is subjected to constant interference from the outside world. To get solution under such conditionds OR makes mathematical models and system study.

Traditionally , public transport services have been planned on the basis of managerial assessment of the quantity and location of the traffic offering. Normally, such assessment would be based on experience from operation of similar systems, and the system influencing factors such as : the likely origin and destination points for passenger journeys, road conditions, etc. If computer and other modern aids are to be used in service planning , however, it is usually necessary to know fairly and precisely the quantitative details of the system operating factors namely : the number of passengers to be catered for , their origin and destinations, and the time interval for which they will be made.

Conceptually, what is required in each case is some method of assessing the factors which dictate the pttern of travel in a given area, and means of collecting and analyzing the necessary data. In practice, however, the two cases have been treated somewhat differently and most research has been devoted.

to the problems of predicting, in the long term, the total travel pattern by all modes of transport in a given area. This research has been carried out in connection with the transportation studies that have been undertaken in many large urban areas.

For assessment of resource (passenger-carrying transports) requirement during peak-period in a particular bus-route in Dhaka City , the following stages may be considered : Collection of data on present day travel patterns by means of some form of traffic survey ; introduction of planning data relating to the future pattern of land use development in the area , together with factors such as expected changes in income and car ownership. This is used in conjunction with the data obtained above, to estimate the future numbers of trips in the area by the use of suitable mathematical models.

The ultimate aim of a transportation study is, of course, to provide that network which is, in some sense, the best one possible to satisfy the predicted demand for transport within the study area. In view of this it may appear that the method of testing alternative networks in somewhat crude , as there will only be a limited number of networks that can be tested out of the vast number of different possibilites .It might be argued that some procedure for designing a network autometically on the basis of predicted demands might give 'best' solution with somewhat more certainty.

It would be wise not to go for designing a network, rather effort would be given to show and analyze the relationship between passengers' demand for the transport and the passengers being served . First of all a bus-route in Dhaka City would be selected and then the critical bus-stations and peak-periods need to be identified to study the demand and facilities .

A relation between available service facilities and the demand is to be brought. The objective thus would be to find the service facilities according to the demand, if there exists a gap between suply and demand and strategies are to be suggested to keep the gap at its lowest.

In the present work a modified queueing approach has been used to study the queueing problem in various points of a selected bus-route in Dhaka City. The route selected was the MIRPUR to GULISTAN connection. This requires a study of the existing generalized queueing theory and a review survey on the transportation problem of the city. The study revealed that in such situations there existed a peak-period of the day when the demand is the highest. In this respect, the most critical stoppages in the selected route were identified.

The nature of the present study requires some basic primary data ; the method of collection and compilation are given in chapter V .

Analysis of the data was done by using a computer of IBM 370/

115 of B U E T center . From the result of the present work, it has become apparent that the problems are due to unplanned transportation system of Dhaka City. Integrated study should be carried out which will cover the overall system study incorporating the psychological and sociological attributes of the drivers as well as the passengers.

The objective of this project work is to assess the requirement of the resources (passenger-carrying transports) in the present situation of the transport system in Dhaka City, and thus to suggest some ways to improve the situation.

Chapter II

BACKGROUND STUDY AND LITERATURE SURVEY

CHAPTER II

BACKGROUND STUDY & LITERATURE SURVEY

The present work considered two aspects , namely :

1) transport problem in a major city , and

2) search for a proper OR (Operations Research) technique(s) to be applied in solving transport problem.

Thus the literature survey could also be divided into two sections accordingly.

2.1. TRANSPORT PROBLEM IN A MAJOR CITY (Dhaka City)

The present population of Dhaka (the capital city of the country) is 34.58 lacs which is increasing steadily. The landed area of the city has increased from twenty eight square miles in 1961 to fourty four square miles in 1980. Figure (2.1) illustrates the growth of Dhaka City during the last over two decades. [FIREOUS (5)]. A quarter of a century ago the travelling distance from one place to another of the city was within normal walking distance . And as the city grew , the activities and hence the movements of the city-dwellers increased. So, transportation emerged as a necessity and people were inclined towards public transports as most of them could not afford private transports.

Various modes of transports are available in Dhaka City. But it has been found that bus transports are the most economical. Thus

Fig.2.1. THE GROWTH OF DHAKA CITY

the demand pressure is mostly placed on them. In early days , the horse drawn carts were the only road transport vehicles . As activities required quick movement, the road transport began to gain prominence gradually. As a result the importance of horsecarts declined gradually and a newer mode of transport known as Rickshaw emerged in the city roads. The rickshaw is pulled by a man and can accomodate two passengers.

As the city extended much towards Mirpur, Gulshan, Uttara , etc. (Figure 2.2), the public buses came into picture with much more importance , because rickshaws are the type of vehicles which can not make longer-haul trips.

The present pattern of public transport services in the city consists of both high and slow speed vehicles. These include rickshaws , auto-rickshaws , auto-tempos , mini-buses and buses. Besides , taxi-cabs also exist which are mostly used for international tourists at very high price . The rickshaws are treated as the slowest vehicle because these are manually driven and the average speed of rickshaws is around five miles per hour . Apart from the rickshaws all others are motorised vehicles and they operate at higher speeds than the rickshaws and also for longer distances . The auto-rickshaws are motorised three seater vehicles which is being used for door to door services and are the costliest of all the public transport modes.The auto-tempo has the same engines as the auto-rickshaws but has two banks of seats at the back to carry eight persons and one person in the front . They make journeys from junction to junction. The mini-buses are smaller version of the buses , and operate in

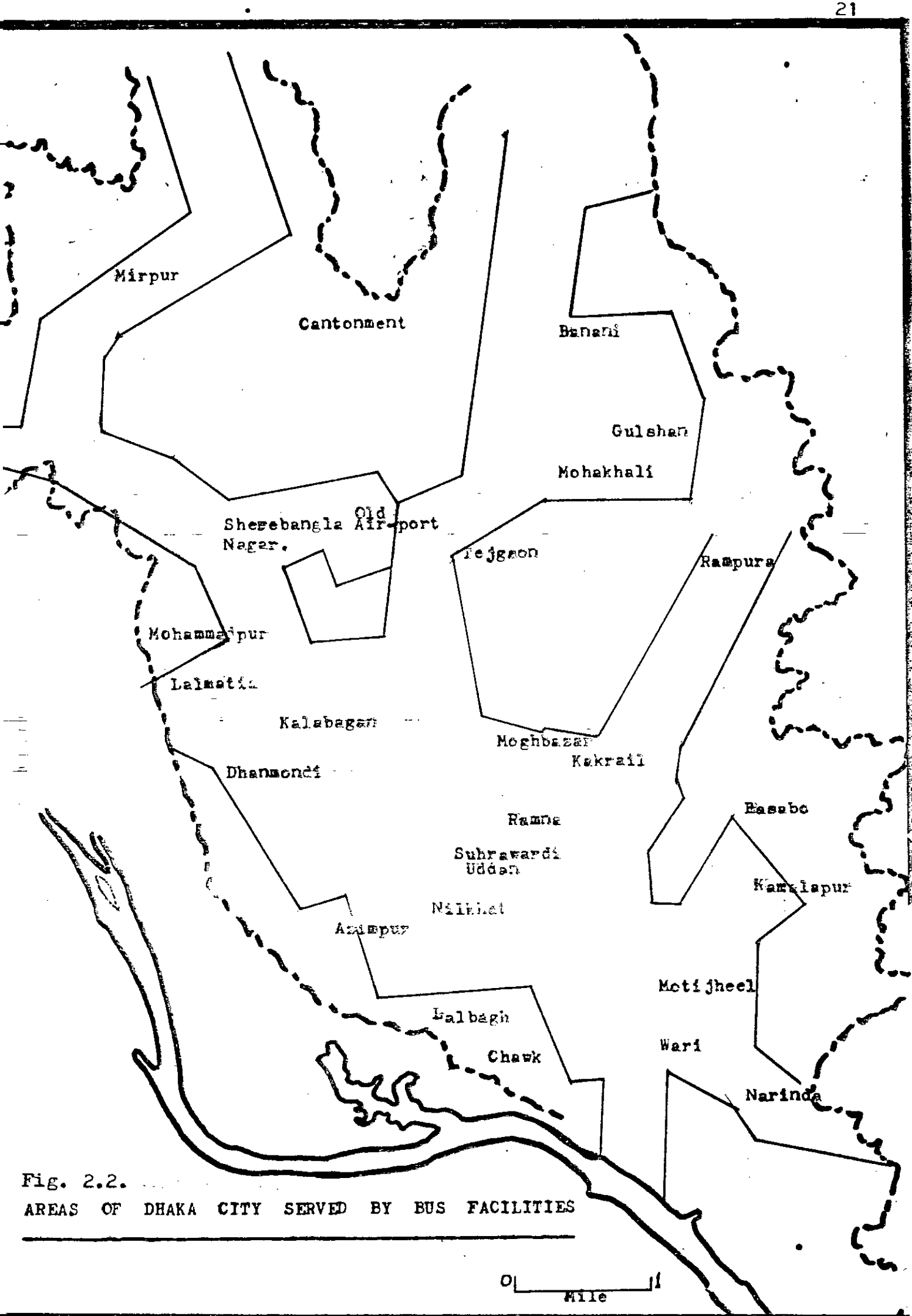


Fig. 2.2.
AREAS OF DHAKA CITY SERVED BY BUS FACILITIES

a particular route like the mormal buses with seating arrangements for all the passengers , but the fare is little higher than the normal buses. The transport problem in a major city, such as Dhaka, could thus be viewed as explained below .

The traffic flow capacity of the roads are not expanding according to the continued increase of vehicles, as a result road congestions become common phenomenon in a normal city life. In order to solve the problem , planners and transport experts throughout the world are opining in favour of mass movement of passengers through such modes as buses , trains , monorails , trolly trans, etc. [BARTHOLOMEW (6)].

Moreever , finding the ways of movement of people during rush hours has gained momentum . The system of transportation has also changed from slow moving vehicles to fast moving vehicles and from automobiles to mass transits , because of the increasing demand of movement during peak periods.

" Transport experts have been giving more thought to faster moving mass transit systems such as switching from buses to mono-rails and underground sub-ways for quicker movements and in shorter time . There has also been other thoughts regarding movement of people which are related to public transport systems , these relate to the designing of the road network system so as to accomodate maximum commuting traffic . Experts also emphasize on the designing of underground parking systems and elevators so as to keep vehicles off the road. To bring about a solution to

transportation problems , theories have also been proposed for redesigning of the land use pattern , so that different cativities are generated at different places and that would reduce the traffic load from being concentrared in just one place." [FIRDOUS(5)]

In this regard the present study on the problems of bus transport in Dhaka City has been limited to the assessment of resources(public transport buses) according to the demand of the users.

Study on the total performance standard of buses would require information on loading capacity , commuting speed , space required by buses to run in normal standard speed , the designing of buses in such a way that maximum number of people could embark and disembark in the shortest possible time , designing of parking systems , improvement of minor road systems and radial roads to accomodate more traffic signalling systems , etc.

It has been observed however that the bus services are not very satisfactory in the city ; most of the times the buses remain overloaded. A great number of people are seen waiting at the bus stops for a long time . Moreover, bus services are not available in many places in the city . People of those areas are compelled to walk a long way to avail the bus facilities or to utilize alternative modes if necessary.

Although there is an increasing demand for buses , the bus fl-

eet in the city did not increase keeping pace with the increase of population ; this is because the owners are reluctant to increase the number of buses in the city routes because further capital investment may adversely affect their profit . So there is a difference between the actual condition and the desired state . In this respect very few research has been done and the authority has not stepped in properly to bridge the ever existing 'gap' between demand and supply in this sector of the city services . The objective of the present work , as mentioned earlier , is thus set to assess the above 'gap' in the system.

2.2. OPERATIONS RESEARCH TECHNIQUE(S) APPLIED TO CONGESTION PROBLEMS

An enormous list of references to the various work on congestion problems may be prepared . But the scope of the present work restricts to limited survey of the basics of OR techniques especially the queueing theories as applied to congestion problems.

The MONTE CARLO technique is quite useful for analysing waiting line problems which are difficult or impossible to be analysed mathematically [HARPER (3) .]. Simulated sampling methods, for example , are quite helpful when the first come - first served assumption is not valid for a particular queueing problem. In many cases , the observed distributions for arrival times and service times can not be fitted to certain mathematical distribution (Poisson and exponential distribution) and Monte Carlo appreach is the only hope under such situations .

The earliest method of analysing applied to queueing problems was

the use of differential difference equations . This method is described first and applied to the simplest queueing situation. More recently , integral equations and Markov chain analysis have been developed to solve queueing problems . [GUPTA (12) - & GHOSAL (14)]

The method depends on deriving the rate of change of the probability of a given state of the system . This is done by considering the probabilities of transitions (e.g. by the arrival of a unit or the completion of service) in a infinitesimal interval . In order that a problem can be solved explicitly by this method , it is necessary that these probabilities should be fairly simple functions . This means,in practice that the method is limited to a few types of input service time distributions.

The queue situations to which this method is applicable can be grouped in four classes according to the type of distributions of arrival intervals and service times .

a) Exponential : The simplest case has been dealt with other cases may have more complex queue discipline or more than one service channel .

b) Erlang : Erlang distributions are derived by combining a number of identical exponential distributions . A constant rate can be considered as a special case of an Erlang distribution.

c) Exponential with varying parameters : The parameter (λ) or (μ) may be a function of time or of the number of units in the system .

d) Hyper - exponential : The variance is greater than for an

exponential distribution . These distributions appear to have little practical application and are not further considered here.

Other analytical techniques have been used to give both general and particular results .

1) Integral Equation : One approach leads to integral equations for the distributions of the waiting time . It is valid for general distributions of arrival and service time , but it is not easily applicable to transient states of the system. It was first used by Lindley for a single service channel .

2) Markov Chains : A sequence of events forms a Markov Chain if the probability of each event can be expressed in terms of the previous event , irrespective of any information about earlier events. Hence acknowledge of any event makes all information about previous events irrelevant to the prediction of subsequent events . In a similar way , a continuous process is Markovian if a knowledge of any instantaneous state of the process makes all previous histroy irrelevent in predicting its future behavior. The instantaneous(of a queueing system) state may be described by the number of units in it . If the arrival and service distributions are exponential , this number of units is all that is needed to determine the probabilities of future instantaneous states , and the process is Markovian .

"AD HOC" METHOD

Some quite general results can be obtained without carrying out the analysis necessary to give a complete description of the system . A good example of this type of "Ad Hoc" approach is

Kendall's derivation of the average queue length and waiting time for a single queue with random arrivals and general service time distribution . The theory of queues has been extended to take in more and more features which appear in real life queueing situations , whether the queues be people , manufactured parts , repair jobs or perishable goods .

FUTURE DEVELOPMENT

The development in the immediate future in OR on congestion problems is clearly in the use of high-speed computers to simulate , not real situations necessarily , but complex models close enough to real situations to yield useful answers of the kind already available from the simpler models for simple situations. [GUPTA (12) & GHOSAL (14)]

"The value of using the computer lies firstly in the possibility it gives of using peculiar distributions of the various intervals involved and of various combinations of such distributions when a multi-phase system is studied . Secondly in the possibility of generating directly the distributions , instead of the average values , of the quantities in which the OR is interested . And finally , in enabling fairly rapid exploration of a field of parameter values in a search for a near optimum.

The Computer , too , would lend power to investigations of changing rate systems with traffic intensities greater than unity. Various techniques of generating distributions on machines and of storing intermediate information are already in the literature and a few OR projects of this nature are already in progress."

Chapter III

Q U E U E I N G T H E O R Y

A N D

I T S A P P L I C A T I O N .

CHAPTER - III

QUEUEING THEORY AND ITS APPLICATION

Queueing is a common phenomenon in the business world, and all queues display a number of basic features. These along with techniques available to solve queueing problems are discussed in this chapter.

3.1. THE BASIC FEATURES OF QUEUES

A detailed knowledge of queueing theory could be gained from reading of standard text books on Operations Research. Thus in the present context much effort is not devoted to this aspect; however , emphasis has been given to understand the scope and its application in a developing country.

QUEUE FORMATION

A queue forms at any time when the demand for a service exceeds the capacity of the service facility. Any group of people or objects awaiting their turn for service constitutes a queue.

QUEUEING SITUATIONS

Queues clearly differ one from the other. Some form rapidly and disperse slowly . Some form slowly and disperse rapidly (e.g. a bus queue). Some form and disperse at the same rate.And some form and disperse erratically.

QUEUES AND ECONOMICS

Virtually all queueing situations have economic applications. In general there are two opposing economic aspects of queues.

1) It can cost money for an object to be idle in a queue. The smaller the service facility the longer the queues and the higher the costs.

2) On the other hand it costs money to increase the capacity of the service facility - even if it is only interest on the capital sunk in providing it. Moreover the greater the service capacity the quicker it will disperse queues and, therefore, the more often it will stand idle.

Clearly , one reason for studying queues is to enable the optimum service facility to be selected so that the overall cost of a service is minimised.

THE ARRIVAL PATTERN

Queue components can arrive at the queue in a variety of patterns. They can arrive in large groups, regularly or irregularly , or steadily , or at random . The last is the commonest and the most complex , though a moment's thought will indicate that it can often be handled using the Poisson distribution (since in a given tiny fraction of time there is a very small probability of a unit joining the queue). A crucial parameter in queueing theory is the average arrival rate (λ).This is simply the average number of queue components arriving per minute , hour , day , etc. , and is found by dividing the total number of arrivals by the total units of time.

THE SERVICE PATTERN

Servicing takes a variety of patterns and can be regular, or virtually instantaneous but with periods of no service at all (e.g. passengers boarding a bus at a busstop), or again random. The latter pattern can often be handled using a negative exponential distribution (i.e. one based on the equation $Y = e^{-x}$) .

Arrivals involve discrete distributions but service times normally involve continuous distributions. Another important parameter in queueing theory is the average service rate (μ). This is the average number of queue components that can be serviced per minute, hours, day, etc.

THE NUMBER OF SERVICE CHANNELS

Arrival of service patterns are often beyond immediate control, but one thing over which full control is usually possible is the number of service channels . In deed , the object of most queue analyses is to determine the optimum number of service channels.

THE QUEUE DISCIPLINE

Although most queues are based on a first-come-first-served system with few exceptions . Sometimes certain queue components have priorities , sometimes a last-come-first-served system works and sometimes components are served at random.

There are , therefore , different methods of determining the

order of service. The method appertaining to any situation is known as the queue discipline.

QUEUES & SYSTEMS

A queue is the group of components waiting to be serviced. A system is the group of components that includes both those waiting to be serviced and also those in the process of being serviced.

QUEUEING THEORY & THE STEADY STATE

At the very start of any operation that has a queueing potential, the queue situation is untypical - the service facility can be idle even though the system has a traffic intensity of more than 1, simply because the first of the flood of customers does not arrive during the first brief moments, or there can be a long queue even though the traffic intensity is less than 0.1 if the queue began to form some time before the service facility opens. However, providing the parameters of the system remain unchanged, the queue will ultimately settle down until it is oscillating about its predictable average state. When this point is reached the queue is said to be in a steady state. Owing to the complex mathematics of queueing, practical formulae can be developed only for steady state queues and in all the theory that follows a steady state queue is assumed.

USEFULNESS & LIMITATIONS OF QUEUEING THEORY

Queueing theory is useful, but it does have its limitations.

(a) Usefulness of queueing theory :-

1. There are numerous situations of importance where the assump-

tions that queueing theory calls for and therefore the results of applying such theory are valid.

2) Queueing theory is a cheaper method of analysis than simulation. The use of simulation on small problems can be very expensive indeed in terms of computer time though it should be appreciated that costs are continually decreasing with the advance of computer technology.

3) Queueing is also superior to simulation in so far that firm results are obtained when the theory is applied as against the approximations that follow the use of simulations employing random numbers.

4) Queueing theory provides models which are often able to provide useful insight into the system under study and into ways in which it might be improved . The results of a theoretical analysis can point to the type of change it is worth investigating.

(b) Limitations of Queueing Theory :-

1) It is difficult to obtain solutions when the system being analysed is always in a transient state and never has time to settle down to a steady state. Such a transient state arises either because the parameters are continually changing or because the system returns again and again to the same initial condition.

2) There is the difficulty of modelling situations in which arrivals and service times display any form of statistical dependance , e. g. where an increasing queue length can hamper the execution of the service.

3) Many real life systems are more complex than the theory assumes and the distribution observed are often less simple than is required by the theory.

4) In real life problems many situations comprise several interacting queues and the equations necessary to model such interacting queues would be both difficult to formulate and difficult to solve without recourse to a heavy computing operation.

3.2. A QUEUEING MODEL

(For the transport situation of a city route)

Amongst the various problems encountered in a city life , waiting for passenger carrying transport is one. A more detailed description of transport problem is given in chapter - IV .

Waiting line problems arise either because there is excessive demand on the facilities resulting in a lengthy waiting , or , unscientific scheduling of transport facilities resulting in highly fluctuating and uneven queue formation and/or lengthy waiting time in the system.

In either case , the problem is to either schedule arrivals or provide facilities or both so as to obtain an optimum balance between the cost associated with waiting time and idle time.

The basic charecteristics of a queueing model are given below :

1) Units arrive , at regular or irregular intervals of time , at a given point called the service center . These units are called entries or arrivals or customers .

2) One or more service channels or service stations or service facilities are assembled at the service center. If the service

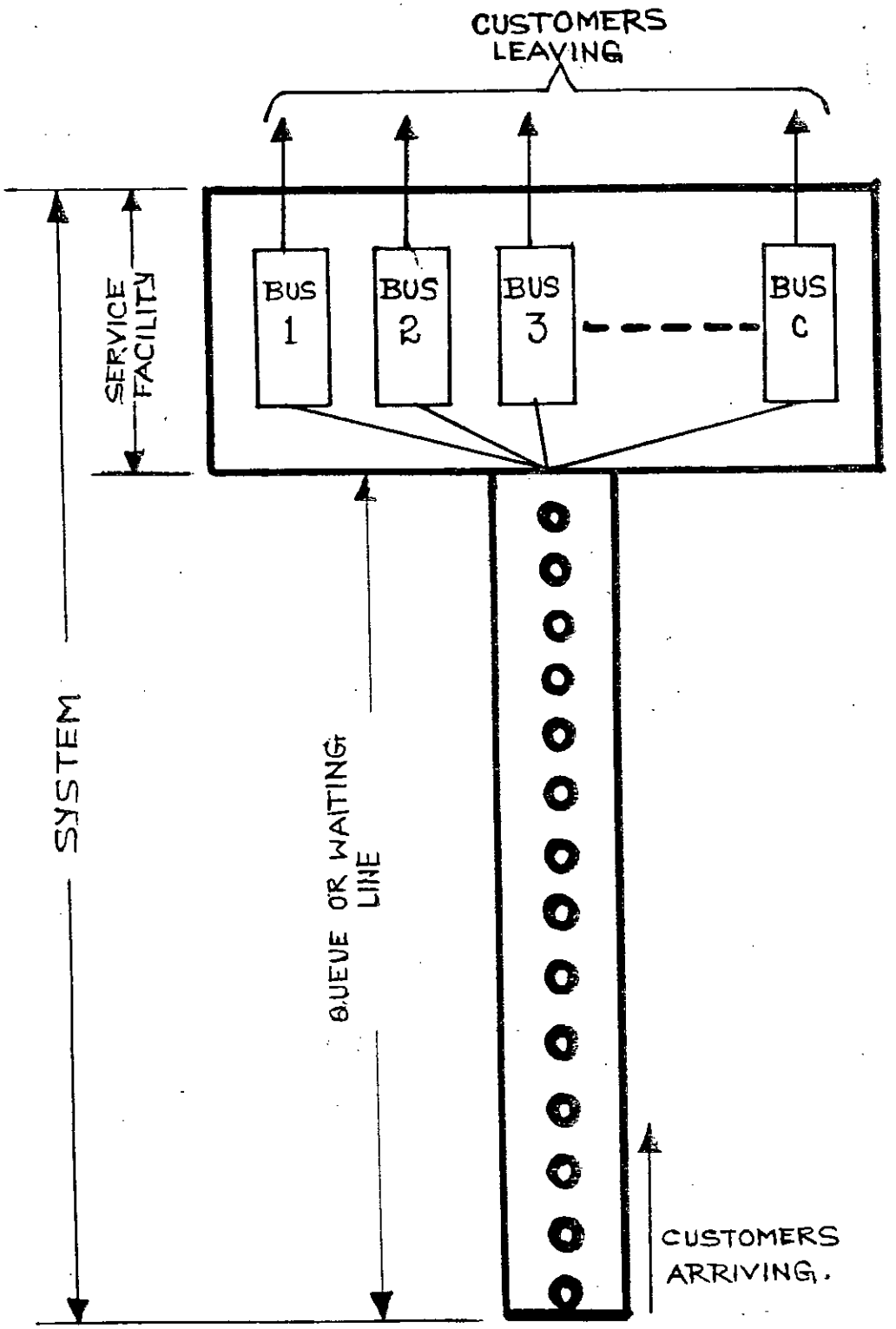


Fig. (3.1) A queueing model.

station is empty (free) , the arriving customers will be served immediately , if not , the arriving customers will wait in line until the service is provided . Once service has been completed , the customer leaves the system.

A queueing model is specified completely by six main characteristics :

1) Input or arrival (inter-arrival) distribution.
2) Output or departure (service) distribution.
3) Service channels.
4) Service discipline.
5) Maximum number of customers allowed in the system.
6) Calling source or population.

3.3. SOME AREAS OF APPLICATION OF QUEUEING THEORY

Waiting line or queueing theory has been applied to a wide variety of business situations. All situations where customers are involved such as restaurants , cafeterias , departmental stores , cinema halls , banks , post offices , petrol pumps , airline counters , patients in clinics , transportation systems , etc. are likely to have waiting lines. Generally , the customer expects a certain level of service , while the firm providing service facility tries to keep the cost minimum while providing the required service. [Waren (1)]

Waiting line theory is also widely used by manufacturing units. It has been popularly used in the area of tool cribes. There is a general complain from the foremen that their workmen wait too long in line for tools and parts. Though the management

wants to reduce the overhead charges , engaging more attendants can actually reduce overall manufacturing costs, since the workers will be working instead of standing in line.

Another problem that has been successfully solved by waiting line theory is the determination of the proper number of docks to be constructed for trucks or ships . Since both dock cost and demurage costs can be very large , the number of docks should be such that the sum of the two costs is minimised

Queueing methods have also been used for the problem of machine breakdowns and repairs . There are a number of machines that breakdown individually and at random times .The machines that breakdown from a waiting line for repairs by maintenance personnel and it is required to find the optimum number of repair personnel which makes the sum of the cost of repairment and the cost of production loss from downtime a minimum.

Queueing theory has been extended to decide wage incentive plans. For example , some workers are asked to operate two machines while the others , four machines . Since the machines are identical , the base rate of payment is same for all workers. However , the incentive bonus for production in excess of quota is half as much per unit for operators with four machines as for those with two machines . Apparently , the arrangement appears to be fair . However , a study of downtime for repairs shows that while the two machines run by one man would have 12% downtime , four machines run by one man would have 16% downtime . The reason is that two (or more) machines can

breakdown at once in the four-machine group which is generally not true for two-machine group. Thus , the worker operating four machines would have to operate at a higher efficiency than his counterpart in order to earn the same incentive . The probleb was solved by paying the operators of the four-machine group a higher base rate determined by using the probabilities computed from queueing theory.[Woren(1)]

QUEUE IN THE PEAK PERIOD

In the peak hours , it is always found that the demand of the passengers is more than service facilities , i.e. the number of buses serving . So a queue of the passengers is formed in the bus-station.

For a better transportation system this queue should not be so long that will be unreasonable and waiting time should not be much more than the passengers will leave the station without being served. The present work is directed in studying the demand - supply situation in this period.

Chapter IV

PUBLIC TRANSPORTATION IN DHAKA CITY

CHAPTER IV

PUBLIC TRANSPORTATION IN DHAKA CITY

The operation and management of the existing transport system (passenger carrying) of city is rather historic . The widely used transport is the man-driven rickshaws . These are very slow moving but at the expense of huge human muscle effort. There exists other modes of transports namely , auto-rickshaws (three wheeler) privately owned . From the point of view of buying capacity of these services by the customers (the public) these types of modes are expensive . From price differential and other considerations the whole society is depending upon the public-bus transports , which are the cheapest and time-saving.

The Bangladesh Road Transport Corporation (BRTC) for the public transportation in different selected routes of Dhaka City existed for more than two decades . Nonetheless , there are many private buses and mini-buses on commercial basis in many important routes of the city .

The private buses and BRTC buses are each with fifty two seating arrangement and the mini-buses have different seating capacities . Besides , there are very few double-deckers. It is supposed that , in private buses and BRTC buses , about seventy persons can run comfortably ; some of them standing in the free passage . And double-deckers are of one hundred fourty persons capacity each .

Only the BRTC buses have the time-schedule to run in particular route and all other public transports do not strictly maintain any time-schedule . There are many routes for public transportations in the city ; most of them are not based on scientific analysis and no analysis has ever been made on this transport system .

4.1. SELECTION OF A ROUTE FOR ANALYSIS

The transport system of the city has the focal point in a place named GULISTAN . The Motijheel commercial area is the country's bigest business center which is adjacent to Gulistan. On the other side , the city is expanding in the northern side along Gulshan , Uttara , Mirpur and other sides. A major portion of middle class families is living in Mirpur area.

From fogure # (4.1) importance of public transportation between Gulistan and Mirpur can be understood . The map showing the roads of almost the whole of Dhaka City , indicates the route of public transport between Gulistan and Mirpur area.

There are three different routes connecting Gulistan and Mirpur. The route that covered many areas of the city including the Major commercial and residential areas of the city has been considered for in the present case . The route as shown in the map touches the following stations :

1) Gulistan
2) General Post Office (GPO)
3) Kakrail
4) Shantinagar (Malibag)
5) Moghbazar
6) Bangla Motors

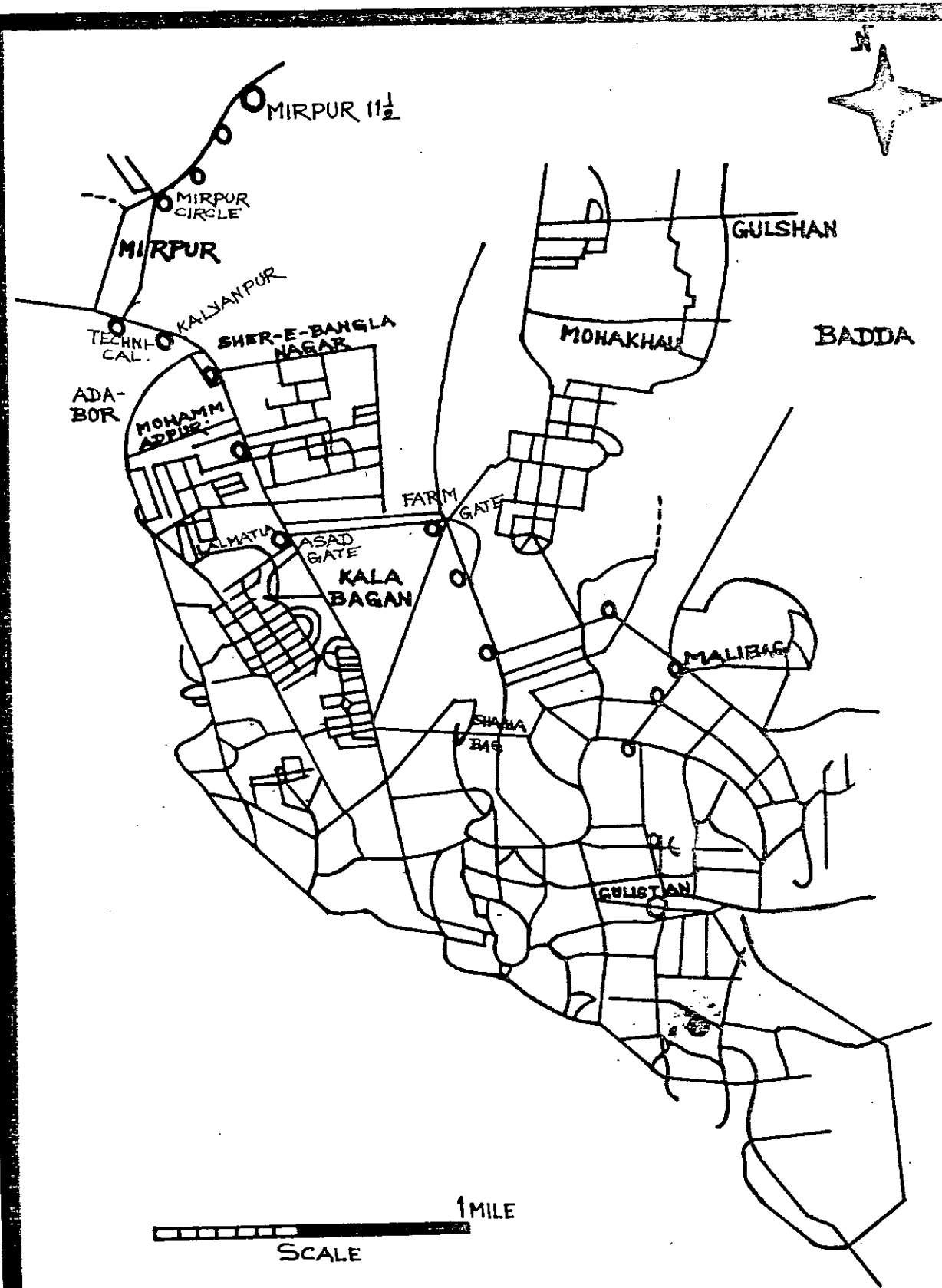


Fig. 4.1
DHAKA CITY MAP INDICATING THE ROUTE

7) Karwan Bazar
8) Farm Gate
9) Asad Gate
10) College Gate
11) Shamoli
12) Kalyanpur
13) Technical
14) Mirpur - 1
15) Mirpur - 2
16) Mirpur - 10
17) Mirpur - 11
18) Mirpur - 11½ (Pollabi)

The distances between the different stoppages are given as follows :

From Gulistan to	Distance in miles	From Mirpur 11½(Pollabi)	Distance in miles
Press club.	0.7	Mirpur-11	1.0
Medical	1.5	Mirpur-2	2.0
Azimpur	2.2	Mirpur-1	2.8
Kalabagan	3.6	Technical	4.1
Asadgate	4.5	Collegegate	5.5
Collegegate	5.2	Asadgate	6.4
Technical	6.8	Farmgate	7.6
Mirpur-1	8.3	Moghbazar	9.1
Mirpur-2	8.8	Malibag	10.0
Mirpur-11	9.8	Gulistan	11.7

Figure (4.2) shows the two routes between Mirpur and Gulistan indicating the distances between different stoppages . In the present work , the route via Mogbazar - Farmgate -Asadgate is selected for analysis.

