PEDESTRIANIZATION IN DHAKA CITY

PROBLEMS AND PROSPECTS

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To my parents,
They showed me love,
confidence, and patience.

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A B S T R A C T

Environmental consciousness has been the main stimulant for a new trend in transportation policy in many developed countries, where a balanced and harmonious coexistence between pedestrians and vehicles is sought. Pedestrianization, a technique recognized as the most comprehensive form of environmental traffic management, has remarkably been gaining a considerable importance in the current trend of modernization of urban activity centres. In the developing countries, pedestrian planning in general has been either totally ignored or too late in coming.

In Dhaka city, as well as in other urban areas of Bangladesh, the pedestrian traffic safety, mobility and accessibility, and the street environment have alarmingly deteriorated. Among different causes of these issues, the institutional constraints, road user behaviour and inadequacy of infrastructural facilities are the main contributory factors. The contemplated impacts on these issues by the rapid growth of the city's population, along with other future implications and constraints, were the main impetus to carry out this research. Main efforts were focussed to assess the severity of the pedestrian-vehicular conflict and the impact of the street infrastructural and environmental conditions on the quality of pedestrian movement. The main methodological technique of this assessment was to conduct pedestrian and vehicular traffic flow survey in two main pedestrian intensive activity areas: Mirpur Road as a major arterial street and New Market Shopping Area as one of the most important retail facility areas. The research, furthermore, investigated the pedestrian behaviour at different types of crossing facilities. Accident statistics were collected and considered a supporting evidence of the conflict intensity.

Results of this research pinpointed, in facts and figures, the

severity of different dimensions of the problem and the necessity to consider changing trends and evolution of conceptual thinking in urban transportation planning. A package of recommended measures and guidelines termed ETSPAM (Environmental Traffic System Planning and Management) is the main output of this research. This package is designed to deal with the requirements relevant to issues of major concern to pedestrian free movement and safety as an indispensable precondition to revitalize the urban environment in Dhaka city. The main goals of the package are the attainment of safe, pleasant and efficient environments for pedestrian routes, and organization of pedestrian traffic as an integrated part of the city's transportation system. The package proposes a number of strategies and policies, in addition to a planning framework, to implement the selected goals and objectives. The strategies and policies lie in the domain of administrative and institutional development, expanded traffic engineering and management, improvements in pedestrian planning process, and improvements in pedestrian infrastructural facilities, road upgrading and public transport.

Title of the Thesis:
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INTRODUCTION

1.1 CONCEPTUAL CONTEXT

Environmental consciousness has been the main stimulant for a new trend in transport policy in many developed countries. This change seeks to achieve a balanced and harmonious coexistence between pedestrians and vehicles. It revitalizes and protects urban areas, reduces the severity of accidents and renders substantial social and economic benefits.

Environmental traffic management is a set of techniques for protecting the environment of an area against the adverse effects of vehicular traffic by measures designed to prevent the entry of extraneous traffic, and to organize internal flows so that they are less damaging in their effects. These techniques are usually considered for positive discrimination in favour of pedestrians, public transport and bicycles. Improvement in the environmental quality of an area following environmental traffic management can be measured in terms of the reduction in noise and other pollution and in the number of fatal or serious accidents. A more subjective assessment can be made in terms of the effects on the physical surroundings of the area - its buildings and its open spaces - which have a profound influence on our positive or negative perception of a place.

Pedestrianization, i.e., the adoption of streets specifically for pedestrian use, is the most comprehensive form of environmental traffic management. Different sources indicate that this technique was first introduced in 1926 in Essen, Federal Republic of Germany, but was receiving international attention only by the second half of the 1960s. Today, this is an extensively growing phenomenon that has been gaining a considerable importance in the current trend of modernization of urban activity centres. Implementation of these concepts has been either totally ignored or too late in coming in the developing countries where many great constraints in financial resources and environment exist.

Pedestrianization, often in conjunction with other measures, provides an effective answer to the aims and objectives of urban development, in particular the improvement of traffic flows and urban renewal. Above all, it reduces traffic conflict and stimulates shopping.

Growing environmental awareness and the perception of the commercial and historical values of town centres led to a desire for larger traffic-free areas. Further, successful pedestrian areas in some countries proved an important factor in the rivalry among towns in attracting business and employment, exhibitions and conferences. This is particularly evident, for example, in Munich which has the highest growth rates in the FRG in both high technology industries and the tourist trade.

Planners and politicians regard an exceptional rise in turnover in the retail trade as the most important criterion for the success of a pedestrian street (Monheim, 1986). However, pedestrianization itself cannot be seen as the only reason. It is more often a result of improvements in the transportation system both for vehicles (through the construction of roads and car parks), and for public transport. However, increased business in pedestrian areas has also its disadvantages: commercial rents rise out of proportion and can often no longer be met by weaker retail businesses and by non-commercial tenants. Another negative effect of pedestrian areas is often the increased traffic in surrounding residential areas, both from through traffic and parked vehicles. Aside from its immediate effectiveness, the establishment of a successful pedestrian area raises people's regard for the quality of the urban environment.

Improved quality of the environment is closely associated with freedom and safety of pedestrian movement(Table 1.1). Accessibility of pedestrians is also a major issue of concern in transportation planning as well as in physical planning. In the broad context of urban planning, the civilized quality of an urban area may be judged against the environmental quality of urban life. The provision of a safe and better environment is, after all, the basic objective of urban planning.

1.2 STATEMENT OF THE PROBLEM

The traffic menace in Dhaka city is one of the most controversial

Table 1.1

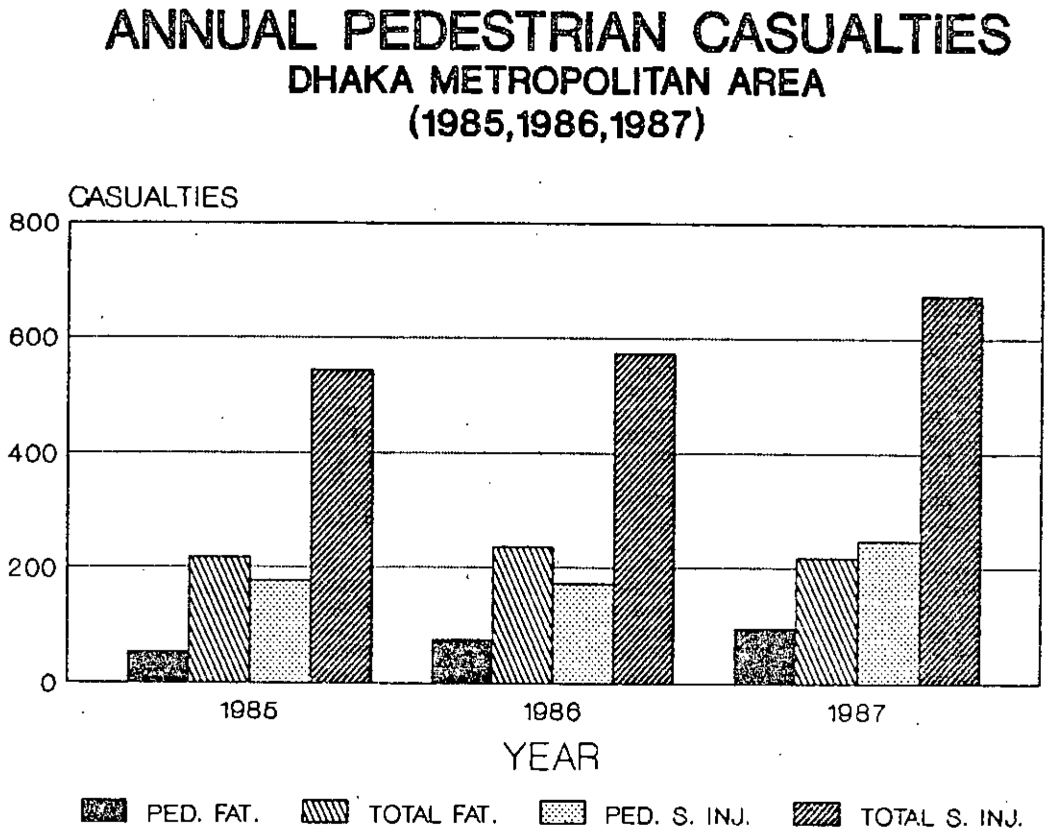
ADEQUACY OF THE ENVIRONMENT FOR PEDESTRIAN TRAFFIC

SAFETY	- FULL SEPARATION OF PEDESTRIANS AND VEHICLES WHEREVER POSSIBLE. - NO MAJOR CONFLICT POINTS; NO EXCESSIVE SPEEDS.
COMFORT	- NO UNDUE PROXIMITY OF PEDESTRIAN AREAS TO VEHICLE FLOWS OR VEHICLE PARKS.
CONVENIENCE	- ADEQUACY OF PEDESTRIAN ACCESS SYSTEM WITHIN THE AREA AND OTHER AREAS. - ADEQUACY OF ACCESS TO PUBLIC TRANSPORT FOR PEDESTRIANS.
VISUAL QUALITY	- NO DOMINANCE OF SCENE BY MOVING OR PARKED VEHICLES. - GOOD LAY-OUT: SEATING, TREES, FLOWERS, FOUNTAINS, ETC. - GOOD APPEARANCE OF FRONTAGE LAND USE DEVELOPMENT.

issues citizens have been facing in the course of continuous change in their urban life. Many publications including press reports expressed concern about the deteriorating effects of traffic on the public safety and on the environment as well. But many official attempts, to investigate the dimensions and causes of the problem, have always given disproportionally little attention to the pedestrian traffic and the street environment. Current transportation and traffic management policies make the pedestrian very secondary when compared to the priority given to the vehicle. Thus, pedestrian safety and mobility are sacrificed to the expedience of the vehicle. Even the proposed remedial measures for the identified issues have always been frustrated by administrative and institutional constraints.

Pedestrians are frequently harassed and intimidated by increasing volumes of vehicular traffic. They are the most vulnerable to road accidents and their casualties always constitute a major proportion amongst road fatalities and serious injuries (Graph 1.1). Accident statistics indicate increasing trend in pedestrian casualties.

Pedestrian mobility and accessibility,on the other hand, continue to suffer a great deal due to the inadequacy of walkways capacity, uncontrolled land use configuration and traffic generating developments and inadequacy of traffic management system. Sidewalks, when exist, are crowded by pedestrians particularly in commercial areas, or misused by many obstructions and by vendors. The existing facilities and traffic control measures are not at all expected to



Ped. Fat.= Pedestrian Fatalities
Total Fat.= Total Fatalities
Ped. S.Inj.= Pedestrian Serious Injuries
Total S.Inj.= Total Serious Injuries

Source: Based on Dhaka Metropolitan Police - Traffic Division Reports.

Graph 1_1

induce orderly pedestrian movement. No undisrupted walkway network exists in any part of the city and walking has never been regarded as an interdependant part of the overall circulation system. The severe inadequacy of public transport services has further constrained the modal choice, especially of the low income groups, and added more burden on walking. As the population density increases, pedestrian free movement will be further restricted and this will be reflected on the proper functioning of walkways and pedestrian activity areas. In the meantime, as the city expands, the latter mode becomes more inconvenient in commuting travels for long distances. In such situation, provision of alternatives gain high urgency, a matter if left unresolved will seriously slow down the pace of future city expansion. These issues justify the basic necessity not only to enhance pedestrian safe and free movement but also to practically recognize walking as an indispensable part that must be integrated with the overall city's transportation system.

Furthermore, pedestrians are in immediate contact with the deteriorating street environment and the surroundings caused by the damaging effects of traffic pollution, both physical and visual. These effects have always been neglected in the implementation of different transport policies. Difficulties incurred on pedestrian movement pose serious shortcomings on retail trade activities of commercial centres.

Continuous ignorance of these issues will assist to forego important opportunities of revitalizing urban life of this city. The rapid growth of population will worsen the situation by increasing the severity of infrastractural facilities deficiency. Unless appropriate strategies are planned and implemented, while considering the pedestrian movement as the focal point of the circulation problem and as a main precondition for a civilized quality of urban life, severe repercussions on this city's urban environment will be too hard to avoid, perhaps even before the turn of this century.

1.3 RATIONALE OF THE STUDY

Failure to recognize the impact of free and safe pedestrian movement in the broad context of urban planning in Dhaka city is a major factor to which the present situation may be attributed. A correct diagnosis of these ills is essential and a full knowledge of possible courses of action is indispensable if we are to improve and safeguard what is still left of civilized life in this city.

An important fact to be seriously taken into account in planning for the circulation system in Dhaka city is strong anticipation of dramatic increase in pedestrian and vehicular traffic in the foreseen future. From different projetions, it is guessed that the population of the city will be between 8 million to 10 million by the year 2000 AD. It means in a period of about 12 years, population will almost double. According to RAJUK (the city development authority) sources, the buildable lands in the city are almost exhausted (Bashar, 1988). Price of all categories of lands will be on sharp rise in the face of growing land demand. Increase in population and lack of buildable lands will gradually increase population density through construction of high rise apartment and office buildings, even with the possible expansion of the city. The increase in density will be comparatively high in many residential and commercial areas leaving major impact on the already overburdened transportation system. Mobility, accessibility and safety of pedestrians and vehicles will become very challenging future issues that will require efficient planning to face this impending crisis. Successful expansion of residential development towards north - like Tongi, Joydebpur and Savar - will depend largely on the introduction of efficient commuting transport services. Town planning will have a greater responsibility than any time in the past. If land uses are left to develop solely according to the forces and incentives of the market, the above issues will gradually become very unmanageable due to uncertainties of traffic generation.

This study attempts to focus attention on the basic necessity of considering changing trends and evolution of conceptual thinking in urban transportation planning, as being experienced in many other countries. For efficient circulation and to revitalize and protect the urban life of this city, transportation on one hand and land use on the other will have to depend on pedestrians, their numbers and needs. Furthermore, problem identification and clear determination of the appropriate goals and objectives desereved an emphasized recognition in this study as the fundamental factor for selecting appropriate strategies and examining the prospects of their applicability.

1.4 OBJECTIVES OF THE STUDY

1. To identify and assess the impact of pedestrian-vehicular interaction on the pedestrian movement, pedestrian safety, and other related aspects of the urban environment in Dhaka city.

2. To study the prevailing pedestrian traffic management applications in the city.

3. To identify the general causes of pedestrian accidents and other pedestrian and environmental traffic difficulties.

4. To identify the nature of the problems and prospects of pedestrianization, with a view to revitalize the urban environmental conditions and protect the pedestrian safety.

5. To examine the pedestrian behaviour at crossings and the factors influencing this behaviour.

6. To explore a range of remedial measures for solution of the different aspects of these problems.

Chapter two of this research report presents main vital issues that will help to understand the nature of the problem, as incurred by the pedestrian-vehicular interaction and inflicted on our urban environments, for a clear conceptual approach to this study. This includes a review of relevant literature and aspects of major importance on pedestrian planning, pedestrian traffic management, design considerations and a review of the experience of some countries in pedestrianization and related traffic restraint methods. Chapter three presents methodology and investigation techniques employed in this research. Chapter four identifies the major pedestrian issues in Dhaka city and the causes of these issues. Chapter five describes the prevailing conditions in main pedestrian activity areas in Dhaka city and presents a systematic analysis of the study areas. Chapter six presents field survey data analysis of Mirpur Road and New Market Shopping Area. Chapter seven is an attempt to investigate the nature and causes of the pedestrian behaviour at different types of crossing facilities. Chapter eight proposes a number of strategies designed to deal with a selected list of goals and objectives. These are a part of a proposed package of recommendations on issues of major concern to pedestrian movement and safety as an integrated part of the question of revitalizing the urban environment of Dhaka city, and perhaps other urban environments in Bangladesh. This study concludes in chapter nine where the applicability of the proposed strategies is tested in view of different contexts.

Chapter 2

PEDESTRIAN-VEHICULAR INTERACTION AND THE URBAN ENVIRONMENT

2.1 INTRODUCTION

Improvement in the environmental quality of our towns should always be considered as a top priority in urban planning and management. The adverse consequences of traffic in the urban areas have exceeded their grave limits and continue to pose a major challenge to all efforts striving towards a more civilized quality of life. Accident rates are very alarming. Difficulties incurred by traffic on the urban environment constitute major issues that usually lack a well deserved attention. A great deal of inconvenience has increasingly become a part of life in the urban streets; elderly people and children frightened of crossing the road or confused by the close passage of vehicles; parents anxious when their children are out on the road; difficult conversation on pavements on account of traffic noise. This is in addition to the unhealthy atmosphere and nuisance caused by fumes, and the visual impact on the lively urban townscape.

Unless positive policies and appropriate techniques are adopted and implemented, these consequences will ultimately become more serious and less manageabale in the future. This is quite evident considering different aspects of current trends. This chapter presents some important issues that will help to understand the nature of the problem inflicted on our environments for a clear conceptual approach to this study. This will include a review of relevant literature with the main focus on pedestrian traffic and related topics on pedestrian safety and convenience, and traffic restraint measures, especially pedestrianization.

2.2 THE NATURE OF URBAN TRAFFIC

2.2.1 City and Traffic

A city is a central place with many activities. It functions as a system in which transport is one of the bonding subsystems. In conventional spatial terms, its total area is divided into spaces for residence, spaces for production (of goods and services) and spaces for mobility, this last category being continuous contiguous strips of space providing connectivity between all other spaces. How a city works and grows is often dependent on the proportion of space devoted to these three principal uses and the arrangements made for movement. The physical layout of the city, constrained by geographical or topographical features, is also defined by its economic and functional activities,and by the constraints imposed by the city's size.

Traffic is a function of activities, and traffic is concentrated in cities because activities are concentrated there. It is characteristics of activities in cities that they mainly take place in buildings, or in places such as markets, depots and stations which for the purpose of this description can be termed buildings. In cities, therefore, traffic can be said to be a function of buildings. The patterns traced by all the pedestrian and vehicular traffic as they move about are closely related to the manner in whcih the buildings are arranged. The journey patterns are extremely complicated.

2.2.2 The Essence of the Problem

With the importance of the vehicle, attention should be drawn to the difficulties arising from its extensive use.

2.2.2.1 ACCESSIBILITY

Vehicular accessibility is the degree of freedom for vehicles to circulate and to penetrate to individual destinations and to stop on arrival. There are two main requirements for good accessibility. First, vehicle users should be able to move from one part of a town to another - or beyond, in safety and with reasonable speed, directness and pleasantness. Second, on arrival in the vicinity of his destination, the driver should be able to penetrate without delay close to his final destination and to stop there without restriction.

2.2.2.2 DETERIORATION OF ENVIRONMENT

The penetration of motor vehicles throughout urban areas is bringing its own peculiar penalties of accidents, anxiety, intimidation, noise, fumes, vibration, dirt and visual intrusion on a vast scale. This is in addition to delays in traffic jams and difficulties of parking.

Safety: The most important aspect of the deteriorated environment is the question of safety. To be safe, to feel safe at all times, to have no serious anxiety that members of the family will be involved in a traffic accident, are surely prerequisites for civilized life. Against this standard, a great deal is left to be desired. There are now virtually no urban streets that are completely safe.

Noise: The motor vehicle is responsible for a great deal of noise pollution. Traffic noise is the predominant noise nuisance in the city. Buses and heavy commercial vehicles are the main sources of noise.

Fumes and Smell: Fumes contain, amongst other substances, carbon monoxide, unburnt elements of fuels and carbon dust. Carbon monoxide is toxic, and carbon dust can act as a carrier for carcinogenic (cancer producing) compounds. In conditions of sunlight, fumes can develop as eye and throat irritants.

2.2.2.3 PEDESTRIAN MOVEMENT

Freedom of pedestrian movement is closely associated with the quality of the environment. The simple act of walking plays an indispensable part in the transport system of any town. Walking accounts for many medium-distance movements, virtually all the final distribution from bus stops and other vehicle parks, and a vast amount of casual coming and going. Therefore, pedestrian movement should be enabled to take place in reasonable comfort and safety. Walking is also an integral part of any other matters, such as looking in shop windows, admiring the scenes, or talking to people. The freedom with which a person can walk about and look around is a very useful guide to the civilized quality of an urban area. Judged against this standard, many of our towns now leave a great deal to be desired.

2.3 ENVIRONMENTAL AREAS AND THE PEDESTRIANS

2.3.1 The Concept

As city traffic has been described earlier as a function of buildings, the problem, essentially, is a matter of rationalizing the arrangement of buildings and access ways. "Traffic in Towns" report compares the circulation problem with that arises every day in the design of buildings, and illustrated by the familiar case of corridors and rooms (Buchanan, 1963).

There must be areas of good environment where people can live, work, shop, look about, and move around on foot in reasonable freedom from the hazards of motor traffic, and there must be complementary networks of roads for effecting the primary distribution of traffic to the environmental areas. These areas are not free of traffic, but the design would ensure that their traffic is related in character and volume to the environmental conditions being sought.

2.3.2 Characteristics of Environmental Areas

The concept of environmental areas describes them as the areas or groups of buildings and other development in which daily life is carried on, and where the maintenance of a good environment is of great importance. Any kind of development - residential, industrial, commercial, etc. or even mixed uses - can form an environmental area. But naturally, the environmental standards will vary according to the kind of area. Safety is, in all cases, a major consideration.

No sociological content is implied by this concept. There is no connection, for example, with the idea of neighbourhoods, the concept is no more and no less than a method of arranging buildings for traffic.

Special mention is made of the design of residential areas for traffic. The main user requirements are the accessibility of vehicular traffic to their dwellings and garages, and the ability of the residents to live in conditions of maximum safety and freedom from the nuisance of moving vehicles, and to send their children out to play and to school with the minimum of risk.

These requirements are very close to what is commonly known as the "Radburn layout". Developed by Clarence Stein and Henry Wright at Radburn in New Jersey (USA) in 1928, the main principles of this system are:

(i) the creation of a superblock (or, as described earlier, an environmental area) free from through traffic, and

(ii) the creation of a system of pedestrian footpaths entirely separate from vehicular routes, and linking together places generating pedestrian traffic.

The several ways in which vehicles menace environment are mainly felt by pedestrians. Pedestrians are most immediately in contact and at risk with the adverse effects of vehicles. Their environment is in a great need for protection. Therefore, the pedestrian traffic environment, its interactive role with the urban environment, and the pedestrian-vehicular interaction as a major aspect, deserved the due attention in this study. It is a very vital issue of the urban transportation, which in turn is a major issue of the comprehensive problem of town planning.

2.4 PEDESTRIAN TRAFFIC CONSIDERATIONS

2.4.1 Introduction

A pedestrian is "any person afoot" and his involvement in traffic is a major consideration in the design of urban road networks. Due to the demands of vehicular traffic in congested urban areas, it is often difficult to make adequate provisions for pedestrians. Yet, this must be done as pedestrians are the life blood of our urban areas, particularly in the busy commercial areas. In general, it has been found that the most successful shopping sections are those which provide the most comfort and pleasure for pedestrians. Pedestrian facilities include sidewalks, crossings and traffic control features on roads. Also, they are parts of bus stops and other loading areas.

In any attempt to improve transportation networks, the requirements of circulation should be faced as one overall problem. The role of pedestrian movement is an aspect which until recently has been neglected. This negligence is still notorious in the developing countries.

2.4.2 Pedestrian Traffic and Transportation Planning

The concern for pedestrian and other forms of non-motorized transport has been long in coming. Among the many explanations, it is appropriate to mention that these categories of transport, because of their low speed and high movement flexibility, require little in terms of infrastructures, capital expenditures, operation and maintenance costs. The lack of technological sophistication and of heavy financial requirements contributed to a general disregard for these types of transport in the face of the major technical, political and financial requirements of motorized modes of transport (Bovy, 1975). Pedestrian movement efficiency and flexibility is, in a way, a handicap for this type of transport, since it allows faster, heavier and bigger transport technologies to dominate and get an overwhelming share of space in rights-of-way, leaving marginal left-over space for slower pedestrians and other non-motorized transport. It is often recognized that governments tend to opt for more visible types of achievements like freeways and mass transit projects than more simpler pedestrian facilities and traffic management schemes.

As pedestrian traffic is far more fluid and adaptive than vehicular traffic, pedestrian facilities have been designed inattentively, or have resulted more or less as by-products from the formal architectural layouts of buildings. Planning for pedestrians must have the aim of providing a more safe, pleasant and attractive environment. It must provide continuous pedestrian circulation integrated with the interfaces of other components of the transportation networks.

2.4.3 Pedestrian Access

The extent of freedom that can be provided for pedestrians in an area, with intensive pedestrian activities, has an important effect on the proper functioning of that area and on the quality of environment that can be provided. With the development of rapid mechanical means of transport, and the ever-growing attraction of commercial and cultural activities, the functions and purposes of existing streets have a different meaning to both pedestrian and driver. From the pedestrian point of view, a street can act as a means of communication between one point in a town and another, as access to buildings and as a public space for play and leisure. The pedestrian and driver's conflicting requirements result in danger and inconveniences to both, espesially to the pedestrian, as well as adding to other difficulties like congestion. The present arrangements of existing streets need to be reorganized to provide an appropriate layout which separates pedestrians and vehicles according to their needs and activities.

Grades of separation were recommended to be achieved by defining different grades of pedestrian free movement as part of the overall circulation network (Antoniou, 1971) (see Fig.2.1). In order to pursue a definition of grades, it was deemed necessary to consider such factors as the amount of vehicular traffic that could be absorbed safely and conveniently, the type of vehicular movement generated by particular activities, etc.

Definition of accessibility in urban areas have tended to concentrate mainly on problems relating to vehicular traffic. Consequently, pedestrianization is often seen in isolation from the circulation problem, and hence only safety and amenity aspects are included (Antoniou, 1971). Until recently, studies had mostly been limited to analysis of individual and isolated shopping streets and not as a part of the overall circulation network.

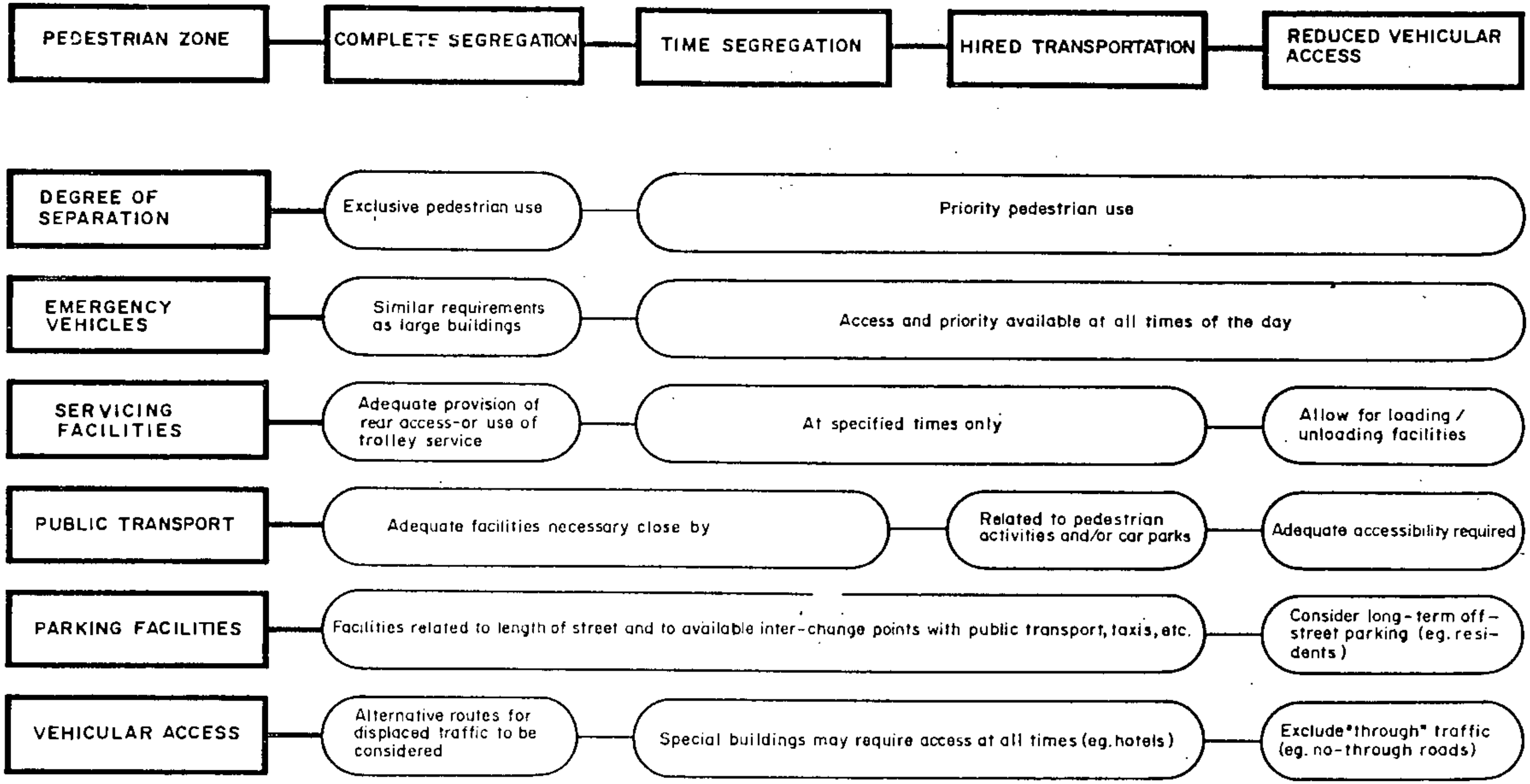


Fig. 2.1 Grades of pedestrian access: a range of factors which may have to be considered according to requirements.

Source: Antoniou, 1971, p.49

If the aim of circulation planning is to improve accessibility at the various levels of the circulation network, it is important to coordinate a primary system for pedestrian movement related to key facilities and available means of transport. Only then it is possible to consider the most appropriate travel system, according to the particular requirements which have to be met within the integrated network system.

2.4.4 Pedestrian Accidents

Pedestrian casualties comprise a major proportion amongst the various classes of road users. The safety of pedestrians in town planning and traffic management still poses a serious challenge to transport planners and practitioners due mainly to the multi-dimensional aspects of pedestrian accidents.

2.4.4.1 AGE FACTOR

Children and the elderly are disproportionally the pedestrian victims. The elderly are particularly vulnerable probably because of decrease in their abilities to perceive oncoming vehicles and because of their lessened agility and speed of movement to cross the roadway quickly. Small children are vulnerable pedestrians because they are more easily hidden from the driver's view and because they are inattentive and careless in traffic due to ignorance. Children have all the problems of other pedestrians in addition to the use of streets as play areas.

2.4.4.2 TYPES OF PEDESTRIAN ACCIDENTS

An important study by Snyder and Knoblauch on over 2000 pedestrian accidents in 13 major cities led to the following list of the 5 most frequently noted types of accidents (Institute of Transportation Engineers,1976):

Dart-out (First Half) (24 per cent). A pedestrian, not in an intersection crosswalk, appears suddenly from the roadside.

Dart-out (Second Half) (9 per cent). This is the same as the dart-out described for the first half above, except that the pedestrian covers half of a normal crossing before being struck.

Intersection Dash (8 per cent). This category covers cases similar to dart-outs with regard to pedestrian exposure to view, but the incident occurs in or near a marked or unmarked crosswalk at an intersection.

Multiple Threat (3 per cent). The pedestrian is struck by car x after other cars blocking the vision of car x stopped in other lanes going in the same direction, and avoiding hitting the pedestrian.

Vehicle Turn Merge with Attention Conflict (7 per cent). The driver is turning into or merging with traffic; the situation is such that he attends to vehicular traffic in one direction and hits the pedestrian who is in a different direction from his attention.

2.4.4.3 PEDESTRIAN ACCIDENTS IN DEVELOPING COUNTRIES

In few of the cities in developing countries accident data were collected such that a detailed breakdown of road user classes could be obtained (Jacobs and Sayer, 1984). The class of road user was often divided simply into "pedestrian" and "vehicle occupant". These data provide insight into the fact that the proportion of pedestrian casualties is substantially higher in these cities than in urban areas in a developed country like Britain (Graph 2.1).

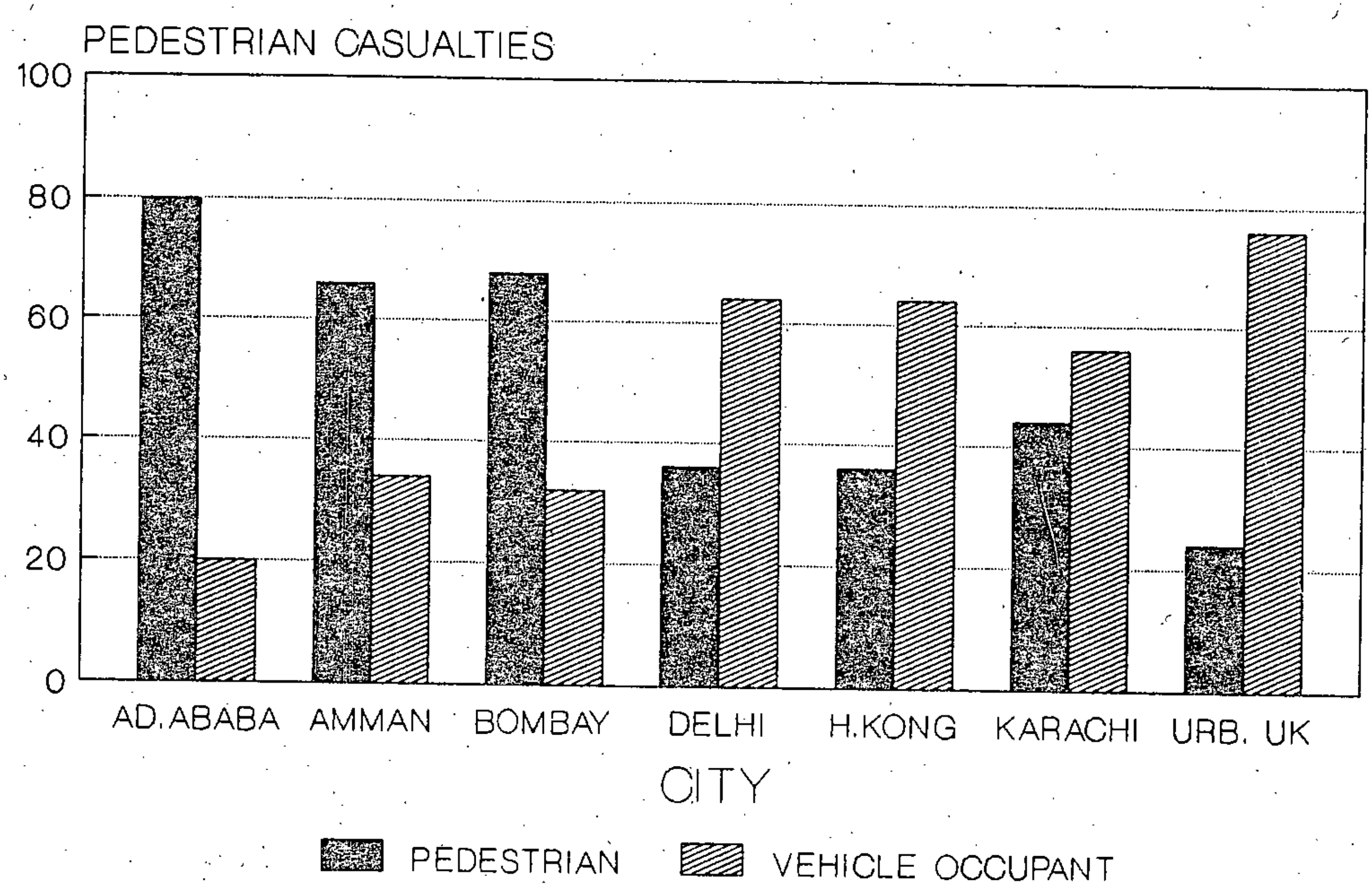
2.4.5 Pedestrian Risk in Crossing Roads

2.4.5.1 DEFINITION

Risk or hazard may be expressed as an accident rate. When a pedestrian crosses a road, some measures of the risk that he or she faces can be given by relating the total pedestrian flow to the number of pedestrian casualties that have occurred on that section of road. Absolute values of risk would require knowledge of pedestrian flows over long periods of time, which is not a feasible proposition. However, it is possible to derive estimates of risk by using sample data. In a number of studies, using casualty counts and pedestrian flows, risk is defined as (Grayson, 1987; Institute of Transportation Engineers, 1976):

$$\text{Pedestrian risk} = \frac{\text{Casualties per year}}{\text{Pedestrian flow per hour}} \times 10^2$$

PEDESTRIAN CASUALTIES IN DEVELOPING COUNTRIES (EXPRESSED IN PER CENT)



SOURCE: BASED ON JACOBS AND SAYER, 1984.

Graph 2.1

2.4.5.2 RISK PATTERN

In 1961, a study made on seven roads in West London shows that near junctions the most dangerous place to cross the road is within 45.7 m (50 yards) of an official crossing, and the safest at signal-controlled crossing (safer than at zebra crossing). The risk is higher in the vicinity of junctions than far from them (Dept. of Scientific and Industrial Research, 1965). Similar studies were conducted in London and in four provincial towns in England indicating similar results. This contradicts doubts in some engineers minds as to the exact value of zebra crossings in relation to pedestrian safety (O'Flaherty, 1974).

In 1962 and 1983, more studies were carried out in West London by the Transport and Road Research Laboratory (Grayson, 1987). In both the cases, the pattern of risk was substantially the same, although the overall level of risk decreased. Pedestrian crossings remained the safest places at which to cross the road, and the area within 50 meters of signal-controlled crossings at junctions the most dangerous.

Furthermore, the risk to the younger (<16 years) and older (>60 years) people is considerably greater than the 16-60 age group. The risk for men is higher than that for women. It could be shown that this was because more men use the high-risk areas in which to cross the road and fewer of them use pedestrian crossing facilities (O'Flaherty, 1974; Grayson, 1987).

2.4.5.3 PEDESDTRIAN RISK IN THE DEVELOPING COUNTRIES

A study of pedestrian risk rates in two cities of the developing countries illustrates the greater degree of risk in crossing busy shopping streets than in urban areas of a developed country like Britain. The levels of risk in Nairobi (Kenya) and Surabaya (Indonesia) were much higher than in Britain for similar levels of vehicular flow. At a flow of 1500 vehicles per hour, for example, the risk rates were 86 per cent and 172 per cent greater in Nairobi and Surabaya respectively than in Britain; at a flow of 3000 vehicles per hour the rates were 180 per cent and 260 per cent greater (Jacobs and Sayer, 1984).

2.5 PEDESTRIAN TRAFFIC MANAGEMENT

Most pedestrian management measures are aimed at segregating the pedestrians from the vehicular traffic. When complete physical segregation is not feasible, controls are aimed at restricting pedestrian movement on the carriageway to particular locations and, if possible, during particular times. Measures in use are pedestrian channelization and provision of pedestrian signals and crossings.

2.5.1 Pedestrian Channelization

This means the use of sidewalks in conjunction with guard-rails or barriers so that pedestrians are kept off the carriageway at certain locations. At dangerous locations and to avoid unwanted interruptions to traffic, guard-rails will need to be used both to keep pedestrians on the sidewalks and to canalize the stream of pedestrian traffic wishing to cross the road. The pedestrian guard-rails should be used wherever the uncontrolled crossing of the carriageway by pedesrians would seriously impede and delay vehicular movements and cause hazards to the pedestrians. The following situations generally warrant the provision of pedestrian guard-rails (The Indian Roads Congress, 1977):

(i) at complex intersections where because of physical and traffic conditions pedestrians are subject to unusual or extreme hazards if permitted to cross indiscriminately;

(ii) at public transport loading islands where it is necessary to confine pedestrians to travel on predetermined crosswalks areas;

(iii) at locations where it is necessary to compel the pedestrians to use facilities such as overpass or subway;

(iv) at locations of exits from schools, factories, cinema houses, stadiums, etc. where there will be sudden surge of crowd, and where pedestrians will be tempted to cross the carriageway at their will without regard to vehicular traffic.

The pedestrian guard-rails should be of sufficient height and so constructed as to make it difficult for pedestrains to go through or jump over. They should be of sturdy design.

2.5.2 Pedestrian Sidewalks

Pedestrian sidewalks should be provided on all new facilities and existing facilities as far as practicable. In order to induce people to remain on the sidewalk, its surface must be at least equal in merit to that of the carriageway. It cannot be accepted that people will walk on a broken or uneven sidewalk when a smooth and flat carriageway is beside it. Pedestrians will be more discouraged to use unpaved sidewalks (of ordinary earth) which are dusty in summer and muddy in rains.

The utility of pedestrian sidewalks is eroded by hawkers and vendors. Sidewalks are quite often invaded by shopkeepers display materials and sign-boards and by stacked construction materials. These conditions should be severely discouraged by strict enforcement of rules to enhance the safety, comfort and convenience of pedestrian movement.

2.5.3 Pedestrian Crossings

(1) AT GRADE PEDESTRIAN CROSSINGS

At grade pedestrian crossings should be located where the least amount of conflict results between pedestrians and vehicles. To minimize curb-to-curb walking distance, crosswalks at intersections should be located well back from the intersection area. At the same time they should be near enough to the intersection to encourage use by pedestrians and to permit full benefit from the traffic control devices.

At grade pedestrian crossings are normally regulated by control and protective devices; those commonly used are:

(a) Crosswalk markings, visible both day and night.

(b) Street lighting in the vicinity of pedestrian crossings.

(c) Pedestrian refuge islands, medians or other channelizing islands.

(d) Traffic signal controls with seperate "Walk" and "Don't Walk" indications.

(e) Barriers or fences between the sidewalks and vehicular traffic lanes to prevent pedestrian crossings at points of hazard or where unreasonable interference to traffic would result (as discussed earlier).

(f) Barriers, fences, or plantings in the median to prevent crossings on divided highways, especially at locations other than those designated for crossing.

Other methods of increasing efficiency of pedestrian crossings and traffic operations in areas of heavy pedestrian-vehicular conflict are:

(1) Elimination of turns.
(2) Provision of seperate signal phases for pedestrians.
(3) Elimination of some crosswalks.

The conversion from two-way to one-way operation results in a reduction in pedestrian-vehicular conflicts. Interference is further reduced by the elimination of one or more turning movements, sometimes a necessary measure during peak flow hours. High intersection capacity can thus be maintained, but it is not fitting unless turning movements can be made at nearby intersections without undue inconvenience.

The most hazardous pedestrian crossings are at locations where wide expanses of street areas are involved. Vehicle speeds are usually higher, and the pedestrian is vulnerable for a longer period of time. In these instances channelization will effectively serve both vehicular and pedestrian movements. The use of channelizing islands, pedestrian refuge islands, loading islands and combinations can do much to guide and assist proper pedestrian movements.

The location of the pedestrian cross-walk at intersections should fulfill the following conditions to ensure safety of the traffic:

(a) Adequate visibility so that the driver of an approaching vehicle has clear view of the traffic on the crosswalk and on the pedestrian sidewalks.
(b) Sufficient space on the pedestrian sidewalks for the pedestrian to wait.
(c) Freedom from obstructions, such as trees, sign posts and electric posts in the path of the pedestrians at either end of the crosswalk.

The uncontrolled crosswalk (zebra crossing) is simply an uncontrolled portion of the carriageway that is reserved for the use of pedestrians crossing the road. Unlike the mandatory traffic signals, the usefulness of the zebra crossing is dependent on the extent to which the driver is willing to yield the right-of-way to a pedestrian stepping on the crossing.

(2) SEGREGATED CROSSINGS

Pedestrian segregated crossings should be provided where pedestrian volume and vehicular traffic volume favour their use. Location and design of pedestrian subways or overpasses require individual study. They may be warranted where there are heavy peak pedestrian movements, such as at central business districts, factories, school or athletic fields in combination with moderate to heavy vehicular traffic, or where abnormal hazard or inconvenience to pedestrians may otherwise result.

Pedestrtian subways or overcrossing structures are not likely to be used unless it is obvious to the pedestrian that it is easier to use such facility than to cross the carriageway. Structures that necessitate pedestrians walking up and down stairs are not likely to be used unless strict control measures are used. Ideally all crossings should be of this type since there is no possibility of conflict between the pedestrian and the vehicle. Unfortunately, this type of crossing also happens to be the most expensive.

2.5.4 Traffic Signals

Traffic signals are used in a variety of ways to control pedestrian movement across the carriageway. The most widely used procedure is simply to allow pedestrians to cross with the signal lights when opposing vehicular traffic is normally brought to a standstill at a junction. Although this is efficient in majority of cases, problems may arise through conflicts between the pedestrian flow and turning vehicles. When this occurs, a seperate pedestrian phase may have to be included in the signal cycle. When pedestrian volumes are very high, vehicular traffic is moderate, and streets are so narrow that it is not possible to have seperate traffic lanes for turning and straight-ahead traffic, consideration should be given to the use of an all-red period during which the pedestrians take the shortest way across the intersection rather than the traditional rectangular route.

Signal-controlled crossings are also provided at locations other than intersections where considerable pedestrian traffic accumulates.

2.5.5 Criteria for Establishing Pedestrian Crossings

Standards and guidelines are needed by the traffic engineer to facilitate selecting the most appropriate level of pedestrian control to handle a given situation. Currently, engineering judgement is the criterion used to justify the installation of pedestrian signals and pedestrian phases (Institute of Transportation Engineers, 1986). The most important considerations in deciding on the installation of pedestrian indications are:

(1) Pedestrian flow.

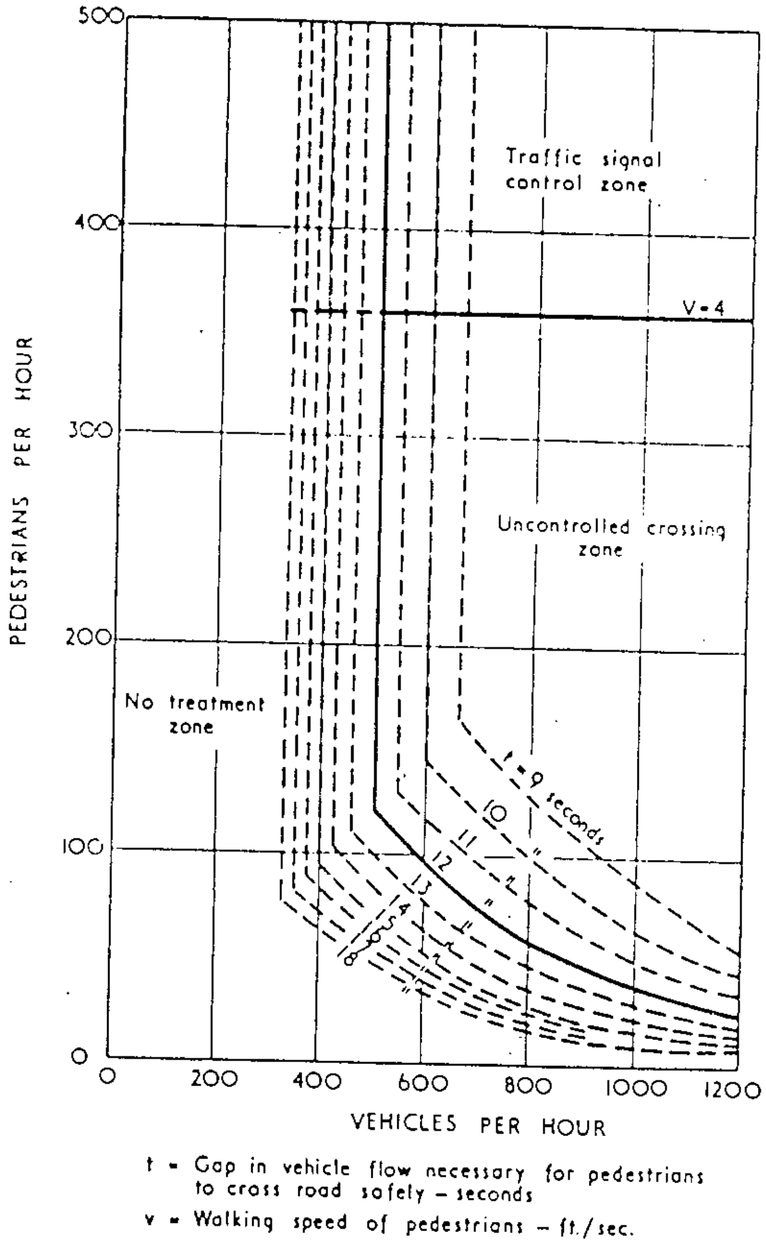
(2) Traffic volumes.

(3) Type of pedestrians.

A number of methods used in justifying these crossing facilities are based on the frequency of the occurrence of adequte gaps in traffic for the use of pedestrians. They also assume that vehicles and pedestrians arrive at random intervals in time. No theoretical allowance is made for saving in accidents in the methods referred to, although in practice some such allowance has to be made (Dept. of Scientific and Industrial Research, 1965). But the need for these regulating devices is most often indicated by the accident statistics at particular locations, although criteria based on the economic savings have also been suggested (O'Flaherty, 1974).

A very extensive analysis appears to have been made by Underwood (Dept. of Scientific and Industrial Research, 1965). He assumes that the maximum permissible delay to pedestrians should be that level at which the rate of increase in delay, with increasing vehicle flow, begins to accelerate. He derives minimum vehicle flow figures from this assumption . To define the minimum pedestrian flow necessary, he assumes that on the average no more than one pedestrian should be waiting to cross at any time. Using these facts, he derives expressions from which the curves in Fig. 2.2 have been drawn. These indicate, for various levels of vehicular and pedestrian flow, whether an uncontrolled crossing is needed or not. In addition, Underwood derives conditions for the establishment of traffic signal control, as shown in Fig. 2.2, by assuming that this was necessary if the proportion of time available was less than 60 per cent of the total time.

The disadvantage of this and other similar types of analyses of the crossing problem is that they all depend on some necessary arbitrary assumptions concerning the level of pedestrian delay that can be permitted, the value of pedestrian time, and the extent to which pedestrians are prepared to suffer delay.



Source: Dept. of Scientific and Industrial Research, 1965, p.402

Fig. 2.2 CRITERIA FOR THE ESTABLISHMENT OF PEDESTRIAN CROSSINGS

2.6 DESIGN STANDARDS

The measures discussed should aid the creation of paths for safe and convenient pedestrian movement. It should make it possible to provide a continuous pedestrian pattern within the target areas which link the focal points of activity.

The basic elements of a walkway system are the various paths, the nodes involving activity concentrations, the intersections, and the vertical access to overpasses and subways. In providing a walkway system, the general aim should be to express a uniform design identity throughout, in terms of function and visual quality, and to aid the pedestrian to orient himself and be aware of his right to use such areas. The overall system must be direct and easy to comprehend and should avoid repeated changes in direction.(Design standards reviewed below are mainly based on: O'Flaherty, 1971; Antoniou, 1971; AASHTO, 1973; Institute of Transportation Engineers, 1976; The Indian Roads Congress, 1977; Sharma, 1985; Davis and Braaksma, 1987; etc.)

2.6.1. Walkway Capacity and Width Considerations

A walkway capacity is influenced by the great fluidity and easy adjustability of pedestrians to different space conditions. Other factors affect the capacity of walkways. For example, during rush hours certain sidewalks have essentially one-way and comparatively fast moving pedestrian traffic. The capacity under such circumstances would be greater than that in shopping areas during shopping hours where pedestrians are moving casually and in different directions.

The capacity of paths (sidewalks) may be taken as 39 persons per meter (12 persons per foot) of width of pavement per minute, after deducing 0.5 m (1.5 ft) "dead width" (1 m in shopping areas). Suggested minimum width is 1.2 m (4 ft) for residential areas and 1.8 m (6 ft) for commercial or major school routes.

Similarly, the size and layout of particular nodes will depend upon the kind of pedestrian activities that take place in an area. Each situation presents different problems, together with different opportunities for solutions. At the intersection of an activity node, a minimum width of 9.5 m (31 ft) is needed to allow for variations in walking speeds due to window shopping and for convenience of movement. At intersection nodes, pedestrian movements are likely to be the heaviest, converging from various directions. Therefore, a wider area than the recommended path will be required. Such nodes must be primarily designed for the purpose of accommodating intensive pedestrian travel and must allow for orientation and directional changes.

2.6.2 Vertical Access

Assuming that a change of level is required, a decision whether to construct an overpass or an underpass (subway) is generally determined to the physical characteristics of the area. However, the use of vertical access facilities, e.g., by staircases, ramps, escalators, lifts, etc., will be necessary.

To make such facilities more inviting, the differences in walk levels should be minimized. Stairways should not give the appearance of being steep. A landing should be provided for every 1.5 to 1.8 m (5 to 6 ft) change in elevation, which is approximately eye height. The treads should not be less than 28 cm (0.92 ft) wide, and the risers not be more than 15 cm (0.5 ft) high.

Pedestrian ramps are generally preferred to stairs. Ramps require greater travel distances than stairs but are much easier to negotiate by the physically handicapped and people with baby carriages and shopping carts. Gradients of ramp should be not more than 15 per cent and preferably not steeper than 10 per cent as recommended by AASHTO (1973). J. Antoniou recommended a maximum gradient of 1 m in 12.5 m (Antoniou, 1971). A maximum acceptable length, measured horizontally, should be 36m. If a greater length is required, a flat section should be provided with a minimum length of 4.5 m. To limit the space required, stairs or ramps may be made more compact by reversing direction or by a winding alighnment.

When escalators are used, they normally operate at a slope of 30 degrees and thus take up less space than ramps.

The vertical clearance over roadways at pedestrian overpasses should be slightly higher than the minimum vertical clearance for vehicular structures. This additional height requirement results in a difference in elevation between a walkway at roadway level and the walkway of the pedestrian overpass of between 5 and 6.7 m (17 and 22 ft). It is generally desireable to minimize this difference in elevation by depressing the roadway or raising the approach to the pedestrian overpass.

Pedestrian subways should have a vertical clearance of 2.4 m and, in some cases, 3 m. While this facility is being considered, thought should be given to any possible need for its supervision and maintenance as this type of crossing can be subject to vandalism and other criminal acts.

2.7 PEDESTRIANIZATION: EXPERIENCE IN SOME COUNTRIES

2.7.1 Changing Trends

Many European and American towns and cities are experiencing a new trend in transport policy. Policy makers no longer accept as the norm the urban street where the motor vehicles totally dominate the pedestrian and the cyclist. Instead, many now seek to achieve a balanced and harmonious coexistence between the two (Hass-Klan, 1986). This change leads not only to more livable streets and better protection of urban areas, but also to a reduction in the severity of accidents and to enormous social and economical benefits.

