An-Najah National University

Faculty of Graduate Studies

Analysis of Major Benefits and Costs for Pedestrian-Overpass
Case Study: Nablus City

Banan "Mohamed Rima'a" Saleem Jadallah

Supervisor
Dr. Osama A. Abaza

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By

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This Thesis was defended successfully on July.30th. 2000 and approved by:

Committee member		Signature
1- Dr. Osama A. Abaza Assistant Professor of Civil Engineering	(Supervisor)	
2- Dr. Khaled Zeidan Ministry of Planning and International Cooperation	(External Examiner)	
3- Dr. Sameer A. Abu-Eisheh Associate Professor of Civil Engineering	(Member)	
4- Dr. Khaled Al-Sahili Assistant Professor of Civil Engineering	(Member)	

إهـــــداء

لمن هباها ربي بالحب و الحنان

و كتب تحت أقدامها الجنان..................أمي

و لمن هباه بالحكمة و العدل

ليكون لنا كالميـــزان.......................أبي

و لمن ساروا الدرب معي

و لمن هم عونا لي على مُر الزمان.......أخوتي

و لقلـة في هــذه الأيــام

و اشعر بوجودهم بالاطمئنان.........................أصدقائي

و لكم جميعا أهدي

أنا ابنتكم بنان

شكـــر وتقـــديــر

بعد الشكر لله سبحانه و تعالى، أتقدم بالشكر الجزيل إلى حضرة الدكتور أسامة أباظة الذي كان مرشدا و ناصحا و عونا لي في استكمال رسالتي هذه، مع كل التقدير و الامتنان.

كما أتقدم بالشكر إلى كل المؤسسات التي مدت لي يد العون و زودتني بالمعلومات القيمة، وأخص بالذكر كل من: -

الشركة العربية للتأمين، شركة ترست للتأمين، الشركة الوطنية للتأمين، و بلدية نابلس.

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Abstract

Pedestrian-overpasses are appropriate when there is high speed and/or high traffic flow, where there is considerable pedestrian delay or a high pedestrian accident problem. Proper evaluation of these parameters resulted in identifying the most appropriate locations for installing pedestrian-overpasses. An economic analysis was proposed in this study for the purpose of reasonable evaluation of the required parameters that justified the installation of such costly structures.

The economic analysis was interpreted in terms of benefit-cost ratio. The later considered the savings of pedestrian accidents and pedestrian delay as the benefits that will be achieved after the installation of overpasses, on the other hand, construction and maintenance costs were considered.

Based on this analysis three different guidelines were developed. Accident guideline, pedestrian delay guideline, and combination of guidelines.

Cases with different assumptions can be applied, based on the proposed modification process. The developed guidelines are applied for unsignalized urban areas. The comparison with currently used warrants implied that the developed guidelines are more specific and flexible.

ملـــــخص

شهدت الأراضي الفلسطينية في الآونة الاخيرة تطورا سياسيا واقتصاديا ملحوظا. حيث كان لعودة أبناء الشعب الفلسطيني من الخارج وتوافد الزائرين من المدن الفلسطينية المجاورة الأثر الواضح في ازدياد حركة المرور للمركبات والمشاة، مما جعل الاحتكاك بين حركتي السير والمشاة يتزايد باطراد. هذا بدوره كان له الأثر السلبي الواضح على سلامة الإنسان، حيث ازدادت حوادث المشاة بشكل ملحوظ.

وعليه كان لابد من التقدم بحلول وإجراءات للحد أو التخفيف من هذه المشاكل. ومن هذه الحلول إنشاء جسور للمشاة. فجسور المشاة هي الحل الأمثل في المناطق التي تشهد أعداد كبيرة من حوادث المشاة، وحركة سير عالية والتي ينجم عنها إعاقة وتأخير لحركة المشاة والمركبات.

إن هذه العوامل هي العناصر الرئيسة في تقيم مبررات إنشاء جسور المشاة. وحيث أن هذه الجسور تعد من المنشآت باهظة الثمن، كان لابد من إنشاء مجموعة من المبررات (Guidelines) مبنية على أسس تقنية واقتصادية آخذة بعين الاعتبار حوادث المشاة (Pedestrian accidents) والتأخير الحاصل للمشاة (Pedestrian delay).

الدراسة مبنية على التحليل الاقتصادي وذلك عن طريق حساب النسبة بين الفائدة التي ستجنى من إنشاء جسر المشاة إلى التكلفة المتوقعة (Benefit-cost ratio). هذا وقد تم اعتبار أن الحد من حوادث المشاة وتوفير الوقت الذي ينتظره المشاة لقطع الشارع هي الفوائد التي ستنتج عن إنشاء الجسر. إن تكاليف الجسر تشمل الإنشاء والصيانة، إضافة إلى الحواجز الحديدية التي سيتم إضافتها على الأرصفة لمنع المشاة من قطع الشارع و توجيههم لاستخدام جسر المشاة.

لقد تم إنشاء ثلاثة نماذج لمبررات إنشاء جسور المشاة مستندة إلى العوامل التالية: -

١-حوادث المشاة ٢- تأخير المشاة ٣- الدمج بين العاملين.

وقد بنيت هذه المبررات على أسس و فرضيات. لكن ما يميز هذا البحث هو قابليته للتكيف مع الفرضيات المختلفة و ذلك من خلال تطبيق عملية التعديل المقترحة.

وقد حددت مبررات إنشاء جسور المشاة لتلائم المناطق الحضرية والتي لا تخضع لنظام الإشارات الضوئية (Unsignalized locations).

وأخيرا فان مقارنة هذه المبررات مع تلك الموجودة حاليا والتي تم تطويرها في دراسات سابقة، أظهرت أن المبررات الاقتصادية كانت اكثر مرونة وتحديدا.

Chapter One

Introduction

1.1 Background

The highway and traffic engineer is responsible for developing forecasts of travel demand, conducting evaluations based on economic and non-economic factors, and identifying alternatives for short, medium, and long range purposes. Almost all evaluation processes require some determination of the benefits and costs associated with the alternatives under consideration.

Pedestrian grade separation (i.e., overpass) is one of the transportation facilities that can be proposed as an alternative for solving problems. This facility is a means of reducing conflicts between vehicular and pedestrian traffic, thus increasing the efficiency and safety of the transportation system.

Because of the high costs associated with grade-separated facilities, they should be incorporated into the early stages of planning new developments, which are intended to generate substantial volumes of pedestrian. Thus, certain criteria must be available to provide designers, planners, and developers with important factors in determining where pedestrian facilities should be considered. These criteria can be interpreted in terms of warrants.

Studies on the development of warrants for pedestrian grade separations have been very limited. Available warrants provide specific volumes of pedestrian and motor vehicles, and vehicle speed for which a pedestrian-overpass is justified. However, while these specific values may be considered appropriate in certain instants, many economic factors should be considered before making a final decision about installing high-cost pedestrian-overpass. While some attempts of using economic analysis to justify the construction of costly pedestrian facilities have been tried, a systematic approach has generally been lacking.

1.2 Aims and objectives

This thesis is intended to analyze the major costs and benefits for justifying the installation of pedestrian overpasses. Many economic and traffic factors can be considered before making a final decision about installing pedestrian-overpasses. This analysis was accomplished by utilizing the concept of benefit-cost ratio.

Pedestrian overpasses are appropriate when there is high speed and/or high traffic flow, and where there is considerable pedestrian delay or a high pedestrian accident problem. Consequently, the most commonly used measures of benefits are: pedestrian accident costs and pedestrian value of time. On the other hand, pedestrian facility cost forms the other part of benefit-cost analysis.

Since pedestrian-overpass are intended to eliminate vehicular-pedestrian interaction, pedestrian accidents and pedestrian delay were assumed to be eliminated after the installation of the overpass. Thus, the annual roadway user benefits were the savings of eliminating both parameters, while, the costs were estimated based on the construction and maintenance costs.

1.3 Study area

Cases of mixed pedestrian-vehicular traffic are being noticed in congested urban areas in many developing countries, such as the Palestinian Territory. Nablus City is considered as the economic capital of the Palestinian Territory, in turns enjoying the prosperity of economic conditions attracting commercial, shopping, and tourism activities.

Thus, Nablus City is considered as a dense development with high pedestrian and vehicular volume. This combination yields in traffic operation problems which are increasing recently at alarming rates.

With respect to the previous facts, the consideration of Nablus City as a case study is an appropriate and representative choice for the purpose of this research.

The study area covers different unsignalized locations in Nablus City, which are distributed across the urban area in the city. These locations were chosen in order to tackle the fluctuated characteristics of the roadways.

1.4 Report outline

This report is composed of seven chapters. Chapter One contains background of pedestrian-overpass warrants, aims and objectives, study area, and report outline. Previous works related to this study are presented in Chapter Two. In Chapter Three, the collection of required traffic parameters (vehicular and pedestrian volumes) is described.

Pedestrian accident analysis and cost estimates are discussed in Chapter Four. Chapter Five introduces the analysis and modeling of pedestrian waiting time (delay).

A proposed design of pedestrian-overpass and its associated construction and maintenance costs are presented in Chapter Six. Benefit-cost analysis, pedestrian-overpass guidelines, and guideline statement are introduced in Chapter Seven.

Finally, Chapter Eight highlights the conclusions and recommendations.

Chapter Two

Literature Review

2.1 Introduction

Pedestrian-overpasses are appropriate when there is high speed and/or high traffic flow, where there is considerable pedestrian delay or a high pedestrian accident problem, or where there is restricted access to the roadway, as with freeway *(Ogden, 1996)*. Proper evaluation of these parameters resulted in identifying the most appropriate locations for installing pedestrian-overpasses.

Different relevant papers, reports, and articles were reviewed which considered pedestrian accidents, pedestrian delay, warrants, and economical analysis.

In the following sections, some of the studies were summarized. Other studies which were mentioned through the next chapters could be found in the references.

2.2 Accidents

The primary need for pedestrian control is to reduce the number and severity of traffic accidents involving pedestrians *(Homburger & Kell, 1996)*. Traffic and highway engineers are continually engaged in the design and/or operation of the control systems, with the aim of reducing accident rate.
To evaluate the success or failure of such safety programs in reducing accidents, data on the frequency, and severity of accidents are needed *(Garber & Hoel, 1988)*.

The success of the safety programs can be enhanced by developing statistically reliable accident prediction models. These safety estimates can be used in identifying accident-prone locations and evaluating the effectiveness of remedial measure *(Rodriguez & Sayed, 1999)*.

Pedestrian-overpasses are considered as one of the remedial measures that enhances the roadway safety. Therefore, to evaluate the effectiveness of pedestrian-overpasses in reducing the number of accidents, an accident prediction model was required.

Quaye et al in 1993 developed equations for estimating the safety of an intersection with respect to pedestrian accidents involving left turning vehicles. These equations described the safety of an "average" signalized intersection when the conflicting pedestrian and vehicular flows are known. Such knowledge enables one to address some important safety issues. First, one can judge whether the number of accidents at a specific signalized intersection, with given pedestrian and vehicular flows, is similar to what one would normally expect. Second, in the event that one would like to examine the effect of a safety intervention at signalized intersections it is important that the changes in safety due to traffic flow be separated from those due to the intervention. Equations relating traffic flow to safety make this possible.

Quaye et al study was done using data on accidents and flows for 15-minute time periods surveyed on Monday to Friday for the years 1983 to 1986. Their study was conducted in the City of Hamilton, Ontario. The authors suggested the following model to be a good choice for modeling the relationship between left turning vehicles and pedestrian accidents.

This model was given by: -

$$E\,(m) = b_o \times F_1^{b1} \times F_2^{b2} \qquad \text{..........2.1}$$

where;

E (m): Expected number of pedestrian accidents per unit of time at a certain intersection.

F_1: Left-turn vehicular flow.

F_2: Conflicting pedestrian flow.

b_o, b_1, b_2: Parameters to be determined.

An important issue was raised by the use of the three base time periods for estimating the accident models. This pertains to whether any advantage or disadvantage is derived from using smaller time periods for estimating models based essentially on the same accident data. Using smaller time periods for estimating the accident models, the number of observational units increases although the total number of accidents remains the same.

The developed models enable the analyst to predict the safety of an intersection when conflicting pedestrian and vehicular flows are known. Furthermore, one can investigate how the safety of an intersection compares to the norm.

Although Quaye et al's study had developed accident prediction models for signalized intersections, the methodology and the model structure described in their paper were generalized for pedestrian-vehicular accidents.

Another approach that can be followed to predict the number of accidents, which is the rate of accident. This concept was utilized in Dissanayake, et al study in 1999. In their study the time series models were described which were developed using regression analysis to forecast highway crash rates, in association with some selected special population subsets. Such models are useful in assessing the safety performance of the subsets since the problems inherent to subsets are different from that of average highway population. They will also enable the high-risk groups to be identified not only under present conditions, but also in the future.

Two sets of models were developed *(Dissanayake et al, 1999)*: one for the state of Florida and the other for whole USA. The population subsets that were considered included older drivers, young drivers, international tourists, and school aged children as non-motorists.

Among the several different model formats tried, one that was best fitting with all the population subsets was of log linear type, which can be obtained by taking the natural logarithm of the actual fatality rates.

The mathematical form of the model was given by: -

$$\text{Log}(X) = a\,T + b \text{..........} 2.2$$

$$X = e^{(a\,T + b)}$$

where;

X : Crash/fatality rate at year T.

T : Independent variable associated with time (Year).

a, b: Parameters to be determined.

This model gave the best fitting to the considered data, which resulted in a reasonably good fitness, illustrated by considerably high R^2 values varying from 0.784 to 0.974.

The main purpose of Dissanayake, et al's model building was to forecast the crash rates by each population subset at various time points within the study horizon. This simplified approach was justified against the models involving number of independent variables of different nature, by using such models to forecast more recent values in relation with safety performance. The forecasted values compared with the actual values have illustrated that most of the complex models were incapable of explaining the future situation. As such, the opinion of authors' is that simple models with year as the independent variable could be of advantage in forecasting the safety performance of the highway system for special population groups.

When considering the simplicity of the nature of Dissanayake, et al's models, models developed for the population subsets will give a good indication about the groups having critical safety problems. And also it will provide an opportunity of checking whether the same population subset will remain critical in the future too. This identification will assist the researchers in the highway safety area to address the safety problems of most critical special population subsets.

2.3 Delay

Pedestrian delay was the second evaluation parameter that was considered to justify the installation of pedestrian-overpasses through out this thesis. This parameter was interpreted in terms of pedestrian waiting time. A simulation model for pedestrian crossing was introduced in Kisisa, et al study in 1998 which enables the estimation of pedestrian delay. Kisisa, et al study briefly discussed the different pedestrian crossing options and analyzed the times with the help of a pedestrian crossing model.

A pedestrian crossing facility can be modeled as a queuing problem, with a minor flow intersecting a major flow. The insertion of a pedestrian refuge island change the model from crossing a single stream into crossing several sub-streams, sequentially. Treating the pedestrian flow as minor stream that crosses a major stream consisting of motor vehicles, it was possible to estimate the average pedestrian delay with the Troutbeck model developed in 1986. This derives the equations for pedestrian delay when there were two vehicle streams in opposite directions, each having the so-called Cowan's (dichotomized headway) distribution.

Based on Troutbeck model in 1986, it was possible to estimate the average waiting times in different crossing configurations, as a function of vehicle volume, pedestrian speed, and crossing distance.

The model had the following form: -

$$W_p = \frac{e^{\lambda(T-\Delta)}}{\alpha^*(q_1+q_2)} - T - \frac{1}{\lambda^*} + \left(\frac{\lambda^*\Delta^2+2\alpha^*\Delta-2\Delta+2\beta\Delta^2-(4/3)\,\lambda^*\Delta^3\beta}{2\lambda^*\Delta+2\alpha^*-2\beta\Delta^2\alpha^*} \right) \text{........2.3}$$

where;

W_p: Waiting time for pedestrian, Sec/ped.

$$\alpha^* = \frac{\alpha_1 q_1 (1-\Delta q_2) + \alpha_2 q_2 (1-\Delta q_1)}{q_1+q_2}$$

$$\beta = \frac{q_1 q_2}{(q_1+q_2)}$$

$$\lambda_1 = \frac{\alpha q_1}{1-\Delta q_1}$$

$$\lambda_2 = \frac{\alpha q_2}{1-\Delta q_2}$$

$$\lambda^* = \lambda_1+\lambda_2$$

Δ: Minimum headway, sec.

T: Crossing time for pedestrian (critical gap), sec.

q_i: Vehicular flow in direction *i* (1,2), veh/sec.

α_i: Proportion of free vehicles in direction *i.*

λi: Decay constant in direction *i.*

It was concluded that a pedestrian refuge island was a very effective (and low cost) option to allow pedestrians to cross large flows of vehicles without significant waiting times, where in the absence of such islands that would be very difficult and dangerous. The crossing model that was considered in Kisisa, et al study was adopted in this thesis.

Kisisa, et al study in 1998 was based on Cowan's headway distribution. This distribution assumed that there is a proportion of vehicles which are restrained to follow other vehicles at a minimum headway Δ and that the remaining vehicles (free vehicles) have headway's greater than Δ. In their study, Kisisa, et al proposed constant values of free vehicles. Different values of the proportion of free vehicles had a substantial effect on the values of pedestrian waiting time as was introduced in Sullivan & Troutbeck study in 1997.