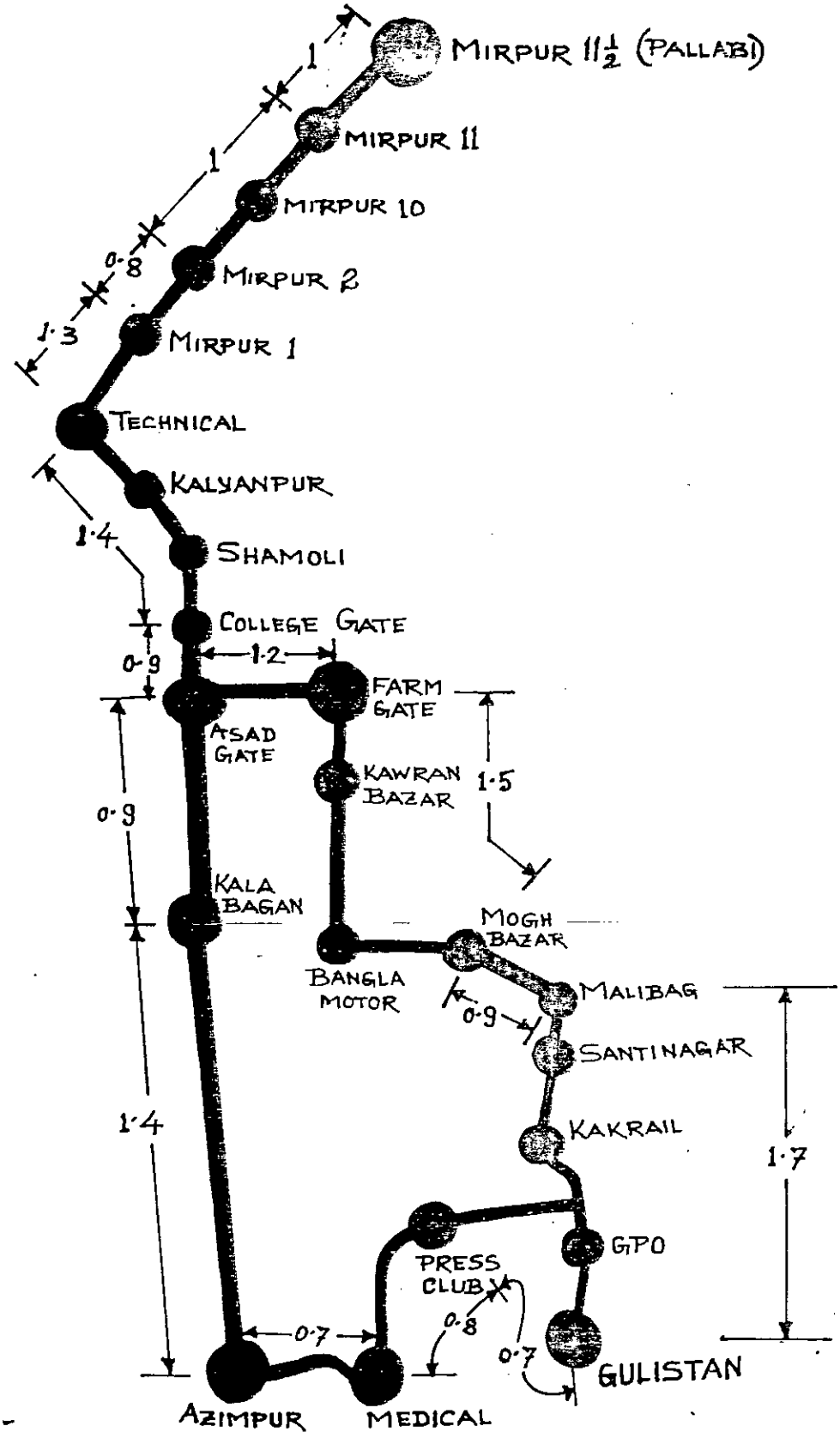


FIG. #(4.2) DISTANCE IN MILE, BETWEEN THE DIFFERENT STOPPAGES OF GULISTAN-MIRPUR ROUTE.

4.2. SELECTION OF STOPPAGES FOR DATA COLLECTION

The above mentioned nineteen stoppages are not all 'critical'. A general survey was carried out to find that few of them were the busy stoppages and the following points were revealed :

GULISTAN : Most of the transports start from this stoppage . It may be called the heart of the transportation system of Dhaka City for both city area and long distance journeys . It is surrounded mostly by commercial areas.

MALIBAG (SHANTINAGAR) : This stoppage covers the areas of Kakrail , Shantinagar , Malibag , Siddeswari . Comparatively less buses move through this stoppage .

FARMGATE : This is the most important bus stoppage . It was found that most of the bus-routes met at this point forming 'bottle neck' . Besides , it is another busiest place and thus it needs consideration .

ASADGATE : With the final destination Mirpur , almost all bus - routes coincide in this stoppage . And this stoppage covers the otherside of the city named Mohammadpur , Sher-e-bangla nagar , Kalabagan , etc. Hence it is of prime importance to be discussed and analysed .

KALYANPUR : Actually the buses passing through Asadgate also pass through this stoppage . But the people from the place ADABAR (which is not yet urbanized) can avail transports from this stoppage .

TECHNICAL : From here the buses which are going to Mirpur are being diverted to its way from the main highway towards Aricha.

MIRPUR-1 : This stoppage may be called the center of Mirpur area and so most of the passengers get down in this stoppage .

MIRPUR-11½ (Pollabi) : This stoppage is the final destination of Gulistan-Mirpur public transport route .

From figure (4.3) it is clear that the buses start for different routes from Gulistan stoppage . At Malibag stoppage buses are coming from Gulistan only , but going to some more three directions (towards Banani , Airport , & Mohammadpur) ; other than the selected route for Farmgate with ultimate destination Mirpur . Mostly BRTC buses are coming through this Malibag stoppage .

From figure (4.3) it becomes clear that for the Farmgate and Asadgate stoppages , the situations are more critical . A large number of buses are coming from other routes to Farmgate stoppage via Shahabag and leaving for five different destinations (Cantonment , Banani , Airport , Mohammadpur and Aricha) other than the selected destination for Mirpur .

In the other critical stoppage Asadgate , large number of buses coming via Science-laboratory and also leaving for other two destinations (Mohammadpur and Gabtoli) other than the selected destination Mirpur .

All the buses passing through Asadgate are also passing through Kalyanpur stoppage . But , at Technical stoppage some buses going towards Gabtoli , and the remaining to the selected final destination Mirpur . The passengers' arrival rate and the service rate for all the mentioned stoppages in figure (4.3) will be discussed in chapter V .

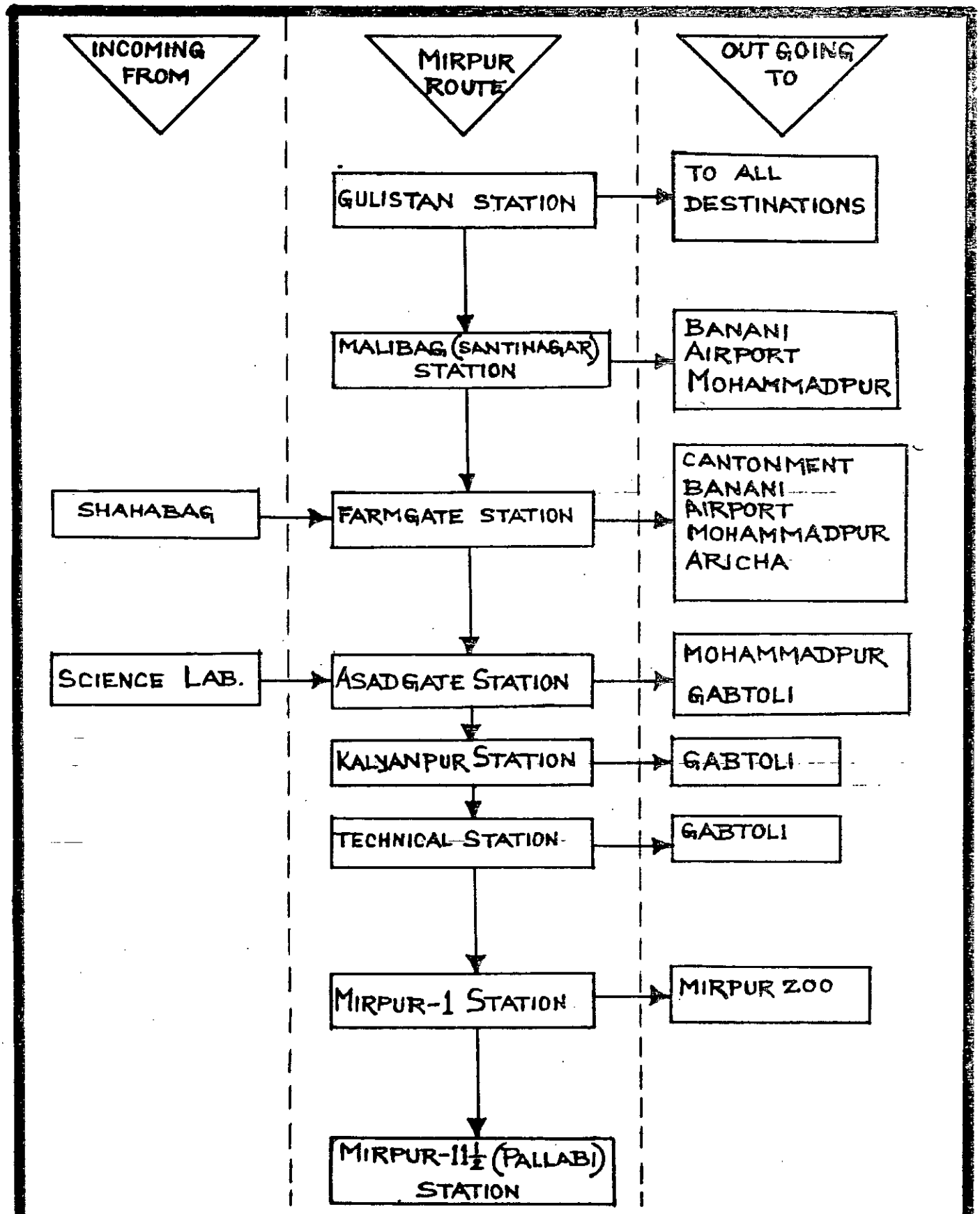


FIG. NO.(4.3) OTHER ROUTES TOUCHING THE SELECTED ROUTE.

4.3. CLASS - WISE DEMAND OF PUBLIC TRANSPORTS

In the previous sections the present operational and management aspect alongwith the scheme of the present study have been stressed upon . It has been recognized that the existing transport system is operating under conditions which need substantial improvement through use of scientific methods and approaches . In the present section another important aspect in the transport system study , namely , passenger demand forecasting , is described . In this respect curves in figure (4.4) gave some insights to estimate the above item .[Wren(1)]

Figure (4.4) shows typical curves for three different income groups relating public transport usage to an index showing the accessibility of public transport . This approach has the advantage of overcoming some of the mathematical difficulties of treating variables that are often highly dependent upon each other , and of enabling the planner to use his judgement in supplying information that is not necessarily available from the surveys ; as has been done to provide the dotted portions of the medium and high income .

In the next chapter it will be discussed in details about the data collection and an overall analysis will be carried out for the critical stoppages with the help of computer programming.

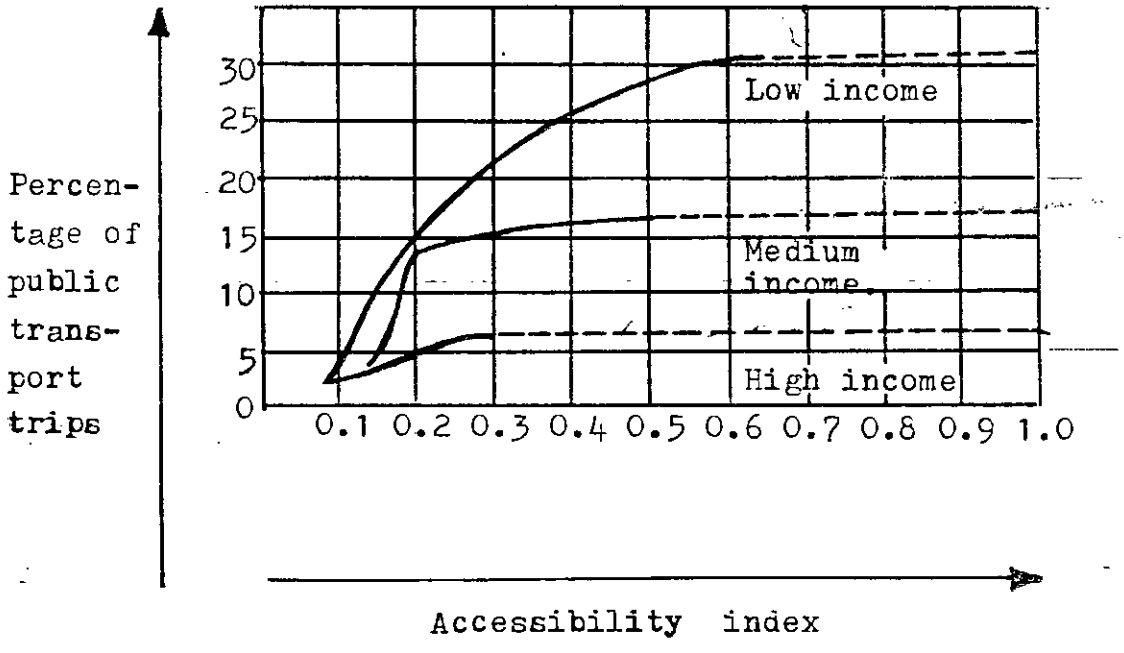


Figure (4.4) Variation of public transport usage with accessibility and income .
[Wren (1)]

Chapter V

DATA COLLECTION AND RESULTS

C H A P T E R - V

D A T A C O L L E C T I O N A N D R E S U L T S

In the preceeding chapters , the transport system of Dhaka City, its operations and associated problems , has been discussed .In this regard scientific approach , for example , modified queueing theory has been indicated to be used in the present context. This , however , needs assessment of the supply-demand situation of the passengers in terms of transport resources . The present chapter is thus devoted to achieve this . The chapter thereby covers , two aspects namely , data collection and analysis (results) .

5.1. DATA COLLECTION PROCEDURES FOR TRAFFIC SURVEY

A typical traffic survey will usully employ several of the data collection methods listed below :

1) Roadside interview :- Vehicles are selected according to a specified sampling method and stopped at each of a number of points at which one or more cordons drawn in and around the study area intersect the road system . The drivers of the vehicles are asked predetermined questions about their journeys , so as to discover the journey origin , destination , intermediate calls , purpose of journey , etc.

2) Home and commercial interview :- A sample of the population (typically five to ten percent) is interviewed at home , and information is obtained about all journeys made by members of the

household on a recent day . The home interview will not , of course , give information about trips starting outside the study area , and other type of survey must be employed to determine these . Similar interviews are conducted at business premises to establish commercial vehicle movements .

3) Registration number surveys :- Registration numbers of vehicles entering and leaving the study area are recorded at cordon points , together with the time of entry or exit . Sampling is achieved through recording only those numbers ending in specified digits or pirs of digits . The entry and exit lists are compared and through vehicle movements determined ; the time difference indicates whether the vehicle stopped in the area or passed directly through .

The most common combination is of the first two arranged so as to give as complete a coverage of all types of journey (i.e. all modes of transport and all classifications of journey purpose such as work , education , shopping , social , etc.) as possible.

Observations are mode of the whole system on several consecutive days three or four times per annum . Obsevers are stationed at strategic points on all routes of the system ; these record the following data for each bus as it passes :

a) route number

b) destination

c) running number

d) time of observation

e) estimate of number of passengers carried.

From this data information may be obtained about the general running patterns , the delays which are occurring to vehicles, and the numbers of passengers being carried past the observation points in the various periods of the day .

It should be noted that information should be available about the numbers of prospective passengers left behind at stoppage , and the lengths of time for which the passengers waited for their bus , so that only a crude estimate of the demand is made . Careful selection of observation points will of course ensure that critical sections of the route are properly covered , and observers , if stationed near stops , may be able to report on the accumulation of passengers at the stop . Data collected manually may be coded for computer use .

5.1.1. DATA COLLECTION PROCEDURE USED

In the present study eight data collectors (observers) were engaged in selected eight stoppages namely , Gulistan , Malibag , Farmgate , Asadgate , Kalyanpur , Technical , Mirpur-1 , and Mirpur-11½ (pallabi) . A prescribed data collection form was made and the required were collected as depicted in figures shown in the appendix .

An observer was stationed in particular stoppage and recorded continuous data and filled up the data forms . Under the existing station , where discipline did not prevailed , proper recording of data was a tedious and laborious job . The situation became all the more difficult as the buses were arriving

and leaving the stoppage in vitually no time . Moreover , as proper schedule was not maintained , they arrive in a bulk . So , an error of about ±15% may be considered . The arrival and departure times of the buses were carefully recorded along with the number of passengers getting up on and down from the buses . Besides , the extra demand , over loading and passengers leaving the station were of importance . The number of passengers who tried to get up on the bus , but could not , is taken as the 'extra demand'. An estimate of 'over loading'' was considered and the number of passengers who left the stoppage after waiting for sometime dissatisfied is taken as 'passengers leaving the station' .

The idea of the present work was to identify the peak periods of the day when the arrival and service rates and also the overall throughput of passengers are the highest . From a preliminary survey of the selected route during several days the busy periods of the day were assumed to be 0800 A.M. to 1100 A.M. and 1400 hrs.(0200 P.M.) to 1800 hrs.(0600 P.M.).The data collection period was taken for two weeks excluding the week-ends and holidays .Thus the periods stood at eight days .

5.2. ANALYSIS OF DATA

Mention has been made earlier regarding the methodology to be used in the present study where it has been indicated that queueing theory techniques as it stands could not be used . This is because the nature of data obtained.

Mention has been made that queueing theory could not be used in strict sense rather a modified of queueing approach has been used in the present work . The reasons being given below :

1) The passengers arriving at the bus stoppage could not be recorded as it should be, as the passengers arriving at the station were not disciplined in a sense that no queues could be established . The passengers arriving at the station wait for the bus in different places around the station as they wish and when the bus comes they almost jump pushing each other to avail the service . Thus the essential parameters for queueing theory can not be obtained , as for example , waiting time of the passengers , queue length , allowable waiting time of the passengers . etc. Nonetheless , first come first served system is also not maintained which proves that the passengers are very much unruly . And in such a situation queueing theory techniques can not be applied .

2) Application of queueing theory technique requires sets of data collected for a long period , over the year if necessary. But for the time limitation of the present work and considering the expense and manpower required for data collection , satisfactory and sufficient data could not be gathered .

3) The buses arriving at a particular bus stoppage were not properly scheduled . It was found that sometimes more than five buses arrived at a time in the station creating a confused situation for the passengers . Some of these buses even did not stop in the station ; the passengers were found to be boarding in and getting down from the buses which were in running condition. This created an equally or even more confused situation for the data collector .

4) The supporting facilities of the stations were found to be almost absent . There were no queue-guiding arrangements in the form of fence or its equivalent . There existed no proper waiting place for the passengers and thus they did not know at which place they were supposed to wait . It was observed that the passengers waited in various places ; this resulted in a difficult situation for the data collector to locate them . The above inherent and serious problems could not allow collection of relevent data as deemed fit for queueing theory application . Thus as mentioned in the objectives in chapter I , the current analysis is directed to achieve an important indicator - " the gap between the demand and supply in terms of passengers-service " . For this purpose a mathematical approach is used . It may be noted that the mathematical formulation, as developed in the present work , has its basis in the general queueing theory . The whole scheme of the mathematical formulation can be divided into the following parts :

1) Arrival pattern of the passengers (λ)
2) Arrival pattern of the service buses
3) Service rate of the passengers (μ)
4) Existing gap of the prevailing supply-demand situation
5) Measures to be taken to reduce the gap in (4) above .

During the eight days' data collection period in eight stations around thirty-five thousand data records were collected . It may be mentioned that the collection period in a day was set for seven hours (0800 A.M. to 1100 A.M. and 0200 P.M. to 0600 P.M.). During these seven-hours period continuous data collection was maintained . Thus for a meaningful interpretation of these data the seven-hours period was broken down to intervals of 15 minutes du-

ration . This operation requires massive calculations which could be done using fast digital computations . Thus the IBM 370/115 computer of the B.U.E.T. computer center was used . For computer based computation the raw data were compiled and arranged in a matrix form as shown below :

Columns / rows		1	2	3	4	------------ j ------------	n
		c1	c2	c3	c4	------------ c_j ------------	cn
1	t1	X11	X12	X13	X14	------------------------	X1n
2	t2	X21	X22	X23	X24	------------------------	X2n
3	t3	X31	X32	X33	X34	------------------------	X3n
4	t4	X41	X42	X43	X44	------------------------	X4n
i	t_i	----	----	----	----	------------ X_{ij}	
m	Tm	Xm1	Xm2	Xm3	Xm4	------------------------	Xmn

Here , t1 , t2 , t3 , t4 , ------------ tm represent the different time periods of 15 minutes each . So that ,

t1 = 0800 A.M. - 0815 A.M.

t2 = 0816 A.M. - 0830 A.M.

t3 = 0831 A.M. - 0845 A.M.

t4 = 0846 A.M. - 0900 A.M.

X_{ij} is the average value of (c_j) ,for a specific time period(i),over the entir data collection period(T); thus

$$X_{ij} = \left[\frac{\sum_{t=1}^{T} (c_j)_t}{T}\right]$$ for a specific(i)

where, T= Data collection period.

From the preliminary survey it was hypothesized that the peak hours

existed during the morning and the afternoon . Accordingly , three hours in the morning and four hours in the afternoon were considered to be the busy periods of the day . This hypothesis was found approximately valid from the figures 5.1 , 5.2 , 5.3 , 5.4 , 5.5 , 5.6 , and 5.7.

The columns c1, c2, c3, c4, ---------- cn represent the observed values of the variables considered . These are given below :

c1 = serial numbers

c2 = service identification (bus numbers)

c3 = bus capacities

c4 = arrival times

c5 = departure times

c6 = number of passengers getting down from the incoming bus to the concerned bus stoppage

c7 = number of passengers getting up to the outgoing bus from the concerned bus stoppage

c8 = number of passengers (observed) causing overloading to the outgoing bus from the concerned bus stoppage

c9 = extra demand for the service by the passengers (in terms of number of passengers) who could not avail the service and was waiting for the next service

c10 = number of passengers leaving the station after waiting for sometimes because of unavailability of the service

The heuristic approach of the necessary calculations are now given below :

ARRIVAL PATTERN OF THE PASSENGERS

This is the arrival rate (λ) as commonly used in queueing theory.

Thus (λ) for any i, is given as, $\lambda = X_{i7} + X_{i9} + X_{i10}$ ... ...(5.1)

for i= 15 minutes intervals

(i = 1,2,3, ... 28 periods in seven hours)

ARRIVAL PATTERN OF SERVICE BUSES :

Bus arrival rate for any i, in terms of their capacities is

$= X_{i3}$ ... ...(5.2)

BUS DETENTION TIME :

The average duration of stopping time of a single bus for any i, is given as ; Bus detention time = $X_{i5} - X_{i4}$ ... .(5.3)

Bus detention time per passenger (15 minutes period basis)

$$= \frac{\text{detention time in 15 minutes period}}{\text{Number of passengers serviced in that period}} \quad \ldots \quad \ldots \quad \ldots(5.4)$$

SERVICE RATE :

Service rate of passengers (μ) for any i, $= X_{i7}$ ... .(5.5)

(per period)

QUEUE LENGTH :

The queue length per period = number of passengers waiting in the system = $X_{i9} - X_{i10}$ ... ... (5.6)

OVER LOADING :

The over loading rate per period = X_{i8} ... ...(5.7)

PASSENGERS THROUGHPUT :

The total number of passengers throughput through the station for any i, $= X_{i3} + X_{i8}$ ... ...(5.8)

The number of buses irrespective of their types arrived per period

$= X_{i2}$ ... ...(5.9)

It may be noted that the GULISTAN and the MIRPUR 11½ (Pallabi) stoppages are the starting and the final destination respectively , hence no queue is supposed to form in these stoppages.

The arrival patterns and the service rates of passengers have been calculated for all the selected bus stoppages which will be shown later on in this chapter .

The two stoppages,namely, FARMGATE and ASADGATE are considered to be critical, and thus need detailed analysis . It could be demonstrated that the'gap's were found critical in these two stoppages .

5.3. R E S U L T S A N D D I S C U S S I O N S

This section is divided into two parts , namely , results and discussion on the results . The results consist of two parts , such as ,

i) general findings of arrival rates and service rates of passengers for the eight stoppages ; and

ii) detailed results for the two critical stoppages at Farmgate and Asadgate .

5.3.1. General findings for the eight stoppages

The average arrival rates of the passengers in different periods of the day are shown in figures 5.1 ,5.2 ,5.3 ,5.4 ,5.5 ,5.6 , and 5.7 which correspond to the results shown in tables T5.1., 5T.2 , 5T.3 , 5T.4 , 5T.5 , 5T.6 , and 5T.7.

Similarly , the service rates of the passengers in the different periods of the day are shown in the figures 5.8 to 5.13 which correspond to the results shown in tables 5T.8 to 5T.13

TABLE T5 - 1

Results for arrival rates of passengers at GULISTAN bus-stoppage

Periods of the day	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	36	50	38	04	-	-	-	-	32.0
0815-0830	24	24	15	41	-	-	-	-	26.0
0830-0845	24	53	19	20	-	-	-	-	29.0
0845-0900	33	00	12	47	-	-	-	-	23.0
0900-0915	33	40	55	64	-	-	-	-	48.0
0915-0930	00	30	17	42	-	-	-	-	22.25
0930-0945	34	00	00	00	-	-	-	-	08.5
0945-1000	25	00	30	00	-	-	-	-	13.75
1000-1015	29	29	18	47	-	-	-	-	30.75
1015-1030	00	33	20	25	-	-	-	-	19.5
1030-1045	47	11	00	54	-	-	-	-	28.0
1045-1100	25	09	00	25	-	-	-	-	14.75
1400-1415	103	37	35	161	-	-	-	-	84.0
1415-1430	35	69	38	00	-	-	-	-	35.5
1430-1445	35	00	20	68	-	-	-	-	30.75
1445-1500	76	95	30	79	-	-	-	-	70.0
1500-1515	30	42	00	00	-	-	-	-	18.0
1515-1530	28	38	79	97	-	-	-	-	60.5
1530-1545	29	32	56	50	-	-	-	-	41.75
1545-1600	46	61	139	40	-	-	-	-	71.5
1600-1615	33	30	42	00	-	-	-	-	26.25
1615-1630	108	18	52	46	-	-	-	-	56.0
1630-1645	22	18	135	66	-	-	-	-	60.25
1645-1700	36	38	00	89	-	-	-	-	40.75
1700-1715	123	32	85	78	-	-	-	-	79.5
1715-1730	00	37	100	51	-	-	-	-	47.0
1730-1745	00	52	60	87	-	-	-	-	49.75
1745-1800	45	35	40	00	-	-	-	-	30.0

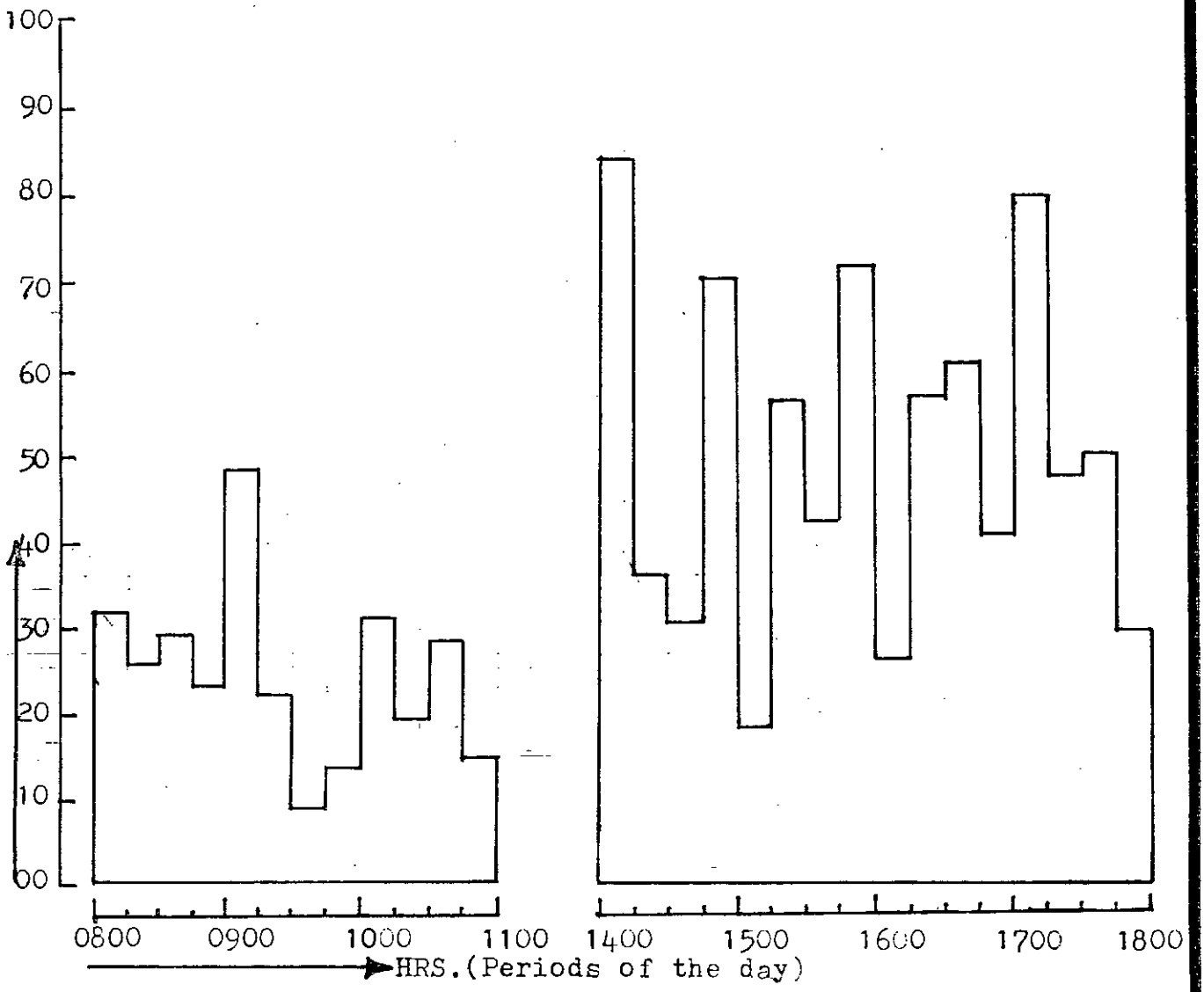


Figure No. 5.1. Average arrival rate of passengers in different periods of the day.