Policy change has grown out of an increasing awareness of environmental problems in urban areas and the realization that without some fundamental action, the functioning of our cities is threatened. Just as the environmental consciousness varies from country to country, so does the extent to which the policies of traffic restraint have been implemented.

In the cities of the developing countries, planning for pedestrians is a very arduous and complex task for the transportation planner who has to face various practical constraints while formulating policies to strike a balance of convenience among the various road users. In urban transportation planning so far, pedestrians have largely been neglected. However, some developing countries, for example India, have recently started planning new schemes with pedestrians as the main focal point.

Following is a brief review of the experience of some developed countries (Britain, The Natherlands and Federal Republic of Germany) in addition to the Indian experience in Bombay. Reviewing such examples will highlighten the concepts and possible measures that may help to induce the development of similar trends in Dhaka city and other urban areas in Bangladesh.

2.7.2 Britain

2.7.2.1 PEDESTRIANIZATION

While ideas for pedestrianization were developed in Britain in the 1930s and 1940s, the first purpose-built pedestrian precincts were not opened until the early 1950s (Hass-Klan, 1986). The same type of precinct also became a feature of town centre developments in the new towns, and from the 1960s such pedestrian facilities were both common and popular in British towns.

The first closure to motor traffic of significant length of an existing street was in Norwich in 1967 - some forty years after Germany's first street closure (in Essen in 1926). Liverpool began closing some city centre streets about a year later, closely followed by Leeds (1970). However, neither excluded buses from these streets. It was regarded desireable to keep buses in pedestrian streets because of the accessibility that they afford, particularly to shops.

Most British pedestrianization schemes were carried out during the 1970s. However, in terms of both scale and design standards, the schemes are modest compared with those elsewhere in Euorope. Furthermore, there has been little recent investigation into the impact that pedestrianization has on traffic, trade and commerce after closure. But observations alone indicate positive results.

Many of the pedestrianized shopping streets are largely dominated by national chain stores. The pedestrianization of the 1970s may hardly be described as helping to create attractive urban space for recreation or tourism. It appears, however, that there might be signs of improvement recently. First, there seems to be a revival of plans for pedestrianization, and secondly those plans show signs of being considerably more sophisticated and directed towards creating an attractive urban environment and not merely getting the cars off the streets.

2.7.2.2 TRAFFIC RESTRAINT

Influenced by the Buchanan report (Ministry of Transport), many local authorities in Britain had ideas, in the late 1960s and early

1970s, of developing "environmental areas". Most schemes were a combination of housing improvement, traffic restraint, and many different types of street improvement. Environmental improvement included pedestrianized streets, children's play areas, car parking spaces, garages, trees and landscaping.

In the city centre, the main weapon of traffic restraint during the 1970s and 1980s has been parking restrictions. In addition to parking regulations, several towns have succeeded in improving public transport as a means of reducing private transport to the town centre. Considerable success has been observed where low fare policy and integrated transport approach are applied (as in Sheffield and Newcastle).

2.7.3 The Netherlands

2.7.3.1 THE WOONERF

The Woonerf - literally, living yard - has been the most celebrated Dutch contribution to urban environmental traffic management in the last decade (Kraay, 1986). Originating in a 1975 report from the Netherlands Association of Local Authorities, the idea has been widely applied in Dutch towns and cities. But the woonerf is only part of a whole package of measures - including the design of urban traffic environment, legislation and law enforcement, information and training - to influence driver behaviour and thus improve both road safety and quality of life. It differs from a normally structured residential street, because the paved area can be (partly) used for traffic as well for playing, walking and parking. But this area has no function for through traffic.

Emphasis has been put on structuring the residential area so that road users, especially drivers, are induced or compelled to drive slowly. The principle is based on the introduction of special rules for behaviour and points out these rules through placing traffic signs.

2.7.3.2 RECENT RESEARCH RESULTS

At the end of 1970s, a number of shopping, village and city woonerven were created. Streets and residential areas were also reconstructed without the intention of turning them into woonerven. Research of the Institute for Road Safety Research (SWOV) into the effects of countermeasures in woonerven and other infrastructural countermeasures showed that accidents were reduced but without significant difference between two types of experimental areas. It also showed that the reduction in accidents, in all types of experiments, was greatest for pedestrians. As an experiment, rigorous countermeasures were taken so as to increase safety and habitability. The road system was divided into arteries, access roads and residential streets. Each type of roads was reconstructed according to function.

In residential streets, the appropriate sets of measures vary from fairly simple ones (one-way traffic and a simple hump) to rather more complicated (one-way traffic combined with a variety of speed-retarding facilities) and to very drastic ones (woonerf or similar structure). The initial results of accident research indicated positive effects on road safety in urban neighbourhoods. In residential streets the number of accidents was halved. The aggregate reduction for all types of roads in the experimental areas was about 20 per cent.

2.7.4 Federal Republic of Germany

2.7.4.1 PEDESTRIANIZATION

Pedestrianized areas in German towns received considerable international attention in the 1960s. In Cologne and Essen, pedestrianization started early: some of the major shopping streets had been closed to traffic by the end of the 1920s. These streets were redesigned in keeping with the newly-built shopping centres and to allow free and easy movement of pedestrians (Monheim, 1986).

By today, more than 800 pedestrianized areas exist in the country as a whole. Most towns and cities with population of more than 250 000 have pedestrian areas, not only in main centre but also in some sub-centres. Almost all towns with over 50 000 people today have a pedestrian area. In large cities, and also in small towns as well, pedestrianization has been the cause of recurrent protests and fears on the part of local traders. Indeed, it is the pressure exerted by the retailers which produces the greatest obstacle to pedestrianization.

2.7.4.2 ENVIRONMENTAL TRAFFIC RESTRAINT ON MAJOR ROADS

The FRG has been conducting a major experiment and associated research project on Area-Wide Traffic Restraint in six model cities. The aim is to reduce the impact of vehicular traffic in large areas within cities. During the 1970s, promising results were achieved with traffic restraint measures in residential areas.

To transfer these measures to large areas, including roads with heavy traffic and businesses, was a main consideration. It was important to develop a clear aim and to apply this in an operationalized manner. The main aims were in the areas of traffic , environmental and urban development.

Berlin is one of the six model cities in this project. The model area is densly populated. In purely residential areas in the FRG, one-way streets are set up to reduce through traffic at low cost. This is not a feasible solution for the multiple use of the roads, as it creates problems for the people not familiar with the area and traffic rules are broken frequently. In Berlin model area, as in other models, a different philosophy is applied: all destinations in the area should be accessible using direct routs, roads should also remain open for motorized traffic, but obstacles to fast driving are increased by narrowing roads, by slightly elevating road surfaces or by other measures. In typical streets, narrowing of the road was used. Narrower sections are easier to cross by pedestrians. The narrower sections with the humps are repeated at equal intervals (every 40 to 50 meters).

2.7.5 India

In India, the influx of population from rural areas has tremendously increased the volume of pedestrians on urban streets. The socio-economic problems lead to a ribbon development for want of adequate space in metropolitan cities which afterall have limited infrastructural facilities and job opportunities. Limited housing facilities and the high cost of living in a metropolis force most of the workers to find residential space just at the outskirts of the meropolis. This consequently leads to a very large number of passenger-trips causing heavy pressure on mass transit (Pasricha, 1983).

Bombay metropolis is the biggest city in India having a population of nearly 11 million. There is a large number of big industries spread all over the body of the city, including the CBD and the suburbs. There are two major modes of transport: local buses and suburban electric trains. The pedestrian dispersal at the important railway stations in the CBD creates a serious traffic situation.

Sidewalks, especially on the main arteries of the city, are substantially encroached by vendors, street furniture, and by the repair of the underground public utility lines - telephones, electricity supply, the drainage system and water supply.

Though the vehicular traffic is not as high as in many other cities of the world, the pedestrian density has made the planning and management of traffic very difficult. Pedestrians, as in other develponig countries, are mostly compelled to be so since they have no choice but to travel by mass transport or on foot.

As no major schemes have been implemented in Bombay and the concept of traffic management has only recently been put into practice for the first time in India, there was an initial resistance to schemes which could cause minor inconveniences and result in longer detoures for private car owners. While formulating various schemes, the most complicated and serious problem generated by overwhelming numbers of vendors was not taken into account and, therefore, the plans remained incomplete. One-way and pedestrian plaza schemes have also been resisted by private motorists. These factors are the weakest point of the concerned administration.

By the year 1982, two major schemes had been implemented in Bombay and accepted by almost all the lobbies, therefore, increasing the credibility of the administration. The schemes enhanced efficient and safe pedestrian movement around Victoria Terminal (V.T.) and Churchgate stations, the two principal railway stations in central

Bombay.

The V.T. railway station generates heavy pedestrian traffic of the order of 75 000 per hour. The scheme eliminated the most vehicle-pedestrian conflicting points by diverting traffic at one point to another road nearby and by channelization at the other two points to reduce the width for pedestrians to cross. This scheme reduced road accidents by 42 per cent and nearly eliminated serious and fatal accidents. It also resulted in efficient dispersal of rail commuters. Noise level around the V.T. has declined.

Churchgate station is an equally important terminal where commuters were made to use subway and overpass to cross the road outside the station. Inadequacy of these two facilities and the long four signal phases for vehicular traffic causes long delay to pedestrians and heavy build-up of vehicular traffic. The development scheme banned all right turns at the main intersection, thereby simplifying the complicated signal junction into an almost T-junction. Pedestrians were given the facility to cross at-grade. Benefits accrued included reduction of number of accidents by 27%, increase of vehicles' travelling speed, major improvement in pedestrian mobility, better discharge of commuters and reduction in noise level. This was the first scheme prepared regarding pedestrian as the main traffic unit.

Chapter 3

METHODOLOGY

AND

INVESTIGATION TECHNIQUES

3.1 SOURCES AND COLLECTION OF DATA

Pedestrian and vehicular traffic field survey was the main direct source of data required for this research. Literature survey, consultations with officials, in addition to the various accident statistics and reports, provided ample sources of valuable data.

3.1.1 Literature Survey

Extensive literature survey was carried out as topics relevant to the subject of this research were spread throughout large number of journals, books, reports, newspaper articles, etc. Information on pedestrian traffic planning and management in Dhaka city was hardly available. Experience of many developed and developing countries in related fields was reviewed to understand the extent of the problem in Dhaka and to perceive the prospects considering various inputs and constraints.

3.1.2 Consultation with Officials

This was sought to explore the perception of some officials in concerned departments on main relevant issues: pedestrian traffic difficulties and existing facilities, traffic management, public transport, accidents, parking, future implications, etc. The main consulted departments include the Dhaka Municipal Corporation, Roads and Highways Department (RHD), RAJUK (the city development authority), traffic division of Dhaka Metropolitan Police, Planning Commission, General Electric Company of Bangladesh (GEC), etc. These departments supplied valuable statistics, reports, maps and other information materials.

3.1.3 Accident Survey

Accident statistics for Dhaka city were mainly obtained from the following sources:

1. Dhaka Metropolitan Police - Traffic Division.
2. Daily newspapers particularly The Bangladesh Observer, New Nation and Ittifaq.
3. Bangladesh Bureau of Statistics: "Statistical Yearbook of Bangladesh, 1986".
4. Report of the Bangladesh Government committee constituted to study and identify the causes of road accidents and to suggest remedial measures, 1983.

3.2 SELECTION OF THE STUDY AREAS

Specific studies and field survey were focussed on areas selected for the reasons discussed below.

3.2.1 Mirpur Road

This road was selected as a major artery with considerable pedestrian and vehicular traffic flow. This is a typical road where the problems of pedestrian-vehicular interaction and other traffic problems are very pronounced. The predominant elements that constitute various conditions and difficulties were considered to represent the overall situation of other major roads in the city.

3.2.2 New Market Shopping Area

One of the most important and busy shopping areas in Dhaka city, the New Market shopping area is a centre of intensive pedestrian activities and intruded by heavy through vehicular traffic. Here, the problems of severe pedestrian-vehicular conflict, traffic pollution and difficulties of pedestrian accessibility are very pronounced. An important feature of this area is the existing pedestrian overpass, which helped to examine the effectiveness of this facility under the present conditions.

3.2.3 At-grade Crossings

The selection of at-grade crossings, considered to study pedestrian behaviour, was basically based on representing different crossings in the city by few typical ones where protection to pedestrians crossing the road at the same grade was provided as classified below.

1. Crossings at intersection.
   (a) Signalized intersection.
   (b) Non-signalized intersection.
2. Crossings far from intersection.
   (a) Controlled crossings (signal- or police-controlled).
   (b) Uncontrolled crossings (zebra crossings).

Selection also considered related factors such as availability of medians, intersection layout, etc. All the crossings were located at major arterial streets of the city with high vehicular flow.

3.3 AREA ANALYSIS

The basic approach was to define the problems of study areas. What was required was a descriptive method which concentrated on exposing the major problems so that, supplemented by field survey data, practical and relevant solutions could be recommended. Fig.3.1 groups together the basic elements which needed to be examined in order to clarify current conditions rapidly.

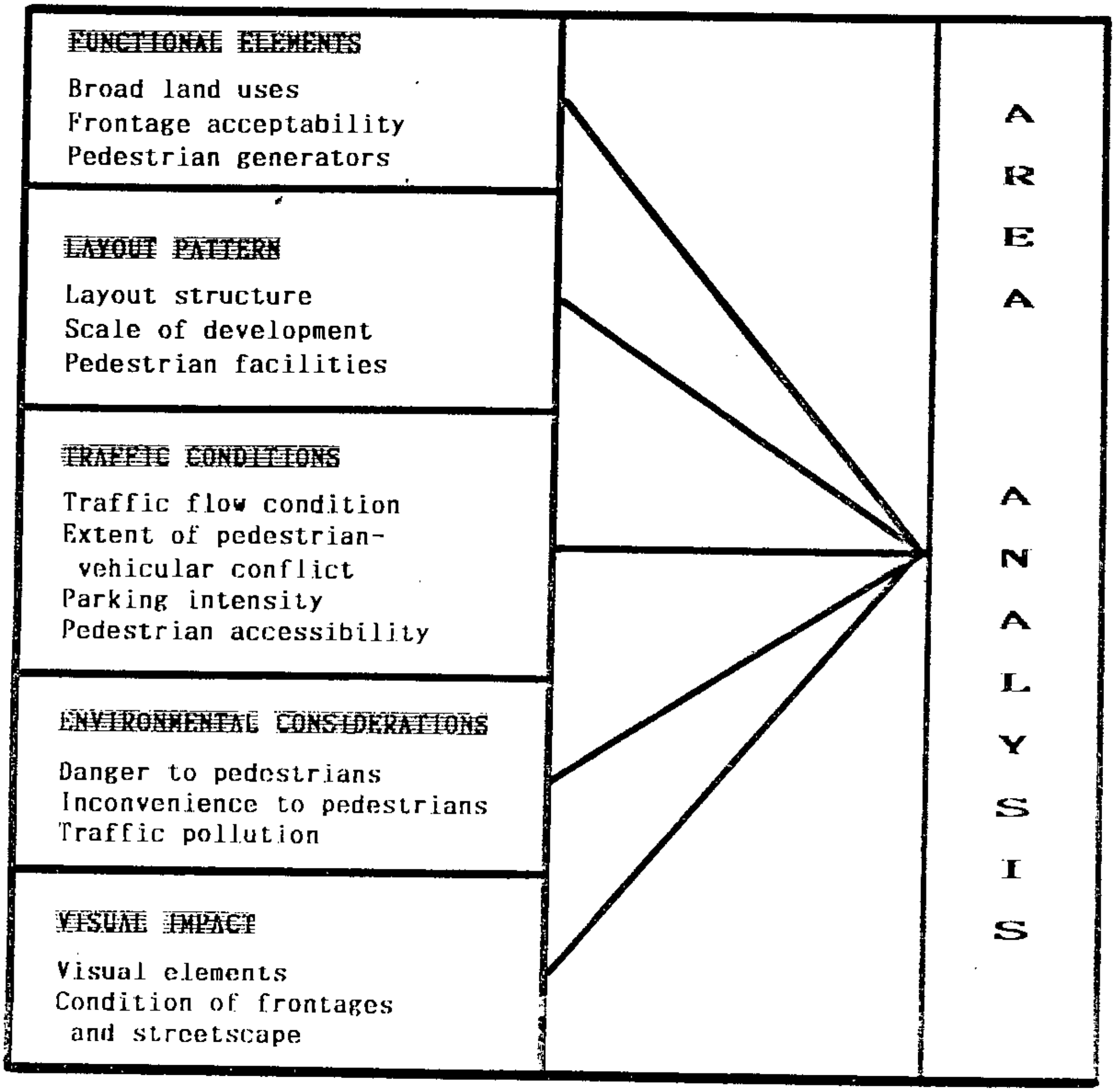


Fig. 3.1

THE BASIC ELEMENTS OF STUDY AREAS' ANALYSIS

3.4 FIELD SURVEY

Traffic field survey was required to obtain pedestrian and vehicular flow data to supplement other information on the study areas. This was possible through conducting pedestrian and vehicular traffic field count in the selected study areas. The obtained data revealed useful information about the prevailing situation though, unfortunately, these data could not be compared with similar sets of data as extensive pedestrian traffic survey has never been carried out, not only in the study areas but also any elsewhere in the city. All works of field survey were conducted in reasonably good weather conditions and on non-rainy days. Extreme care was taken for getting most accurate results. Therefore, survey was conducted only on the most normal days with typical traffic flow conditions. An IBM PC and Lotus 123 software aided in producing graphical representation of the field survey results. The following data categories were obtained in the survey.

1. Pedestrian flow:

   (a) Flow at the sidewalks at 5 selected sections of Mirpur Road.

   (b) Crossing flow at the 5 sections of Mirpur Road and at the New Market shopping area (including the flow at the overpass).

   (c) Flow at crossings.

2. Pedestrian density:

This included pedestrian density at the sidewalks of Mirpur Road along the strip bisecting the New Market area.

3. Vehicular flow;

This included flow in both study areas and considered the flow and its effects on road capacity, measuring the flow in terms of passenger car equivaleht (PCE).

3.4.1 Pedestrian Flow Measurement

AT SIDEWALKS

The total field servey period (700 to 2000 hours) was disaggregated into continuous 30-minute counting periods. "Stationary observer" technique was used where one observer was assigned at each sidewalk to count every person passing him. A suitably designed survey form facilitated data breakdown considering flow direction, age group and sex.

ACROSS THE ROAD

A stationary observer was assigned to count pedestrians crossing the road at each section within a strip of 100 m. Similar servey forms were used as in the above survey for Mirpur Road. In case of crossing flow in New Market area, the survey form simply considered the number of persons regardless to direction, age and sex. The latter counting method was also applied for the flow at the overpass. The very high pedestrian flow in this area constrained the use of details that were feasible for the flow in Mirpur Road.

AT CROSSINGS

This survey was conducted to study pedestrian behaviour at crossings. The basic method employed was to consider a number of at-grade crossings on some of the arterial roads of the city representing all typical cases. Having established the number and types of crossings, the next step was to measure the sections on the ground and to mark them by any existing and easily visible marks - such as signboard, electric post, street mark, etc. At each section, a distance of 18.3 m (20 yards) was measured out on both sides of the crosswalk (This distance was selected as it was used in previous studies in some countries, Britain for example, to study pedestrian behaviour, in addition to its convenience). In all cases, the crosswalks were quite visible to drivers and pedestrians. Two observers were assigned at each crossing; one to count number of pedestrians using the crosswalk and the other to count those crossing within the measured section excluding the crosswalk. For each crossing, the observation period was 180 minutes of continuous count. This period included a traffic flow peak. Time was disaggregated into 15-minute counts to enhance reliability and check consistency of the data.

3.4.2 Pedestrian Density Measurement

The method of assessment employed is called the "moving observer" technique. The sidewalk was divided into 100-m strips. To obtain an estimate of the number of people on this given length of sidewalk, an observer traversed its length in one direction, counting every person he passed in whatever direction they happened to be moving and ignoring those who overtook him going in the same direction. He then traversed the section in the opposite direction doing the same thing. The average of the two totals he obtained was the estimate of the average number of people on the sidewalk.

In measuring pedestrian flow and pedestrian density, all pedestrians were assumed to use the sidewalk, thus the count took into consideration also all pedestrians walking off the sidewalk along the carriageway.

Density measurement was repeated for each sidewalk every 30 minutes. The moving observer technique was first used at one section in Mirpur Road, but was abandoned at the other sections mainly because of low density and abrupt change in the flow. However, this technique was found useful for density measurement in the New Market shopping area considering the high density and nature of pedestrian movement in this area.

3.4.3 Vehicular Traffic Survey

The first step was to select the vehicle classification to be used for field traffic count. All the vehicles travelling on Mirpur Road, and similarly in New Market area, were classified considering their types and passenger car equivalence. On Mirpur Road, the observation station was selected near the intersection of the road with Road No. 10 of Dhanmondi (This is an intermediary location for the study area and, moreover, the vehicular flow at this section is expected to be close to the real average flow on this route). Four observers were assigned to count the vehicles passing in both directions: two for each direction for motorized and non-motorized vehicles. In New Market area, similar counting method was applied, with observation station selected at the pedestrian overpass.

Chapter 4

PEDESTRIAN AND VEHICULAR TRAFFIC IN DHAKA CITY

4.1 TRAFFIC IN DHAKA CITY

4.1.1 Introduction

Dhaka is a fast-growing metropolitan city with a population of about six million crowded in an area of 440 square km. The central areas which hold most of the population have a density of over 10 400 persons per square kilometer (27 000 per square mile).

In the years following the liberation war of the country, the rural-urban migration has been the major component of the population growth rate. This uncontrolled influx of people has brought the worst effects on the infrastructure of the city. The urban life quality has deteriorated seriously. The resulting deficient services have posed continuous impediment to development.

One of the most tangible effects is the multi-dimensional traffic operational problem. Congestion and accidents are regular features of the city road network. The consequence is the loss of life and resourses to the nation. Establishment of an efficient road transport system is one of the topmost challenging issues of the country's development programmes.

4.1.2 Traffic and Paratransit

Traffic in Dhaka consists a mixture of fast motorized traffic and primitive non-motorized slow modes, in addition to the pedestrians. The pedestrian traffic is very heavy due to high density of population. The very widely diversified traffic units with their great disparity in size and speed create a number of problems and areas of conflict. Because of low speed of certain types of vehicles, the capacity of roads is adversely affected and severe congestion and accidents occur. Most of the diversified types of vehicles operate under public transport sector. Many of them are paratransit modes. The following discussion describes briefly the most common modes (Taxi cabs are still unpopular for being expensive and only 392 vehicles of this type have been licenced since 1972).

Cycle-rickshaw:

The cycle-rickshaw is used throughout Bangladesh and is the most common form of non-motorized transport for short distance travel within towns and cities. This human-driven three-wheeler has always been regarded as the major contributor to traffic jams, accidents and many other inconveniences. In Dhaka city, the large numbers of cycle-rickshaws (over 100 000) and their incredible lack of discipline do pose serious traffic problems. Slow speed and comparatively unstable structure are the most disadvantageous features of cycle-rickshaws.

Auto-rickshaw (baby taxi):

Auto-rickshaw is based on three-wheeled scooter chassis with two seats behind the driver (illegally three or four passengers are often carried). These vehicles operate as taxi (likecycle-rickshaws) taking the passengers to their destinations and not stopping to pick up other passengers en route. They tend to congregate in ranks at major transport interchange points and main activity areas. Regarding traffic operation, auto-rickshaws are considered much less of a problem compared to cycle-rickshaws.

Auto-tempo:

The auto-tempo is based, like the auto-rickshaw, on three-wheeled scooter chassis, but instead of having two seats behind the driver it has two banks of total eight to ten seats facing each other. These vehicles have only appeared in Dhaka during the last decade. More common style of operation is similar to a bus. Vehicles ply between two fixed points on a defined route and pick up and drop passengers anywhere along that route. Auto-tempos represent a challenge to both cycle-rickshaws and buses: to cycle-rickshaws because they can offer much lower fares, but still with some element of personal service; to buses because they can operate in streets that would not normally be accessible to ordinary buses.

4.1.3 Public Transport

Public transport in Dhaka city is characterized by its high growth rate, its diversity and its poor financial performance. Demand for urban public transport services is already enormous and growing at a rapid rate, due largely to the rise in population of the city. This has given rise to paratransit or intermediate public transport modes such as cycle-rickshaws, mini-buses, auto-rickshaws and tempos. Though personal motorized vehicle ownership will continue to rise, walking and public transport will remain the major travel modes. With increasing city size and area, trip lengths will increase and the burden of commuter travel will increasingly fall upon the public transport sector, as longer trips will tend to discourage walking and cycling as convenient alternatives.

Although a few cities in developing countries have or are building rail mass transit systems, the vast majority will still be relying for many years to come on road-based systems (Jacobs, et al., 1986). Thus in the future, as at present, the conventional bus and the many forms of paratransit will be playing the key role in meeting the increasing demand for transport in these cities.

With the low levels of car ownership that exist in Dhaka city, and with the growing demand for public transport, the existing mobility conditions are detrimental to economic wellbeing of the community. The inadequacy of the present system and its inefficient operation, which results in accidents, congestion, overloading and low levels of service, are mainly attributed to such factors as lack of buses, inadequacy of roads and insufficient funds.

4.1.4 Mixed Traffic Operation

A spectrum of slow and fast moving vehciles operate on the roads of

Dhaka city, with diverse operational and dimensional chracteristics. The resulting operational incompatibility aggravates the situation.

The speed variation and constrained maneuvering capability undermine the efficiency and capacity of the roads and intersections. Slow traffic occupies the street space for longer time than the faster vehicles and hence reduces the capicity of the road. Slower vehicles are subject to more crossing and overtaking maneuvers by the faster ones, thus in turn reducing the effective speed of the faster traffic.The slower traffic has also to slow down during crossing and overtaking by the faster ones in addition to running the risk of accidents during these maneuvers. If the volume of slow moving traffic is predominant, a major portion of the carriageway is occupied by slow moving vehicles and the faster traffic has to be slow down to almost the speed of the slow moving traffic. This occurs very frequently on even many of the major arterial roads of this city. The situation is more confusing and frustrating at the intersections. Points of severe conflict emerge when slow and fast vehicles move forward or turn in different directions, each vehicle trying to force its way. Constant stoppage, acceleration and deceleration and movement in low gears increase operational costs and wear and tear of vehicles. The severity of these problems caused by mixed operation, along with the rapid increase in the numbers of vehicles and pedestrians, has exposed the inadequacy of the existing street system and traffic management.

4.1.5 Modal Choice and Walking

Data on pedestrian travel in Dhaka city is very scarce and hardly available. When available, these data might prove rather unreliable and difficult to compare with other data sets. Traffic zone sizes, population densities, socio-economic status, etc. together with the availability and efficiency levels of public transport, strongly affect inter- and intra-zonal trip rates, especially in reference to short trips. Trip linkages are very difficult to define, and since a large amount of pedestrian trips fall in this category, pedestrian trip rates vary widely according to the specified trip definitions.

In an attempt made in 1981, six neighbourhoods were selected to represent social and spatial variations within Dhaka city (Hussein, 1987). Two neighbourhoods were chosen to represent each of the three existing social groups (upper, middle and lower social classes). For each class, one neighbourhood was located closer to the city centre and the other away from the centre. The sample survey showed the following proportions of the modal choice: walking (29%), cycle-rickshaw (37%), car (19%), auto-rickshaw (3%), motor-cycle (2%) and cycle (1%).

Modal choice, however, deviated significantly from this overall pattern when individual neighbourhoods were considered. According to the same study, car trips accounted for (51%) of the trips in the Banani high-class neighbourhood were many households (88%) have access to cars, the cycle-rickshaw took second place (21%). Walking accounted only for (8%). In the Dhanmondi high-class neighbourhood, cycle-rickshaw accounted for (42%) and cars (38%). This neighbourhood is located closer to business centres and so cycle-rickshaw is a convenient mode for short trips. This neighbourhood is also well connected by bus service and this mode account for (10%) for trips to the central business district (CBD).

In middle-class neighbourhoods, trip pattern was as follows: In Mohammedpur - walking (27%), cycle-rickshaw (29%), car (14%) and bus (10%). In Kalabagan (a neighbourhood closer to the CBD) - walking (17%), cycle-rickshaw (62%), car (9%) and bus (4%).

In poor neighbourhoods, walking was found as the predominant mode of transport: In Maghbazar (close to the CBD) - walking (68%), cycle-rickshaw (20%) and bus (7%). In Lalbagh (in old Dhaka) - cycle-rickshaw (40%) and the rest of trips were on foot.

These data are a qualitative indicator, as factual figures at present are likely to be different. Various parameters that define and influence trip pattern or modal choice - such as socio-economic status, car ownership, public transport efficiency and accessibility, etc., change along the span of time. In the above study, trip linkages and walking within areas of activities were not considered, though considerable amount of pedestrian movements falls in these categories. Amounts of walking, therefore, are expected to account for higher proportions.

4.2 MAJOR PEDESTRIAN ISSUES IN DHAKA CITY

4.2.1 Introduction

There are certain traffic operational problems which arise due to the lack of proper knowledge and care regarding the planning of the traffic system at the design stage and the control and administration of traffic in the operational conditions. Dhaka was marked as one of the world's most vulnerable cities as the traffic system and traffic management are concerned (Rahi and Ahmed, 1983). The traffic menace in this city has been causing tremendous suffering for the community, not only in terms of accidents but also in terms of many inconveniences and environmental destruction. The 700 km (440 mile) road network is a daily arena where the majority of the road users struggle their way out amidst congestion, confusion and traffic pollution. Different constraints continue to frustrate hopes for a better transportation system. Appropriate measures are yet to be considered seriously to improve the existing conditions to maximize efficiency and safety.

4.2.2 Pedestrian Accidents

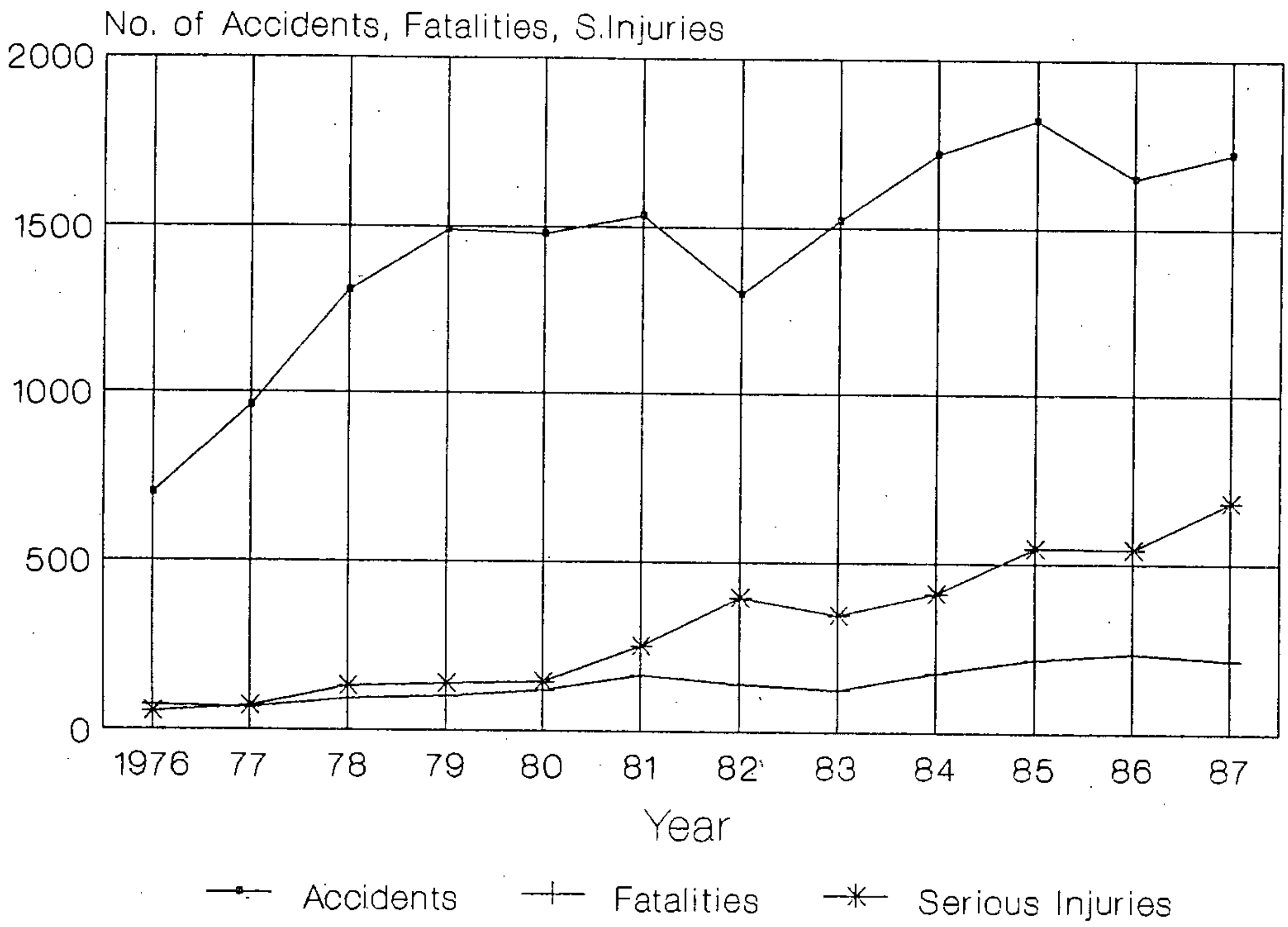
Two types of pedestrian-vehicular interaction cause problems: indiscriminate road crossing and walking along the carriageway. The general level of road crossing facilities provided for pedestrians is poor. While there is a lack of pedestrian crossings in areas of pedestrian activities, there are also many instances of marked crossings being provided at inappropriate locations, particularly on high-speed or high-traffic volume arterials. Signal-controlled pedestrian crossings are few (only five signals in operation installed by General Electric Company of Bangladesh Limited) and they are not well enforced. Consequently, respect for crossings by pedestrians and drivers alike is at very low level. The pedestrian often walks along the carriageway because the sidewalk is either non-existent, too narrow or impassable. Where an adequate sidewalk is provided, pedestrians generally use it.

The pedestrian-vehicular interaction, in the light of different factors of accidents, often turns to be disastrous. In terms of road fatalities and serious injuries, the pedestrian casualties constitute a major proportion amongst road users in the city. Aside from the arterial roads, residential roads are not safe for children to play. Vulnerability of route to school is high (Graphs 4.1, 4.2, 4.3, 4.4, 4.5, and Tables 4.1, 4.2).

4.2.3 Environmental Difficulties

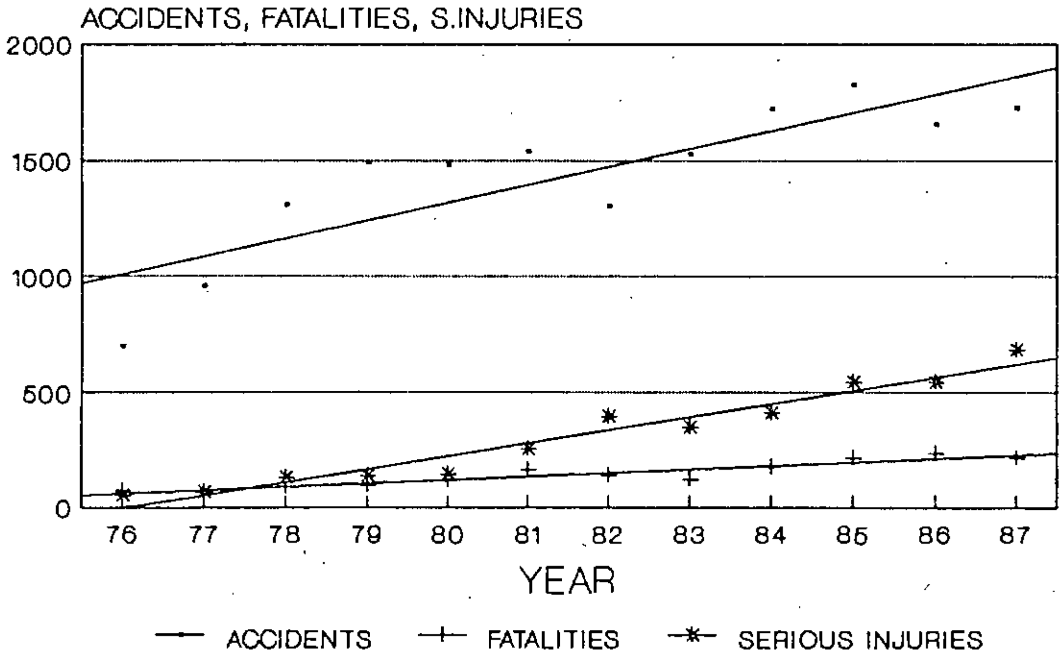
Vehicular traffic in Dhaka city contributes largely to the environmental pollution and deterioration. In addition to the intimidation and anxiety felt by the road users, noise, fumes, dirt

ANNUAL DISTRIBUTION OF ROAD ACCIDENTS
DHAKA METROPOLITAN AREA (1976-87)



Graph 4.1

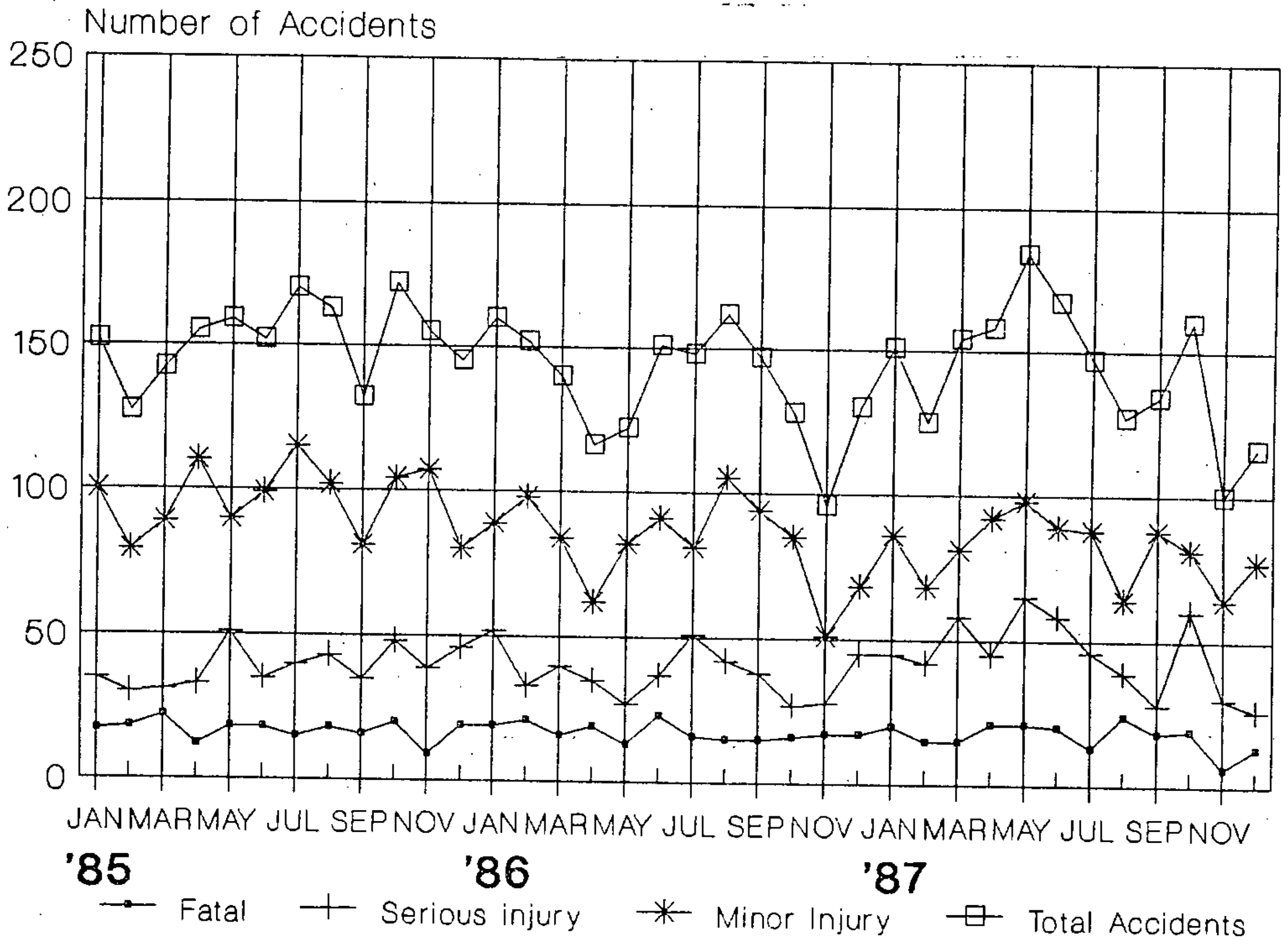
GENERAL TREND OF ROAD ACCIDENTS
DHAKA METROPOLITAN AREA (1976-87)



SOURCE: DHAKA METROPOLITAN POLICE

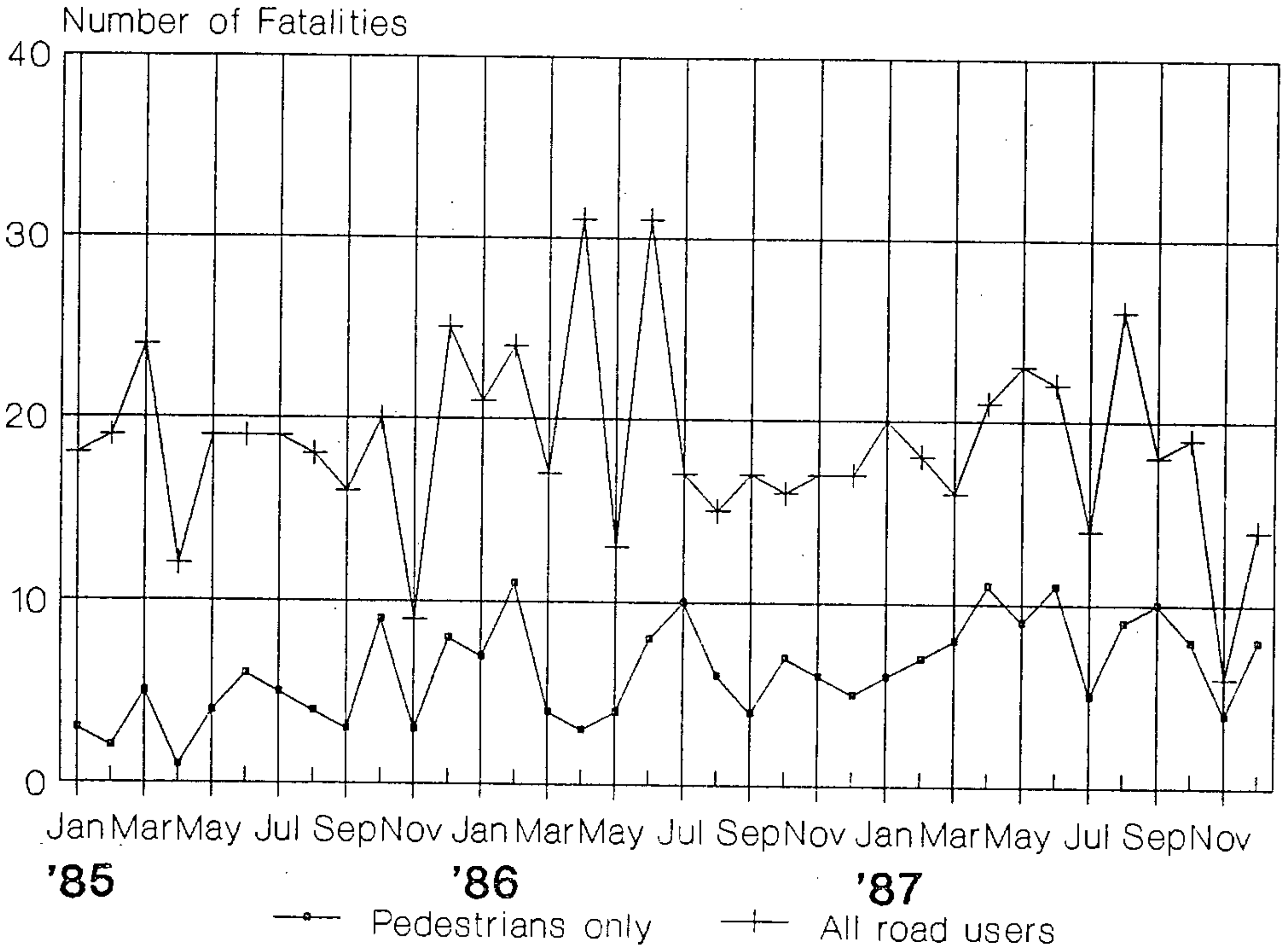
Graph 4.2

MONTHLY DISTRIBUTION OF ROAD ACCIDENTS
DHAKA METROPOLITAN AREA (1985,1986,1987)



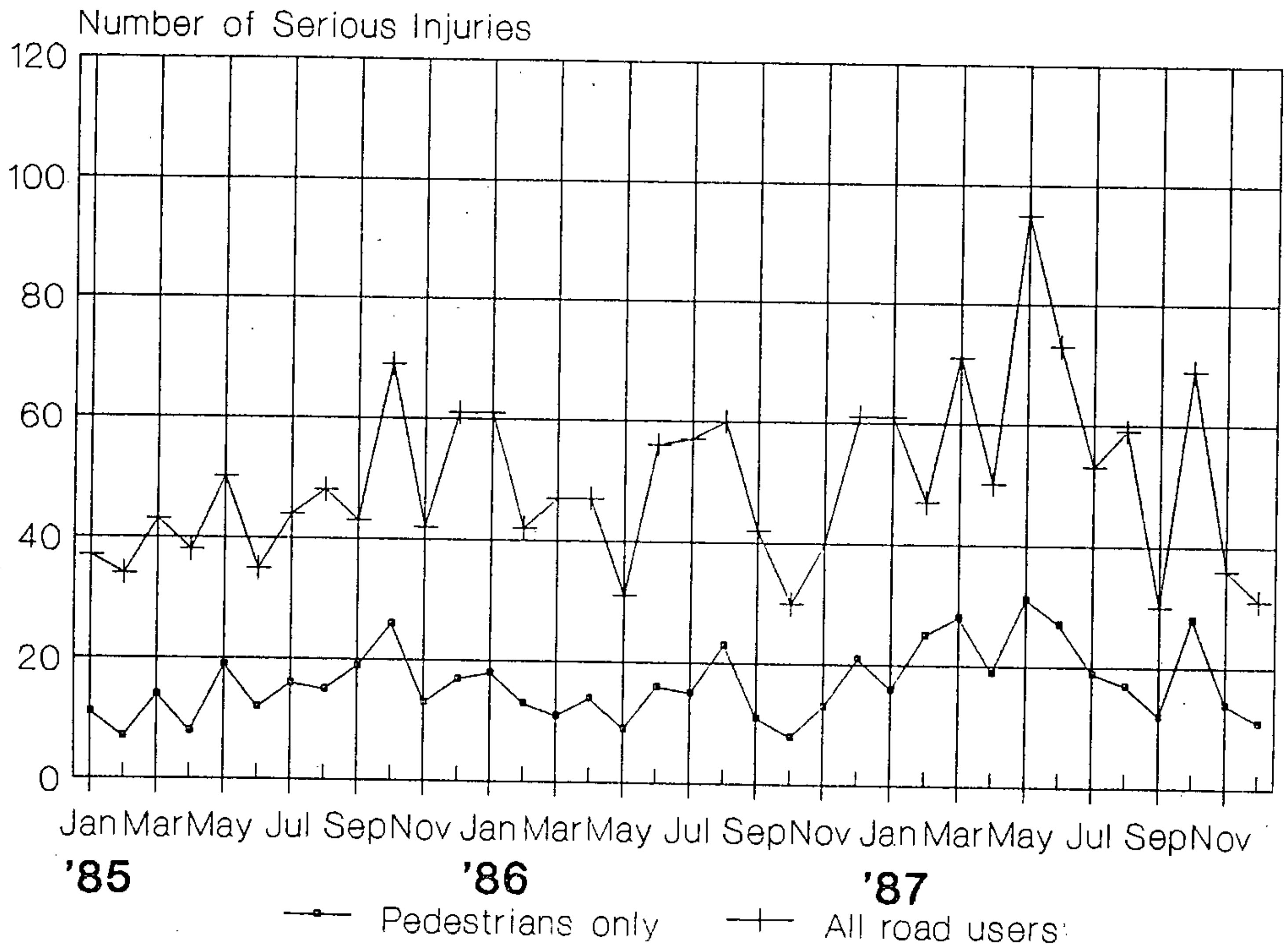
Graph 4-3

PEDESTRIAN FATALITIES
DHAKA METROPOLITAN AREA (1985,1986,1987)



Graph 4.4

PEDESTRIAN SERIOUS INJURIES
DHAKA METROPOLITAN AREA (1985,1986,1987)



Graph 4.5

Table 4.1

PEDESTRIAN FATALITIES IN DHAKA CITY - 1986 (AGE DISTRIBUTION)

Age	Fatalities MALE	FEMALE	TOTAL
01-09	8	2	10
10-19	9	0	9
20-29	7	2	9
30-39	7	0	7
40-49	11	2	13
50-59	10	0	10
60+	5	0	5
Unspecified	21	3	24
Total	78	9	87

Source: Compiled from local daily newspapers accident reports.

Table 4.2

PEDESTRIAN FATALITIES IN DHAKA CITY - 1987 (AGE DISTRIBUTION)

Age	Fatalities MALE	FEMALE	TOTAL
01-09	9	11	20
10-19	21	2	23
20-29	15	1	16
30-39	3	0	3
40-49	11	1	12
50-59	3	3	6
60+	9	1	10
Unspecified	9	2	11
Total	80	21	101

Source: Compiled from local daily newspapers accident reports.

and visual intrusion predominate the road network on a vast scale. The nuisances of vehicular traffic jeoparadize the quality of civilized life in the city and cause grave concern and uncertainty regarding future traffic. The pedestrians are most immediately in contact with these environmental problems.

4.2.4 Pedestrian Circulation Mobility and Accessibility

Pedestrian movement is an integrated part in the city's transport system. This part has been seriously neglected in different areas of Dhaka. No pedestrian circulation network exists in the city and generally walkways are often interrupted and mobility is undermined by deficient infrastructure and low level of service. The pedestrian circulation system includes sidewalks, crossings, precincts, accesses to shops and buildings, circulation within buildings and shopping areas - such as shopping arcades, adequate stairways and escalators -, open spaces - such as public parks -, etc.

The circulation system in the CBD and major shopping areas lacks the necessary network continuity. Sidewalks are narrow, disrupted, cut and relocated with considerable detours around buildings, barriers, etc. In many cases, crossings are non-existent or inappropriately located. In residential areas, sidewalks are found very rarely. No traffic restraint measures are applied, except in few residential quarters. Pedestrians in the residential areas have to share the carriageway space with the vehicles, The road shoulders, if they exist, are inadequate for walking.

There is a serious deficiency in the network connectivity to interfaces with the public transport system - such as bus stands and transit terminals. Low pedestrian walkway capacity, or level of service, is also a major problem in many areas with intensive pedestrian activities. Many sidewalks and crossings are underdesigned compared to space demand. Low levels of service with large numbers of pedestrians spilled from activity centres drive many pedestrians to the hazardous carriageway.

Pedestrian quality of service requires a great deal of improvement. The pedestrian in Dhaka city has very little freedom to walk about and look around, as considerable part of attention is needed to avoid collision with vehicles, with other pedestrians and many stationary objects like sign-boards, electric posts, material displayed by street vendors, etc. No weather protection and landscaping amenities are provided.

4.3 NATURE AND CAUSES OF THE PROBLEMS

4.3.1 The Institutional Crisis

Natural Process has played a dominant role in the growth of road transport in Dhaka city. It has taken its own course of development which appears to be quite distinct had the system worked under a well devised and centrally organized planning process. A well defined and coordinated national road transport policy is a prerequisite for healthy growth of the road transport industry in a country. This city lacks such policy which is essential to control and regulate the haphazard expansion and operation of road transport, to enhance its efficiency and convenience and to minimize its negative social effects, including occurrance of accidents. Lack of an overall and firm control on regulation of the mechanism, through which the system develops and operates, ranks among top priorities for an urgent solution. This factor accounts for major responsibilities for the suffering of all the classes of road users, particularly the pedestrians.

There are various agencies to administer and enforce laws relating to road transport with little coordination among them. There is no central agency charged with overall responsibility to guide, coordinate, control and supervise the activities of different authorities administering traffic laws. The Road and Road Transport (RRT) Division of the Ministry of Communication lays down broad policies in respect of road transport. The Motor Vehicles (MV) laws are supposed to be implemented by Dhaka Metropolitan Police. There is no full time officer to look into the matters relating to licensing of drivers, controlling and regulating of vehicles. Driving licenses are sometimes issued without proper test. Little control is exercised over vehicles operational fitness. Such elements account for many accidents.

Pedestrian planning in Dhaka city is extremely neglected and ignored even in intensive pedestrian activity areas. Despite its importance in revitalizing the urban areas, as now recognized in many other parts of the world, this issue has traditionally been bypassed by the concerned departments at different stages of transportation planning and management in Dhaka city. Integration of pedestrian traffic movement with public transport services may sound at present too much of a luxury, considering the immense inconveniences felt by the pedestrians and public transport users, due mainly to acute inadequacy of public transport services. A major cause for the situation is that the Ministry of Communication issues route permits through Regional Transport authority (RTA) and Bangladesh Transport Authority (BTA) almost without restriction. This has resulted in concentration of commercial vehicles, particularly buses, on certain routes where they expect to earn relatively higher return.

Due to inadequacy of enforcement, the traffic offenders dare to disobey the laws and have little respect for traffic laws enforcing agency. Moreover, the police personnel are not properly trained neither equipped to deal with the traffic situation. They are sometimes reluctant in taking actions or detecting violation of traffic rules, especially after experiencing some offenders influence.

Other agencies also take part in road and road transport planning and management like the Ministry of Works, the Dhaka Municipal Corporation, RAJUK (the city's development authority - previously known as Dhaka Improvement Trust), the Roads and Highways Department (RHD), and other related agencies and institutions. The Planning Commission appraises individual schemes proposed by different agencies.