Sullivan & Troutbeck study in 1997 considered the model for estimating the proportion of free vehicles, and details the investigation of the proportion of free vehicles as a function of the link geometry. It was necessary to define the effects of the link geometry before the effect of intersections on the headway distribution can be incorporated.

An exponential relationship has been examined in Sullivan & Troutbeck study and found to be well suited to the modeling of the proportion of free vehicles.

The exponential relationship was in the following form: -

$$\alpha = e^{-Aq} \text{..........} 2.4$$

where;

α: Proportion of free vehicles.

q: The flow rate, in vehicles per second.

A: Is a function of the lane width and has the range of 3.4-7.5.

Only one site dependent factor, that being lane width, which is easily measured, was needed to describe the parameter for the exponential model. In modeling the flow in each lane, the characteristics of the traffic flow were found to be dependent on the lane type being modeled. The curb lane sustained a higher proportion of tree vehicles than the median lane for similar flow rates. This finding was significant in the analysis of priority intersections. The difference was attributed to driver behavior and was related to the expected ease of overtaking. Using these results, the proportion of free vehicles was described as a function of the lane type, lane width and the vehicle flow rate through the use of exponential relationships.

The pedestrian waiting time model was presented in equation 2.3. Before the adoption of this model, its development and assumptions were investigated. These assumptions were introduced in Troutbeck study in 1986.

The average time a driver has to wait before he or she can cross two major streams has been a major performance indicator for unsignalized intersections. The equations presented in Troutbeck study gave an estimate of this average delay as a function of the following parameters. The average delay to isolated minor stream vehicles, the degree of saturation of the minor stream (minor stream entry flow/maximum entry flow) and a form factor (which quantifies the effect of queuing in the minor stream). It was assumed that drivers were consistent and homogenous and that headways in each major stream were independent of other headways in the same stream and in the other stream.

The discussion in Troutbeck study indicated that the degree of bunching (proportion of free vehicles) in the major stream had a major effect of average delay.

Pedestrian waiting times was considered as one of the criterion for the development of pedestrian-overpass guidelines. Similar concept was adopted in King's study in 1977; however, the concept was applied for the signal warrants.

The concept of better service manifests itself by reducing the average or maximum delay, a reduction in the probability of stops or a reduction in accident potential. King study was concerned with using pedestrian delay as the boundary criterion in traffic signal warrants.

In King's study, tolerable pedestrian delay was the prime criterion on which the proposed warrant was based, and such delay was essentially independent of the crosswalk location. It was recognized that at an intersection a pedestrian must contend not only with cross traffic but also with turning vehicles. Those vehicles turning from the cross streets will be few in number; however, since these intersections required a signal, they would have failed to satisfy the warrants for vehicle volume.

The numerical warrants for both mid-block and intersection locations were presented. Before signals were installed, these warrants should be met or exceeded for four hours on an average weekday. Alternatively, the warrant could be met or exceeded for ten hours on any weekend if at least three hours were on the day with lighter volumes. These periods were selected to correspond to those used for other warrants developed and reflected the typical peaking characteristics of urban traffic.

Although the application of King study and this thesis was different, the final out put of these studies reflected a similar pattern.

2.4 Social cost

Based on benefit-cost ratio analysis, pedestrian accidents and pedestrian delay were interpreted in terms of monetary value. This was accomplished by determining the cost of accidents and the value of pedestrian's time.

The elements included in the values of these parameters and the methodology followed to estimate these values were discussed thoroughly in a paper prepared by Murphy & Deucchi in 1998.

Not surprisingly, there is a little agreement about how to estimate the social cost or why, with the result that estimates and interpretations can diverge tremendously. In this situation, policymakers and others who wished to apply estimates of the social cost of motor vehicle use might find it useful to have most of the major estimates summarized and evaluated in one place.

This was the purpose of Murphy & Deucchi study to review much of the present literature on the social cost of motor vehicle use in the United States as an aid to those who wish to use the estimates. The studies reviewed were presented in chronological order. The target was to review the purpose, scope, and conclusions, and to summarize the cost estimates by individual category. In addition, the level of detail for each major cost estimate in the studies was assessed.

California Energy Commission (CEC) developed one of the studies that were reviewed in Murphy & Deucchi study. CEC quantified several kinds of social costs: travel time, accidents, infrastructure maintenance and repair, air pollution, etc.

Travel time: CEC used the "Personal Vehicle Model," a demand forecasting model that projects vehicle stock, vehicle mile travel "VMT", and fuel consumption for personal cars and trucks, to estimate that congestion costs, including the disutility of aggravation, were $10.60 per hour (1992$). CEC also estimated the actual net change in travel time in Los Angeles under the various policy scenarios.

Accidents: The cost of accidents was estimated by multiplying the cost per injury or death by the number of injuries or deaths, for several kinds of injuries.

2.5 Warrants

Studies on the development of warrants for pedestrian-overpasses have been limited. One of these studies was prepared by the New Jersey Department of Transportation in 1975 *(Powers et al, 1975)*. Powers et al study described the development of a priority ranking system for locations where pedestrian-overpass was proposed.

Powers et al study proposed an approach which rated alternate sites and listed them in a priority order. This priority ranking system required a minimum number of measurements and gave a uniform system for comparison of sites. Recommended locations were divided into two categories; one where pedestrian activity exists (e.g., where pedestrians are observed crossing at-grade on the roadway), and the other where pedestrian activity is not possible (e.g., controlled access roadway).

The parameters used to warrant the need for a pedestrian grade separation at a site where pedestrian activity exists were *(Powers et al, 1975)*: -

1. The relationship between vehicular and pedestrian volumes with a peak hour average delay factor applied.
2. The amount of pedestrian crossing time needed compared to the maximum green and yellow time available to pedestrians for a signalized site or the actual sight distance compared to the desirable sight distance for a non-signalized site.
3. The number of school children.
4. The distance to the nearest alternate crossing considering the type of protection at the alternate crossing.
5. A judgement value.

The parameters used to warrant the need for a pedestrian grade separation at a site where pedestrian activity is not possible were *(Powers et al, 1975)*: -

1. Pedestrian trip generation;
2. Distance to nearest alternate crossing considering the type of protection at the alternate crossing.
3. A judgement value.

Powers et al had developed three computer programs. The first program computed peak hour pedestrian delay at signalized intersections from field data. The second program computed the priority ranking score for each site from the field and delay data, while the last program formatted and outputted the scores in their priority ranking.

Institute of Transportation Engineers *(ITE, 1998)* prepared another report in 1998. ITE report summarized two sets of warrants that were developed in 1984 and 1988.

According to a 1988 synthesis study by Zegeer and Zegeer *(ITE, 1998)*, state and local government agencies considered grade-separated crossings to be most beneficial under certain conditions. While these conditions were somewhat general, they did provide important factors for designers, planners, and developers to consider in determining where pedestrian facilities should be constructed. More specific warrants were developed by Axler in 1984 *(ITE, 1998)* for grade-separated pedestrian crossing.

Note that these criteria provided specific volumes of pedestrians and motor vehicles and vehicle speeds for which a pedestrian-overpass or underpass was justified. However, while these specific values may be considered appropriate in certain nstances, many economic and other factors also should be considered before making a final decision about installing high-cost grade-separated facilities for pedestrians.

2.6 Economic analysis

While some attempts at using economic analysis to justify the construction of pedestrian facilities were tried, a systematic approach has generally been lacking *(Powers, et al, 1975)*.

Benefit-cost ratio analysis was utilized in this thesis to measure the effectiveness of pedestrian overpasses, in reducing the number of accidents and pedestrian delay. A similar concept was adopted in Bhesania study which was prepared in 1991. However, the concept was applied for the installation of mast-mounted signals and it considered only the reduction of accidents. Bhesania study provided the thesis with an adequate way of the economic analysis and implied the elements that have to be involved in the estimation of annual cost of accident and annual project cost.

Bhesania article described the impact of mast-mounted signal heads and all-red intervals on safety, and examined the cost-effectiveness of such improvement. The benefit-cost ratio was used to conduct an economic analysis of the project. The benefit-cost ratio expressed the comparative worth of project by; the ratio of the annual benefits to the annual costs. A project was considered to be economically viable if a benefit-cost ratio of one or greater was realized. The annual road user benefit was the reduction in number of accidents that resulted from the replacement of signal heads on mast arms. These benefits or savings in accident costs would have to be compared with the project costs to determine the benefit-cost ratio.

1. Accident cost

In highway economy studies, accident cost is an important factor and is included as one of the elements of the highways travelling cost. The overall cost of accidents involves such factors as wage loss, medical expense, insurance administration, motor vehicle property damage, and indirect work loss. In 1988, the National Safety Council reported an average accident cost of U.S. Dollar 3,400.0. This conservative value was used during Bhesania study. This value did not include non-priceable human elements, such as pain, anguish, suffering, and sentimentalities.

Before and after studies were conducted for one year. It was found that the installation of the proposed signals was able to reduce accidents up to 25 percent. The annual benefits from savings in accident costs were then estimated.

2. Project cost

The total bid price of the project was estimated. To determine the annual cost of the project, an 8 percent interest rate and a 30-year useful life of the project was assumed. Then the capital recovery factor was estimated. The annual cost of the project was determined by multiplying total bid price by capital recovery factor.

3. Benefit-cost ratio (B/C)

The benefit-cost ratio expresses the comparative worth of project by the ratio of the annual benefits to the annual costs.

Thus,

$$B/C = \frac{\text{Annual benefits from improvements}}{\text{Annual costs of improvements}} \quad \ldots\ldots\ldots\ldots 2.5$$

The previous formula was applied to the considered case, a value of 10.46 was obtained.

When considering the increasing cost of accidents in the future, the benefit-cost ratio would be greater if the traffic volumes remain fairly constant and similar reductions in accidents continue to occur over a period of time.

It was found in Bhesania's study that using the mast-mounted signals was a cost-effective improvement that successfully reduced the number of accidents at intersections. This measure resulted in large safety benefits when it was implemented at signalized locations with post-mounted signal heads. These intersections had experienced a large number of right-angle collisions prior to the installation of mast-mounted signals.

Chapter Three

Traffic Data Parameters

3.1 Introduction

In order for accident data to be meaningful, they must be compared and linked with the experience of exposure data, such as traffic volume and length of the road. This data does not only clarify the relationship, but can even alter what accident data signify *(FHWA, 1980)*.

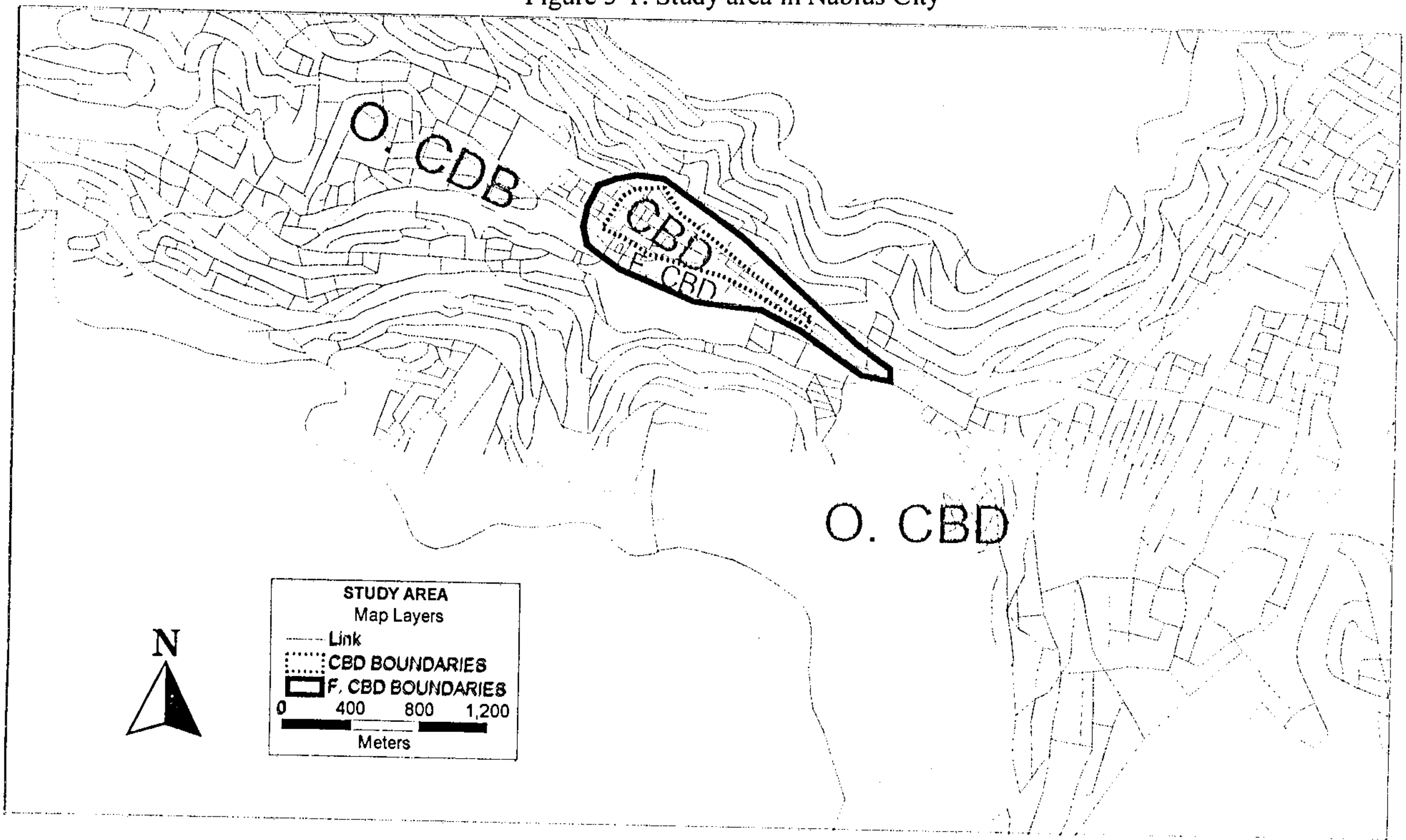
This statement was also applied for relating the delay with a measurable parameter in order to make the use of the resulted guidelines developed in this study easier.

As this thesis is concerned with the pedestrian-overpasses that have a major effect on the vehicles and pedestrians, vehicular and pedestrian flow were used as exposure parameters. The study area, the analysis, and estimation of the traffic parameters were described in following sections.

3.2 Study area

The study area in Nablus City was divided into three major blocks, the Central Business District (CBD), fringes of CBD area, and out of CBD area. Figure 3-1 illustrates these blocks.

Figure 3-1: Study area in Nablus City



The locations within the study area were chosen according to certain criteria which were presented in Chapter Four. These locations are the following: -

1. CBD area which consists of:-
   - Faisle Street in front of Police Station (C-1), and in front of Al-Watani Hospital (C-2).
   - Al-Ghazali Street on the opposite side of Al-Watani Hospital (C-3), in front of Nablus Municipality (C-4), and Al-Hadadeen Street (C-5).
   - Hitten intersection (C-6).
   - Al-Husien Roundabout in front of Al-Sied Exchanger (C-7).
   - Al-A'del-Hamdi Kan'an intersection (C-8).
   - Sufian-Hamdi Kan'an intersection (C-9).

2. Fringes of CBD which consists of:-
   - Faisle Street in front of Directorate of Education (F-1), and in front of Vocational Training Center (F-2).
   - ANZ Grindlays Bank intersection (F-3).

3. Major arterials out of CBD which consists of:-
   - Amman Street in front of Yousef Tomb (O-1).

- Al-Quds Street in front of Al'nwar Hall (O-2), and in front of the secondary intersection to Balata Refugee Camp (O-3).
- Rafedia Street in front of Al-Rawda Mosque and Ashoor Sweets (O-4).
- Haifa Street in front of Ein Refugee Camp (O-5).

These locations were illustrated in Figure 3-2.

3.3 Analysis of the traffic data used in this study

The database used in this study covers the traffic data for the years 1996, 1997, and 1998 for the selected locations in Nablus City.