AT GULISTAN STOPPAGE

TABLE T5 - 2

Results for average arrival rates of passengers at MALIBAG-stoppage

Periods of the day	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	30	138	138	-	-	-	-	-	102
0815-0830	55	47	63	-	-	-	-	-	55
0830-0845	141	65	112	-	-	-	-	-	106
0845-0900	110	196	67	-	-	-	-	-	124.33
0900-0915	75	84	115	-	-	-	-	-	91.33
0915-0930	60	44	57	-	-	-	-	-	53.66
0930-0945	50	48	86	-	-	-	-	-	61.33
0945-1000	15	24	38	-	-	-	-	-	25.66
1000-1015	40	32	34	-	-	-	-	-	35.33
1015-1030	25	54	24	-	-	-	-	-	34.33
1030-1045	25	30	61	-	-	-	-	-	38.66
1045-1100	00	53	37	-	-	-	-	-	30
1400-1415	64	25	00	-	-	-	-	-	29.66
1415-1430	20	45	48	-	-	-	-	-	37.66
1430-1445	20	18	21	-	-	-	-	-	19.66
1445-1500	26	26	18	-	-	-	-	-	23.33
1500-1515	65	28	64	-	-	-	-	-	52.33
1515-1530	17	47	21	-	-	-	-	-	28.33
1530-1545	75	36	24	-	-	-	-	-	45
1545-1600	00	34	64	-	-	-	-	-	32.66
1615-1630	95	23	25	-	-	-	-	-	47.66
1630-1645	25	65	32	-	-	-	-	-	40.66
1645-1700	25	61	96	-	-	-	-	-	60.66
1700-1715	73	112	37	-	-	-	-	-	74
1715-1730	86	53	49	-	-	-	-	-	62.66
1730-1745	30	49	76	-	-	-	-	-	51.66
1745-1800	64	42	105	-	-	-	-	-	70.33

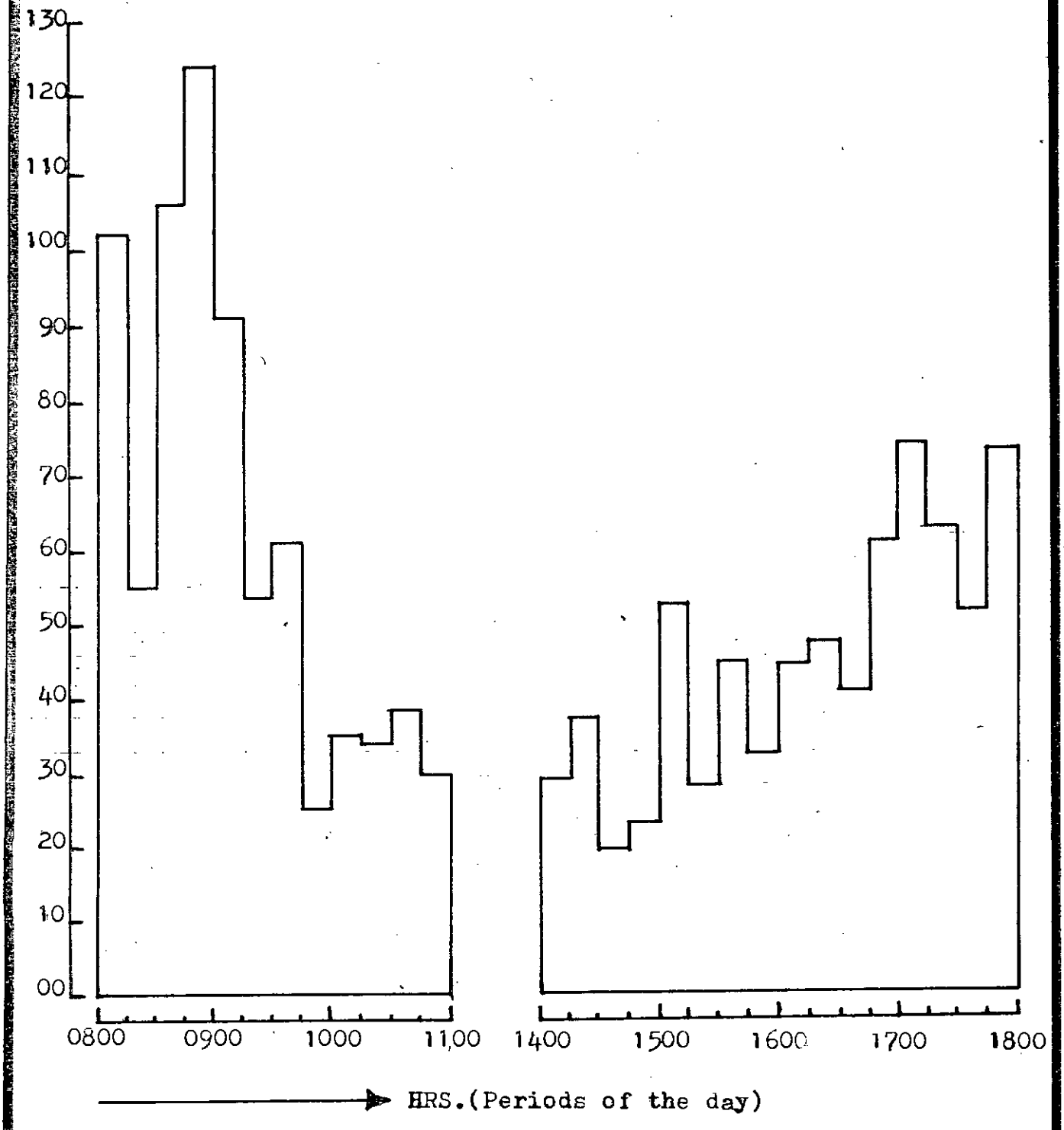


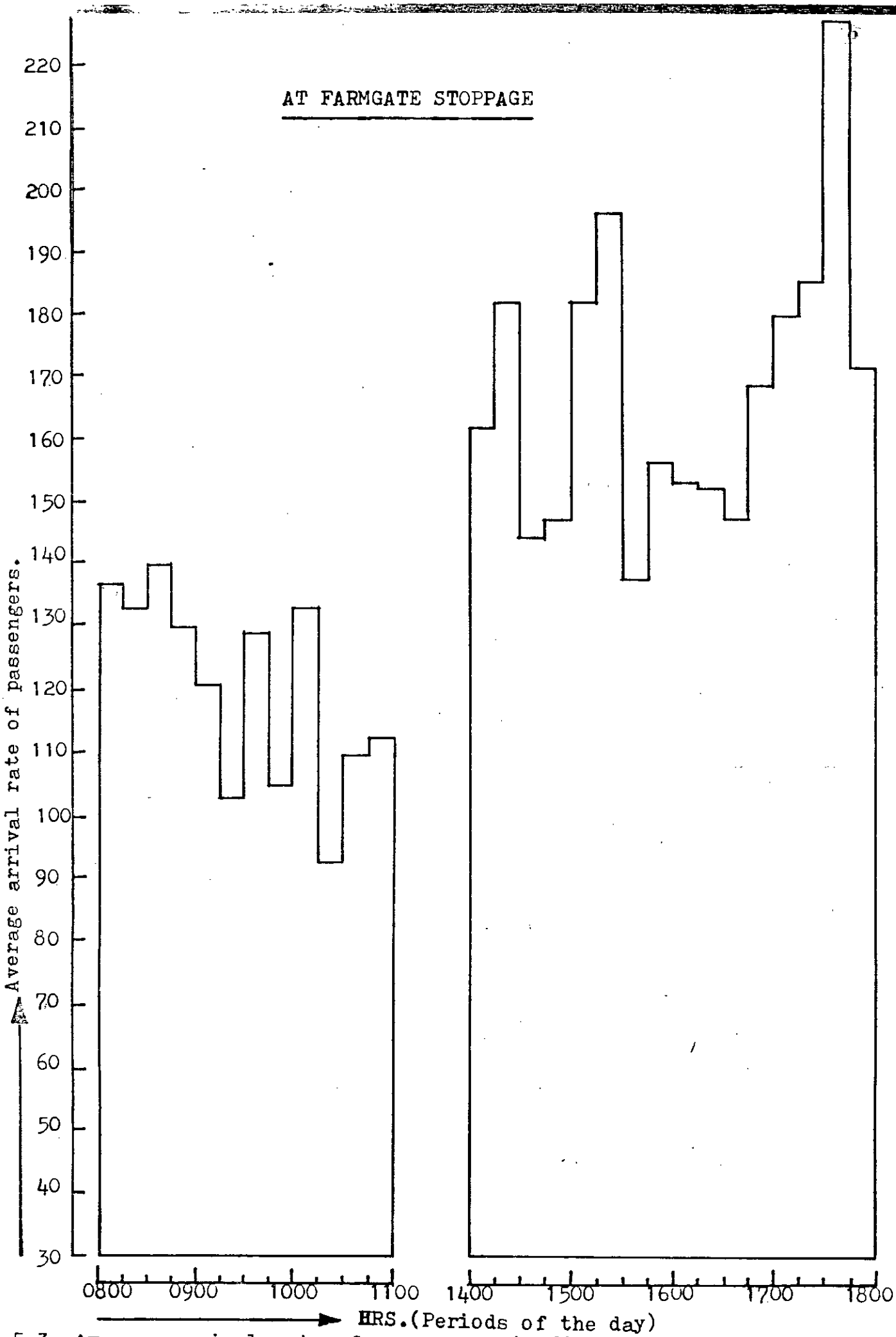
Figure No. 5.2. Average arrival rate of passengers in different periods of the day.

AT MALIBAGH STOPPAGE

TABLE T5 - 3

Results for average arrival rates of passengers at FARMGATE-stoppage

Periods of the day	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	140	73	176	115	248	127	48	167	136.75
0815-0830	119	135	142	106	326	65	106	63	132.75
0830-0845	128	129	99	122	272	55	157	154	139.5
0845-0900	109	80	87	85	239	192	139	105	129.5
0900-0915	120	111	98	162	148	41	199	87	120.75
0915-0930	144	63	125	117	166	72	71	65	102.875
0930-0945	95	81	134	175	143	137	140	125	128.75
0945-1000	111	123	67	68	159	84	93	133	104.75
1000-1015	140	121	124	56	114	196	216	92	132.375
1015-1030	70	61	54	43	158	138	115	100	92.375
1030-1045	68	98	76	46	193	103	187	108	109.875
1045-1100	39	29	131	50	270	106	128	145	112.25
1400-1415	140	73	173	255	258	124	165	105	161.625
1415-1430	155	188	67	284	375	111	153	119	181.5
1430-1445	126	122	151	238	175	70	173	97	144.0
1445-1500	84	126	99	202	298	60	162	144	146.875
1500-1515	121	113	245	250	429	46	133	117	181.75
1515-1530	77	140	140	291	476	86	219	139	196.0
1530-1545	114	68	122	250	222	71	110	144	137.625
1545-1600	85	171	76	235	251	118	177	135	156.0
1600-1615	37	100	164	310	201	94	152	165	152.875
1615-1630	101	94	86	237	362	42	136	158	152.0
1630-1645	121	72	137	190	396	83	109	73	147.625
1645-1700	96	39	83	312	323	81	186	146	158.25
1700-1715	123	183	85	313	253	99	164	215	179.375
1715-1730	112	131	108	384	389	111	135	108	184.75
1730-1745	124	110	63	611	384	95	334	93	226.75
1745-1800	82	140	146	309	318	174	132	69	171.25



. 5.3. Average arrival rate of passengers in different periods of the day.

TABLE 5T - 4

Results for the arrival rates of passengers at ASADGATE-stoppage

Periods of the day	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	17	47	56	66	36	43	51	34	43.75
0815-0830	26	57	35	65	26	40	26	37	39.0
0830-0845	15	61	47	63	27	56	45	35	43.625
0845-0900	30	57	52	50	66	43	35	36	46.125
0900-0915	36	42	63	35	41	46	35	40	42.25
0915-0930	55	58	57	42	74	44	32	29	48.875
0930-0945	29	37	50	51	35	40	36	39	39.625
0945-1000	68	38	51	41	64	41	39	31	46.625
1000-1015	60	62	73	38	71	40	28	36	51.0
1015-1030	16	26	42	55	59	47	36	34	39.375
1030-1045	11	45	67	45	44	41	34	46	41.625
1045-1100	50	38	48	49	45	48	52	29	44.875
1400-1415	59	49	29	40	55	47	50	33	45.25
1415-1430	66	28	37	32	40	62	39	43	43.375
1430-1445	83	90	73	36	41	50	34	47	56.75
1445-1500	75	76	80	51	64	42	20	76	60.5
1500-1515	97	80	48	54	37	67	41	59	60.375
1515-1530	55	71	66	64	66	100	72	55	68.625
1530-1545	73	60	65	58	49	51	71	69	62.0
1545-1600	60	42	51	52	78	69	67	76	61.875
1600-1615	73	64	84	43	59	63	85	76	68.375
1615-1630	58	64	82	55	60	60	56	91	65.75
1630-1645	60	86	68	82	59	70	66	69	70.0
1645-1700	66	53	58	67	93	66	60	67	66.25
1700-1715	62	52	24	57	70	63	57	88	59.125
1715-1730	83	62	20	60	67	54	51	64	57.625
1730-1745	81	58	14	47	59	65	76	72	59.0
1745-1800	73	71	01	61	131	75	90	89	73.875

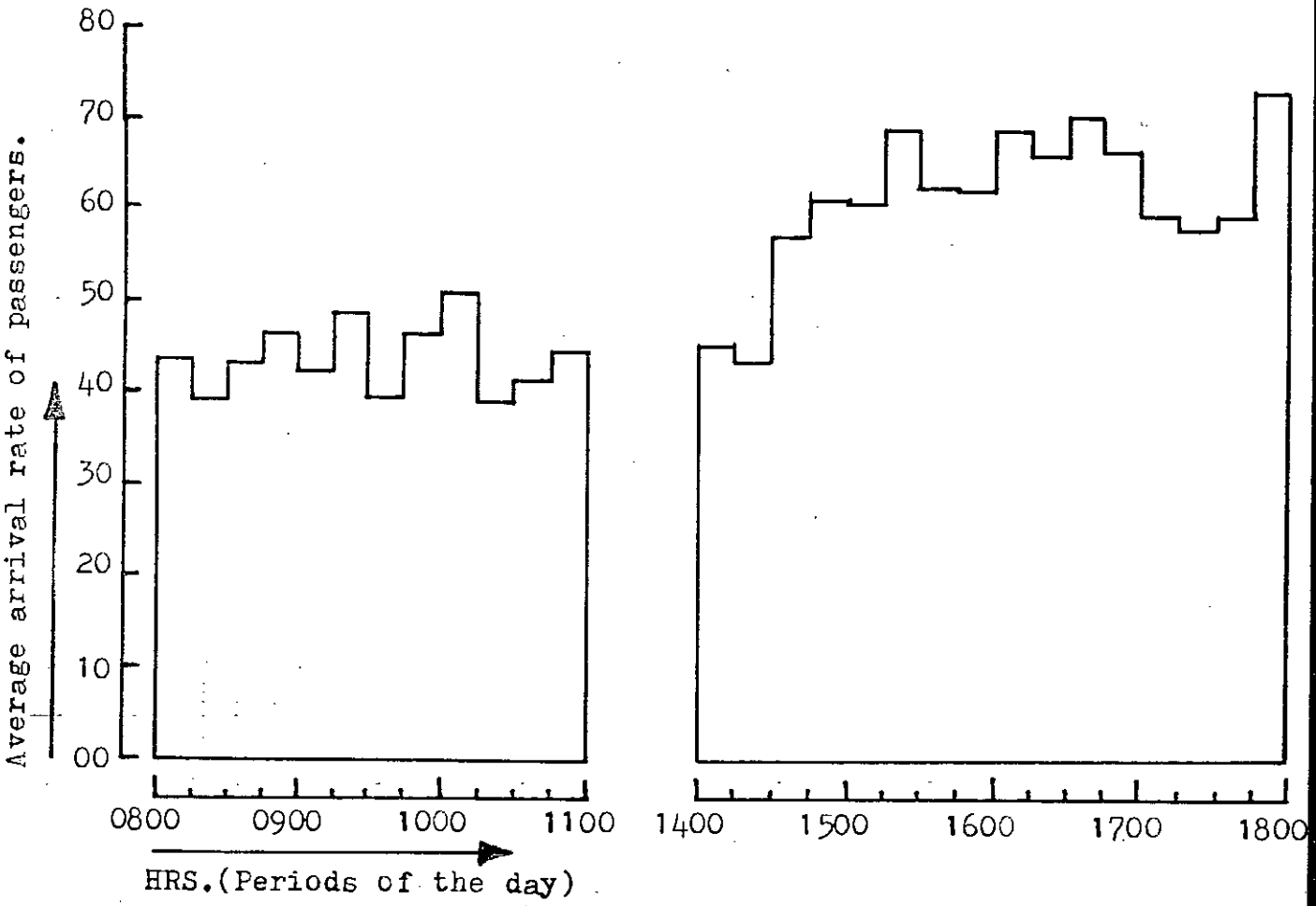


Figure No. 5.4. Average arrival rate of passengers in different periods of the day.

AT ASADGATE STOPPAGE

TABLE 5T - 5

Results for the arrival rates of passengers at KALYANPUR-stoppage

Periods of the day	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	11	43	106	33	34	59	42	11	42.4
0815-0830	16	77	49	31	19	34	28	19	34.1
0830-0845	13	98	22	47	24	26	32	21	35.4
0845-0900	14	54	38	25	67	37	24	44	37.9
0900-0915	27	82	12	39	60	56	48	44	46.0
0915-0930	24	69	15	71	45	80	65	18	48.4
0930-0945	11	99	15	21	46	27	69	50	42.25
0945-1000	20	71	110	33	37	50	65	42	53.5
1000-1015	12	142	97	49	57	60	58	34	63.6
1015-1030	03	162	131	96	29	90	108	55	84.25
1030-1045	11	80	141	54	45	59	33	56	59.9
1045-1100	13	28	44	124	29	52	51	33	46.75
1400-1415	95	85	63	104	32	62	30	27	62.25
1415-1430	111	94	108	88	19	51	08	31	63.75
1430-1445	188	114	77	120	38	42	16	46	80.1
1445-1500	75	42	87	116	31	35	33	82	62.6
1500-1515	16	70	76	66	62	52	42	117	62.6
1515-1530	97	110	41	67	34	61	63	79	69.0
1530-1545	111	153	54	94	55	58	64	66	81.9
1545-1600	183	126	67	133	87	91	53	90	103.75
1600-1615	99	109	142	115	47	73	72	78	91.9
1615-1630	62	81	80	65	52	85	55	26	63.25
1630-1645	79	80	12	91	36	61	69	103	66.4
1645-1700	143	106	14	45	91	70	63	148	85.0
1700-1715	226	76	17	67	84	91	73	308	117.75
1715-1730	92	128	23	53	85	93	49	249	96.5
1730-1745	160	166	18	64	91	85	35	154	96.6
1745-1800	136	148	38	72	78	85	71	140	96.0

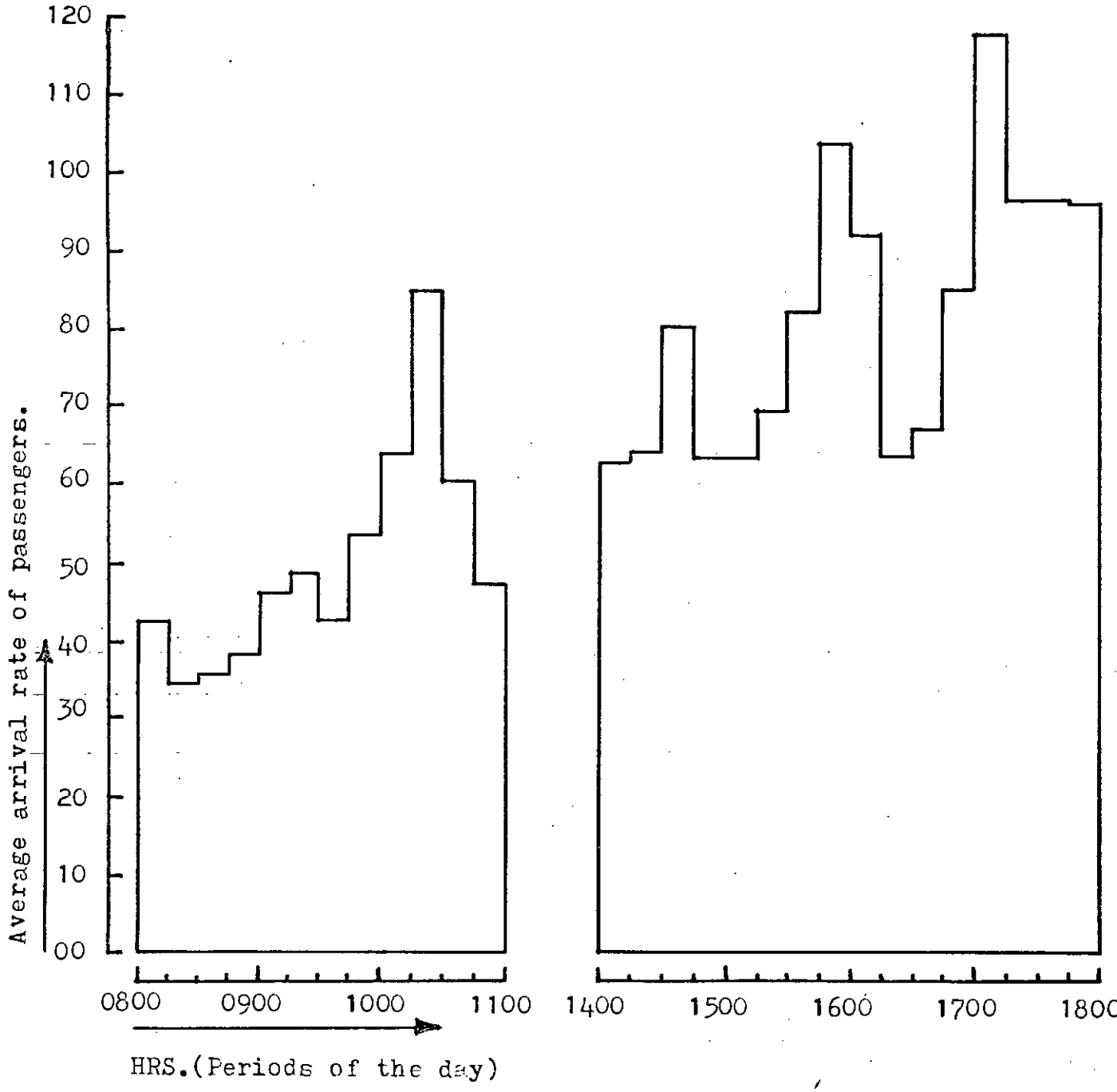


Figure No. 5.5. Average arrival rate of passengers in different periods of the day.

AT KALYANPUR ATOPPAGE

TABLE 5T - 6

Results for the arrival rates of passengers at TECHNICAL-stoppage

Periods of the day	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	35	49	47	41	50	69	123	53	58.4
0815-0830	44	66	33	22	28	67	60	64	48.0
0830-0845	34	62	33	19	34	75	35	68	45.0
0845-0900	42	60	32	33	28	74	64	26	44.9
0900-0915	29	49	34	46	32	55	58	23	40.75
0915-0930	25	60	24	58	44	53	53	49	45.75
0930-0945	38	52	37	54	35	44	32	51	42.9
0945-1000	22	52	52	57	49	40	69	45	48.25
1000-1015	30	45	37	58	49	53	20	34	40.75
1015-1030	17	48	27	51	36	47	50	61	42.1
1030-1045	14	44	37	32	22	45	46	34	34.25
1045-1100	47	47	51	53	54	68	21	36	47.1
1400-1415	40	50	20	44	30	86	31	95	49.5
1415-1430	34	128	25	39	29	67	41	71	54.25
1430-1445	22	31	50	40	43	66	55	60	45.9
1445-1500	50	38	55	53	28	95	45	50	58.0
1500-1515	40	52	45	36	54	55	31	57	46.25
1515-1530	44	81	40	23	47	55	55	62	50.9
1530-1545	33	43	59	44	53	51	27	50	45.0
1545-1600	37	35	51	56	45	53	59	64	50.0
1600-1615	60	66	63	32	45	48	50	69	54.1
1615-1630	43	53	34	39	69	47	55	52	49.0
1630-1645	51	48	47	24	50	41	47	23	41.4
1645-1700	79	51	50	30	84	58	65	69	60.75
1700-1715	79	55	41	42	89	84	17	77	60.75
1715-1730	84	26	49	29	35	53	35	66	47.1
1730-1745	73	73	70	26	34	35	45	41	43.4
1745-1800	116	75	59	29	57	45	33	36	40.25

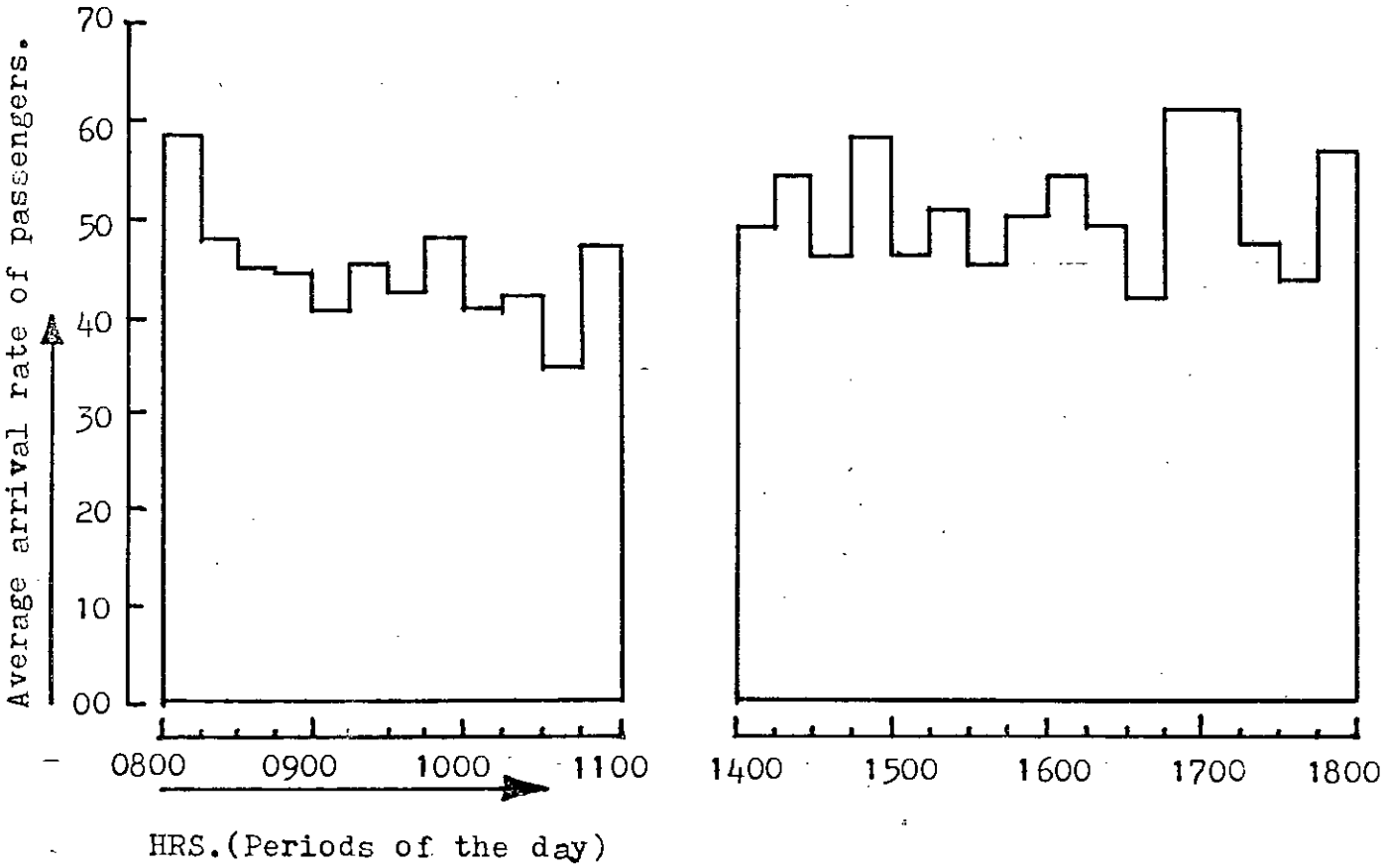


Figure No. 5.6. Average arrival rate of passengers in different periods of the day.

AT TECHNICAL STOPPAGE

TABLE 5T - 7

Results of arrival rates of passengers at MIRPUR-1 bus stoppage

Periods of the day	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	-	31	90	68	53	24	28	81	53.6
0815-0830	-	71	75	80	66	70	54	65	68.7
0830-0845	-	74	109	95	139	133	84	46	97.1
0845-0900	-	66	97	78	82	159	76	107	95.0
0900-0915	-	70	99	152	99	112	96	90	102.6
0915-0930	-	81	51	79	46	93	70	75	70.7
0930-0945	-	69	47	80	49	112	68	62	69.6
0945-1000	-	44	46	63	58	77	81	105	67.7
1000-1015	-	74	29	122	108	108	49	73	93.3
1015-1030	-	61	69	37	66	63	111	58	75.7
1030-1045	-	94	41	73	58	130	49	71	73.7
1045-1100	-	50	07	23	73	92	87	55	55.3
1400-1415	-	82	73	21	33	31	27	51	45.4
1415-1430	-	151	62	52	43	21	33	57	60.6
1430-1445	-	78	44	54	48	47	31	57	51.3
1445-1500	-	99	42	39	57	44	63	63	58.1
1500-1515	-	77	39	39	55	38	45	32	46.4
1515-1530	-	78	18	50	63	38	43	58	49.7
1530-1545	-	63	26	48	108	56	41	72	59.1
1545-1600	-	62	50	94	68	41	45	60	60.0
1600-1615	-	69	139	51	64	88	40	55	72.3
1615-1630	-	103	28	45	88	54	51	67	62.3
1630-1645	-	105	114	62	93	58	73	58	80.4
1645-1700	-	103	87	127	80	76	41	64	82.6
1700-1715	-	101	58	61	110	105	57	77	81.3
1715-1730	-	183	75	86	94	74	104	110	103.4
1730-1745	-	241	93	173	135	121	94	173	147.1
1745-1800	-	180	119	105	206	115	88	173	140.9

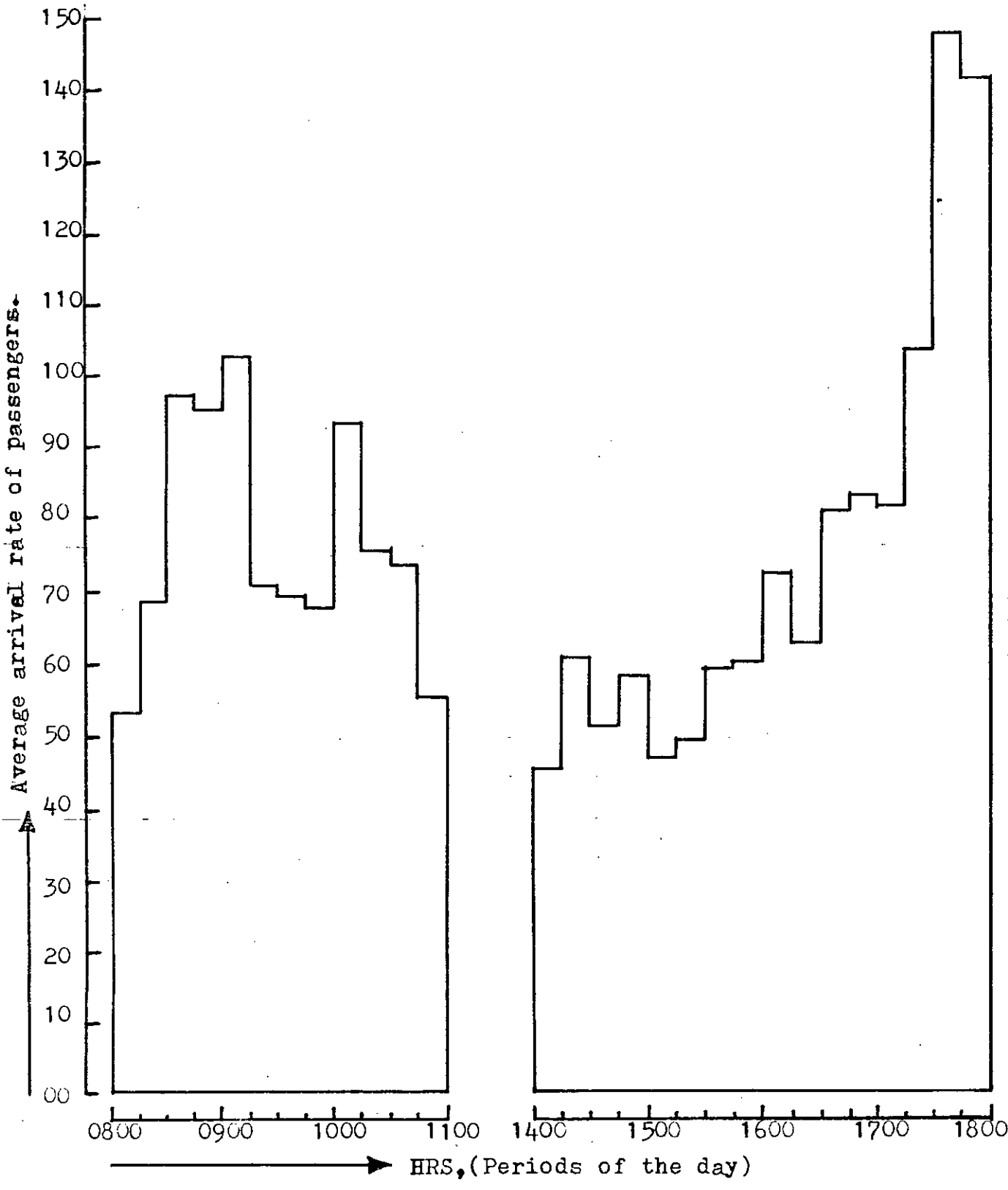


Figure No. 5.7. Average arrival rate of passengers in different periods of the day.