4.3.2 Behaviour of Road Users

Lack of public awareness on road safety and use has always negative effects on the road user behaviour. The socio-economic factors might have rendered this behaviour more indisciplined and rather unpredictable. Pedestrians and drivers as well are defiant to mandatory traffic regulations. They are neither aware of the risks involved in road journey nor of the inconveniences caused to other road users.

The human factor has always been identified as the main contributor to traffic hazards. Based on official accident statistics, an attempt was made to attribute the main causes of road accidents in Dhaka city. The compiled results are shown in Table 4.3. These results may be compared with a similar set of data obtained for some developing countries as shown in Table 4.4 (Jacobs, Sayer and Downing, 1981). In these data, road user error was identified as the main cause in at least 70% of the road accidents.

4.3.3 Unskilled Drivers

Most of the drivers in the city lack the professional knowledge and skill. A large number of experienced drivers have left the country for overseas employment, resulting in filling the vacuum by new inexperienced ones. Many of them hold fake driving licences with which they operate motor vehicles, particularly public transport vehicles. After the recent introduction of a new system of licence renewal, where the traffic division of Dhaka Metropolitan Police was given the responsibility under the Motor Vehicle Act, at least 10 per cent of the checked driving licences in the city were found to be fake (New Nation, July 20, 1988).

Table 4.3

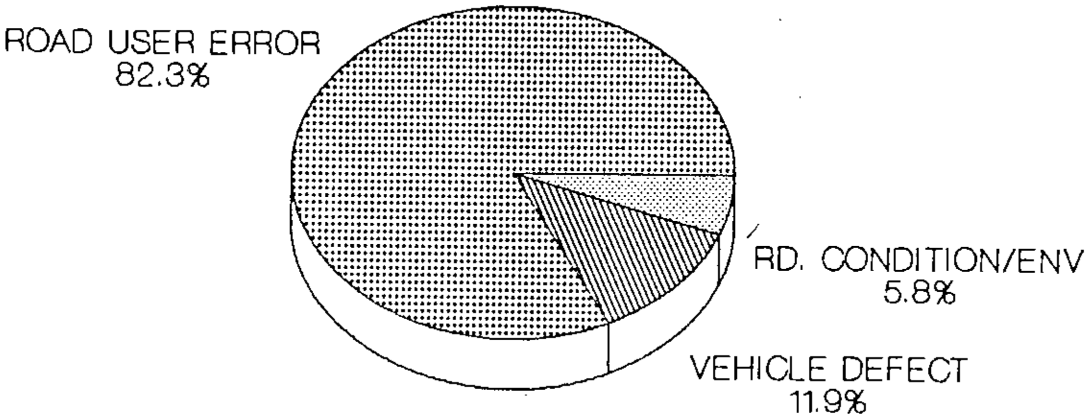
DISTRIBUTION OF ACCIDENTS BY MAIN CAUSES IN DHAKA METROPOLITAN AREA

Main Cause of Accident	Extent of Responsibility in Per Cent		
	1981	1982	1983*
Road user error	81.2	83.3	82.4
Vehicle defect	12.4	10.5	12.8
Adverse road conditions or environment	6.4	6.2	4.8
Total	100	100	100

* Statistics represent first six months of the year.

Source: Compiled from the "Report of the Committee Constituted to Study and Identify the Causes of Road Accidents and to Suggest Remedial Measures", Ministry of Communications, Dhaka, 1983.

CAUSES OF ACCIDENTS IN DHAKA CITY
(EXPRESSED IN PER CENT)



SOURCE: COMPILED FROM THE REPORT OF THE GOVT. COMMITTEE ON ACCIDENT CAUSES, 1983

(Figures on the pie chart indicate the averages of the corresponding data for the years 1981-1983 as shown in Table 4.3).

Graph 4.6

Table 4.4
DISTRIBUTION OF ACCIDENTS BY MAIN CAUSES IN DEVELOPING COUNTRIES

Main Cause of Accident	Extent of Responsibility in Per Cent				
	Jamaica 1977	Ghana 1974	Botswana 1976	Malysia 1976	Hong Kong 1977
Road user error	95	77	71	87	92
Vehicle defect	1	16	12	1	*
Adverse road conditions or environment	1	5	2	8	*
Other	3	2	15	4	8

* Grouped with "other".

Source: Jacobs, G.D. et al (1981), "A Preliminary Study of Road User Behaviour in Developing Countries", TRRL Report SR 646, Dept. of Transport, Crowthorne.

4.3.4 Deficiencies in the Road Network

The city road network is in need of layout improvement, markings, segregation of motorized and non-motorized vehicles and provision of pedestrian movement facilities and channelization. While rickshaw is a predominant mode of transport in this city, traffic management measures hardly take real account of the large volume of rickshaws, their maneuverability and speed. There has never been any serious attempt to consider pedestrian traffic flow volume and requirements in providing walkways. Only few major roads have medians or islands that could provide refuge for pedestrian crossing. Controlled crossings are few. The only two existing overpasses are of little use in absence of effective management and control measures. Sidewalks in most cases are narrow, impassable or non-existent.

Earlier studies of accidents at intersections indicated that the problems are associated with the design and control of the intersection (Rahi and Amin, 1983). Apparently, this is caused by the following contributory factors:

- Major intersection areas are wide-open and there are hardly any channelized islands or channelized markings that could induce orderly vehicular and pedestrian movements.
- The problem of sight distance exists for most of the turning movements.

- Traffic law enforcement is insufficient, mainly at major intersections. No measures arc applied to deter inorderly pedestrian movement.
- Both motorized and non-motorized vehicles park indiscriminately at unauthorized places, particularly at street corners, causing congestion and impeding pedestrian crossing.
- There are no crosswalk arrangements at most of the intersections, thus increasing pedestrian vulnerability.

Other than at intersections, the conditions of roads effect the movement and rate of accidents. The conditions refer to all physical features of the roadway such as length, width, construction standards, surface conditions and geometric features.

4.3.5 Inadequate Signs, Signals, and Delineation

Display of standard signs, signals and road markings act as guide for road users to ensure safe and efficient movement. But the number and provision of these facilities are inadequate. Road users are usually defiant to the control devices rendering them less effective. At the signal-controlled intersections, control is not standadized to cope with the nature and composition of vehicular and pedestrian traffic. Most of the existing five signal-controlled pedestrian crossings are usually inoperative. In pedestrian activity areas, there is a lack of standard directional signs and maps required to give information about the location of streets, major buildings and facilities. Fig. 4.1 shows the location of the existing traffic light signals in Dhaka city.

4.3.6 Lighting

Poor visibility at night, due to insufficient and standardized lighting, is a major cause of accidents and inconveniences, particularly to pedestrians, at most of the city roads at night. The glare of high beam of head-light almost blinds the drivers of the on-coming vehicles.

4.3.7 Lack of Parking Facilities

In Dhaka city there is a severe lack of parking places. As a result, vehicles are parked on the carriageway even in the busiest and most congested commercial areas. This problem is very acute in front of cinema houses and large buildings where heavy pedestrian traffic is generated. On-street parking poses a serious impediment to vehicular and pedestrian flow and causes traffic hazards. The situation is worsened when some of the sidewalks are invaded by vehicles. Such uncontrolled parking limits sight distance and visibility when the pedestrians start crossing the road. Pedestrian crossing is further hindered where vehicles are parked or stopped at crosswalks.

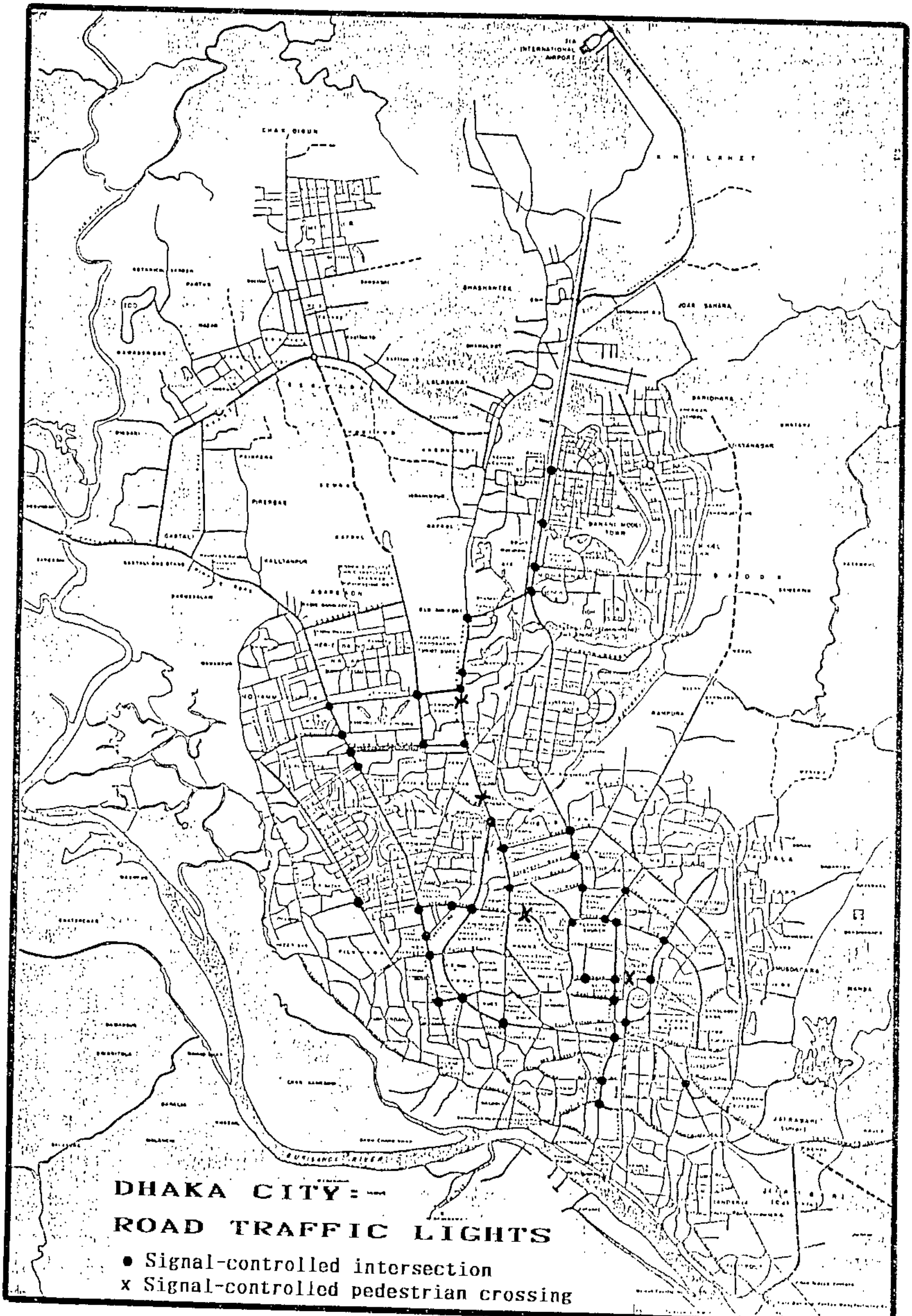


FIG. 4.1

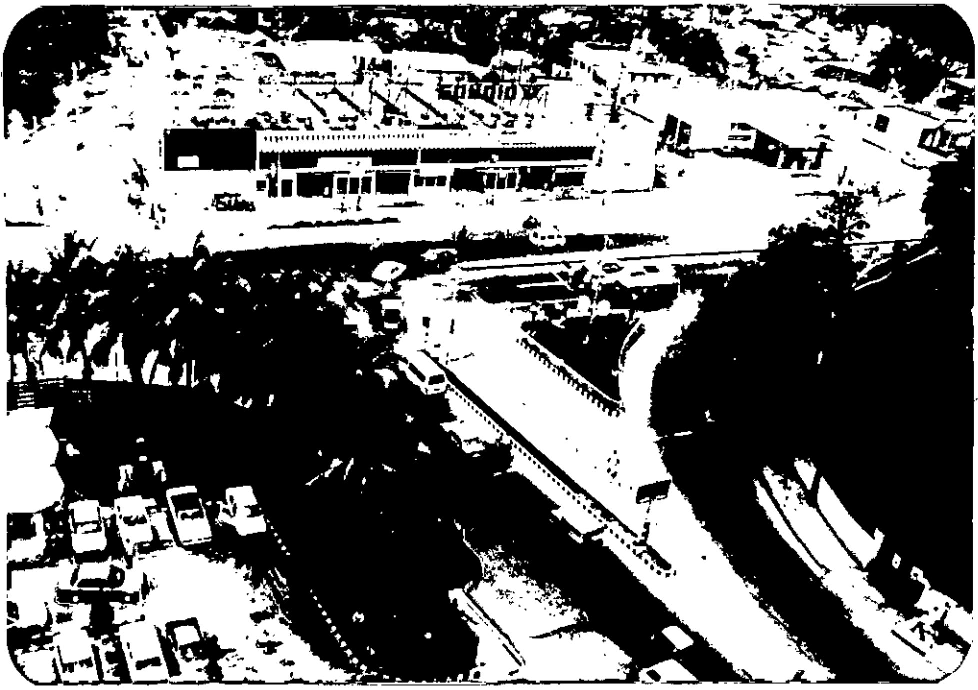
SCALE: 1 cm = 777 m

4.3.8 Inadequate Public Transport Services

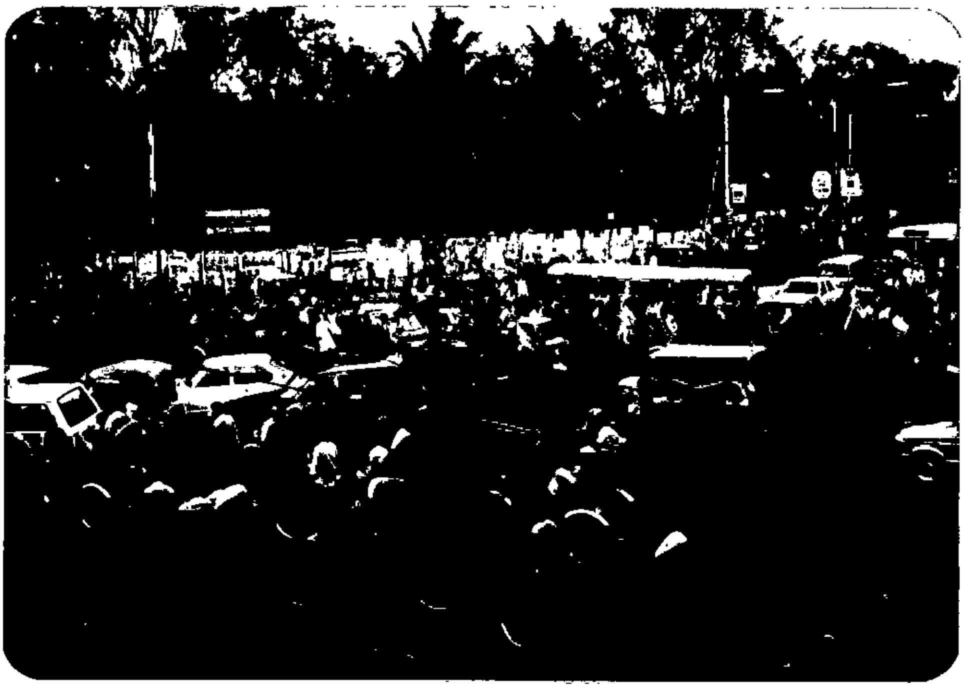
As stated earlier, there is a shortage in the supply of passenger transport vehicles in Dhaka city. This results in serious overloading causing traffic hazards and inferior quality of services. In addition to the question of safety, public transport services are inaccessible mostly in low income group areas. This situation limits the modal choice to longer distance walking and to the expensive cycle-rickshaw transport. Public transport stops and terminals provide no convenient facilities to the passengers who start and end their journey as pedestrians. Public transport loading and unloading locations are not integrated with the walkways. Inorderly pedestrian waiting and crossing occur near these locations.

4.3.9 Working and Living Conditions of Transport Workers

The working and living conditions of a person has a great impact on his physical and mental wellbeing as well as on his efficiency and professional performance. The environment in which the drivers and other transport workers in this city, as well as elsewhere in the country, live and perform their duties is unsatisfactory. The professional drivers and other transport workers have no job security and many of them are required to work beyond schedule hours. Due to their conditions, they cannot fully concentrate on their duties. Being away from their family lives, many of the drivers indulge themselves in undesireable activities and get addicted to gambling and drinking. During working hours, they are indiscipline and behave beyond the control of their employers and traffic rules. Driving under such physical and mental conditions may often be disastrous in consequences.



A channelized intersection in Dhaka city.

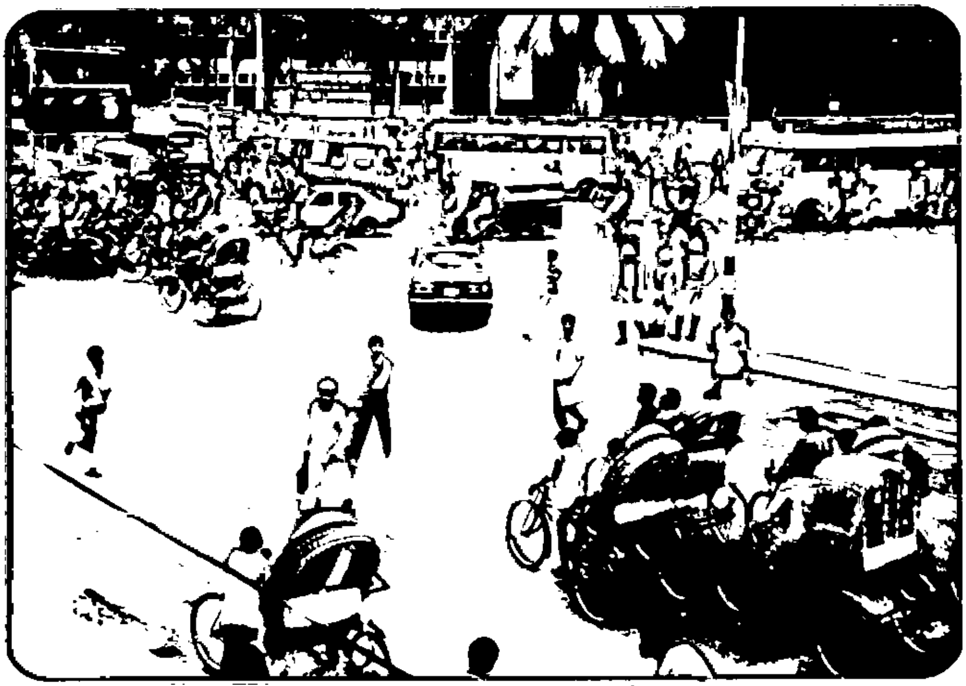


Traffic delay and confusion at the unchannelized intersection of Mirpur Road and N.Elephant Road.

High traffic volumes and low levels of service force the pedestrians and vehicles into close proximity.

Mixed traffic operation of motorized and non-motorized vehicles causes a great deal of delay and confusion for the vehicular and pedestrian traffic as well.

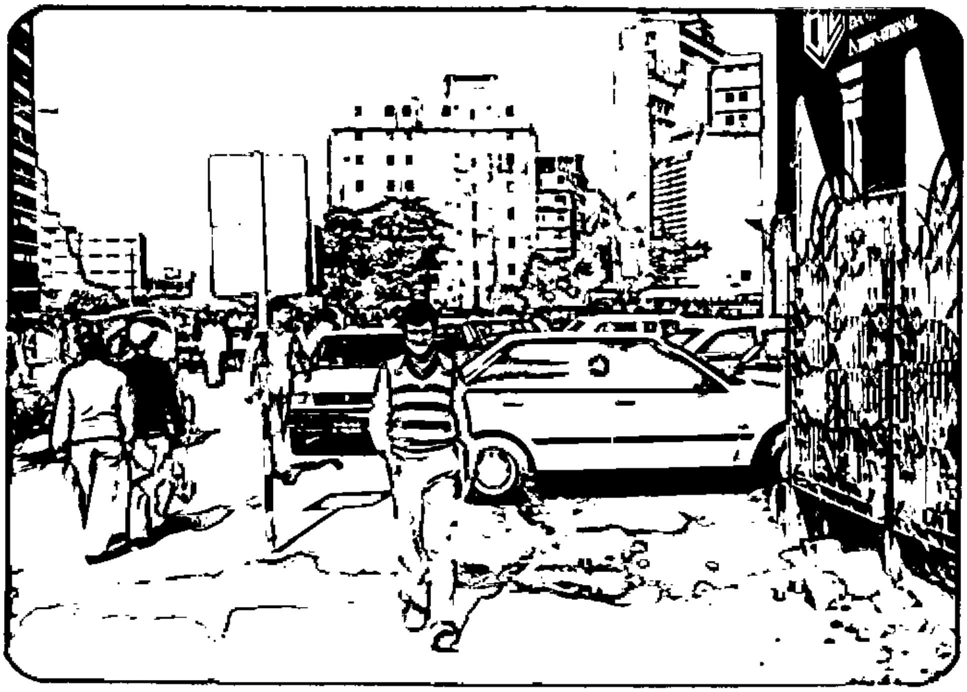
Crosswalks are not marked or not maintained even at many major intersections.



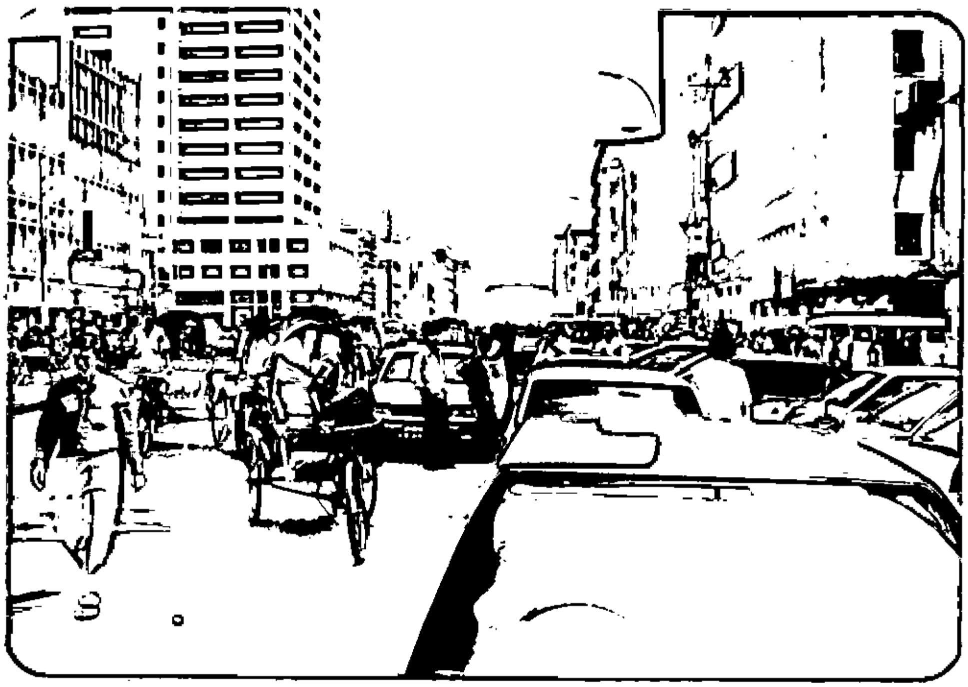
When crosswalks are provided and protected, the pedestrians tend to use them.

Misuse of sidewalks in the CBD

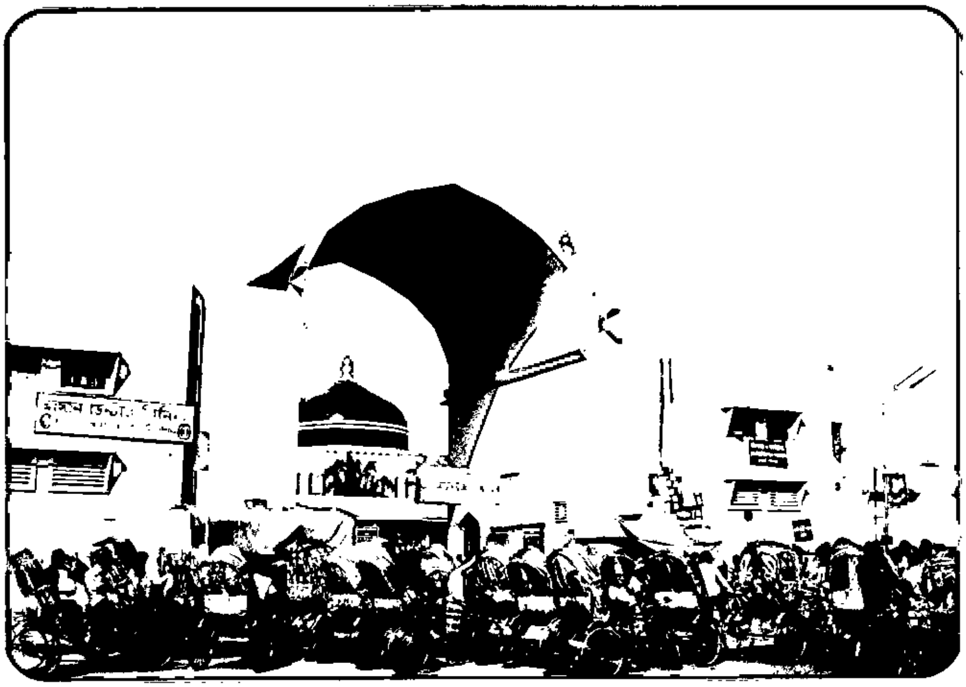
Sidewalks of many arterial streets can be featured in representations on the decline of streetscapes.



Encroachment of vehicles: Parking on sidewalks aggravates the pedestrian-vehicular conflict and undermines the circulation.



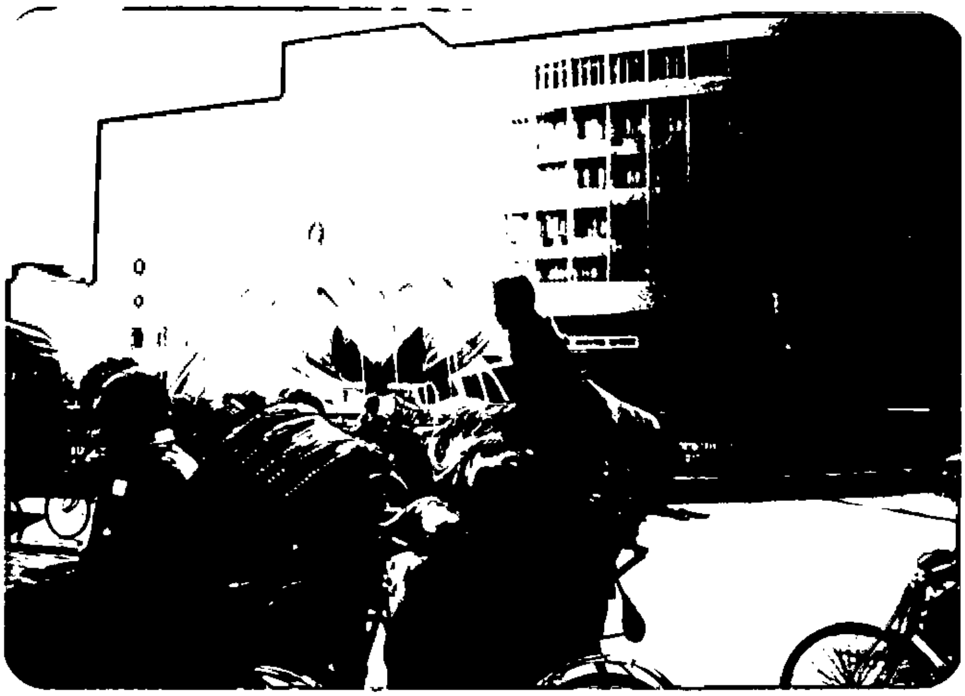
Double on-street parking in the CBD: Serious reduction in street capacity.



Cycle-rickshaw parking at the southern gate of the Govt. New Market reduces pedestrian accessibility and causes confusion and delay for traffic in general.

Indiscriminate cycle-rickshaw parking on major arterial streets: A blow for street capacity and a frustrating challenge for the city's traffic management.

Slow moving vehicles occupy over 75% of the street capacity in the New Market shopping area.



The slow moving vehicles are in direct conflict with the visual quality of the city streets.

Chapter 5

STUDY AREA'S ANALYSIS

5.1 PEDESTRIAN ACTIVITY AREAS: A BRIEF REVIEW

5.1.1 Shopping Centres

The proper functioning and success of a shopping centre depend to a great extent on traffic planning considerations of the site and the surrounding area of the centre. The degree of freedom of the pedestrians to move about and their accessibility to different parts of a retail shopping centre are of prime importance for its success. Existing shopping centres in Dhaka were established with no prior traffic study. In terms of land uses and their effects on generated traffic, in many cases, areas surrounding the shopping centres are highly incompatible with the activities of the centres.

Two main contributions to facilitate pedestrian movement in shopping areas are shopping precincts (e.g. New Market) and shopping arcades (e.g. Baitul Mukarram Shopping arcades, Gulshan North and Gulshan South shopping arcades and Stadium shopping arcades). Such centres attract large numbers of shoppers from all over the city. Yet walkways in most of these centres have inadequate levels of service. Conflicts in pedestrian movement become severe during peak shopping hours in shopping centres like Baitul Mukarram. In shopping areas like Gulistan and New Market, sidewalks are most of the time occupied by vendors and their merchandise.

Despite most of the shopping centres are accessible by major roads, parking is the main concern. Limited parking spaces are available, mostly using shoulders of the road. Large number of cycle rickshaws compete for the space with motorized vehicles rendering the situation more difficult. Sometimes, vehicles are even parked on the sidewalks. Thus access roads to the shopping centres are subject to many difficulties in terms of capacity and other aspects of efficiency. Usually, these roads function as major traffic routes carrying large volumes of through vehicular traffic. This leads to congestion and environmental difficulties resulting from noise and fumes.

Central shopping areas, by their wide range of goods, enable more people to do the bulk of their shopping in about one weekly expedition. This trend has been reinforced by the increased use of motor vehicles, thus attracting shoppers even from long distances. These shopping areas are usually crowded and pedestrian requirements there become more complex. On the other hand, local shopping areas, frequently attract people who live and work in the vicinity. This kind of facility generates pedestrian traffic in the immediate surroundings.

5.1.2 The C.B.D.

ACTIVITIES:

The city centre or the central business district (CBD) is surrounded and dissected by major roads that function as main traffic routes for both local and considerably heavy through traffic. All classes of vehicles operate on these routes. Almost all major intersections are signalized.

The multiplicity of functions in the centre invariably attracts large numbers of people. Commercial activities are the main category of these functions. Most of the buildings are occupied by business enterprises, banks, newspaper houses, large autonomous and semi-autonomous organizations, hotels and restaurants, administrative buildings, central offices and headquarters of many private, national and international organizations, showrooms, cinema houses, shopping centres, etc. Nearby are the National Stadium and the largest mosque of the country.

Business activities are heavily concentrated in this area. Here the day begins with dispersal of commuters from generation points to individual places of employment. The next phase is concerned with personal contact of people between centres of business activities followed by a displacement of people to local shopping centres and lunch-time facilities. Then activities revolve once more round the business areas, and finally converge on transport vehicles leading out of the centre.

During peak hours, certain sidewalks flood with pedestrians who move within the centre in direct conflict with vehicular traffic. The deficiency of the road network, especially at its intersections, appears to continue throughout the business hours. Slow movement, frequency of areas of conflict, traffic jams, severe delay, fustration, etc. are regular features caused mainly by inorderly movements of motorized and non-motorized vehicles and pedestrians, indiscriminate, parking and ineffective traffic management measures.

SIDEWALKS AND CROSSINGS:

Certain sidewalks are heavily crowded especially at peak hours. Sometimes, part of the sidewalk is not suitable for walking. Sidewalks effectiveness is undermined by many signs, poles, piles of materials and other obstructions. However, the most serious cause of reducing the effective width of sidewalks, in some places almost to zero, are the vendors where they spread their merchandise on the pavement as far as they dare. Vehicles are sometimes seen parked on the sidewalks of busy roads (as in the vicinity of BCCI Bank). Pedestrians are therefore forced to use the carriageway, zigzagging through irregularly parked vehicles and the busy traffic flow.

Crosswalks are marked at some intersections, in virtue of vehicular traffic signals. Except in very few cases, no crossing facilities are provided at mid-block locations. No separate pedestrian phase is included in the traffic signal cycles at intersections. Due to slow movement of vehicular traffic, the pedestrians have the courage to cross in random manner at different sections, thus impeding the vehicular movement and endangering themselves. Two pedestrian signal controlled crossings are found at DIT Avenut and Topkhana Road.

PARKING:

During business hours, almost all the road shoulders in the centre and the nearby lanes are blocked by indiscriminate parking. Though double parking - occupying additional space on the road - accounts for a small proportion of the road, the critical factor is the amount of time a lane is out of action. This factor takes serious proportions during peak hours. Cycle-rickshaws stopping everywhere undermine the circulation efficiency and capacity of the CBD notoriously. Absence of adequate parking spaces, enormous traffic generation and poor traffic management are the main contributing factors to this situation.

ENVIRONMENTAL CONDITIONS:

The large concentration of traffic with its adverse effects turns the central area into an unpleasant place. The effects of danger, noise, fume and confusion are more pronounced than normal because the heavy vehicular and pedestrian flow with inadequate facilities forces pedestrians and vehicles into closer proximity.

The street scenes are unattractive. They are badly disfigured by constant streams of mixed traffic. The scenes at intersections are far worse. The severe traffic congestion, assisted by the reduction of effective road width by undesireable parking, is in direct conflict with the environmental qualities of the central area.

5.1.3 Residential Areas

Different residential areas in Dhaka city may be broadly classified into zones of three distinct socio-economic strata: upper, middle and lower class areas. All are densely populated, with relative variation considering the socio-economic status. In addition to residential buildings, these areas usually have some infrastrtuctural facilities, such as schools, kindergardens, community centres, post offices, mosques, shops and business premises.

Grid-iron pattern predominates the road networks in the planned areas (like Dhanmondi, Gulshan and Banani), thus allowing through traffic to pass. But the majority of the city's population live in the city's densely built areas of four, five, and six storey buildings with narrow and deplorable roads and alleyways.

These dense areas consequently generate heavy pedestrian traffic. School children make a considerable proportion. No traffic restraint measures are applied in residential roads. However, speed humps are used in some residential quarters belonging to various corporations. These humps are usually effective in speed reduction, but are not standardized. No controls of speed limits are maintained. Side-walks in residential areas are almost non-existent. In the case of narrow roads, carriageway occupies the whole space. In wider roads where road shoulders are left unpaved, these shoulders are inadequate for pedestrian use as long as they remain muddy or dusty, or broken by ditches or blocked by building materials or other objects. Scattered garbage and trash containers add to the ill-scene and the stench of the sidewalks.

Residents lack the feeling of safety and freedom from the nuisance of moving vehicles. Children are unsafe to play on the residential roads and their routes to school are risky.

Lighting is insufficient, if exists, and this makes the road more hazardous to pedestrians. This also subjects them to the often committed criminal acts.

5.2 MIRPUR ROAD

5.2.1 Functional Elements

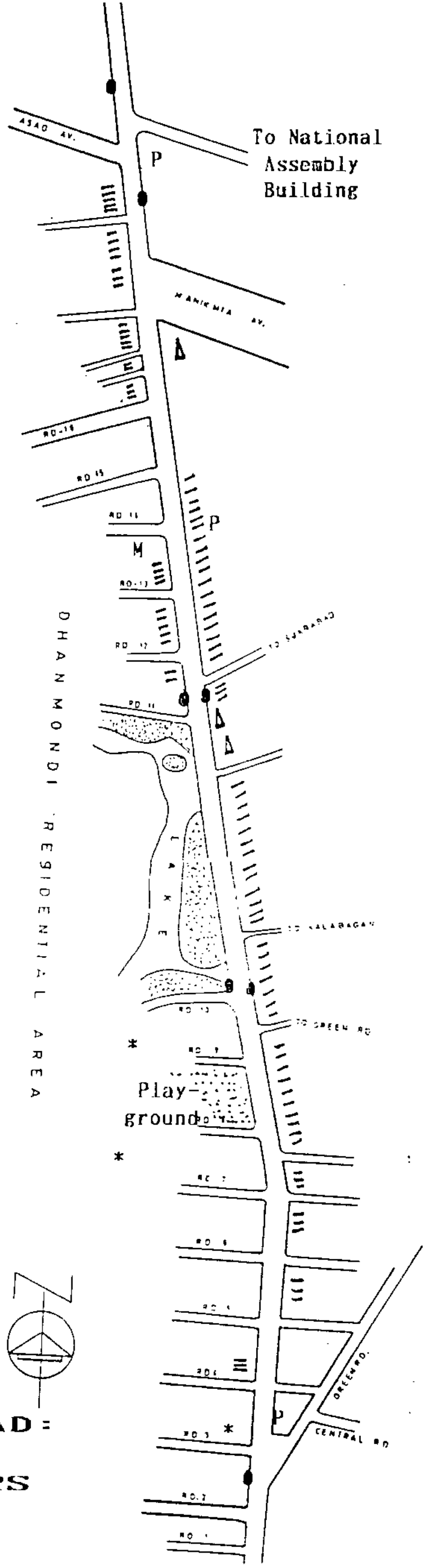
A major arterial road, Mirpur Road enhances accessibility to many residential areas - mainly Dhanmondi, Kala Bagan, Sukrabad, Lalmatia, Mohammedpur, Sher-e-Bangla Nagar, Shamoly and Mirpur ; and to many important roads and shopping areas - mainly New Market area, New Elephant Road, Green Road, Manik Mia Avenue and Assad Avenue. Ultimately, Mirpur Road stretches westward to Dhaka-Aricha Road, which is the most important road link to Aricha from where ferries provide connections to the western half of the country. In addition, Mirtpur Road provides accessibility to important venues, such as the National Assembly Building, and important services and utilities (Fig. 5.1).

A number of diversified frontage uses have developed so far. In the study area, in addition to residential land use the main existing frontage uses are: Three schools and colleges, shops, open spaces (lake, park, play-grounds), automobile workshops, three petrol pumps, one large mosque, banks, clinics, restaurants, fire brigade and other public services (Fig. 5.2).

Intensive conflict exists between the generated heavy traffic and the physical surrounding. The fundamental acceptability of frontage

Fig. 5.1 MIRPUR ROAD:
A MAJOR ARTERY IN DHAKA CITY

Scale: 1 cm = 250 m



≡ Frontage shops/commercial use

Δ School/college

⁂ Open space

* Cultural centre/library

M Mosque

P Petrol pump

● Bus stand

(Unspecified frontage uses are mostly residential)

Scale: 1 cm = 110 m

FIG. 5.2 MIRPUR ROAD: PESESTRIAN GENERATORS

uses along this route can be classified broadly in terms of danger and inconveniences. For example, where schools are located adjoining this road, the frontage can be described as "unacceptable". At some locations where shops are situated on one or both sides of this heavy traffic route, the frontages may be said as "unacceptable" when conflicts are critical, or "undesireable" when conflicts are not as critical.

The linkage characteristics of Mirpur Road, along with the frontage land uses, attract heavy vehicular traffic and on-street parking especially by shoppers. Heavy pedestrian traffic is generated mainly from the immediate surroundings for the same factors, particularly by public transport stops.

5.2.2 Layout Pattern

Mirpur Road runs through a number of residential areas inhabited by a spectrum of social classes. These residential areas are densely populated, least dense is Dhanmondi. Most of the residential buildings are three and four storeyed built very densely and served by narrow roads. The existing scale of development reveals high density of use causing great load on vehicular and pedestrian traffic movements.

Except at a short portion of the road ending at its intersection with road no. 3 of Dhanmondi, no median was constructed (construction of median started only recently). Many distributor roads connect Mirpur Road to adjoining areas of development on both sides. Paved sidewalks were constructed on both sides of the road.

At all surveyed sections of the road, sidewalks are 2.4 m (8 ft) wide and elevated by 25 to 30 cm (10 to 12 inches) from the carriageway.

The intersections can be classified into two broad categories:

(A) A main traffic stream crossing another main traffic stream. All these intersections are signalized.

(B) Minor traffic streams entering or crossing the main traffic stream. This occurs on both sides of the road, more frequently on the western side. The main factor contributing to this layout is the grid-iron pattern predominating in residential areas like Dhanmondi. All these intersections are non-signalized.

Other than at the main intersections no pedestrian crossing facilities exist on the road. Zebra crossings are marked at some of these intersections in virtue of the traffic signals.

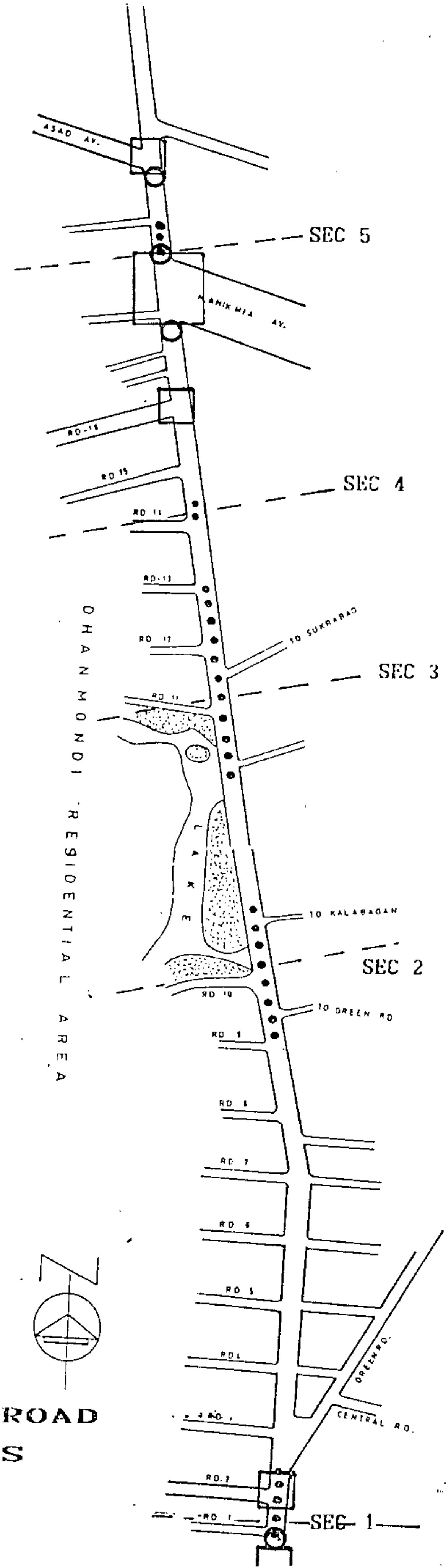
5.2.3 Traffic Conditions

All classes of vehicles operate on this route, with time restriction for trucks only. As a major 2-way road and with absence of channelization and medians, there is a lack of freedom from interference of opposing traffic. Considering the nature of the layout pattern and the absence of effective control measures, a vast scale of congestion and frequent areas of conflict prevails. Road user behaviour and extensive right-turn movements are the prime contributing factors. No proper longitudinal delineation of the carriageway is maintained, thus adding to the operational risk and inconveniences.

Slow non-motorized vehicular traffic constitutes a major proportion of the whole traffic and occupies considerable space on the road. General traffic on this road is characterized by inorderly movements of mixed operation. Vehicular-pedestrian interaction occurs at sections where sidewalks are inadeuate for walking and where pedestrians cross the road everywhere with no means of control. Many of these pedesrians are school children. Where sidewalks are inadequately maintained or elsewise occupied, pedestrians use the carriageway (Fig. 5.3).

5.2.4 Environmental Considerations

Preliminary observations followed by pedestrian and vehicular traffic flow survey at different sections of the road revealed a number of problems, caused particularly by traffic behaviour, layout pattern and the existing conditions of the road. Field survey helped to assess the levels of service and the extent of safety, comfort



Signal-controlled intersection

Marked crosswalk

Intensive pedestrian crossing

Scale: 1 cm = 110 m

FIG. 5.3 MIRPUR ROAD TRAFFIC CONDITIONS

(SURVEY SECTIONS INDICATED)

and convenience in terms of intensity and severity of conflict.

As the situation depicted earlier, the vehicular-pedestrian conflict on this road is very pronounced. Pedestrians who use the sidewalks still face a great deal of inconveniences at many locations. The 2.4 m width of the sidewalk is frequently reduced to a much less effective width. The main causes appear to be:

1. The pavement is cracked and buckled at several places.
2. The street furniture is so wretched that slides of it can be featured in representations on the decline of streetscapes. Along the curb is an ill-placed assortment of trash containers, signs, etc. Some of the sidewalks are used for loading and unloading of goods, piling of construction materials and keeping different items in front of shops and workshops. At some places cows were noticed tied and kept on the sidewalks. Some restaurants extended their benches to the sidewalk. Vendors were also seen sharing a large portion of the sidewalk.
3. Many cycle-rickshaws and pushcarts park on the sidewalk during their off-time. Even rickshaw repair and maintenance works are carried on the sidewalks.
4. Sidewalks are elevated 25 to 30 cm. from the carriageway. Pedestrians prefer a much less height. They also hesitate to use the sidewalk with steep-faced curb. When designing the road, no consideration was given to the requirements of the physically handicapped. Ramped sidewalk approach and curb cut ramps are generally much easier to negotiate.

5. No weather protection facilities are provided at public transit stands.

Crossing Mirpur Road' is another experience and it demonstrates the skills of pedestrians in such actions which are more acrobatic in nature than normal behaviour. The pedestrian often crosses the road at stages, maneuvering for gaps in the traffic flow, and may sometimes have to run back to the curb from where he has started when his attempt to save his life becomes questionable. Intimidation and anxiety predominate the feelings of the crossing pedestrian at the uncontrolled sections. Vulnerability to accidents and considerable delay continue for many hours and become intolerable throughout the peak hours. Where children cross frequently in the vicinity of the existing schools, no considerations has been given for their safe and convenient crossing - not even a simple zebra crossing. In general, lack of pedestrian crossing facilities and poor traffic management and maintenance are mainly responsible for the present conditions:

1. At the signalized intersections, no separate pedestrian phase is included in the traffic signal cycle.
2. Other than at signalized intersections, there are no forms of crossing or segregation.
3. With the layout pattern of the road and the surroundings, there are many distributory road links on both sides. These generate frequent and uncontrolled right-turn movements of vehicles at various sections causing more conflict areas with other vehicles and

crossing pedestrians.

4. The intersections are not channelized. This form of facility regulate the conflicting traffic movements into safe and orderly movements of both vehicles and pedestrians.

5. guard-rails and barriers are not used in conjunction with sidewalks.

6. Street lighting is insufficient.

7. There are many ditches and manholes at different locations of the road. Vehicles often tend to avoid such surface irregularities, thus increasing the extent of conflict with crossing pedestrians.

8. Mixed motorized and non-motorized vehicular traffic operating at any section of the road implies different speeds. This in turn makes pedestrian crossing more complex and risky.

9. Apart from the pedestrian-vehicular conflict, amenity is seriously reduced by the effects of traffic pollution and noise, leaving adverse effects on the pedestrians and on the surroundings.

5.2.5 Visual Impact

Many visual elements in the study area contribute to unattractive and unpleasant display. The inorderly movement of the mixed vehicular traffic, the extensive vehicular-pedestrian conflict, the misused sidewalks by cattle, dumped garbage, illegal occupation by shop displays, vendors, stacked building materials and many other obstructions, the frontage scene quality - all make a very deteriorated streetscape. If undisturbed by such elements, open spaces in the vicinity of the area could have gained a much greater value. These spaces include the playground, the lake, the children park and the large open space surrounding the National Assembly Building.

5.3 THE NEW MARKET SHOPPING AREA

5.3.1 Functional Elements

The New Market Area is one of the most important and busiest shopping areas in Dhaka city. Few market and shopping centres have been developed in this area. They include the Government New Market, New Super Markets (North and South), Katcha Bazar (vegetable market) Gausia Market, Chandi Chawk Market, Hawkers market, and several other shops and restaurants closeby. These markets constitute a large concentration of retail trade where shops and shopping centres are mostly segregated into groupings of small shops specializing in a range of goods mainly of clothes, household items, books, stationaries, jewellery, food stuff, tailors, leather, cosmetics and toileterries, electrical and hardware stores, etc.

The area is served by some infrastructural facilities, mainly a post office and a telegraph and telephone office. Nearby are few private clinics. The area is at a short walking distance from the University of Dhaka, the Bangladesh University of Engineering and Technology, the Dhaka College, the Eden Girls College and few other schools. It is also close to many residential areas. One of the prominent feature in the vicinity is a public cinema hall.

Considering the functional acceptability of the frontage land uses, the existing cinema hall at its present location can undoubtedly be classified as unacceptable. The volume of generated pedestrian traffic and cycle-rickshaws constantly occupying a major space of the road, makes this particular land use in direct severe conflict with the environmental capacity of the area. Considering the question of integration of this shopping area, this land use being dissected by heavy traffic flows on Mirpur Road and Elephant Road may also be described as unacceptable. This argument holds strong with the present traffic control measures. However, with the intensified development and activities in this area, a great proportion of solving the conflict lies within the traffic management domain.

5.3.2 Layout Pattern

Mirpur Road bisects the area into two parts. The area ends southward at Nilkhet Road. Both the intersections of Mirpur Road with Elephant Road and Nilkhet Road are signalized. Mirpur Road is about 33 m wide and the carriageway is divided by a 1.20 m median. Nilkhet Road is about 27 m wide with no median. Both the intersections are also unchannelized.

Despite the intensified pedestrian activities in this area, a pedestrian overpass is the only crossing facility. Previously, two zebra crossings were marked, but lack of maintenance has turned them into an old memory. Pedestrian guard-rails are still erect on the eastern sidewalk stretching between the two intersections.

The area is particularly lacking in open space. This has been a source of parking problem. A part of the road at the eastern and southern access to New Market is reserved for car parking. A section is reserved as a parking lot for the motorcyclists.

Shopping premises in the area are one to three storeyed buildings. The pedestrian overpass vertical access consists of two flights of stairs, with one landing at midway (layout map is shown in Fig. 5.4).

5.3.3 Traffic Conditions

The main problem stems from the fact that the New Market area is situated at the intersection of major traffic routes, each carrying large volumes of vehicular traffic flow. All classes of vehicles operate on these routes. The area is served by public transport vehicles including buses en route to other areas. Through traffic constitutes a major proportion, conflicting with the shopping traffic.

Traffic management and control measures are ineffective. This rendered the traffic movement slow, congested and confused. Without firm police control, the traffic signals at both intersections lack

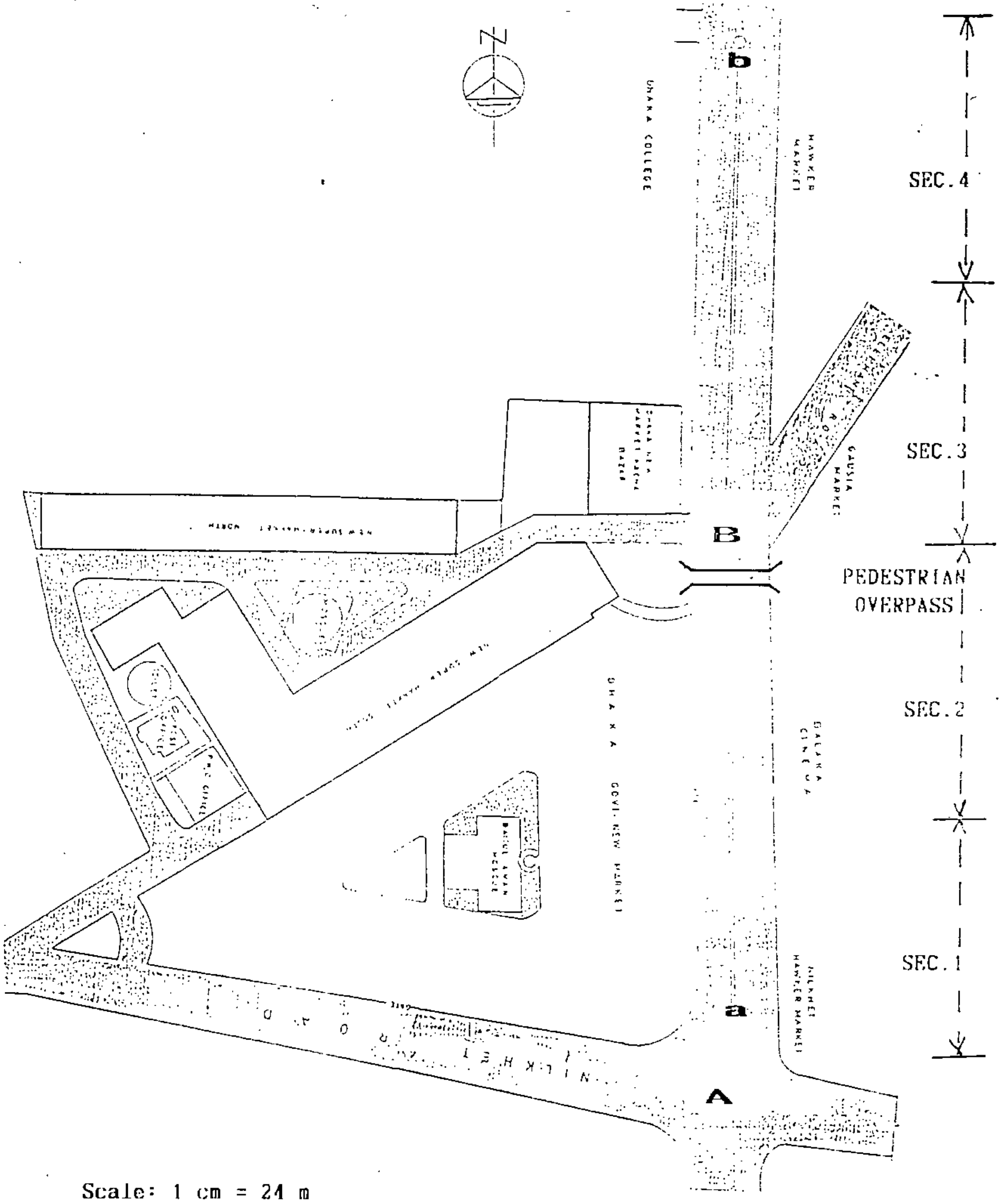


FIG. 5.4 NEW MARKET SHOPPING AREA

(SURVEY SECTIONS INDICATED)

even the minimum respect of road users. Streets are two-way, but left turn movement from Mirpur Road to Elephant Road is prohibited. This measure has constantly been controlled by police personnel. Provision for right turn movement was recently introduced at this intersection with the help of right turn phase in the traffic signal cycle. This provision has severely increased the congestion and confusion at this junction regardless to the existing traffic signals. At the other intersection, vehicles move in all directions simultaneously causing similar problems in the whole intersection area. The signal has little effect on the traffic behaviour.