The traffic data consists of: -

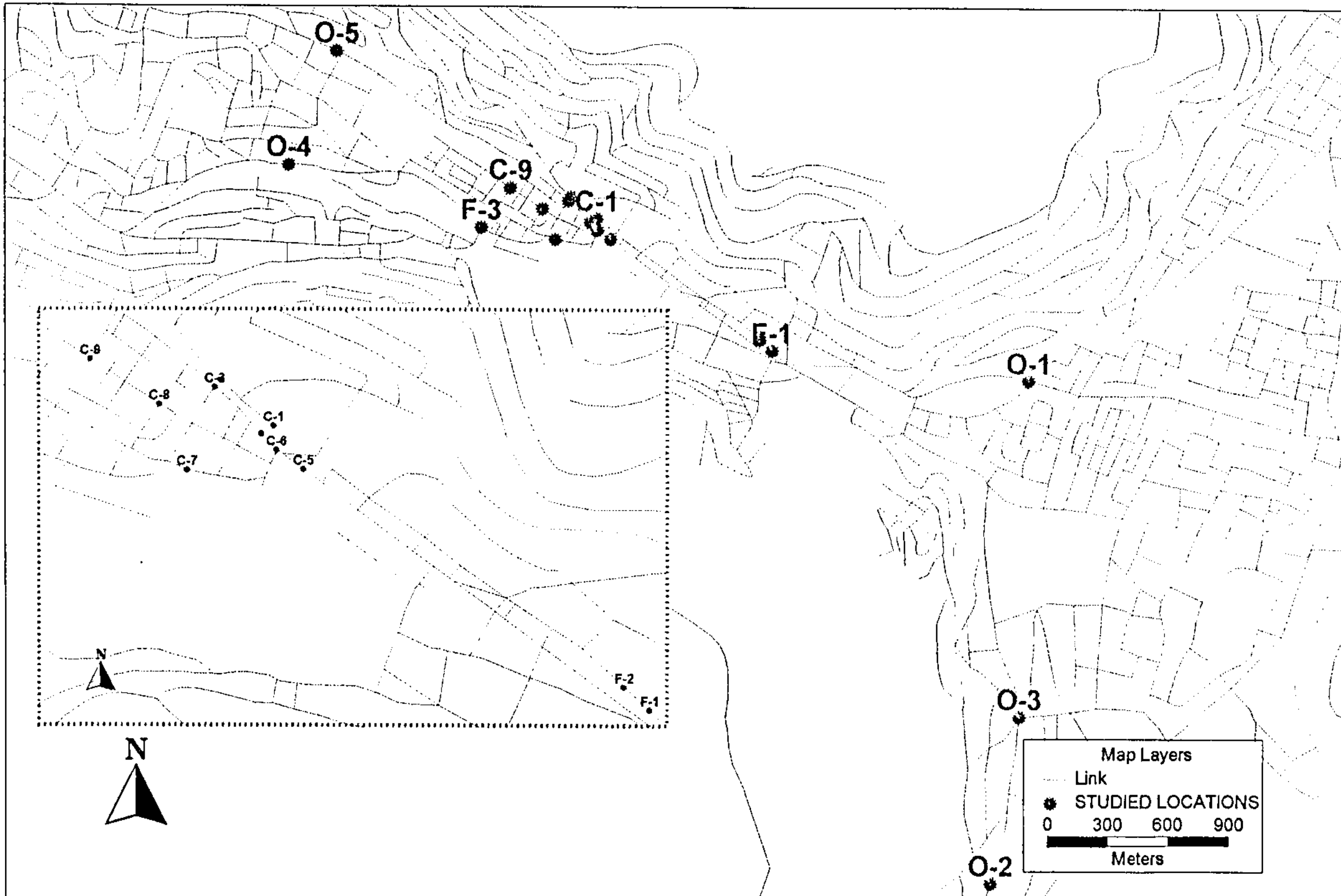
1- Previous data of vehicular and pedestrian counts for certain locations.

2- Limited pedestrian counts for other locations.

Therefore, in order to establish a reliable database, the following needs should be considered: -

1. Analyze the available data to make use of it as much as possible.
2. Conduct a traffic survey for a comprehensive database suitable for the needs of this research.

Figure 3-2: Considered locations within the study area



3.3.1 Analyze the available data

3.3.1.1 Vehicular volume

The data was utilized from An-Najah National University graduation's projects or traffic laboratory reports for the years 1995-1998 for different locations in Nablus City.

Counts were available for different counting periods, depending on the project reviewed. For example, 1995 data was extracted from a project titled Traffic System Management for Nablus CBD area *(Touqan, et al, 1996)*. The data was available for 15-minute, one-hour count in most locations, and for 6-hour counts for only two locations. Both of these locations were considered as control stations. Based on these stations the expansion factors were estimated to extend the counts for other locations.

The vehicular counts data was reviewed and the following restraints were noticed: -

- All the locations considered had a very limited counting duration. Some of them had only one count in the year 1998, and others may had two or three counts in different years.

- All counting durations were less than twenty-four hours and covered limited days of the week and for limited periods of the year.
- Some of these locations cover counts during peak and off-peak hours.
- Only two locations in Nablus City had vehicular counts for 24 hours, one was at Haifa Street in 1996, the other at Jamal Abed Alnaser Street in 1998.

Based of the above-mentioned restraints which reflect the lack of reliable data, the following were concluded: -

1. Estimation of the Average Daily Traffic (ADT) from the data available was some how difficult for the selected locations, while estimation of the Average Annual Daily Traffic (AADT) was impossible.
2. In order to predict the ADT for all the selected locations, the percentage of peak hour relative to ADT was used.
3. Expansion factors were estimated in order to expand the available traffic volume data to 12-hour volumes.
4. The percentage of 12-hour traffic volume relative to ADT was also estimated.

Based on the calculations performed on the traffic data, the following were found: -

1. Peak hour volume (P.H.V) forms 10 percent of the 12-hour volume.
2. Based on the count conducted at the intersections in the area of Nablus Governorate *(Doluieh & Shaheen, 1998)* it was estimated that 12-hour vehicular volume forms about 80 percent of ADT.

Therefore, from the statistics mentioned above, it was concluded that the P.H.V is equivalent to 8 percent of ADT.

Table 3-1 represents a sample data analysis for Faisle Street. For more details of vehicular volumes, please refer to Appendix (B).

Table 3-1: Analysis of vehicular volume for Faisle Street

Time	**East-West**	**West-East**	**Total**
2-3pm	1190	1448	2638
6hr.vol	7788	9476	17264
12hr.volume	**14977**	**18224**	**33201**
ADT96	**18721**	**22780**	**41501**

Source: Touqan, Douleh, & Ismaeil, 1996.

P.H.V	**East-West**	**West-East**	**Total**
Time			
7:45-8:45 a.m	1455	1312	2767
2:00-3:00 p.m	1238	1406	2644
12hr.volume	**14550**	**13120**	**27670**
ADT98	**18188**	**16400**	**34588**

Source: Dornier & Universal Group, 1998.

For the cases where the data was available for more than one year, the average of two or more counts was estimated and used. Grindlays Bank intersection in Appendix (B) was an example of such case.

For Haifa Street in front of Ein Refugee Camp, counts from Al-Salaam Mosque intersection and Haifa Street-Yafa Street intersection were considered since Haifa Street forms a link between these two intersections. The average of both volumes was considered as traffic volume count for this link.

In certain locations such as the link in front of Nablus Municipality the 12-hour volume was estimated in two ways; first, expansion of 1-hour volume to 6-hour volume then to 12-hour volume, second, expansion of P.H.V to 12-hour volume. The traffic volume considered was the average of the two volumes.

In order to estimate ADT for each year during the study period, traffic growth rate was estimated for each location. This issue was accomplished depending on the different counts available for each location per year. For locations that had only one count during the study period a 5 percent growth rate was used for the period between 1996-1998 *(PCBS, 1998)*.

Figure 3-3 illustrated the average vehicular growth rates and Table 3-2 summarized the calculated 12-hour volume and ADT for each of the considered locations in Nablus City.

It was noticed that vehicular volume in certain locations decreased from 1996 to 1998. This could be justified that these locations were influenced by some regulations, which forced some of the users to change their routes.

Figure 3-3: Annual vehicular growth rate for each of the considered location

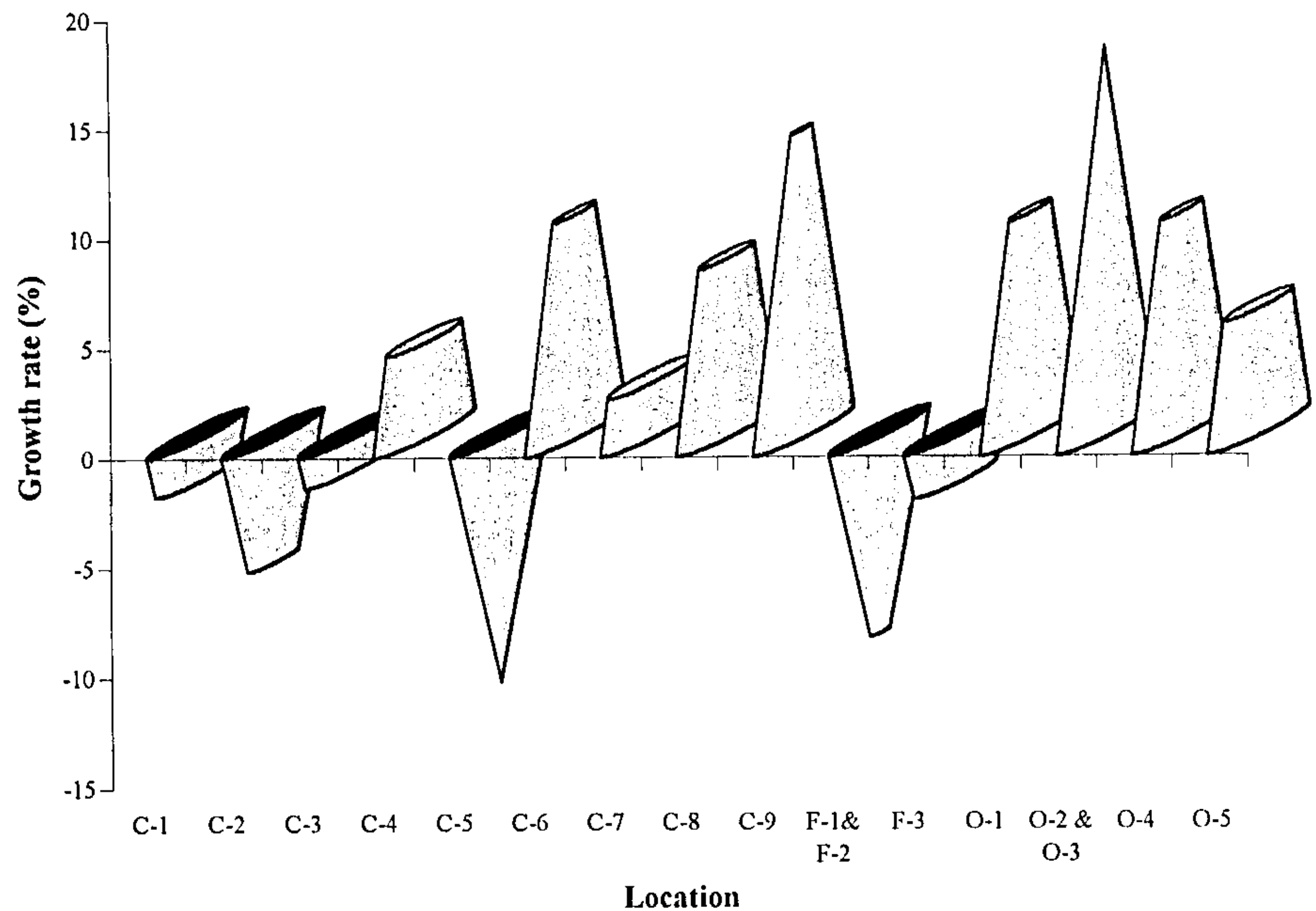


Table 3-2: Estimated 12-hour volume and ADT for each location per year

Location	1996		1997		1998	
	12-hr. vol.	24-hr. vol.	12-hr. vol.	24-hr. vol.	12-hr. vol.	24-hr. vol.
C-1	17050	21315	16700	20875	16370	20460
C-2	19520	24400	18400	23000	17340	21675
C-3	17665	22080	17280	21600	17010	21265
C-4	19520	24400	20400	25500	21270	26590
C-5	19195	24000	18280	22850	16050	18825
C-6 North	1390	1735	1460	1820	1530	1910
C-6 South	600	745	630	780	655	815
C-6 West	1240	1550	1300	1625	1365	1705
C-7	9490	11860	9725	12155	9965	12460
C-8 North	5790	7240	5660	7070	5530	6910
C-8 South	4465	5580	4765	5955	5085	6355
C-8 East	3810	4755	4375	5470	5055	6315
C-8 West	5010	6255	5345	6680	5715	7145
C-9 North	5375	6720	5850	7310	6365	7955
C-9 South	5320	6650	5505	6880	5695	7120
C-9 East	4720	5895	5450	6810	6305	7880
C-9 West	4125	5155	5170	6465	6490	8110
F-1	33205	41505	30480	38100	27670	34590
F-2	33205	41505	30480	38100	27670	34590
F-3 North	6310	7885	6665	8330	7045	8805
F-3 South	13040	16300	12820	16025	12605	15755
F-3 East	12300	15370	11485	14355	10725	13405
F-3 West	4305	5385	4995	6240	4700	5875
O-1	10855	13565	11395	14240	11960	14950
O-2	9085	11355	10210	12760	11470	14338
O-3	9085	11355	10210	12760	11470	14338
O-4	14832	18540	15575	19465	16350	20438
O-5	9130	11410	9645	12055	10190	12740

Refer to Figure 3-2 for key abbreviations.

3.3.1.2 Pedestrian volume

The data collected in the years 1995, 1997-1998 for pedestrian volume counts for different locations in Nablus City was considered.

Counts were available for different counting periods in the different sources. For example, 1995 data was obtained from a project titled Traffic System Management for Nablus CBD area *(Touqan, et al, 1996)*. The data was available for 15-minute counts for different counting periods and specific locations.

The pedestrian counts from these projects were for total pedestrian flow crossing the road on a crosswalk and/or away from crosswalk, in addition to the pedestrians walking near sidewalk.

The review of all studied data resulted in the following restraints: -

- The counts were available only for few locations which were limited in comparison to the vehicular counting locations.
- The counting periods were also limited. Which made the counting periods for most locations incompatible with those for vehicular counts.
- For all these locations the counts were available for less than 12 hours except for two locations, Faisle Street in front of Al-Watani Hospital and Al-Ghazali Street in front of Nablus Municipality.

From the above-mentioned restraints, different issues were concluded as those mentioned previously for vehicular volume.

It was found that pedestrian P.H.V formed 15 percent of 12-hour volume in the CBD area and 24 percent for the other studied locations.

Since, none of the locations considered had pedestrian counts for 24 hours, there was a need to project the percentage of 12-hour volume relative to 24-hour pedestrian volume. Since the 12-hour vehicular volume formed 80 percent of ADT and due to the fact that pedestrian activities are reduced during nighttime in most locations, a percentage of 90 percent was considered.

Table 3-3 represents a sample data analysis for Al-Hadadeen Street. For more details of pedestrian volumes, please refer to Appendix (B).

Table 3-3: Analysis of pedestrian volume for Al-Hadadeen Street

Time	**Pedestrian counts**
9:00-10:00am	222
12hr. volume	**1480**
24hr. volume 97	**1644**

Source: Shaar & Al-Kilani, 1997.

In most locations the 12-hour volume was estimated in two ways; expansion of the available pedestrian volume to 12-hour volume, and expansion of P.H.V to 12-hour volume. The average of two pedestrian volumes was considered.

In order to estimate average pedestrian volume for each year during the study period, pedestrian growth rate was estimated for each location. This issue was accomplished depending on the different counts available for the location per year. Annual pedestrian growth rates are presented in Figure 3-4.

For locations that had only one count during the study period, 6 percent growth rate was considered. This rate was estimated as an average value of the locations that had different previous counts (i.e., C-1, C-2, C-3, & C-4). Since the pedestrian activities for the locations in the fringes of CBD area are relatively fewer than those for CBD, a growth rate of the value of 3.0 percent was considered for those locations.

3.3.2 Traffic survey

For locations out side CBD, pedestrian volume survey was conducted for the purpose of this study, at the following locations: -

- Amman Street in front of Yousef Tomb.
- Al-Quds Street in front of Al'nwar Hall, and in front of the secondary intersection to Balata Refugee Camp.
- Haifa Street in front of Ein Refugee Camp.
- Rafedia Street in front of Al-Rawda Mosque.
- Faisle Street in front of Vocational Training Center, and in front of Directorate of Education.

These locations are illustrated in Figure 3-5.