AT MIRPU-1 STOPPAGE

TABLE 5T - 8

Results for the service rate of passengers at Malibag-stoppage

Periods of the day	Dates in Feb.1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	30	115	132	-	-	-	-	-	92.3
0815-0830	40	35	59	-	-	-	-	-	44.7
0830-0845	91	45	91	-	-	-	-	-	75.7
0845-0900	77	159	50	-	-	-	-	-	95.3
0900-0915	75	73	111	-	-	-	-	-	86.3
0915-0930	60	37	51	-	-	-	-	-	49.3
0930-0945	50	35	78	-	-	-	-	-	54.3
0945-1000	15	24	38	-	-	-	-	-	25.7
1000-1015	30	32	34	-	-	-	-	-	32.0
1015-1030	00	40	24	-	-	-	-	-	21.3
1030-1045	00	30	61	-	-	-	-	-	30.3
1045-1100	00	53	33	-	-	-	-	-	27.7
1400-1415	49	25	00	-	-	-	-	-	24.7
1415-1430	20	44	48	-	-	-	-	-	37.3
1430-1445	20	18	21	-	-	-	-	-	19.7
1445-1500	26	26	16	-	-	-	-	-	22.7
1500-1515	60	28	63	-	-	-	-	-	50.3
1515-1530	15	44	19	-	-	-	-	-	26.0
1530-1545	60	31	24	-	-	-	-	-	38.3
1545-1600	00	30	54	-	-	-	-	-	28.0
1600-1615	18	48	37	-	-	-	-	-	34.3
1615-1630	60	23	25	-	-	-	-	-	36.0
1630-1645	20	48	29	-	-	-	-	-	32.3
1645-1700	25	40	70	-	-	-	-	-	45.0
1700-1715	61	98	25	-	-	-	-	-	61.3
1715-1730	63	48	30	-	-	-	-	-	47.0
1730-1745	30	35	50	-	-	-	-	-	38.3
1745-1800	45	32	79	-	-	-	-	-	52.0

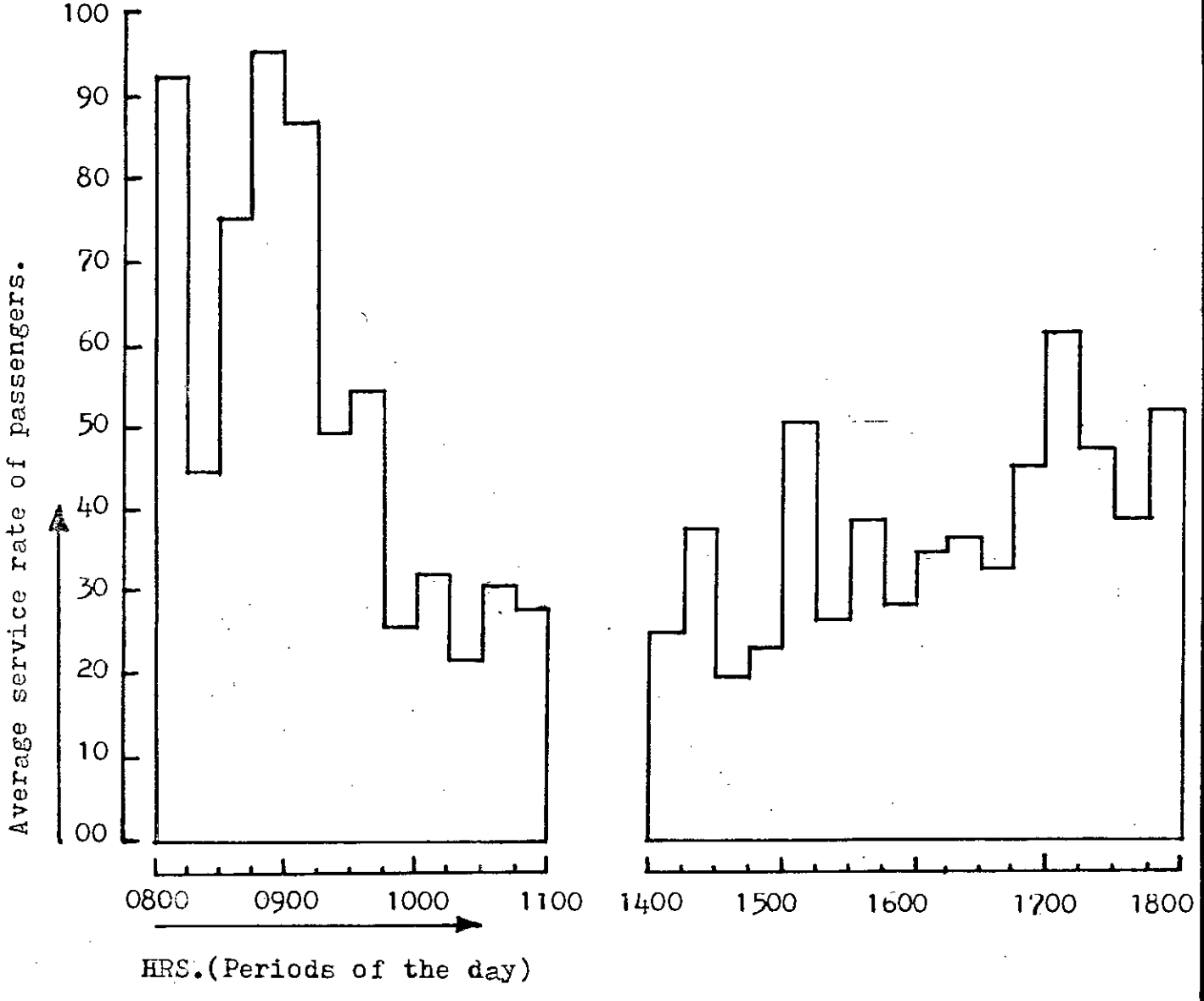


Figure No. 5.8. Average service rate of passengers in different periods of the day.

AT MALIBAGH STOPPAGE

TABLE 5T - 9

Results for the service rates of the passengers at FARMGATE-station

Periods of the day	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	140	73	148	115	181	93	48	164	120.25
0815-0830	119	109	108	84	239	51	88	60	107.25
0830-0845	128	127	99	79	257	54	127	142	126.625
0845-0900	109	80	87	63	229	185	126	99	122.25
0900-0915	110	85	83	122	148	38	186	85	107.125
0915-0930	144	53	109	98	166	67	65	63	95.625
0930-0945	95	67	96	117	141	112	120	122	108.75
0945-1000	111	107	65	68	159	81	76	131	99.75
1000-1015	140	101	98	56	114	177	184	89	119.875
1015-1030	70	61	54	32	158	138	93	95	87.625
1030-1045	68	82	59	34	169	103	177	108	100.0
1045-1100	39	29	129	44	226	106	89	137	99.875
1400-1415	90	57	86	153	199	120	151	98	119.25
1415-1430	84	147	35	164	297	97	129	95	131.0
1430-1445	81	80	107	209	146	65	158	94	117.5
1445-1500	58	73	81	169	218	60	157	126	117.75
1500-1515	77	72	159	201	280	46	111	109	131.875
1515-1530	37	104	91	247	317	86	159	125	145.75
1530-1545	63	59	83	209	201	71	88	123	112.125
1545-1600	42	121	56	189	230	118	165	131	131.5
1600-1615	31	67	115	216	191	94	130	143	123.375
1615-1630	69	69	54	196	206	42	117	123	109.5
1630-1645	62	41	74	162	265	83	91	48	103.25
1645-1700	48	29	46	237	199	81	158	936	117.0
1700-1715	46	108	51	248	199	99	132	179	132.75
1715-1730	45	75	80	323	276	111	88	73	133.875
1730-1745	56	82	63	474	267	95	177	63	159.625
1745-1800	42	97	87	199	169	174	121	69	119.75

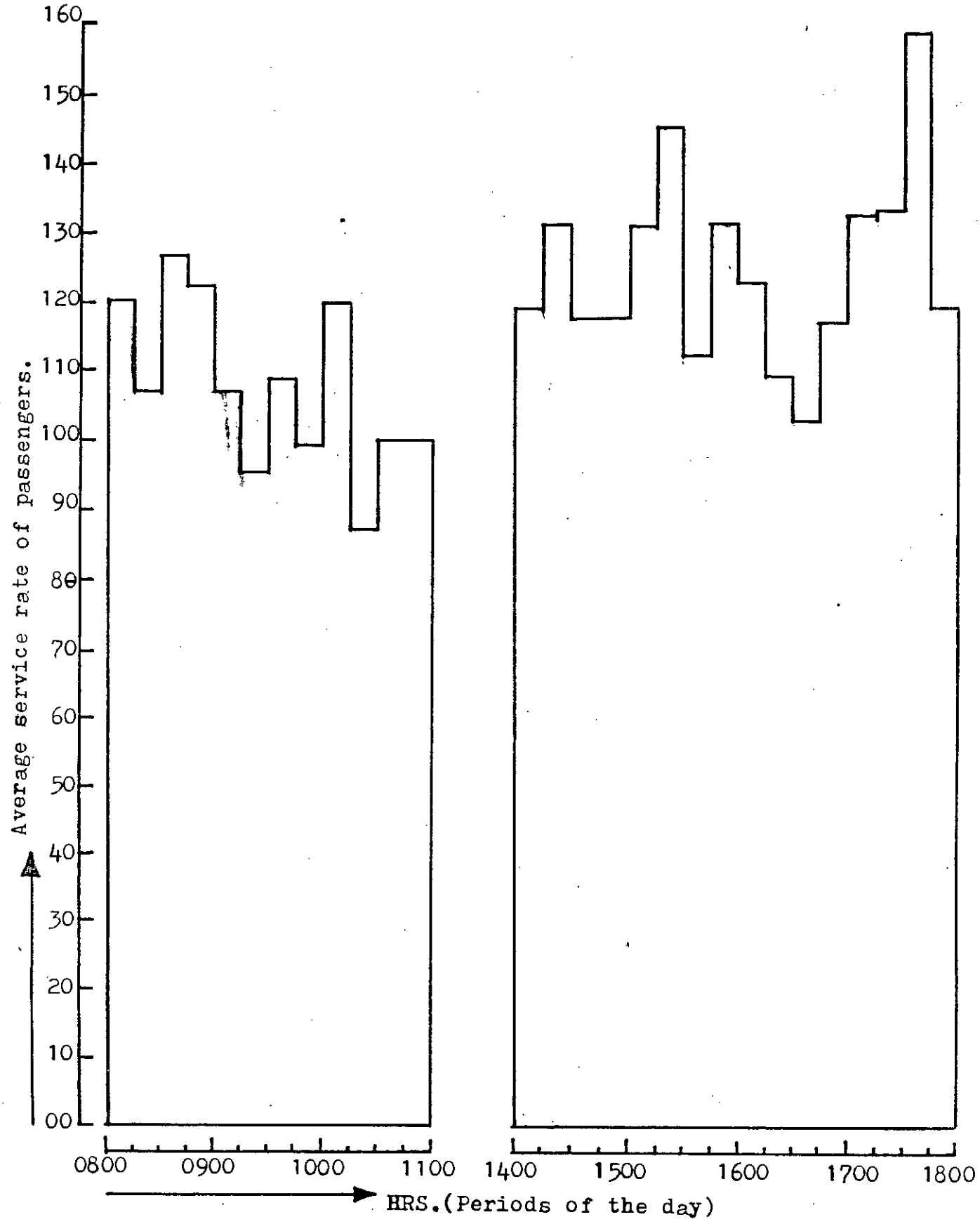


Fig. 5.9. Average service rate of passengers in different periods of the day .

AT FARMGATE STOPPAGE

TABLE 5T - 10

Results for the service rate of passengers at ASADGATE stoppage.

Periods of the day	Dates in Feb. 1984.								Average.
	12	13	14	15	16	19	22	23	
0800-0815	17	47	56	66	36	43	51	34	43.75
0815-0830	26	57	35	65	26	40	26	37	39.00
0830-0845	15	61	47	63	27	56	45	35	43.625
0845-0900	30	57	52	50	66	43	35	36	46.125
0900-0915	36	42	63	35	41	46	35	40	42.25
0915-0930	55	58	57	42	74	44	32	29	48.875
0930-0945	29	37	50	51	35	40	36	39	39.625
0945-1000	68	38	51	41	64	41	39	31	46.625
1000-1015	60	62	73	38	71	40	28	36	51.0
1015-1030	16	26	42	55	59	47	36	34	39.375
1030-1045	11	45	67	45	44	41	34	46	41.625
1045-1100	50	38	48	49	45	48	52	29	44.875
1400-1415	40	49	29	40	55	47	50	33	42.875
1415-1430	66	28	37	32	40	62	39	43	43.375
1430-1445	83	90	73	36	41	50	34	47	56.75
1445-1500	75	76	80	51	64	42	20	76	60.5
1500-1515	97	80	48	54	37	67	41	59	60.375
1515-1530	55	71	66	64	66	100	72	55	68.625
1530-1545	73	60	65	58	49	51	71	69	62.0
1545-1600	60	42	51	52	78	69	67	76	61.875
1600-1615	73	64	84	43	59	63	85	76	68.375
1615-1630	58	64	82	55	60	60	56	91	65.75
1630-1645	60	86	68	82	59	70	66	69	70.0
1645-1700	66	53	58	67	93	66	60	67	66.25
1700-1715	62	52	24	57	70	63	57	88	59.125
1715-1730	83	62	20	60	67	54	51	64	57.625
1730-1745	81	58	14	47	59	65	76	72	59.0
1745-1800	73	71	01	61	131	75	90	89	73.875

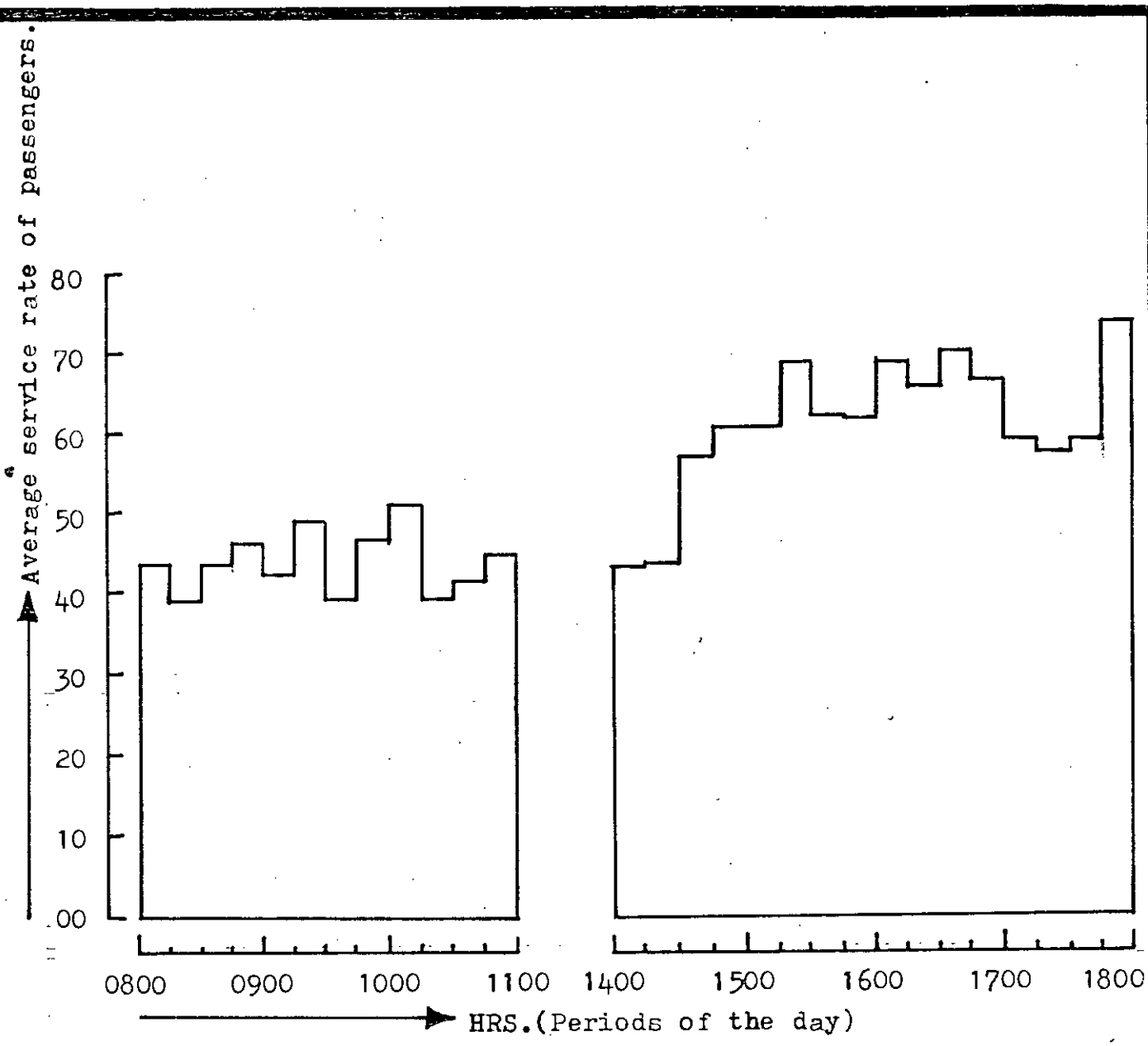


Figure No. 5.10. Average service rate of passengers in different periods of the day.

AT ASADGATE STOPPAGE

TABLE 5T - 11

Results for the service rate of passengers at KALYANPUR stoppage.

Periods of the day	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	11	23	39	19	22	24	08	07	19.125
0815-0830	16	33	25	18	09	06	06	06	14.9
0830-0845	13	38	09	28	13	09	08	09	15.9
0845-0900	14	16	17	14	12	08	04	21	13.2
0900-0915	23	28	11	15	05	13	10	14	14.9
0915-0930	24	22	07	32	06	10	09	06	14.5
0930-0945	11	36	10	12	19	15	15	24	17.75
0945-1000	20	24	46	17	05	19	15	21	20.9
1000-1015	12	59	40	20	15	09	18	22	24.4
1015-1030	03	55	38	48	13	29	23	25	29.25
1030-1045	11	41	54	26	18	10	11	25	24.5
1045-1100	13	28	18	48	08	20	19	21	21.9
1400-1415	80	39	25	41	12	18	08	11	29.25
1415-1430	75	27	38	47	03	06	02	10	26.0
1430-1445	51	51	16	36	18	32	05	04	26.6
1445-1500	33	15	43	41	06	15	24	08	23.1
1500-1515	05	21	39	30	36	11	07	21	21.25
1515-1530	37	48	39	27	08	09	08	22	24.75
1530-1545	88	66	25	40	30	03	12	24	36.0
1545-1600	88	44	35	64	40	17	18	30	42.0
1600-1615	40	45	56	36	14	39	13	18	32.6
1615-1630	26	34	35	31	24	17	18	12	24.6
1630-1645	30	32	12	36	10	29	34	31	26.75
1645-1700	50	40	11	23	29	12	18	60	30.4
1700-1715	159	34	14	25	50	25	13	119	54.9
1715-1730	40	59	13	21	30	31	10	110	39.25
1730-1745	55	65	14	26	35	35	02	60	36.5
1745-1800	59	85	17	31	32	25	19	66	41.75

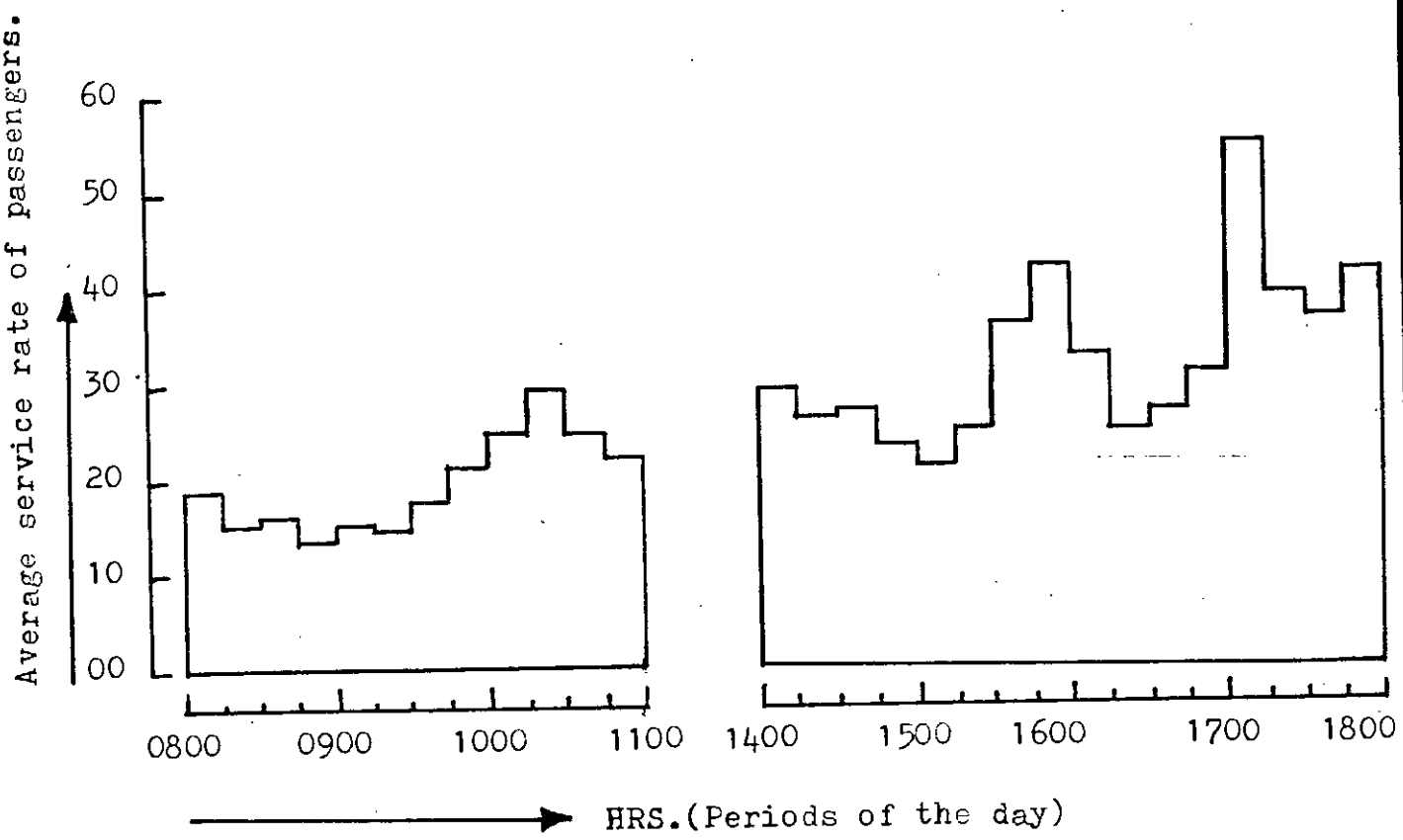


Figure No. 5.11. Average aervice rate of passengers in different periods of the day.

AT KALYANPUR STOPPAGE

TABLE 5T - 12

Results for the service rate of passengers at TECHNICAL stoppage.

Periods of the day	Dates in Feb. 1984. 12	13	14	15	16	19	22	23	Average
0800-0815	35	49	47	41	50	68	123	53	58.25
0815-0830	44	66	33	22	28	67	60	64	48.0
0830-0845	35	62	33	19	34	73	35	68	44.9
0845-0900	42	60	32	33	28	74	63	26	44.75
0900-0915	29	49	34	46	32	55	58	23	40.75
0915-0930	25	60	24	58	44	53	53	49	45.75
0930-0945	38	52	37	54	35	43	32	51	42.75
0945-1000	22	52	52	57	49	40	69	44	48.1
1000-1015	30	45	37	58	49	53	20	34	40.75
1015-1030	17	48	27	51	36	47	50	61	42.1
1030-1045	14	44	37	32	22	45	46	33	34.1
1045-1100	47	47	51	53	54	68	21	36	47.1
1400-1415	40	50	20	44	30	85	31	95	49.4
1415-1430	34	128	25	39	29	67	41	71	54.25
1430-1445	22	31	50	40	43	66	55	60	45.9
1445-1500	50	38	55	53	28	94	45	49	57.75
1500-1515	40	52	45	36	54	55	31	57	46.25
1515-1530	44	81	40	23	47	55	55	62	50.9
1530-1545	33	43	59	44	53	51	27	50	45.0
1545-1600	37	35	51	56	45	52	59	64	49.9
1600-1615	58	66	63	32	45	48	50	68	53.75
1615-1630	43	53	34	39	69	47	55	50	48.75
1630-1645	51	48	47	24	40	41	47	21	39.9
1645-1700	79	51	50	30	55	58	65	69	57.1
1700-1715	79	55	41	42	87	84	17	77	60.25
1715-1730	84	26	49	29	35	53	35	66	47.1
1730-1745	73	73	70	26	34	35	45	41	43.4
1745-1800	116	75	59	29	57	45	33	36	56.25

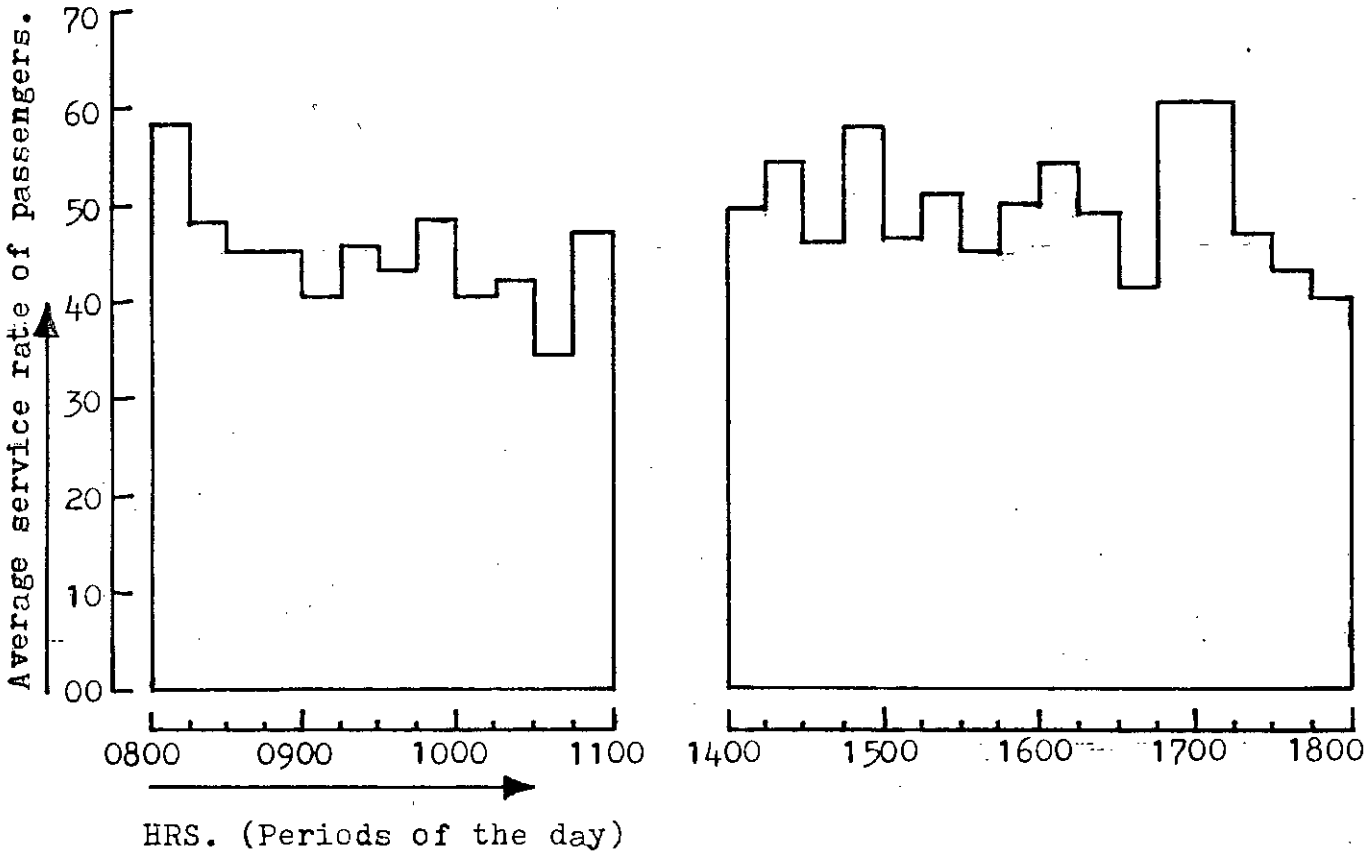


Figure No. 5.12. Average service rate of passengers in different periods of the day .

AT TECHNICAL STOPPAGE

TABLE 5T - 13

Results for the service rate of passengers at MIRPUR-1 stoppage.