The lack of open space in the area causes a complex parking problem. Ticketed parking is provided at all sides of the Govt. New Market. Parking also occurs at other locations. Cars park even at, or close to, the intersections, though local traffic management measures try to eliminate this parking. Indiscriminate parking by large numbers of cycle-rickshaws has the worst effects on vehicular and pedestrian movement and accessibility within the area. Concentration of these slow vehicles at all the gates of the shopping area causes serious impediment to pedestrian movements.

Vehicular movements, just as it suffer at the intersections, suffer at other sections of the road as well. No fixed lanes are maintained for different classes of vehicles. Capacity is further reduced by the extended space reserved on the sides of the carriageway for car parking.

Amidst this situation, large numbers of pedestrians are continously moving within this area. The heaviest pedestrian crossing flow occurs between the eastern and the western side of Mirpur Road. Unbarred by any effective measure to channalise the flow, the great majority of pedestrians tend to cross at all sections of the carriageway ignoring the overpass. The pedestrians usually overflood the sidewalks and large numbers of them walk along the carriageway.

5.3.4 Environmental Considerations

The effects of danger, noise and confusion are very pronounced in this area. The inorderly traffic movements and the inadequate pedestrian facilities and control measures force pedestrians and vehicles into closer proximity and continuous conflict. It is inevitable in the present conditions that there is a severe conflict between pedestrians and vehicles throughout this tightly packed shopping area. This is most marked at points where the main pedestrian movements cross the heavy traffic flows between the two intersections in the area, and at a further short strip to the north. It is also very evident where a major portion of the pedestrians walk along the carriageway.

In Mirpur Road where the area is bisected, the average widths of the eastern and western sidewalks are 2.5 m and 2 m respectively, but only partially suitable for walking. At many locations in the area, the pavements are cracked and buckled or have pot-holes. Signs and poles are among the various other obstructions, however the most serious obstruction to the sidewalk effectiveness is the activity of the vendors. This has drastically reduced the effective sidewalk width to as narrow as less than one meter.

As mentioned earlier, the only crossing facility in the area is the overpass. Absence of control measures and the present median induce the pedestrians to cross using the carriageway. When vehicular flow is high, delay to pedestrians increases as traffic gaps become less, but when the flow is less and the gaps are longer vehicles travel at greater speeds endangering pedestrian crossing. At intersections, the continuous vehicular left turn movement , due to absence of pedestrian separate phase in the signal cycle, increases the difficulty and risk of crossing.

Thus in all cases, pedestrians face a great deal of inconveniences and danger in the present conditions. This also increases congestions and confusion to the road users. Though the consequent delay has never been estimated, it is very evident as it occurs very often and involves significant time. Shoppers also face inconveniences while moving within the shopping area or in the building itself. The narrow passages and walkways of the Hawker Market and Gausia Market are obvious examples. The staircases are mostly not lighted, narrow, damaged and ill-maintained.

However, the shopping precinct of New Market attracts great numbers of pedestrians as they feel comparatively safe from the traffic hazard, thus bringing a larger retail trade turnover and providing a better environment for shoppers and traders. Many pedestrians also go window-shopping. It worths mentioning here that the poor drainage system in the area reduces its accessibility during and after heavy rain showers.

5.3.5 Visual Impact

The street scenes and buildings are inattractive in scale and quality. The streets are badly disfigured by almost constant flow of traffic moving through the area and by indiscriminate parking of vehicles specially the cycle-rickshaws. The area is at present being intruded upon by heavy through traffic. The severe traffic congestion, the vehicular-pedestrian conflict, the assortment and intensity of vehicular traffic and its behaviour - all assisted in deteriorating the visual qualities of the area.

Chapter 6

DATA ANALYSIS

6.1 MIRPUR ROAD

6.1.1 Pedestrian Flow

6.1.1.1 FLOW AT SIDEWALKS

Peak flow and peak times:

Considering the nature of pedestrian activities in Mirpur Road, three peak times are in general likely to occur; one in the morning, one around 1400 hours and the last around 1700 hours. However, peak time varies for different sections with the variation of the activities near the concerned section and its distance from main activity centres and public transit services.

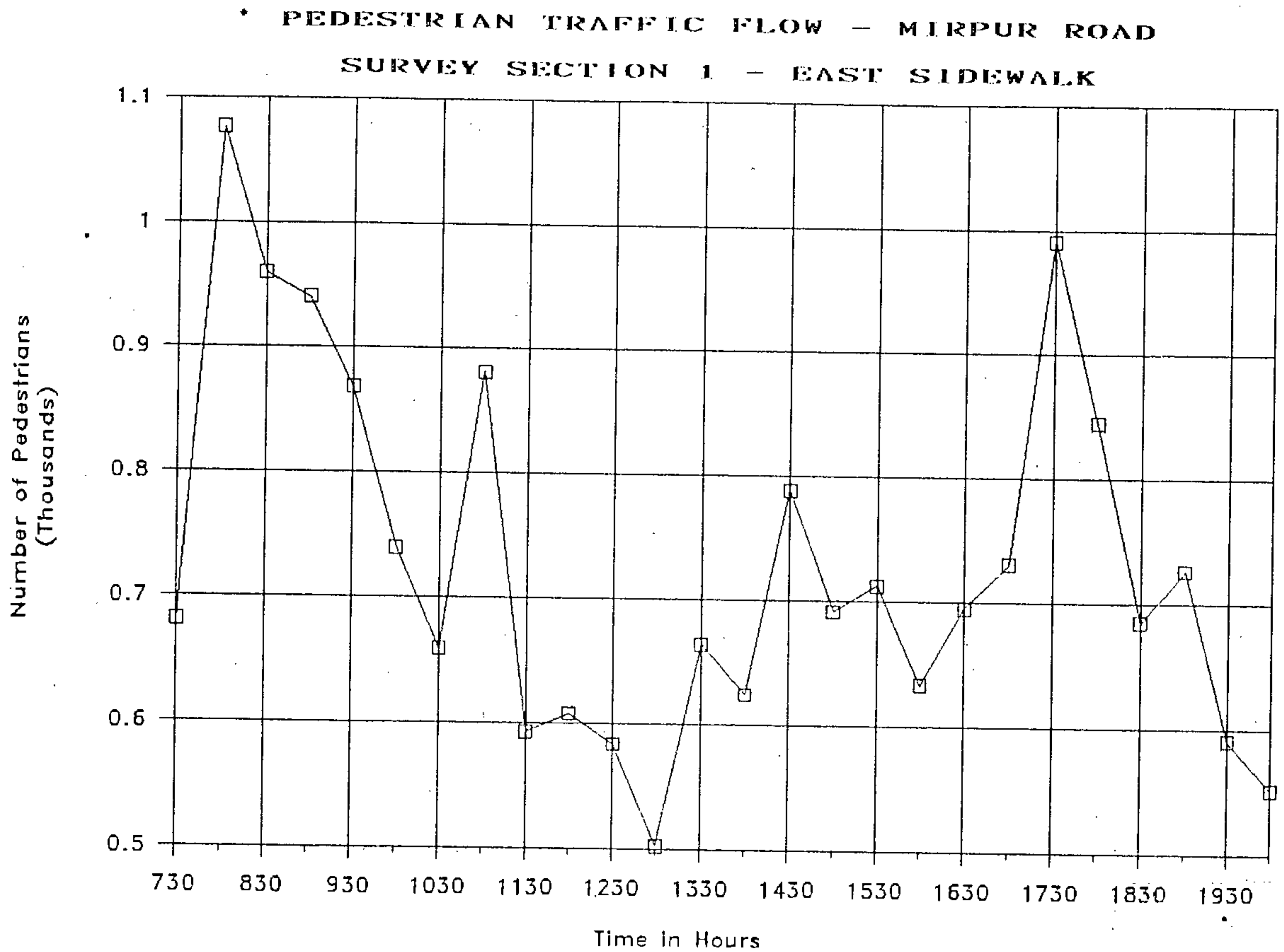
A brief look at the graphical illustrations makes obvious how flow is intensive when people start travelling to their places of employment during the first hour. Usually, this happens between 700 and 830 hours. The flow rises again with the start of business and shopping activities, as indicated by the flow between 930 and 1130 hours. The next peak time coincides with the closing of government offices and most of the public sector enterprises (graphs at 1300 to 1500 hours). The last peak occurs with the closing of private sector offices and rising shopping activities (graphs after 1630 hours). This high flow may continue until 1900 hours, especially in the vicinity of shopping centres (last peak flow was observed between 1630 and 1830 hours at all locations). Peak flow values varied between east and west sidewalks.

At section 3 where pedestrian densities were observed, similar peak time pattern predominates as at other sections.

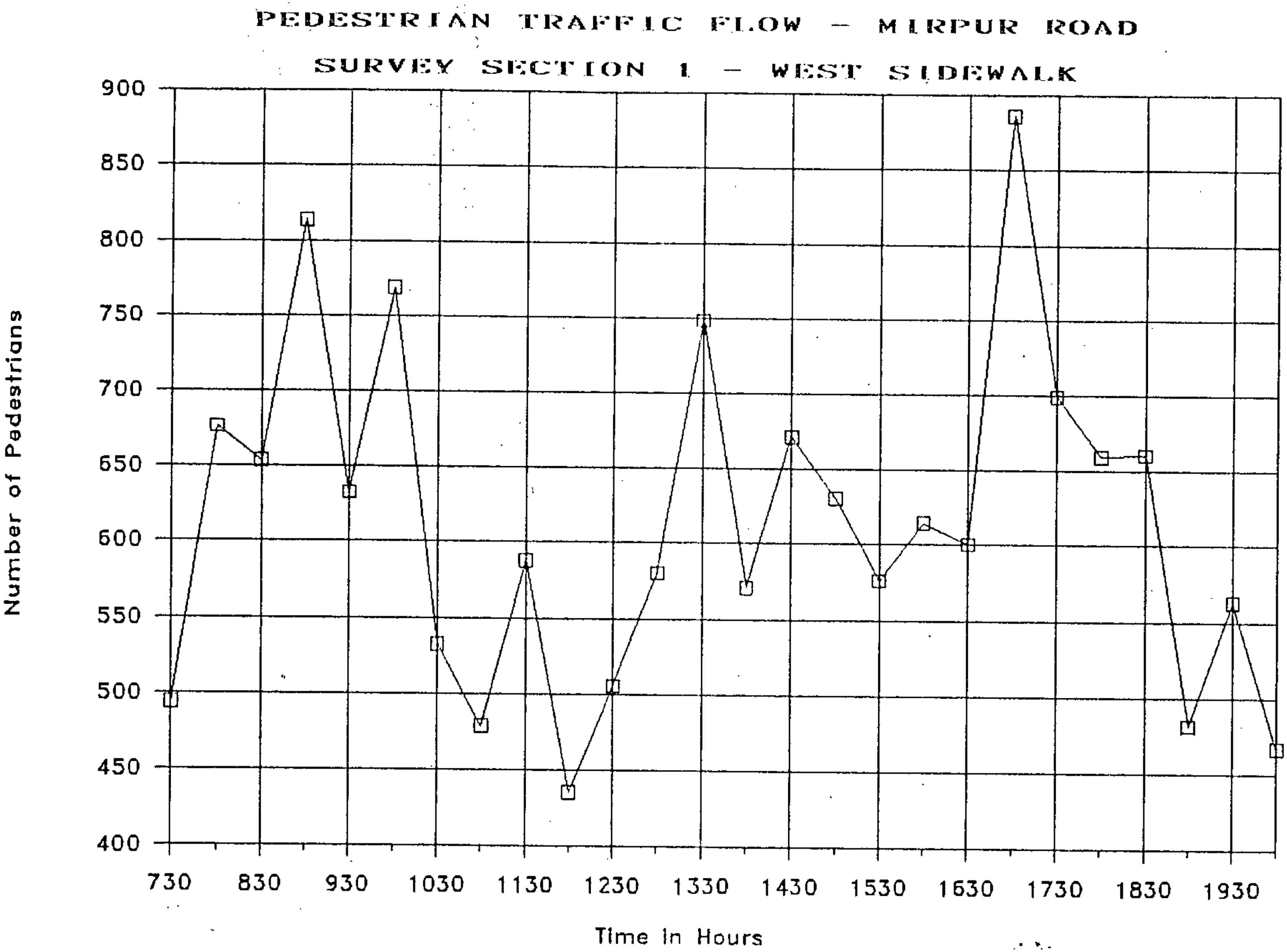
<u>Flow variation pattern</u>:

Rapid and considerable fluctuation was observed when the flow was considered at a sidewalk adjacent to bus stands. At section 1, fluctuation is steep at the west sidewalk and mild at the east sidewalk. A considerable proportion of flow at the west sidewalk is generated by the public bus stand there. Similar trend was observed at section 2 at both sidewalks. But fluctuation extent is less here as the curve is less steep at many points. This may be referred to the fact that a very frequent, almost continuous, bus loading and unloading take place near this section.

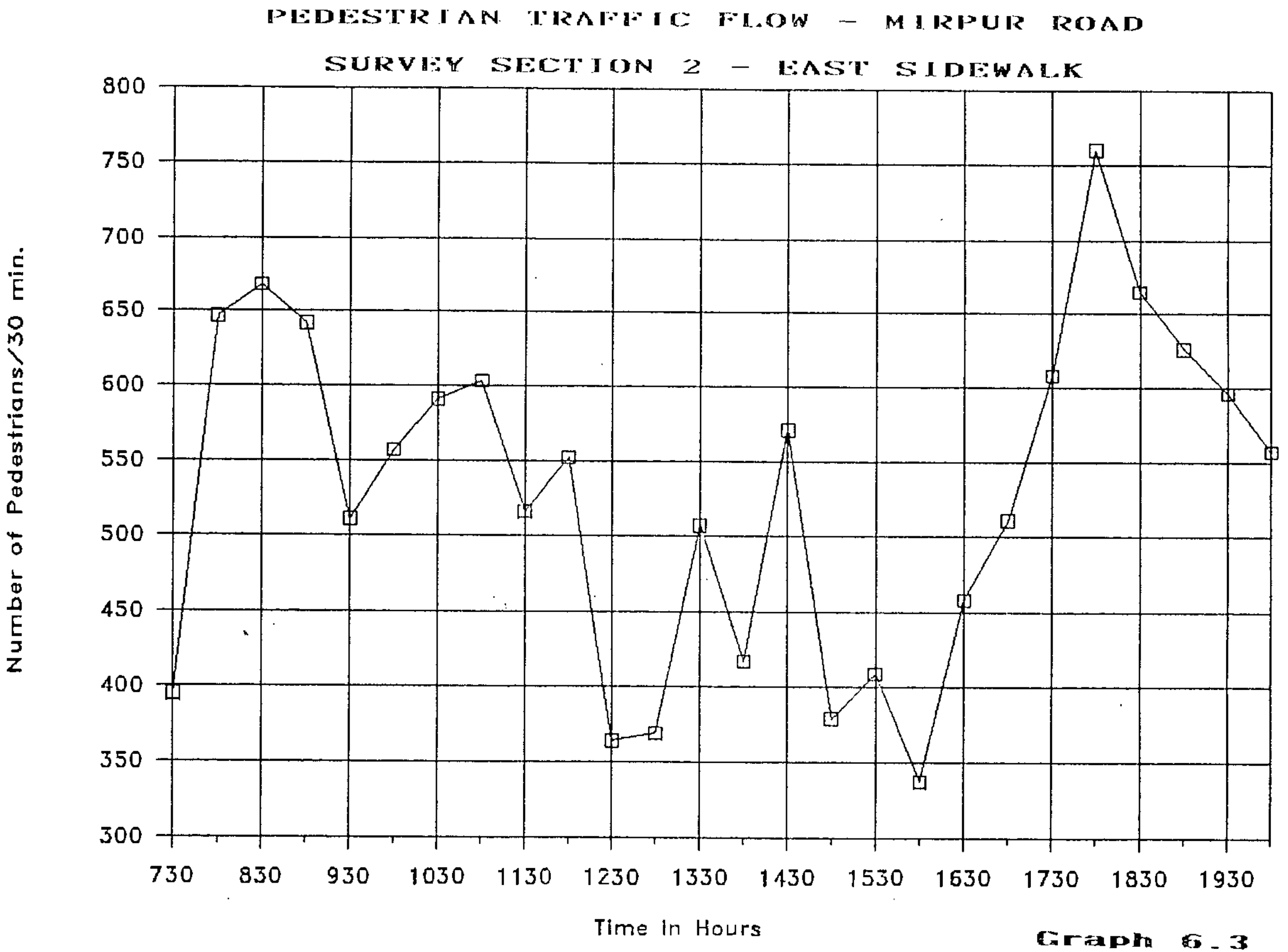
Steep variation was also marked just before and after peak hours. This indicate the considerable impact of through pedestrian traffic - pedestrians traveling along the road or, generated by public transport services en route to other destinations - on flow variation. In the vicinity of schools, the sidewalks adjacent to the school had much higher flow than the other sidewalks. This is evident in the case of flow at section 4.


PEDESTRIAN TRAFFIC FLOW - MIRPUR ROAD
SURVEY SECTION 1 - EAST SIDEWALK
Number of Pedestrians
(Thousands)
1.1
1
0.9
0.8
0.7
0.6
0.5
730
830
930
1030
1130
1230
1330
1430
1530
1630
1730
1830
1930
Time in Hours

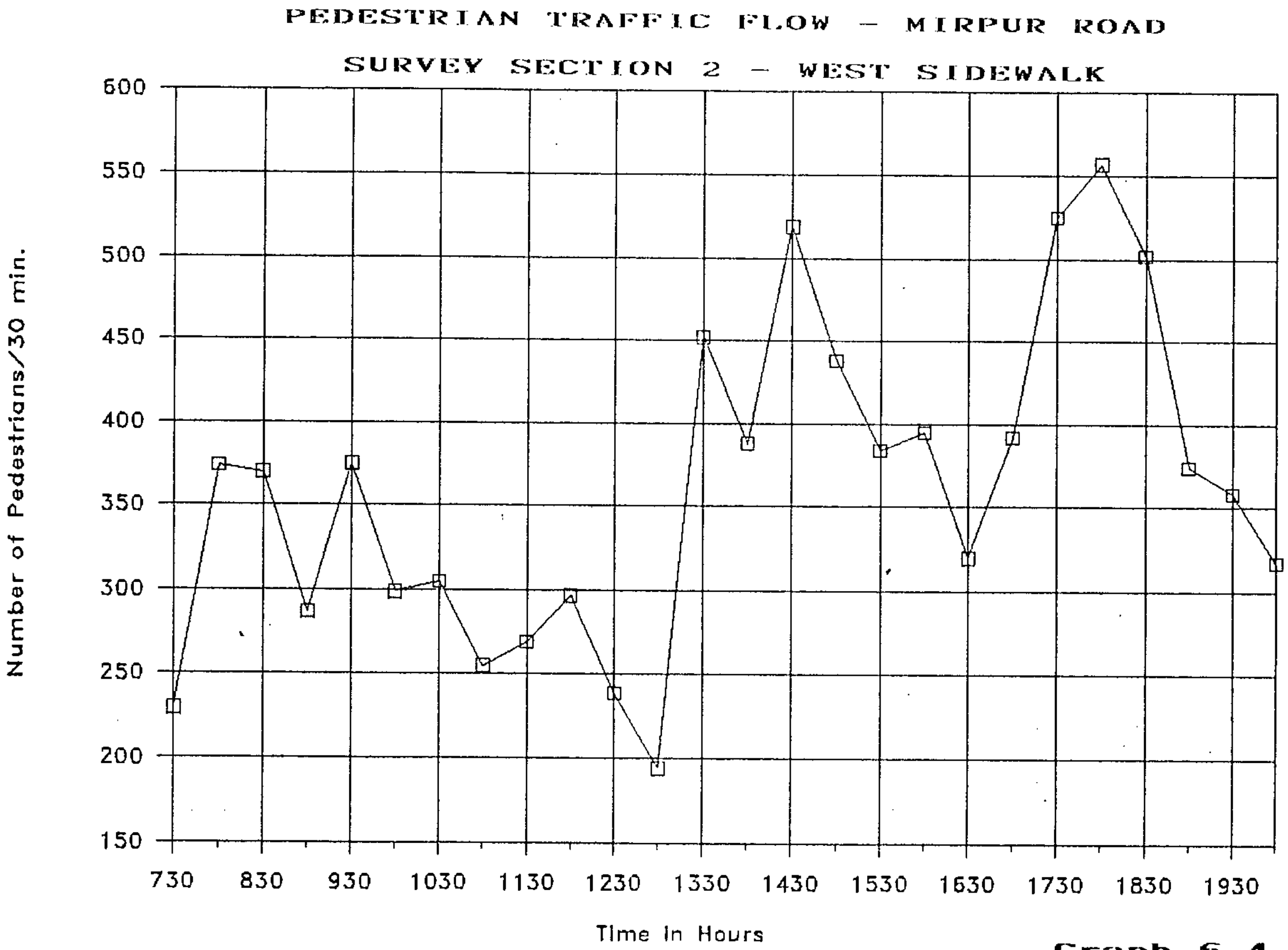
Graph 6_1


PEDESTRIAN TRAFFIC FLOW - MIRPUR ROAD
SURVEY SECTION 1 - WEST SIDEWALK
Number of Pedestrians
900
850
800
750
700
650
600
550
500
450
400
730
830
930
1030
1130
1230
1330
1430
1530
1630
1730
1830
1930
Time in Hours

Graph 6.2


PEDESTRIAN TRAFFIC FLOW - MIRPUR ROAD
SURVEY SECTION 2 - EAST SIDEWALK
Number of Pedestrians/30 min.
800
750
700
650
600
550
500
450
400
350
300
730
830
930
1030
1130
1230
1330
1430
1530
1630
1730
1830
1930
Time In Hours

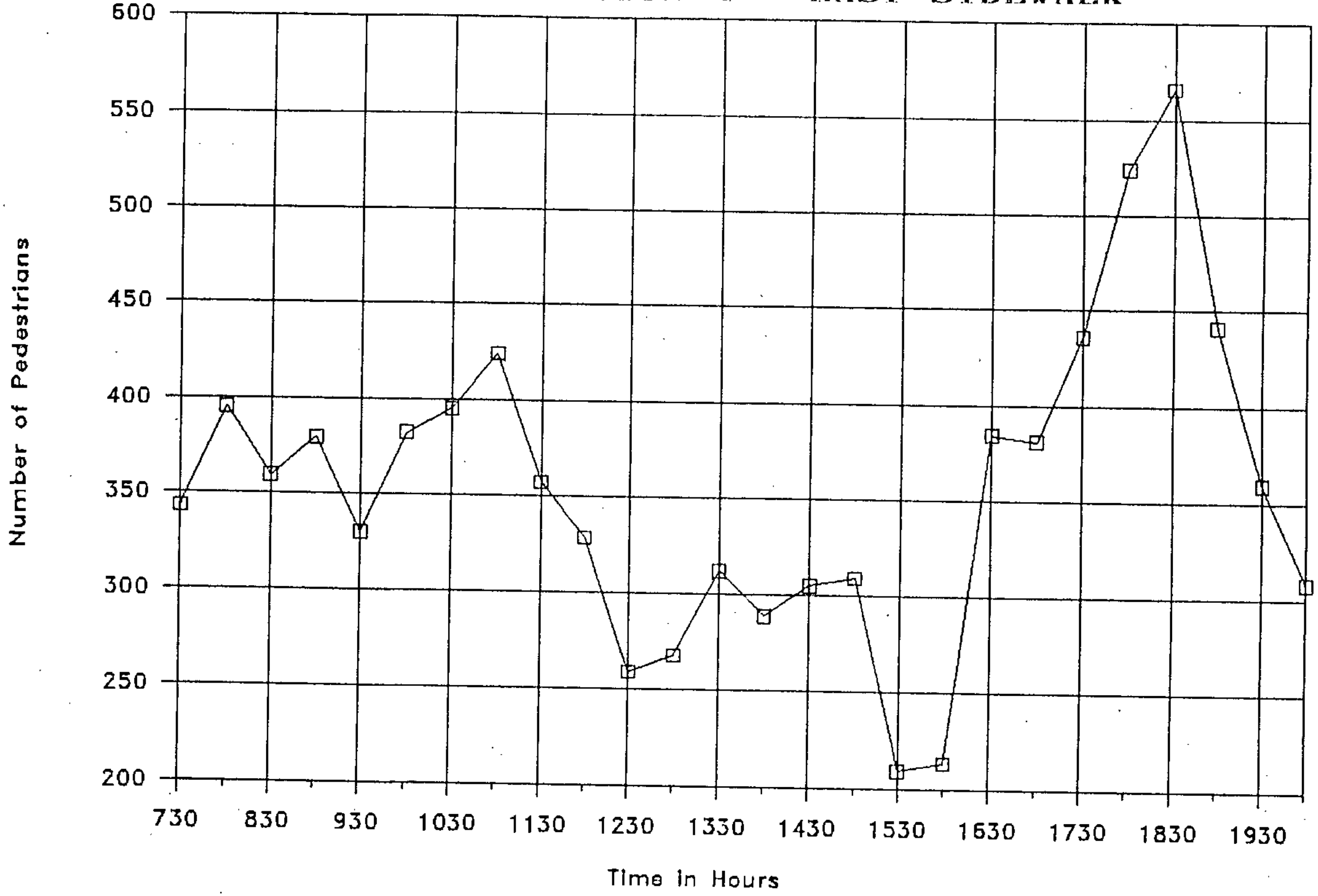
Graph 6.3


PEDESTRIAN TRAFFIC FLOW - MIRPUR ROAD
SURVEY SECTION 2 - WEST SIDEWALK
Number of Pedestrians/30 min.
600
550
500
450
400
350
300
250
200
150
730
830
930
1030
1130
1230
1330
1430
1530
1630
1730
1830
1930
Time in Hours

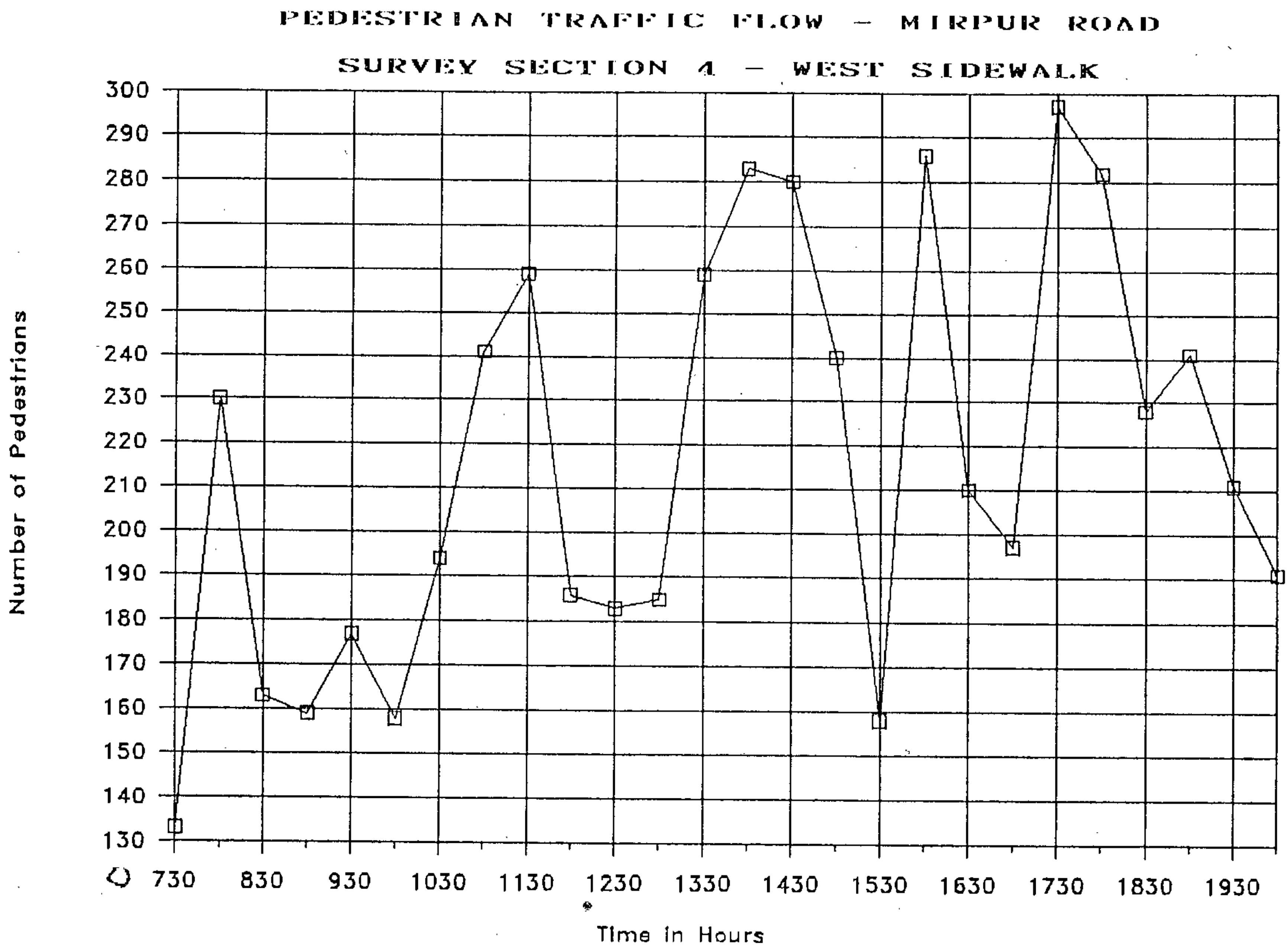
Graph 6.4

PEDESTRIAN TRAFFIC FLOW – MIRPUR ROAD

SURVEY SECTION 4 – EAST SIDEWALK



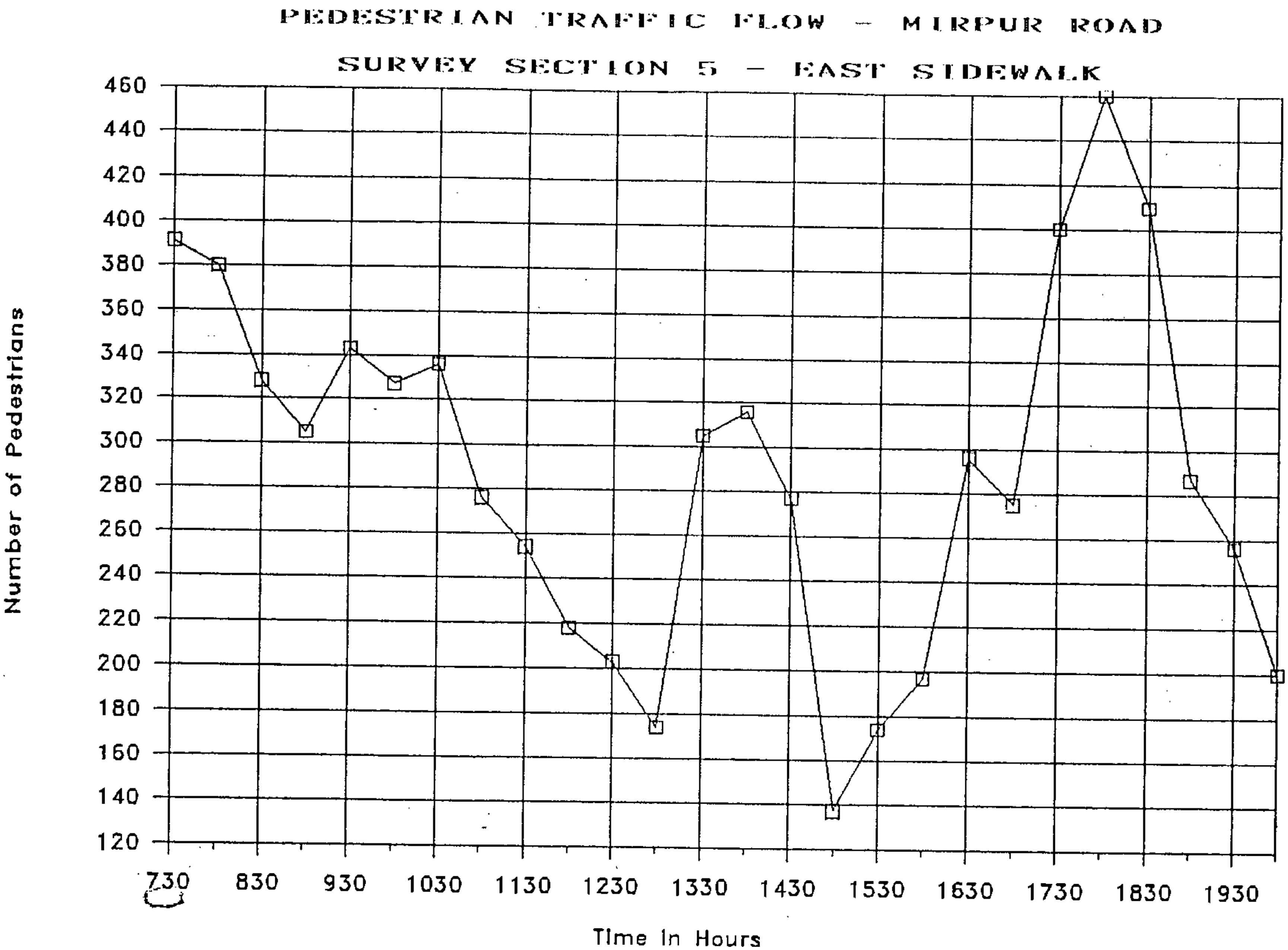
Graph 6_5



PEDESTRIAN TRAFFIC FLOW - MIRPUR ROAD
SURVEY SECTION 4 - WEST SIDEWALK
Number of Pedestrians
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
730
830
930
1030
1130
1230
1330
1430
1530
1630
1730
1830
1930
Time in Hours

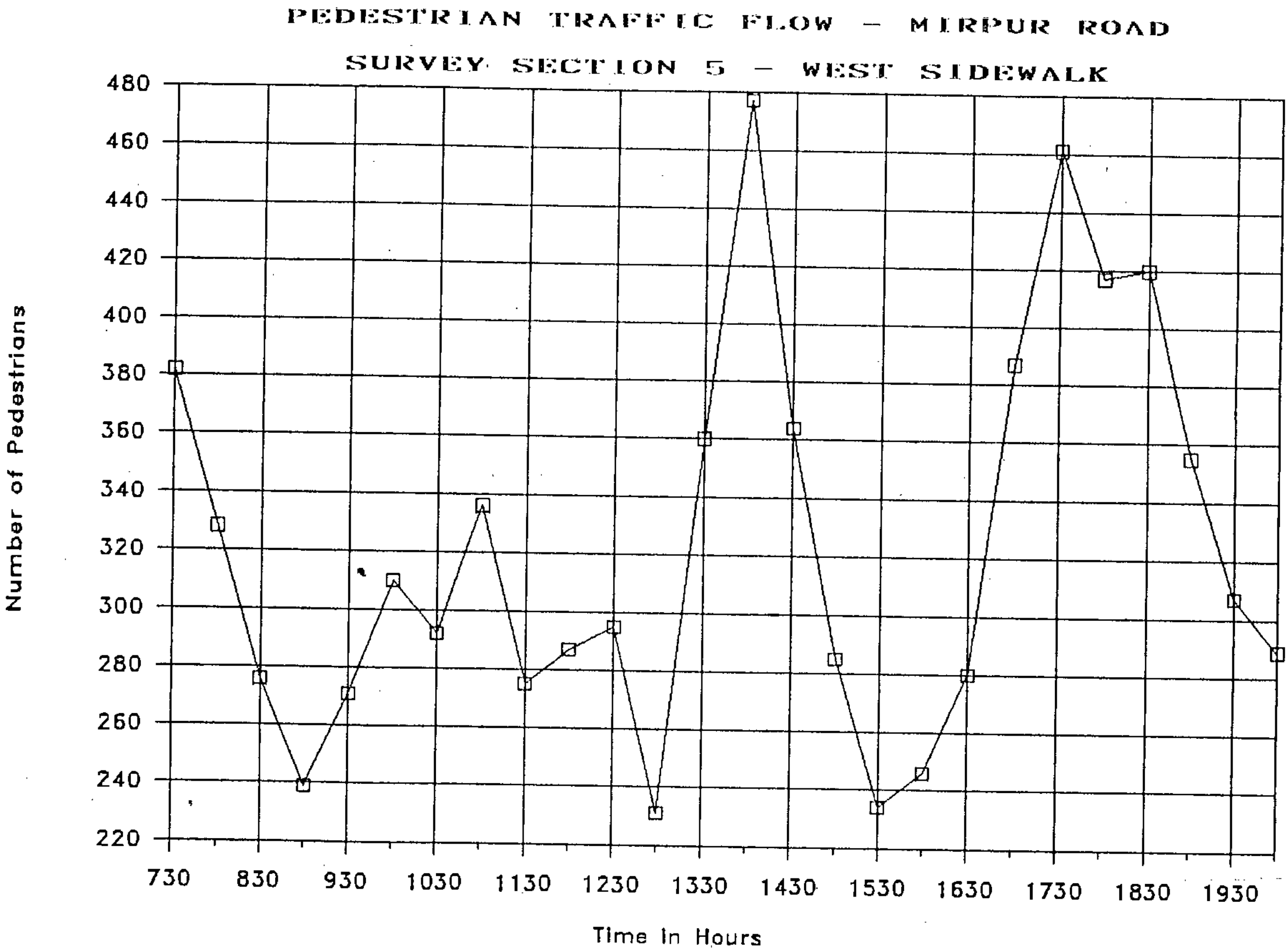
Graph 6.6

127



PEDESTRIAN TRAFFIC FLOW - MIRPUR ROAD
SURVEY SECTION 5 - EAST SIDEWALK
Number of Pedestrians
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
730
830
930
1030
1130
1230
1330
1430
1530
1630
1730
1830
1930
Time In Hours

Graph 6.7


PEDESTRIAN TRAFFIC FLOW - MIRPUR ROAD
SURVEY SECTION 5 - WEST SIDEWALK
Number of Pedestrians
480
460
440
420
400
380
360
340
320
300
280
260
240
220
730
830
930
1030
1130
1230
1330
1430
1530
1630
1730
1830
1930
Time in Hours

Graph 6_8

Level of service (LOS):

Sidewalk width at all surveyed sections was 2.4 m (8 ft). As many of the frontage land uses are shops, and width is less at few locations, dead width can be assumed to be 0.9 m (3 ft) thus reducing the effective width to 1.5 m (5 ft). The levels of service are estimated as in Table 6.1 assuming that the whole pedestrian flow uses the sidewalk facility. These analysis are based on LOS standards (Davis and Braaksma, 1987 and Fruin 1971).

6.1.1.2 PEDESTRIAN FLOW ACROSS THE ROAD

Peak flow and peak times:

Graphic illustrations indicate that the commuting journey - travel between home and work -- influenced pedestrian crossing activity to reach its greatest peak in the morning (between 730 to 930 hours). This is evident at sections 1,2,3 & 5, where the major contribution to crossing movements is caused by the public transit stands - mainly buses and minibuses - existing near these sections. In general, as flow peaks occur at sidewalks at three distinctive times, the case of crossing flow is likewise.

Flow variation pattern:

Crossing flow variation pattern depends largely on the local

Table 6.1

SIDEWALK LEVELS OF SERVICE

MIRPUR ROAD

Section	L.O.S. At peak flow	L.O.S. At 80% peak flow
EAST SIDEWALK		
1	B	A
2	A	A
3	D	C
4	A	A
5	A	A
WEST SIDEWALK		
1	A	A
2	A	A
3	C	B
4	A	A
5	A	A

Source: Field survey.

conditions and immediate surrounding of the crossing venue. At section 1 where it links directly with a major shopping street - New Elephant Road - and very busy public bus stands, no major abrupt variation was observed. This is particularly obvious after shopping and other business activities begin, mainly after 1000 hours, though variation is relatively higher near peak hours. This pattern is similar at other sections during the morning period. But variation at these sections is very steep with major rise and fall pattern in the afternoon and evening periods. A major generator of pedestrian crossing movements at these sections is the public bus service. This seems to be the prime reason behind this different flow pattern.

<u>Pedestrian behaviour at controlled crossings</u>:

Both sections 1 and 5 were located near signal-controlled intersections. Despite the signal cycle does not include a phase for pedestrians, this type of control helps pedestrians to cross at or near the marked zebra crossings.

During 13 hours of survey, the total number of pedestrians who crossed at section 1 (length = 100 m), including those who used the zebra crossing, was 15368. The number of pedestrians who used zebra crossing during the same period was 8436 (i.e., 55%) which is significantly high considering the pedestrian behaviour at crossings in general and the fact that the median existing at this section helps as a pedestrian refuge, and also considering the long strip of this section. But heavy vehicular flow passing here and the convenient location of the zebra crossing can explain this behaviour. Ratios of pedestrians crossing at zebra did not vary substantially, but relatively their numbers increased at peak hours, which mostly coincided with vehicular peak hours.

But at section 5, the situation was different. During the same period of survey, total number of pedestrians who crossed the section (of similar length), including those who crossed at zebra, was 7564. Number of pedestrians who used the zebra crossing was 2909 (i.e., 38%) despite the absence of median. This ratio went as low as 22% during the first hour when the vehicular flow was low, and exceeded 50% at pedestrian and vehicular peak hours. During morning hours until 1330 hours, pedestrian flow at zebra marked a continuous but minor fluctuation. This was followed by a small peak about 1430 hours. But the major peak occurred during the last peak hours (1730 - 1830 hours). This coincided with vehicular peak flow and major rise of pedestrian flow at the same section.

Considering behaviour of different age and sex groups of pedestrians crossing the road, ratios of different groups using zebra crossings at signalized intersections are different from the general average ratio. Since this condition of crossing exists only at sections 1 and 5, study of crossing behaviour at section 1 is a better guide as this section is more complex and used by heavy pedestrian flow.

Analysis of the below 16-year and above 60-year age groups resulted in the ratios shown in Table 6.2

<u>Pedestrian flow and criteria for establishing pedestrian crossings</u>:

With reference to the criteria used as a guide to establish pedestrian crossings (Fig. 2.2), examining the flow peaks at different sections of Mirpur Road against these criteria will certainly lead to emphasize a very hazardous situation and the necessity to establish severe control measures. Even a modest consideration of the existing flow, for example the average hourly flow, indicates the seriousness of the situation. This is quite obvious when the vehicular traffic flow is taken into account.

During 13 hours of pedestrian traffic survey at different sections, the average hourly flow was as shown in Table 6.3 Comparing these results with the above mentioned criteria, the average pedestrian crossing flow is far greater than even the highest limits that recommend controlled flow. Therefore, at sections 1,2.3 & 5, the pedestrian and vehicular flows are within the "Traffic signal control zone". Due to the present flow volume and other existing conditions, a package of measures must be adopted to aid control and facilitate crossing. At section 4, uncontrolled crossing facility, at least, should be provided. Pedestrians crossing at this section may also be diverted to the signal-controlled intersection of this road with road no. 16. Marked zebra crossings are required at this

Table 6.2

PEDESTRIAN FLOW AT ZEBRA CROSSING

Survey period: 13 hrs (700-2000 hrs)
Survey station: Mirpur Road - Section MR/S1
Date: 28.10.1987 (Wednesday)
Weather: Fine

Age	Z	Y	I
MALE:			
<16	810	297	73%
16-59	6592	5979	52%
>60	193	116	63%
FEMALE:			
<16	214	147	59%
16-59	565	412	57%
>60	49	25	66%

Z = Number of pedestrians using zebra crossing at the intersection.
Y = Number of pedestrians crossing at locations within a 100-m strip near the zebra crossing.
I = 100 × Z/(Z+Y), an index expressing pedestrian behaviour at this crossing

Source: Field survey.

Table 6.3

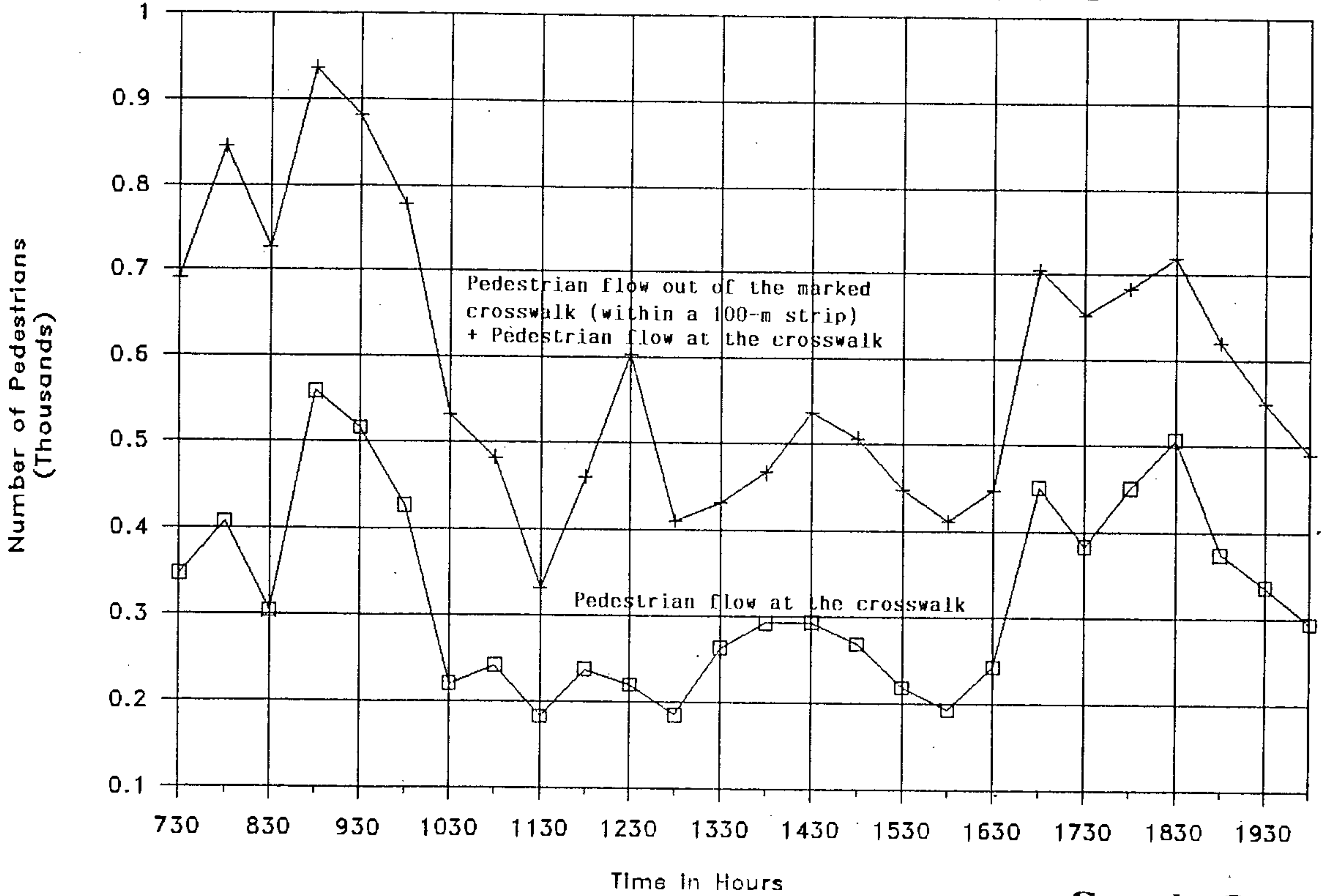
PEDESTRIAN FLOW ACROSS MIRPUR ROAD

Section	Total Flow (13 hrs)	Average Flow (ped./hr)
1	15368	1182
2	10643	819
3	7257	558
4	4025	310
5	7564	582

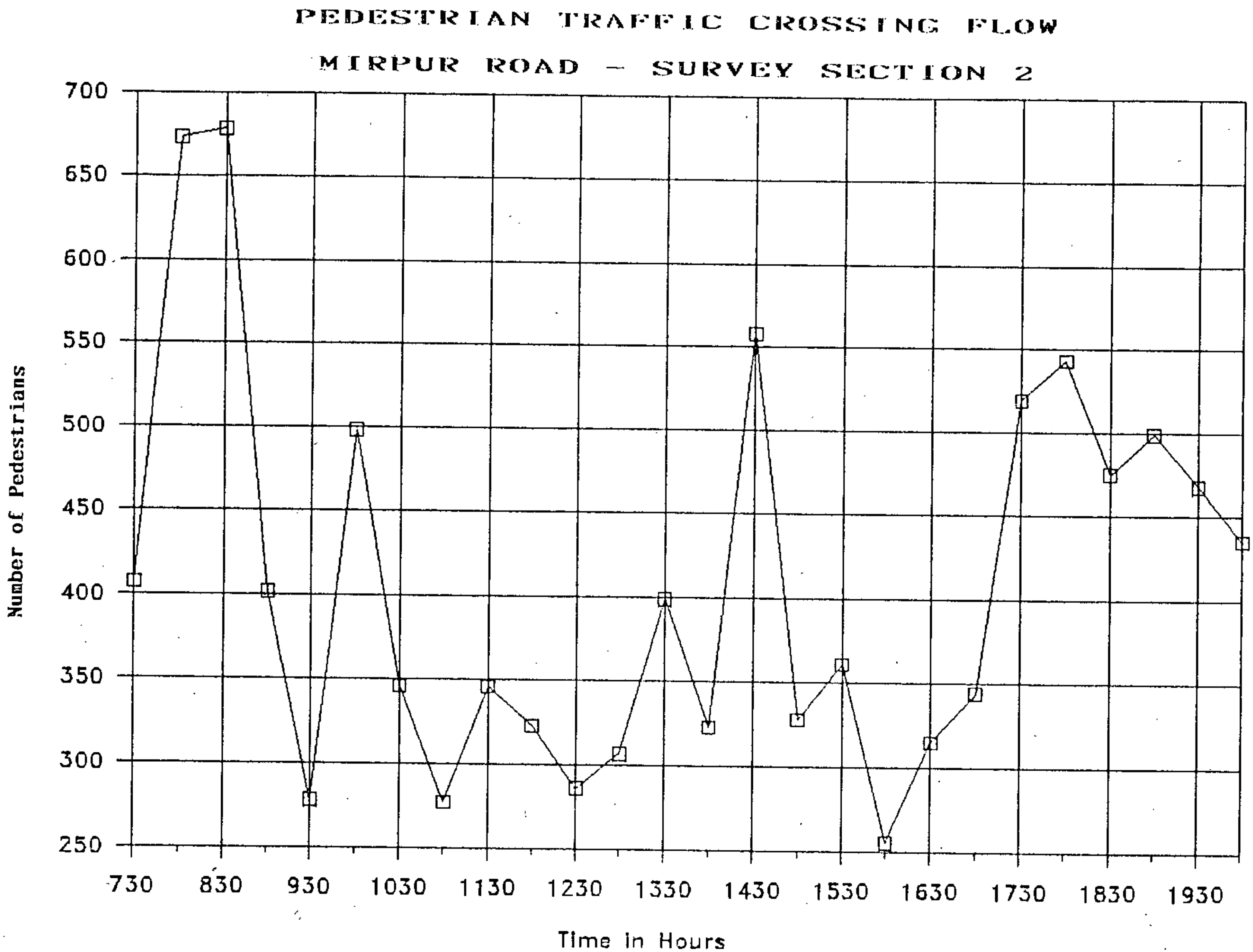
Source: Field survey.