Figure 3-4: Annual pedestrian growth rate for each of the considered location

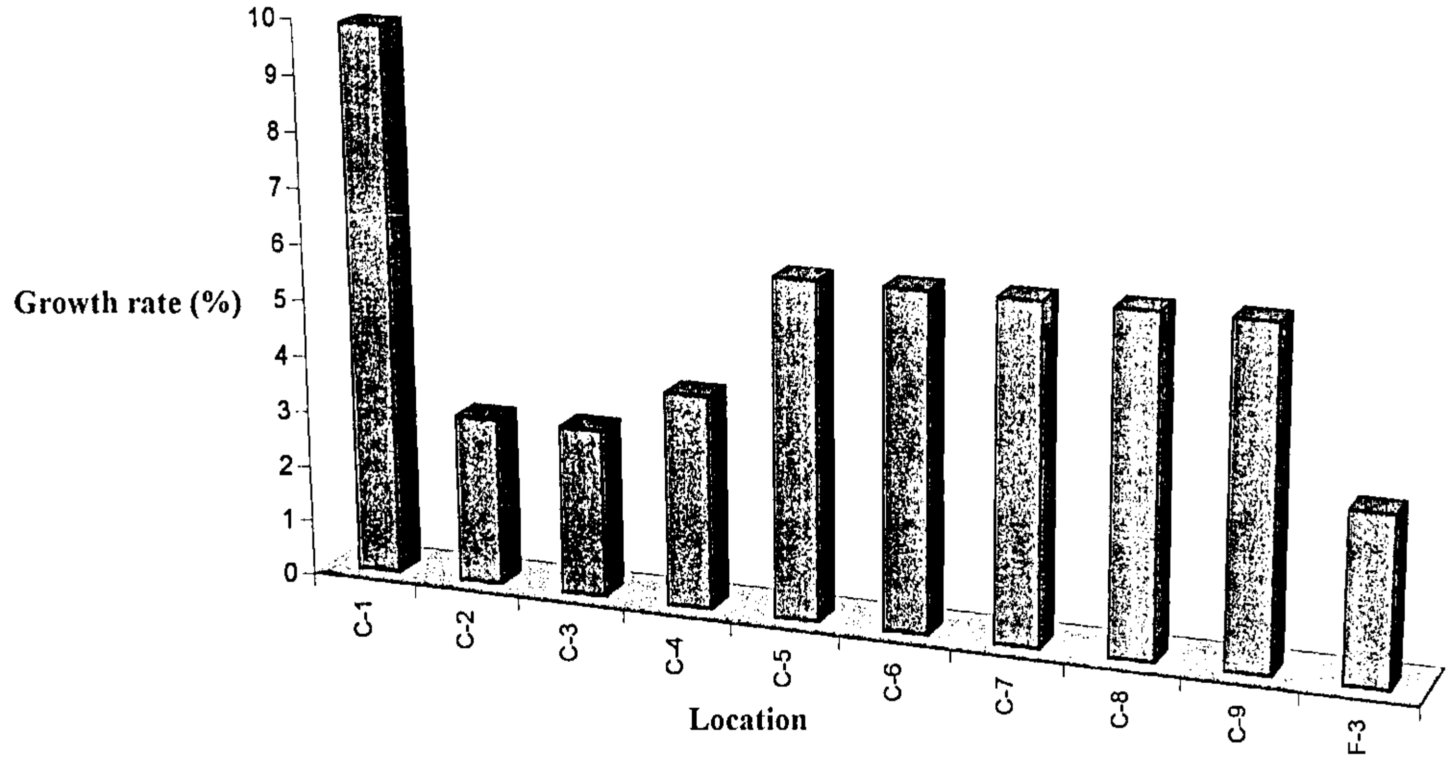
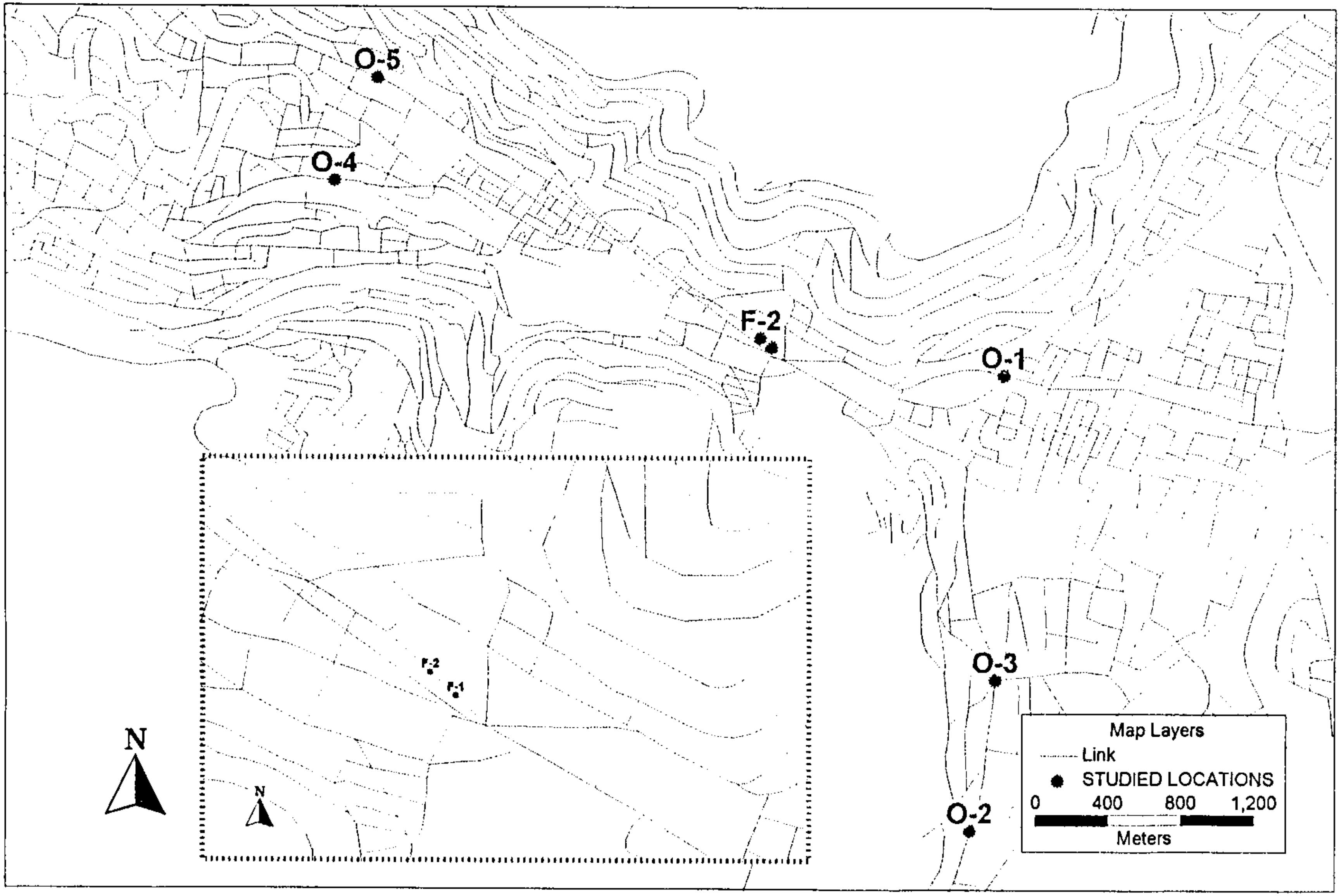


Figure 3-5: Pedestrian counting locations



It should be mentioned that the pedestrian volume count consisted of total number of pedestrians that were crossing the road in both directions on the crosswalk. In addition, the pedestrians crossing away of cross walk were counted up to a 100.0m distance in both sides of the crosswalk. This distance covers the location of accidents occurred during the study period.

Counting periods were chosen to cover the peak periods of the day. From the analysis of previous data it was found that most of pedestrian peak hours occurred during 8:00-10:00am and 12:00-2:00pm. For Rafedia Street, additional counting period was chosen to capture the evening activities.

Two control stations were chosen, one at Al-Quds Street in front of Al'nwar Hall and the other at Faisle Street in front of Vocational Training Center.

To determine the pedestrian volume for each year, annual growth rate for each location was determined. For Faisle Street that is at the fringes of CBD, 3.0 percent growth rate was used for the same reasoning mentioned previously for Grindlays intersection.

For all locations out of CBD, a 1.5 percent growth rate was considered. This is because these locations had few activities which made the pedestrian growth small and related mostly to population growth rate *(Dornier & Universal Group, 1998)*.

To determine the 12-hour and 24-hour pedestrian volume for each location, the data was analyzed and presented in Table 3-4.

Table 3-4: Estimated 12-hour and 24-hour pedestrian volume per year

Location	**1996**		**1997**		**1998**	
	12-hr. vol.	24-hr. vol.	12-hr. vol.	24-hr. vol.	12-hr. vol.	24-hr. vol.
C-1	4180	4645	4590	5100	5045	5605
C-2	6450	7165	6645	7380	6845	7605
C-3	6450	7170	6645	7380	6845	7605
C-4	3295	3660	3420	3800	3550	3945
C-5	1520	1690	1610	1790	1710	1900
C-6 North	1110	1235	1180	1310	1250	1390
C-6 South	2840	3155	3010	3345	3190	3545
C-6 West	1145	1270	1210	1345	1285	1425
C-7	5880	6535	6235	6925	6610	7340
C-8 North	2020	2245	2140	2380	2270	2520
C-8 South	4980	5535	5280	5865	5595	6220
C-8 East	1755	1950	1860	2070	1975	2190
C-8 West	1515	1685	1605	1785	1700	1890
C-9 North	1125	1250	1190	1325	1265	1405
C-9 South	1340	1490	1420	1580	1505	1675
C-9 East	1065	1185	1130	1255	1200	1330
C-9 West	280	310	300	330	315	350
F-1	970	1080	1000	1110	1030	1145
F-2	385	425	395	440	405	450
F-3 North	995	1105	1025	1140	1055	1175
F-3 South	2000	2220	2060	2290	2120	2360
F-3 East	530	590	545	610	565	625
F-3 West	470	525	485	540	500	555
O-1	1015	1125	1030	1145	1045	1160
O-2	680	755	690	765	700	780
O-3	340	380	345	385	350	390
O-4	535	595	545	605	555	615
O-5	2190	2430	2220	2465	2255	2505

Refer to Figure 3-2 for key abbreviations.

The purpose of this thesis was to develop guidelines for pedestrian-overpasses. To accomplish this purpose, different models were developed, presented, and analyzed. One of these model parameters was the traffic parameter. Thus the contribution of this chapter was during the developing of models and while applying these models. In this chapter, the vehicular volume and pedestrian volumes were analyzed and presented.

Chapter Four

Pedestrian Accidents Analysis and Cost Estimate

4.1 Introduction

Pedestrian grade separations are means of reducing conflicts between vehicular and pedestrian traffic, thus increasing the efficiency and safety of the transportation system *(Powers, et al, 1975).* One of the factors usually considered to justify a transportation project is the improvement in traffic safety *(Garber & Hoel, 1988).*

The primary need for pedestrian control is to reduce the number and severity of traffic accidents involving pedestrians. Pedestrians are slow and fragile as compared to motor vehicles; a collision between a vehicle and a pedestrian almost inevitable results in at least an injury, often a fatality *(Homburger & Kell, 1996)*.

Collisions between pedestrians and motor vehicles continue to be serious safety problem in different countries all over the world. For example, during 1989 in U.S.A 6,552 pedestrians were killed, which represented 14.4 percent of the nation's motor vehicle fatalities. An estimated 119,000 pedestrians were injured during that same year *(Federal Highway Administration "FHWA", 1992).*

It was estimated that the social costs of accidents were between U.S$ 33.0 and U.S.$37 billion *(Murphy & Delucchi, 1998)*. Herein, about 137 million New Israeli Sheqel were paid for personal injuries during 1996-1999 in Nablus Governorate as indicated by local insurance companies. These statistics reflect the amount of economic loss due to accidents.

Since pedestrian overpasses are mainly constructed to eliminate the interaction between pedestrian and vehicles, it is expected that pedestrian related accidents would be eliminated. ITE 5A-5 in 1998, suggested several benefits and costs associated with installing pedestrian overpasses. One of these benefits that belong to the safety is the social cost of accidents.

Since pedestrian accidents are expected to be eliminated after the installation of overpasses, the core of this chapter was to discuss and analyze these accidents, and their associated costs.

4.2 Accident data collection

In order to study the safety of the highway system, traffic engineers must have information and data on the location, frequency, severity, and types of accidents that are occurring *(McShane & Roess, 1990)*.

In the next sections these issues are discussed.

4.2.1 Accident data source and contents

Accident data was extracted from a graduation thesis conducted at An-Najah National University *(Kobari, 2000)*. The data was collected from Nablus Court and Police Station.

The mentioned graduate thesis covered all types of accidents. For the purpose of guideline development, the pedestrian accidents were elicited from the previous database. In addition, the cleaning and organization of the pedestrian accident data were also accomplished during the study of guideline development.

Pedestrian accident data used in this study were for the mid-blocks and in the vicinity of the intersections for the years 1996 to 1998. The database contained details about accidents such as cause, type, location, time and date of occurrence, number of injuries or fatalities, driver information, vehicle information, etc.

Table 4-1 presents a sample data of pedestrian accidents for different locations in Nablus City.

Table 4-1: Sample data of pedestrian accidents in Nablus City

Location	Date	No. of accidents	No. of injuries	S-1[1]	S-2[1]	S-3[1]	S-4[1]	S-5[1]
C-1	03/05/97	1	3	1[2]	2	1		
C-1	28/11/98	1	3	1	1	1		
C-7	27/12/97	1	1	2				
C-7	14/09/97	1	1	1				
C-7	12/04/97	1	4	1	1	1	1	
F-1	09/09/96	1	1	1				
O-1	16/08/97	1	1	2				
O-5	15/09/98	1	1	1				
O-5	23/06/97	1	5	1	1	2	2	1

Refer to Figure 3-2 for key abbreviations.
1: S-1: Severity of injury no. 1, S-2: Severity of injury no. 2, S-3: Severity of injury no. 3, S-4: Severity of injury no. 4, and S-5: Severity of injury no. 5.
2: S-1, 2, 3, 4, 5 =1 slight injury, S-1, 2, 3, 4, 5 = 2 sever injury.
Source: Kobari, 2000.

Insurance companies were another source of accident data. The primary objective of the data collected from these companies was to estimate cost of accidents, as will be presented in the next sections. However, this data contained very useful information about the number of each type of casualty.

4.2.2 Study area

In order for accident data to be meaningful, they must be compared and linked with the experience of exposure data. Exposure data are important because they are crucial to calculating the actual likelihood of an accident.

Therefore, the coordination between accident locations and their corresponding traffic flow data was necessary. The lack of traffic flow data prevented the use of all pedestrian accidents occurred within the boundaries of Nablus City. The problem of limited traffic data parameters was discussed thoroughly in Chapter Three.

Thus, the studied locations which were presented in Chapter Three were chosen according to the following criteria:

1. Availability of traffic data.
2. Prone-pedestrian accident location.
3. Variety of location's characteristics, hence, the considered locations were distributed in different districts in Nablus City.

The studied locations were chosen at mid-blocks and intersections. In the case of intersections, the pedestrian accidents were occurred in the approach leading to the intersection and not within the area of the intersection.

4.3 Data analysis

Since the core of this study was to develop guidelines, and not oriented as a database for pedestrian accidents, detailed analysis for such type of accidents is out of the scope of this study. However, a general analysis was made to give an indication of the pattern of this type of accidents.

Overall, in the period 1997-1998, 815 accidents were recorded at all locations in Nablus City. Of these, three hundred and ninety involved pedestrian. The percentage of pedestrian accidents was found to be about 47.7 percent in the urban area of Nablus City.

The total number of pedestrian casualties during 1997-1998 was four hundred and thirty two casualties. Based on the information collected from Nablus Court and Police Station, the percentage of each type of severity was estimated and presented in Table 4-2, while Table 4-3 summarized the severity index (*SI*) for each type of severity. Severity index is defined as the number of fatality or slight injury, etc. per accident.

Table 4-2: Percentage of each type of severity during 1997-1998

Severity	No.	Percentage
Slight	297	70%
Medium	9	2%
Sever	115	27%
Fatality	6	1%
Total	**427**	**100%**

It should be mentioned that the marginal difference between the total number of injuries mentioned in the above statement (432 casualties), and the total of 427 casualties which is available at end of the table, is due to fact that few of the injuries were not clearly classified.

Table 4-3: Severity index (*SI*) for each type of severity during 1997-1998

Severity	***SI***
Slight	0.7620
Medium	0.0231
Sever	0.2950
Fatality	0.0154

Based on the results of Table 4-2 and Table 4-3, the most frequent severity was the slight severity, while fatalities formed the lowest percentage of severity types.

It was found that about 83.3 percent of the fatalities occurred at major arterials in Nablus City, the rest occurred at local streets. Therefore, the severity of injuries increased at major arterials, since they had relatively high speed.

Based on the information obtained from the local insurance companies during the study period, the severity index was estimated again, and listed in Table 4-4.

Table 4-4: Severity index (*SI*) for each type of severity (insurance companies)

Severity	*SI*
Slight	1.10
Medium	0.22
Sever	0.06
Fatality	0.013

The results presented in this table differ from those in Table 4-3. Insurance companies recorded higher slight severity index and lower fatality severity index. The principal difference was for medium and sever injuries. The severity index for medium injury in Table 4-3 seems to be similar to that for sever injury in Table 4-4, and vice versa. This difference was due to the fact that police reports do not recognize the difference between medium and sever injuries and in most cases both types of injuries are classified as sever injuries. This caused high severity index for sever injuries in Table 4-3.