Periods of the day	Dates in Feb. 1984. 12	13	14	15	16	19	22	23	Average
0800-0815	-	31	83	68	53	24	28	77	52.0
0815-0830	-	59	75	80	66	70	52	65	66.7
0830-0845	-	66	100	95	136	133	84	46	94.3
0845-0900	-	62	97	78	82	159	76	107	94.4
0900-0915	-	67	91	152	99	112	96	90	101.0
0915-0930	-	74	49	79	46	93	68	75	69.1
0930-0945	-	69	47	80	49	112	64	62	69.0
0945-1000	-	44	44	49	58	77	81	105	65.4
1000-1015	-	64	29	122	108	108	49	73	79.0
1015-1030	-	58	54	37	66	63	111	58	72.1
1030-1045	-	76	36	73	58	130	49	71	70.4
1045-1100	-	44	07	23	73	92	87	55	54.4
1400-1415	-	73	62	21	33	31	27	51	42.6
1415-1430	-	143	58	52	43	21	33	57	58.1
1430-1445	-	70	39	54	48	47	31	57	49.4
1445-1500	-	67	37	37	57	44	63	63	52.6
1500-1515	-	61	34	37	53	38	45	32	42.9
1515-1530	-	66	18	45	63	38	43	58	47.3
1530-1545	-	51	26	46	105	56	41	72	56.7
1545-1600	-	53	42	88	68	41	45	60	56.7
1600-1615	-	44	126	48	64	75	40	55	64.6
1615-1630	-	77	25	45	80	54	51	67	57.0
1630-1645	-	98	96	55	82	58	69	58	73.7
1645-1700	-	93	60	112	67	76	41	64	73.3
1700-1715	-	80	50	54	110	105	57	77	76.1
1715-1730	-	110	52	53	94	74	104	110	85.3
1730-1745	-	179	66	144	130	114	94	173	128.6
1745-1800	-	137	91	88	192	105	88	173	124.9

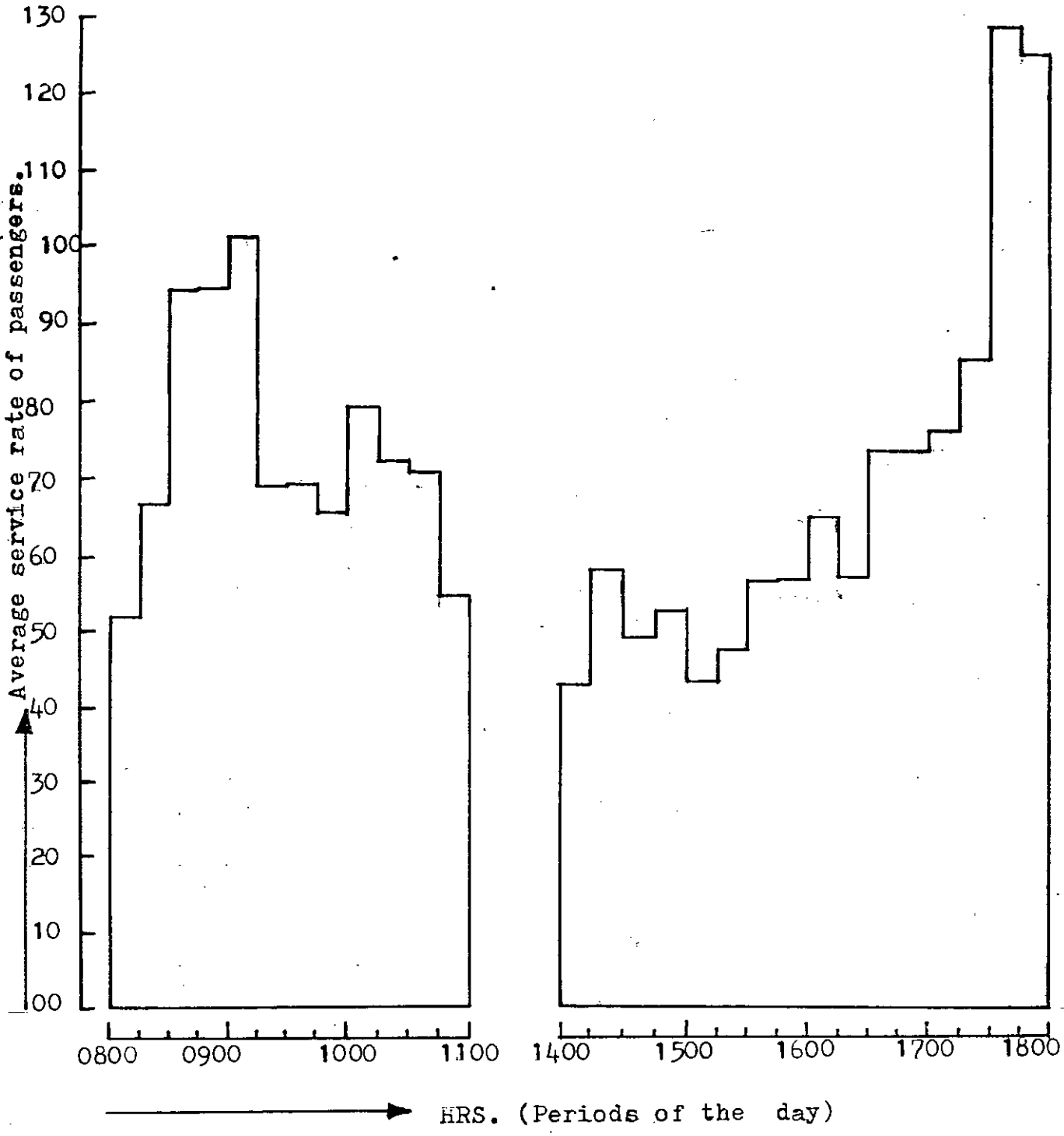


Figure No. 5.13. Average service rate of passengers in different periods of the day .

AT MIRPUR-1 STOPPAGE

The difference between the demand (arrival rate of passengers) and supply (service rate of passengers) , which is the actual queue formation can be shown in figures 5.20 , 5.21 , 5.22 , 5.23 , 5.24 , 5.25.

The average arrival and service rates per fifteen minutes as shown in figures (figure 5.1 to 5.13) indicate that these are fluctuating in nature . Thus theoretical distribution namely poisson distribution may not be a close fit which requires that the above parameters take constant values .

The average arrival rates of passengers in the various stoppages show that two sharp peaks exist , one in around 0800 to 0900 hrs. in the morning and the other in around 1700 to 1800 hrs. in the afternoon . The lean period is found around 1100 hrs. and 1400 hrs. But in Asadgate stoppage it is found to be nearly constant at 45 to 60 per fifteen minutes period and in the Kalyanpur stoppage the peaks are in the first half of the day in around 1030 hrs. with 84 per fifteen minutes period and in the afternoon 1715 hrs. with 118 per fifteen minutes period .

The present study has revealed that the service rates in the various stoppages follow identical pattern as those of the arrivals . This finding is not a surprise or a mere coincidence . The experience from the system operation has established this agreement .

For the Gulistan , Malibag , Farmgate , Asadgate , Kalyanpur , Technical , and Mirpur-1 stoppages the peak arrival rates of the passengers were found during 1400-1415 hrs., 0845-0900 hrs., 1730-

1745 hrs., 1745-1800 hrs., 1700-1715 hrs., 1645-1715 hrs., and 1730-1745 hrs., respectively . This shows that the highest arrival rate in general exists in the second half of the day in around 1700 hrs.

On the other hand , the lowest arrival rates at these stoppages were found during 0930-0945 hrs. , 1430-1445 hrs, 1015-1030 hrs, 1015-1030 hrs., 0815-0830 hrs. , 1030-1045 hrs. . Thus in general the lowest arrival rates existed around 1000 hrs.

The positive 'gap' between demand and supply of the resources (passenger-carrying capacity) are found to exist . This is revealed from the present study and from the authorities . This above mentioned 'gap' of demand-supply are evident from the figures 5.20 , 5.21 , 5.22 , 5.23 , 5.24 , and 5.25 This 'gap' is not desirable and may not be acceptable . The extent of these 'gap' are shown in figures 5.14 , 5.15 , 5.16 , 5.17 , 5.18 , and 5.19. It is found that there exists a positive 'gap' , the reduction of which would require more services . It is observed that the extent of 'gap' is the highest at the Farmgate and Kalyanpur stoppages . Farmgate was considered as a critical stoppage. But Kalyanpur should not be considered as a critical stoppage. However , the possible reason may be due to error in data collection; othdr possible reason may be that this particular stoppage lacks minimal facilities , thus most of the buses do not stop at this station . This requires that a further study may be carried out on this stoppage .

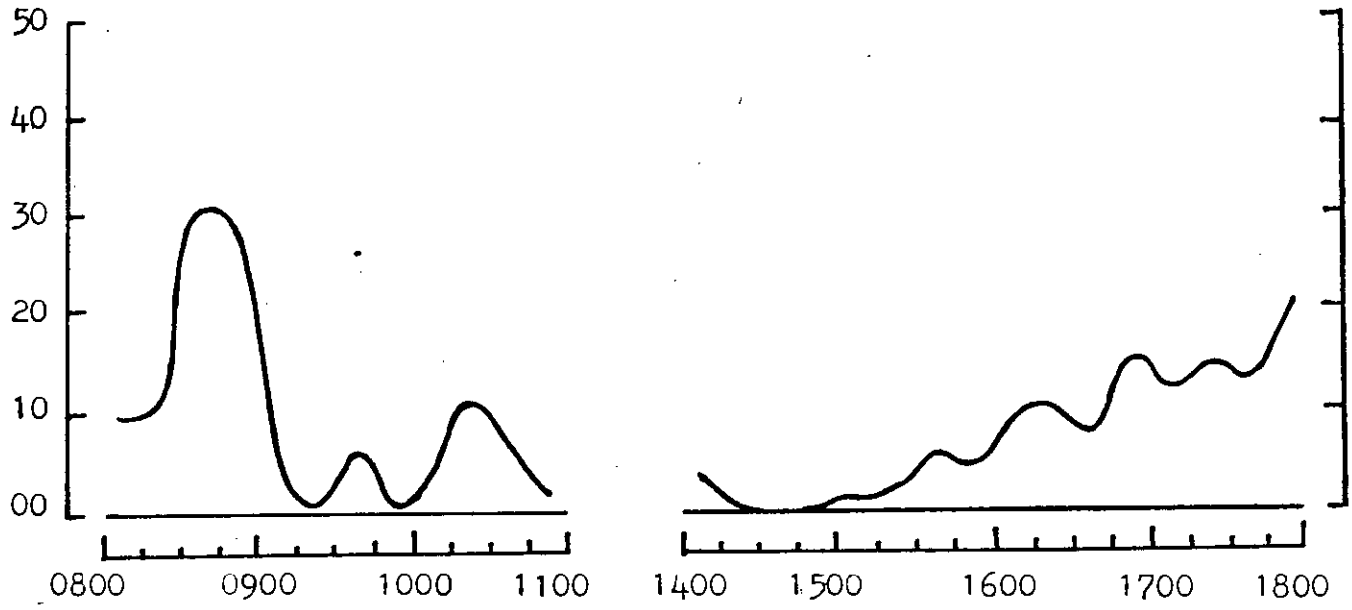


Figure No. 5.14. The nature of the queue length (in terms of number of passengers) in different periods of the day at MALIBAG .

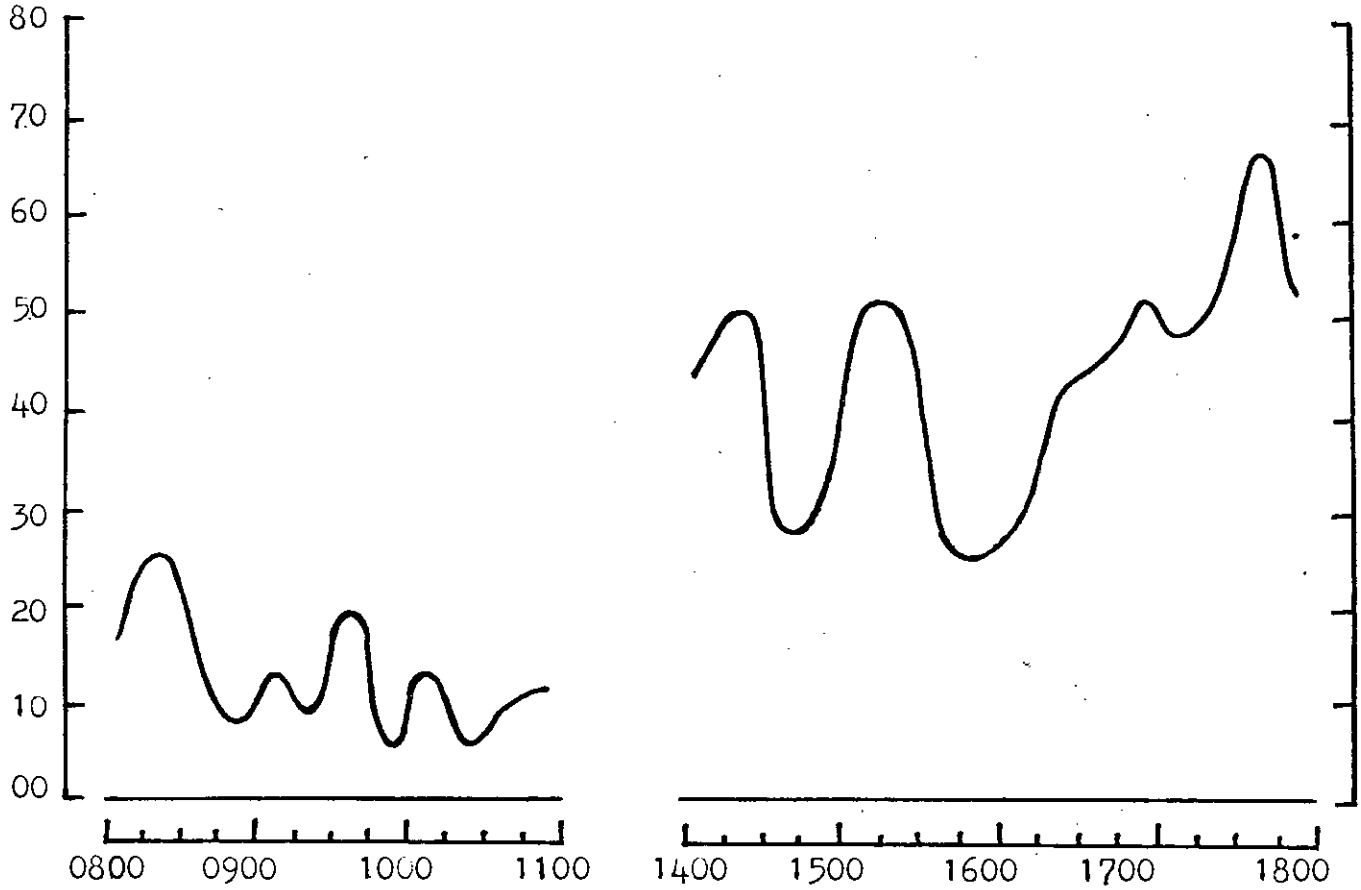


Figure No. 5.15. The nature of the queue length (in terms of number of passengers) in different periods of the day at FARMGATE .

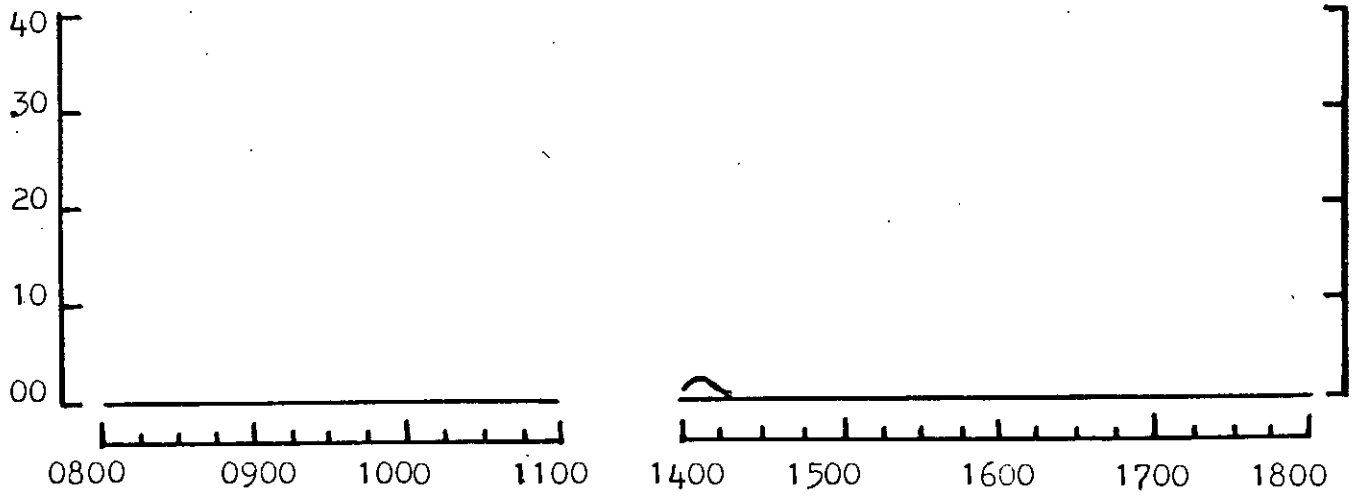


Figure No. 5.16. The nature of the queue length (in terms of number of passengers) in different periods of the day at ASADGATE .

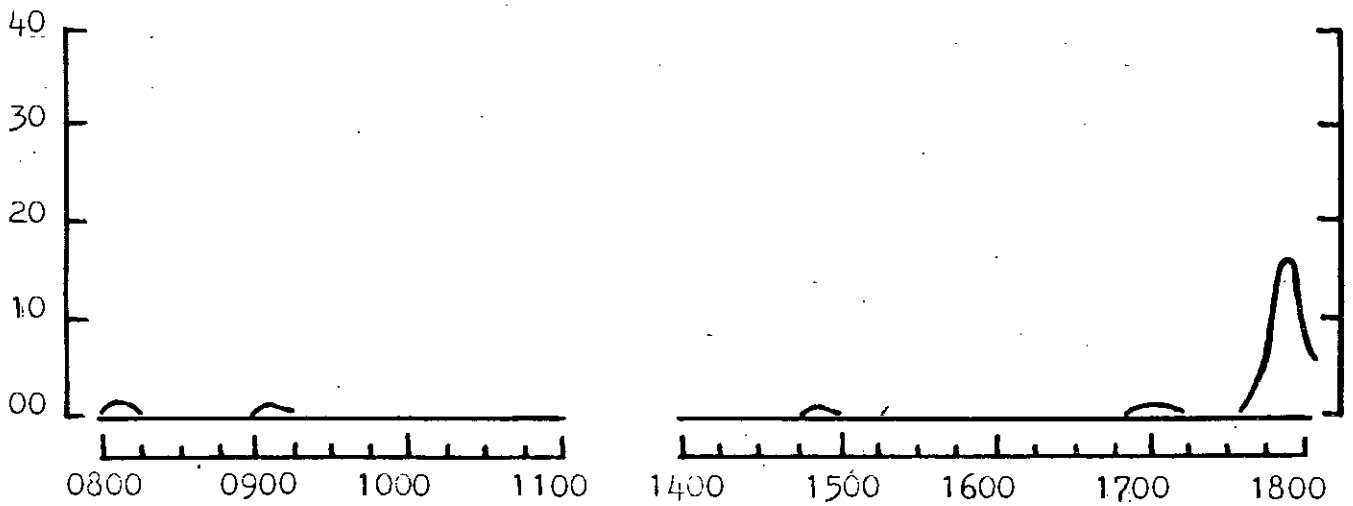


Figure No. 5.17. The nature of the queue length (in terms of number of passengers) in different periods of the day at TECHNICAL .

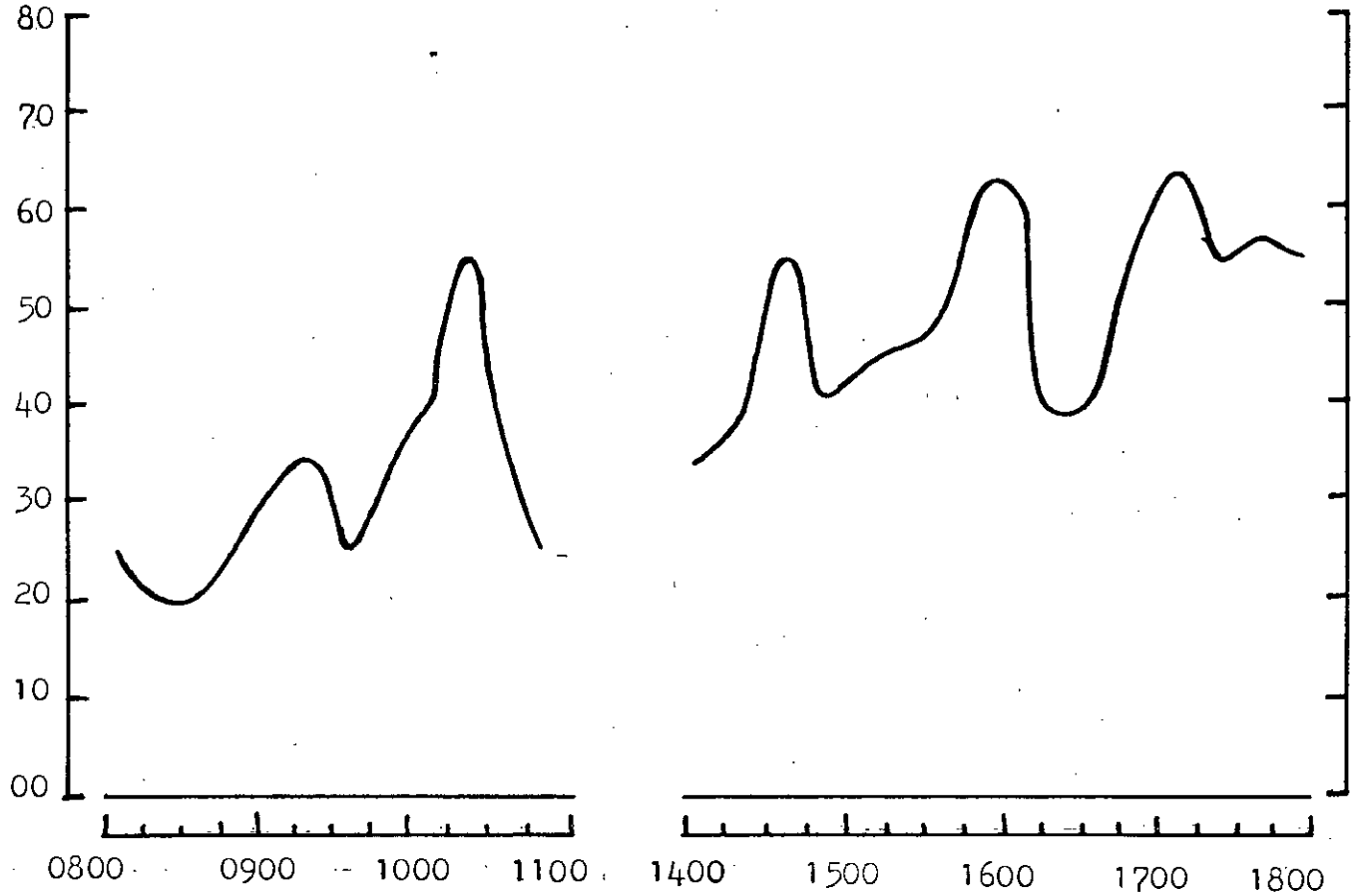


Figure No. 5.18. The nature of the queue length (in terms of number of passengers) in different periods of the day at KALYANPUR.

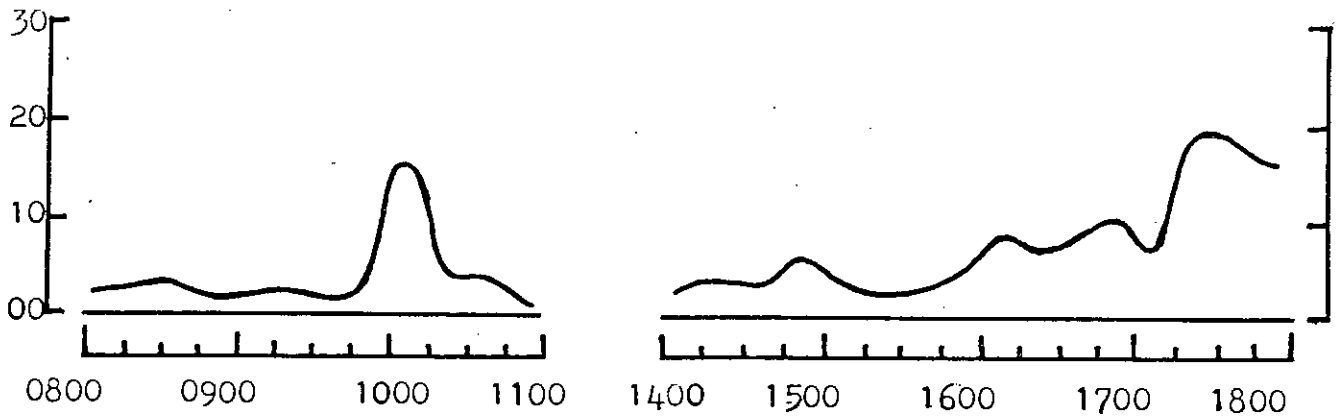


Figure No. 5.19. The nature of the queue length (in terms of number of passengers) in different periods of the day at MIRPUR-1 .

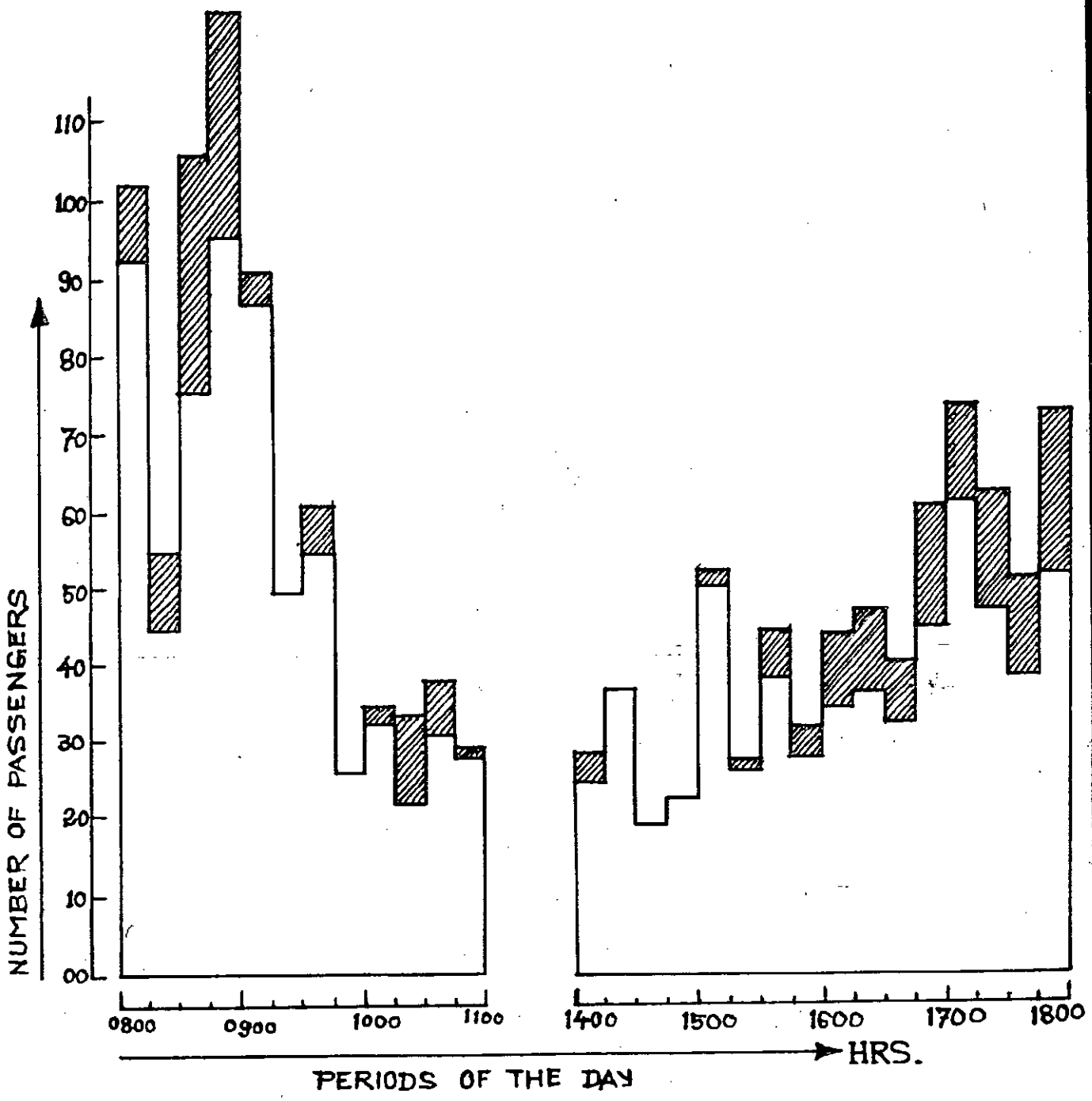
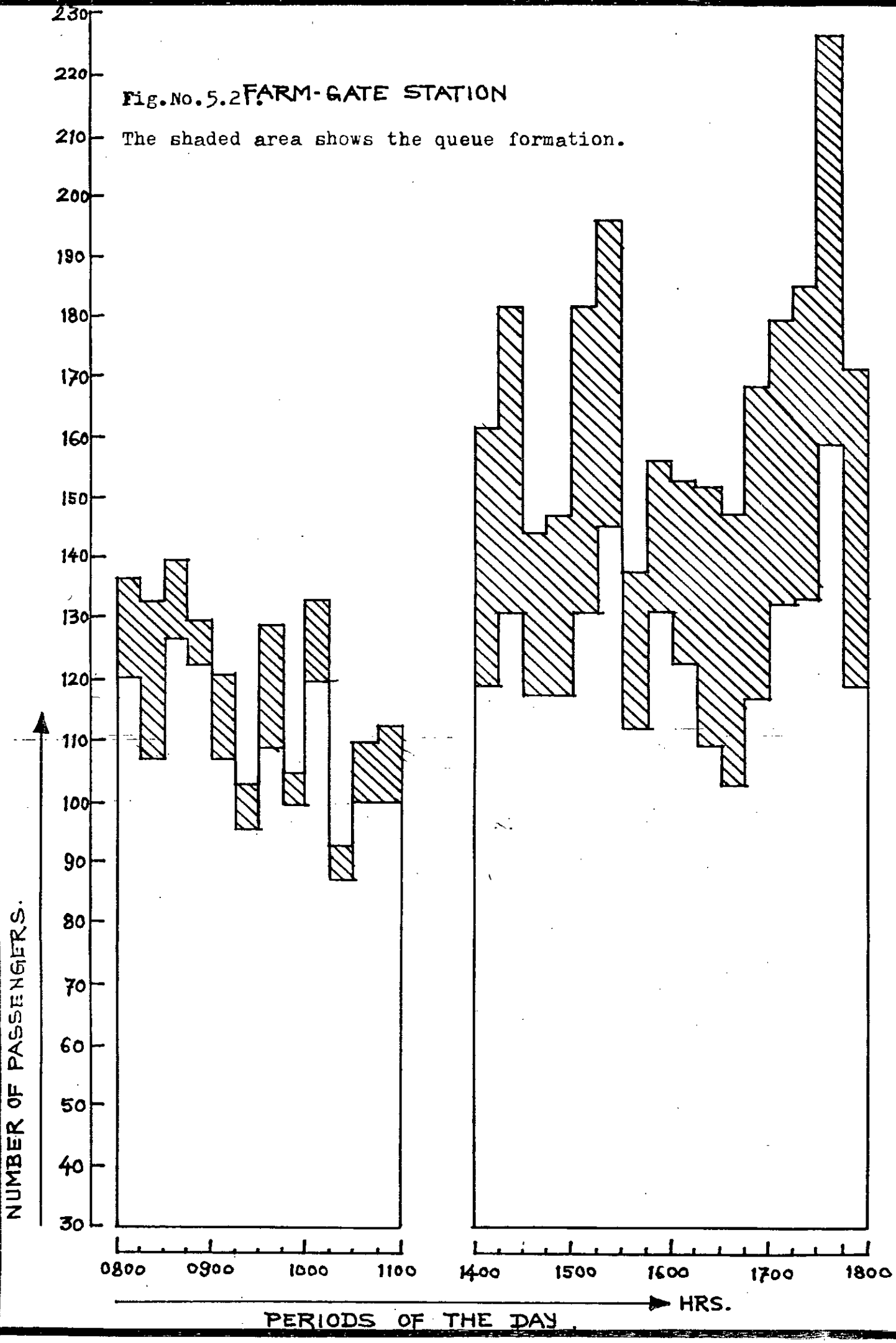


FIG. # 5.20. MALIBAG STATION

The shaded area shows the queue formation.