PEDESTRIAN TRAFFIC CROSSING FLOW

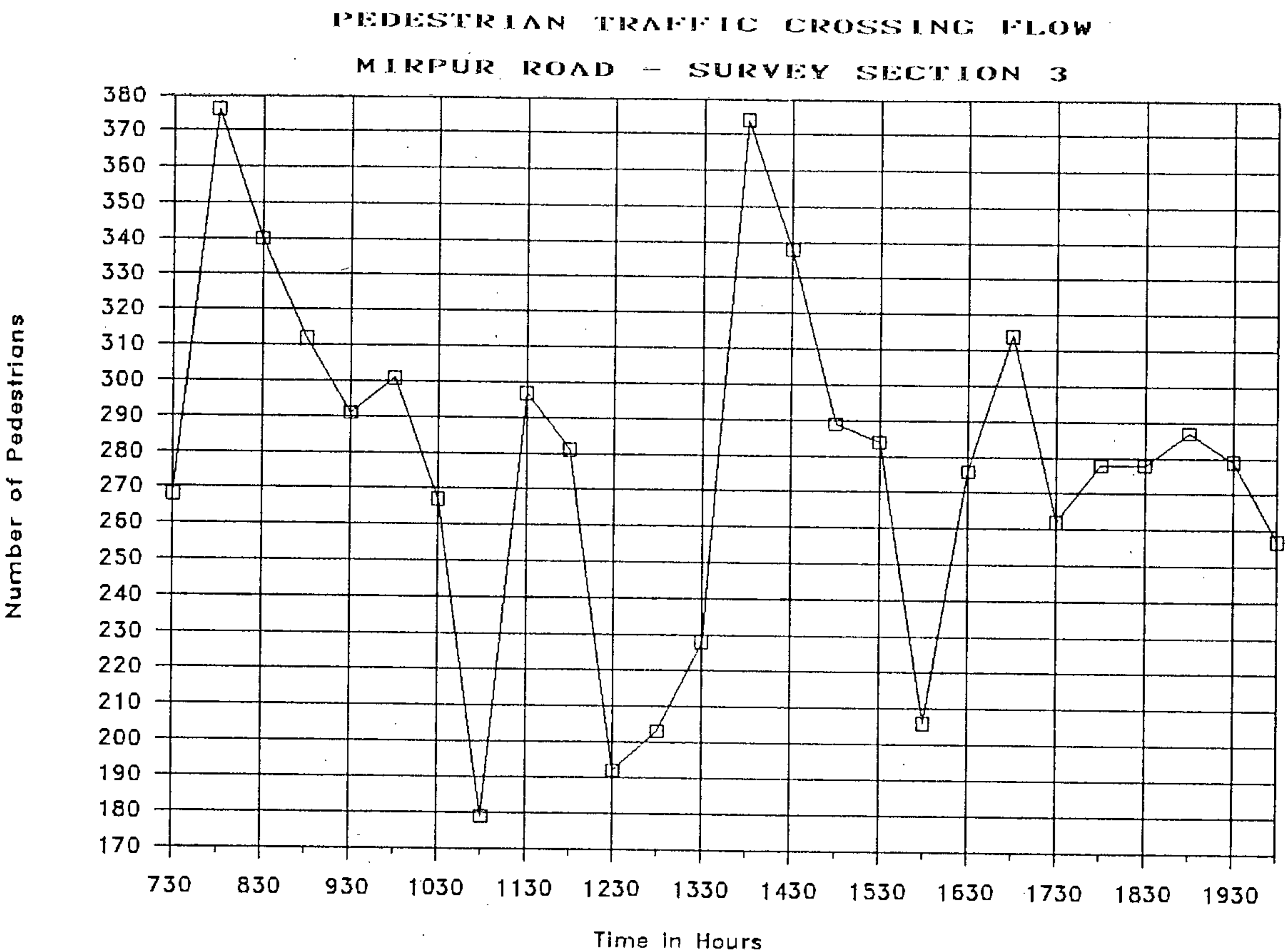
MIRPUR ROAD – SURVEY SECTION 1



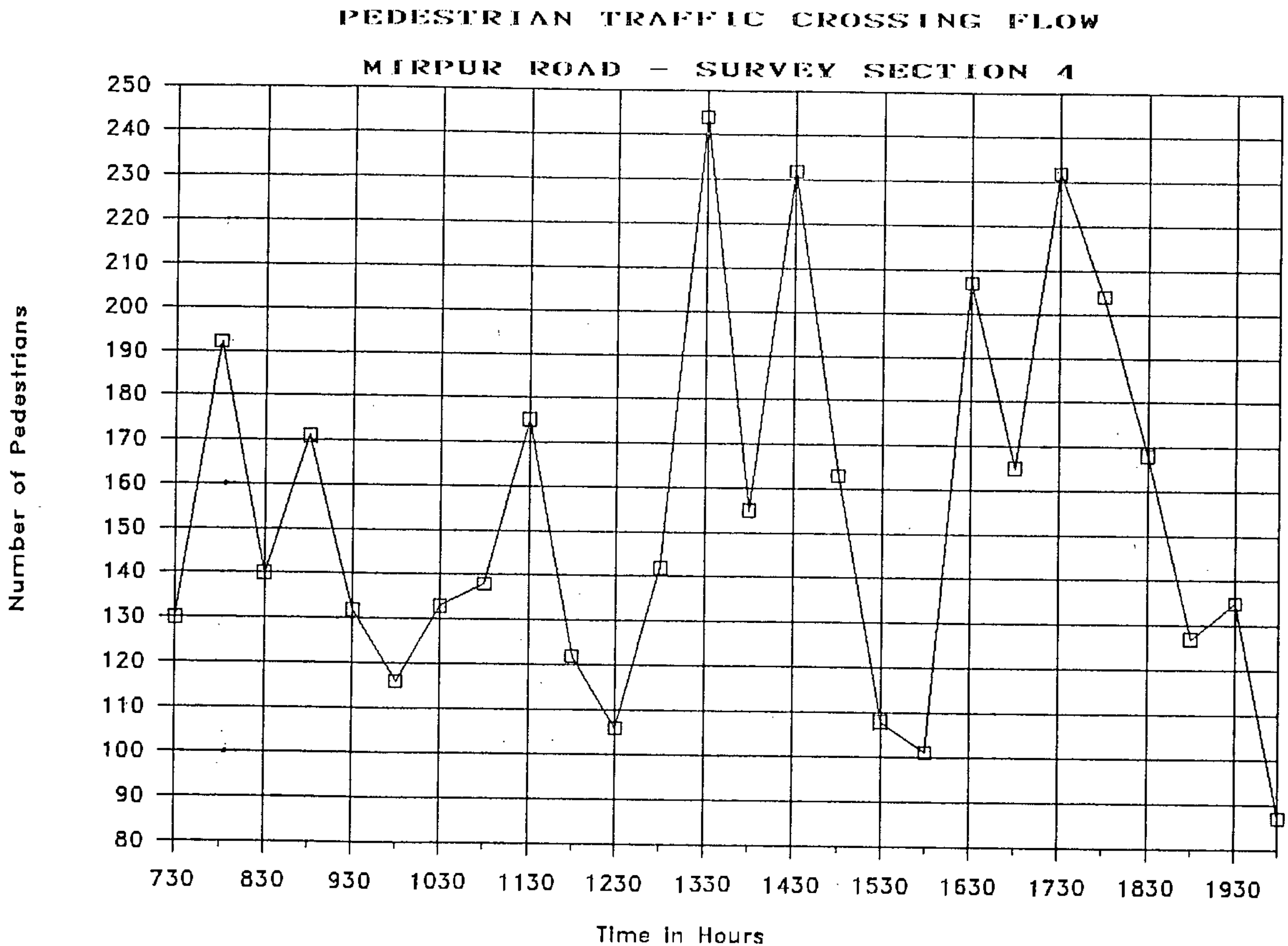
Graph 6.9


PEDESTRIAN TRAFFIC CROSSING FLOW
MIRPUR ROAD - SURVEY SECTION 2
Number of Pedestrians
700
650
600
550
500
450
400
350
300
250
730
830
930
1030
1130
1230
1330
1430
1530
1630
1730
1830
1930
Time in Hours

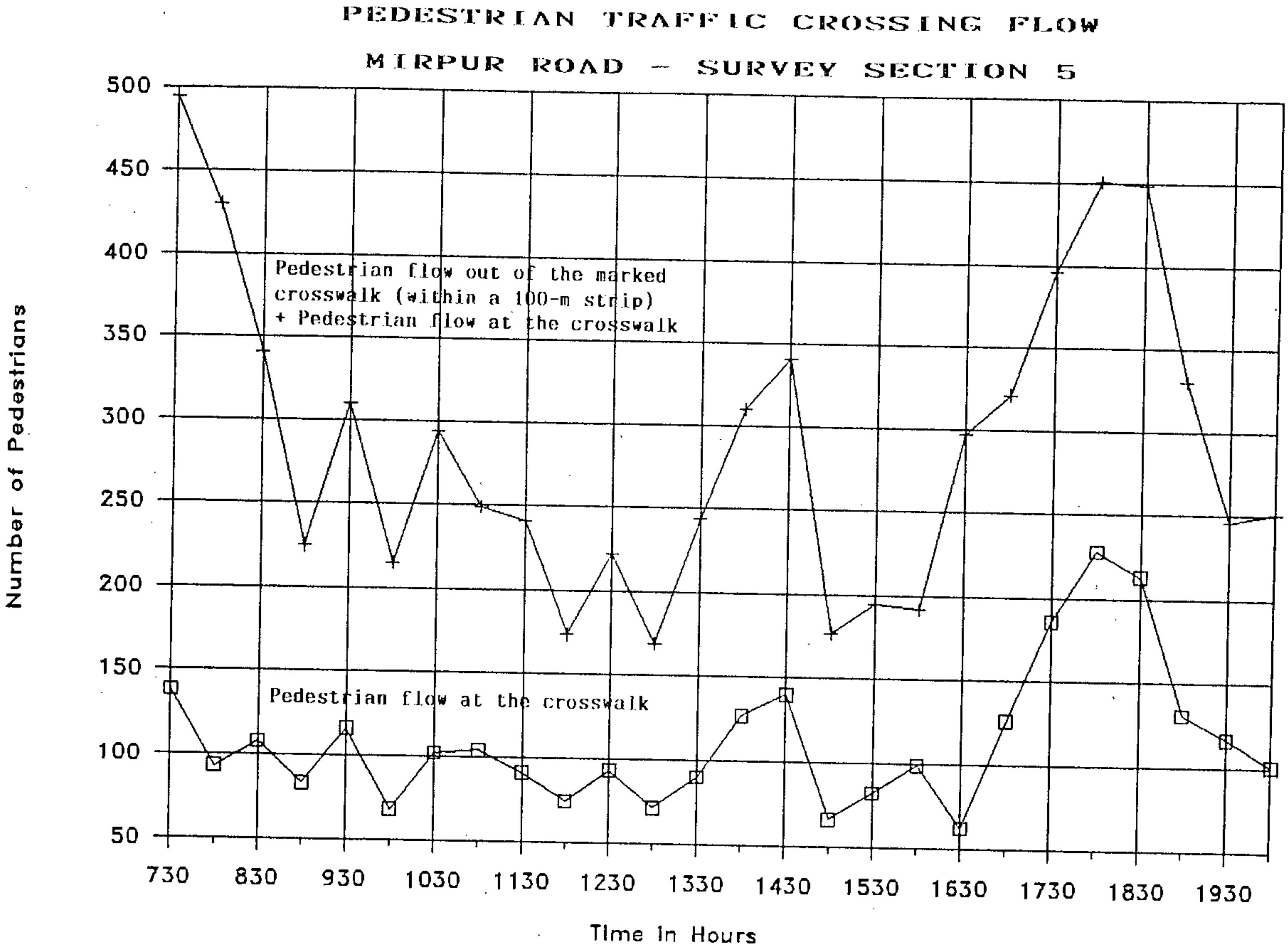
Graph 6.10


PEDESTRIAN TRAFFIC CROSSING FLOW
MIRPUR ROAD - SURVEY SECTION 3
Number of Pedestrians
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
730
830
930
1030
1130
1230
1330
1430
1530
1630
1730
1830
1930
Time in Hours

Graph 6.11


PEDESTRIAN TRAFFIC CROSSING FLOW
MIRPUR ROAD - SURVEY SECTION 4
Number of Pedestrians
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
730
830
930
1030
1130
1230
1330
1430
1530
1630
1730
1830
1930
Time in Hours

Graph 6.12



PEDESTRIAN TRAFFIC CROSSING FLOW
MIRPUR ROAD - SURVEY SECTION 5
Number of Pedestrians
500
450
400
350
300
250
200
150
100
50
Pedestrian flow out of the marked crosswalk (within a 100-m strip)
+ Pedestrian flow at the crosswalk
Pedestrian flow at the crosswalk
730
830
930
1030
1130
1230
1330
1430
1530
1630
1730
1830
1930
Time in Hours

Graph 6.13

intersection (Details will be discussed in Chapter 8).

6.1.2 Vehicular Flow

All classes of vehicles operate on this route, with time restriction applied for trucks only. During 13 hours of traffic field survey, average vehicular traffic flow was 4438 veh./hr for both directions. Average estimated hourly passenger car equivalent (PCE) for both directions was 6091 pce/hr.

Peak hours in vehicular flow, as the case in pedestrian flow, can be noticed in three periods. An abrupt and steep rise occurred during the first hour. No major flow fluctuation was recorded during morning hours. Two major peak flows occurred around 1400 and 1730 hours. Although all classes of vehicles contributed to flow variation at different periods, cars and cycle-rickshaws were the main contributing categories. Table 6.4 demonstrates composition of flow and PCE with respect to motorized and non-motorized vehicles for each flow direction. The estimated figures indicate how non-motorized vehicles outnumber the motorized vehicles and occupy more space of the roadway pavement. It worths mentioning that total flow in one direction is very close to the total flow in the other direction for motorized transport vehicles, and for the non-motorized as well.

Table 6.4

VEHICULAR TRAFFIC FLOW

MIRPUR ROAD

Survey period: 13 hrs (700-2000 hrs)
Survey station: MR/S2
Date: 02.11.1987 (Monday)
Weather: Fine

Direction (North | South)	↑		↑	↓		↓
Total flow (veh.)	15077	27770	12693	14007	29920	15913
Total PCE	22526	38513	15987	17045	40665	23620
Average flow (veh./hr)	1160		976	1077		1224
PCE/hr	1732		1230	1311		1817
PCE %	59		41	42		58

<u>For both directions</u>:

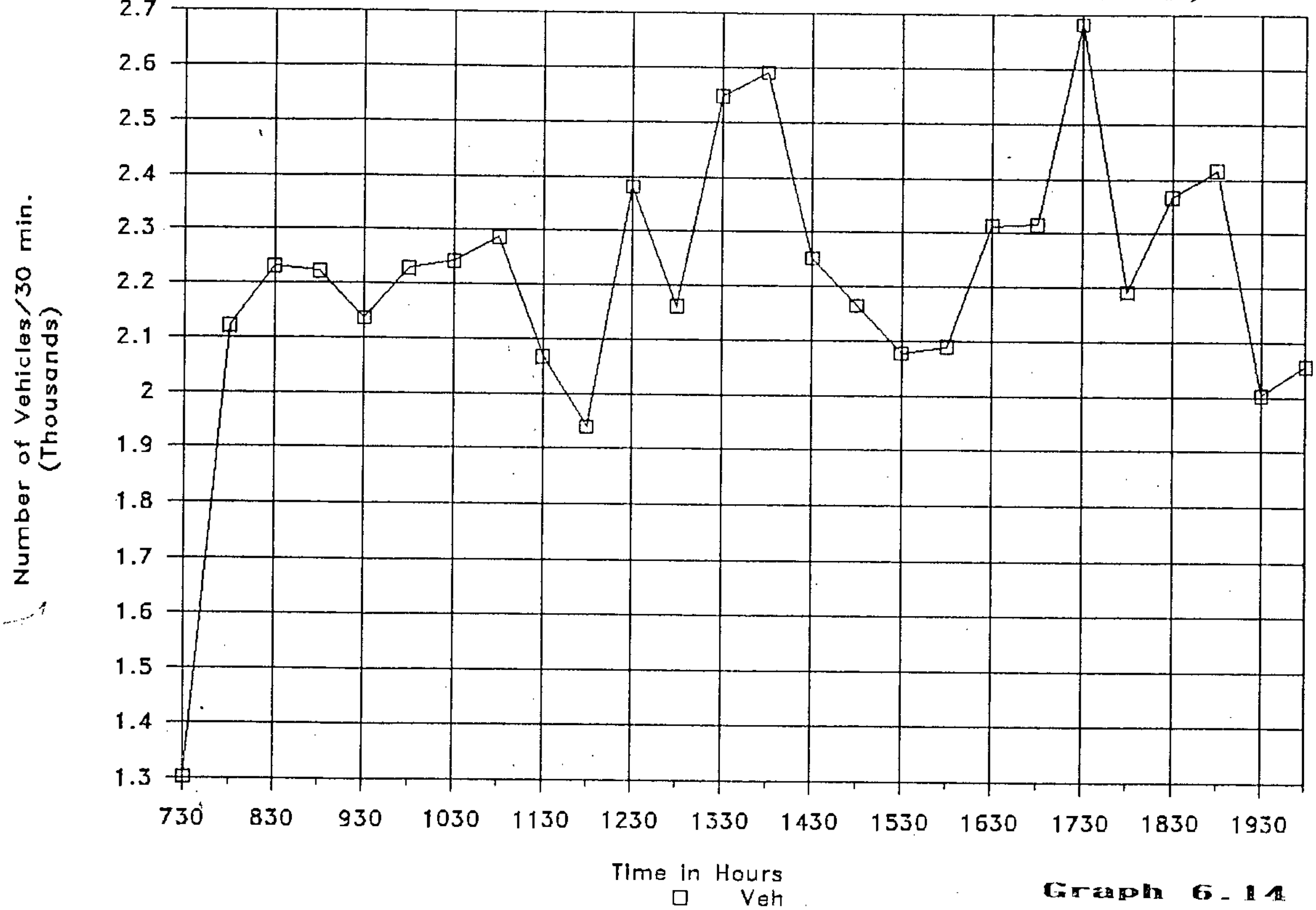
Total flow = 57690 veh.
Average flow = 4438 veh./hr
Total PCE = 79178
PCE/hr = 6090

↑ Motorized vehicles.
↑ Non-motorized vehicles.

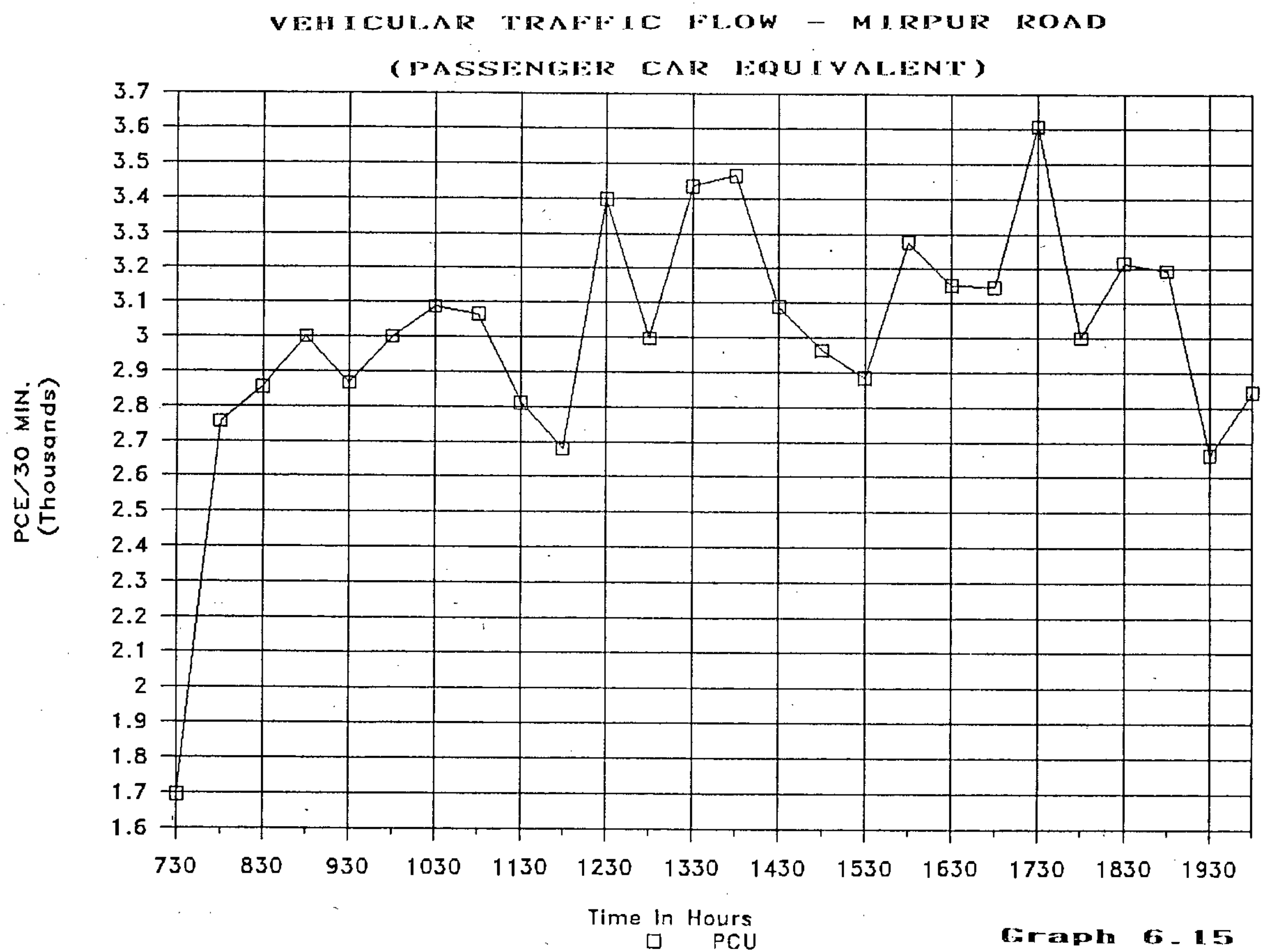
Source: Field survey.

VEHICULAR TRAFFIC FLOW – MIRPUR ROAD

(NUMBER OF VEHICLES – BOTH DIRECTIONS)



Graph 6.14


VEHICULAR TRAFFIC FLOW – MIRPUR ROAD
(PASSENGER CAR EQUIVALENT)
PCE/30 MIN.
(Thousands)
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
730
830
930
1030
1130
1230
1330
1430
1530
1630
1730
1830
1930
Time In Hours
PCU

Graph 6.15

6.2 NEW MARKET SHOPPING AREA

6.2.1 Pedestrian Flow

As this is a shopping area, pedestrian activities and movements are intensified during the afternoon and evening hours, particularly after office working hours. This pattern is predominant at sidewalks. Crossing flow is heavy throughout the field survey period as many people cross the road for different purposes, other than shopping, due to the nature of the surrounding land uses.

6.2.1.1 PEDESTRIAN DENSITY AT SIDEWALKS

Peak densities and peak times:

Pedestrian densities remain remarkably low during the morning hours, especially at sections 1 and 2. They rise in the afternoon, but peak hours are noticed to be after 1600 hours. At all sidewalks, the highest peak densities were observed between 1700 and 1830 hours. In general, high densities continued between 1600 and 2000 hours. The greatest two peak densities occurred at east sidewalk at sections 1 and 2 at 1730 hours when density module fell to less than 0.25 m^2/ped. The peak densities were relatively less at other sections, but sidewalks at these sections remained crowded during the evening peak hours.

Density variation pattern:

Field survey data reveal three periods of major density variation. Low density is noticed in the morning until the beginning of shopping activities, i.e., at about 1000 hours. Densities rise with the rise of shopping activities to more than double and maintain minor fluctuation until about 1600 hours. This is followed by a period of very intensified activities, as indicated by steep rise in densities. This period continues until about 2000 hours.

During data analysis process, it was hypothesized that the greatest intensity of pedestrian movement at sidewalks continued to predominate after 1600 hours, until 2000 hours, and that this period was the main activity period in this area and, hence, related densities during this period would practically be a more useful guide in designing pedestrian facilities in the area. Further analysis revealed an interesting and strong supporting evidence. Assuming average pedestrian density for the entire surveyed period at each section to be "D", and for the main 4-hour active period to be "D_1", the ratios D_1/D for different sections were estimated as in Table 6.5. In all cases these ratios were within the range of 1.4 to 1.8. It should be borne in mind that the existing cinema hall is a major factor causing enormous intrusion of the east sidewalk and other nearby facilities frequently and abruptly.

Table 6.5

PEDESTRIAN DENSITIES AT SIDEWALKS NEW MARKET SHOPPING AREA

Survey period: 13 hours (700-2000 hrs)
Date: 01.11.1987 (Sunday)
Weather: Fine

(Densities are expressed here as "pedestrian per square meter").

	Sec.1	Sec.2	Sec.3	Sec.4
EAST SIDEWALK				
D	1.23	1.30	1.05	0.65
D_1	1.79	2.28	1.57	0.95
D_1/D	1.5	1.8	1.51	1.5
WEST SIDEWALK				
D	0.96	0.81	1.24	1.26
D_1	1.39	1.39	1.73	1.92
D_1/D	1.5	1.7	1.4	1.5

D = Average pedestrian density for the whole survey period.

D_1 = Average pedestrian density for the main 4-hour active period.

Source: Field survey.

Level of service (LOS):

Although sidewalk width is irregular at various sections, width variation is small. Average width is approximately 3 m at the east sidewalks and 2.5 at the west sidewalks. Effective width may be assumed 2 m and 1.5 m respectively.

Based on LOS standards (Table A.2), levels of service at different sections of sidewalks were estimated as in Table 6.6. This estimation is based on the average densities related to the period of the main busy hours, i.e., D_1 shown in Table 6.5 .

6.2.1.2 CROSSING PEDESTRIAN FLOW

Peak flow and peak times:

A heavy crossing flow occurred between 730 and 800 hours at section 3 making the second highest peak flow. This flow was abrupt and caused in its greatest proportions by women heading towards garment industries to the east of the area. A steep fall in the flow followed this peak. The highest peak occurred around 1800 hours when total crossing flow mounted to about 5600 pedestrians in 30 minutes.

Flow variation pattern:

Following the morning peak, a steep recession took place until 900

Table 6.6

SIDEWALKS LEVELS OF SERVICE

NEW MARKET SHOPPING AREA

Survey period: 13 hours (700-2000 hrs)
Date: 01.11.1987 (Sunday)
Weather: Fine

Section	Module (m^2/ped.)	L.O.S.
EAST SIDEWALK		
1	0.56	E
2	0.44	F
3	0.64	E
4	1.05	D
WEST SIDEWALK		
1	0.72	E
2	0.72	E
3	0.58	E
4	0.52	E

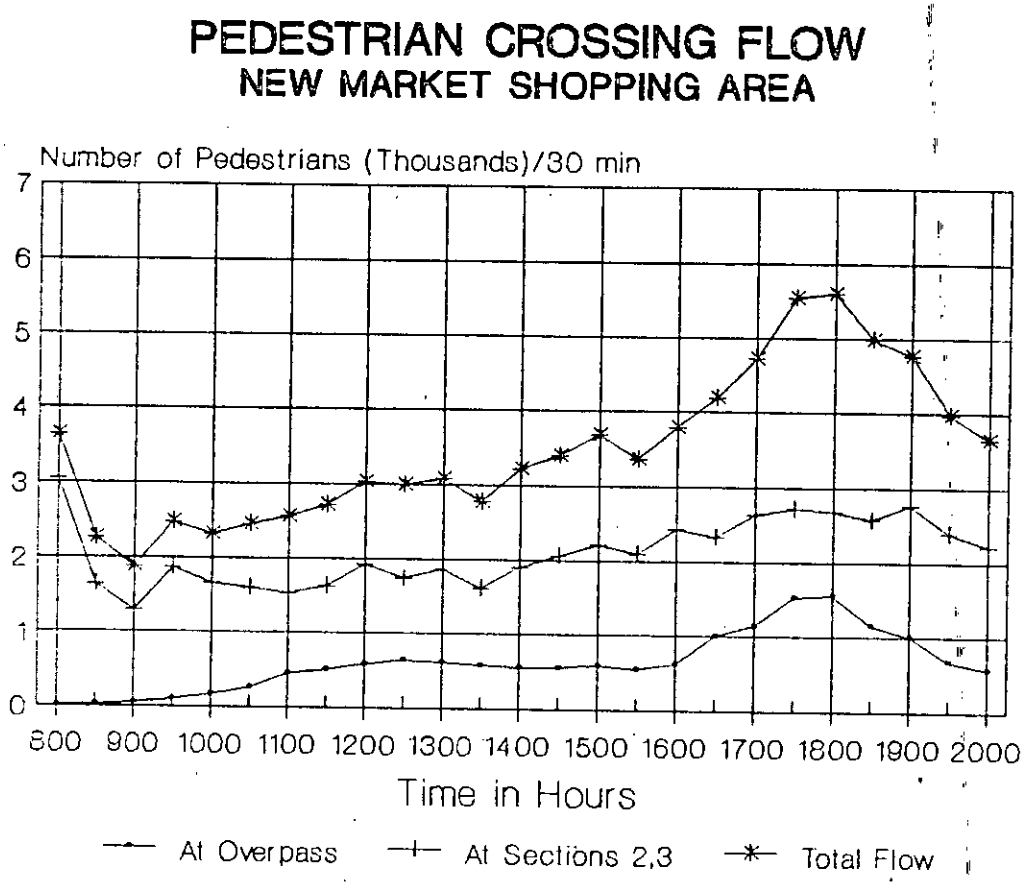
Source: Field survey.

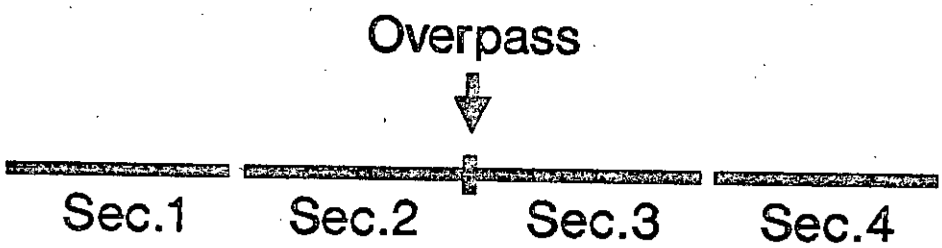
hours. With the start of business activities, the flow started to rise slowly with minor fluctuation until 1600 hours. Between 1600 and 2000 hours, shopping activities were very intensive. Graphic illustrations show how the bulk of pedestrian movements took place during this period.

Average flow for the whole survey period was 6974 ped./hr. Average flow during the main busy shopping hours (1600 to 2000 hours) was 9365 ped./hr. This makes a ratio (1.34) which is close to the ratios of the corresponding pedestrian densities at sidewalks (Table 6.5).

<u>Pedestrian behaviour at the overpass</u>:

Crossing flow data analysis and field observations emphasize the fact that pedestrians tend to resist using segregated crossings at different grade levels. Even when vehicular traffic flow was at its peak, accompanied by heavy pedestrian flow at mid-day, only about 27% of the total pedestrian flow, within 100 m on both sides, used the overpass. In the morning, this ratio was very low and started from as little as 0.5%. For the whole field survey period, total recorded crossing flow was 87177 pedestrians. Total crossing within 100 m on both sides of the overpass, including crossing at overpass, was 68060 ped. and total flow at overpass was 15576 ped. (i.e. 22.9%). For the main busy hours, total crossing flow was 37458 ped., total flow within 100 m was 29022 ped. and total flow at the overpass was 8681 ped. (i.e. 29.9%). The highest ratios occurred


PEDESTRIAN CROSSING FLOW
NEW MARKET SHOPPING AREA
Number of Pedestrians (Thousands)/30 min
0
1
2
3
4
5
6
7
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Time in Hours
At Overpass
At Sections 2,3
Total Flow


Overpass
Sec.1
Sec.2
Sec.3
Sec.4

Graph 6.16

between 1700 and 1800 hours, particularly after work went over at garment industries and other private sector enterprises. Though not estimated, it was observed during field survey that women and children made the greatest proportion of flow at the overpass.

<u>Pedestrian flow and criteria for establishing pedestrian crossings</u>:

Vehicular-pedestrian interaction at the surveyed area is enormous. For this reason, the existing overpass was constructed. But with the hardly 23% of pedestrians using this facility, and considering the severe conflict in the area, the situation undoubtedly unveils monstrous errors. The present pedestrian and vehicular flow volumes and the state of conflict necessitate complete segregation. Application of a pakage of traffic management and drastic control measures is a matter of great urgency.

6.2.2 Vehicular Flow

All classes of vehicular traffic operate in this area, with time restriction applied to trucks only. (This is demonstrated in the vehicular traffic survey tables for this area). The survey station for vehicular flow was fixed at the overpass. Two distinctive peaks occurred around 1230 hours and 1730 hours, with almost a steady rise and fall during the whole period preceding and following peak flows. Table 6.7 indicate only about 21% of the total PCE contributed by

Table 6-7

VEHICULAR TRAFFIC FLOW

NEW MARKET SHOPPING AREA

Survey period: 12 hrs 30 min. (730-2000 hrs)
Survey station: At the pedestrian overpass.
Date: 10.01.1988 (Sunday)
Weather: Fine

Direction North | South	↿		↑	↓		⇂
Total flow (veh.)	28218		9700	10998		29107
		37918			40105	
Total PCE	41860		10794	12039		42874
		52654			54913	
Average flow (veh./hr)	2257		776	880		2329
PCE/hr	3349		864	963		3430
PCE %	79		21	22		78

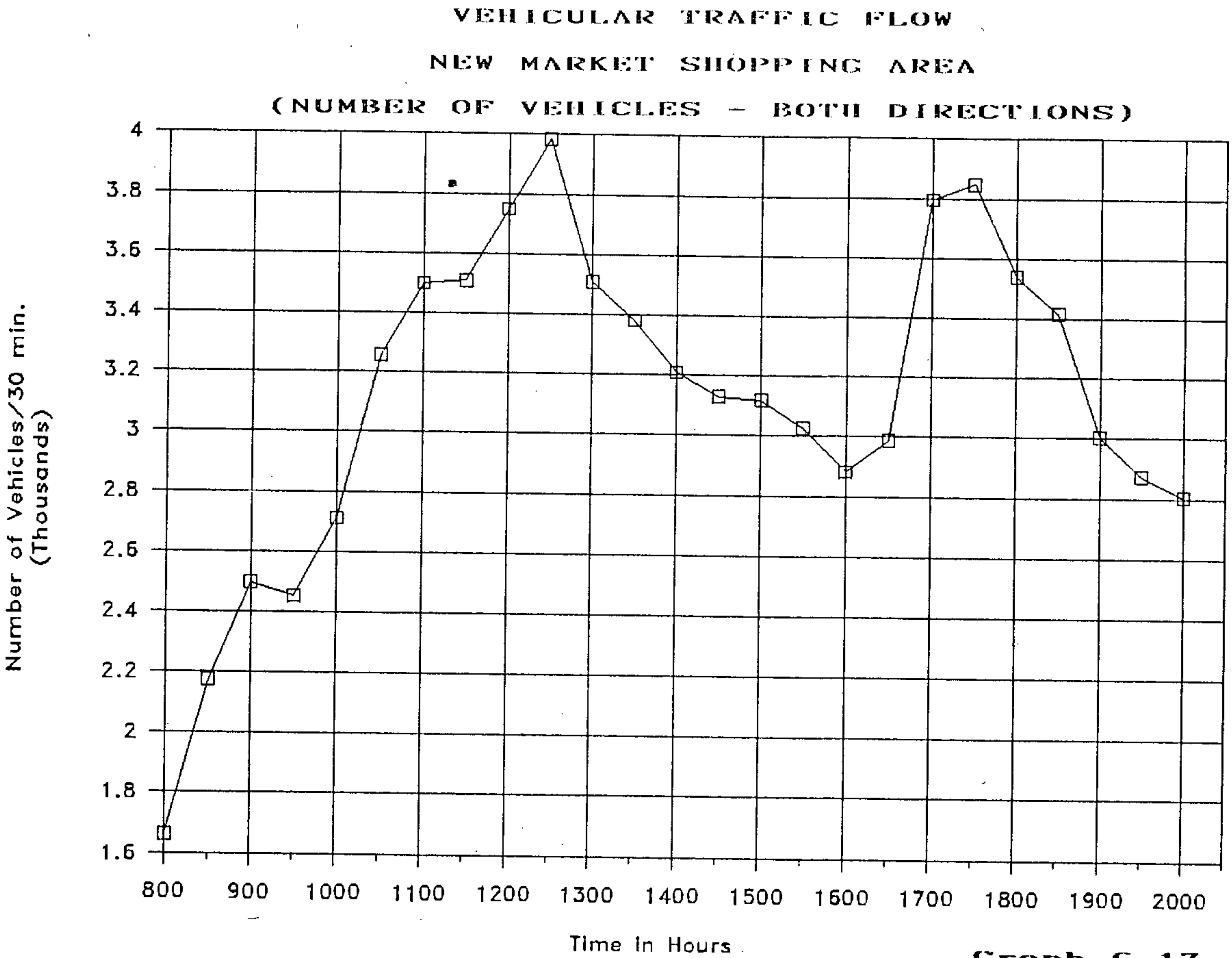
<u>For both directions</u>:

Total flow = 78023 veh.
Average flow = 6242 veh./hr
Total PCE = 107567
PCE/hr = 8605

↑ Motorized vehicles.
↿ Non-motorized vehicles.

Source: Field survey.

motorized traffic and 79% by non-motorized traffic. The table demonstrates composition of flow and PCE for these two categories of vehicular traffic in both directions. Like in Mirpur Road in the previous traffic survey, it is noticed that total flow in one direction is very close to the total flow in the other direction for the motorizerd as well as for the non-motorized transport vehicles.

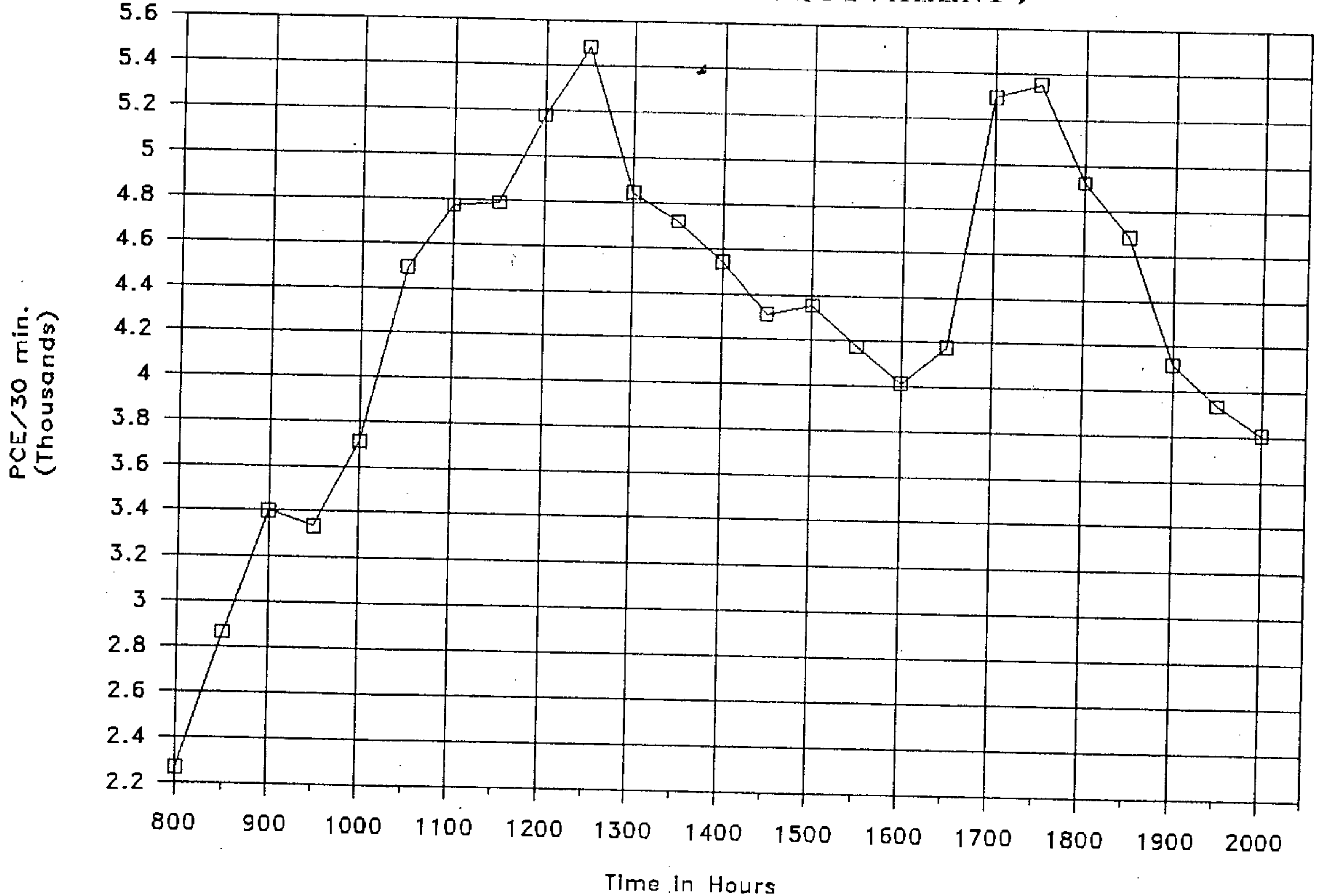

VEHICULAR TRAFFIC FLOW
NEW MARKET SHOPPING AREA
(NUMBER OF VEHICLES - BOTH DIRECTIONS)
Number of Vehicles/30 min. (Thousands)
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Time in Hours

Graph 6.17

VEHICULAR TRAFFIC FLOW

NEW MARKET SHOPPING AREA

(PASSENGER CAR EQUIVALENT)



Graph 6.18

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Chapter 7

PEDESTRIAN BEHAVIOUR AT CROSSINGS

7.1 INTRODUCTION

Pedestrian actions are less predictable than those of drivers. Many pedestrians consider themselves outside the law in traffic matters and pedestrian regulations in Dhaka city are rarely enforced. This makes it difficult to design a facility for safe and orderly pedestrian movement.

Pedestrians tend to walk in a path that represents the shortest distance between two points, thus along streets they often cross at mid-block and fail to stay in crosswalks. Pedestrians also have a basic resistance to changing grades when crossing roadways and tend to avoid using underpass or overpass pedestrian facilities.

An important factor in relation to pedestrian behaviour and accidents is age. Very young pedestrians are often careless in traffic due to ignorance and exuberance, whereas the elderly appear inattentive or defiant toward vehicles and drivers.

In Dhaka city, as the phenomenon in other cities of developing countries, pedestrians have the greater proportion of fatalities and serious injuries amongst the various classes of road users. As shown in Chapter 4, the greatest responsibility for accidents is attributed to the human factor or, in other words, the road user behaviour. Since nearly all casualties happen on the carriageway, this very strongly indicates the necessity to segregate pedestrians from vehicles.

Installation of automatic vehicles' and pedestrian signals improved to some extent the control and flow of traffic in the city. Unfortunately, desireable conditions could not be attained due to many factors mainly the large increase of vehicles, the migration to Dhaka city of great number of people from the rural areas, and the predominant behaviour and attitudes of the road users.

The Dhaka Municipal Corporation, with the help of traffic division of Dhaka Metropolitan police, carried out at different stages field survey and installed 44 vehicle signals and 5 pedestrian signals. Yet there is a serious shortage in the number of these signals and the marked crosswalks, and also in the number of the deployed traffic police personnel. Inadequate maintenance is another problem as malfunctioning of signals and marked crossings reduces the efficiency of these facilities and influence the behaviour of drivers and pedestrians.

7.2 SELECTED CROSSINGS

The selected nine at-grade crossings assigned to study pedestrian behaviour were at the following locations:

(1) At intersections:

(i) Signalized intersections.

- Cross intersection (Kakrail Road at its intersection with Shantinagar Road), denoted here as crossing "A".

- T-intersection (New Elephant Road at its intersection with Mirpur Road), crossing "B".

(ii) Non-signalized intersection (Bashani Road at Shahbagh intersection, crossing "C".

(2) At more than 18.3 meter (20 yards) from intersection:

(i) Controlled crossings.

- New Airport Road, Kawran Bazar (signal-controlled), crossing "D".

- New Airport Road, between Farmgate and old airport (signal-controlled), crossing "E".

- Topkhana Road (police-controlled), crossing "F".

(ii) Uncontrolled crossings (zebra crossings).

- Topkhana Road, near National Press Club, crossing "G".

- New Elephant Road, crossing "H".

- Bongobondhu Avenue, crossing "I".

7.3 SURVEY DATA ANALYSIS

Aided by an IBM PC, the survey data was processed to produce graphical representation of all counts of the nine cases. Pedestrian behaviour was measured by "Behaviour Index" defined as:

$$100 \times \frac{\text{The number of pedestrians using the crossing}}{\text{The number of pedestrians crossing the road on and within 18.3 meters of the crossing}}$$

Assuming

Z = Number of pedestrians using the crossing, and

Y = Number of pedestrians crossing the road within 18.3 m (20 yd) of the crossing,

$$\text{Behaviour Index} = 100 \times Z/(Y+Z)$$

At each crossing, total 12 of 15-minute counts were obtained. The index was calculated for each count (Table 7.1). The 12 resulting indices in each case were averaged to establish the behaviour index for every crossing. Indices for the same control type were again averaged to calculate behaviour indices versus types of control (Table 7.2). Considering individual cases, consistency of behaviour was observed at all crossings. The resulting low values of standard deviation of the indices for individual crossings provided a supporting evidence for this consistency (Table 7.1).

At signalized intersections, great variation in the index values was observed at the two different forms of intersections: high value at cross intersection (64) and low value at T-intersection (28), whereas this value was high at the non-signalized intersection (73). At crossings far from intersections, indices had higher values at the controlled crossings and comparatively lower values at the uncontrolled ones.

Table 7.1
PEDESTRIAN BEHAVIOUR INDICES AT CROSSINGS

OBS. NO.	CROSSING								
	A	B	C	D	E	F	G	H	I
1	66.6	27.8	79.5	36.5	65.5	75.7	49.0	25.4	42.6
2	63.0	33.5	67.6	56.2	59.4	72.2	50.4	31.0	37.9
3	74.7	30.8	70.5	62.4	57.6	74.8	47.9	22.9	36.2
4	67.0	31.5	66.9	63.3	74.2	74.6	50.5	25.7	42.8
5	73.3	23.8	67.7	66.7	67.9	74.9	32.1	30.2	41.6
6	66.7	23.5	72.8	63.3	67.1	80.6	38.3	21.1	44.8
7	75.9	27.3	73.1	61.5	61.4	77.1	44.9	29.5	40.3
8	73.2	27.5	72.0	77.2	71.4	71.0	37.4	33.7	45.6
9	60.3	27.3	79.4	71.1	61.2	73.1	42.0	31.6	41.7
10	52.2	27.2	78.5	76.3	52.3	73.4	46.7	27.4	41.4
11	49.2	24.7	73.5	78.3	58.6	70.0	47.0	26.6	41.7
12	47.9	25.5	78.5	82.9	56.1	77.9	45.1	23.2	41.6
$\bar{I}$	64.2	27.5	73.3	66.3	62.7	74.6	44.3	27.4	41.5
S.D.	9.5	3.0	4.5	11.9	6.3	2.9	5.5	3.7	2.5

$\bar{I}$ = Average behaviour index at individual crossing.
S.D. = Standard deviation of indices at individual crossing.

Source: Field survey.

Table 7.2
BEHAVIOUR INDICES
VS. TYPES OF CONTROL

Location	Behaviour Index
At intersection:	
- Signalized (┼)	64
- Signalized (┴)	28
- Non-signalized	73
Far from intersection:	
- Controlled crossing	68
- Uncontrolled crossing	38

(┼): Cross intersection.
(┴): Tee intersection.

Source: Field survey.

7.4 CONCLUSIONS

The pedestrian behaviour indices established in this study, and their consistency for each individual case, reflect the nature of pedestrian behaviour in crossing roads in the city with respect to different types of control. However, the index for each crossing indicates conformity with other factors and local conditions existing at the crossing. The main factors that may always influence this behaviour are:

(a) Factors effecting the gaps needed for pedestrian crossing mainly

(1) width of the street,

(2) volume of vehicular flow,

(3) speeds of the vehicles, and

(4) availability of pedestrian refuge.

(b) Vehicles stopping at the crossing.

(c) On-street parking.

(d) Location of the crossing with respect to an intersection.

(e) Number of potential points of pedestrian-vehicular conflict at intersections.

In other words, the vulnerability of the pedestrian, while crossing the road, influences his behaviour. This vulnerability, at all the examined sections, appeared to be a function of the above stated factors, in addition to the type of control. Behaviour is further influenced by other factors mainly layout pattern of the crossing area, age, sex, etc. (Fig.7.1)

The influence of the main factors appeared in this study can be illustrated as follows:

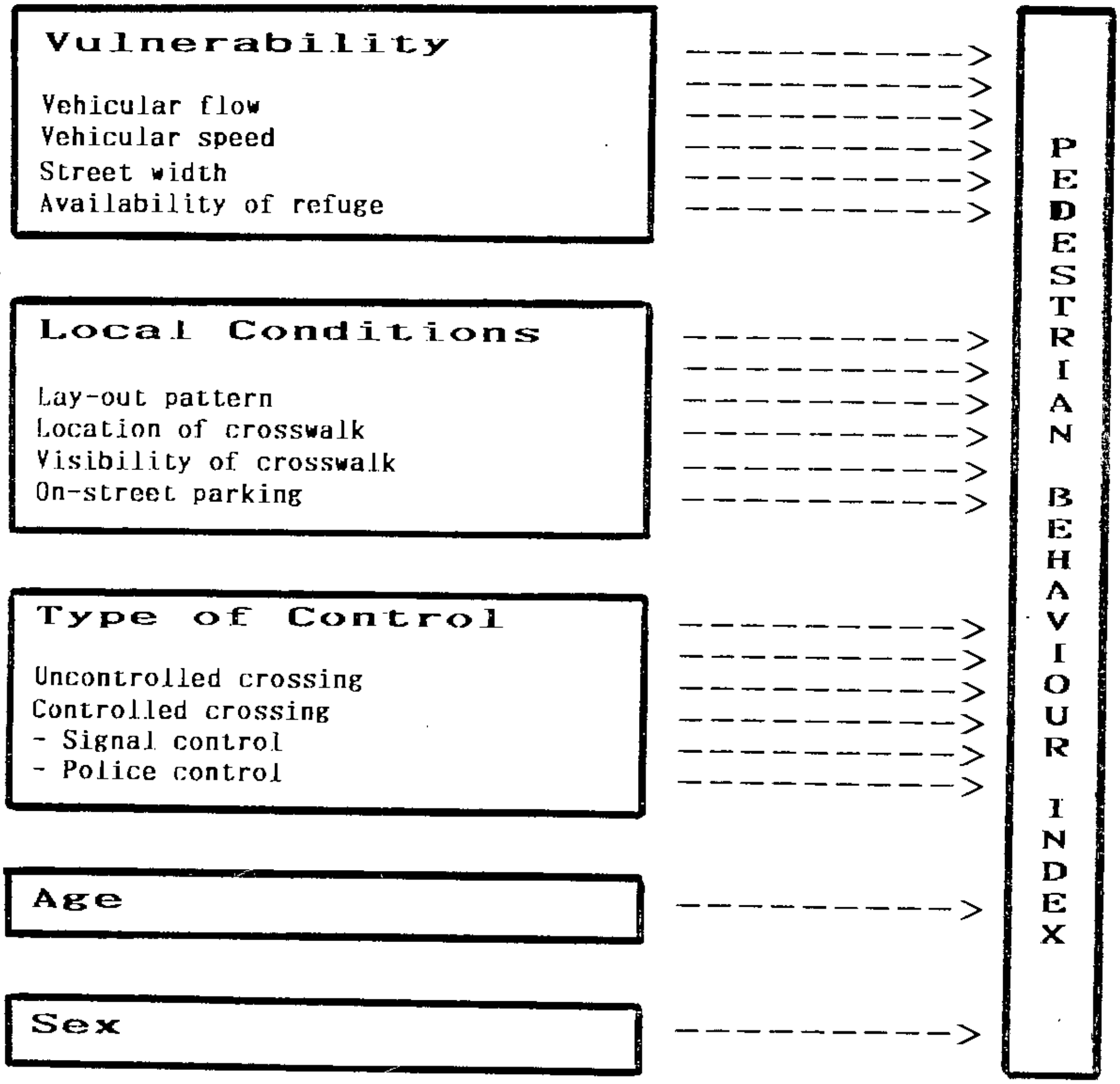
- At the signalized cross intersection, there are 8 points of pedestrian-vehicular conflict (Fig.7.2). At the crossing considered here, there are 2 expected points of conflict (practically 3 due to continuous left turn vehicular movement and more conflict points at the intersection as pedestrians try always to cross regardless to traffic signals). The high volume of vehicular traffic forced larger numbers of pedestrians to use the crossing. The street at this section was also 6-lane wide (High volume of vehicular traffic slows down the vehicles' speed. But some times this volume becomes too high to leave any sufficient gaps and inhibits random pedestrian crossing forcing them to use the crossing facility).

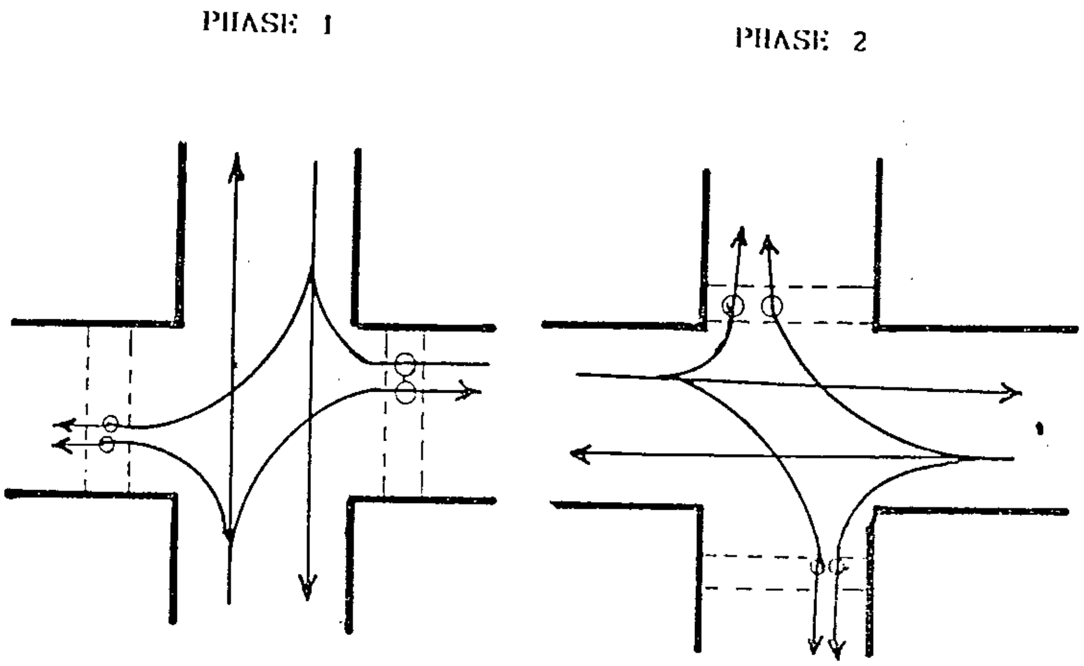
- At the signalized intersection (New Elephant Road with Mirpur Road) there are 3 points of pedestrian-vehicular conflict (1 point at the crossing, practically more for the same reasons above). This section is channelized providing good refuge for pedestrians. Vehicles were moving at low speeds due to their high volume and slow operation at this intersection. These factors encouraged lower proportion of pedestrians to use the crossing. One more factor led to this result: vehicles stopping at the crossing waiting for the green signal.