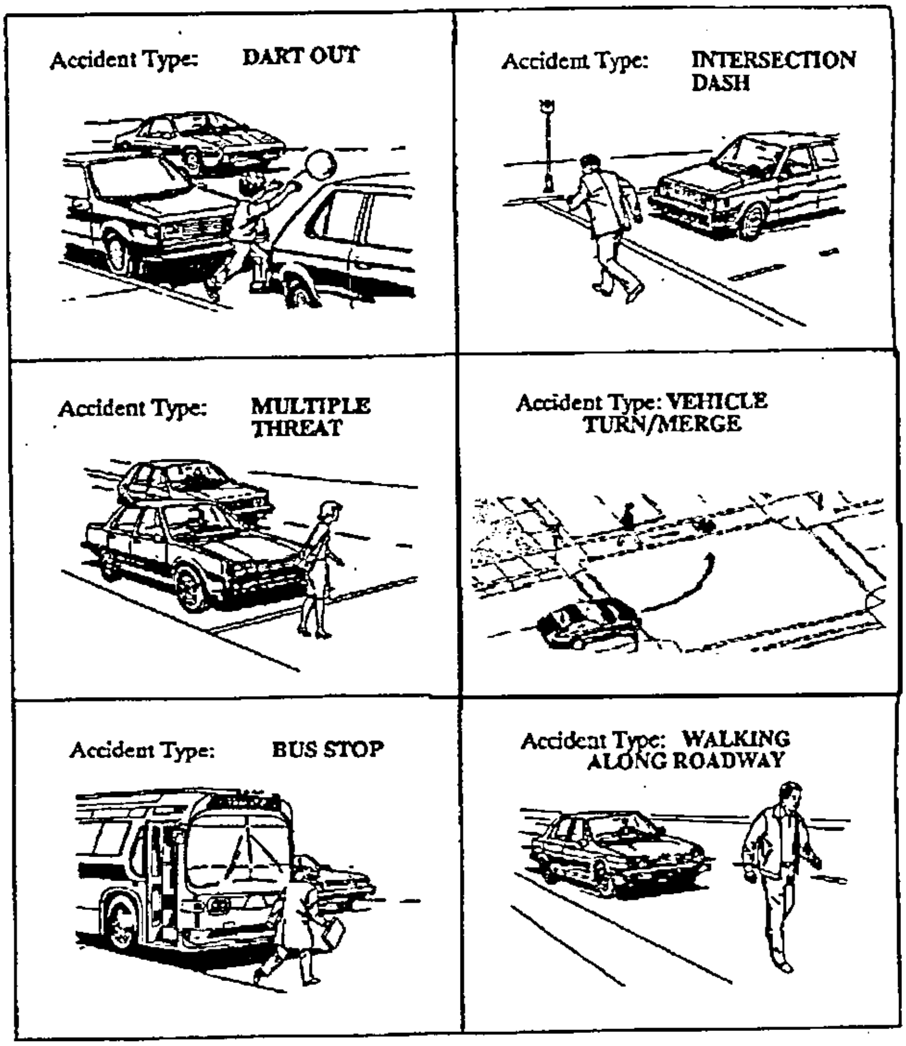
- **Pedestrian-motor vehicle crash types**

Based on studies conducted by FHWA, pedestrian crashes have been classified by specific types. Some of the most common crash types include the following:

1. Dart-out (first half): Pedestrian sudden appearance and short time exposure (driver does not have time to react). Pedestrian crossed less than halfway.
2. Mid-block dash: Pedestrian running but not sudden appearance or short time exposure.
3. Intersection dash: Same as dart-out, but for intersections.
4. Multiple threat: Pedestrian is hit as he steps into the next traffic lane by a vehicle moving in the same directions as vehicle(s) that stopped for the pedestrian. Collision vehicle driver's vision of pedestrian obstructed by the stopped vehicle.
5. Bus stop related: Pedestrian steps out from in front of a bus at a bus stop and is struck by vehicle moving in the same direction as the bus while passing the bus.
6. Result of vehicle-vehicle crash: Pedestrian hit by vehicle(s) as a result of a vehicle-vehicle collision.
7. Walking along the roadway: Pedestrian struck while walking along the edge of the highway or on the shoulder *(FHWA, 1992)*.
8. Turning vehicle: Vehicle making a turn at an intersection strikes a pedestrian.
9. Pedestrian struck by a backing vehicle *(FHWA, 1996)*.

In Figure 4-1 some common types of pedestrian accidents were illustrated.

Figure 4-1: Illustration of common types of pedestrian accidents



Source: FHWA, 1992, & FHWA, 1996.

From pedestrian accident data available for Nablus City, it was difficult to classify the pedestrian accidents according to the above-mentioned categories, since the police station reports do not include such details. Generally, the accidents can be categorized as presented in Table 4-5. The results in this table indicated that the highest percentage of crash types (about 54.1 percent) occurred while pedestrian crossing the mid-block, while the lowest percentage (about 0.51 percent) occurred due to turning vehicle.

Table 4-5: Number and percentage of each pedestrian accident type for Nablus City

Crash type	No.	Percentage
2	211	54.1%
1,7,3	85	21.79%
9	28	7.20%
8	2	0.51%
Others	64	16.40%
Total	**390**	**100%**

The number of pedestrian accidents and their associated number of injuries were presented in Table 4-6 for each of the considered areas.

Table 4-6: Pedestrian accidents and injuries within the study area

Area	No. of accidents	No. of injuries			Percentage of each severity	
		Slight	Sever	Total	Slight	Sever
CBD	31	34	2	36	94.44%	5.56%
Fringe of CBD	8	7	1	8	87.50%	12.50%
Out of CBD	24	23	6	29	79.31%	20.69%
Total	**63**	**64**	**9**	**73**		

It should be mentioned that the number of accidents presented in Table 4-6 is incomparable, since each area had different number of accident locations. One conclusion from Table 4-6 is that, as the location become far away from the CBD area and classified as arterials, the severity of accident increases. This is due to the fact that CBD area is crowded with pedestrians and vehicles, which increase the conflict between them. At the same time, the drivers are forced in most cases to slow down their travelling speed. Therefore, the CBD had the greatest percentage of slight injuries, vice versa for out of CBD.

This conclusion confirmed with the one that had been reached before when the fatalities were analyzed. Which indicated that the highest percentage of fatalities (high severity) occurred at major arterials out of CBD area.

4.4 Social cost of accidents

In most accounts, the social costs of transportation can be defined as those costs incurred by society as a whole, not solely by the users as direct costs, nor those that are incurred solely by the nonusers, such as those associated with accidents *(Murphy & Delucchi, 1998)*.

A social cost analysis can provide cost data and cost estimates, which can help analysts and policymakers evaluate the costs of transportation project, policies, and long-range scenarios, establish efficient prices for transportation services, and prioritize research and funding *(Murphy & Delucchi, 1998)*.

In this study, the social costs of accidents were used to evaluate transportation project cost. Safety projects provide benefits to highway users by reducing the number and/or severity of accidents. Quantification of these benefits requires that costs be assigned to different levels of crash severity and used in conjunction with crash reduction estimates *(Homburger & Kell, 1996)*.

Based on the procedures of a 1991 study, FHWA recommended costs per injury were given in Table 4-7.

Table 4-7: FHWA accident costs per injury (1994 Dollars)

KABC scale			**Abbreviated injury scale**		
Severity	**Descriptor**	**Cost ($)**	**Severity**	**Descriptor**	**Cost ($)**
K	Fatal	2600000	AIS 6	Fatal	2600000
A	Incapacitating	1800000	AIS 5	Critical	1980000
B	Evident	36000	AIS 4	Severe	490000
C	Possible	19000	AIS 3	Serious	150000
PDO	Property damage only	2000	AIS 2	Moderate	40000
			AIS 1	Minor	5000

Source: Homburger & Kell, 1996.

The costs mentioned in Table 4-7 are more applicable for U.S.A. It is advisable that each territory uses its own accident's cost.

Therefore, one of the issues that were handled during this thesis is to estimate the cost of accident according to crash severity.

4.4.1 Cost data of accidents

The elements that are commonly considered while estimating the cost of accidents are the following *(Bhesania, 1991)*: -

- Wage loss.
- Property damage.
- Medical treatment.
- Administration by police and insurance companies.
- Loss of future earning.
- Subjective costs; pain and suffering.

In order to estimate the cost of accidents, the most proper way was to obtain the indemnities issued by the insurance companies. Which covers the whole elements mentioned above. Therefore, different insurance companies were visited, and interviews were held to collect the required information.

According to the Israeli law, which is still valid in the Palestinian Territory for insurance, it does not specify a ceiling for the indemnity of personal injuries. However, to determine the value of indemnity using Israeli law, a special formula had to be followed. This formula covers the following items *(Oaeda & Halabi, 1986)*: -

- Percentage of inability due to the accident.
- Age.
- Net monthly wage.

The formula and its application were presented in Appendix (A).

For the case of pedestrian accidents, the cost of property damage is excluded, since its value is negligible with respect to other associated costs. For the purpose of this study the cost of each type of injuries was determined based on actual indemnities that was collected from insurance companies. In Table 4-8 the cost of each type of injuries is presented.

Table 4-8: Accident costs per injury for each year in NIS[1]

Year	Company	Injury type					
		Slight	Medium	Sever	Very sever	Fatality no.1	Fatality no.2
1996	Trust						
	Arabia	2508	21558	68780	233258		
	National						
1997	Trust	2778	8912	44350		25857	155000
	Arabia	2499	20047	70238	379515	24714	228111
	National						
1998	Trust						
	Arabia	3101	19620	63578	253877	26385	97000
	National						
1999	Trust	2812	9629	51133		32429	117500
	Arabia	4183	18469	66432	311535	32583	266375
	National	2657	8306	27766		36830	

1: NIS is abbreviation of New Israeli Sheqel.
Fatality no.1: Very young or very old dependant persons.
Fatality no.2: Independent persons with specified monthly income.

The cost data in Table 4-8 represents the average indemnities that were paid, by each insurance company, for each injury type in terms of each year NIS.

Based on the data collected from the insurance companies the indemnity value for slight injury reached approximately 5,000.0 NIS, while, the value of medium injury range was 5,000.0-25,000.0 NIS. In the case of sever injury, the indemnity was between 25,000.0 and 100,000.0 NIS. It should be emphasized that very sever type of accidents was only classified by Arabia Insurance Company and had a value of more than 100,000.0 NIS. The values in Table 4-8 are within these ranges.

In the case of fatality, the reader can notice the difference between the value of two categories, which was resulted from the different definition of each type as follows:

- Fatality no.1: Very young or very old dependant persons.
- Fatality no.2: Independent persons with specified monthly income.

It should be noticed that the above mentioned companies were the only ones that were able to offer the required data. This was due to inadequate way for saving the data in their files, or they did not have the willingness to offer any help.

In certain years some of the insurance companies did not have the cost data in an organized form, or the type of injury was not available during that year, which resulted in empty blocks in Table 4-8.

4.4.2 Pedestrian accidents cost estimate

Benefits are determined on the basis of expected number of accidents that will be prevented if the proposed overpass is implemented, and costs are the capital and continuing costs for constructing and operating the proposed overpass.

The benefits may be obtained in monetary terms, by multiplying the expected number of accidents prevented by an assigned cost for each type of accident severity *(Garber & Hoel, 1988)*.

4.4.2.1 Pedestrian accident cost for each type of severity

With reference to Table 4-8, the cost of accidents for each severity can be determined. However, these values are corresponding to each year NIS. The fact that the currency exchange is changing with time, made the use of these figures by their current values is unrealistic. Therefore, the annual equivalent value of each injury cost must be estimated.

The time values of money and interest rate utilized together generate the concept of equivalence *(Tarquin & Blank, 1976)*. Thus, the number of interest periods and the corresponding interest rate were to be determined to estimate the equivalent accident cost. Interest periods were defined as the study period that is three years (1996-1998). The interest rate during this period was obtained from Bank of Palestine as presented in Table 4-9.

Table 4-9: Interest rate for different currencies in different years

Currency	From	To	Interest rate (%)		
			1996	1997	1998
NIS	1,000.00	99,999.00	11.00	9.00	7.00
	100,000.00	499,999.00	11.50	10.00	9.00
	500,000.00	999,999.00	11.75	11.00	10.00
	>1,000,000.00		12.00	13.00	12.00
U.S.$	200.00	49,999.00	4.00	5.00	4.25
	50000.00	99,999.00	5.00	5.35	5.00
	>100,000.00		5.50	5.40	5.10

Regarding New Israeli Sheqel, the interest rate had a range of 7.0-13.0 percent. While, U.S. Dollars had a lower interest rate which was between 4.0-5.5 percent.

In order to estimate the equivalent accident cost in U.S. Dollar the exchange rate was collected from Palestine Monetary Authority (PMA) as summarized in Table 4-10.

Table 4-10: Average exchange rate

Period	From NIS to U.S.$
1996	3.26
1997	3.474
1998	3.795

The accident cost for each severity were estimated in terms of 1996 U.S. Dollars using the information from Table 4-8, Table 4-9, and Table 4-10, in addition to the following equation *(Tarquin & Blank, 1976)*: -

$$P = F\,[1/(1+i)^n] \ldots\ldots\ldots\ldots 4.1$$

where;

P: Present worth.

F: Future worth.

i: Interest rate.

n: Number of interest periods, months, years, etc.

Based on the above-mentioned information, the cost of accident per injury type was estimated and summarized in Table 4-11. A sample calculation was presented in Appendix (A).

Table 4-11: Cost of accident per injury type (1996 U.S. Dollar)

Severity	Cost ($)
Slight	775
Medium	4616
Sever	18251
Very sever	62068
Fatality no.1	6785
Fatality no.2	37996

Generally, the type of injury expresses its cost. As the severity increases, its associated cost increases. Exceptionally, the cost of fatality is less than the cost of sever and very sever injuries.

Based on the data presented in Table 4-1, Table 4-11, and equation 4.1, the cost of accidents for each of the considered locations was estimated, as summarized in Table 4-12. A sample calculation was presented in Appendix (A).

Table 4-12: Pedestrian accident cost at each of the considered locations

Location	**Pedestrian accident cost in U.S. Dollar**		
	1996	**1997**	**1998**
C-1 & C-4	775.0	7,229.0	3,168.0
C-2 & C-3	775.0	3,228.0	792.0
C-5	NA	NA	1,584.0
C-6 South	775.0	2,421.0	NA
C-7	NA	8,843.0	NA
C-8 North	NA	NA	2,376.0
C-9 East	NA	NA	1,584.0
F-1	NA	775.0	4,808.0
F-2	1,550.0	807.0	792.0
F-3 South	NA	807.0	792.0
O-1	775.0	3,228.0	792.0
O-2	NA	8,036.0	1,584.0
O-3	NA	807.0	7,966.0
O-4	775.0	807.0	5,573.0
O-5	NA	12,037.0	792.0

Refer to Figure 3-2 for key abbreviations.
NA: No accidents were recorded.

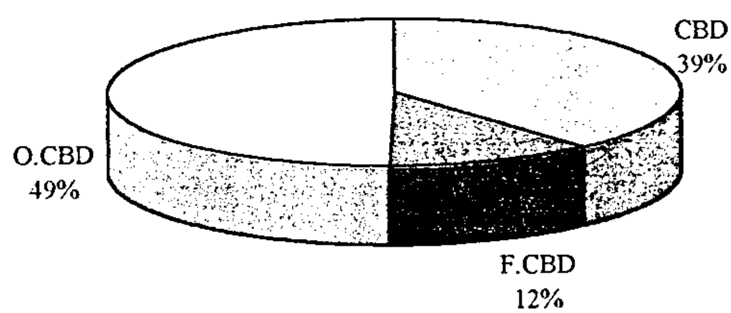
For the considered locations and during the study period, about U.S. Dollar 87,053.00 were lost due to pedestrian accidents.

Based on Table 4-12, in the CBD area and during the study period the roadways in front of Police station and Nablus Municipality recorded the highest cost of pedestrian accidents, while the east approach of Sufian-Hamdi Kan'an intersection recorded the lowest cost of pedestrian accidents.

At the fringes of CBD area, Faisle Street in front of Directorate of Education recorded the highest cost of pedestrian accidents, and the lowest cost was recorded at the south approach of ANZ Grindlays Bank intersection. However, out side the CBD area the highest cost of pedestrian accidents was recorded at Haifa Street in front of Ein Refugee Camp and the lowest cost was recorded at Amman Street in front of Yousef Tomb.

The ranking of total pedestrian accident cost by location illustrated in Figure 4-2, indicated that out of CBD area captured the highest percentage of accidents cost, while the fringes of CBD area captured the lowest percentage.

Figure 4-2: Ranking of pedestrian accident cost by location



This cost represents the accident cost for each year. In order to estimate the annual accident cost, the following equation was used *(Tarquin & Blank, 1976)*: -

$$A = P \frac{i(1+i)^n}{(1+i)^n - 1} \quad \ldots\ldots\ldots\ldots 4.2$$

where;

A: Equivalent uniform annual amount.

P: Present worth.

i: Interest rate.

n: Number of interest periods, months, years, etc.

From Table 4-9, average interest rate was considered as 4.96 percent. The number of interest periods was three years.

Using previous information, the annual accident cost was estimated and summarized in Table 4-13. An example of the calculation procedure was presented in Appendix (A).

Table 4-13: Annual accident cost at each of the considered locations

Location	Pedestrian accident cost in 1996 U.S. Dollar
C-1 & C-4	3860.0
C-2 & C-3	1604.0
C-5	506.0
C-6 South	1081.0
C-7	2963.0
C-8 North	758.0
C-9 East	253.0
F-1	1880.60
F-2	1063.00
F-3 South	523.0
O-1	1604.0
O-2	3198.0
O-3	2812.0
O-4	2319.0
O-5	4285.0

Refer to Figure 3-2 for key abbreviations.

4.4.2.2 Average pedestrian accident cost for urban area

To estimate the cost of the predicted accidents, the predicted severity had to be determined. To project future accident cost savings, it is inappropriate to use past severity experience at a specific site, especially if it involved a fatality.

The fact that there was a fatality at a hazardous location last year may not support a conclusion that a life will be saved during each coming year due to the installation of an engineering countermeasure.

The most effective use of the cost data in Table 4-11 is to calculate for all similar sites an average loss (L) for each manner of collision, given by *(Homburger & Kell, 1996)*: -

$$L = \frac{\sum(l \times n(l))}{n} \quad \text{.........4.3}$$

where;

L: Average loss for each manner of collision

l: Loss associated with a particular injury level.