Fig.No.5.2 FARM-GATE STATION

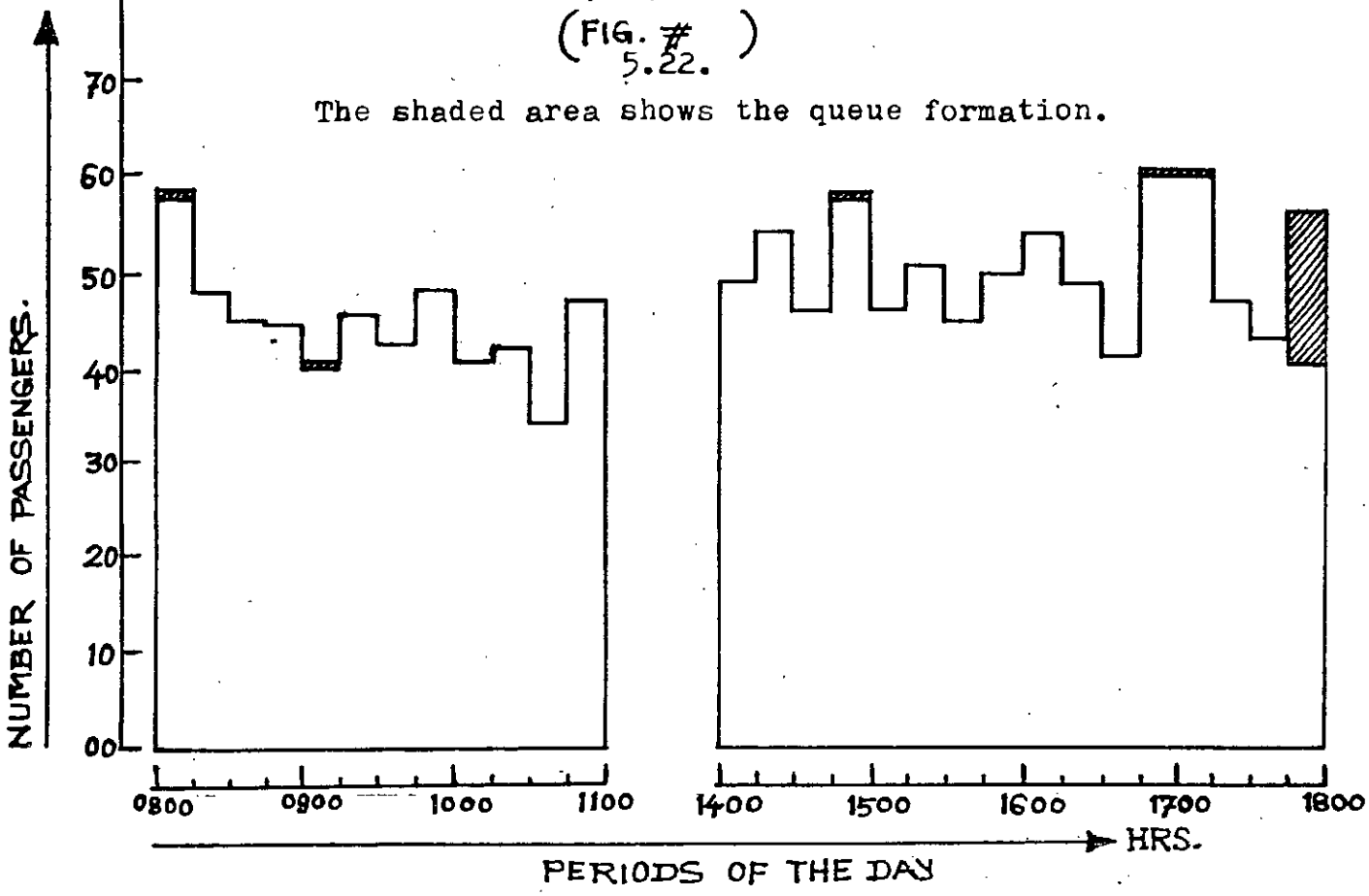
The shaded area shows the queue formation.



TECHNICAL STATION

(FIG. # 5.22.)

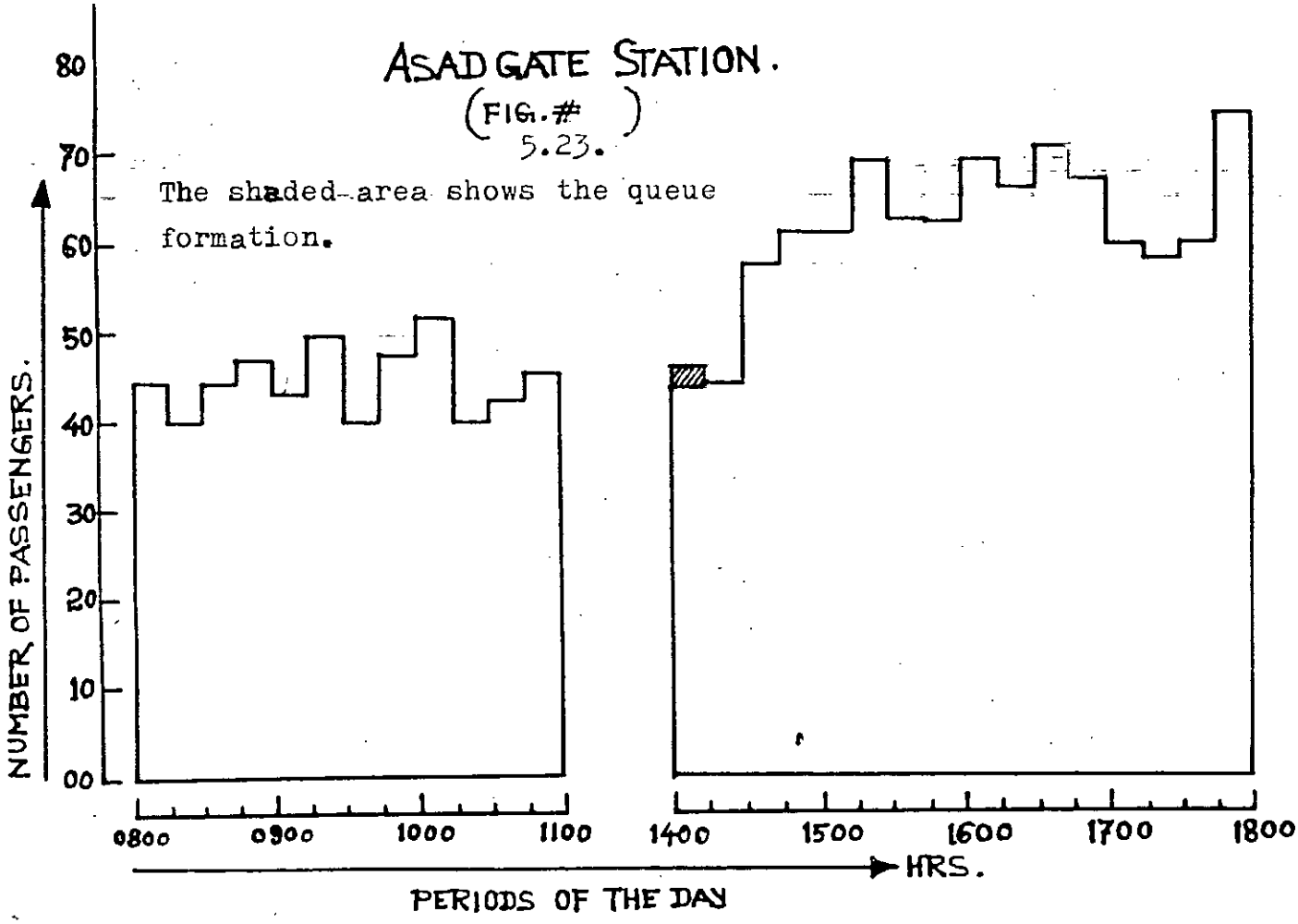
The shaded area shows the queue formation.



ASAD GATE STATION.

(FIG. # 5.23.)

The shaded area shows the queue formation.



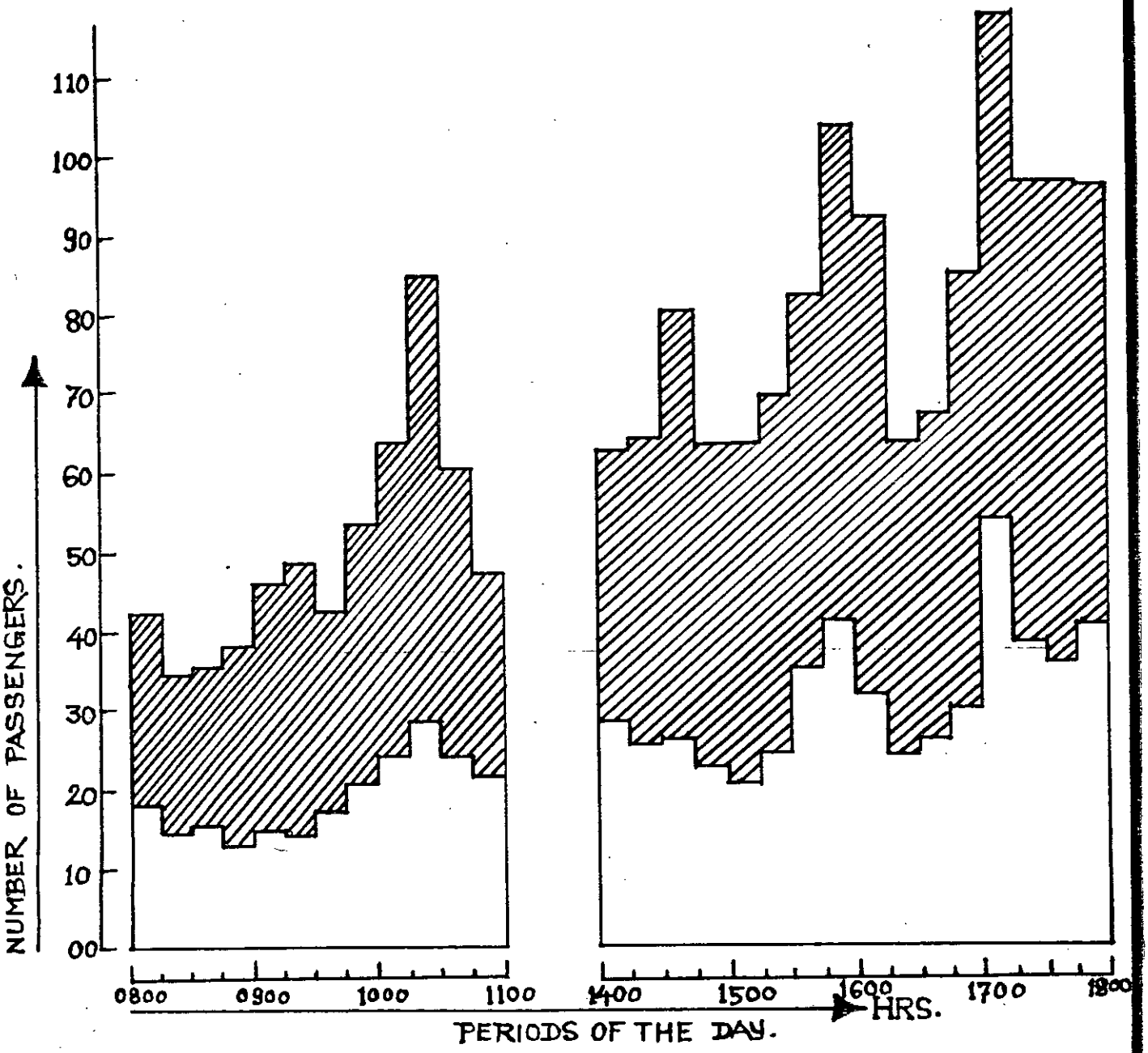
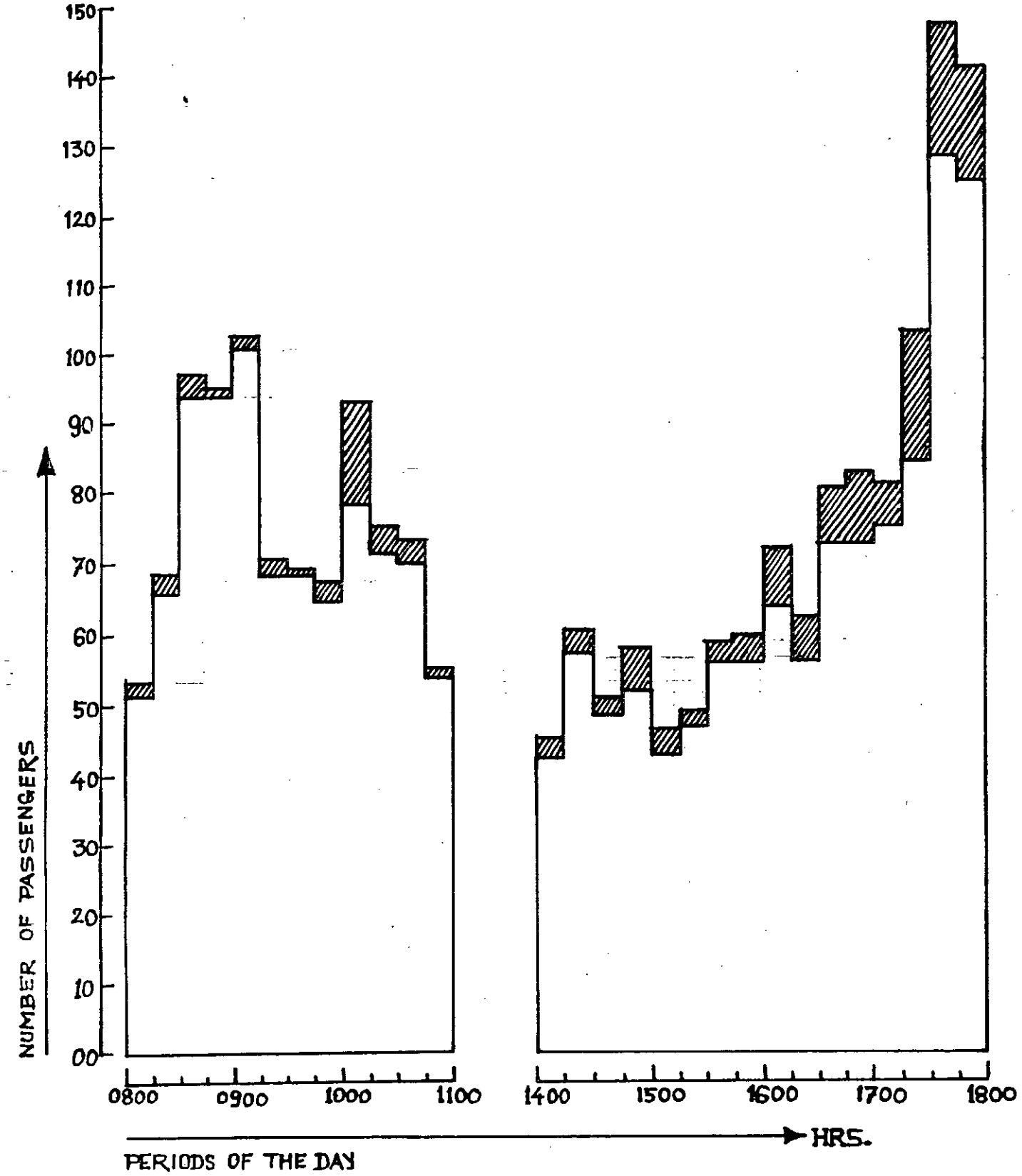


FIG. NO. 5.24. KALYANPUR STATION.

The shaded area shows the queue formation.

MIRPUR-1 STATION



The shaded area shows the queue formation.

FIG.# 5.25.

5.3.2. DETAILED RESULTS & DISCUSSIONS OF THE CRITICAL STOPPAGES AT FARMGATE AND ASADGATE

It was mentioned in the previous the critical stoppages at Farmgate and Asadgate . More complex situations are prevailing in these stoppages because of locality importance, transportation networks, etc. The detailed analyses for these two stoppages were made using equations 5.1 through equation 5.8 It may, howener , be emphasized that a computer based solution could be appropriate . But considering the enormous volume of data for either of these stoppages , only the Farmgate stoppage data were made computer-based and a FORTRAN IV language was used . The computer programme and the various results in the matrix form are shown in Appendix .

Figures 5.26 and 5.32 show the average detention time per bus in Farmgate and Asadgate stoppages respectively for the various periods of the day . This variable factor is found to be highly fluctuating ranging from 1 second to 14 seconds per bus in Farmgate stoppage , and 4 seconds to 8 seconds in average per fifteen minutes period at Asadgate stoppage . From the figures it is seen that detention may take a value of zero as the buses arrive but do not stop at the station . Thus it has become evident that detention time depends on queue length , available loading capacity on the bus(random variable) and attitude of the driver .

Figures 5.27 and 5.33 show the average bus arrival in terms of their capacity in different periods of the day for these two stoppages . The arrival rates of buses (in terms of capacity of passengers) are observed to be nearly constant , thus indicating

TABLE 5T - 14

Results for the detention time(in seconds) per bus in different periods of the day at FARMGATE stoppage .

(detention time/number of buses)

Periods of the day.	Dates in Feb. 1984.								Time per bus
	12	13	14	15	16	19	22	23	
800-0815	34/07	14/08	20/12	23/12	19/11	13/10	996/9	22/15	13.58
815-0830	23/07	24/08	25/09	18/08	27/14	10/06	00/07	13/09	2.06
830-0845	26/08	34/10	24/09	120/8	55/20	13/07	11/11	15/08	3.68
845-0900	55/07	13/07	101/9	58/06	193/17	160/11	43/09	55/09	9.04
900-0915	17/06	17/06	17/07	30/12	67/23	11/08	16/09	11/12	2.24
915-0930	19/07	10/04	19/08	25/10	54/26	16/10	03/08	11/15	1.78
930-0945	25/08	16/06	20/08	27/10	43/19	24/17	10/13	35/12	2.15
945-1000	48/08	102/9	16/07	15/09	406/26	25/13	39/12	24/13	6.96
000-1015	23/09	19/09	20/09	13/09	29/13	16/20	10/19	30/13	1.58
015-1030	14/06	16/05	16/06	08/06	17/17	13/20	00/14	16/10	1.19
030-1045	22/06	13/06	16/07	06/05	17/12	06/10	66/12	19/12	2.36
045-1100	57/05	06/02	56/09	13/06	11/19	38/16	102/21	103/14	4.19
400-1415	30/09	08/06	14/08	33/17	344/15	288/15	32/13	19/11	8.17
415-1430	16/06	24/10	07/04	29/16	12/16	16/14	16/08	17/08	1.67
430-1445	15/05	20/06	27/12	43/20	02/13	03/14	22/14	21/11	1.61
445-1500	48/04	56/07	63/06	159/16	03/10	45/12	102/13	62/13	6.64
500-1515	16/06	19/07	35/14	33/14	01/12	00/10	17/14	19/15	1.52
515-1530	06/04	17/08	30/06	43/19	08/15	10/14	21/14	19/14	1.64
530-1545	10/05	14/06	20/08	43/20	07/15	15/15	14/12	20/12	1.54
545-1600	53/05	22/07	99/05	61/13	91/14	17/12	58/11	112/14	6.33
600-1615	07/03	21/05	18/08	29/16	08/15	05/12	17/11	22/14	1.51
615-1630	17/05	18/05	11/04	22/15	02/12	03/08	23/15	17/09	1.55
1630-1645	14/05	10/03	20/05	23/13	05/10	03/14	15/11	08/06	1.46
1645-1700	09/03	47/03	88/03	67/13	02/09	02/11	111/13	53/08	6.02
1700-1715	06/05	26/08	16/04	27/14	13/18	14/16	19/10	21/11	1.65
1715-1730	06/04	17/05	28/08	22/18	13/18	03/15	16/10	11/07	1.36
1730-1745	06/04	15/05	12/05	26/25	11/16	01/16	29/15	19/08	1.27
1745-1800	57/04	59/06	103/06	21/14	53/16	01/13	102/15	99/13	5.69

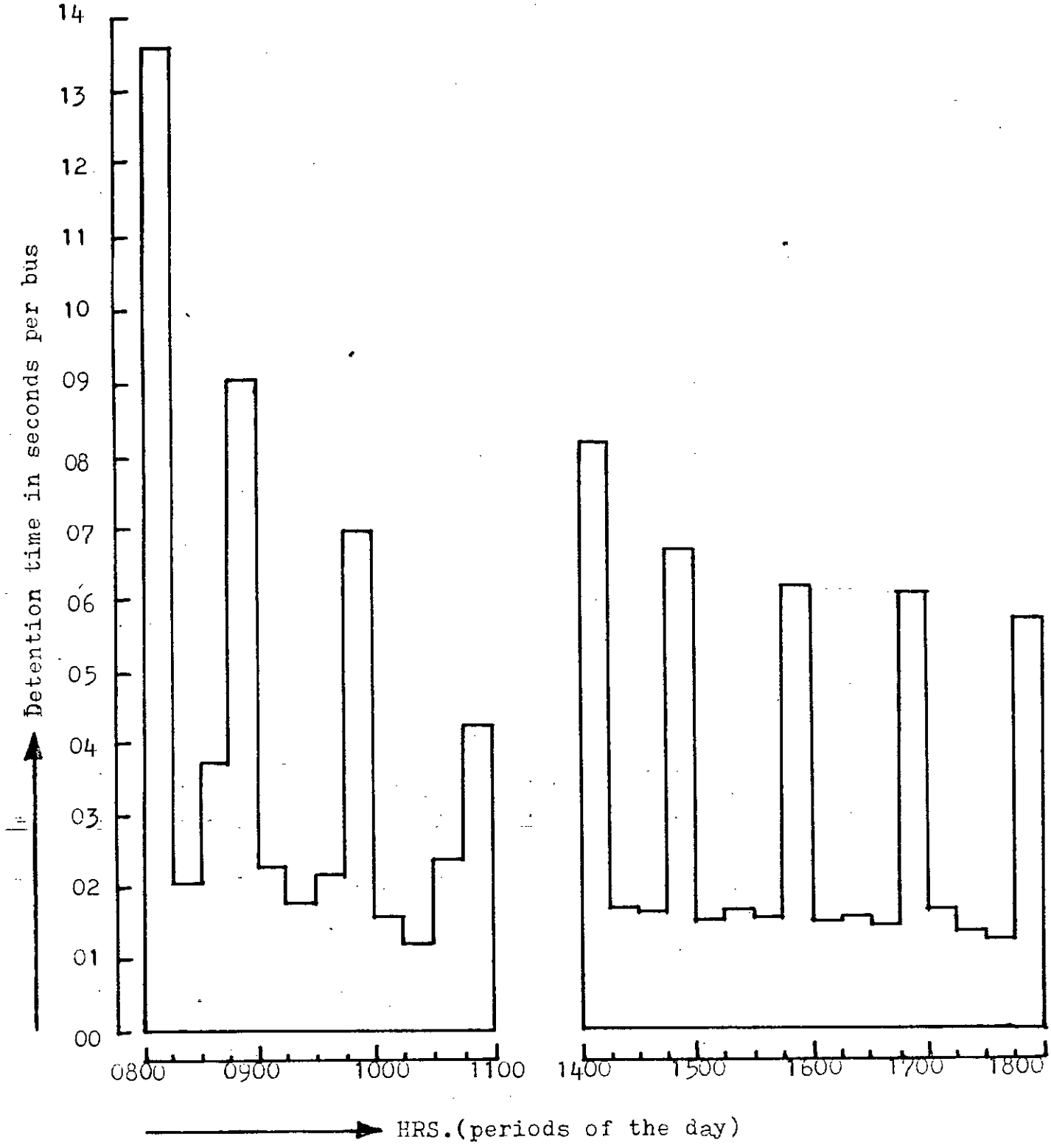


Figure No. 5.26. Detention time in seconds per bus in different periods of the day

AT FARMGATE STOPPAGE

TABLE 5T- 15

Results for the bus arrivals (in terms of capacity) in different periods of the day, at FARMGATE stoppage

Periods of the day.	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	208	213	455	425	377	525	325	625	394.125
0815-0830	238	338	495	325	424	320	330	375	355.625
0830-0845	315	505	380	405	602	425	515	360	438.375
0845-0900	320	287	384	294	583	666	425	425	423.0
0900-0915	315	340	295	565	722	430	435	550	456.5
0915-0930	261	225	416	404	842	570	396	625	467.375
0930-0945	381	250	385	475	578	930	590	525	514.25
0945-1000	416	433	285	338	858	750	475	575	516.25
1000-1015	499	469	356	399	428	1146	770	665	591.5
1015-1030	234	208	274	226	685	1125	560	445	469.625
1030-1045	296	230	270	226	472	527	544	585	393.75
1045-1100	211	105	505	212	590	854	875	595	493.375
1400-1415	370	225	420	539	431	792	585	485	480.875
1415-1430	285	473	158	508	496	745	365	360	423.75
1430-1445	270	355	606	620	370	610	595	555	497.625
1445-1500	170	319	267	518	397	645	595	595	438.25
1500-1515	327	330	610	514	419	505	585	630	490.0
1515-1530	180	395	350	679	500	720	620	590	504.25
1530-1545	275	255	330	663	536	615	505	545	465.5
1545-1600	248	362	240	496	476	600	485	660	445.875
1600-1615	143	260	425	566	532	640	500	635	462.625
1615-1630	290	255	260	448	408	385	636	405	385.875
1630-1645	285	210	300	457	358	745	450	260	383.125
1645-1700	182	145	175	499	354	690	590	395	378.75
1700-1715	320	447	222	457	582	730	445	550	469.125
1715-1730	255	350	377	574	558	765	415	290	448.0
1730-1745	250	292	265	1054	690	750	690	335	540.75
1745-1800	280	262	302	555	490	605	650	485	453.625

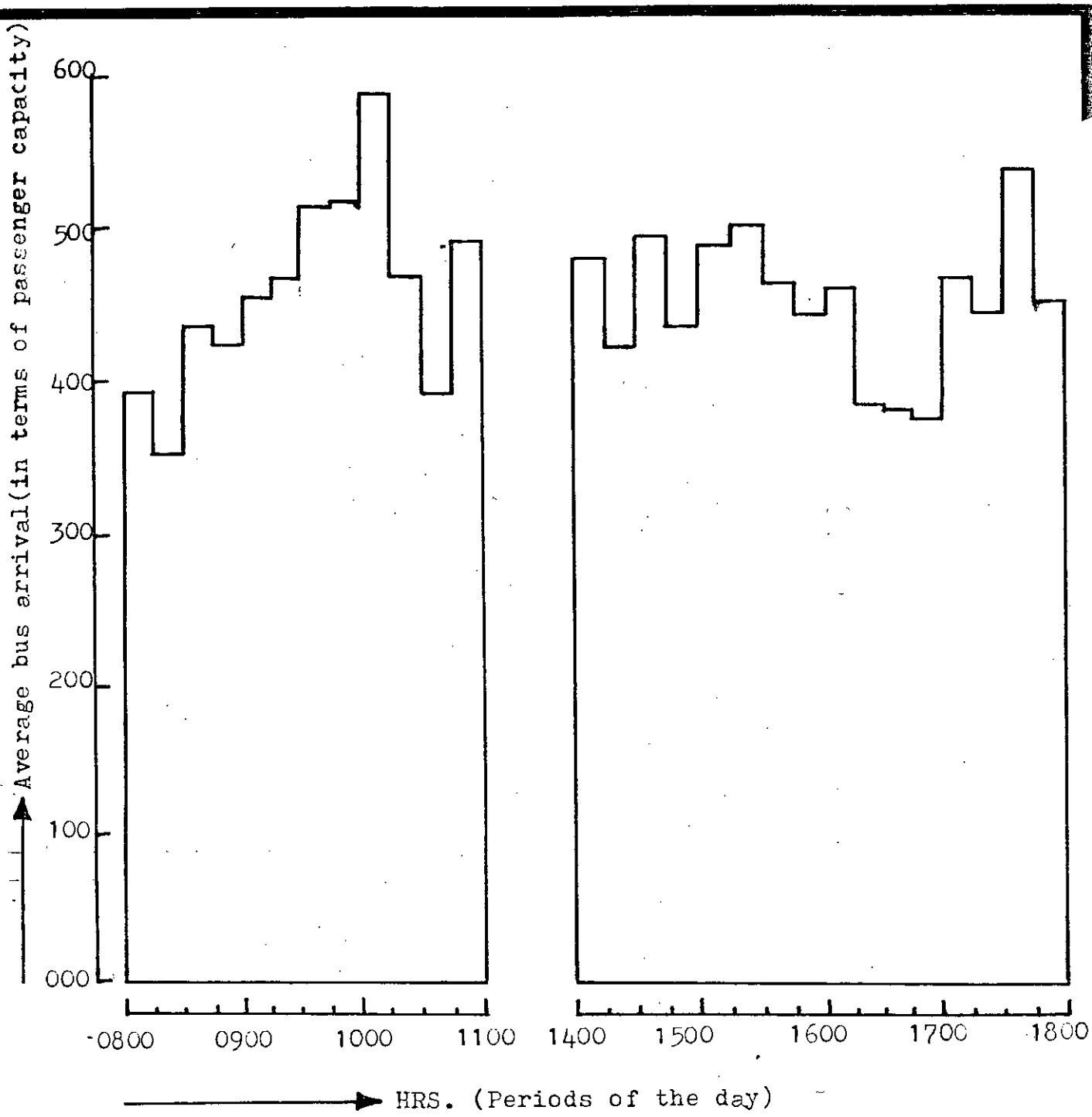


Figure No. 5.27. Average bus arrival in terms of capacity in different periods of the day

AT FARMGATE STOPPAGE

TABLE 5T - 16

Results for the average number of passengers running through the FARMGATE stoppage.

Periods of the day.	Dates in Feb. 1984. 12	13	14	15	16	19	22	23	Average .
0800-0815	208	213	474	425	482	583	342	695	427.75
0815-0830	238	358	516	330	572	363	434	417	403.5
0830-0845	315	511	380	418	761	466	634	430	489.375
0845-0900	328	287	384	308	678	803	535	511	479.25
0900-0915	326	352	305	587	756	498	551	555	491.25
0915-0930	261	233	427	457	854	632	484	636	498.0
0930-0945	418	258	410	529	632	985	713	560	563.125
0945-1000	426	441	285	338	866	796	530	618	537.5
1000-1015	499	479	371	399	463	1217	864	692	623.0
1015-1030	234	208	274	235	777	1221	645	515	513.625
1030-1045	304	239	278	234	638	527	606	663	436.125
1045-1100	211	105	510	217	720	907	920	665	531.875
1400-1415	394	231	467	599	591	801	745	572	550.0
1415-1430	335	502	180	562	721	745	430	449	478.0
1430-1445	300	371	643	694	496	610	690	668	559.0
1445-1500	180	350	281	592	611	649	669	695	503.375
1500-1515	357	357	668	628	678	505	640	693	565.75
1515-1530	204	429	381	777	764	733	788	645	590.125
1530-1545	306	265	362	773	680	615	564	671	529.5
1545-1600	267	399	257	616	652	618	570	745	515.5
1600-1615	154	284	456	730	695	640	557	723	529.875
1615-1630	315	275	287	571	599	395	736	505	460.375
1630-1645	328	244	345	524	526	745	520	317	443.625
1645-1700	216	153	201	687	503	695	743	523	465.125
1700-1715	367	499	266	621	718	730	545	730	559.5
1715-1730	288	391	396	764	811	765	490	349	531.75
1730-1745	290	302	271	1373	977	765	907	392	659.625
1745-1800	306	279	341	794	752	635	726	492	540.625