- At the non-signalized intersection (Shahbagh) a large roundabout

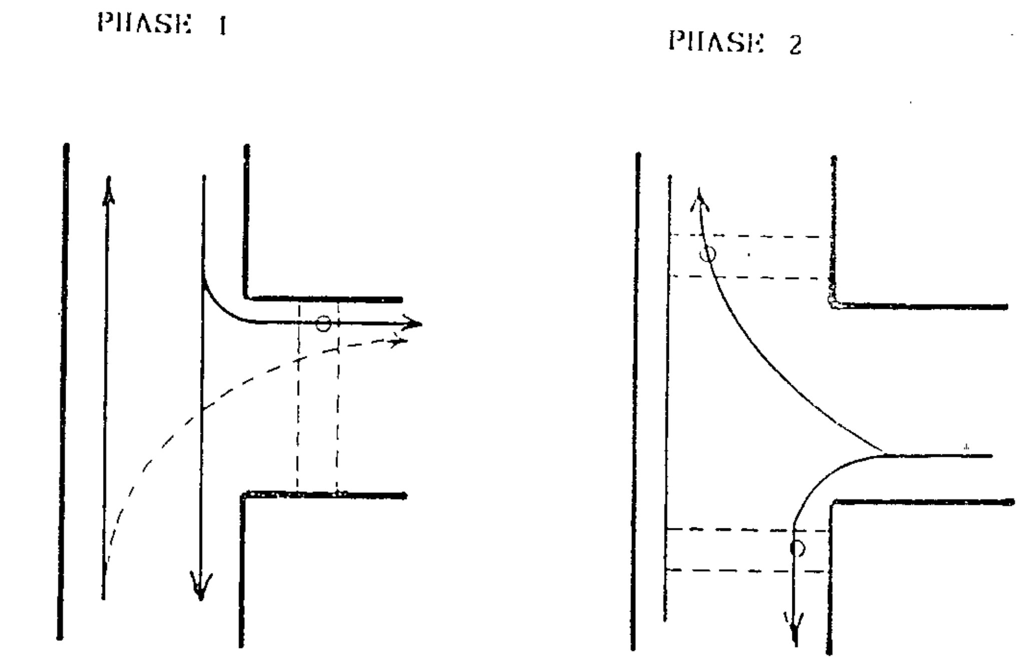
Fig.7.1

FACTORS INFLUENCING PEDESTRIAN BEHAVIOUR AT CROSSINGS





Cross intersection - 8 conflicts



T-Intersection - 3 conflicts
(Right-turn from Mirpur Road to
New Elephant Road was prohibited)

Fig. 7.2 PEDESTRIAN-VEHICULAR CONFLICTS AT SIGNAL-CONTROLLED INTERSECTIONS

(Non-prohibition of left-turn movements in phase 1 increases the number of conflict points) exists. The street is 6-lane wide with no refuge for pedestrians other than at the crossing. Vehicles travelled at relatively high speeds. This section got the highest behaviour index.

- Away from intersections, vehicles were travelling at high speeds. At the three controlled crossings, narrow medians existed. The highest behaviour index occurred at the police-controlled crossing. At the three uncontrolled crossings, the lowest index occurred in New Elephant Road where the street is narrower and divided by a median and where at peak hours vehicles travelled at lower speeds. Furthermore, as this is a shopping street, the nature of pedestrian activities on both sides of the road induces indiscriminate crossing.

- Some crossings at intersections were located at wrong places, far from the intersection for example, thus pedestrians using the sidewalks of the other road tend to cross beyond the crossing facility. In cases where vehicles' stop line is impractically far from the intersection, vehicles especially cycle-rickshaws tend always to stop on the crosswalk and beyond their stop line. This reduces the effectiveness of the pedestrian facility and adds to the pedestrian vulnerability and inconvenience. The location of the latter mentioned crosswalk is an evident example. Fig.7.3 shows the preferred location of pedestrian crossing.

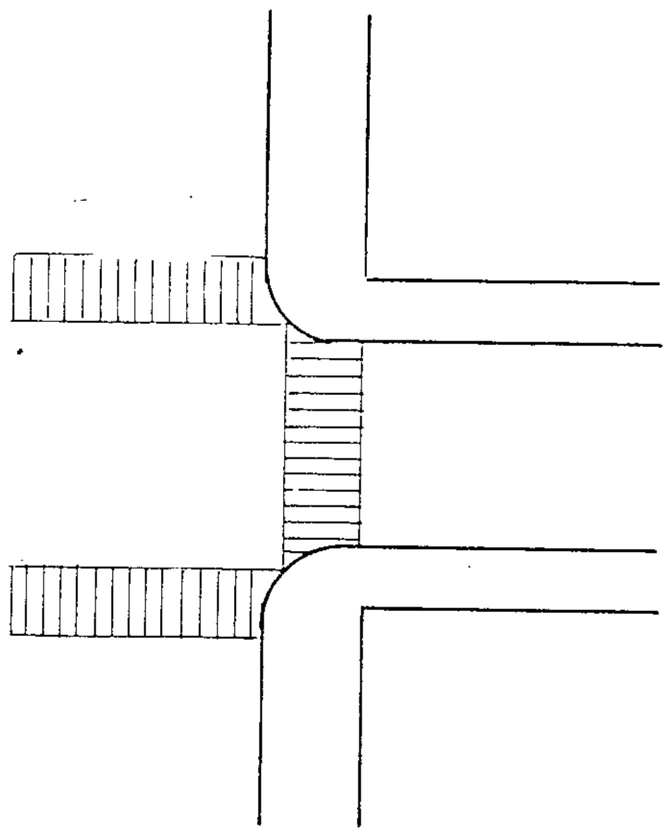
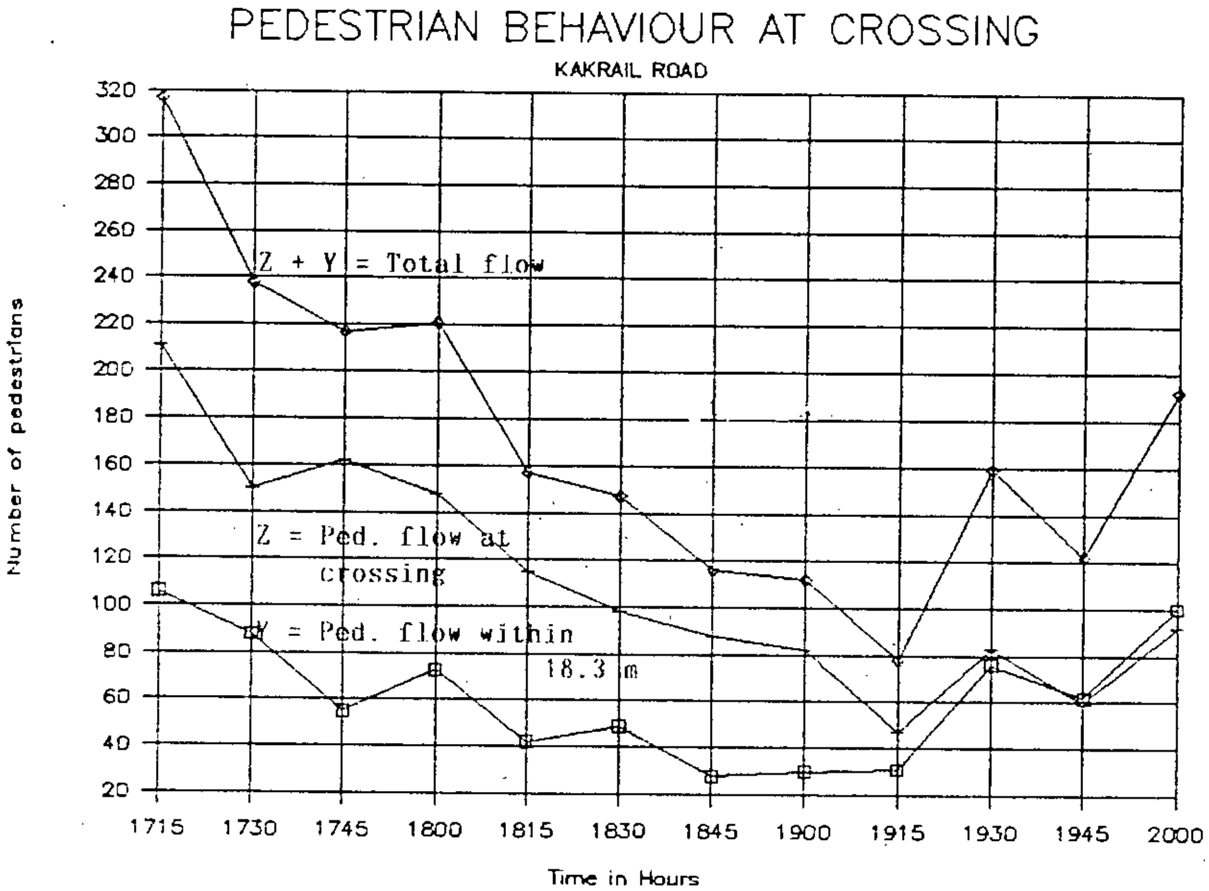
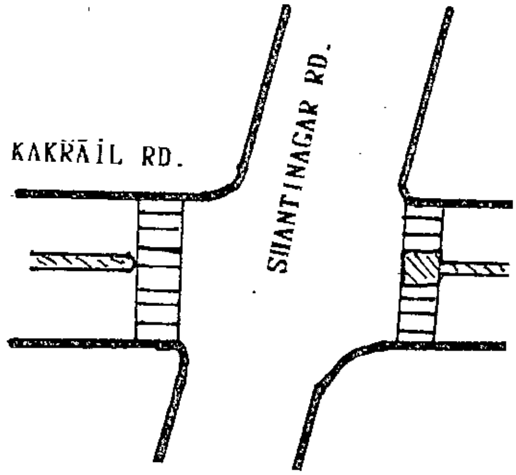


Fig. 7.3 PREFERRED LOCATION OF PEDESTRIAN CROSSWALK.

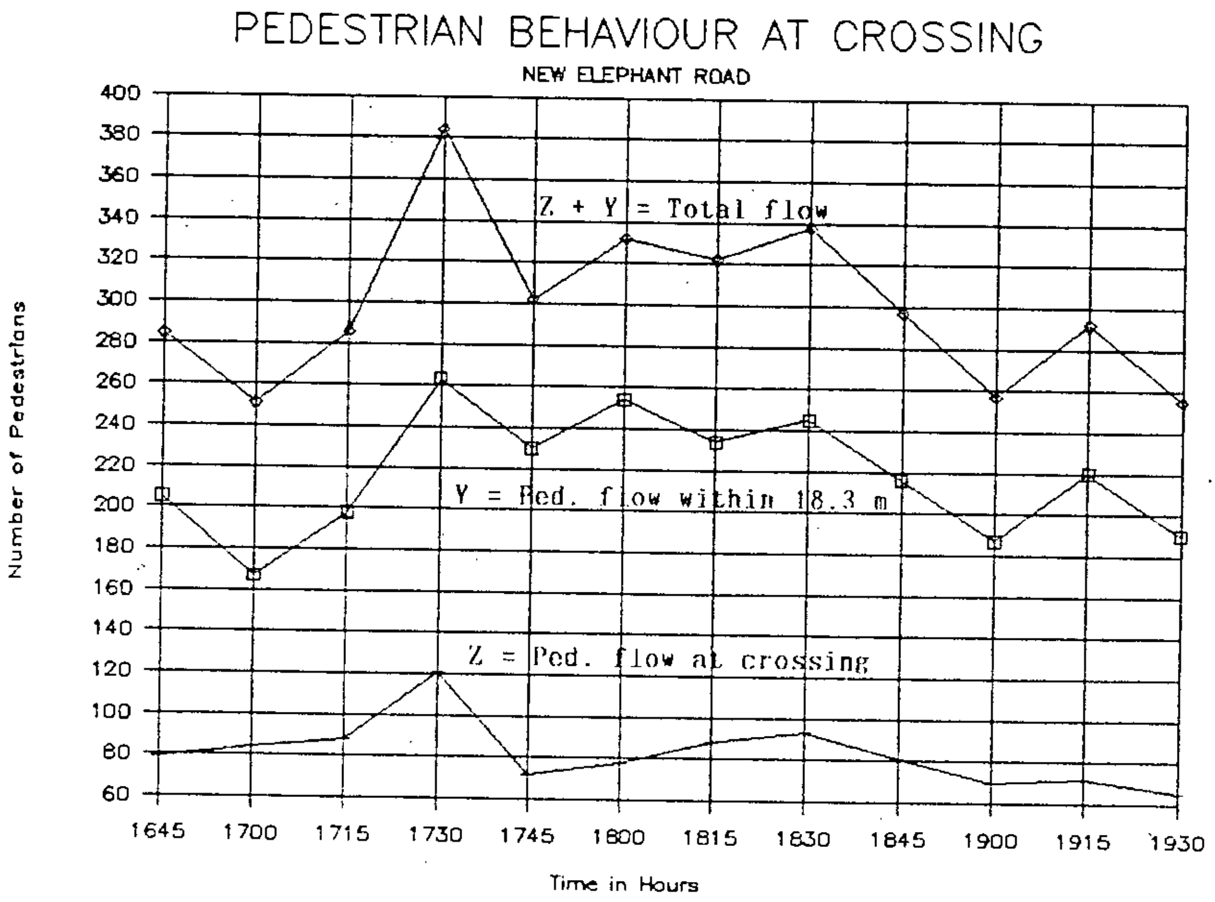


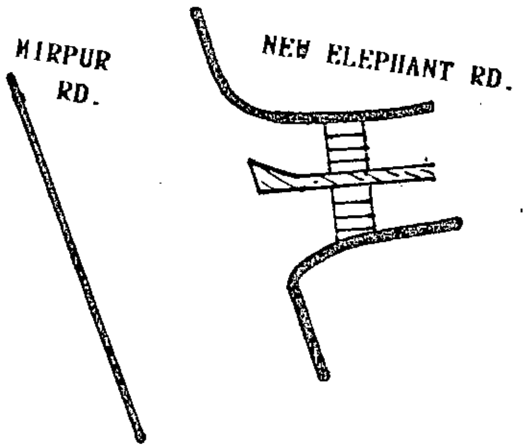


Crossing "A"

Location: At signalized cross intersection
Street width: 6 lanes
Median width at crossing: 1.5 m approx.

Graph 7.1

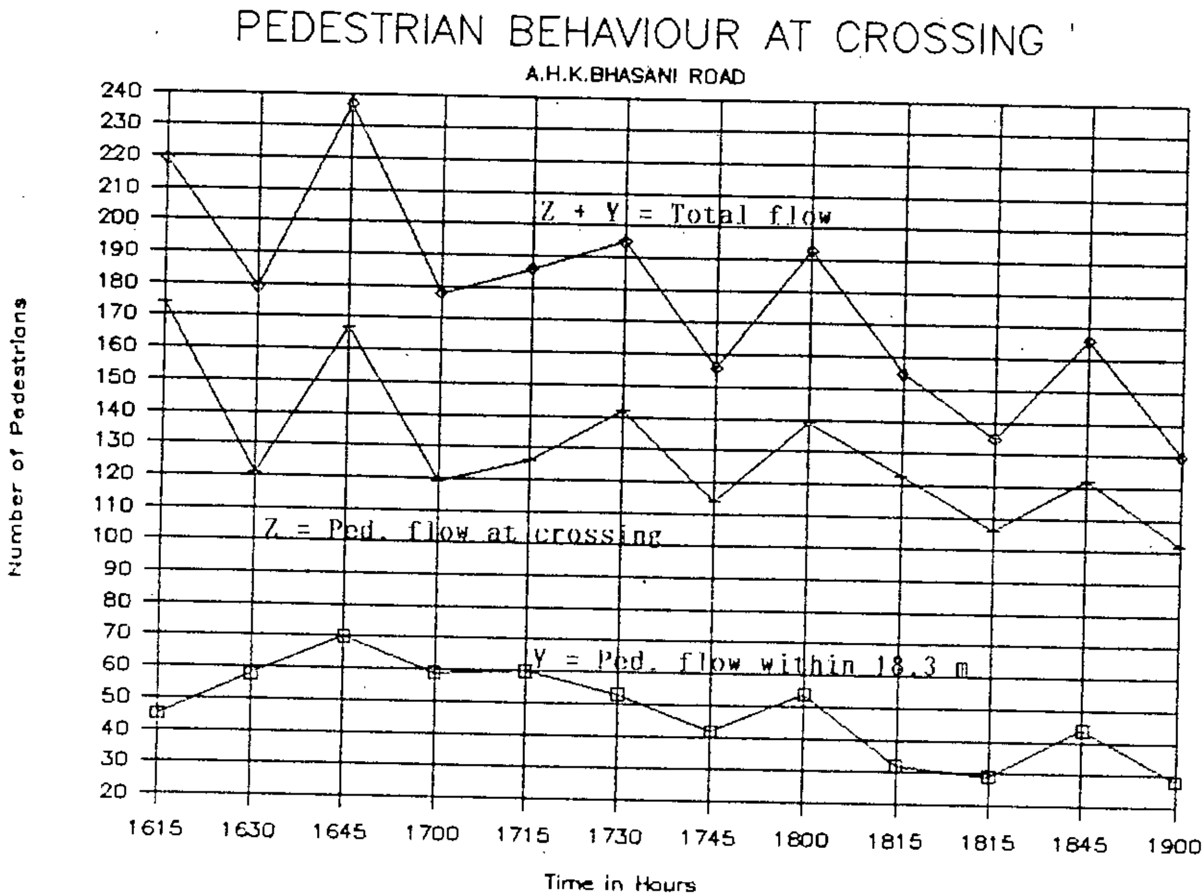


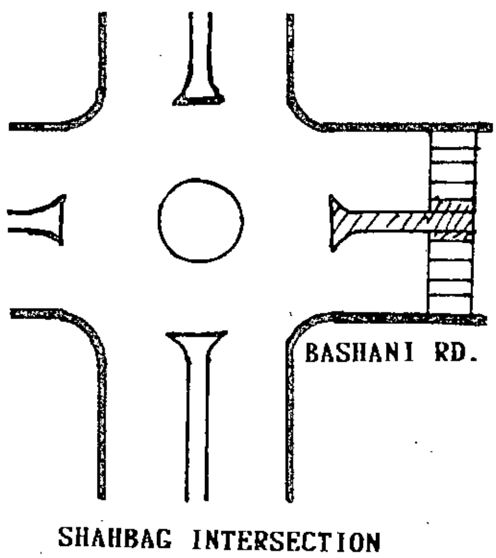


Crossing "B"

Location: At signalized T-intersection
Street width: 6 lanes
Median width at crossing: 1.0 m approx.

Graph 7.2

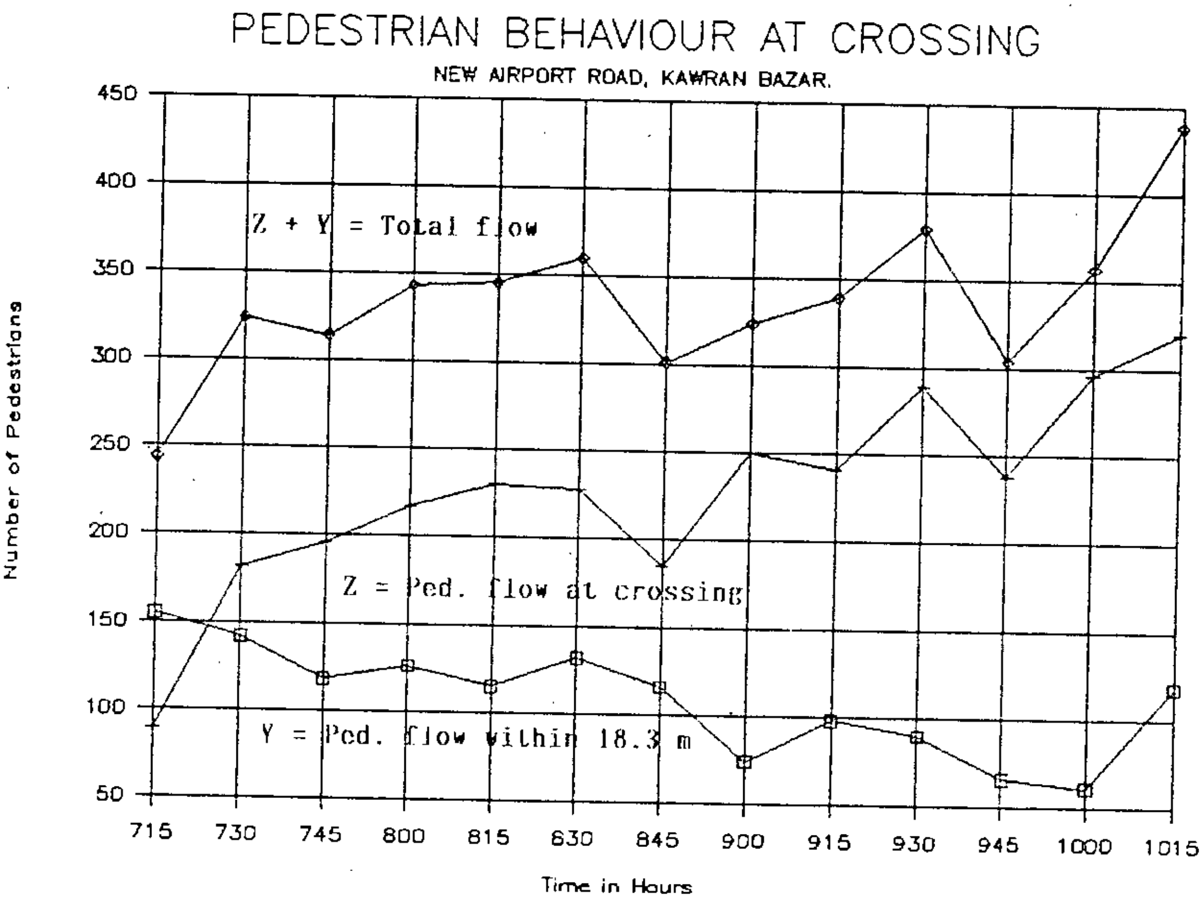


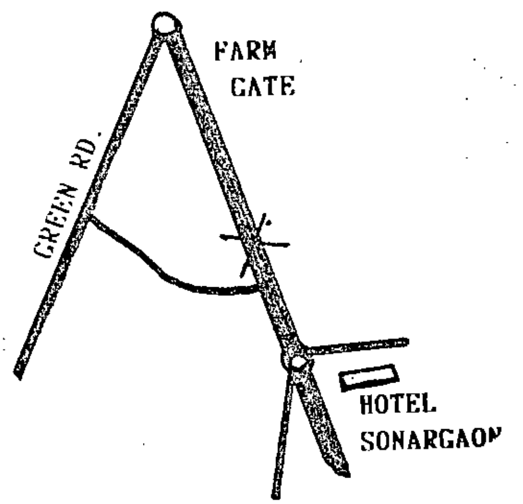


Crossing "C"

Location: At non-signalized cross intersection
Street width: 6 lanes
Median width at crossing: 1.5 m approx.

Graph 7.3

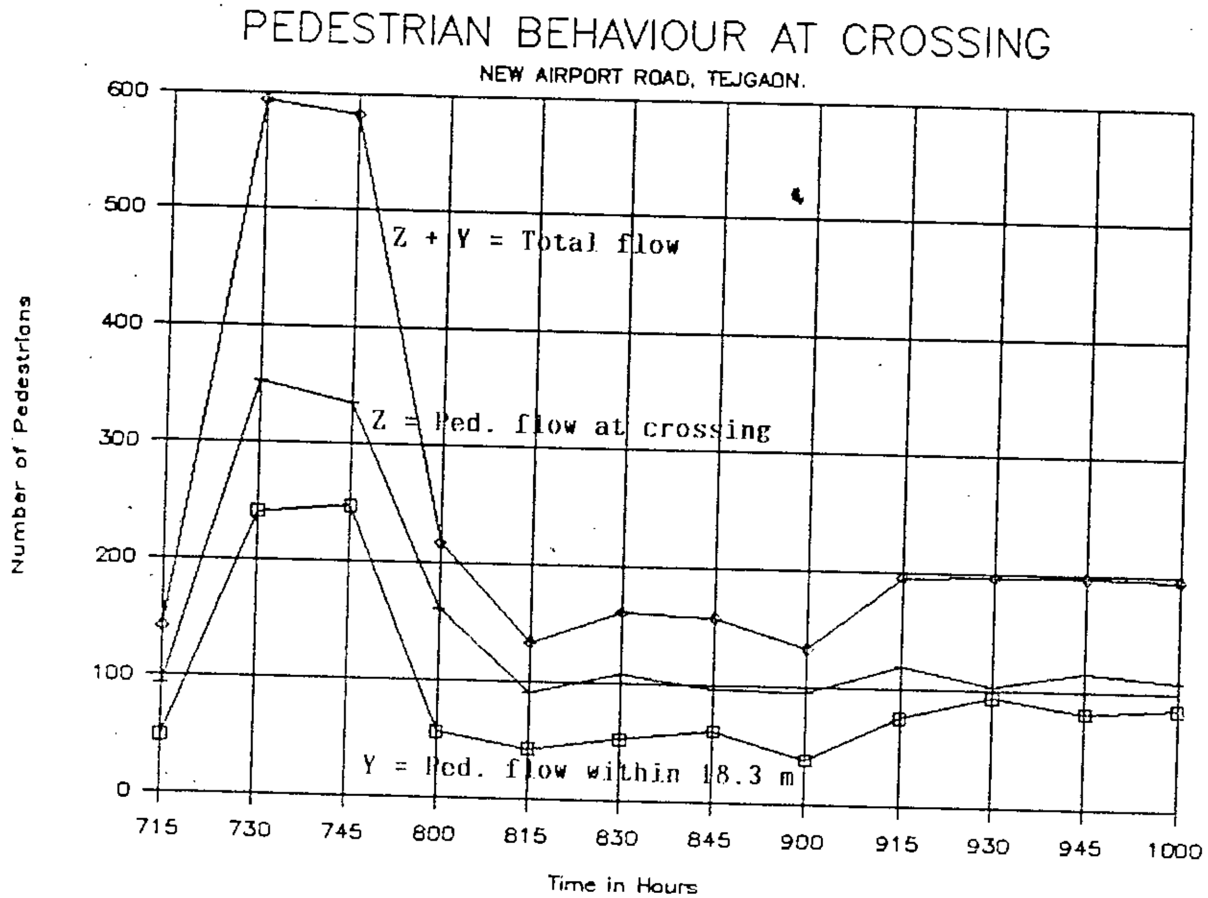


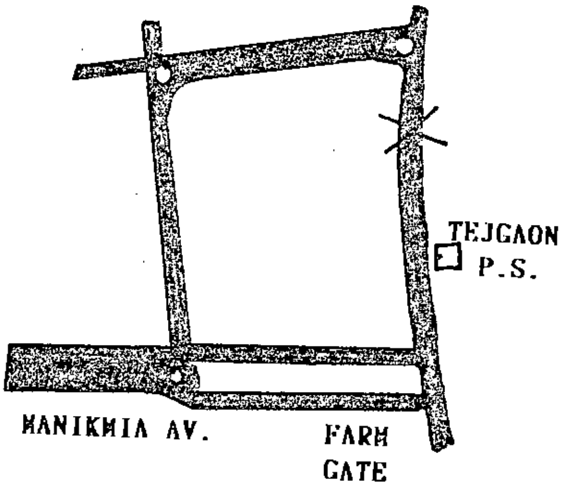


Crossing "D"

Location: Far from intersection
Street width: 6 lanes
Median width at crossing: 0.5 m approx.
Type of control: Signal control

Graph 7-4

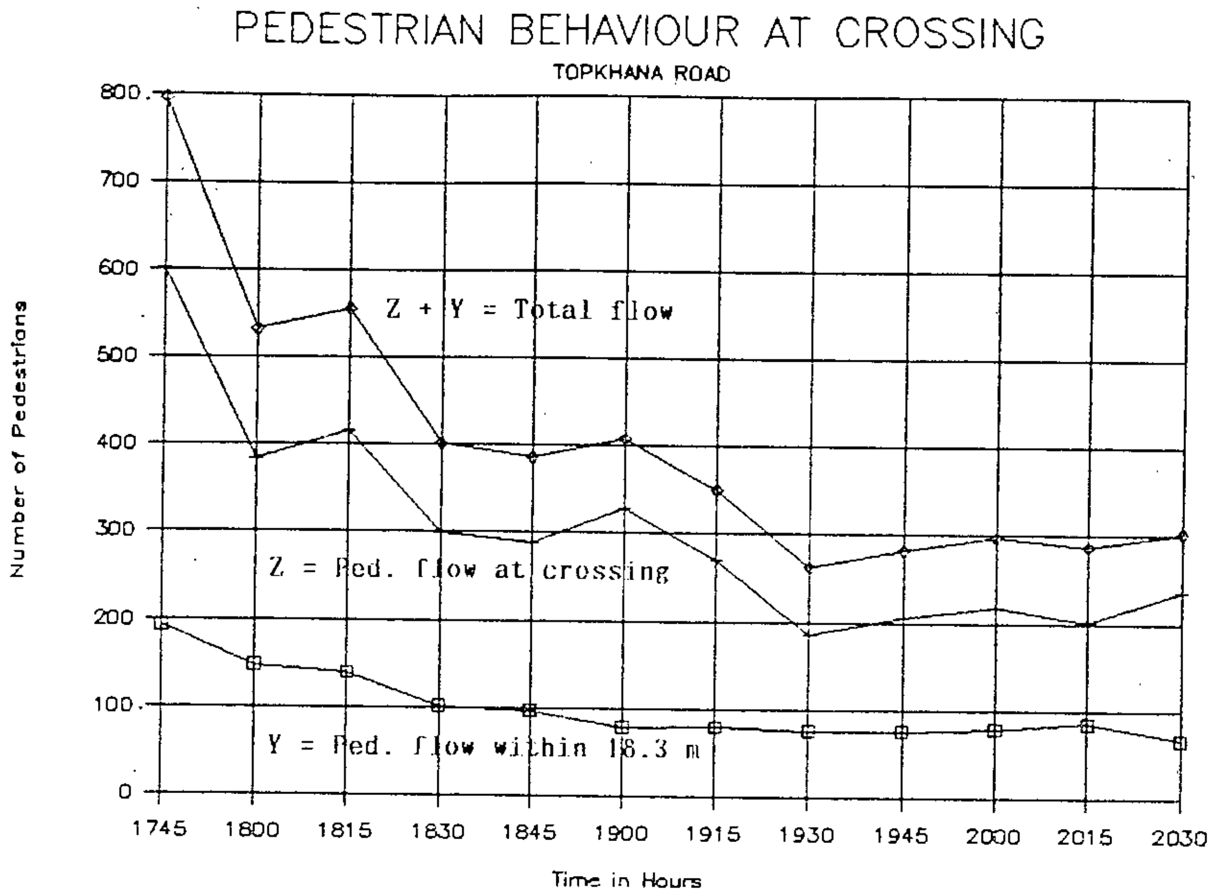


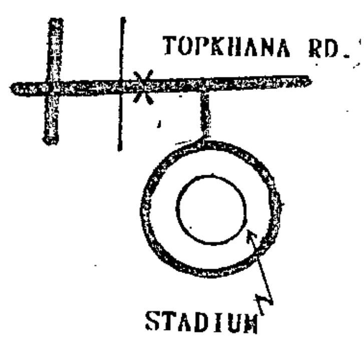


Crossing "E"

Location: Far from intersection
Street width: 6 lanes
Median width at crossing: 0.5 m approx.
Type of control: Signal control

Graph 7.5

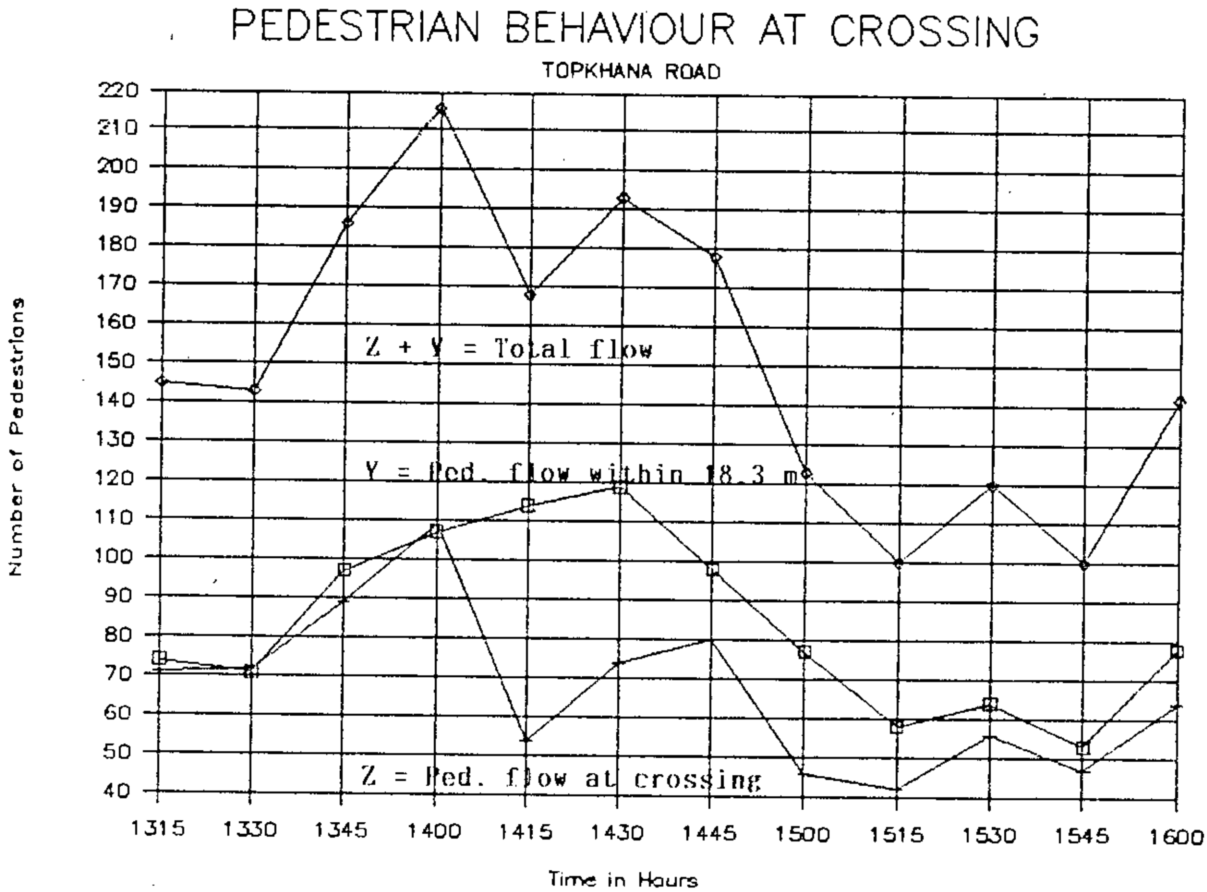


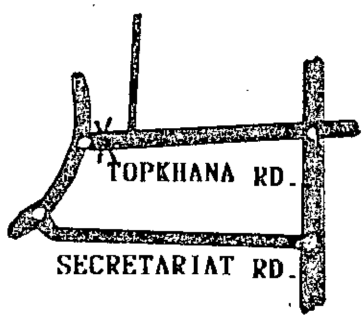


Crossing "F"

Location: Far from intersection
Street width: 6 lanes
Median width at crossing: 0.5 m approx.
Type of control: Police control

Graph 7.6

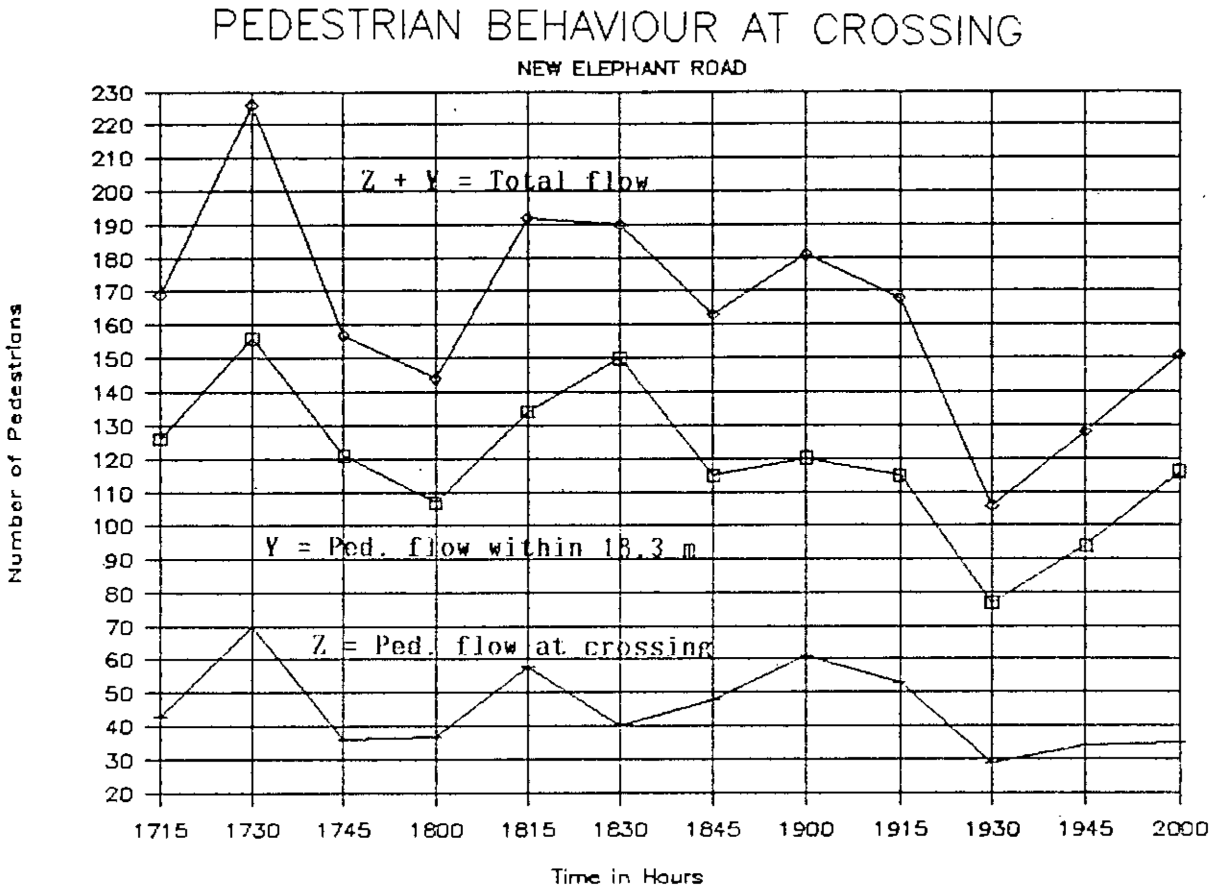


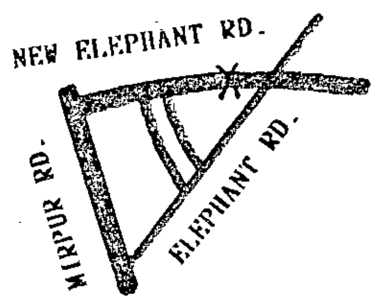


Crossing "G"

Location: Far from intersection
Street width: 6 lanes
Median width at crossing: No median
Type of control: No control

Graph 7.7

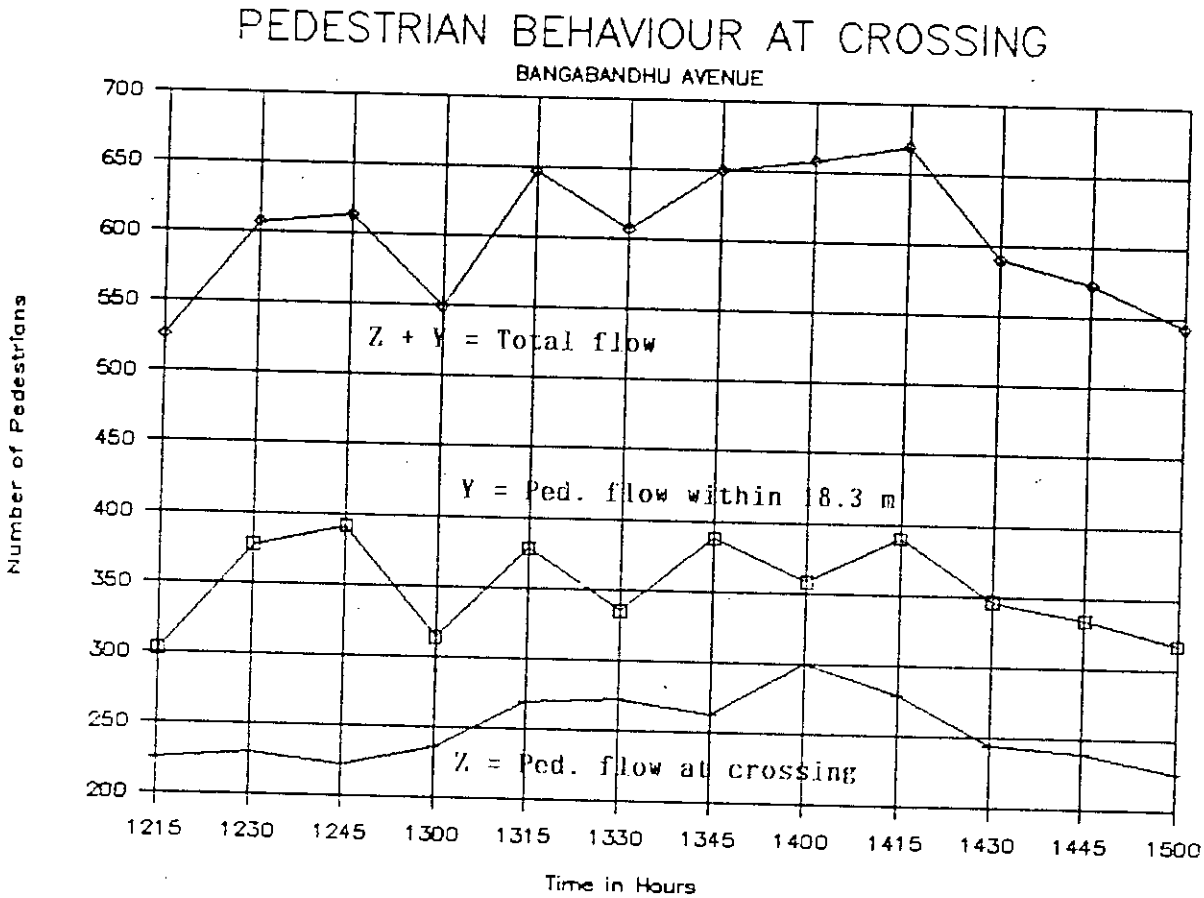


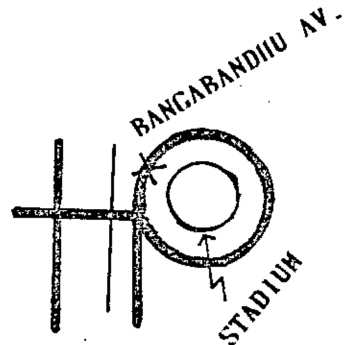


Crossing "H"

Location: Far from intersection
Street width: 6 lanes
Median width at crossing: 1.5 m approx.
Type of control: No control

Graph 7.8





Crossing "I"

Location: Far from intersection
Street width: 6 lanes
Median width at crossing: 1.0 m approx.
Type of control: No control

Graph 7.9

Chapter 8

ENVIRONMENTAL TRAFFIC SYSTEM PLANNING AND MANAGEMENT FOR DHAKA CITY (E.T.S.P.A.M.)

8.1 INTRODUCTION

Field observations and consultations with concerned officials and professionals reveal a frustrating, yet manageable, situation. Factors leading to accidents and other environmental difficulties have gone to the extremes. A great deal is left to be done to extenuate the severity of the existing complex problem. Different aspects of the problem are interdependent implying the necessity of comprehensive solutions.

From the previous analysis of this study, and before proposing or recommending any solutions, three main conclusions may be drawn. The first is that there is no one easy and complete solution to the problem posed by traffic growth and the pedestrian-vehicular conflict. All remedies will have to be used in one form or another. But secondly since different remedies are interrelated and each reacts immediately on the others, it is imperative that they should not be applied haphazard by different authorities reacting to different incentives, but in a carefully coordinated way after comprehensive analysis and study of the whole situation. Thirdly, any such organized attempt for an overall solution to the problem will necessarily involve a vast scale redevelopment of transportation in the city as an integrated system.

This chapter contains a package of guidelines and recommendations with due consideration to the fact that factors causing the present traffic calamities take part at different phases of planning, implementation and management of different schemes. This fact encourages a comprehensive approach to deal with the situation. The prescribed guidelines and recommendations could be useful as a tool for the concerned authorities and practitioners to plan, design and manage a more efficient system. Main attention is focussed on different tactics and measures intended to provide a suitable physical and institutional environment for safe, convenient and pleasant pedestrian movement. Main relevant issues, particularly traffic restraint measures and public transport, are also highlighted. For convenience of this research, the prescribed package may be termed as Environmental Traffic System Planning and Management (ETSPAM).

8.2. ETSPAM STRATEGIES

As stated earlier, there is no straightforward solution for the complex situation this research is dealing with. Few categories of strategies have been designed to synthesize a comprehensive approach for tackling the situation. Tactics and measures based on these strategies will certainly vary according to the local circumstances of individual areas and roads under consideration. The strategies are:

1. Improved administration and enforcement of traffic laws.

2. Institutional development to promote coordination between transport agencies, increase staff capabilities and facilities and improve agencies flexibility.

3. Expanded traffic engineering and management.

4. Improved pedestrian planning process.

5. Improved pedestrian facilities and network systems.

6. Improved public transportation system to satisfy the needs of the majority of low income population.

7. Road upgrading.

8.3 PLANNING CONTEXT AND PROBLEM ANALYSIS

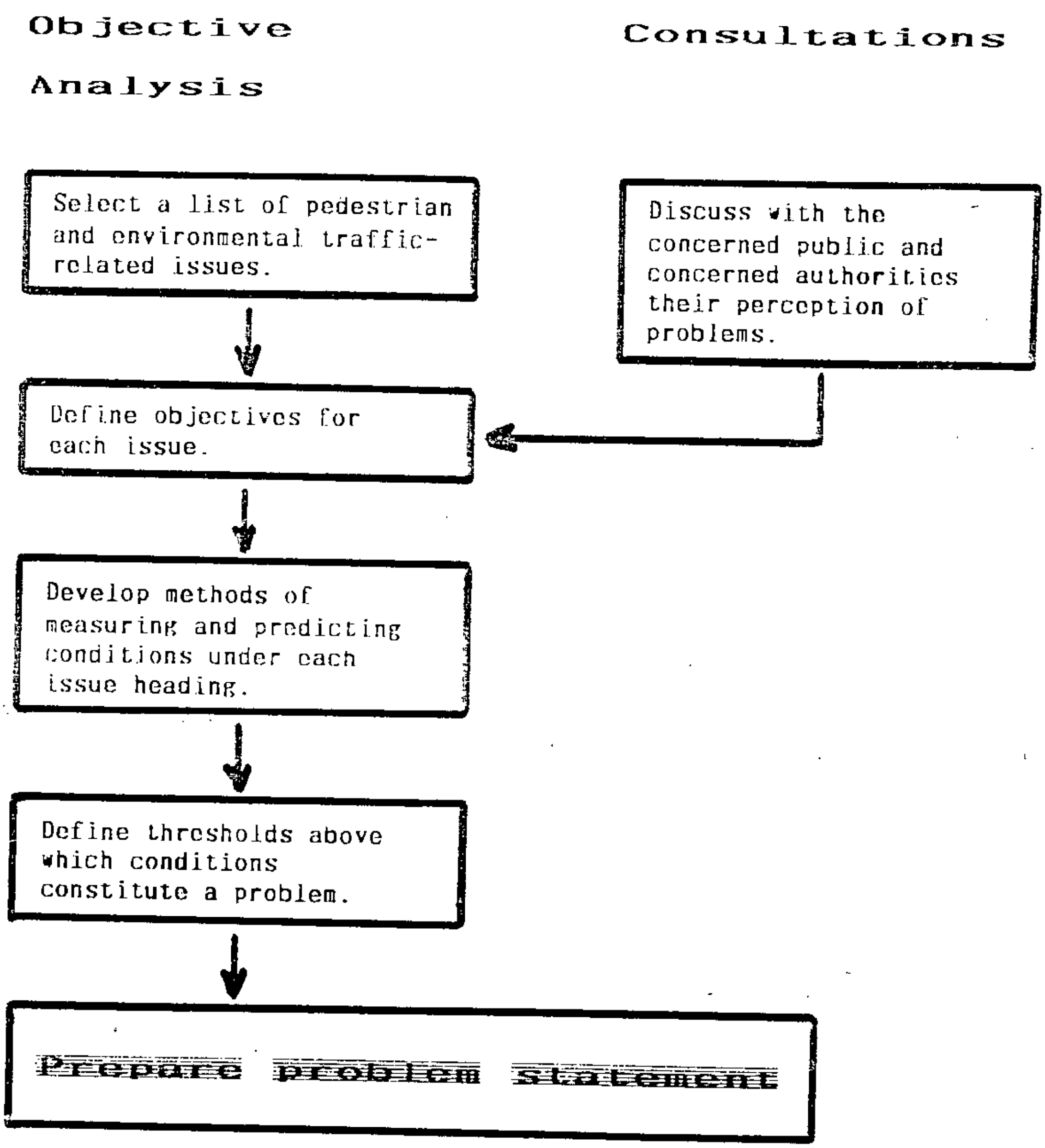
It should be recognized that to improve transportation networks in Dhaka city, the requirements of circulation are to be faced as one overall problem. Pedestrian movement is still the most neglected aspect of the present circulation system. The deteriorated environment stands no chance in drawing real attention of the planning authorities. If we are serious in turning our streets more livable and protecting our urban areas, planning pattern should be better organized, real goals and objectives should be well defined, and actions should be properly implemented. ETSPAM provides the planning process with guidelines and recommendations to guide and support the planning framework. This includes improvement of problem identification and analysis process.

8.3.1 Problem Identification and Perception

To identify and analyse pedestrian and other environmental traffic problems in Dhaka city, it is proposed to consider two strands of the process: objective analysis and consultations (Fig.8.1). The first strand implies selection of a list of relevant issues. Through consultations, objectives for each issue are defined. After analysing the existing or predicted conditions, thresholds above

Fig. 8.1

PROBLEM IDENTIFICATION AND PERCEPTION



which conditions constitute a problem are defined. Examples of issues for which thresholds are defined to measure the level of the problem are general traffic accidents, pedestrian accidents, delays to vehicular traffic, delays to pedestrian traffic, noise, pedestrian intimidation, parking, etc. Pedestrian intimidation can be assessed, for example, by reference to traffic flow, traffic speed and street width.

Consultations are discussions to be held with the concerned public using facilities, with the owners and occupants of buildings in and around the concerned area, and with the authorities responsble for various aspects of amenities in the area. At the end of the analysis process, a list of the identified and perceived problems is compiled and recorded in a "problem statement" to form a basis for development schemes.

8.3.2 Determination of Goals and Objectives

With a prior understanding of the problem to be met, a necessary step in any planning activity is identification of the goals and objectives that are desired. All goals and objectives stem from basic values that are important to people.

For Dhaka city, and in conformity with the proposed ETSPAM strategies, a comprehensive set of goals and objectives is recommended as demonstrated in Fig.8.2.

Fig.8.2

PROPOSED E.T.S.P.A.M. GOALS, OBJECTIVES AND STRATEGIES

Goals:

1. Attainment of safe, pleasant and efficient urban environments for pedestrian routes and activity areas.
2. Organization of pedestrian traffic as an integrated part of the urban transportation system.

Objectives	Strategies/Policies
Promotion of pedestrian mobility and accessibility	Improvement of pedestrian network continuity. Improvement of pedestrian network capacity. Improvement of pedestrian connectivity to public transport system. Improvement of pedestrian quality of service. Reduction of conflicts between vehicles and pedestrians.
Increase of pedestrian traffic Safety	Decrease of risk exposure. Improvement of road users' behaviour: - drivers and pedestrians are more circumspect.
Increase of roadway efficiency	Improvement of management and maintenance. Improvement of roadway capacity Improvement of street lights. Improvement of traffic signals. Improvement of low-income areas.
Improvement of parking management	Improved management of parking space. Improvement of parking capacity.
Promotion of public transit	Provision of service to low-income groups. Improvement of service quality. Improvement of management. Improvement of intermodal coordination.
Improvement of environmental conditions	Less traffic noise. Less exhaust gas emission. Improvement of urban ecology: - more and wider variety of plants. - improved microclimate. Improvement of visual quality.

8.4. PROPOSED PEDESTRIAN PLANNING AND TRAFFIC RESTRAINT

8.4.1 Introduction.

The success of pedestrian areas in some countries gave a major impetus to deal with the streets as 'living space'. In Bangladesh innovations in transport planning have to be developed to contain the increasingly unbearable effects of traffic in the urban areas. These should try to achieve a reasonable balance between all parties of road users, and be concerned with the whole transport network in the city, not just individual streets.

To improve the situation in Dhaka city, it is quite important to develop a change in attitudes characterized by a general demand for a quality environment. Concerned institutions should encourage active participation from the private, as well as the public sectors in planning for pedestrian spaces and improvisng the street environment. It is therefore recommended to establish an interdisciplinary approach in which transportation planners, engineers, planners, landscape architects and designers team up with real estate and development specialists.

8.4.2 Planning Framework

To develop a pedestrian planning framework for Dhaka city, it is essential to examine pedestrian requirements in terms of movement patterns, activities and physical development. The projection of existing conditions and the coordination of the three basic requirements will assist in formulating various alternatives so that a feasible network can be adopted. This will naturally require vast scale programme including extensive field survey.

The degree of pedestrian movement will need to be related to various travel modes. Every journey starts and ends on foot. The distance on foot depends on how close the vehicle comes to the origin and destination. Therefore, to project the existing conditions into the future, it is necessary to consider the extent of future change in public transport system and in the degree of vehicular access.

Physical development in terms of land use and pedestrian activity zones are to be defined. It is important to assess the range of opportunities available for redevelopment in relation to pedestrian movement. By projecting these elements into future requirement, it is possible to formulate various alternative pedestrian networks. Producing a feasible network must consider linking places of maximum pedestrian activity with points of interchange i.e., public transport services, car parks, shopping centres, leisure facilities, tourist attractions, and other amenities (see Fig. 8.3).