$n(l)$: Number of level l injuries due to a certain manner of collision.

n: Total number of accidents with the specified manner of collision.

The previous formula can be written in another form as: -

$$L = \sum (l \times SI) \quad \text{..........4.4}$$

In order to estimate the cost of the predicted pedestrian accidents at urban areas, the data of Nablus City was used, since it was considered as a representative case study.

Using the data from Table 4-3 and Table 4-11 to apply formula 4.3, the average cost of pedestrian accident was equal to U.S. Dollar 6425.00. The same estimate was repeated for the data obtained from insurance companies and listed in Table 4-4. The pedestrian accident cost was found to be U.S. Dollar 3,600.0. To choose the most accurate value between the two estimates, the average value for the all indemnities (which were paid by insurance companies) was estimated. The later value was more reasonable. Thus, the cost of pedestrian accident was found to be U.S. Dollar 3,600.0. The calculation of this cost was illustrated in Appendix (A).

4.5 Predicted number of prevented accidents

The number of pedestrian accidents and their corresponding traffic flow data during the study period for each location were collected, as mentioned previously. In order to predict the number of pedestrian accidents, a trial was done to develop a model that relates the number of accidents with traffic flow data, based on regression analysis. For this purpose, accidents resulted from crossing pedestrian were modeled.

Several trials were made and different models (linear, log-linear) were examined. A large number of analyses were performed on the whole data, transformed data, and combinations of data. Since the sample size available was too small to describe the pattern of accidents, the resulted models were incapable to predict the number of accidents.

4.5.1 Examined model structures

One of the model structures that was tried in this study, examined the number of accidents in relation to the product of vehicular and pedestrian traffic flows, which are conflicting at certain location. The form of model was similar to the one developed by Hauer et al in 1988 *(Quaye, Leden, & Hauer, 1993)*.

In the model structure, accident frequency is a function of the product of traffic flows raised to a specific power *(Rodriguez & Tarek, 1998)*.

The model is given by: -

$$E\ (m) = b_o \times F_1^{b1} \times F_2^{b2} \text{..........} 4.5$$

where;

$E\ (m)$: Expected number of accidents per unit of time.

F_1: Vehicular flow.

F_2: Pedestrian flow.

b_o, b_1, b_2: Parameters to be determined.

The previous model was used in the form of: -

$$Ln\ (E\ (m)) = Ln(b_o) + b_1 \times Ln(F_1) + b_2 \times Ln(F_2) \text{..........} 4.6$$

The adequacy of the model was checked using statistical analysis. Coefficient of determination R^2 was used to measure how well a multiple regression model fits the available data. The resulted R^2 was 2 percent, which indicated a very low fit of the model to the data. Using F-test statistics indicated that the model was not useful for predicting the number of accidents. Therefore, the above model structure was incapable of predicting the number of accidents.

Another model that was examined related the rate of pedestrian accidents to the product of pedestrian and vehicular volumes.

The model was in the form of: -

$$R = b_o \times F_1^{b1} \times F_2^{b2} \text{..........} 4.7$$

where;

R: Rate of accidents, accident/no. of pedestrians.

F_1: Vehicular flow.

F_2: Pedestrian flow.

b_o, b_1, b_2: Parameters to be determined.

While the rate of accident is defined as follows *(Garber & Hoel, 1988)*:-

$$R = \frac{n \times 100{,}000.0}{365 \times PDT} \text{..........} 4.8$$

where,

R: Rate of accidents, accident/no. of.pedestrians.

n: Number of pedestrian accidents.

PDT: Pedestrian daily traffic.

In order to estimate the required parameters, using regression analysis, the model was used in the form of: -

$$Ln(R) = Ln(b_o) + b_1 \times Ln(F_1) + b_2 \times Ln(F_2) \qquad 4.9$$

Again, the adequacy of the model was checked using statistical analysis. Neither R^2 nor F-test gave an adequate result.

The previously mentioned models are only examples of the examined models. In fact, and as mentioned at the beginning of section 4-5, several trials were made and none of them gave adequate results.

In summary pedestrian accidents and their associated costs at different locations in Nablus City were presented and analyzed, and an average value of pedestrian accident cost was estimated. Since the core of this thesis was to develop guidelines based on the benefit-cost ratio analysis, one of the proposed benefits was the saving in accident costs. These accidents were assumed to be eliminated after the installation of a pedestrian-overpass.

Chapter Five

Pedestrian Delay Analysis and Modeling

5.1 Introduction

As mentioned in chapter two, ITE 5A-5 in 1998 suggests several benefits and costs associated with installing pedestrian overpasses. In addition to the social cost of accidents, pedestrian travel time was also considered.

Factors such as vehicular and pedestrian delay are generally used as benefits to amortize against the cost of overpass implementation. The cost for vehicle delay is a defined quantity; however, the value for pedestrian's time is some how difficult to assess. The problem is more acute when the majority of pedestrians are of school age *(Powers, et al, 1975)*.

Since the installation of pedestrian overpass affects the pedestrian travel time, the core of this chapter was to discuss and analyze this parameter, and its associated cost.

5.2 Vehicle delay

Garber & Hoel in 1988 defined vehicle delay as the time lost by a vehicle due to causes beyond the control of the driver.

When delay study is carried out, information may be collected on the location, duration, and causes of delays. Data obtained from delay study gives a good indication of the level of service that exists on the study section. These data also aid the traffic engineer in identifying problem locations, which may require special attention in order to improve the overall flow of traffic on the route *(Garber & Hoel, 1988)*.

- **Some of delay data applications**

The data obtained from delay studies may be used in any one of the following traffic engineering tasks: -

1. Identification of locations with relatively high delays and the causes for those delays.
2. Performance of before and after studies to evaluate the effectiveness of traffic operation improvements.
3. Performance of economic studies in the evaluation of traffic operation alternatives that reduce travel time *(Garber & Hoel, 1988)*.

Some of related issues to the vehicle delay are: stopped delay per vehicle, approach delay per vehicle, and total intersection delay *(McShane & Roess, 1990)*.

Due to the interaction between pedestrian and vehicles, another type of delay is raised, which is the vehicle delay caused by pedestrian. The vehicle is delayed while pedestrian is crossing the roadway and/or while walking near side walks.

The amount of time the vehicle is delayed can be converted in terms of passenger delay, by applying vehicle occupancy rate. Cost of delay (time value) can be then estimated *(Meyer& Miller, 1984)*.

Since the installation of pedestrian overpasses eliminates the conflict between pedestrians and vehicles, this delay was assumed to be eliminated. Therefore, another benefit for pedestrian overpasses was added.

Many references were reviewed to adopt a model which estimate this delay. None of the available references concerned with such type of delay. Developing delay model was out of the scope of this study, since it was concerned mainly on developing guidelines. Therefore, the vehicle delay caused by pedestrian was not considered.

5.3 Study area

The locations considered in Nablus City for the estimation of pedestrian waiting time, were similar to those for accident study.

For the purposes of developing guidelines, waiting time was estimated at general locations. The characteristics of these locations cover most of urban area characteristics, within the Palestinian Territory.

5.4 Pedestrian waiting time

The time a driver has to wait before he can cross or merge with other streams is an important performance indicator for unsignalized intersections. This delay is used to evaluate the performance of signalized intersections, the performance of roundabouts, traffic interactions at unsignalized intersections, and for specific problems related to pedestrians crossing roads *(Troutbeck, 1986)*.

For a pedestrian wishing to cross a bi-directional roadway, there are three different possible behavior patterns that can be postulated *(King, 1977)*: -

1. The pedestrian crosses whenever he or she perceives an acceptable gap in both directions of travel.
2. The pedestrian crosses whenever he or she perceives an acceptable gap in the near stream of traffic, which is in anticipation of the subsequent acceptable gap in the far stream.

3. The pedestrian crosses whenever he or she perceives an acceptable gap in the near stream of traffic and waits on the median of the divided roadway for an acceptable gap in the far stream.

Pattern 1 and 2 apply to undivided highways. It was concluded that pattern 1 appeared more frequently than pattern 2. Pattern 3 is common for divided highways, when the median provides adequate refuge *(King, 1977)*.

Since a pedestrian wishing to cross roadway have to wait for a suitable gap in the vehicle flow, a number of factors determine the waiting time that the pedestrian faces.

The waiting time problems relate most of all to the motor traffic volume, the crossing distance, the availability of safe spots to wait before crossing, and physical fitness of pedestrian.

For less able or daring pedestrians that are unable to run across, the waiting time before they can cross safely can easily become so high that is almost impossible to cross. This results in restrained mobility, and unacceptable risks *(Kisisa, et al, 1998)*.

In the following sections, the analysis of waiting times and crossing models were presented.

5.5 Crossing model

A pedestrian crossing facility can be modeled as a queuing problem, with a minor flow intersecting a major flow. The insertion of median or pedestrian refuge island, changes the model from crossing a single stream into crossing several sub-streams, sequentially *(Kisisa, et al, 1998)*.

Treating the pedestrian flow as minor stream that crosses a major stream consisting of motor vehicles, it is possible to estimate the average pedestrian delay with Troutbeck model developed in 1988.

Troutbeck derives the equations for pedestrian delay when there are two vehicle streams, each having the so-called Cowan's (dichotomized headway) distribution: -

$$W_p = \frac{e^{\lambda(T-\Delta)}}{\alpha^*(q_1+q_2)} - T - \frac{1}{\lambda^*} + \left(\frac{\lambda^*\Delta^2+2\alpha^*\Delta-2\Delta+2\beta\Delta^2-(4/3)\lambda^*\Delta^3\beta}{2\lambda^*\Delta+2\alpha^*-2\beta\Delta^2\alpha^*} \right) \quad \text{........5.1}$$

where;

$$\alpha^* = \frac{\alpha_1 q_1 (1-\Delta q_2) + \alpha_2 q_2 (1-\Delta q_1)}{q_1+q_2}$$

$$\beta = \frac{q_1 q_2}{(q_1+q_2)}$$

$$\lambda_1 = \frac{\alpha q_1}{1-\Delta q_1}$$

$$\lambda_2 = \frac{\alpha q_2}{1-\Delta q_2}$$

$$\lambda^* = \lambda_1 + \lambda_2$$

Δ: Minimum headway, sec.

T: Crossing time for pedestrian (critical gap), sec.

q_i: Vehicular flow in direction *i* (1,2), veh/sec.

α_i: Proportion of free vehicles in direction *i*.

λi: Decay constant in direction *i*.

The estimated delay is experienced by individual minor stream units.

All pedestrians are able to cross the road as soon as there is an acceptable gap.

The delay depends upon, the distribution of gaps in the vehicle streams, the order of free and restrained vehicles, and the size of the minimum acceptable gap (critical gap) for pedestrians, T.

Pedestrians cannot cross the vehicle streams unless the gap between successive vehicles is greater than or equal to T.

5.5.1 Model assumptions

The following assumptions were set for model development *(Troutbeck, 1986)*: -

1. The minor stream drivers consider all major stream vehicles to be identical and that the minor stream drivers are consistent and homogenous. While this latter assumption is not strictly true, its effect is minimal.
2. The headways between vehicles in one major stream are independent of headways in the other major stream. Further, the headways in each stream are also independent. It does not matter if the two major streams are in the same direction or in opposite directions.
3. Minor stream movements are based on conventional gap-acceptance behavior. It is assumed that minor stream vehicles cannot cross the major stream unless the gap between successive major stream vehicle is greater than or equal to T. If the gap is greater than T then the minor stream vehicle crosses the roadway after the previous major stream vehicle.

Further, for larger gaps in the previous major stream, several minor stream vehicles will cross the roadway.

Although these assumptions can give rise to unrealistic simultaneous departure of major and minor streams, they still enable average delays to be correctly estimated *(Troutbeck, 1986)*.

5.5.2 Major stream headway distribution

In addition to the common negative exponential model, there have been a number of other models proposed to represent the distribution of headways *(Troutbeck, 1986)*.

The model which has the greatest application to the problem here, is Cowan's relatively simple dichotomized model. This distribution assumes that there is a proportion of vehicles, which are restrained to follow other vehicles at a minimum headway Δ, and that the remaining vehicles (free vehicles) have headways greater than Δ *(Troutbeck, 1986, & Kisisa et al, 1998)*.

5.5.3 Crossing model parameters

1. Minimum vehicular headway, Δ

Sullivan and Troutbeck in 1997 found that in the most cases the minimum vehicular headway could be set to 2 seconds, and still provide a good representation of the headway distribution. In this study this value was applied.

2. Crossing time for pedestrian (critical gap), T

It is the time required for the pedestrian to cross the roadway. Crossing time can be expressed in the following equation: -

$$T = W/S \ldots\ldots\ldots\ldots 5.2$$

where;

W: Width of the roadway to be crossed by pedestrian, m.

S: Average pedestrian walking speed, m/s.

Roadway width for each of the considered location in Nablus City was presented in Table 5-1 *(Lafe & Badawi, 1999), and (Dornier & Universal Group, 1998)*.

For the purpose of guideline development, W has the values (6.0, 7.0, 8.0……. 17.0m). These values were determined from an inventory study conducted at Nablus City *(Dornier & Universal Group, 1999)*. The considered values represent most of the roadways width for urban areas in the Palestinian Territory.

Table 5-1: Roadway width for study area in Nablus City

Location	Roadway width (m)
C-1	12.0
C-2	9.0
C-3	11.4
C-4	11.0
C-5	11.5
C-6 North	9.0
C-6 South	7.3
C-6 West	7.3
C-7	9.1
C-8 North	13.2
C-8 South	13.0
C-8 East	7.0×2*
C-8 West	7.0×2*
C-9 North	8.8
C-9 South	8.8
C-9 East	7.0×2*
C-9 West	15.0
F-1	13.0
F-2	13.0
F-3 North	7.7
F-3 South	12.0
F-3 East	10.0
F-3 West	10.0
O-1	16.0
O-2	7.0×2*
O-3	7.0×2*
O-4	13.0
O-5	10.0×2*

* : Divided roadways
Refer to Figure 3-2 for key abbreviations.
Source: Lafe & Badawi, 1999 and Dornier & Universal Group, 1999.

A field study was made to estimate the average pedestrian walking speed at different locations in Nablus City *(Traffic laboratory, 1999)*. Table 5-2 summarizes the results obtained. For all other locations, the average pedestrian speed was considered as 1.35m/sec. This speed was estimated as the average values of Table 5-2.

Table 5-2: Average pedestrian walking speed

Location	S (m/sec.)
C-1	1.47
C-2	1.26
C-3	1.35
C-4	1.31

Refer to Figure 3-2 for key abbreviations.

Using the previous mentioned values to apply equation 5.2, the crossing time was estimated.

3. Vehicular flow, q_i

The vehicular flow was considered in terms of the hourly volume for each direction. This volume was estimated as follows: -

- Estimate 12-hour volume, which is 80 percent of ADT, as indicated in Chapter Three.
- Average hourly vehicular volume was then estimated by dividing the 12-hour volume by 12.

The unit of the vehicular volume when applied to model was in veh./sec. The values of hourly volume were 200, 400,.......3400 veh./hr. These volumes cover the minimum and maximum volumes observed in Nablus City, either for one direction or two directions.

4. Proportion of free vehicles, α_i

Cowan's headway distribution assumes that there is a proportion of vehicles, which are restrained to follow other vehicles at a minimum headway Δ, and that the remaining vehicles (free vehicles, α) have headway's greater than Δ *(Troutbeck, 1986, & Kisisa et al, 1998)*.

The value of α can not be measured in the field. It is a calibration term that ensures that the distribution of the larger gaps is correct and that the distribution has an appropriate mean *(Sullivan and Troutbeck, 1997)*.

The proportion of free vehicles on a road link is dependent on the geometry of the road link and the presence of intersections along the link.
Current methods for describing the proportion of free vehicles on a road link predominantly use linear relationships with the vehicle flow rate. An exponential relationship has been examined and found to be better suited to the modeling of the proportion of free vehicles than the existing linear relationships.

In modeling the flow in each lane, the characteristics of the traffic flow were found to be dependent on the lane type being modeled. The curb lane sustained a higher proportion of free vehicles than the median lane for similar flow rates. The difference is attributed to driver behavior and is related to the expected ease of overtaking.

Using these results the proportion of free vehicles is described as a function of the lane type, lane width and the vehicle flow rate through the use of the following exponential relationships *(Sullivan and Troutbeck, 1997)*: -

$$\alpha = e^{-Aq} \qquad \text{..........5.3}$$

where;

A: Constant with values in Table 5-3.

q: Vehicular flow veh./sec.