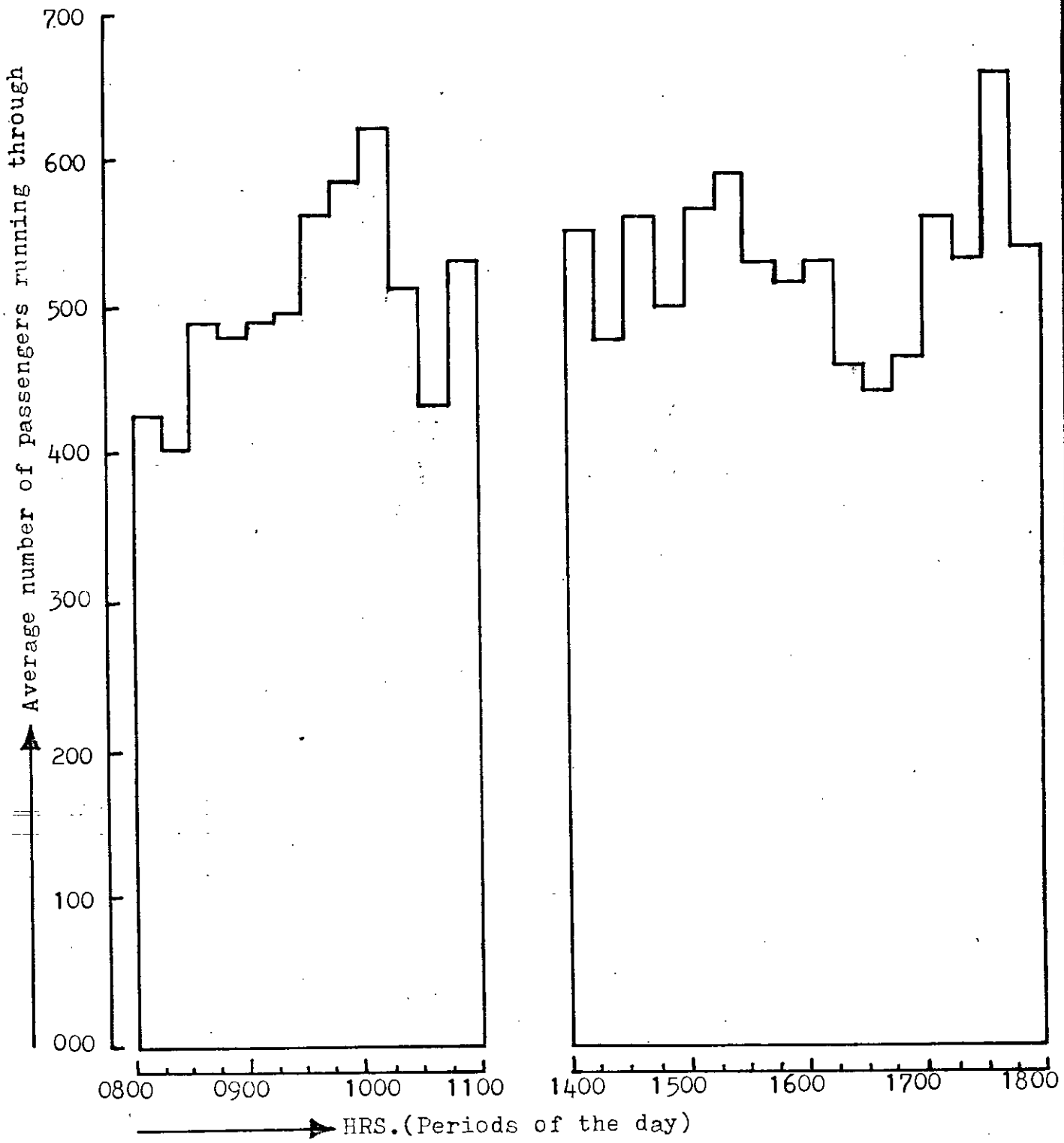
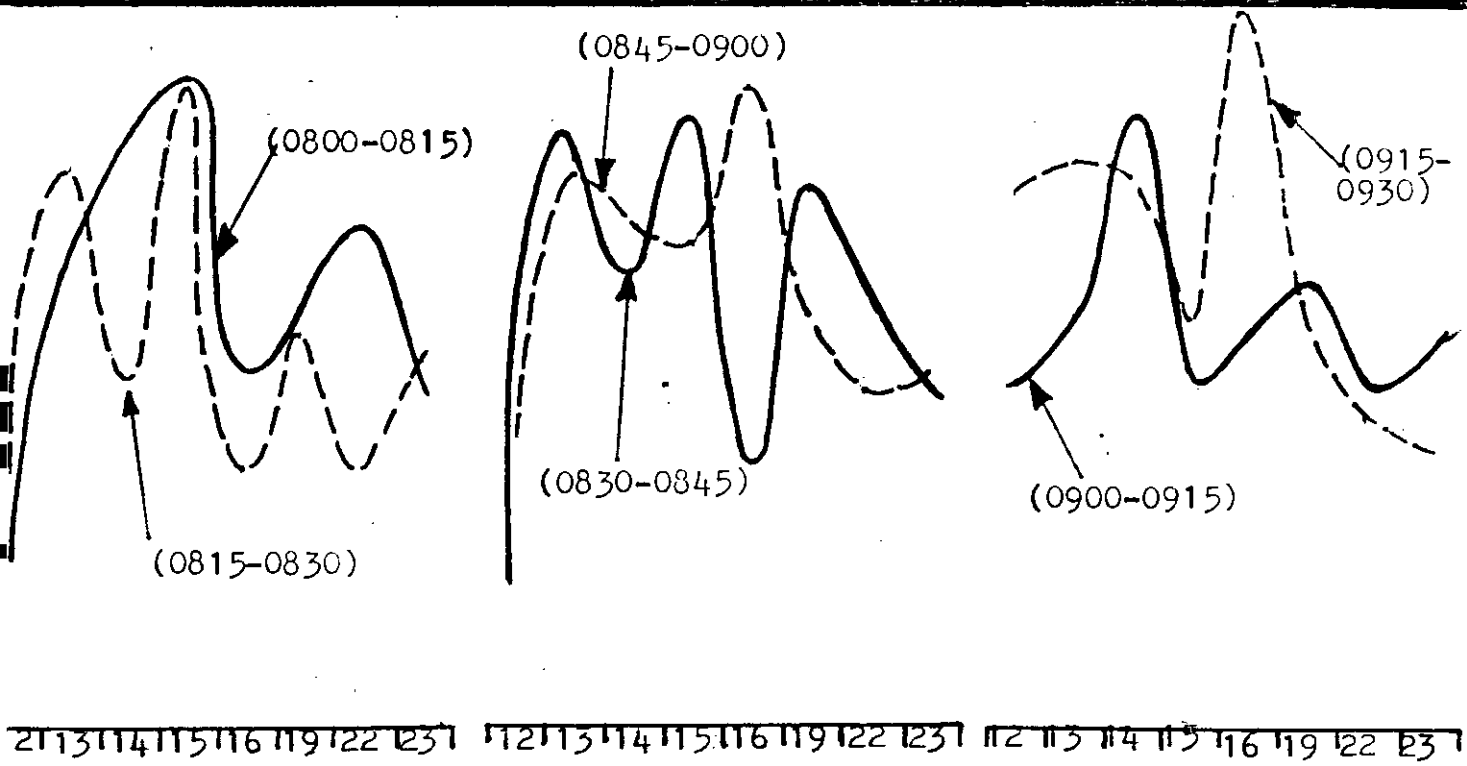
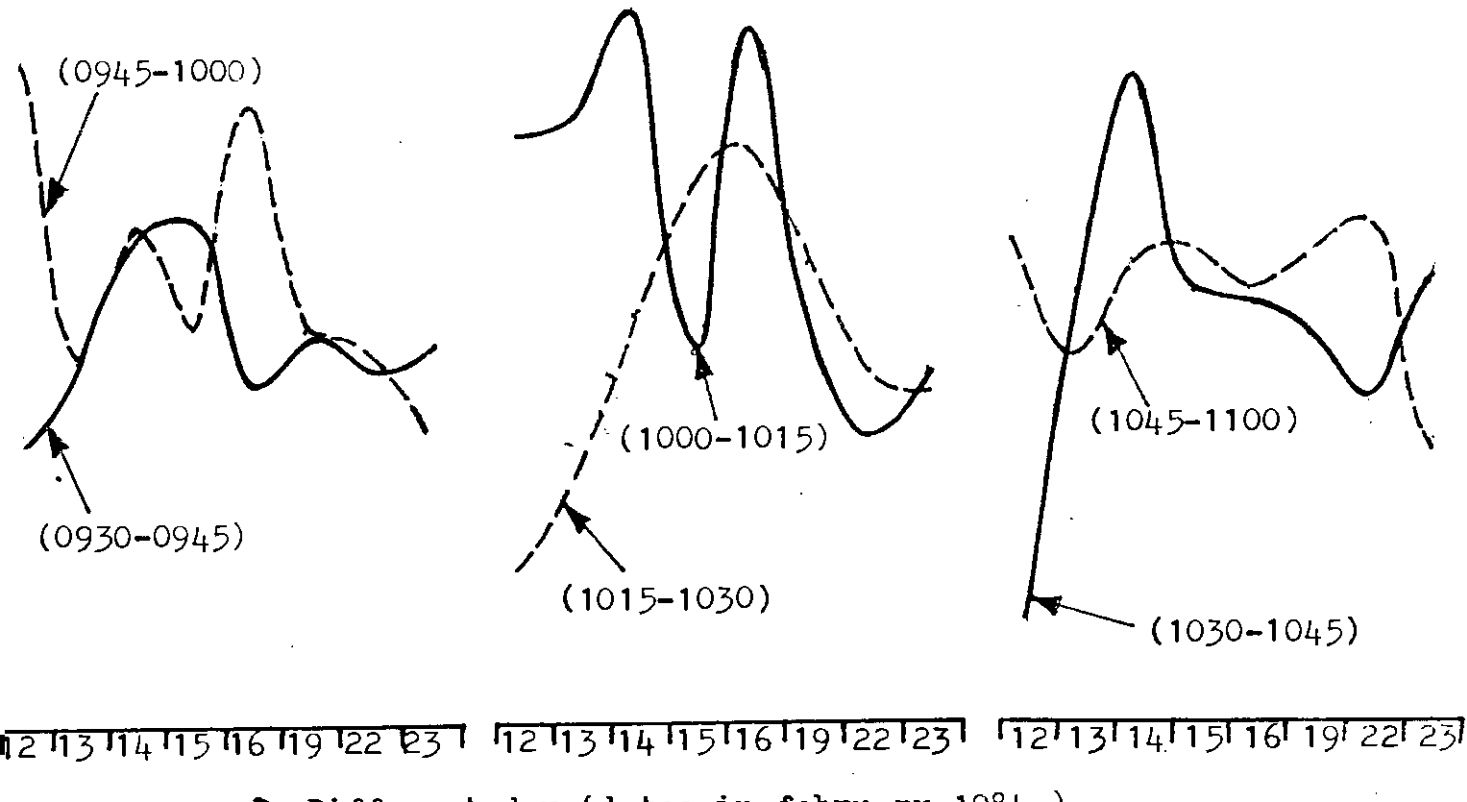


Figure No. 5.28. Average number of passengers running through in different periods of the day

AT FARM GATE STOPPAGE





Different days(dates in february,1984.)

Figure No. 5.29. The nature of the service rate in a particular period in different data-collecting days .

AT ASADGATE STOPPAGE

TABLE 5T - 12

Results for the overloading rate in different periods of the day at ASADGATE stoppage .

Periods of the day .	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	00	00	00	00	00	00	00	00	00
0815-0830	02	00	00	00	00	00	00	00	0.25
0830-0845	00	00	00	00	00	00	00	00	00
0845-0900	00	00	00	00	00	00	00	00	00
0900-0915	13	00	00	00	00	00	00	00	1.625
0915-0930	03	00	00	00	00	00	00	00	0.375
0930-0945	00	00	00	00	00	00	00	00	00
0945-1000	00	00	00	00	00	09	00	00	1.125
1000-1015	00	00	00	15	00	00	00	00	1.875
1015-1030	00	00	00	00	00	09	00	00	1.125
1030-1045	00	00	10	00	00	00	00	00	1.25
1045-1100	00	00	00	00	00	00	00	00	00
1400-1415	10	23	00	30	38	15	42	39	24.625
1415-1430	54	18	00	09	26	24	38	55	28.0
1430-1445	72	39	00	22	28	23	37	64	35.625
1445-1500	25	53	00	39	52	32	23	70	36.75
1500-1515	40	60	07	52	33	39	49	61	42.625
1515-1530	00	58	13	50	40	57	62	69	43.625
1530-1545	00	41	13	50	35	31	73	44	35.875
1545-1600	03	24	09	38	56	51	46	43	33.75
1600-1615	48	40	08	45	48	38	83	73	47.875
1615-1630	00	27	35	49	50	46	56	75	42.25
1630-1645	00	68	27	60	50	66	64	56	48.875
1645-1700	26	44	30	39	52	58	67	59	46.875
1700-1715	32	27	25	45	37	51	34	55	38.25
1715-1730	45	35	13	31	44	37	41	54	37.5
1730-1745	48	28	40	37	32	44	48	44	40.125
1745-1800	64	45	32	34	35	55	62	61	48.5

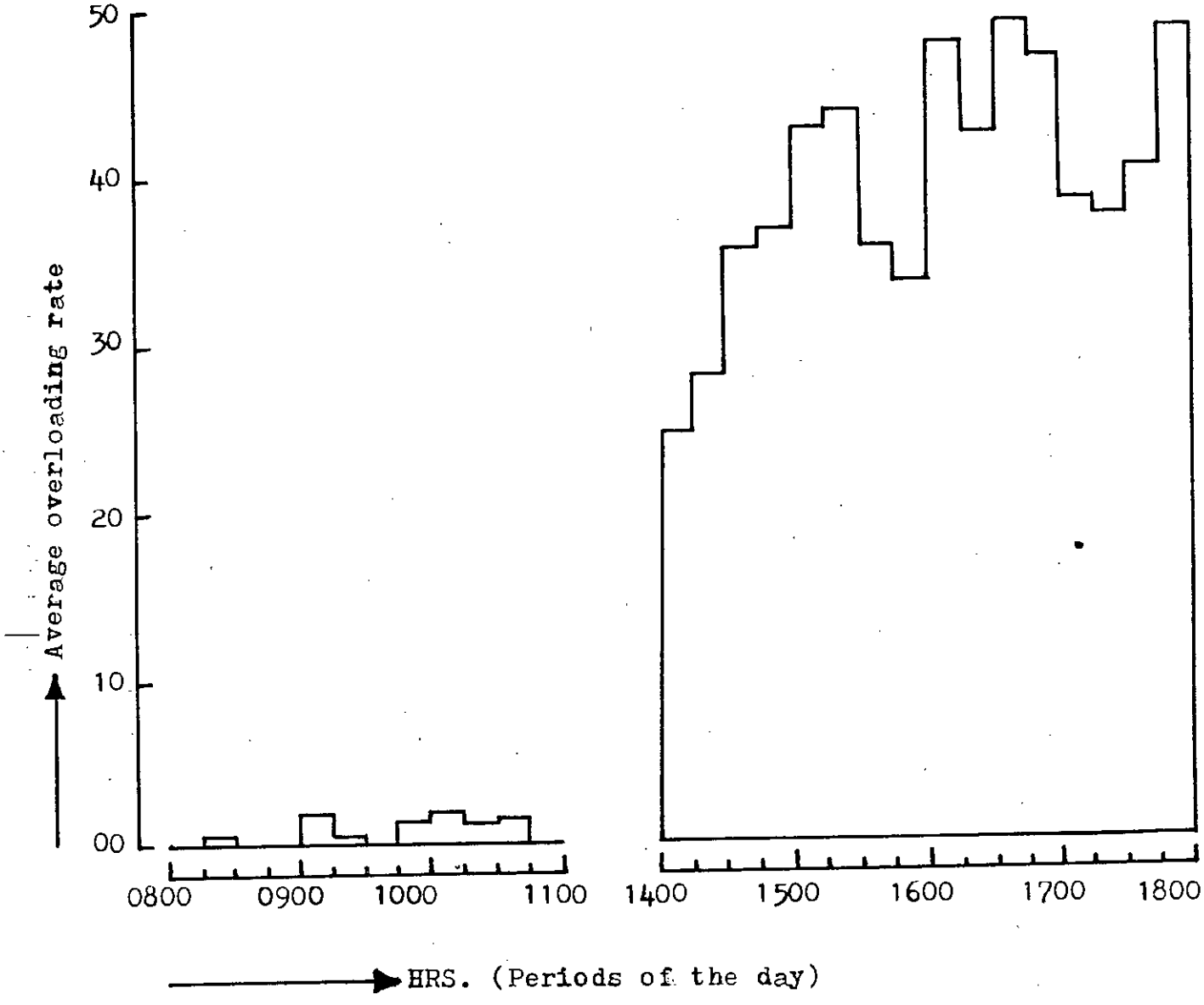


Figure No. 5.30. Average overloading rate in different periods of the day

AT ASADGATE STOPPAGE

TABLE 5T - 18.

Results for the total number of passengers running through the ASADGATE stoppage .

Periods of the day.	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	861	496	531	565	394	399	532	461	529.875
0815-0830	844	643	433	605	423	534	431	573	560.875
0830-0845	614	821	502	725	465	601	495	532	594.375
0845-0900	973	921	714	705	954	534	495	464	720.0
0900-0915	802	824	1178	625	891	720	605	567	776.5
0915-0930	1037	930	856	820	1165	863	676	500	855.875
0930-0945	580	823	1085	875	890	783	570	637	780.375
0945-1000	1178	601	1006	850	1060	827	818	610	868.75
1000-1015	702	1138	1245	895	988	613	392	674	830.875
1015-1030	290	413	782	650	816	658	536	538	585.375
1030-1045	070	561	687	470	604	679	785	814	583.75
1045-1100	480	527	632	475	497	812	703	680	600.75
1400-1415	463	490	385	458	710	410	499	397	476.5
1415-1430	1000	339	602	401	415	460	501	516	529.25
1430-1445	745	647	824	415	450	489	463	596	578.625
1445-1500	767	763	938	540	724	566	345	676	664.875
1500-1515	1030	890	819	869	460	649	551	629	737.125
1515-1530	711	780	823	767	576	836	556	997	755.75
1530-1545	1077	585	693	765	502	637	712	936	738.375
1545-1600	924	384	766	722	804	582	536	615	666.625
1600-1615	1134	561	1043	647	755	603	865	1000	826.0
1615-1630	904	495	743	595	582	545	655	1071	698.75
1630-1645	863	904	485	632	867	877	736	590	744.25
1645-1700	814	634	567	538	697	878	888	738	719.25
1700-1715	783	469	451	497	673	728	570	693	608.0
1715-1730	1164	478	373	636	710	535	537	624	632.125
1730-1745	973	461	428	498	499	608	653	574	586.75
1745-1800	1085	665	491	497	1078	766	772	732	760.75

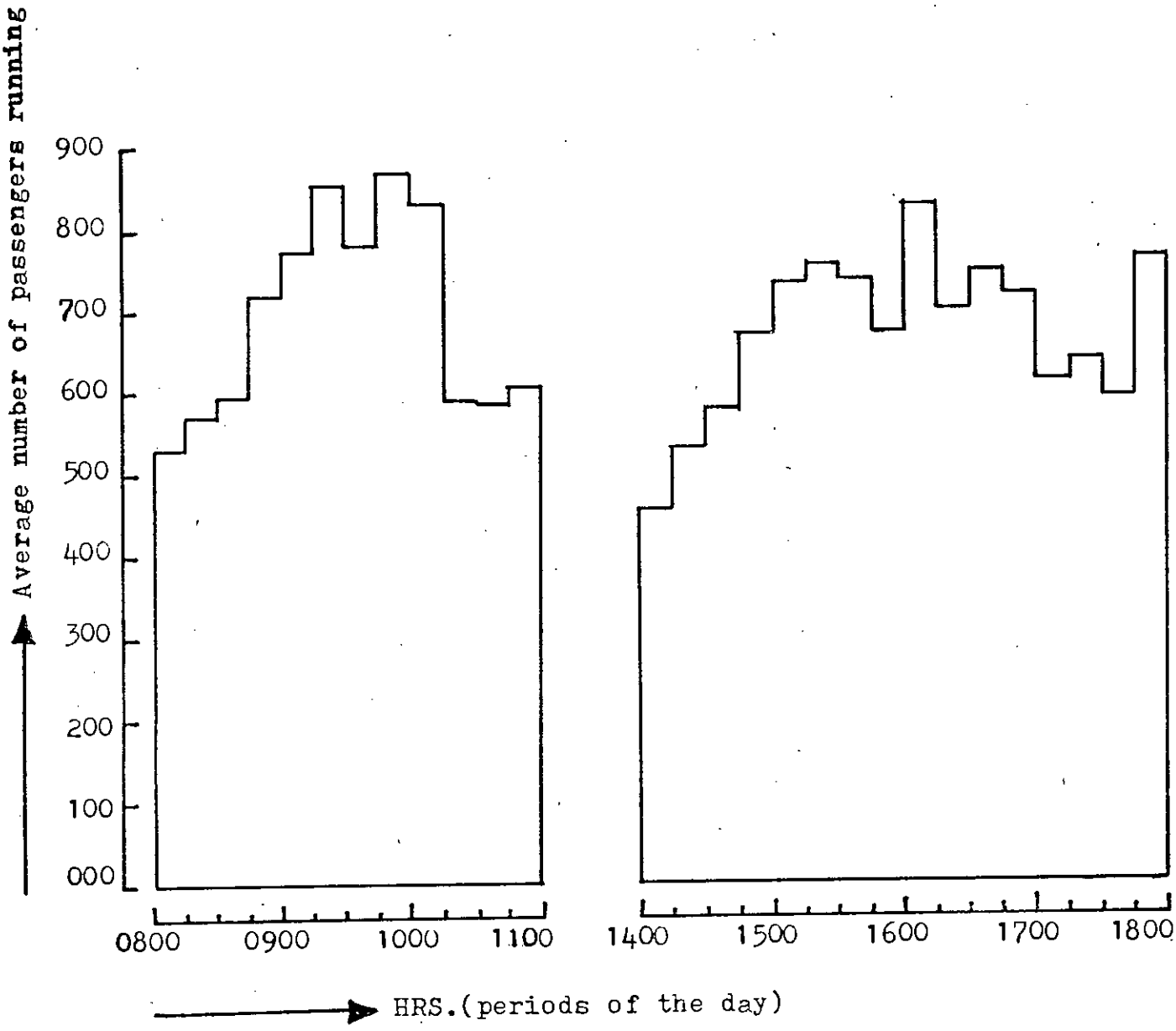


Figure No. 5.31. Average number of passengers running through the stoppage in different periods of the day

AT ASADGATE STOPPAGE

TABLE 5T - 19

Results for the detention time (in seconds) in different periods of the day at ASADGATE stoppage .

Periods of the day.	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	08	16	05	00	04	05	03	05	5.75
0815-0830	10	13	07	00	04	05	05	02	5.75
0830-0845	07	18	08	00	04	04	06	03	6.25
0845-0900	09	15	09	00	05	06	08	03	6.875
0900-0915	17	13	07	00	04	04	03	04	6.5
0915-0930	14	12	10	00	03	03	06	04	6.5
0930-0945	09	11	10	00	03	04	05	07	6.125
0945-1000	13	11	12	00	09	06	04	03	7.25
1000-1015	12	12	10	00	08	02	04	07	6.875
1015-1030	02	10	07	00	03	04	04	02	4.0
1030-1045	01	12	07	00	05	03	05	06	4.875
1045-1100	11	11	02	00	05	02	03	01	4.375
1400-1415	07	09	10	06	02	04	03	05	5.75
1415-1430	15	08	06	06	06	06	04	03	6.75
1430-1445	10	12	06	05	06	03	07	05	6.75
1445-1500	08	11	08	05	04	04	04	03	5.875
1500-1515	15	14	02	04	07	04	04	04	6.75
1515-1530	11	12	07	03	05	04	07	04	6.625
1530-1545	08	12	05	02	07	04	05	04	5.875
1545-1600	09	08	02	03	07	06	02	04	5.125
1600-1615	09	11	06	05	07	04	05	03	6.25
1615-1630	13	09	06	03	04	03	02	04	5.5
1630-1645	14	12	06	03	04	04	03	02	6.0
1645-1700	11	13	05	05	06	02	02	02	5.75
1700-1715	09	09	08	04	05	04	02	03	5.5
1715-1730	08	08	06	04	03	06	04	04	5.375
1730-1745	12	08	06	05	03	03	02	03	5.25
1745-1800	10	09	06	06	01	03	06	03	5.5

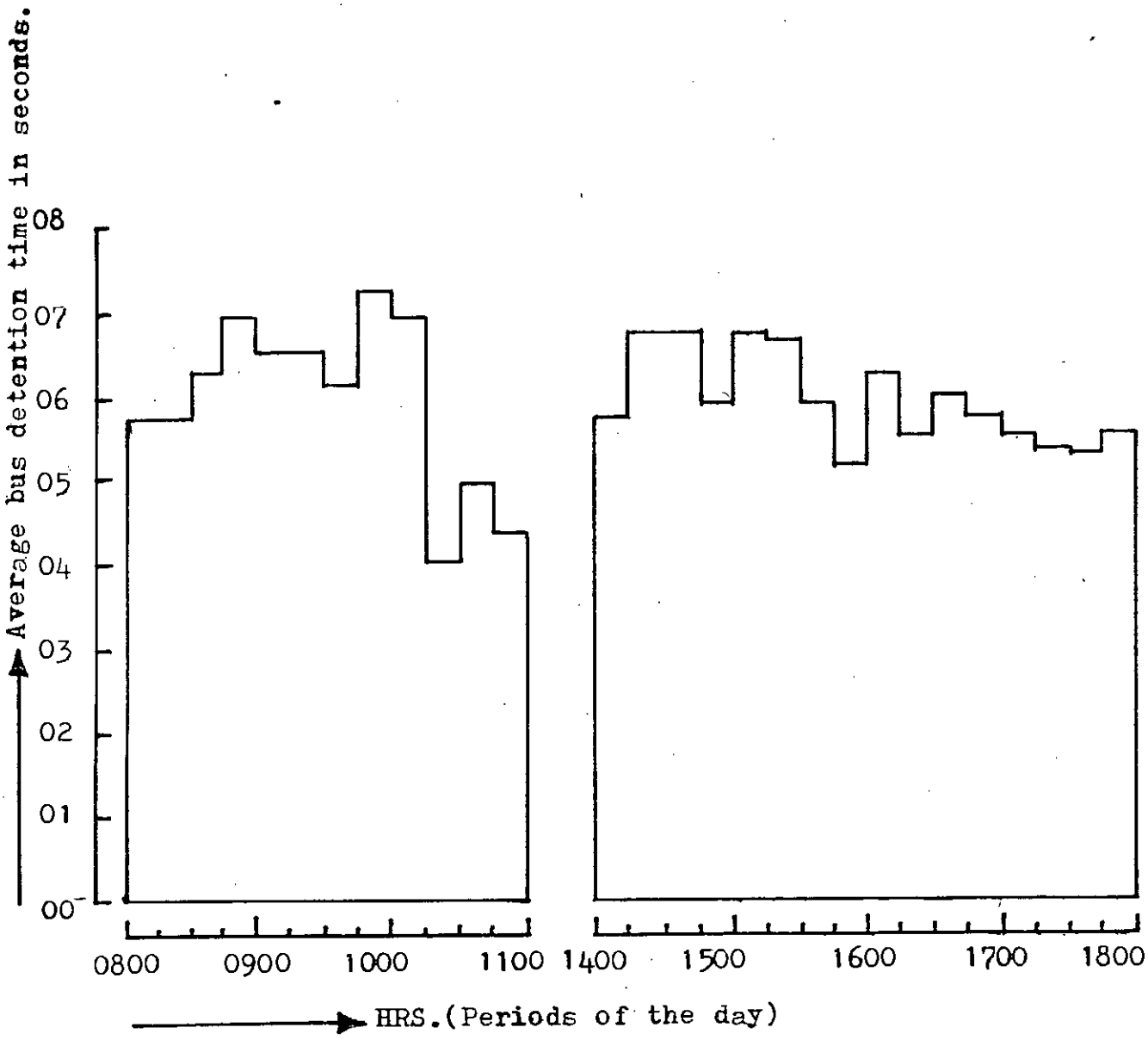


Figure No. 5.32. Average bus detention time in seconds in different periods of the day

AT ASADGATE STOPPAGE

TABLE 5T - 20

Results for the bus-arrival rate (in terms of capacity) at ASADGATE stoppage .

Periods of the day.	Dates in Feb. 1984.								Average
	12	13	14	15	16	19	22	23	
0800-0815	861	496	531	565	394	399	532	461	529.875
0815-0830	842	643	433	605	423	534	431	574	560.625
0830-0845	614	821	502	725	465	601	495	532	594.375
0845-0900	973	921	714	705	954	534	495	464	720.0
0900-0915	789	824	1178	625	891	720	605	567	774.875
0915-0930	1034	930	856	820	1165	863	676	500	855.5
0930-0945	580	823	1085	875	890	783	570	637	780.375
0945-1000	1178	601	1006	850	1060	818	818	610	867.625
1000-1015	702	1138	1245	880	988	613	392	674	829.0
1015-1030	290	413	782	650	816	649	536	538	584.25
1030-1045	070	561	677	470	604	697	785	814	582.5
1045-1100	480	527	632	475	497	812	703	680	600.75
1400-1415	453	467	385	428	672	395	457	358	451.875
1415-1430	946	321	602	392	389	436	463	461	501.25
1430-1445	673	608	824	393	422	466	426	532	543.0
1445-1500	742	710	938	501	672	534	322	606	628.125
1500-1515	990	830	819	817	427	610	502	568	695.375
1515-1530	711	722	823	717	536	779	494	928	713.75
1530-1545	1077	544	680	715	467	606	639	892	702.5
1545-1600	921	360	757	684	748	531	490	572	632.875
1600-1615	1086	521	1035	602	707	565	782	927	778.125
1615-1630	904	468	743	546	532	499	599	996	660.875
1630-1645	863	836	462	572	817	811	672	534	695.875
1645-1700	788	590	537	499	645	820	821	679	672.375
1700-1715	751	442	426	452	636	677	536	638	569.75
1715-1730	1119	443	360	605	666	498	496	570	594.625
1730-1745	925	433	388	461	467	564	605	530	546.625
1745-1800	1021	572	459	463	1043	711	710	671	706.25

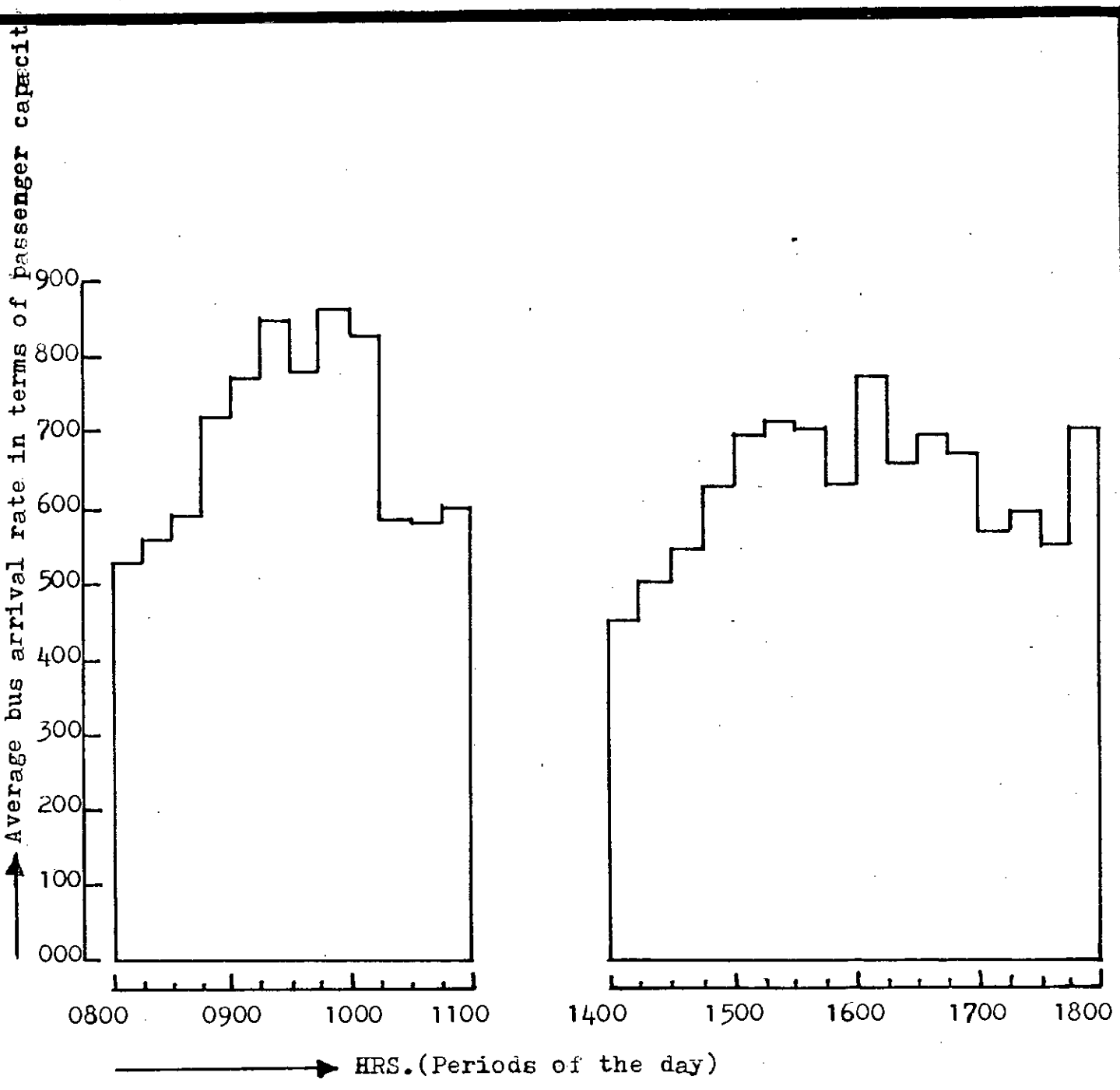


Figure No. 5.33. **Average bus arrival rate in terms of passenger capacity in different periods of the day.**

AT ASADGATE STOPPAGE

a likely of poisson distribution for such events . Figures nos. 5.28 and 5.31 shows the average throughput of passengers at these two stations in different periods of the day . The highest throughputs are observed at 0900 hrs. and 1600 hrs. of each day . It seems that sufficient data collected over a long period of the year would perhaps show that these distributions would fit the poisson distribution .

The nature of the service rates in various periods are shown in figure no. 5.29 for the Asadgate stoppage . Figure no. 5.30 shows the average overloading rate in various periods of the day. An interesting phenomenon is observed from these studies that the overloading rate is negligible at morning period but very high at afternoon . This is obvious as flow direction of passengers is towards city during the first half of the day and this reverses at the afternoon .

The objective of the present work was to assess the 'gap' of demand-supply of the service facilities ; however , the possible ways and means to reduce this 'gap' may not be suggested at this point . A cost-benifit study may be warranted before any decision to increase the resources . But it is felt that better operational management may improve this situation .

Chapter VI

C O N C L U S S I O N S & R E C O M M E N D A T I O N S

C H A P T E R V I

C O N C L U S S I O N S & R E C O M M E N D A T I O N S

In order to achiewe the objective of the present work in assessing the resources (passenger-carrying transports) requirements during the peak periods of the day, the 'gap' between the demand and supply situation of the bus transports in the Gulistan-Mirpur route of the Dhaka City was determined .