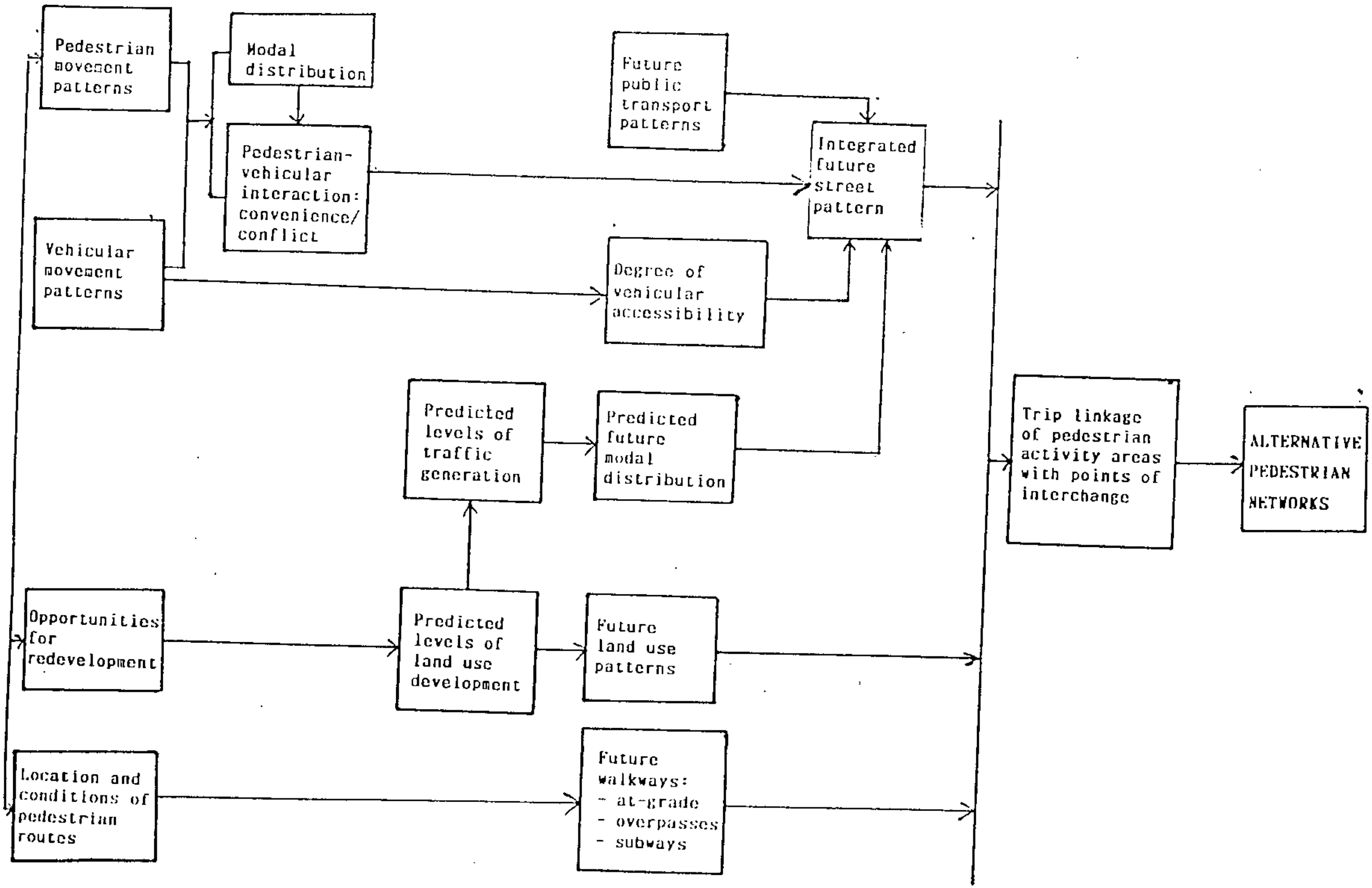


FIG. 8.3 PLANNING FRAMEWORK

8.4.3 Pedestrian Priority Areas

If the quality of life is to be made tenable in places with intensive pedestrian movement, where exclusive pedestrian areas are not physically feasible, then efforts should be done to designate "Pedestrian Priority Areas". These are areas meant to facilitate safe and convenient pedestrian movement through certain restrictions on vehicles entering the areas. It appears that little can be done about the number of vehicles entering an area, although motorists tend to avoid areas that are subject to restriction or obstruction. However, the speed of vehicles can be controlled by the use of the ramp, i.e., a raised hump. This would be a feature of the designated pedestrian priority area and the frequency of these ramps would determine the speed of vehicles.

Success in these areas requires change in mental attitude of the concerned authorities and the road users. There would need to be other features incorporated in these areas, sensible parking being one.

8.4.4 Pedestrianization of Shopping Streets

To introduce a pedestrianization scheme of any shopping street in Dhaka city, future implications concerning traffic movement and layout pattern of the street and the surrounding area are to be carefully examined. Busy and narrow streets and localities where shopping needs have grown so much that these streets can hardly cope with the pedestrian movement, are suitable to be declared pedestrian precincts. Vehicles are to be prohibited entry to these streets. Delivery vehicles and garbage trucks may be allowed during specified hours. Emergency vehicles may be allowed at any time.

Although traders are against the principle of imposing any traffic restraint measures in their streets, these schemes which proved fruitful in many countries of the world worth to be experimented in Dhaka. The present Govt. New Market precinct is a strong evidence. Pedestrianization schemes in shopping streets will have the effect of improving shopping conditions and consolidating commercial activities. But with the implementation of such schemes, success will largely depend on provision of efficient access and car parks. Relief roads should be available to accommodate diverted traffic.

Retail traders and shoppers should be made aware of the important results of implementing pedestrianization in prospective shopping streets. In addition to improving shopping conditions, environmental conditions and pedestrian safety will be considerably enhanced. What appears to be good for the customer is also good for the trader. Such schemes may provide opportunities for extensions to businesses to maximize trade.

Experience in some countries indicates that the highest incidence of success appears to have been achieved in those streets where 100 per cent rear access is achieved and a total ban on vehicles is enforced. Therefore, there is ample evidence to suggest that even minimal schemes comprising closure to through traffic on one day of the week only will provide sufficient benefit to justify implementation in Dhaka city.

8.4.5 Traffic Controls on Major Roads

Major roads here refer to the main arterial system in Dhaka city which includes arterial streets and serves the major centres of activity of the city. As discussed earlier, capacity is reduced considerably at links and intersections mainly due to the indisciplined traffic behaviour and pedestrian crossing. Inadequate geometric and other physical features contribute to inefficient and difficult control of traffic movement. Study on Mirpur Road reveals a typical example where almost all difficulties are very pronounced.

To improve efficiency of the arterial street system, it is necessary to provide adequate control devices and degree of enforcement of traffic regulations. But the fact that controls can have a strong bearing on street utilization can be good and bad from the stand point of the life of the city and its environment values. If used unwisely, traffic controls can lead to blighted areas with depressed property values and major upheavals in land use patterns.

The following recommended control devices should be carefully considered. Mixed motorized and non-motorized traffic operation influences details of some control devices;

1- Control of access to abutting lands, usually necessitated in view of the conflict that exists between effectively serving through movement and providing access to a dispersed pattern of trip origins and destinations.

2- Traffic control devices such as signs, markings, signals and islands should be placed adequately on or adjacent to streets and highways to regulate, warn or guide traffic.

3- Regulation of turns.

4- Parking restrictions.

5- One-way operation only in absense of alternative solutions. Prohibition of on-street parking is a better alternative.

6- Medians should be adequately constructed on all arterials. Standards should be developed for median design for Dhaka city's arterials considering capacity and safety requirements.

8.4.6 Traffic Restraint in the C.B.D.

Future planning policies for transport, pedestrians and development in the CBD should be concerned with producing a system where each part is in balance with the other parts. Transport should be able to cope with the number of people who end up as pedestrians on the pavements of the central area and who then fill the buildings that are there or will be there in the planned time span to receive them. The quality of the entire environment in such a planned system is to be maintained at a level acceptable to the demands and requirments of the community as a whole.

The most effective weapon of traffic restraint recommended here is parking restrictions. They can be very effective if enforced. The fundamental weakness of parking policies lies in insufficient enforcement. Strict rules and regulations should be imposed and number of traffic police personnel should be considerably increased. Off-street parking facilities will be required.

Improving public transport as a means of reducing private transport to the CBD should be among the top priorities of future policies. This may include restricting plying of non-motorized vehicles in designated roads or in the whole area, increasing buses and motorized paratransit vehicles operating to and within the area and regulating through traffic by diverting it to another route. Surface rail transit is not recommended as it would cause serious physical problems including obstruction and delay to vehicular movement due to the layout pattern of the CBD and the surrounding areas. Control of fare of different public transport vehicles is essential for efficiency considerations.

Long term measures for developing the CBD should imply drastic steps. This may become necessary where it is found that very high employment density or unalterable low street capacity prevents any other forms of traffic management. Under such conditions, solutions should consider measures based on provision of off-street parking facilities, diversion of through traffic, and major innovations in public transport system. Decentralization of some major traffic generators in the CBD will be an efficient tool to reduce traffic.

8.4.7 Traffic Restraint in Residential Areas

Low cost measures should be adopted to reduce through traffic generated particularly in residential areas with grid-iron layout pattern. Roadway alteration and one-way streets as applied in residential areas of some countries to reduce through traffic are not recommended for residential areas in Dhaka city. They cause confusion and large detours and traffic rules would be broken very frequently.

Models can be experimented using a different philosophy obstacles, to discourage through traffic and to deter fast driving, may be used. The most effective measure is likely to be slight elevation of road surface, i.e., by constructing ramps (humps) at short intervals

(40 to 50 m) and at intersections. This measure will increase safety, particularly for pedestrians and playing children. Other physical and visual facilities (to limit sight distance) may be used to induce motorized traffic to enter the residential area at a low speed and continue to drive slowly. The introduction of special rules for behaviour and placing traffic signs to point out these rules may serve as complementary measures.

Environmental traffic management in resdidential areas should provide residents with a network of roads and walkways designed for residential use and play areas for children. The objective is to improve the condition of pedestrians who have priority in these roads, though pedestrians and children should not obstruct vehicle traffic. The maximum speed of motorized traffic on residential access roads should not exceed 15 km per hour (approximately 9 mph).

Schemes should be considered to develop safe routes for school children on their way to and from school. The street or the immediate residential environment is, for the child , one of the main contexts for social interaction as well as for physical development. This fact is rarely accommodated in official environmental policies. Although the few existing designated play areas might attract some children away from the street, they are unlikely to replace it as the main focus of their activities. Therefore, for planning a residential street a thorough understanding of residents perceptions and children's needs is required.

8.4.8 Environmental Considerations

In Dhaka city, environmental standards related to traffic pollution and accidents have never been established. Acceptable levels should be determined and emphasised in traffic engineering design, traffic management and building design. Levels of acceptable noise and air pollution by the community are, undoubtedly, very low compared with those in developed and many developing countries. The main reason is, perhaps, the severity of other traffic problems, particularly accidents, inadequate accessibility of pedestrians and inconveniences of public transport. This lessens or distracts people's demand for a better environment. Concerned authorities should increase road users awareness of environmental values and implement measures to control traffic pollution, including control of through traffic and use of horn in environmentally sensitive areas.

In pedestrian planning, impact of these items on pedestrian behaviour and convenience should be clearly understood. Other environmental conditions, such as heat rain and humidity, substantially influence pedestrian activities. For example, the number of shoppers in a shopping area is considerably reduced during heavy rain or high temperature. Attention should, therefore, be given to the effect of microclimate on planning of pedestrian activity areas and walkways. Such considerations include wind and rain effects, the overshadowing of walkways by buildings and trees, use of arcades in shopping areas, etc. Provision of adequate lighting is important at night in areas of social and leisure activities. Careful lighting can provide attractive, safe and pleasant surroundings. If the vehicular traffic is removed from an area, the problem of lighting is simplified, and so emphasis can be laid on the requirements of pedestrian movement. The lighting pattern should express the form and function of the pedestrians setting.

8.4.9 Walkway Facilities and Information

It is important to provide on the pedestrian network a number of essential features based on expected flow patterns. These include public conveniences, public telephones and mail boxes, etc. Shopping areas may also include free trolleys for taking purchases from shops to the car parks and nearest public transport terminals in the vicinity of the shopping areas.

Standardized information should be applied throughout the walkway system and be concerned with such features as directions and connotation graphics and maps. These can play a vital part in providing orientation in the system. Standard terms should be used to indicate routes and facilities with minimum confusion. Directional signs should give information about the location of streets and major buildings. Such signs should be given a standard fixing and colour and should be conspicuous in the system. Maps and routes directions should also be provided in prominent locations. Regarding information requirements of individual frontages, ample opportunity should be given to local people to contribute to the character of the system.

8.5 RECOMMENDATIONS FOR MIRPUR ROAD

A package of measures is recommended to deal with the situatin in Mirpur Road.

1. Sidewalk pavements require immediate repair and proper maintenance. They should be kept clean from all obstructions. Further construction of sidewalks is necessary at locations where they do not exist. The present width (2.4 m) is currently suitable but widening will be required with future rise in demand.

2. In the vicinity of schools, sidewalks should be supplemented by guard-rail upto the nearest crossing facility to regulate and protect school children crossing.

3. Crossing facilities should be provided at all places with identified intensive crossing activity. Pedestrian signals are recommended at sections 2 and 3 of the road. The other three sections are at or near to signal-controlled intersections. At the latter sections, crosswalks should be clearly marked. Signal cycle at section 5 should include a separate phase for right-turn movements of vehicles. All main intersections should properly be channelized. Pedestrian crossings can be substantially enhanced through:

(a) Construction of medians of adequate width which will serve as pedestrian refuge.

(b) Construction of speed suppression humps that should be raised mildly and marked properly at the approach of crossings.

4. Standard signs should be displayed along the route. Maps of residential areas should also be displayed near the intersections of Mirpur Road with the main distributor roads.

5. Quantitative and qualitative improvement of street lighting should be urgently considered.

6. Parking should be strictly prohibited near all intersections. Double on-street parking should be treated likewise.

7. Medians of 1.2 to 1.8 m (4 to 6 ft) minimum width should be constructed along the road. Guard-rails may be erected on the median particularly at locations of considerable vehicular-pedestrian conflict.

8. Walkway network including sidewalks and crosswalks should be continuous and well integrated. Sidewalk approaches should be ramped mildly for convenience of the pedestrians and the physically handicapped.

9. Public transport services should be properly regulated and controlled along the route. Buses and minibuses should stop at the curb for loading and unloading of passengers. It is suggested here to mark loading bays for this purpose. With clear marking and delineation of the carriageway, vehicular traffic movements become more orderly. Pedestrians should be provided with weather protection amenities at public transport stands.

10. Carriageway pavement should be repaired and maintained more efficiently.

11. Motorized and non-motorized vehicles should be confined to separate lanes. Physical separation by means of island or median is likely to cause operational problems for loading, unloading and on-street parking considerations. However, if special arrangements can tackle these difficulties, this type of separation will substantially enhance the road capacity.

12. Streetscape and pedestrian quality of service should be promoted and improved through planting trees and improving frontage visual quality.

8.6 RECOMMENDATIONS FOR NEW MARKET SHOPPING AREA

A package of actions including few drastic traffic restraint measures should be implemented in New Market Shopping Area to change the present havoc and traffic menace into a safe and convenient environment for both shoppers and traders and for traffic circulation as well. These actions should be considered in short term schemes and include:

1. East and west sidewalks should be substantially widened, though this implies narrowing of carriageway pavement (Table 6.2 may be used as a guide to design and expand the sidewalk pavement according to new enhanced levels of service).

2. Pedestrians should be strictly channelized by guard-rails to be erected along east and west side-walks. No pedestrian should be allowed to walk along the carriageway.

3. Guard-rails should be erected along the median in Mirpur Road between the intersections of this road with New Elephant Road and Nilkhet Road. Openings should be allowed only at crosswalks.

4. Cross-walks should be marked at sections "a" and "b" only (Fig.5.4).

5. Repair and maintenance of sidewalk pavement.

6. Channelization of intersection A and total prohibition of right turn movements at intersection B.

7. Prohibition of double parking in general and any parking at intersection areas.

8. No cycle-rickshaw should be allowed to stop or park on the street within the entire shopping area. This should include New Supermarket area. All cycle-rickshaws should be made to park and wait in one or two designated and well controlled cycle-rickshaw terminals. South-west location is suggested for such terminal. No rickshaw should be allowed, consequently, to stop or park near the entrance or gate of any of the markets in the area.

9. Motorized and non-motorized vehicle movements should be separated by means of constructing narrow medians. Space allocated for each type of vehicles should consider the proportion of both types.

10. The existing over-pass should be properly maintained. It may be physically extended at both ends to give direct service from its deck to the first floor of Gausia Market and similarly to Govt. New Market at the western end.

11. Vendor activities on the sidewalks should be controlled and eliminated.

12. Pedestrian phase should be included in the signal cycle at intersection A.

13. Signals at intersection B are not necessary and may be removed

if right-turn movements are prohibited.

14. Adequate lighting and maintenance are required.

15. Approaches to sidewalks should be ramped.

16. Speed suppressing measures (humps) should be used at the intersections.

17. Parking fees should be imposed for all on-street parking cars in the whole shopping area not only near the Govt. New Market gates.

18. Arrangements should be made to link the area with efficient bus services.

Medium term measures should consider construction of a flyover to enable total pedestrianization and integration of the area. This implies removal of the existing overpass. Cycle-rickshaws should ultimately be banned within the area.

8.7 PUBLIC TRANSPORT

8.7.1 The Need for New Approaches

Traditional transportation planning methods with their emphasis on deciding when and where to build the next road, do not provide the solution. Even in developed countries, the costs of urban road construction are becoming unacceptable, not only in monetary terms but also in terms of social disruption and environmental destruction.

Traditional approaches have resulted in haphazard growth of public transport system in Dhaka city and encouraged the use of private cars and large numbers of cycle-rickshaws leading to intensive congestion of streets, air and noise pollusion and the use of scarce foreign exchange for fuel and repair facilities. Concerned authorities may consider innovative solutions. Priority must be given to projects improving public transport. These projects should focus on the needs of the urban poor. Traffic engineering and management measures should make better use of existing street systems while financial and organizational techniques improve the efficiency of bus operations (Buses are more economical than small motorized vehicles in terms of costs per passenger.kilometer).

8.7.2 Recommendations

Various resources and studies provide an ample evidence to consider that for certain economic reasons trips by private transport are unlikely to form more than a small fraction of total trips even in the year 2000. It follows from this that the selection of transport projects should be based primarily on the need to provide acceptable levels of service by public transport for the majority of the city population. Walking should be included as a mode, and pedestrian facilities should be integrated with the public transport systme. Attention should be given to ways of improving the performance of the existing public transport services and of increasing the supply of public transport by both the public and private sectors. This will involve consideration of the management, operational and financial capabilities of both public and private operators. It will also require the investigation of any legal, institutional or financial factors which may be inhibiting the expansion of services.

The development of paratransit systems has generated controversy over the use of small or large vehicles and the problems posed by the large numbers of cycle-rickshaws (at present more than 100 000 cycle-rickshaws ply in Dhaka city). Some transport officials even argue that there is a surplus of public transport supply compared with demand, just by seeing many cycle-rickshaws standing idle in different commercial centres. Resolving the arguments is not an easy task because technical merits of a particular system may be masked by institutionalized constraints. In general, small vehicles are likely to be more expensive to operate (per passenger.km) than large vehicles (assuming the same operator were to be running the two types). But returns on the smaller vehicle may be higher because of higher fares. To decide on any public transport system in the city it is very essential to understand to what extent public transport is a social obligation - a social service or economic stimulant. Since majority of population belong to low income group, it becomes a great social obligation to provide a convenient and affordable system and to upgrade poor urban areas to achieve better accessibility. Therefore, provision of large vehicles - buses and minibuses - will be a better solution.

It may not be optimum solution to the problem of interaction of motorized and non-motorized vehicles by simply restricting the slow vehicles. Any attempt to enforce a quantitative restriction on the numbers of cycle rickshaws operating is likely to be repeatedly frustrated by the plying of unauthorized rickshaws, unless increased supply of other forms of public transport and their comparative cost make rickshaw operation substantially less remunerative than it is at present. Until this is achieved, policy should be to control manufacturing and operating of rickshaws and ensure a higher standard of road discipline from the rickshaw pullers. Concerned officials have repeatedly pointed out their perception of serious unemployment problems as a consequence of restricting rickshaws on short term basis. In this context, they suggest creating re-employment opportunities for the effected rickshaw pullers.

Measures applied in developing countries should be very carefully examined before considering any of them for Dhaka city. Many of these measures have brought no solutions. Traffic congestion in Bombay or Cairo, for example, was not noticeably less after flyovers were built (Diandas, 1984). It is argued that the iron law of traffic congestion ensures that every increase in capacity is met by increase in demand for it. Traffic fills available spaces. Colombo bottlenecks are tackled by brilliantly designed mini-roundabouts, but the constraint moves on to the next junction. Suburban passenger trains operate in a number of cities. To apply this solution in Dhaka city, certain factors must be considered to justify any project of this kind. In some developing countries, if a new railway is to be built whether of the suburban or the metropolitan type, a minimum of 20 000 passengers per hour at peak would be needed to justify the outlay in space and cost, and if underground construction is needed, then perhaps 40 000. In Dhaka, the existing layout pattern of roads and economic factors make conditions for such justification more rigorous. Electric buses are certainly not recommended for operation in Dhaka, neither are trams, considering the disruption they may cause to general traffic flow. Conventional buses and mini-buses will be the optimum alternative for the coming few years at least.

In general, the following measures are recommended for more efficient role of public transport in Dhaka city:

1. Provision of adequate number of motorized public transport vehicles, especially buses and mini-buses, by public and private sectors. Private operators of public transport should be given enough incentives, such as improving fare policy and import conditions, to increase their intra-city operation.

2. Undertaking low-cost traffic management measures to increase efficiency and reduce expenditures, accidents and pollution.

3. Linking public transport stands and terminals with main traffic generation centres through adequate walkways and other pedestrian facilities.

4. Making better use of roads. The possibilities are:

- Better organization of traffic flow.
- Inexpensive road upgrading.
- Staggered work hours.

8.8 SUMMARY OF RECOMMENDATIONS

In conformity with ETSPAM strategies and selected goals and objectives, the main recommended measures may be summarized as below.

8.8.1 Administrative Measures

1. Establishment of a highly empowered public agency to function as a key coordinator with all agencies concerned with traffic in Dhaka city, supported by qualified staff and all necessary flexibility.

2. Highest priority should be given to upgrading traffic enforcement effectiveness. A special branch of police with well trained personnel may be assigned to enforce traffic laws in the city.

3. Legislations should be incorporated and enforced on pedestrians to check their indiscriminate crossing at undesignated places in areas of high pedestrian-vehicular conflict.

4. Accident investigation and relevant data collection by the traffic division of Dhaka Metropolitan Police should be improved. Central data bank for road accidents in the city (or on the national level) may be formed.

5. Expansion of pedestrians and drivers education on traffic laws and behaviour through mass media and training programmes. Children should learn how to deal with vehicular traffic through special

courses to be included in their text books or through assigned training programmes.

6. Coordination, cooperation and joint action among transport authorities, associated planning and development authorities, relevant engineering departments, metropolitan traffic police personnel, traders and public transport operators. The public agency suggested earlier may coordinate such joint action.

7. Coordination of activities of different agencies concerned with construction of roads and cutting of roads to install or maintain public utilities, such as electric cables, telephone cables, water and sewerage lines, etc.

8. Strict observation of land use compatibility with respect to its interaction with traffic.

9. Regulation and control of activities of the transport workers and their unions should be implemented in the interest of healthy growth and efficient operation of road transport in the city.

10. Promotion of citizen involvement mechanism in local planning.

11. Recognition of adequate pedestrian planning effectiveness in revitalizing urban activities in the city.

8.8.2 Improvements in Roadway Design, Maintenance and Management

1. Adequate measures should be taken for maintenance of carriageway and sidewalks. Ditches, cracks and patches have a detrimental consequence on the speed, safety and convenience of vehicular and pedestrian traffic.

2. Improvement of the quantity and quality of street lighting. A planned programme of street lighting maintenance is greatly needed.

3. Improvement of traffic signals. Duration of signal cycle phases should be determined on the basis of extensive traffic survey. This duration may vary for the same intersection at peak and off-peak hours (Almost all traffic signal cycles in Dhaka city have been fixed after traffic field survey of 90 minutes only). Pedestrian signal cycle should be improved. Cycle time for pedestrian crossing is usually shorter than that needed by pedestrians wishing to cross. Pedestrians are, therefore, often stuck in the middle of the road or take the risk of crossing with many vehicles passing at a considerable speed.

4. All traffic signs and signals should be standardized and be displayed properly at appropriate locations. Many more signs and signals are needed.

5. To avoid traffic congestion and road accidents caused by through traffic, Dhaka city should have a suitable by pass road around it for the vehicles with origins and destinations outside the city area.

6. Medians should be constructed wherever feasible on arterials to regulate and control turning movements, enhance roadway capacity and provide refuge for pedestrians crossing the roads.

7. Geometric improvement at intersections and arterials.

8. Removal of objects obstructing sight distance.

9. Design standards for roads should reflect the proportions of motorized and non-motorized vehicles (particularly cycle-rickshaws) on the roads.

10. Upgrading of low income areas where the condition of access roads, local streets and alleys is generally poor. This can be achieved by soil grading, surfacing and general rehabilitation of existing roads.

8.8.3 Improvements in Pedestrian Planning

1. Integration of walking as a mode in transportation planning.

2. Extensive study of pedestrian behaviour as a precursor to

effective planning.

3. Active participation of public and private sectors to improve the street environment.

4. A systematic programme to raise consciousness for pedestrians and to develop a change in attitudes characterized by a general demand for a quality environment.

5. An interdisciplinary approach to planning should be involved in establishing effective pedestrian planning guidelines.

6. There is a need for developing a constituency for pedestrianization. Better communication tools are needed to enlist public support.

7. Needs of different groups, such as concerned officials, merchants, engineers, planners and developers, should be considered properly in any comprehensive transport plan. In implementing a new concept such as pedestrianization, one finds that different groups have different needs. Too often a comprehensive plan either neglects the interests of a particular group or brings two or more groups into conflict with each other.

8. Pedestrian planning should be considered within the broader context of energy conservation. One effecient approach aims at creating a community based on the principles of mixed use and pedestrianization. In mixed use planning, families live, work and play in the same geographical areas. This is better known as

"superblock neighbourhood concept".

9. It is strongly recommended to designate model areas in the city to undergo, for experimental purposes, restraint measures and pedestrian planning techniques. Such models should remain temporarily subject to evaluation and modification for extensive future applications.

8.8.4 Improvements in Pedestrian Mobility, Accessibility, Safety and Convenience.

1. Standards or guidelines should be developed to facilitate selecting the most appropriate levels of pedestrian control to handle individual situations. Well defined criteria should be established for use to justify the installation of pedestrian crossings and other facilities.

2. A national campaign should be undertaken via newspapers and television public service spots to educate the public about the meaning of pedestrian indications. Drivers should also be educated to pedestrians needs.

3. Pedestrian networks should be well connected to interfaces with the public transport system through pedestrian friendly routing and stops. Accessways should be short, safe and attractive.

4. Pedestrian network capacity should be adequately considered at design and management stages of sidewalks, arterial crossings, shopping precincts and accessways to main transport terminals and transit stations. Traffic management should improve pedestrian traffic by using such techniques as one way schemes, parking elimination (to allow for sidewalk widening), better signal timing and pedestrianized streets.

5. Pedestrian quality of service should be improved through urban design, landscaping, pavement improvement, weather protection etc. Pedestrian network should provide convenient, safe and attractive access to retail and leisure activity centres where vehicular transport is reduced or banned.

6. Strict traffic restraint measures should be wisely implemented and enforced in the CBD, shopping and leisure areas, residential areas, arterials, vicinity of schools and any designated pedestrian priority areas. Restraint measures should include control of speed limits through speed reducing street modifications and enforcement.

7. Pedestrian activities should be segregated from vehicular traffic as far as feasible. Orderly pedestrian movement should be enforced to minimize pedestrian-vehicular conflicts. Adequate pedestrian channelization of sidewalks and crossing facilities, including overpasses, should be implemented and enforced.

8. Driver's stoppage should be made mandatory at pedestrian grade crossings.

9. No vehicles should be allowed to stop or park at pedestrian crossings.

10. Public spaces and pedestrian facilities should be designed for the users of all ages and physical needs.

11. Walkway pavements should be kept clear and in good conditions through control of vendor activities and removal of objects obstructing movement.

12. Separate signal phase for pedestrian crossings should be introduced at intersections with intensive pedestrian movement.

8.8.5 Other Safety Considerations

1. Adequate channelization should be implemented to regulate conflicting traffic movements by means of traffic islands or pavement markings to facilitate the safe and orderly movements of both vehicles and pedestrians.

2. Sight distance should be improved at intersections and vulnerable road links. Parking should be strictly prohibited within intersection areas.

3. It is important that safety features, such as geometry, be introduced at the design stage, rather than be added later, for economical considerations and to avoid relocation of public utility services.

4. Planning can have a profound effect upon the level of road safety in the city. The grid layout of roads in residential areas, for example, encourages through traffic and has a considerable impact upon the level of pedestrian accidents in particular. Thus at the planning stage, consideration should be given to road safety.

Chapter 9

APPLICABILITY OF E.T.S.P.A.M. STRATEGIES

9.1 INSTITUTIONAL CONTEXT

It is a prime necessity to formulate and implement a well defined and coordinated road transport policy in order to develop, regulate and control a healthy growth of road transport to meet the public demand and minimize the negative social effects of traffic operation. It is strongly recommended to set up a 'public agency' to act as a key coordinator with all agencies concerned with traffic in Dhaka city. The proposed agency should be highly empowered to plan, design and coordinate traffic management activities, prepare relevant projects, monitor and evaluate their implementation and recommend or prepare complementary schemes such as those related with reinforcement and educational aspects.

Establishment of such agency would simplify implementation of ETSPAM strategies and enhance coordination to get greater benefits. There are three areas which need attention - (1) the internal organization (2) the external relations, and (3) staff skills. Concern for the position of the agency in its institutional environment will be related to the agency's flexibility, i.e. its ability to change its approach to meet the varying conditions of that environment. Aided by sufficiently qualified staff, achieving such flexibility can mean rather drastic achievements and improvement by the agencies.

Public agencies and institutions are usually infamous for their resistance to change. Civil service requirements and external influences often severely restrict agency flexibility. The proposed agency is expected to deal with a wide spectrum of activities. It should face the need to extend itself beyond preparing projects for highways and transportation structures. Transportation agencies must now be able to deal with a much broader series of interrelated matters where their authority intersects with that of the other institutions: services to enhance the economic position of the low income inhabitants, more adequate traffic management, environmental consciousness and means for integrating public transportation services.

Pedestrian planning implications should be well apprehended and recognized by concerned institutions. Policy makers should no longer accept as the norm the urban street where the vehicle totally dominates the pedestrian. Instead, they should seek a balanced and harmonious coexistence between the two. This is applicable not only in Dhaka city but also in other urban centres of the country. Development of environmental consciousness among concerned institutions and among the public is perhaps a prerequisite to formulate and implement traffic restraint policies including pedestrianization.

The applicability of the proposed ETSPAM strategies will largely depend on the skills of management and coordination available in the transport related institutions as well as on the ability of these agencies to control and operate ETSPAM projects in ways which meet the selected goals and objectives. The proposed public agency is recommended in view of the fact that in Dhaka city transportation planning and implementation involve many national and local government agencies as well as private establishments of transport operators. The authority over existing facilities and services is dispersed among a number of agencies and organizations - often characterised by rigidity in behaviour and job boundary - that function independently of one another without any noticeable degree of coordination. Some decision making practice relies on limited arrangements between organizations, which do not provide a stable and ongoing framework for planning, implementation and operation of the transportation system.

Trained staff to deal with low cost schemes, as those proposed by ETSPAM, is an important consideration. Scarcity of trained personnel - most of them capital intensive projects oriented - and lack of skilled staff pose a difficulty in dealing with such schemes.

Efficient coordination is required also to deal with constraints imposed by the existing procedure for initiating, designing, approving, funding and implementing projects. The constraints result from legislative mandates, financial and personnel resources, objectives of agencies concerned with transport projects and from the working relationships between those agencies.

Finally, it should be taken into consideration that the relatively small number of trained administrative staff is spread throughout different departments. Furthermore, they are loaded with short term crisis assignments and day-to-day operation responsibilities incompatible with continuous concentration on the adoption of strategies similar to those of ETSPAM. Bureaucratic traditions and jurisdictional considerations have insulated them from the demands of various departments, which usually prevents proper coordination or joint organization of their work.

9.2 SOCIO-ECONOMIC CONTEXT

ETSPAM strategies and actions are designed to upgrade the urban quality of life in Dhaka city for the whole community and not for particular groups. The socio-economic characteristics of the city population are, therefore, relevant to the assessment of the applicability of a project. Strategies geared toward improvement of pedestrian movement and public transit are bound to be appealing to the low income people majority who continue to face economic, time and other social constraints.

Applicability of issues related to public transport is particularly of major relevance to socio-economic characteristics. As the low income group harvests important benefits in terms of mobility and job opportunity as a consequence of improved public transport, the affluent group will tend to resist traffic restraint measures, such as restriction of parking or pedestrianization of some streets in the CBD. Car users, if diverted to public transport areas like the CBD, may find it very difficult to ride the bus due to low service quality and extreme overcrowding. This kind of scheme is plugued with the problem of estimating the demand and with the uncertainties to the responses. This issue should be dealt with very carefully. However, implementation of such schemes depends largely on adequate extra supply of public transport vehicles particularly buses and mini-buses.

Gradual elimination of cycle-rickshaws from the city streets will eventually create serious unemployment problem for the people dependent on this business. But this problem must be negotiated wisely to restore street life of the city. In view of the enormous difficulties suffered by the traveling people in their daily life, this metropolitan city must not forego the advantages of organized public transport just in order to protect the employment of rickshaw pullers.

Retailers tend always to resist traffic restraint schemes such as restriction of parking in shopping streets. Such incident happened recently in New Elephant Road. Absence of alternative parking spaces provoked resistanse by traders and frequent violations of the traffic management rules by the shoppers. Such schemes are usually frustrated due to inadequate enforcement.

9.3 ROAD USERS AND ENFORCEMENT

Countermeasures of accidents and other environmental difficulties may be much less effective in Dhaka city than anticipated owing to poor road user behaviour. This is in turn due to lack of awareness of traffic regulations and a predominant general attitude towards road safety. Pedestrians are defiant to all traffic rules and their behaviour, as indicated by field survey, is almost solely influenced by local circumstances. Majority of the drivers are cycle-rickshaw pullers and do not abide by any traffic law or discipline. It is a matter of great concern that drivers, in general, show no respect to other road users and treat pedestrians as if they are second rate citizens.

Combined publicity and enforcement campaign in developing countries, Egypt and Singapore for example, has provided evidence for the road safety benefits of enforcement and led to substantial reduction in fatalities and serious injuries. Applicability of ETSPAM strategies requires drastic implementation of enforcement and educational measures in Dhaka city.

Education:

Educating the road using public is an essential underpinning to the system of law and its enforcement by means of police intervention and use of sanctions against offenders. Relentless efforts are required to make road users relinguish their negative attitudes. Educational programmes on traffic law should be expanded and frequently communicated to the public through newspapers, textbooks audio visual aids, etc. Institutional arrangements should be made to conduct these programmes with all possible attention. Employed drivers should attend periodical training programmes for a specified number of hours every year. This can be enforced through, for example, linking it with driving licence renewal. These programmes will be of little effect unless combined with enforcement.

Legislation:

The motor vehicle ordinance, 1983 (Chapter 10) explicitly allows for suitably severe penalties for offences. But practically this legislation does not exist. Violation of traffic law in this metropolitan city occurs almost by every one at an amazing frequency. Parking offence is, perhaps, the only punishable one. and this is also infrequent and imposes a minimal fine. Other penalties are exercised usually following road accidents, though drivers of public service vehicles responsible for accidents often manage to escape. It may be more practicable to revise this legislation and attach or incorporate, a detailed and precise list of offenses and penalties to enable the traffic law enforcing officers to take the offenders to the nearest police station and impose immediate payment of specified fine or impose such fine on site. Legislation should introduce proper sanctions to check pedestrian violation of traffic law.

Enforcement:

Enforcement is a very vital component of the traffic environment. Unfortunately, this factor is suffering a serious constraint. The strength of traffic police personnel deployed on the roads of Dhaka city is about 350. The total strength is only 900 and there are at least 500 traffic points. The requirements in three shifts are at least 3000 police personnel. This acute shortage has made the traffic police task frustrating and rather very difficult.

Inadequate strength of traffic police, in view of the prevailing traffic situation, has resulted in a dilemma concerning police intervention and discretion. This is a major weakness of the present enforcement system. To use discretion to best effect, officers need to be aware of the rationale behind regulations. Proper training is, therefore, required to attain the best effectiveness.

9.4 CITIZEN INVOLVEMENT MECHANISM

The general public whose individual lives are to be effected by the implementation of traffic restraint and pedestrianization measures should be allowed to play an important role in the planning process. Despite the citizen has a very little scope in influencing public officials who are appointed by the government and responsible for planning and implementation, citizen involvement is needed to ensure responsiveness of different transport actions to citizen desires and to maintain citizen support of planning and implementation.

Some form of organizational structure or mechanism should be designated to enable direct involvement of the citizens of the concerned area in the planning process. A combination of some or all, of the following techniques and activities is recommended to be used to develop an effective citizen participation mechanism.

(a) Conduct studies and sample surveys of citizen attitudes and values regarding safety and other traffic related environmental issues, social, economic and physical goals, objectives and needs.

(b) Providing informal working sessions with citizens representing different geographic areas.

(c) Hold public hearings at which plans, programmes and policies are presented and public comment received.

(d) Conduct public information programmes to insure that citizens are well informed regarding opportunities and problems.

Appendix – A

TERMINOLOGY FOR DATA ANALYSIS

TERMINOLOGY

Capacity:

Capacity is defined in the 1985 Highway Capacity Manual as "the maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a lane or roadway during a specified time period under prevailing roadway, traffic, and control conditions" (Roess and McShane, 1987).

Pedestrian volume and density:

Pedestrian volume is defined as the number of persons passing a given point in a unit of time. Pedestrian density can either be expressed in number of pedestrians per square meter or its reciprocal; the number of square meters of area per pedestrian.

The Passenger Car Equivalent (PCE):

A way of accounting for the interaction of various kinds of traffic is to express the capacity of roads in terms of a common unit. The unit generally employed is the "passenger car equivalent". The values of PCE adopted for the conversion in this research are those adopted by ESCAP (Economic and Social Commission for Asia and the Pacific), except for cycle-rickshaw and push-cart. The ESCAP value of 2 was considered excessive by some agencies and would lead to overestimation of traffic flow compared with the practical capacity of the road. Roads and Highways Department (RHD) suggests 0.5 as a practical value for the cycle-rickshaw. This value implies underestimation of the impact of this particular vehicle on road capacity in terms of time and space, which significantly requires more than that of a passenger car. This value is also not supported by practical analysis. The Indian Roads Congress (1976) recommended "1.5" a practical value as a result of extensive field tests and analysis. It also recommended "6" as the PCE value for push-cart. These two values are adopted for this research. The PCE values adopted for data analysis are shown in Table A - 1.

Level of Service (LOS):

The 1985 Highway Capacity Manual defines Level of Service as "a qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers maneuver, traffic interruptions, comfort and convenience, and safety". For Pedestrian traffic, LOS is a measure of adequacy of walkway facilities. Design procedures for walkways are referenced to LOS standards. Normal free walking speed increases as more area becomes available to pedestrians, i.e., as the density decreases. However, flow volume increases as the area per pedestrian decreases, until a critical point is reached at which movement is highly restricted because of lack of space.

In analysing the adequacy of pedestriasn facilities, two important

VEHICLE TYPE	P.C.E.
Car, Jeep, Pick-up, Microbus	1
Truck	3
Bus	3
Auto-rickshaw	1
Motor-cycle	0.5
Pedal-cycle	0.5
Cycle-rickshaw	1.5
Push-cart	6

Source: Shankland Cox Partnership, 1979.
The Indian Roads Congress, 1976.

Table A - 1

PASSENGER CAR EQUIVALENT OF DIFFERENT VEHICLE TYPES relationships must be considered: (a) average walking speed is a function of pedestrian traffic density; and (b) maximum pedestrian traffic flow is related to traffic density:

$$Q = V/A$$

where

Q = pedestrian traffic flow (ped./min./m of width),

V = mean walking speed (m/sec.), and

A = area per pedestrian in square meter (m^2/ped.), termed here as "area module".

The recommended standards of LOS shown in Table A-2 incorporate relative measures of the prevailing unit flow rates, area modules and speed.

Table A - 2

WALKWAY LEVEL OF SERVICE CRITERIA

LOS	Module (m^2/ped.)	Flow (ped./min./m of width)	Speed (m/sec.)	Comments
A	3.2 or more	23 or less	1.3-1.4	Free flow No conflicts
B	2.3-3.2	23-33	1.2-1.3	Normal walking speed Minor conflicts
C	1.4-2.3	33-49	1.1-1.2	Restricted flow Some conflicts Walking speed controlled
D	0.9-1.4	49-66	1.0-1.1	Conflict Walking speed restricted Difficulty in passing
E	0.5-0.9	66-82	0.7-1.0	Frequent adjustment of gait Walking speed restricted
F	0.5 or less	variable to 82	less than 0.7	Shuffling and bunching Extreme restriction of speed Breakdown of flow

Source: Davis and Braaksma, 1987.

Appendix – B

FIELD SURVEY

MIRPUR ROAD

Table B – 1

PEDESTRIAN TRAFFIC FLOW SURVEY
MIRPUR ROAD
SURVEY SECTION 1 – EAST SIDEWALK

Date: 28.10.1987 (Wednesday)
Weather: Fine

TIME	DIRECTION S -> N									DIRECTION N -> S									GRAND TOTAL
	MALE			FEMALE			S. TOTAL		TOTAL	MALE			FEMALE			S. TOTAL		TOTAL	
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	24	261	2	15	25	0	287	40	327	26	291	3	19	15	0	320	34	354	681
0800	14	385	3	12	60	0	402	72	474	11	416	5	8	162	0	432	170	602	1076
0830	14	344	5	14	31	0	363	45	408	21	454	10	20	47	0	485	67	552	960
0900	4	366	2	0	17	2	372	19	391	20	488	8	10	23	1	516	34	550	941
0930	6	304	3	0	18	1	313	19	332	6	480	4	6	40	0	490	46	536	868
1000	8	241	3	2	15	0	252	17	269	14	425	2	2	26	1	441	29	470	739
1030	8	220	0	10	36	0	228	46	274	6	346	8	0	25	0	360	25	385	659
1100	6	457	0	3	16	1	436	20	483	7	352	0	8	29	2	359	39	398	881
1130	10	222	1	5	18	3	233	26	259	15	292	2	12	12	1	309	25	334.	593
1200	9	234	2	10	16	1	245	27	272	12	307	3	3	9	2	322	14	336	608
1230	9	262	1	8	14	0	272	22	294	27	237	0	9	17	0	264	26	290	584
1300	3	198	3	5	22	2	204	29	233	28	222	5	4	8	2	255	14	269	502
1330	12	318	0	2	20	0	330	22	352	6	282	2	4	18	0	290	22	312	664
1400	9	241	3	11	57	0	253	68	321	16	240	6	8	32	1	262	41	303	624
1430	24	372	6	13	50	1	402	64	466	14	363	6	13	24	2	383	39	322	788
1500	18	311	3	10	37	1	332	48	380	9	272	2	11	17	0	283	28	311	691
1530	15	327	4	6	38	2	346	46	392	16	256	5	6	35	2	277	43	320	712
1600	10	314	4	7	16	1	328	24	352	8	253	2	2	16	0	263	18	281	633
1630	14	328	7	12	25	0	349	37	386	12	262	6	10	18	1	280	29	309	695
1700	4	367	6	10	46	0	377	56	433	14	232	4	9	37	1	250	47	297	730
1730	8	523	3	3	74	1	534	78	612	4	316	1	3	53	2	321	58	379	991
1800	6	388	5	4	58	0	399	62	461	6	321	3	4	49	0	330	53	383	844
1830	9	297	7	6	23	2	313	31	344	11	294	5	9	22	0	310	31	341	685
1900	11	282	4	2	17	1	397	20	417	13	250	4	8	33	1	267	42	309	726
1930	4	304	3	4	20	0	311	24	335	6	223	4	3	20	0	233	23	256	591
2000	2	295	5	3	14	0	302	17	319	4	207	3	1	18	0	214	19	233	552

Table B - 2

PEDESTRIAN TRAFFIC FLOW SURVEY

MIRPUR ROAD

SURVEY SECTION 1 - WEST SIDEWALK

Date: 28.10.1987 (Wednesday)
Weather: Fine

TIME	DIRECTION S -> N									DIRECTION N -> S									GRAND
	MALE			FEMALE			S.TOTAL		TOTAL	MALE			FEMALE			S.TOTAL		TOTAL	TOTAL
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	28	122	2	9	6	0	152	15	167	124	173	3	4	23	0	300	27	327	494
0800	78	271	3	21	28	0	352	49	401	50	186	3	10	26	0	239	36	275	676
0830	86	308	3	12	17	0	397	29	426	45	169	4	0	9	0	218	9	227	653
0900	135	396	0	5	18	0	531	23	554	58	188	3	2	9	0	249	11	260	814
0930	138	218	3	15	17	0	359	32	391	56	167	2	8	8	0	225	16	241	632
1000	197	262	2	6	18	2	461	26	487	62	198	0	6	15	1	260	22	282	769
1030	54	257	3	5	18	1	314	24	338	36	142	3	4	10	0	181	14	195	533
1100	32	244	3	6	12	0	279	18	297	28	140	3	2	9	0	171	11	182	479
1130	47	286	2	4	18	1	335	23	358	47	156	4	2	20	1	207	23	230	588
1200	35	230	2	5	14	0	267	19	286	23	103	2	9	12	0	128	21	149	435
1230	39	206	0	6	11	2	245	19	264	33	184	2	10	11	2	219	23	242	506
1300	46	307	2	6	15	1	355	22	377	36	150	0	9	6	2	186	17	203	580
1330	54	374	4	8	21	3	432	32	464	37	214	2	14	15	3	253	32	285	749
1400	18	318	12	12	18	0	348	30	378	20	151	6	8	6	2	177	16	193	571
1430	26	301	6	18	30	4	333	52	385	18	222	6	12	26	2	246	40	286	671
1500	25	266	9	9	24	1	300	34	334	30	236	7	4	16	3	273	23	296	630
1530	24	270	10	8	33	2	304	43	347	12	182	9	10	16	0	203	26	229	576
1600	34	257	12	9	30	3	313	42	355	18	198	4	12	24	3	220	39	259	614
1630	36	248	6	16	36	1	290	53	343	20	185	3	15	34	0	208	49	257	600
1700	46	325	8	34	97	2	379	133	512	27	264	2	26	51	4	293	81	374	886
1730	20	352	10	10	27	0	382	37	419	12	214	4	15	35	0	230	50	280	699
1800	18	341	6	16	39	2	365	57	422	14	182	3	10	28	0	199	38	237	659
1830	20	336	11	9	32	0	367	41	408	18	199	6	10	18	1	223	29	252	660
1900	15	262	8	5	16	2	285	23	308	10	139	5	3	17	0	154	20	174	482
1930	22	313	4	8	9	3	339	20	359	14	175	5	2	8	0	194	10	204	563
2000	14	265	8	11	17	0	287	28	315	5	139	4	0	4	0	148	4	152	467

Table B – 3

PEDESTRIAN TRAFFIC CROSSING SURVEY

MIRPUR ROAD

SURVEY SECTION 1 – ZEBRA CROSSING

Date: 28.10.1987 (Wednesday)
Weather: Fine

TIME	DIRECTION W -> E									DIRECTION W <- E									GRAND TOTAL
	MALE			FEMALE			S.TOTAL		TOTAL	MALE			FEMALE			S.TOTAL		TOTAL	
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	18	100	5	12	20	0	123	32	155	26	143	4	7	12	0	173	19	192	347
0800	7	130	6	39	68	0	143	107	250	4	139	8	2	4	0	151	6	157	407
0830	13	139	4	3	9	0	156	12	168	8	120	2	4	3	0	130	7	137	305
0900	125	243	4	5	9	0	372	14	386	3	156	3	0	11	0	162	11	173	559
0930	122	230	8	0	12	0	360	12	372	5	130	3	1	4	1	138	6	144	516
1000	82	192	4	4	7	2	278	13	291	6	112	9	2	5	1	127	8	135	426
1030	8	73	0	3	4	1	81	8	89	11	98	3	4	14	2	112	20	132	221
1100	13	92	7	2	3	2	112	7	119	12	91	3	2	15	0	106	17	123	242
1130	17	66	5	2	4	1	88	7	95	3	74	4	1	4	2	81	7	88	183
1200	4	62	5	4	4	0	71	8	79	12	125	3	7	12	0	140	19	159	238
1230	3	69	2	0	8	0	74	8	82	8	108	3	2	16	1	119	19	138	220
1300	4	70	2	2	3	1	76	6	82	4	87	2	4	3	3	93	10	103	185
1330	2	112	3	0	4	1	117	5	122	4	127	3	2	5	1	134	8	142	264
1400	11	75	5	3	5	2	91	10	101	9	171	2	2	6	2	182	10	192	293
1430	2	98	3	2	7	2	103	11	114	7	160	3	0	10	0	170	10	180	294
1500	4	69	1	2	8	0	74	10	84	15	158	2	3	7	0	175	10	185	269
1530	5	61	4	3	4	1	70	8	78	7	104	3	2	22	3	114	27	141	219
1600	9	58	1	2	3	1	68	6	74	4	89	2	8	12	4	95	24	119	193
1630	13	94	2	2	9	0	109	11	120	14	91	3	3	10	2	108	15	123	243
1700	15	104	3	3	10	0	122	13	135	60	114	5	42	94	1	179	137	316	451
1730	17	151	4	3	7	1	172	11	183	19	156	4	4	15	2	179	21	200	383
1800	5	143	4	2	3	2	152	7	159	14	239	4	5	28	2	257	35	292	451
1830	10	210	2	1	4	0	222	5	227	13	246	3	2	14	2	262	18	280	507
1900	3	134	5	0	2	0	142	2	144	7	209	4	1	9	1	220	11	231	375
1930	12	119	4	3	3	2	135	8	143	8	171	8	2	5	0	187	7	194	337
2000	3	115	2	0	2	0	120	2	122	0	165	5	0	3	0	170	3	173	295

Table B - 4

PEDESTRIAN TRAFFIC CROSSING SURVEY
MIRPUR ROAD - SURVEY SECTION 1
(100-M STRIP OUT OF ZEBRA)

Date: 28.10.1987 (Wednesday)
Weather: Fine

TIME	DIRECTION W -> E									DIRECTION W <- E									GRAND TOTAL
	MALE			FEMALE			S.TOTAL		TOTAL	MALE			FEMALE			S.TOTAL		TOTAL	
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	5	140	2	6	13	0	147	19	166	5	154	3	2	14	0	162	16	178	344
0800	6	152	2	23	64	0	160	87	247	3	230	4	2	7	0	237	9	246	439
0830	5	164	1	4	16	0	170	20	190	2	220	0	4	6	0	222	10	232	422
0900	14	155	0	2	3	0	169	5	174	5	183	0	2	14	0	188	16	204	378
0930	16	153	5	3	10	1	174	14	188	11	158	2	2	5	0	171	7	178	366
1000	15	118	0	3	2	1	133	6	139	13	193	0	5	2	0	206	7	213	352
1030	13	115	0	0	18	0	128	18	146	4	143	0	3	15	0	147	18	165	311
1100	2	112	0	2	11	0	114	13	127	7	84	0	0	21	1	91	22	113	240
1130	0	61	2	0	5	2	63	7	70	2	73	2	0	2	0	77	2	79	149
1200	3	73	3	5	7	2	79	14	93	4	110	1	3	11	1	115	15	130	223
1230	3	150	2	7	9	0	155	16	171	2	189	0	1	18	2	191	21	212	383
1300	11	78	0	6	9	1	89	16	105	11	99	0	3	7	0	110	10	120	225
1330	2	67	0	0	2	0	69	2	71	2	85	4	0	5	0	91	5	96	167
1400	3	69	4	3	5	0	76	8	84	5	81	3	0	1	0	89	1	90	174
1430	5	80	2	0	3	0	87	3	90	2	140	6	1	3	0	148	4	152	242
1500	1	66	5	3	5	0	72	8	80	3	141	8	1	4	1	152	6	158	238
1530	7	73	0	1	5	2	80	8	88	6	118	6	3	6	2	130	11	141	229
1600	9	87	2	2	7	1	98	10	108	9	95	3	3	0	0	107	3	110	218
1630	13	56	3	6	6	0	72	12	84	6	101	3	3	7	0	110	10	120	204
1700	10	84	3	2	3	0	97	5	102	13	123	5	4	5	1	141	10	151	253
1730	2	108	2	1	2	0	112	3	115	3	125	3	5	15	2	131	22	153	268
1800	9	74	1	1	2	2	84	5	89	6	122	2	3	10	0	130	13	143	232
1830	5	77	1	2	1	1	83	4	87	2	108	6	2	5	2	116	9	125	212
1900	3	75	0	3	2	0	78	5	83	0	150	5	2	5	0	155	7	162	245
1930	0	71	2	4	4	0	73	8	81	3	122	3	1	3	0	128	4	132	213
2000	0	69	0	0	3	0	69	3	72	6	105	5	3	4	0	116	7	123	195

Table B - 5

PEDESTRIAN TRAFFIC FLOW SURVEY

MIRPUR ROAD

SURVEY SECTION 2 - EAST SIDEWALK

Date: 26.10.1987 (Monday)
Weather: Fine

TIME	DIRECTION S -> N									DIRECTION N -> S									GRAND
	MALE			FEMALE			S.TOTAL		TOTAL	MALE			FEMALE			S.TOTAL		TOTAL	TOTAL
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	23	122	0	12	7	0	145	19	164	49	145	1	22	14	0	195	36	231	395
0800	29	208	0	9	14	0	237	23	260	52	247	3	54	30	1	302	85	387	647
0830	32	192	2	6	17	0	226	23	249	69	313	5	15	16	1	387	32	419	668
0900	48	238	1	3	11	0	287	14	301	66	258	2	6	9	0	326	15	341	642
0930	36	186	3	9	11	1	225	21	246	35	204	2	5	18	1	241	24	265	511
1000	60	160	3	33	15	0	223	48	271	67	197	0	5	16	1	264	22	286	557
1030	57	148	5	58	17	0	210	75	285	87	172	3	23	20	1	262	44	306	591
1100	94	150	8	38	5	1	252	44	296	90	194	5	12	5	1	289	18	307	603
1130	51	152	2	14	9	1	205	24	229	99	163	4	9	10	2	266	21	287	516
1200	34	136	3	50	16	1	173	67	240	105	142	5	48	11	1	252	60	312	552
1230	35	91	3	5	6	1	129	12	141	71	124	4	12	12	0	199	24	223	364
1300	46	96	2	10	8	0	144	18	162	53	128	4	14	7	1	185	22	207	369
1330	53	142	2	6	10	0	197	16	213	119	158	1	4	12	0	278	16	294	507
1400	18	138	5	1	11	1	161	13	174	30	185	6	8	12	2	221	22	243	417
1430	107	150	3	15	19	2	260	36	296	24	214	4	9	23	1	242	33	275	571
1500	40	132	3	3	10	1	175	14	189	38	124	2	9	16	1	164	26	190	379
1530	23	114	5	18	10	5	142	33	175	47	161	4	8	12	2	212	22	234	409
1600	20	113	6	16	10	2	139	28	167	20	98	9	18	22	3	127	43	170	337
1630	38	136	18	15	20	1	192	36	228	32	154	9	10	24	1	195	35	230	458
1700	21	160	10	16	29	2	191	47	238	27	199	8	9	28	2	234	39	273	511
1730	40	205	4	9	26	2	249	37	286	27	236	6	10	42	1	269	53	322	608
1800	33	316	12	6	29	3	361	38	399	28	274	15	14	29	1	317	44	361	760
1830	38	269	9	12	17	1	316	30	346	34	254	6	8	16	1	294	25	319	665
1900	39	232	11	8	14	0	282	22	304	38	255	8	5	16	0	301	21	322	626
1930	48	224	5	11	13	1	277	25	302	34	240	6	2	11	1	280	14	294	596
2000	23	211	2	11	12	1	236	24	260	42	218	10	8	17	2	270	27	297	557

Table B – 6

PEDESTRIAN TRAFFIC FLOW SURVEY

MIRPUR ROAD

SURVEY SECTION 2 – WEST SIDEWALK

Date: 26.10.1987 (Monday)
Weather: Fine

TIME	DIRECTION S -> N									DIRECTION N -> S									GRAND TOTAL
	MALE			FEMALE			S. TOTAL		TOTAL	MALE			FEMALE			S. TOTAL		TOTAL	
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	21	87	1	11	21	0	109	32	141	18	51	2	5	13	0	71	18	89	230
0800	28	152	5	28	28	0	185	56	241	22	66	6	13	26	0	94	39	133	374
0830	25	194	5	9	21	1	224	31	255	19	83	0	3	10	0	102	13	115	370
0900	24	140	3	6	15	0	167	21	188	5	84	3	2	5	0	92	7	99	287
0930	22	141	5	25	19	2	168	46	214	18	111	7	13	11	1	136	25	161	375
1000	23	132	2	13	11	0	157	24	181	9	88	2	2	16	1	99	19	118	299
1030	30	135	4	14	12	1	169	27	196	11	79	4	8	7	0	94	15	109	305
1100	19	100	6	10	10	0	125	20	145	7	89	5	3	5	1	101	9	110	255
1130	4	101	2	8	10	0	107	18	125	20	88	5	14	17	0	113	31	144	269
1200	10	119	2	12	16	0	131	28	159	10	107	2	8	11	0	119	19	138	297
1230	15	96	3	10	10	1	114	21	135	9	83	3	5	4	0	95	9	104	239
1300	15	82	5	8	10	0	102	18	120	5	55	3	5	5	1	63	11	74	194
1330	33	182	5	6	42	0	220	48	268	35	119	4	9	17	0	158	26	184	452
1400	22	145	9	8	14	2	176	24	200	23	136	4	7	18	0	163	25	188	388
1430	32	178	11	10	24	1	221	35	256	20	205	10	8	19	1	235	28	263	519
1500	18	132	14	9	17	1	164	27	191	17	203	6	2	17	2	226	21	247	438
1530	10	124	9	16	25	1	143	42	185	17	158	2	9	13	0	177	22	199	384
1600	28	140	11	6	21	4	179	31	210	16	143	10	5	9	2	169	16	185	395
1630	16	122	3	8	10	0	141	18	159	18	119	13	4	6	1	150	11	161	320
1700	20	136	5	8	13	0	161	21	182	23	145	10	12	20	0	178	32	210	392
1730	26	181	6	9	30	2	213	41	254	35	204	8	13	10	1	247	24	271	525
1800	21	230	4	6	22	2	255	30	285	23	221	3	9	15	1	247	25	272	557
1830	15	188	4	11	8	1	207	20	227	21	234	3	10	7	0	258	17	275	502
1900	16	162	2	4	9	0	180	13	193	4	154	5	8	9	1	163	18	181	374
1930	3	156	4	4	4	2	163	10	173	5	164	5	4	6	1	174	11	185	358
2000	4	134	4	2	10	1	142	13	155	8	127	11	4	11	1	146	16	162	317

Table B – 7

PEDESTRIAN TRAFFIC CROSSING SURVEY

MIRPUR ROAD

SURVEY SECTION 2 (100-M STRIP)

Date: 26.10.1987 (Monday)
Weather: Fine

TIME	DIRECTION W -> E									DIRECTION W <- E									GRAND TOTAL
	MALE			FEMALE			S.TOTAL		TOTAL	MALE			FEMALE			S.TOTAL		TOTAL	
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	9	163	0	2	19	0	172	21	193	23	174	0	5	12	0	197	17	214	107
0800	12	270	0	3	30	3	282	36	318	36	273	11	18	17	0	320	35	355	673
0830	16	312	5	0	5	2	333	7	340	24	308	4	0	2	0	336	2	338	678
0900	18	153	6	1	3	0	177	4	181	12	194	6	0	9	0	212	9	221	402
0930	9	117	5	3	10	0	131	13	144	8	108	6	3	9	0	122	12	134	278
1000	10	221	4	2	11	0	235	13	248	24	185	8	2	29	2	217	33	250	498
1030	11	126	5	3	9	3	142	15	157	15	143	6	5	17	3	164	25	189	346
1100	6	138	8	0	2	2	152	4	156	3	107	3	0	8	0	113	8	121	277
1130	6	162	3	5	12	2	171	19	190	14	122	5	5	8	2	141	15	156	346
1200	20	143	3	2	5	0	166	7	173	5	119	0	8	18	0	124	26	150	323
1230	9	126	3	5	8	0	138	13	151	15	113	2	0	5	0	130	5	135	286
1300	13	135	5	0	11	2	153	13	166	12	122	3	0	2	2	137	4	141	307
1330	21	209	5	2	14	0	235	16	251	6	128	3	0	11	0	137	11	148	399
1400	8	152	3	0	3	0	163	3	166	3	147	0	2	5	0	150	7	157	323
1430	26	251	3	11	6	1	280	18	298	29	204	2	8	15	2	235	25	260	558
1500	23	165	5	9	3	0	193	12	205	3	113	0	5	2	0	116	7	123	328
1530	20	155	2	5	14	0	177	19	196	14	116	2	14	18	1	132	33	165	361
1600	18	81	2	8	0	1	101	9	110	17	107	3	2	15	1	127	18	145	255
1630	21	150	0	8	11	1	171	20	191	12	96	2	3	11	0	110	14	124	315
1700	17	141	2	3	8	0	160	11	171	9	144	2	2	14	2	155	18	173	344
1730	29	210	0	2	8	3	239	13	252	14	227	0	8	18	0	241	26	267	519
1800	18	263	0	5	15	1	281	21	302	12	215	1	3	9	1	228	13	241	543
1830	38	206	3	15	18	0	247	33	280	32	147	0	2	12	2	179	16	195	475
1900	42	233	3	3	8	0	278	11	289	26	170	0	5	9	0	196	14	210	499
1930	42	186	2	14	12	2	230	28	258	35	150	2	3	17	3	187	23	210	468
2000	36	177	5	9	14	1	218	24	242	23	127	9	11	21	2	159	34	193	435

Table B - 8

PEDESTRIAN TRAFFIC DENSITY SYRVEY

MIRPUR ROAD - SURVEY SECTION 3

Date: 10.10.1987 (Sunday)
Weather: Fine

(Pedestrian densities were estimated along two strips "a and b" at this section of 160 m each at east and west sidewalks. Densities are expressed here as "Density Module" i.e., m^2/ped.)