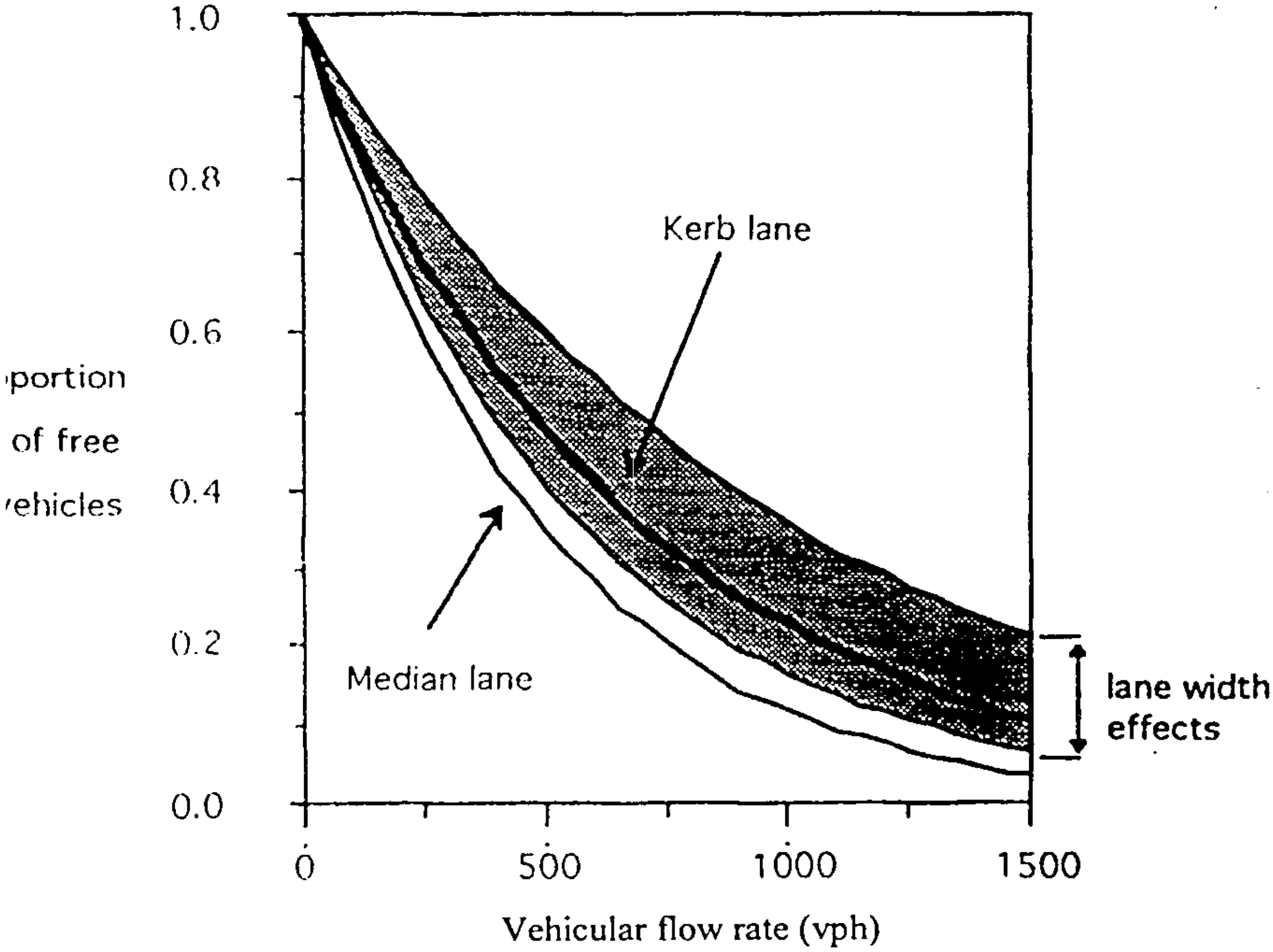
Table 5-3: Values for variable *A* in exponential equation for given lane type and lane width

Lane width (L)	*A*	
	Median lane	All other lanes
L<3.0m	7.5	6.5
3.0≤ L≤3.5m		5.25
L>3.5m		3.4

Source: Sullivan and Troutbeck, 1997.

Plots of the exponential relationship for each lane type were given in Figure 5-1. The figure illustrates the large difference in the proportion of free vehicles for different lane type.

Figure 5-1: Plot of proportion of free vehicles exponential relationships for each lane type



Source: Sullivan and Troutbeck, 1997.

With multi-lane roads the number of gaps available for overtaking is dependent on the flow in the adjacent lane and the travel speed of vehicles in that lane. As the flow in either lane increases then the number of vehicles able to overtake decreases, and bunching increases. The flow in the median lane was observed to have less availability of overtaking maneuvers, and as a result had a higher proportion of bunched vehicles than the curb lane.

For the considered locations in Nablus City, the proportion of free vehicles was estimated and the values were listed in Table 5-4. The proportion of free vehicles in Nablus City ranges from 0.177-0.93. This wide range was observed mainly in the CBD area, since it has different characteristics in vehicular volume and roadway geometry. While, at the fringes of CBD area and out of the CBD area the values were consistent.

5.6 Results and analysis of waiting time for Nablus City

With the model presented in section 5.5, it was possible to estimate the average waiting times, as a function of the vehicle volume, pedestrian speed, and crossing distance. This had been done and presented in Table 5-4. These values were estimated for vehicular volume in 1996.

Table 5-4: Pedestrian waiting times (W_p) at Nablus City in 1996

Location	q (veh./hr.)	T (sec.)	α	W_p (sec./ped.)
C-1	1420.0	8.18	0.224	36.5
C-2	1627.0	7.13	0.177	36.77
C-3	1463.0	8.47	0.214	42.79
C-4	1627.0	8.42	0.178	55.63
C-5	1599.0	8.52	0.261	88.03
C-6 West	94.0	5.41	0.932	0.405
C-7	791.0	6.74	0.537	8.91
C-8 South	372.0	9.63	0.752	6.70
C-9 West	343.0	11.11	0.769	8.37
F-3 West	442.0	7.41	0.712	4.67
O-1	824.0	11.85	0.523	43.34
O-2	342.0, 350.0	5.19×2*	0.669,0.663	(1.56+1.60) =3.16
O-4	1126.0	9.63	0.404	47.02
O-5	361.0, 400.0	7.41×2*	0.689, 0.661	(3.41+3.87) =7.28

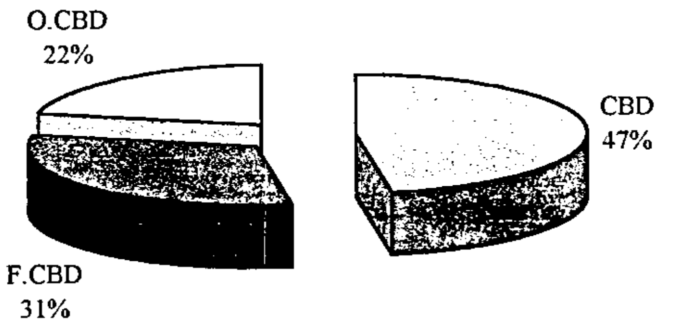
*: Divided roadways.
Refer to Figure 3-2 for key abbreviations.

For the divided roadways, W_p was estimated for each direction, separately. This explains the availability of two figures at certain locations in the same column.

Al-Hadadeen Street experienced the highest value of pedestrian waiting time, while the lowest value was observed at the west approach of Hitten intersection. The high difference between the waiting time values raised from different vehicular volumes and roadway geometry.

Figure 5-2 illustrated that CBD area experienced the highest percentage of pedestrian waiting time, while out of the CBD area experienced the lowest percentage.

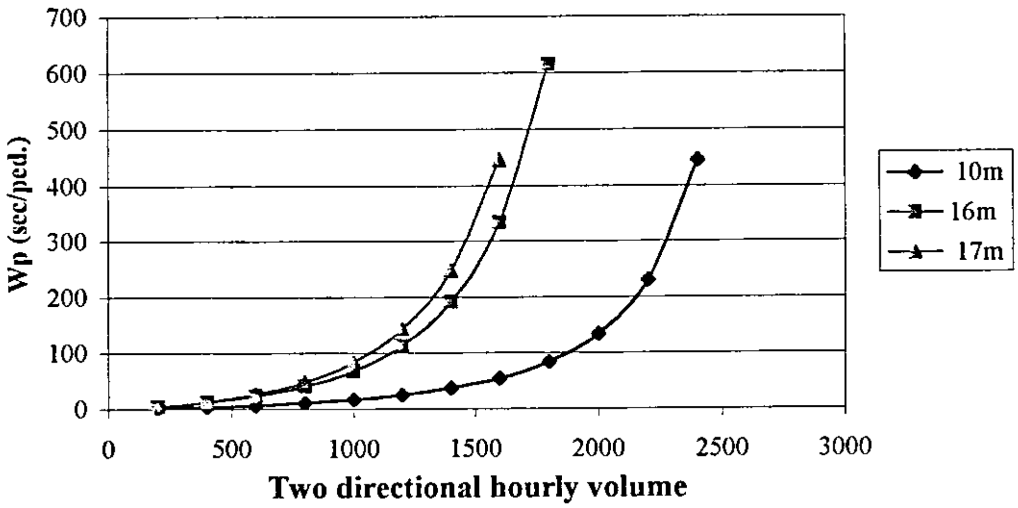
Figure 5-2: Ranking of pedestrian waiting time per location



Based on equation 5.1, the waiting time for pedestrian was estimated for different roadway widths. This was illustrated in Figure 5-3. From this figure it was obvious that, as the vehicular volume increases the waiting time increases, for the same roadway width.

This figure also illustrated how the roadway width affected the waiting time value. At the same vehicular volume, wider roadways experienced higher waiting time.

Figure 5-3: Pedestrian waiting time for different roadway width



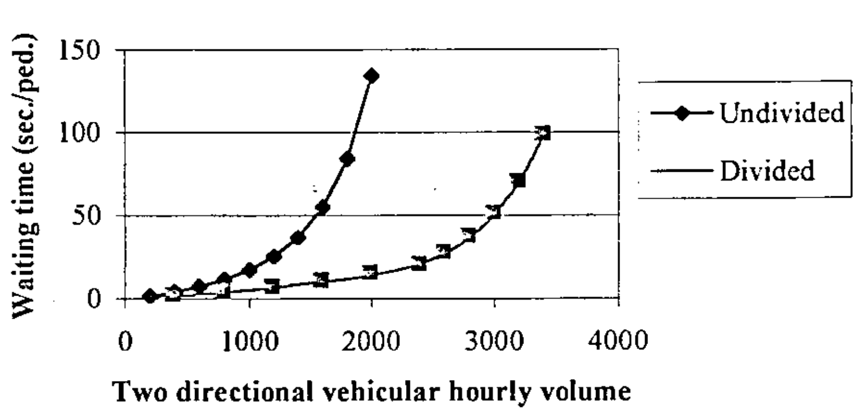
For divided roadways, the presence of a median reduces the complexity of the conflict between pedestrians and two-directional traffic. It also provides a shorter crossing, which increases the chance of an adequate gap T *(Kisisa et al, 1998).*

To estimate the pedestrian waiting time for a roadway crossing with a median or a refuge island, it is decomposed into separate crossings of sub-streams, each with their own critical gap, depending on the crossing distance.

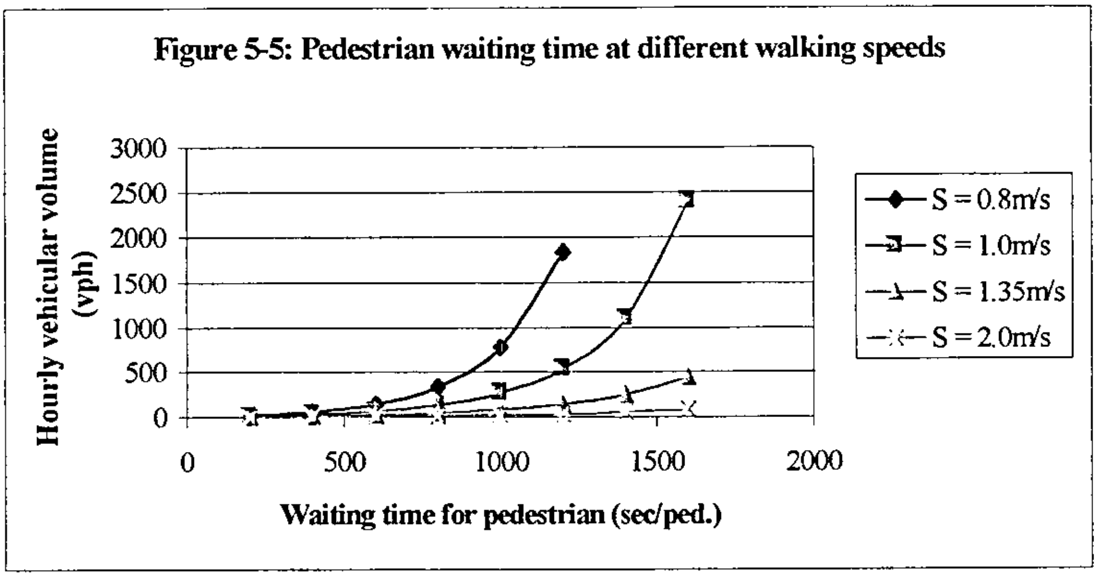
The total waiting time is the summation of the waiting times for crossing each of sub-streams.

In Figure 5-4 a comparison between crossing undivided and divided roadways was illustrated. This figure showed that the estimated waiting times was reduced dramatically by the provision of a median, which allows the pedestrians to cross direction by direction.

Figure 5-4: Pedestrian waiting time for undivided and divided roadways



The effect of pedestrian walking speed on the pedestrian waiting time was studied, and the results were illustrated in Figure 5-5. The results indicated that at a certain value of vehicular volume as pedestrian walking speed increases the waiting time decreases, and vice versa.



5.7 Value of time

An important element of cost model comparison is the value of time associated with travel. The underlying basis for assigning a monetary value to travel time relates to the fact that time not spent in travel can be used for productive purposes in other activities. In the case of travel to work, this assertion seems reasonable.

Several studies have examined the value of time and have concluded that, in the case of the journey to work, the value for trip time components (waiting time, transfer time, etc.) is about 100 percent of traveler's wage. Therefore, in the case of work travel, a reasonable estimate of the value of time for work trips can be related to the traveler's wage. For other trip purposes, the value of travel time becomes less obvious.

Still, different dollar values have been used to represent the value of time, which has been found to be sensitive to trip purpose, traveler's income level, and the amount of time saving per trip.

Two important observations should be made about value of time measures. First, because the value of time depends on the traveler's income level, more benefit will be assessed for projects that improve travel time for higher-income individuals. Second, the dependence of travel time value on income and trip length requires computation of different user travel times for each alternative under consideration, an analysis problem that exceeds the computational resources of most planning agencies. Because of this computational problem, planners sometimes use an average value of travel time by trip purpose for all users of the system (e.g., U.S. Dollar 3.0 per vehicle hour is used by the American Association of state Highway and Transportation Officials, AASHTO) *(Meyer& Miller, 1984)*.

Therefore, to estimate the value of time for the Palestinian Territory, the average wage was determined. This was presented in the next section.

5.7.1 Average daily wage

For the purposes of this study, the average daily wage was estimated from the statistics of Palestinian Central Bureau of Statistics (PCBS). The values presented in Table 5-5 were the average wage for different working categories in Palestinian Territory.

Table 5-5: Annual average wage

Year	Average daily wage (NIS)	Average daily wage (U.S. Dollar)
1996	50.60	15.52
1997	56.60	16.30
1998	58.90	15.52

Source: PCBS, 2000.

From the values in Table 5-5, it was noticed that the average daily wage in NIS increased with time, while average daily wage in U.S. Dollar in 1998 was less than the one in 1997. This was because the exchange rate of NIS decreased relative to U.S. Dollar during that year.

5.7.2 Working hours and days

In order to estimate the average wage per hour, the working hours were determined. From PCBS statistics it was found that the average daily working hours in the Palestinian Territory is equal to 8.0 hours. To estimate the total waiting time per year, the total working days were considered to be 313 days *(PCBS, 2000)*. Table 5-6 presents the value of time for each year.

Table 5-6: Time value in U.S. Dollar

Year	Time value (U.S.$/hr.)
1996	1.94
1997	2.04
1998	1.94

5.7.3 Percentage of working trips

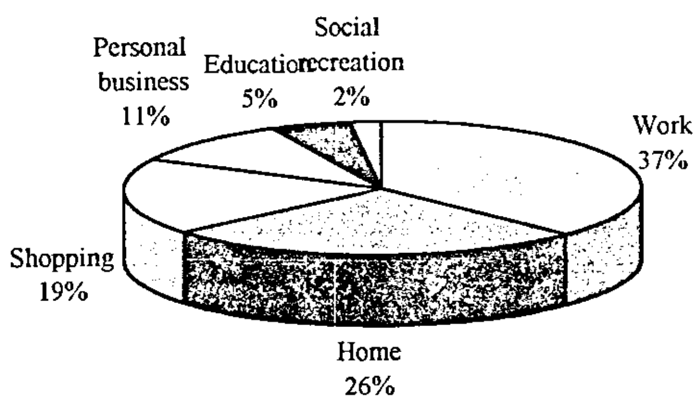
A study was conducted at Nablus City in 1998 to analyze the pedestrian behavior within the urban area *(Lafe & Badawi, 1999)*. About 200 interviews were made, one of the parameters considered was the trip purpose. The number of trips per purpose and the percentage of each trip purpose are presented in Table 5-7. Figure 5-6 illustrated the percentage of each trip purpose. Working trips form the highest percentage among trip purposes.