This 'gap' is quite sizeable and needs to be lowered down to some acceptable range . The performance of the system is affected due to reasons such as :

i) lack of application of scientific methodology in planning and scheduling of transports ,

ii) shortage of transports ,

iii) operational inefficiency , and

iv) attitude and behaviour pattern of the public (unhealthy norms towards discipline and order) .

From the present work it has become evident that the prevailing positive 'gap' of demand-supply is one of the important reasons of unplanned queue formation and dissatisfaction amonst the passengers toward the service .

The two critical stoppages are the two important bus stoppages in the city . This require major modifications and facilities development . Nonetheless , from the present analysis it is

revealed that further study needs to be made on the Kalyanpur stoppage . This stoppage also needs facilities development.To improve the performance of the transport system of the city, a detailed and comprehensive study may be suggested . This would need basic data collection which would become a daunting task unless some infra-structure is developed in the stoppages. One such infra-structure facility for passenger-queueing is given in figures 6.1 and 6.2.

This queueing arrangement is not a newer concept rather a much used in the developed world . A similar arrangement exists in the cantonment area of Dhaka City . This may be inferred that with this arrangement the behaviour pattern of the public in the queue could be improved and thus queue jumping and indiscipline amongst them could be avoided . This would further benefit in terms of avoidance of crowding and unhappy congestion in front of the stoppage thus help smooth and normal flow of traffic.

An assessment of the resource requirement to reduce the 'gap' (mentioned earlier) has been made for example to Farmgate stoppage in particular . This is shown in table 6T.1. Should a standard BRTC bus of capacity of 70 passengers being considered , the total number of extra buses' service required in seven hours is thirty six . Thus an average of five buses are required per hour .

This means that a few extra number of buses are to be added

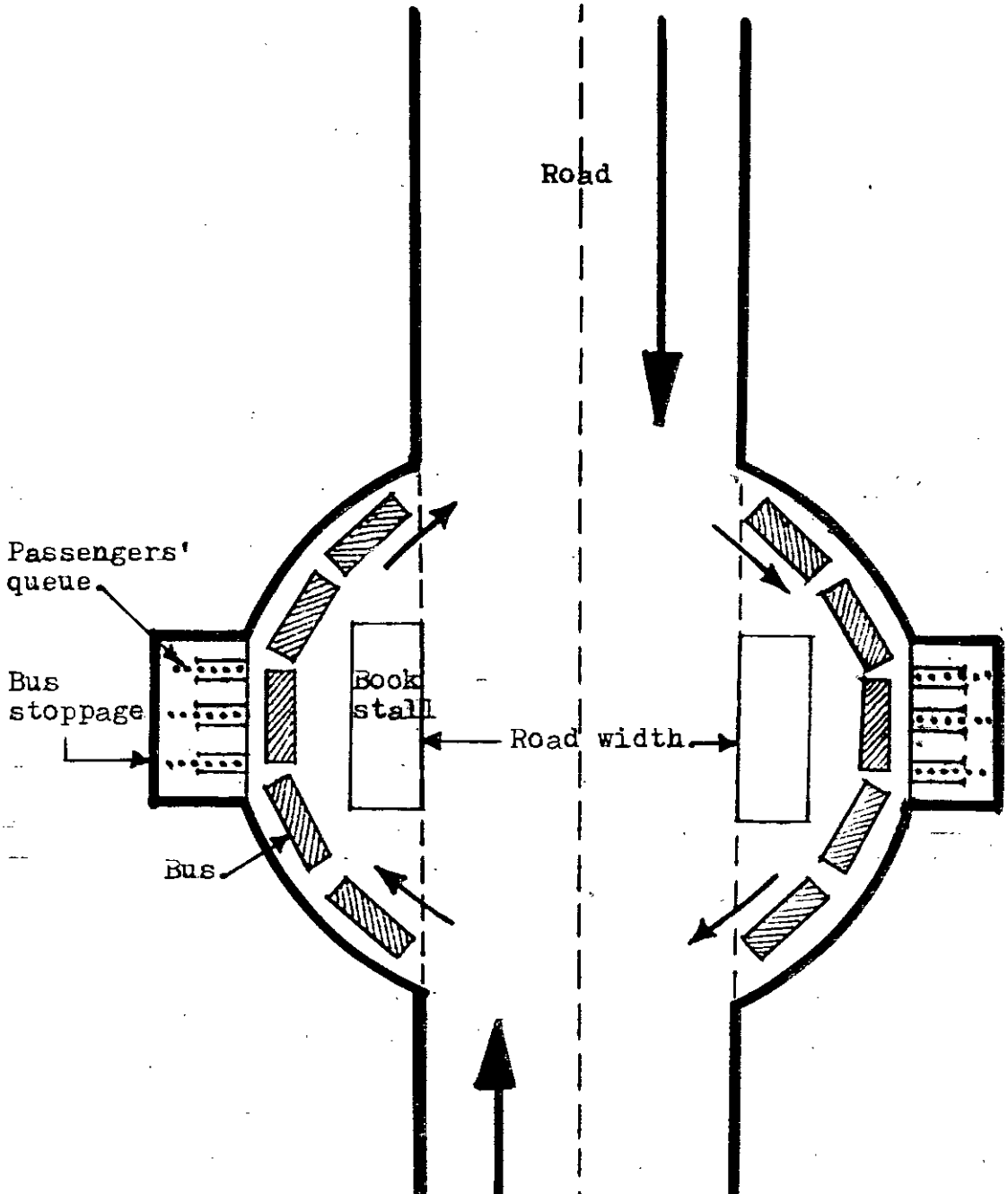


Fig. No. 6.1 Diagrametic idea of the proposed bus-stoppage.

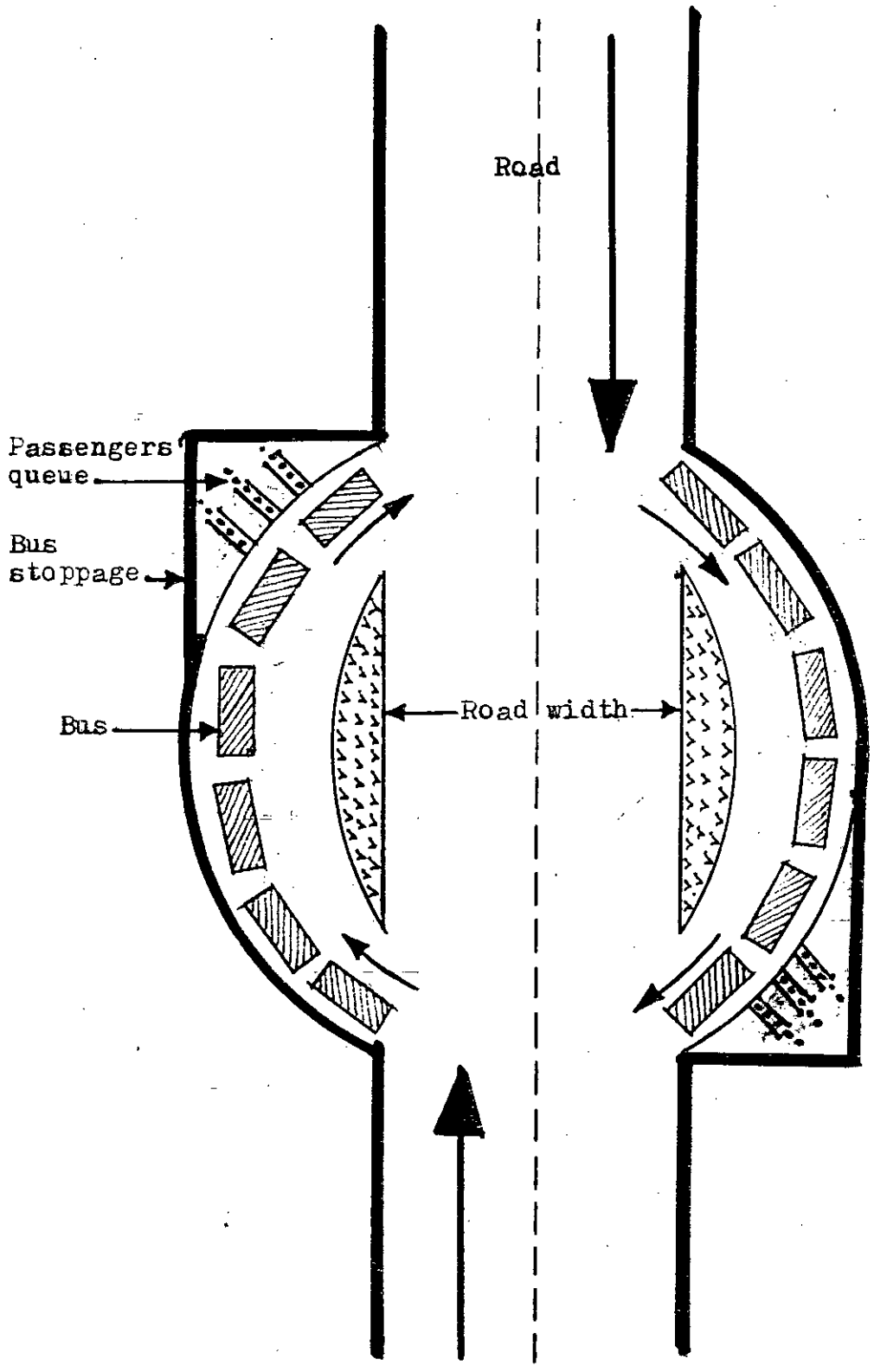


Fig. No. 6.2. Diagrametic idea of the proposed bus-stoppage.

TABLE 6T - 1

Results for the proposal to give service to the extra number of passengers in the existing transportation system at FARMGATE stoppage in Gulistan-Mirpur bus-route .

Periods of the day.	Dates in Feb. 1984.								Total	Extra BRTC bus reqd. per hour
	12	13	14	15	16	19	22	23		
0800-0815	00	00	47	00	172	92	17	73	401	
0815-0830	00	46	55	27	235	57	122	45	587	
0830-0845	00	08	00	56	174	42	149	82	511	4
0845-0900	08	00	00	36	105	144	123	92	508	
0900-0915	21	38	25	62	34	71	129	07	387	
0915-0930	00	18	27	72	12	67	94	13	303	
0930-0945	37	22	63	112	56	80	143	38	551	3
0945-1000	10	24	02	00	08	49	72	45	210	
1000-1015	00	30	41	00	35	90	126	30	352	
1015-1030	00	00	00	20	92	96	107	75	390	
1030-1045	08	25	25	20	190	00	72	78	418	3
1045-1100	00	00	07	11	174	53	84	78	407	
1400-1415	74	22	134	162	219	13	174	94	892	
1415-1430	121	70	54	174	303	14	89	113	938	
1430-1445	75	58	81	103	155	05	110	116	703	6
1445-1500	36	84	32	107	294	04	79	118	754	
1500-1515	74	68	144	163	408	00	77	71	1005	
1515-1530	64	34	80	142	423	13	228	69	1053	
1530-1545	82	19	71	151	165	00	81	147	716	6
1545-1600	62	87	37	166	197	18	97	89	753	
1600-1615	17	57	80	258	173	00	79	110	774	
1615-1630	57	45	59	164	347	10	119	135	936	
1630-1645	102	65	108	95	299	00	88	82	839	6
1645-1700	82	18	63	263	273	05	181	136	1021	
1700-1715	124	127	78	229	190	00	132	216	1096	
1715-1730	100	97	47	251	366	00	122	94	1077	
1730-1745	108	38	06	456	404	15	374	87	1388	8
1745-1800	66	60	98	349	411	30	87	07	1108	

to the existing fleet so that additional 5x70 i.e. 350 passengers could be served per hour from this stoppage .

In the present work , due to the time limitations , the assessment has been carried out for the passenger carrying transports in the Gulistan-Mirpur bus route of Dhaka City . Also an overall picture of the existing transport system in the entire Dhaka City can be drawn from this work for further study to be carried out in future .

Any future study would require basic data which are to be collected for the existing system . A computer-based data bank may be established so that planning and scheduling of buses in a forward week may be done beforehand . The infra-structure facilities for the stoppages are to be developed and measures may be taken to make the public more disciplined and that their attitude be changed so that proper queue could be maintained .

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A P P E N D I X

DATA COLLECTION for the project :- Assessment of resource(passenger carrying transport) requirement during peak period in a particular Bus-route in Dhaka city.

Route:-DHAKA-MIRPUR #2 Stoppage# Kallanpur Date 16.6.84.

	Sl.#	Time	Bus capacity	Arrival time	No. of passengers getting down.	No. of passengers getting up.	Departure time.	Type of transport.
	1	7'25	71	7'25	2	2	7'27	[illegible]
	2	7'27	64	7'27	—	1	7'30	[illegible]
	3	7'33	31	7'33	1	2	7'34	[illegible]
	4	7'34	26	7'34	0	1	7'35	M-67
	5	7'35	26	7'35	3	1	7'35	M-34
	6	7'36	26	7'36	—	1	7'36	M-35
	7	7'36	26	7'36	—	—	7'37	M-141
	8	7'37	26	7'37	2	3	7'38	M-[illegible]
	9	7'38	26	7'38	1	—	7'38	M-3[illegible]
	10	7'39	63	7'39	—	1	7'39	P-30
	11	7'40	26	7'40	2	—	7'40	M-3[illegible]
	12	7'41	26	7'41	3	2	7'42	M-3[illegible]
	13	7'42	25	7'42	1	2	7'43	M-3[illegible]
	14	7'44	25	7'44	—	—	7'44	M-[illegible]
	15	7'44	26	7'44	3	1	7'45	M-[illegible]
	16	7'45	26	7'45	—	—	7'46	M-[illegible]
	17	7'46	26	7'46	—	1	7'47	M-3[illegible]
	18	7'47	26	7'47	—	1	7'48	M-4[illegible]
	19	7'48	26	7'48	1	—	7'48	M-4[illegible]
	20	7'49	25	7'49	2	—	7'49	M-35
	21	7'51	25	7'51	—	1	7'51	M-3[illegible]

Data collection sheet sample

DATA COLLECTION (cont.)

Sl. #	Extra demand.	Bus Overloaded by No.	Passengers leaving the station	Service rate: Time interval	Service rate: No. of buses passing.	Customers arrival rate: Time interval	Customers arrival rate: No. of passengers arriving.
1	x	x		14		14	18
2	x	x	6				
3	3	7					
4	x	x					
5							
6	2	6	5				
7	4	8	15				
8	2	3	18				
9	x	x	10				
10	x	x	3				
11	x	x	5				
12	x	x	5				
13	x	x	15				
14	2	5	10				
15	x	x	3				
16	x	x	3				
17							
18							
19							
20	x	x	5				
21	x	x	5				

Data collection sheet sample

COMPUTER CENTRE

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DACCA

PROBLEM Asad Gate Station

PROGRAMMER

PAGE

DATE 12-02-84

FORTRAN STATEMENT

02783	82809	070	0730	0730	03	05	01	00	00
02784	83840	070	0731	0732	04	06	00	00	00
02785	03893	040	0732	0733	03	02	00	00	00
02786	03343	040	0734	0734	01	02	00	00	00
02787	03629	045	0734	0735	01	01	00	00	00
02788	03342	035	0735	0736	02	03	00	00	00
02789	03381	036	0736	0737	01	03	00	00	00
02790	03388	036	0738	0739	02	04	00	00	00
02791	83819	070	0739	0740	03	02	00	00	00
02792	03758	036	0740	0741	02	01	00	00	00
02793	03387	036	0742	0742	01	00	00	00	00
02794	04317	035	0743	0745	02	03	00	00	00
02795	04111	036	0745	0746	03	02	00	00	00
02796	03950	036	0746	0746	00	02	00	00	00
02797	03050	040	0747	0747	00	00	00	00	00
02798	03922	036	0747	0748	02	01	00	00	00
02799	82352	070	0748	0748	01	02	00	00	00
02800	01924	036	0749	0749	03	02	00	00	00
02801	03439	036	0749	0749	00	00	00	00	00
02802	03160	036	0750	0750	03	00	00	00	00
02803	02965	035	0750	0751	03	00	00	00	00
02804	03827	036	0751	0751	02	01	00	00	00
02805	03658	044	0752	0752	02	02	00	00	00
02806	03489	043	0753	0755	02	01	00	00	00
02807	04186	034	0756	0758	02	03	00	00	00

Computer code sheet sample

Computer programme used for data analysis

```
DOS FORTRAN IV 360N-FO-479 3.8   |      MAINPGM            DATE    14/07/84      TIME     16.52.08       PAGE 0001

                C     THIS PROGRAMME IS DONE BY EZHARUL HAQUE
                C     MSC THESIS
0001                  WRITE (3,20)
0002            20    FORMAT (1H1///,10X,'NAME OF THE STATION = FARMGATE',///)
0003                  ID=1
                C
0004                  WRITE(3,1[ )ID
0005                  WRITE(3,15)
0006                  IJ=0
0007                  I1=0
0008                  I2=0
0009                  I3=0
0010                  I4=0
0011                  I5=0
0012                  I6=0
0013                  I7=0
0014                  I8=0
0015                  I9=0
0016                  I10=0
0017                  ITEST=0
0018                  N=800
0019            30    N=N+15
0020                  ITEST=ITEST+1
0021                  IF (N.EQ.1115) N=1415
0022                  IF (N.EQ.1815) GO TO 25
0023                  GO TO 35
0024            25    N=815
0025                  ID=ID+1
0026                  WRITE (3,10) ID
0027            10    FORMAT(//1H ,10X,'DATA SET = DAY',I2,/)
0028                  WRITE (3,15)
0029            35    IJX=N/100
0030                  IJX=IJX*100
0031                  IJX=N-IJX
0032                  IF (IJX.EQ.60) N=N+40
0033                  ISUM1=I5-I4
0034                  ISUM2=I3
0035                  ISUM3=I7
0036                  ISUM4=I9-I10
0037                  ISUM5=I7+I9+I10
0038                  ISUM6=I8
0039                  ISUM12=I3+I8
0040                  KOUNT=1
0041                  IF (ITEST.EQ.1)KOUNT=0
0042            100   READ(1,5,END=400)I1,I2,I3,I4,I5,I6,I7,I8,I9,I10
0043                  IF (I4.GT.N.OR.(N-I4).GT.900) GO TO 300
0044                  KOUNT=KOUNT+1
0045                  ISUM1=ISUM1+I5-I4
0046                  ISUM2=ISUM2+I3
0047                  ISUM3=ISUM3+I7
0048                  ISUM4=ISUM4+I9-I10
0049                  ISUM5=ISUM5+I7+I9+I10
0050                  ISUM6=ISUM6+I8
0051                  ISUM12=ISUM12+I3+I8
0052                  GO TO 100
0053            300   WRITE (3,50) N,ISUM1,KOUNT,ISUM2,ISUM3,ISUM4,ISUM5,ISUM6,ISUM12
0054            50    FORMAT (1H , 9X,3I5,I6,4X,I4,2X,I5,3(2X,I4))
0055                  IF (IJ.EQ.1) GO TO 5
0056                  IF(ID.EQ.3) STOP
0057                  GO TO 30
0058            400   IJ=1
0059                  GO TO 300
0060            15    FORMAT(1H ,10X,'TIME  BUS   NO. BUS ARR. PASSEN OBS. PASSN OBS.  T
                     1OTAL',/1H ,10X,'INT.  WAITG BUS CAPACITY GERS   QUE- ARR.  OVER- D
                     2ASSEN.',/1H ,16X,'SEC.  RUN  -WISE    SERVED UE    RATE  LOADG THRU-
                     3PUT',/)
0061            5     FORMAT(I5,3X,I5,3X,I3,4X,I4,4X,I4,4X,I2,4X,I2,4X,I2,4X,I2,4X,I2)
0062            500   STOP
0063                  END
```

Results obtained from computer analysis

NAME OF THE STATION = FARMGATE

DATA SET = DAY 1

TIME INT.	BUS WAITG SEC.	NO. BUS RUN	BUS ARR. CAPACITY -WISE	PASSENGERS SERVED	OBS. QUEUE	PASSN ARR. RATE	OBS. OVER-LOADG	TOTAL PASSEN. THRU-PUT
815	34	7	208	140	0	140	0	208
830	23	7	238	119	0	119	0	238
845	26	8	315	128	0	128	0	315
900	55	7	320	109	0	109	8	328
915	17	6	315	110	10	120	11	326
930	19	7	261	144	0	144	0	261
945	25	8	381	95	0	95	37	418
1000	48	8	416	111	0	111	10	426
1015	23	9	499	140	0	140	0	499
1030	14	6	234	70	0	70	0	234
1045	22	6	296	68	0	68	8	304
1100	57	5	211	39	0	39	0	211
1415	30	9	370	90	-10	140	24	394
1430	16	6	285	84	-15	155	50	335
1445	15	5	270	81	-9	126	30	300
1500	48	4	170	58	-6	[illegible]	10	180
1515	16	6	327	77	-14	121	30	357
1530	6	4	180	37	-16	77	24	204
1545	10	5	275	63	-13	114	31	306
1600	53	5	248	42	-15	[illegible]	19	267
1615	7	3	143	31	-6	77	11	154
1630	17	5	290	69	4	101	25	315
1645	14	5	285	62	-9	121	43	328
1700	9	3	182	48	-4	[illegible]	34	216
1715	6	5	320	46	3	[illegible]	47	367
1730	6	4	255	45	1	[illegible]	33	288
1745	6	4	250	56	18	[illegible]	40	290
1800	57	4	280	42	6	[illegible]	26	306

DATA SET = DAY 2

TIME INT.	BUS WAITG SEC.	NO. BUS RUN	BUS ARR. CAPACITY -WISE	PASSENGERS SERVED	OBS. QUEUE	PASSN ARR. RATE	OBS. OVER-LOADG	TOTAL PASSEN. THRU-PUT
815	14	8	213	73	0	[illegible]	0	213
830	24	8	338	109	2	[illegible]	20	358
845	34	10	505	127	2	[illegible]	6	511
900	13	7	287	80	0	[illegible]	0	287
915	17	6	340	85	-2	[illegible]	12	352
930	10	4	225	53	2	[illegible]	8	233
945	16	6	250	67	-4	[illegible]	8	258
1000	102	9	433	107	-6	[illegible]	8	441
1015	19	9	469	101	-8	[illegible]	10	479
1030	16	5	208	61	0	[illegible]	0	208
1045	13	6	230	82	-4	[illegible]	9	239
1100	6	2	105	29	0	[illegible]	0	105
1415	8	6	225	57	0	[illegible]	6	231
1430	24	10	473	147	-11	[illegible]	29	502
1445	20	6	355	80	-2	[illegible]	16	371
1500	56	7	319	73	-1	[illegible]	31	350
1515	19	7	330	72	-5	[illegible]	27	357
1530	16	8	395	104	0	[illegible]	34	429
1545	14	6	255	59	-1	[illegible]	10	265
1600	22	7	362	121	0	[illegible]	37	399
1615	21	5	260	67	-13	[illegible]	24	284
1630	18	5	255	69	-13	[illegible]	20	275
1645	10	3	210	41	-7	[illegible]	34	244
1700	47	3	145	29	2	[illegible]	8	153
1715	26	8	447	108	-9	[illegible]	52	499
1730	17	5	350	75	6	[illegible]	41	391
1745	15	5	292	82	-4	[illegible]	10	302
1800	59	6	262	97	-27	[illegible]	17	279

DATA SET = DAY 3

TIME INT.	BUS WAITG SEC.	NO. BUS RUN	BUS ARR. CAPACITY -WISE	PASSENGERS SERVED	OBS. QUEUE	PASSN ARR. RATE	OBS. OVER-LOADG	TOTAL PASSEN. THRU-PUT
815	20	12	455	148	-2	176	19	474
830	25	9	495	108	-1	143	21	516
845	24	9	380	99	0	99	0	380
900	101	9	384	87	0	87	0	384
915	17	7	295	83	-3	98	10	305
930	19	8	416	109	-2	125	11	427
945	20	8	385	96	-4	134	25	410
1000	16	7	285	65	2	67	0	285
1015	20	9	356	98	-4	124	15	371
1030	16	6	274	54	0	54	0	274
1045	16	7	270	59	-9	76	8	278
1100	56	9	505	129	-2	131	5	510
1415	14	8	420	86	-11	173	47	467
1430	7	4	158	35	-6	67	22	180
1445	27	12	606	107	-20	151	37	643
1500	63	6	267	81	-6	99	14	281
1515	35	14	610	159	-16	245	58	668
1530	30	6	350	91	-11	140	31	381
1545	20	8	330	83	-5	122	32	362
1600	99	5	240	56	0	76	17	257
1615	18	8	425	116	-3	164	31	456
1630	11	4	260	84	-6	86	27	287
1645	20	5	300	74	-11	137	45	345
1700	88	3	175	46	-1	83	26	201
1715	16	4	222	51	4	85	44	266
1730	28	8	377	[illegible]	-4	108	19	306
1745	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Results obtained from computer analysis

DATA SET = DAY 4

TIME INT.	BUS WAITG SEC.	NO. BUS RUN	BUS ARR. CAPACITY -WISE	PASSEN GERS SERVED	OBS. QUE- UE	PASSN ARR. RATE	OBS. OVER- LOADG	TOTAL PASSEN. THRU-PUT
815	23	12	425	115	0	115	0	425
830	18	8	325	84	14	106	5	330
845	120	8	405	79	29	122	13	419
900	58	6	294	63	16	85	14	308
915	30	12	565	122	22	162	22	587
930	25	10	404	98	-1	117	53	457
945	27	10	475	117	40	175	54	529
1000	15	9	338	68	0	68	0	338
1015	13	9	399	56	0	56	0	399
1030	8	6	226	32	1	42	9	235
1045	6	5	226	34	-2	46	8	234
1100	13	8	212	44	6	50	5	217
1415	33	17	539	153	50	255	60	599
1430	29	16	508	164	64	284	54	562
1445	43	20	620	209	29	238	74	694
1500	159	16	518	169	17	202	74	592
1515	33	14	514	201	27	250	118	628
1530	43	19	679	247	26	291	98	777
1545	43	20	663	209	25	250	110	773
1600	61	13	496	189	32	235	120	616
1615	29	16	566	216	82	310	164	730
1630	22	15	448	196	41	237	123	571
1645	23	13	457	162	10	190	67	524
1700	67	13	499	237	39	312	188	687
1715	27	14	457	248	65	313	164	621
1730	22	18	574	323	61	384	190	764
1745	26	25	1054	474	51	611	319	1373
1800	21	14	555	199	40	309	239	794

DATA SET = DAY 5

TIME INT.	BUS WAITG SEC.	NO. BUS RUN	BUS ARR. CAPACITY -WISE	PASSEN GERS SERVED	OBS. QUE- UE	PASSN ARR. RATE	OBS. OVER- LOADG	TOTAL PASSEN. THRU-PUT
815	19	11	377	181	67	248	105	482
830	27	14	424	239	87	326	148	572
845	55	20	602	257	15	272	159	761
900	193	17	583	229	10	239	95	678
915	67	23	722	148	0	148	34	756
930	54	26	842	166	0	166	12	854
945	43	19	578	141	2	143	54	632
1000	8406	26	858	159	0	159	8	866
1015	29	13	428	114	0	114	35	463
1030	17	17	685	158	0	158	92	777
1045	17	12	472	169	24	193	166	639
1100	-11	19	590	226	44	270	130	720
1415	-344	15	431	199	59	258	160	591
1430	12	16	496	297	78	375	225	721
1445	2	13	370	146	29	175	126	496
1500	3	10	397	218	80	298	214	611
1515	1	12	419	280	149	429	259	678
1530	8	15	500	317	159	476	264	764
1545	7	15	536	201	21	222	144	680
1600	91	14	476	230	21	251	176	652
1615	8	15	532	191	10	201	163	695
1630	2	12	408	206	156	362	191	599
1645	5	10	358	265	131	396	168	526
1700	-2	9	354	190	124	323	149	503
1715	13	18	582	199	54	253	136	718
1730	13	18	558	276	113	389	253	811
1745	11	16	696	267	117	384	287	977
1800	-53	16	490	169	149	318	262	752

DATA SET = DAY 6

TIME INT.	BUS WAITG SEC.	NO. BUS RUN	BUS ARR. CAPACITY -WISE	PASSEN GERS SERVED	OBS. QUE- UE	PASSN ARR. RATE	OBS. OVER- LOADG	TOTAL PASSEN. THRU-PUT
815	13	10	525	93	10	127	58	583
830	10	6	320	51	14	65	43	363
845	13	7	425	54	1	55	41	466
900	160	11	666	185	7	192	137	803
915	11	8	430	38	3	41	68	498
930	16	10	570	67	6	73	62	632
945	24	17	930	112	25	137	55	985
1000	-25	13	750	81	3	84	46	796
1015	16	20	1146	177	19	196	71	1217
1030	13	20	1125	138	0	138	96	1221
1045	6	10	527	103	0	103	0	527
1100	-38	16	854	106	0	106	53	907
1415	-288	15	792	120	4	124	9	801
1430	16	14	745	97	14	111	0	745
1445	3	14	610	65	5	70	0	610
1500	45	12	645	60	0	60	4	649
1515	0	10	505	46	0	46	0	505
1530	10	14	720	86	0	86	13	733
1545	15	15	615	71	0	71	0	615
1600	17	12	600	118	0	118	18	618
1615	5	12	640	94	0	94	0	640
1630	-3	8	385	42	0	42	10	395
1645	3	14	745	83	0	83	0	745
1700	-2	11	690	81	0	81	5	695
1715	14	16	730	99	0	99	0	730
1730	13	15	765	111	0	111	0	765
1745	1	16	750	95	0	95	15	765
1800	-1	13	605	174	0	174	30	635

DATA SET = DAY 7

TIME INT.	BUS WAITG SEC.	NO. BUS RUN	BUS ARR. CAPACITY -WISE	PASSEN GERS SERVED	OBS. DUE- UE	PASSN ARR. RATE	OBS. OVER- LOADG	TOTAL PASSEN. THRU-PUT
815	996	9	325	48	0	48	17	342
830	0	7	330	88	18	106	104	434
845	11	11	515	127	30	157	119	634
900	43	9	425	126	13	139	110	535
915	16	9	435	186	13	199	116	551
930	-3	8	396	65	6	71	88	484
945	10	13	590	120	20	140	123	713
1000	39	12	475	76	17	93	55	530
1015	10	19	770	184	32	216	94	864
1030	0	14	560	93	22	115	85	645
1045	66	12	544	177	10	187	62	606
1100	102	21	875	89	39	128	45	920
1415	32	13	585	151	14	165	160	745
1430	16	8	365	129	24	153	65	430
1445	22	14	595	158	15	173	95	690
1500	102	13	595	157	5	162	74	669
1515	17	14	585	111	22	133	55	640
1530	21	14	620	159	60	219	168	788
1545	14	12	505	88	22	110	59	564
1600	58	11	485	165	12	177	85	570
1615	17	11	500	130	12	152	57	557
1630	23	15	636	117	11	136	100	736
1645	15	11	450	91	18	109	70	520
1700	111	13	590	158	28	186	153	743
1715	19	10	445	132	32	164	100	545
1730	16	10	415	88	47	135	75	490
1745	29	15	690	177	157	334	217	907
1800	102	15	650	121	11	132	76	726

DATA SET = DAY 8

TIME INT.	BUS WAITG SEC.	NO. BUS RUN	BUS ARR. CAPACITY -WISE	PASSEN GERS SERVED	OBS. DUE- UE	PASSN ARR. RATE	OBS. OVER- LOADG	TOTAL PASSEN. THRU-PUT
815	22	15	625	164	3	167	70	695
830	13	9	375	60	3	63	42	417
845	15	8	360	142	12	154	70	430
900	55	9	425	99	6	105	86	511
915	11	12	550	85	2	87	5	555
930	11	15	625	63	2	65	11	636
945	35	12	525	122	3	125	35	560
1000	24	13	575	131	2	133	43	618
1015	30	13	665	89	3	92	27	692
1030	16	10	445	95	5	100	70	515
1045	19	12	585	108	0	108	78	663
1100	103	14	595	137	8	145	70	665
1415	19	11	485	98	7	105	87	572
1430	17	8	360	95	24	119	89	449
1445	21	11	555	94	3	97	113	668
1500	62	13	595	126	18	144	100	695
1515	19	15	630	109	8	117	63	693
1530	19	14	590	125	14	139	55	645
1545	20	12	545	123	21	144	126	671
1600	112	14	660	131	4	135	85	745
1615	22	14	635	143	22	165	88	723
1630	17	9	405	123	35	158	100	595
1645	8	6	260	48	25	73	57	317
1700	53	8	395	138	8	146	128	523
1715	21	11	550	179	36	215	180	730
1730	11	7	290	73	35	108	59	349
1745	19	8	335	63	30	93	57	392
1800	99	13	485	69	0	69	7	492

EOJ NT06BAB

DATE 14/07

Results obtained from computer analysis