Time	EAST SIDEWALK "a"	EAST SIDEWALK "b"	West Sidewalk "a"	West Sidewalk "b"
0700	2.1	3.2	9.6	7.5
0730	2.6	5.9	6.2	10.9
0800	1.7	4.4	7.7	9.6
0830	1.5	2.8	6.3	10.0
0900	1.3	2.4	5.9	7.5
0930	1.5	2.8	3.7	5.1
1000	1.7	2.9	4.8	5.9
1030	1.6	2.2	3.5	4.6
1100	1.7	2.9	3.5	4.7
1130	2.1	3.0	3.4	5.1
1200	2.2	5.0	4.9	4.4
1230	2.7	2.8	3.2	4.5
1300	2.2	4.4	2.9	3.9
1330	1.7	5.7	3.1	4.9
1400	2.1	6.1	1.9	4.1
1430	2.6	4.4	3.0	3.3
1500	2.6	6.2	2.7	4.8
1530	3.6	4.9	2.5	5.5
1600	2.2	6.0	2.1	4.1
1630	1.8	4.4	2.0	4.1
1700	1.3	3.0	2.0	4.1
1730	1.5	2.1	2.4	2.9
1800	1.0	1.4	2.2	2.9
1830	1.1	1.9	2.1	2.6
1900	1.5	2.0	2.1	2.4
1930	1.4	5.0	3.2	3.5
2000	1.3	4.4	3.6	4.0

Table B – 9

PEDESTRIAN TRAFFIC CROSSING SURVEY

MIRPUR ROAD

SURVEY SECTION 3 (100-M STRIP)

Date: 18.10.1987 (Sunday)
Weather: Fine

TIME	DIRECTION W -> E									DIRECTION W <- E									GRAND TOTAL
	MALE			FEMALE			S. TOTAL		TOTAL	MALE			FEMALE			S. TOTAL		TOTAL	
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	12	61	5	6	8	0	78	14	92	16	138	0	7	15	0	154	22	176	268
0800	16	124	6	5	10	0	146	15	161	21	165	0	2	27	0	186	29	215	376
0830	3	118	0	3	8	0	121	11	132	15	170	3	5	13	2	188	20	208	340
0900	11	157	3	1	7	1	171	9	180	5	120	2	0	5	0	127	5	132	312
0930	13	134	1	2	7	0	148	9	157	7	109	1	8	8	1	117	17	134	291
1000	11	154	2	2	3	1	167	6	173	18	94	2	1	13	0	114	14	128	301
1030	8	124	0	3	8	2	132	13	145	10	91	0	3	18	0	101	21	122	267
1100	10	61	1	2	10	0	72	12	84	7	63	2	1	21	1	72	23	95	179
1130	7	124	3	2	7	2	134	11	145	13	122	3	2	10	2	138	14	152	297
1200	5	125	2	3	8	1	132	12	144	8	109	2	2	16	0	119	18	137	281
1230	10	85	2	5	10	0	97	15	112	3	71	0	2	3	1	74	6	80	192
1300	2	112	2	3	7	0	116	10	126	2	64	1	3	7	0	67	10	77	203
1330	2	125	0	2	3	2	127	7	134	11	78	1	2	2	0	90	4	94	228
1400	8	191	1	4	22	2	200	28	228	13	122	0	3	8	0	135	11	146	374
1430	18	160	0	1	10	0	178	11	189	11	112	1	7	16	2	123	25	149	338
1500	10	136	3	2	8	1	149	11	160	10	107	0	5	7	0	117	12	129	289
1530	4	117	2	3	3	0	123	6	129	10	128	0	2	13	2	138	17	155	284
1600	4	95	0	1	7	1	99	9	108	6	85	1	3	2	1	92	6	98	206
1630	15	104	1	1	13	0	120	14	134	16	106	3	5	11	1	125	17	142	276
1700	7	129	3	8	24	0	139	32	171	8	111	1	7	16	0	120	23	143	314
1730	5	131	1	2	18	2	137	22	159	10	86	0	2	5	0	96	7	103	262
1800	7	157	6	5	8	1	170	14	184	8	65	2	6	11	2	75	19	94	278
1830	7	145	2	3	6	0	154	9	163	7	98	0	3	7	0	105	10	115	278
1900	3	158	2	5	21	0	163	26	189	5	78	2	4	8	1	85	13	98	287
1930	3	146	0	6	3	1	149	10	159	5	103	3	3	6	0	111	9	120	279
2000	7	134	0	3	13	0	141	16	157	4	87	2	0	7	0	93	7	100	257

Table B - 10

PEDESTRIAN TRAFFIC FLOW SURVEY

MIRPUR ROAD

SURVEY SECTION 4 - EAST SIDEWALK

Date: 25.10.1987 (Sunday)
Weather: Fine

TIME	DIRECTION S -> N									DIRECTION N -> S									GRAND TOTAL
	MALE			FEMALE			S.TOTAL		TOTAL	MALE			FEMALE			S.TOTAL		TOTAL	
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	42	70	4	10	12	0	116	22	138	39	78	6	32	47	3	123	82	205	343
0800	28	108	10	10	27	0	146	37	183	48	104	6	27	24	3	158	54	212	395
0830	35	108	8	14	17	3	151	34	185	32	114	5	5	16	2	151	23	174	359
0900	38	133	5	6	5	1	176	12	188	45	119	3	4	18	2	167	24	191	379
0930	32	107	5	18	14	1	144	33	177	30	104	5	4	8	2	139	14	153	330
1000	66	106	3	10	12	0	175	22	197	41	125	3	4	12	0	169	16	185	382
1030	101	100	5	17	10	1	206	28	234	27	103	5	8	16	2	135	26	161	395
1100	75	95	6	5	4	0	176	9	185	143	74	3	10	9	0	220	19	239	424
1130	32	78	3	12	4	0	113	16	129	81	125	5	4	11	2	211	17	228	357
1200	50	86	4	42	15	1	140	58	198	41	72	0	12	3	2	113	17	130	328
1230	27	73	2	12	5	2	102	19	121	30	95	2	2	6	3	127	11	138	259
1300	36	66	3	11	10	1	105	22	127	49	74	5	2	9	2	128	13	141	268
1330	38	77	4	6	8	2	119	16	135	32	131	3	6	5	0	166	11	177	312
1400	42	74	6	4	5	0	122	9	131	66	79	4	3	6	0	149	9	158	289
1430	43	90	2	11	8	0	135	19	154	44	91	4	6	5	1	139	12	151	305
1500	39	88	0	1	2	0	127	3	130	50	106	5	8	10	0	161	18	179	309
1530	33	55	5	2	5	2	93	9	102	30	67	0	5	5	0	97	10	107	209
1600	22	47	2	4	6	0	71	10	81	41	74	2	9	6	0	117	15	132	213
1630	28	86	3	3	31	2	117	36	153	128	83	2	10	6	2	213	18	231	384
1700	50	112	2	9	13	2	164	24	188	57	108	4	9	14	1	169	24	193	381
1730	42	145	6	18	19	1	193	38	231	34	121	6	28	15	1	161	44	205	436
1800	77	169	2	12	11	0	248	23	271	65	158	3	6	18	3	226	27	253	524
1830	68	178	5	12	12	0	251	24	275	74	199	2	5	11	0	275	16	291	566
1900	39	150	3	16	21	0	192	37	229	45	140	2	9	16	0	187	25	212	441
1930	41	102	3	5	9	0	146	14	160	44	142	3	4	6	0	189	10	199	359
2000	30	104	3	5	6	0	137	11	148	29	122	2	2	5	0	153	7	160	308

Table B - 11

PEDESTRIAN TRAFFIC FLOW SURVEY

MIRPUR ROAD

SURVEY SECTION 4 - WEST SIDEWALK

Date: 25.10.1987 (Sunday)
Weather: Fine

TIME	DIRECTION S -> N									DIRECTION N -> S									GRAND TOTAL
	MALE			FEMALE			S.TOTAL		TOTAL	MALE			FEMALE			S.TOTAL		TOTAL	
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	6	37	1	0	8	0	44	8	52	12	55	1	8	5	0	68	13	81	133
0800	9	61	7	4	20	0	77	24	101	16	73	5	12	23	0	94	35	129	230
0830	12	55	4	4	12	0	71	16	87	15	50	1	3	7	0	66	10	76	163
0900	3	58	3	5	5	0	64	10	74	10	60	4	5	6	0	74	11	85	159
0930	7	60	7	4	7	0	74	11	85	16	65	1	5	5	0	82	10	92	177
1000	5	38	9	0	3	2	52	5	57	4	80	6	2	9	0	90	11	101	158
1030	5	77	5	2	6	2	87	10	97	9	73	7	3	5	0	89	8	97	194
1100	8	80	6	5	9	0	94	14	108	14	82	4	11	21	1	100	33	133	241
1130	14	92	4	8	9	0	110	17	127	10	104	6	3	9	0	120	12	132	259
1200	16	70	4	0	5	1	90	6	96	6	68	5	3	6	2	79	11	90	186
1230	1	62	4	2	3	0	67	5	72	10	80	3	8	8	2	93	18	111	183
1300	14	49	2	5	8	1	65	14	79	15	72	6	8	5	0	93	13	106	185
1330	20	91	12	2	5	2	123	9	132	20	88	10	3	6	0	118	9	127	259
1400	20	109	4	4	8	1	133	13	146	34	94	6	0	3	0	134	3	137	283
1430	39	85	3	14	11	2	127	27	154	20	88	6	3	8	1	114	12	126	280
1500	9	98	3	4	6	0	110	10	120	18	79	2	9	9	3	99	21	120	240
1530	10	59	2	0	4	1	71	5	76	12	55	4	2	9	0	71	11	82	158
1600	14	103	6	5	8	1	123	14	137	28	94	9	6	12	0	131	18	149	286
1630	8	88	11	1	2	0	107	3	110	3	64	10	5	17	1	77	23	100	210
1700	11	74	4	2	4	2	89	8	97	17	71	4	2	5	1	92	8	100	197
1730	12	107	4	8	9	3	123	20	143	9	112	9	9	15	0	130	24	154	297
1800	10	121	4	10	6	0	135	16	151	11	106	4	0	8	2	121	10	131	282
1830	5	108	4	3	10	0	117	13	130	2	88	2	2	4	0	92	6	98	228
1900	11	100	3	0	2	1	114	3	117	8	106	0	4	6	4	114	10	124	241
1930	11	74	3	5	4	0	88	9	97	8	89	3	4	10	0	100	14	114	211
2000	5	76	3	0	3	0	84	3	87	8	88	4	1	3	0	100	4	104	191

Table B – 12

PEDESTRIAN TRAFFIC CROSSING SURVEY

MIRPUR ROAD

SURVEY SECTION 4 (100-M STRIP)

Date: 25.10.1987 (Sunday)
Weather: Fine

TIME	DIRECTION W -> E									DIRECTION W <- E									GRAND TOTAL
	MALE			FEMALE			S.TOTAL		TOTAL	MALE			FEMALE			S.TOTAL		TOTAL	
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	0	43	0	0	5	0	43	5	48	6	50	0	20	6	0	56	26	82	130
0800	5	77	0	0	13	0	82	13	95	10	66	0	7	14	0	76	21	97	192
0830	6	52	0	3	9	0	58	12	70	6	49	2	2	11	0	57	13	70	140
0900	6	53	1	3	3	0	60	6	66	7	87	2	3	6	0	96	9	105	171
0930	6	43	2	0	2	1	51	3	54	6	55	1	5	10	1	62	16	78	132
1000	7	46	2	1	2	0	55	3	58	5	45	0	2	6	0	50	8	58	116
1030	2	55	1	2	3	1	58	6	64	7	52	3	4	3	0	62	7	69	133
1100	3	49	2	2	2	0	54	4	58	5	60	6	6	3	0	71	9	80	138
1130	9	69	0	5	4	2	78	11	89	19	60	2	1	3	1	81	5	86	175
1200	6	41	1	3	3	1	48	7	55	7	55	1	0	2	2	63	4	67	122
1230	9	42	2	2	2	0	53	4	57	12	32	2	1	2	0	46	3	49	106
1300	12	63	1	2	5	0	76	7	83	9	43	2	2	3	0	54	5	59	142
1330	10	108	2	6	2	2	120	10	130	20	81	3	5	5	0	104	10	114	244
1400	21	53	2	0	3	0	76	3	79	10	59	2	0	4	1	71	5	76	155
1430	10	91	5	0	6	2	106	8	114	19	77	3	9	10	0	99	19	118	232
1500	13	52	0	3	5	0	65	8	73	17	62	3	6	2	0	82	8	90	163
1530	10	45	0	2	3	2	55	7	62	6	32	4	0	3	1	42	4	46	108
1600	5	37	0	9	5	0	42	14	56	13	27	0	2	3	0	40	5	45	101
1630	28	56	5	6	9	0	89	15	104	12	53	2	7	27	2	67	36	103	207
1700	27	64	3	0	3	1	94	4	98	19	35	2	6	5	0	56	11	67	165
1730	28	90	0	10	7	0	118	17	135	23	62	3	2	7	0	88	9	97	232
1800	10	87	2	3	5	0	99	8	107	9	66	3	12	6	1	78	19	97	204
1830	6	81	0	2	3	0	87	5	92	7	67	0	0	2	0	74	2	76	168
1900	12	49	0	3	4	0	61	7	68	16	36	2	2	3	0	54	5	59	127
1930	7	63	0	2	5	0	70	7	77	10	43	0	0	5	0	53	5	58	135
2000	6	25	0	2	4	0	31	6	37	9	39	0	0	2	0	48	2	50	37

Table B - 13

PEDESTRIAN TRAFFIC FLOW SURVEY
MIRPUR ROAD
SURVEY SECTION 5 - EAST SIDEWALK

Date: 27.10.1987 (Tuesday)
Weather: Fine

TIME	DIRECTION S -> N									DIRECTION N -> S									GRAND
	MALE			FEMALE			S.TOTAL		TOTAL	MALE			FEMALE			S.TOTAL		TOTAL	TOTAL
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	5	139	3	3	17	0	147	20	167	15	185	12	0	12	0	212	12	224	391
0800	12	142	8	3	16	0	162	19	181	10	167	11	0	9	2	188	11	199	380
0830	13	110	4	10	10	2	127	22	149	8	149	2	3	15	2	159	20	179	328
0900	8	106	4	4	2	0	118	6	124	10	151	4	5	8	3	165	16	181	305
0930	19	130	3	2	7	2	152	11	163	17	149	4	2	8	0	170	10	180	343
1000	10	131	4	4	8	0	145	12	157	24	125	10	1	10	0	159	11	170	327
1030	15	129	6	5	9	1	150	15	165	53	92	8	6	10	2	153	18	171	336
1100	15	125	5	6	3	2	145	11	156	34	66	5	9	5	1	105	15	120	276
1130	14	119	5	3	4	0	138	7	145	28	67	4	5	4	1	99	10	109	254
1200	33	110	4	2	6	2	147	10	157	8	40	4	3	6	0	52	9	61	218
1230	21	97	5	4	5	3	123	12	135	4	44	3	10	6	1	51	17	68	203
1300	15	85	6	3	5	0	106	8	114	1	47	2	2	5	3	50	10	60	174
1330	9	83	1	4	25	3	93	32	125	22	131	4	1	20	2	157	23	180	305
1400	53	126	3	7	4	0	182	11	193	20	89	3	5	5	1	112	11	123	316
1430	18	146	0	6	4	3	164	13	177	22	59	5	6	6	2	86	14	100	277
1500	16	49	4	6	10	2	69	18	87	14	20	6	3	5	2	40	10	50	137
1530	27	68	0	0	2	2	95	4	99	15	55	0	2	3	0	70	5	75	174
1600	24	67	4	4	9	0	95	13	108	22	49	3	4	9	2	74	15	89	197
1630	88	97	5	1	10	2	190	13	203	31	48	2	4	5	3	81	12	93	296
1700	23	110	3	2	4	1	136	7	143	30	85	5	3	8	1	120	12	132	275
1730	22	136	3	5	24	2	161	31	192	33	154	1	6	12	2	188	20	208	400
1800	33	210	4	1	8	0	247	9	256	47	142	2	2	11	0	191	13	204	460
1830	36	197	3	2	9	1	236	12	248	18	130	2	3	8	1	150	12	162	410
1900	18	128	2	1	5	1	148	7	155	29	95	4	0	4	0	128	4	132	287
1930	22	119	0	4	6	0	141	10	151	30	65	2	4	4	0	97	8	105	256
2000	20	89	2	8	8	0	111	16	127	16	52	1	1	3	0	69	4	73	200

Table B – 14

PEDESTRIAN TRAFFIC FLOW SURVEY

MIRPUR ROAD

SURVEY SECTION 5 – WEST SIDEWALK

Date: 27.10.1987 (Tuesday)
Weather: Fine

TIME	DIRECTION S -> N									DIRECTION N -> S									GRAND TOTAL
	MALE			FEMALE			S.TOTAL		TOTAL	MALE			FEMALE			S.TOTAL		TOTAL	
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	10	110	5	9	26	0	125	35	160	19	145	18	17	23	0	182	40	222	382
0800	12	104	4	4	17	1	120	22	142	15	137	2	5	27	0	154	32	186	328
0830	9	86	4	2	4	0	99	6	105	13	144	4	3	7	0	161	10	171	276
0900	9	82	3	5	6	0	94	11	105	9	109	0	6	10	0	118	16	134	239
0930	13	79	5	4	3	2	97	9	106	25	128	5	3	4	0	158	7	165	271
1000	19	91	6	8	17	0	116	25	141	24	125	5	6	8	1	154	15	169	310
1030	17	95	0	5	16	1	112	22	134	28	106	2	8	13	1	136	22	158	292
1100	28	112	5	8	6	2	145	16	161	35	119	6	5	8	2	160	15	175	336
1130	19	101	2	3	8	2	122	13	135	21	103	9	1	6	0	133	7	140	275
1200	16	107	5	5	6	1	128	12	140	15	118	3	2	8	1	136	11	147	287
1230	27	104	4	4	12	0	135	16	151	13	110	5	3	10	3	128	16	144	295
1300	21	79	5	5	6	1	105	12	117	10	92	4	3	5	0	106	8	114	231
1330	14	142	8	7	9	3	164	19	183	18	126	10	6	15	2	154	23	177	360
1400	38	168	4	5	5	1	210	11	221	58	182	2	3	10	1	242	14	256	477
1430	22	157	6	5	15	2	185	22	207	15	125	9	3	4	1	149	8	157	364
1500	18	104	8	3	11	0	130	14	144	25	97	6	2	9	3	128	14	142	286
1530	22	101	3	3	12	1	126	16	142	5	76	3	2	4	2	84	8	92	234
1600	21	94	3	2	10	2	118	14	132	4	98	4	0	8	0	106	8	114	246
1630	55	86	6	2	8	1	147	11	158	6	97	10	3	6	0	113	9	122	280
1700	27	161	9	6	39	1	197	46	243	12	109	5	4	13	1	126	18	144	387
1730	18	193	12	10	31	3	223	44	267	5	161	11	4	11	2	177	17	194	461
1800	21	198	5	6	15	2	224	23	247	11	138	10	4	5	2	159	11	170	417
1830	5	201	6	0	14	0	212	14	226	13	168	3	3	6	1	184	10	194	420
1900	27	157	2	4	9	1	186	14	200	11	134	5	2	3	0	150	5	155	355
1930	29	137	7	3	8	0	173	11	184	9	98	3	3	9	1	110	13	123	307
2000	13	132	2	8	6	0	147	14	161	7	110	2	2	7	0	119	9	128	289

Table B – 15

PEDESTRIAN TRAFFIC CROSSING SURVEY

MIRPUR ROAD

SURVEY SECTION 5 – ZEBRA CROSSING

Date: 27.10.1987 (Tuesday)
Weather: Fine

TIME	DIRECTION W -> E									DIRECTION W <- E									GRAND TOTAL
	MALE			FEMALE			S.TOTAL		TOTAL	MALE			FEMALE			S.TOTAL		TOTAL	
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	12	64	3	11	9	0	79	20	99	6	32	0	0	1	0	38	1	39	138
0800	5	48	5	3	5	0	58	8	66	7	16	0	2	2	0	23	4	27	93
0830	7	47	2	7	11	0	56	18	74	8	15	5	4	2	0	28	6	34	108
0900	2	36	3	4	3	2	41	9	50	3	18	0	8	3	1	21	12	33	83
0930	2	53	5	3	5	1	60	9	69	0	39	1	2	2	3	40	7	47	116
1000	3	42	3	1	5	0	48	6	54	2	6	1	2	3	0	9	5	14	68
1030	6	55	2	2	3	2	63	7	70	3	18	2	6	2	1	23	9	32	102
1100	2	59	3	4	7	0	64	11	75	2	20	3	2	1	1	25	4	29	104
1130	3	45	5	5	6	1	53	12	65	6	11	6	1	2	0	23	3	26	91
1200	5	43	2	4	5	1	50	10	60	1	4	2	1	4	2	7	7	14	74
1230	8	48	2	2	3	2	58	7	65	3	14	4	4	3	0	21	7	28	93
1300	2	28	3	4	5	1	33	10	43	1	18	2	3	4	0	21	7	28	71
1330	5	41	4	3	6	0	50	9	59	3	15	5	2	5	1	23	8	31	90
1400	9	73	3	8	2	0	85	10	95	6	20	0	5	1	0	26	6	32	127
1430	5	85	3	7	2	2	93	11	104	5	25	2	1	2	1	32	4	36	140
1500	3	29	1	4	3	1	33	8	41	3	5	4	5	6	2	12	13	25	66
1530	6	41	2	2	7	0	49	9	58	6	3	2	4	7	2	11	13	24	82
1600	2	60	2	5	11	2	64	18	82	3	7	0	4	3	0	10	7	17	99
1630	6	38	1	2	3	1	45	6	51	3	2	1	3	1	1	6	5	11	62
1700	7	71	9	2	5	1	87	8	95	4	14	5	6	2	0	23	8	31	126
1730	6	123	7	4	13	2	136	19	155	2	18	2	4	3	2	22	9	31	186
1800	3	119	4	2	11	2	126	15	141	12	64	1	2	7	1	77	10	87	228
1830	6	90	2	1	4	0	98	5	103	17	74	2	6	11	0	93	17	110	213
1900	3	55	2	3	3	1	60	7	67	6	53	1	2	2	0	60	4	64	131
1930	3	52	3	6	2	0	58	8	66	8	31	2	4	6	0	41	10	51	117
2000	0	48	0	3	6	0	48	9	57	2	39	1	0	2	0	42	2	44	101

Table B – 16

PEDESTRIAN TRAFFIC CROSSING SURVEY
MIRPUR ROAD – SURVEY SECTION 5
(100-M STRIP OUT OF ZEBRA)

Date: 27.10.1987 (Tuesday)
Weather: Fine

TIME	DIRECTION W -> E									DIRECTION W <- E									GRAND TOTAL
	MALE			FEMALE			S.TOTAL		TOTAL	MALE			FEMALE			S.TOTAL		TOTAL	
	<16	16-59	60+	<16	16-59	60+	M	F		<16	16-59	60+	<16	16-59	60+	M	F		
0730	3	101	0	2	25	0	104	27	131	11	182	1	0	31	0	194	31	225	356
0800	5	94	2	1	7	0	101	8	109	7	168	5	25	23	0	180	48	228	337
0830	11	73	2	3	5	0	86	8	94	5	98	3	26	7	0	106	33	139	233
0900	8	67	2	3	2	0	77	5	82	1	42	2	9	5	1	45	15	60	142
0930	5	102	6	4	3	1	113	8	121	5	57	0	6	5	0	62	11	73	194
1000	3	85	1	2	7	1	89	10	99	6	27	2	6	6	1	35	13	48	147
1030	6	95	3	1	8	2	104	11	115	8	56	1	7	3	2	65	12	77	192
1100	7	78	5	6	5	0	90	11	101	3	32	0	4	3	2	35	9	44	145
1130	13	94	2	2	6	0	109	8	117	2	25	1	1	4	0	28	5	33	150
1200	2	49	5	4	3	1	56	8	64	4	21	2	4	2	3	27	9	36	100
1230	5	64	5	5	3	0	74	8	82	11	28	1	3	3	1	40	7	47	129
1300	5	56	0	2	4	1	61	7	68	2	15	5	3	5	0	22	8	30	98
1330	6	78	3	25	3	2	87	30	117	2	27	1	4	2	1	30	7	37	154
1400	0	115	0	0	2	0	115	2	117	3	55	0	0	8	0	58	8	66	183
1430	0	107	0	7	7	0	107	14	121	2	75	0	1	2	0	77	3	80	201
1500	7	71	0	1	4	0	78	5	83	2	21	1	2	2	0	24	4	28	111
1530	3	55	1	2	2	0	59	4	63	1	42	1	1	3	2	44	6	50	113
1600	5	64	2	1	3	0	71	4	75	2	14	0	0	0	2	16	2	18	93
1630	6	139	2	2	8	1	147	11	158	13	55	0	2	6	1	68	9	77	235
1700	13	109	0	0	7	0	122	7	129	7	49	0	3	5	2	56	10	66	195
1730	3	120	0	1	10	1	123	12	135	2	70	1	0	2	0	73	2	75	210
1800	5	133	2	1	3	1	140	5	145	5	60	2	2	8	1	67	11	78	223
1830	6	122	1	2	7	2	129	11	140	7	83	0	3	2	1	90	6	96	236
1900	7	90	1	2	7	0	98	9	107	9	72	1	1	9	0	82	10	92	199
1930	0	80	0	0	6	1	80	7	87	1	38	0	0	3	0	39	3	42	129
2000	4	79	0	6	8	0	83	14	97	8	36	0	3	6	0	44	9	53	150

Table B – 17

VEHICULAR TRAFFIC FLOW SURVEY

MIRPUR ROAD

(NORTH – SOUTH FLOW)

Date: 02.11.1987 (Monday)
Weather: Fine

TIME	MOTORIZED VEHICLES							NON-MOTORIZED VEHICLES					Grand Total Veh.	Grand Total PCE
	Car Jeep Pick-Up M.Bus	Truck	Bus	Auto-Rick	Motor Cycle	Total Veh.	Total PCE	Pedal Cycle	Push-Cart	Cycle Rick.	Total Veh.	Total PCE		
0730	336	2	49	30	44	461	541	37	1	267	305	425	766	966
0800	554	3	82	48	58	745	886	48	1	463	512	725	1257	1611
0830	569	7	58	70	67	771	868	47	0	526	573	813	1344	1681
0900	343	3	87	77	78	588	729	48	5	680	733	1074	1321	1803
0930	326	3	76	75	95	575	686	52	2	656	710	1022	1285	1708
1000	328	25	70	76	110	609	744	59	2	667	728	1042	1337	1786
1030	291	14	59	113	62	539	654	43	6	739	788	1166	1327	1820
1100	336	17	62	116	84	615	731	33	5	682	719	1069	1334	1800
1130	264	16	53	99	76	508	608	24	7	585	616	932	1124	1540
1200	214	16	58	79	67	434	549	22	3	568	593	881	1027	1430
1230	220	30	48	87	79	464	581	24	6	603	633	953	1097	1534
1300	243	15	46	91	61	456	548	33	3	599	635	933	1091	1481
1330	262	18	54	101	60	495	609	35	8	558	601	903	1096	1512
1400	278	15	58	105	49	505	627	35	8	537	580	871	1085	1498
1430	248	14	53	90	55	460	567	25	5	600	630	943	1090	1510
1500	238	16	55	88	45	442	562	37	4	585	626	920	1068	1482
1530	223	11	56	123	56	469	575	24	5	544	573	858	1042	1433
1600	252	8	61	139	41	501	619	41	7	754	802	1194	1303	1813
1630	271	10	82	128	53	544	702	40	3	522	565	821	1109	1523
1700	235	8	53	134	56	486	580	36	7	513	556	830	1042	1410
1730	328	7	74	137	95	641	756	43	6	540	589	868	1230	1624
1800	229	6	65	124	60	484	596	37	18	494	549	868	1033	1464
1830	284	10	85	173	94	646	789	35	16	581	632	985	1278	1774
1900	312	6	71	142	91	622	731	28	6	635	669	1003	1291	1734
1930	215	4	60	106	85	470	556	24	11	462	497	771	967	1327
2000	210	53	46	119	49	477	651	26	6	467	499	750	976	1401

Table B – 18

VEHICULAR TRAFFIC FLOW SURVEY

MIRPUR ROAD

(SOUTH – NORTH FLOW)

Date: 02.11.1987 (Monday)
Weather: Fine

TIME	MOTORIZED VEHICLES							NON-MOTORIZED VEHICLES					Grand Total Veh.	Grand Total PCE
	Car Jeep Pick-Up M.Bus	Truck	Bus	Auto-Rick	Motor Cycle	Total Veh.	Total PCE	Pedal Cycle	Push-Cart	Cycle Rick.	Total Veh.	Total PCE		
0730	168	0	64	36	22	290	407	44	0	201	245	324	535	731
0800	272	7	71	56	29	435	577	74	1	354	429	574	864	1151
0830	359	4	84	61	30	538	699	52	3	294	349	485	887	1184
0900	307	5	74	76	35	497	638	33	1	370	404	378	901	1216
0930	233	2	67	64	42	408	525	35	7	401	443	661	851	1186
1000	246	5	59	78	36	424	534	24	6	438	468	705	892	1239
1030	280	35	72	94	37	518	714	25	1	371	397	575	915	1289
1100	271	8	60	84	43	466	581	32	1	454	487	703	953	1284
1130	220	21	51	85	77	454	560	14	8	468	490	757	944	1317
1200	184	24	32	77	35	352	447	35	5	520	560	828	912	1275
1230	267	56	87	75	62	547	802	41	10	687	738	1111	1285	1913
1300	229	20	59	66	39	413	552	23	8	626	657	999	1070	1551
1330	370	17	47	121	68	623	717	29	10	791	830	1261	1453	1978
1400	422	18	49	117	75	681	778	34	6	786	826	1232	1507	2010
1430	377	30	74	83	49	613	797	35	7	507	549	820	1162	1617
1500	288	8	56	86	56	494	594	32	19	551	602	957	1096	1551
1530	240	18	68	83	42	451	602	32	13	540	585	904	1036	1506
1600	277	18	58	91	60	504	626	30	11	542	583	894	1087	1520
1630	272	13	55	108	64	512	616	31	11	650	692	1057	1204	1673
1700	252	7	71	96	71	497	618	32	5	740	777	1156	1274	1774
1730	320	5	76	112	66	579	708	48	22	803	873	1361	1452	2069
1800	264	2	78	118	55	517	650	36	10	596	642	972	1159	1622
1830	238	1	74	126	43	482	611	37	5	565	607	896	1089	1507
1900	240	2	49	96	78	465	528	46	6	608	660	971	1125	1499
1930	248	0	40	67	58	413	464	36	4	583	623	917	1036	1381
2000	271	13	64	107	65	520	642	23	2	536	561	828	1081	1470

Appendix – C

FIELD SURVEY

NEW MARKET SHOPPING AREA

Table C – 1

PEDESTRIAN TRAFFIC DENSITY SURVEY

NEW MARKET SHOPPING AREA

Location: Sidewalks where Mirpur Road bisects New Market Shopping Area.
Date: 01.11.1987 (Sunday).
Weather: Fine.

(Densities are expressed here as "Density Module" i.e., m^2/ped.)

TIME	East Sidewalk SECTIONS 1	2	3	4	West Sidewalk SECTIONS 1	2	3	4
0700	1.8	4.0	2.8	3.3	3.8	5.4	1.5	2.1
0730	1.1	2.4	1.6	1.6	2.8	5.0	1.2	2.3
0800	1.4	3.0	1.7	1.1	3.8	4.7	1.2	1.5
0830	1.2	2.3	1.8	1.6	3.8	3.9	1.5	1.5
0900	1.0	2.0	1.5	1.3	2.9	2.8	1.2	1.1
0930	1.1	1.5	1.3	1.8	2.6	2.5	0.9	0.9
1000	1.1	1.6	1.2	1.9	1.7	1.7	0.9	1.2
1030	1.0	1.2	1.2	1.6	1.3	1.8	0.8	1.0
1100	0.9	0.9	1.0	2.1	1.4	1.7	0.8	1.1
1130	0.8	0.8	0.9	1.9	1.0	1.6	0.7	1.0
1200	0.8	0.8	0.8	2.1	0.7	1.3	1.0	1.1
1230	0.9	0.9	1.1	2.2	0.8	1.6	1.0	0.7
1300	1.0	1.0	1.2	1.9	0.8	1.6	0.8	0.7
1330	0.9	1.0	1.4	2.0	1.0	1.9	0.7	0.9
1400	0.9	1.1	1.3	2.1	1.3	1.5	1.0	1.0
1430	0.9	1.0	1.6	2.6	0.9	1.1	0.8	1.1
1500	1.0	0.7	1.1	2.1	0.9	1.2	0.9	0.8
1530	0.9	0.7	0.9	2.4	1.2	1.1	0.8	0.8
1600	0.9	0.8	0.9	2.3	0.9	1.1	0.7	0.8
1630	0.7	0.6	0.8	1.5	0.8	1.0	0.7	0.6
1700	0.5	0.4	0.6	1.0	0.8	0.7	0.4	0.4
1730	0.4	0.3	0.6	0.7	0.6	0.6	0.7	0.5
1800	0.6	0.4	0.5	0.8	0.6	0.7	0.5	0.5
1830	0.6	0.4	0.6	1.0	0.6	0.5	0.5	0.4
1900	0.6	0.5	0.6	1.1	0.7	0.7	0.5	0.5
1930	0.7	0.5	0.7	1.3	0.9	1.0	0.7	0.7
2000	0.5	0.5	0.8	2.0	0.9	0.8	0.9	0.9

Source: Field Survey.

Table C - 2

PEDESTRIAN CROSSING FLOW SURVEY

NEW MARKET SHOPPING AREA

Location: Mirpur Road bisecting the New Market Shopping Area.
Date: 13.01.1988 (Wednesday).
Weather: Fine.

(Flow is expressed here as ped./30 min.)

TIME	Sec.1	Sec.2	Over-pass	Sec.3	2+3	Total Flow	R*
0800	571	402	16	2654	3056	3643	0.5
0830	607	521	23	1115	1636	2266	1.4
0900	540	396	49	898	1294	1883	3.6
0930	517	664	90	1205	1869	2476	4.6
1000	502	627	160	1035	1662	2324	8.8
1030	581	551	264	1058	1609	2454	14.1
1100	586	645	452	887	1532	2570	22.8
1130	575	744	514	882	1626	2715	24.0
1200	520	651	588	1274	1925	3033	23.4
1230	602	548	646	1196	1744	2992	27.0
1300	597	665	619	1204	1869	3085	24.9
1330	585	641	582	976	1617	2784	26.5
1400	768	794	560	1106	1900	3228	22.8
1430	779	1024	566	1037	2061	3406	21.5
1500	876	1146	595	1074	2220	3691	21.1
1530	718	1062	554	1030	2092	3364	20.9
1600	757	1215	617	1216	2431	3805	20.2
1630	855	1169	1008	1168	2337	4200	30.1
1700	940	1244	1145	1394	2638	4723	30.3
1730	1295	1433	1534	1283	2716	5545	36.1
1800	1362	1427	1556	1255	2682	5600	36.7
1830	1252	1474	1158	1102	2576	4986	31.0
1900	981	1748	1022	1018	2766	4769	27.0
1930	897	1366	680	1035	2401	3978	22.1
2000	854	1170	578	1055	2225	3657	20.6
Total			15576		52484	87177	

$$* \quad R = 100 \times \frac{\text{Flow at overpass}}{\text{Flow at overpass + Flow at the two adjacent sections}}$$

Source: Field survey.

Table C - 3

VEHICULAR TRAFFIC FLOW SURVEY
NEW MARKET SHOPPING AREA
(NORTH - SOUTH FLOW)

Date: 10.01.1988 (Sunday)
Weather: Fine

TIME	MOTORIZED VEHICLES							NON-MOTORIZED VEHICLES					Grand Total Veh.	Grand Total PCE
	Car Jeep Pick-Up M.Bus	Truck	Bus	Auto-Rick	Motor Cycle	Total Veh.	Total PCE	Pedal Cycle	Push-Cart	Cycle Rick.	Total Veh.	Total PCE		
0800	249	1	43	26	32	351	423	52	6	414	472	683	823	1106
0830	326	0	55	44	49	474	560	91	0	584	675	922	1149	1482
0900	296	0	46	54	92	488	534	62	8	828	898	1321	1386	1855
0930	242	6	26	48	101	423	437	54	5	680	739	1077	1162	1514
1000	205	5	37	80	100	427	461	107	7	980	1094	1566	1521	2027
1030	271	8	34	82	114	509	536	90	12	1076	1178	1731	1687	2267
1100	354	13	22	95	109	593	609	99	10	1208	1317	1922	1910	2531
1130	320	10	30	112	122	594	613	79	7	1197	1283	1877	1877	2490
1200	313	13	28	89	110	553	580	82	8	1351	1441	2116	1994	2696
1230	343	8	32	87	99	569	600	80	5	1531	1616	2367	2185	2967
1300	209	7	27	103	64	410	446	68	8	1267	1343	1983	1753	2429
1330	227	10	26	79	76	418	452	80	17	1169	1266	1896	1684	2348
1400	184	3	24	67	64	342	364	64	3	998	1065	1547	1407	1911
1430	205	12	36	103	60	416	482	74	12	886	972	1438	1388	1920
1500	199	7	34	77	49	366	424	71	6	1051	1128	1648	1494	2072
1530	194	5	31	95	53	378	424	66	8	1194	1268	1872	1646	2296
1600	197	7	34	91	70	399	446	64	7	1061	1132	1666	1531	2112
1630	232	6	22	88	45	393	427	67	11	1128	1206	1792	1599	2219
1700	247	4	29	102	53	435	475	72	12	1459	1543	2297	1978	2772
1730	216	0	38	104	44	402	456	102	18	1401	1521	2261	1923	2717
1800	239	6	34	70	37	386	448	106	14	1396	1516	2231	1902	2679
1830	237	10	26	91	61	425	467	99	16	1130	1245	1841	1670	2308
1900	252	18	19	89	43	421	474	48	20	982	1050	1617	1471	2091
1930	265	11	18	68	32	394	436	59	12	975	1046	1564	1440	2000
2000	261	10	20	86	55	432	465	82	18	993	1093	1639	1525	2104

Table C - 4

VEHICULAR TRAFFIC FLOW SURVEY
NEW MARKET SHOPPING AREA
(SOUTH - NORTH FLOW)

Date: 10.01.1988 (Sunday)
Weather: Fine

TIME	MOTORIZED VEHICLES							NON-MOTORIZED VEHICLES					Grand Total Veh.	Grand Total PCE
	Car Jeep Pick-Up M.Bus	Truck	Bus	Auto-Rick	Motor Cycle	Total Veh.	Total PCE	Pedal Cycle	Push-Cart	Cycle Rick.	Total Veh.	Total PCE		
0800	151	7	42	46	18	264	353	84	6	485	575	806	839	1159
0830	235	7	35	58	35	370	437	40	1	614	655	947	1025	1384
0900	178	6	29	45	36	294	346	34	2	781	817	1201	1111	1547
0930	166	3	34	74	26	303	364	42	4	942	988	1458	1291	1822
1000	118	6	24	60	46	254	291	36	6	894	936	1395	1190	1686
1030	145	6	31	102	53	337	385	40	7	1186	1233	1841	1570	2226
1100	170	3	29	90	58	350	385	23	4	1214	1241	1857	1591	2242
1130	246	14	29	71	56	416	474	30	6	1182	1218	1824	1634	2298
1200	184	8	23	76	53	344	380	64	11	1337	1412	2104	1756	2484
1230	201	7	32	92	85	417	453	66	13	1301	1380	2063	1797	2516
1300	220	5	28	88	68	409	441	64	4	1280	1348	1976	1757	2417
1330	230	7	26	80	51	394	435	54	8	1241	1303	1937	1697	2372
1400	208	10	30	65	56	369	421	43	23	1367	1433	2210	1802	2631
1430	322	10	62	100	95	589	686	72	11	1070	1153	1707	1742	2393
1500	281	8	58	114	85	546	636	70	22	986	1078	1646	1624	2282
1530	166	3	31	74	67	341	376	86	7	946	1039	1504	1380	1880
1600	133	12	30	91	43	309	372	68	8	966	1042	1531	1351	1903
1630	163	6	26	106	55	356	393	60	17	955	1032	1565	1388	1958
1700	185	2	43	121	90	441	486	97	16	1264	1377	2041	1818	2527
1730	250	2	34	122	92	500	526	83	13	1329	1425	2113	1925	2639
1800	208	3	32	113	72	428	462	76	10	1124	1210	1784	1638	2246
1830	203	1	23	126	86	439	444	67	8	1233	1308	1931	1747	2375
1900	216	5	26	109	131	487	484	59	7	980	1046	1542	1533	2026
1930	175	8	18	88	85	374	384	67	7	985	1059	1553	1433	1937
2000	162	13	14	93	87	369	380	50	2	858	910	1324	1279	1704

Appendix - D

ACCIDENT DATA

Table D - 1

CASUALTIES BY CLASS OF ROAD USERS (1985)

DHAKA METROPOLITAN AREA

Month	Cases	Pedes. F	Pedes. S	Driver F	Driver S	Helper F	Helper S	Passgr F	Passgr S	M.C. F	M.C. S	R.P. F	R.P. S	P.C. F	P.C. S	Other F	Other S	Total F	Total S
Jan.	152	3	11	1	5	1	2	4	4	1	2	1	1	0	1	7	11	18	37
Feb.	127	2	7	1	2	0	2	3	3	0	1	2	2	1	2	10	15	19	34
Mar.	142	5	14	0	3	2	1	6	9	0	2	0	3	0	0	11	11	24	43
Apr.	155	1	8	0	2	0	3	3	5	1	0	0	2	0	1	7	17	12	38
May	159	4	19	2	2	0	1	2	15	0	1	1	1	2	0	8	11	19	50
Jun.	152	6	12	0	1	0	0	7	16	0	2	0	3	0	0	6	1	19	35
Jul.	170	5	16	0	2	0	1	2	1	2	0	2	5	1	2	7	8	19	44
Aug.	163	4	15	1	3	0	0	6	13	0	3	2	2	0	0	5	12	18	48
Sep.	132	3	19	1	1	1	2	5	17	0	0	1	0	0	0	5	4	16	43
Oct.	172	9	26	0	2	0	0	7	11	0	2	0	1	0	1	4	26	20	69
Nov.	155	3	13	2	0	0	1	2	18	0	1	0	2	0	0	2	7	9	42
Dec.	145	8	17	0	4	1	2	9	23	1	3	2	3	0	2	4	7	25	61

Pedes.: Pedestrian
Passgr: Passenger
M.C.: Motor-cyclist
R.P.: Rickshaw puller
P.C.: Pedal-cyclist

F : Fatalities
S : Serious injuries.

Source: Dhaka Metropolitan Police - Traffic Division.

Table D – 2

CASUALTIES BY CLASS OF ROAD USERS (1986)

DHAKA METROPOLITAN AREA

Month	Cases	Pedes. F	Pedes. S	Driver F	Driver S	Helper F	Helper S	Passgr F	Passgr S	M.C. F	M.C. S	R.P. F	R.P. S	P.C. F	P.C. S	Other F	Other S	Total F	Total S
Jan.	160	7	18	0	2	0	0	8	16	0	2	1	1	0	1	5	21	21	61
Feb.	152	11	13	1	1	0	1	9	13	1	0	0	0	0	0	3	14	24	42
Mar.	140	4	11	0	0	1	1	2	18	0	1	0	3	1	0	9	13	17	47
Apr.	116	3	14	2	0	1	0	14	19	0	0	1	4	0	0	10	10	31	47
May	122	4	9	0	0	0	0	5	14	0	0	0	1	1	1	3	6	13	31
Jun.	151	8	16	2	5	2	3	7	13	2	2	1	3	0	0	9	14	31	56
Jul.	148	10	15	1	4	0	2	4	21	0	0	0	2	0	2	2	11	17	57
Aug.	162	6	23	0	3	0	4	6	17	1	3	0	4	0	1	2	5	15	60
Sep.	147	4	11	0	1	0	1	7	16	0	0	2	1	1	0	3	12	17	42
Oct.	128	7	8	0	0	1	0	5	14	0	1	1	1	0	0	2	6	16	30
Nov.	96	6	13	1	3	0	2	7	15	0	2	0	0	0	0	3	5	17	40
Dec.	130	5	21	1	4	1	2	6	18	1	2	1	2	1	1	1	11	17	61

Pedes.: Pedestrian
Passgr: Passenger
M.C.: Motor-cyclist
R.P.: Rickshaw puller
P.C.: Pedal-cyclist

F : Fatalities.
S : Serious injuries.

Source: Dhaka Metropolitan Police – Traffic Division.

Table D - 3

CASUALTIES BY CLASS OF ROAD USERS (1987)

DHAKA METROPOLITAN AREA

Month	Cases	Pedes. F	Pedes. S	Driver F	Driver S	Helper F	Helper S	Passgr F	Passgr S	M.C. F	M.C. S	R.P. F	R.P. S	P.C. F	P.C. S	Other F	Other S	Total F	Total S
Jan.	151	6	16	0	2	0	1	9	24	0	2	0	2	0	0	5	14	20	61
Feb.	125	7	25	0	0	1	0	7	9	0	0	1	0	0	1	2	12	18	47
Mar.	154	8	28	0	3	0	2	4	17	0	3	0	4	1	0	3	14	16	71
Apr.	158	11	19	1	0	0	3	7	11	0	2	0	2	0	0	2	13	21	50
May	184	9	31	2	6	0	1	5	28	1	4	2	2	0	2	4	21	23	95
Jun.	167	11	27	0	1	2	1	6	23	0	3	0	3	0	0	3	15	22	73
Jul.	147	5	19	0	2	0	0	6	16	1	1	1	2	1	1	0	12	14	53
Aug.	127	9	17	1	2	1	2	11	21	0	2	0	1	1	0	3	14	26	59
Sep.	134	10	12	0	0	0	0	8	8	0	1	0	1	0	1	0	7	18	30
Oct.	160	8	28	1	1	0	1	6	17	0	2	1	3	0	0	3	17	19	69
Nov.	100	4	14	0	0	1	0	0	12	1	0	0	2	0	1	0	7	6	36
Dec.	116	8	11	0	2	0	1	4	9	0	1	0	1	0	1	2	5	14	31

Pedes.: Pedestrian
Passgr: Passenger
M.C.: Motor-cyclist
R.P.: Rickshaw puller
P.C.: Pedal-cyclist

F : Fatalities.
S : Serious injuries.

Source: Dhaka Metropolitan Police - Traffic Division.

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