Table 5-7: Percentage of trips per purpose

Trip Purpose	Number of trips	Percentage of trips (%)
Work	75.0	37.5
Home	53.0	26.5
Shopping	37.0	18.5
Personal business	21.0	10.5
Education	10.0	5.0
Social recreation	4.0	2.0
Total	**200.0**	**100.00**

Source: Lafe & Badawi, 1999.

Figure 5-6: Percentage of trips per purpose



Another estimates of a Master Plan study reported about 36 percent of the population were employed. The rate was estimated to grow to 39 percent by the year 2015, due to the expected shift in the population age structure and higher involvement of women in the work force *(Dornier & Universal Group, 1998)*.

The average percentage of working trips reported in the Master Plan study was equal to 37.5 percent, which is consistent with the previous results. This value was considered for the purpose of this study.

5.8 Pedestrian delay cost for Nablus City

This chapter discussed different issues regarding the estimation of pedestrian waiting time, working hours and days, and the percentage of working trips. In Chapter Three, pedestrian volume was estimated for each of the considered locations. Based on these parameters it was possible to estimate the total waiting time for each of the considered locations in Nablus City. The time value was utilized in order to interpret the waiting time (delay) values in terms of cost. The process followed to estimate this cost was summarized in the flowchart presented in Figure 5-7. The results were listed in Table 5-8. A sample calculation was presented in Appendix (A).

Figure 5-7: Annual cost of pedestrian delay (ADC)

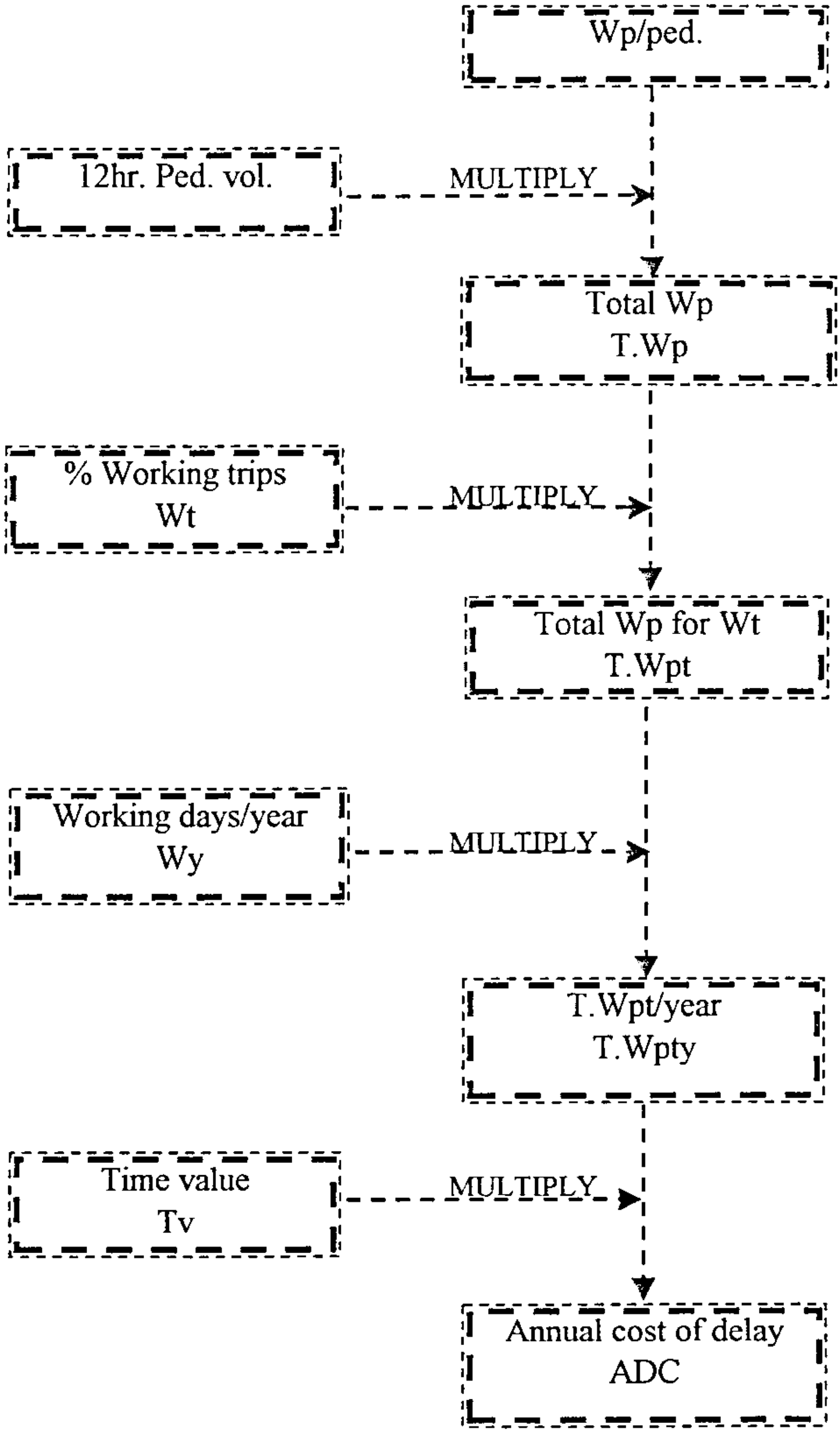


Table 5-8: Pedestrian delay cost at the considered locations in Nablus City

Location	Pedestrian delay cost in U.S. Dollar		
	1996	1997	1998
C-1 & C-4	21,242.0	24,977.0	26,754.0
C-2 & C-3	32,725.0	32,122.0	29037.0
C-5	8,652.0	7,961.0	4,468.0
C-6 South	34.0	41.0	46.0
C-7	3,313.0	3,842.0	4,042.0
C-8 North	1,281.0	1,378.0	1,344.0
C-9 East	111.0	145.0	173.0
F-3 South	4,281.0	4,453.0	4,203.0
O-1	2,773.0	3,665.0	4,468.0
O-2	151.0	186.0	209.0
O-3	76.0	93.0	104.0
O-4	1,591.0	2,177.0	2,775.0
O-5	1,006.0	1,148.0	1,189.0

Refer to Figure 3-2 for key abbreviations.

For the considered locations and during the study period, about U.S. Dollar 238,236.00 were lost while pedestrian are waiting to cross the road. This issue indicates the serious economic problem resulted from waiting times.

The annual delay cost was then estimated based on equation 4.2, and the results were presented in Table 5-9. A sample calculation was presented in Appendix (A).

Table 5-9: Annual pedestrian delay cost at the considered locations in Nablus City

Location	Pedestrian delay cost in 1996 U.S. Dollar
C-1 & C-4	24303.00
C-2 & C-3	31330.00
C-5	7070.00
C-6	40.22
C-7	3730.47
C-8	1336.79
C-9	231.87
F-3	4323.79
O-1	3618.98
O-2	172.88
O-3	86.31
O-4	2168.94
O-5	1114.34

Refer to Figure 3-2 for key abbreviations.

The results presented in Table 5-8 and Table 5-9 were consistent with the results presented previously in Table 5-4. All of these results ensure that the CBD area experienced pedestrian delay more than other areas.

Two types of benefit were considered to be accomplished after the installation of pedestrian-overpass. First, the benefits resulted from pedestrian accident savings which were presented in Chapter Four. The second type was the benefits resulted from pedestrian delay savings.

In this chapter the annual delay cost was estimated. Based on the assumption that pedestrian waiting time (delay) will be eliminated after the installation of pedestrian-overpass, the values of annual pedestrian delay presented in this chapter will be considered as the other type of benefits.

Chapter Six

Pedestrian Overpass

6.1 Introduction

Grade-separated crossings refer to facilities that provide the pedestrians and motor vehicles to cross at different levels, and such facilities can greatly reduce pedestrian-vehicle conflicts and potential accidents. Pedestrian overpasses are considered one of these facilities *(ITE, 1998)*.

The main objective of this research was to develop benefit-cost guidelines for pedestrian overpasses. The benefits associated with such facility were considered in previous chapters, while in this chapter, the associated cost was determined.

ITE 5A-5 in 1998 suggested several costs associated with installing pedestrian overpasses. These costs included construction cost, site preparation, finishing touches (e.g., lighting, landscaping), and operation and maintenance costs *(ITE, 1998)*. All of these parameters were discussed thoroughly in the next sections.

6.2 Types of facilities

Several types of grade-separated crossings are available, such as *(ITE, 1998)*: -

Overpasses

1. Pedestrian overpasses/bridges: These are passageways for pedestrians constructed over a roadway in which stairs or ramps generally lead up to the overpass. It is required that stairs should not be the only means to access an overpass or under-pass, although they can be used with a ramp. In some cases, however, the road is depressed and the bridge is at ground level.
2. Elevated walkways: These refer to sidewalks or walkways above ground level that often run parallel to the flow of motor vehicles. Such facilities may be freestanding or connected to adjacent buildings.
3. Skywalks/Skyway: These typically refer to enclosed walkways built one or more levels above ground level that connect buildings at mid-block. These crossings allow for walking etween buildings without being exposed to inclement weather and are especially beneficial to elderly and physically disadvantaged pedestrians with lesser mobility.

A. Underpasses

1. Pedestrian tunnels/underpasses: These generally involve stairs or ramps that lead down to a below-ground passageway. In some cases, however, the underpass is at ground level and the road is elevated.
2. Below-grade pedestrian networks: These facilities refer to extensive underground walkways that carry pedestrians parallel and perpendicular to the flow of motor vehicles traveling above them.

For purpose of this study, pedestrian-overpass was considered.

In the following sections different issues related to the pedestrian overpasses were discussed, such as; planning considerations, design elements, construction, and maintenance cost of such structures.

6.3 Planning considerations

This study concerned with the development of guidelines for pedestrian overpasses, based on benefit cost analysis. Another major issue which must be considered before installing the overpass, was to predict whether the pedestrians will accept such new structure, or if this structure will be used.

The effectiveness of grade-separated crossings depends on their perceived ease of accessibility by pedestrians. Because an overpass will not necessarily be used simply because it improves safety. Instead, pedestrians tend to weigh the perceived safety of using the facility against the extra effort and time required *(ITE, 1998)*.

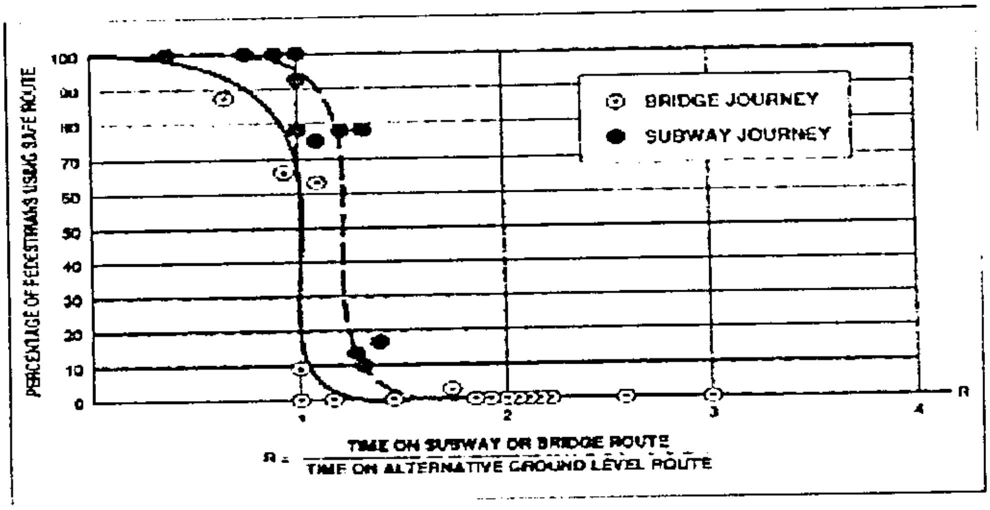
Studies have also shown that grade-separated crossings should ideally be on the normal path of pedestrian movements *(ITE, 1998)*. In this study, the proposed locations of overpasses satisfied this requirement.

One study by Moore and Older found that the degree of use of overpasses and underpasses by pedestrians depends on walking distances and convenience of the facility. A convenience measure, *R*, was defined as the ratio of time to travel on the overpass or underpass divided by time to travel at ground level. Figure 6-1 illustrates the percentage of pedestrians using the facility versus *R (ITE, 1998)*.

For Nablus City, *R* was estimated for different locations in 1996, as listed in Table 6-1. An example of estimating the convenience measure was presented in Appendix (A).

It should be stressed that Figure 6-1 clarified only the pedestrian's convenience, when he or she has the opportunity to choose, without imposing any kind of regulations.

Figure 6-1: Pedestrian use of grade separated crossing



Source: ITE, 1998.

Table 6-1: Convenience measure, *R*, for selected locations in Nablus City

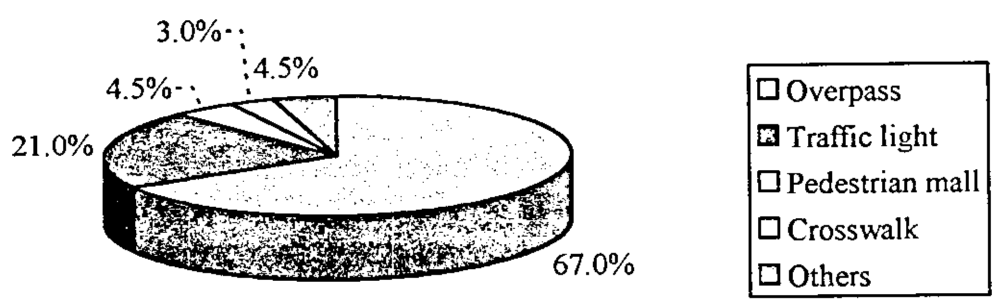
Location	*R*
C-1 & C-4	0.82
C-2 & C-3	0.85
C-5	0.77
C-7	4.6
F-3 South	1.74
O-1	1.4

Refer to Figure 3-2 for key abbreviations.

When the value of convenience measure is less than one, it indicates that the time required to cross the roadway at grade, is more than the time required to cross the roadway using the overpass. This means that using the overpass provides time saving for the users. The values in Table 6-1 indicated that the installation of pedestrian-overpass at some locations in Nablus City will provide time saving for the users, while for other locations the opposite was true.

A study conducted at Nablus City in 1998 measured the citizen's opinion in choosing the type of crossing facility *(Lafe & Badawi, 1999)*. The results illustrated in Figure 6-2 indicated that pedestrian preference for overpasses, occupied the overwhelming majority among other crossing facilities.

Figure 6-2: Percent of use for each type of crossing facility



6.4 Design considerations

In previous chapters the benefits associated with the installation of pedestrian overpasses were discussed. The other side of benefit cost guidelines, were the costs of pedestrian-overpasses. The design elements of the overpass were determined, in order to estimate the costs of such facilities.

To accomplish this target, a proposed design for pedestrian overpass in front of the Nablus Municipality was adopted. It should be mentioned that the Engineering Department in Nablus Municipality prepared this proposal.

The proposed design was the only available design for such structures, in spite that the problem of the conflict between pedestrians and vehicles is increasing at alarming rates in the Palestinian Territory. However, all the implemented improvement measures were based on short-term planning, traffic system management.

Therefore, this proposal was adopted to satisfy the purposes of this study, and it was considered as a typical design for the Palestinian Territory.

6.4.1 Design elements

The elements of the typical overpass were listed below. Architectural drawing for the overpass is available in Drawing No.1, Appendix (C).

6.4.1.1 Length

The length of the overpass was considered as a variable parameter, depending on the location of the overpass. The length covered the width of the roadway, median if available, and the staircases. Two staircases were considered for each overpass. A typical 3.0m staircase width was adopted.

Table 6-2 listed the length of each overpass for some of the locations considered in Nablus City. For the purpose of guideline development, different lengths were considered.

Table 6-2: Overpass length for some of the considered locations in Nablus City

Location	**Overpass length (m)**
C-1 & C-4	59.0
C-2 & C-3	28.4
C-5	17.5
C-6 South	13.3
C-7	15.1
C-8 North	19.2
C-9 West	22.0
F-1	19.0
F-2	19.0
F-3 South	18.0
O-1	22.0
O-2	21.5
O-3	21.5
O-4	19.0
O-5	27.0

Refer to Figure 3-2 for key abbreviations.

6.4.1.2 Width

Based on the design prepared by Nablus Municipality, a typical overpass width was considered as 3.0m.

A study conducted for Nablus City in 1998, analyzed and determined the most practical width for overpass and staircase *(Lafe & Badawi, 1999)*. The outcome for this study was very much the same as the value considered.

6.4.1.3 Vertical clearance

The clear height of an overpass is a matter of determination for the route as a whole. This height in turn may be governed by the standards of the system. Although various American state laws vary somewhat, most states permit the vehicle height, including load, to be between 4.1m and 4.4m.

The clear height of all structures above traveled way and shoulders should be at least 0.3 m greater than the legal height, and allowance should be made for future resurfacing.

The recommended minimum is 4.4m and the desirable is 5.0m *(AASHTO, 1994)*.

Based on the design prepared by Nablus Municipality, the vertical clearance for the proposed overpass was considered as 5.8m, which satisfied AASHTO requirements.

6.4.2 Overpass cover

Overpass should be enclosed to prevent the dropping of rocks or other debris onto vehicles passing below *(ITE, 1998)*. However, fences, railings or other physical barriers may also be used to prevent pedestrians from falling down.

For the considered overpass, a certain system of enclosing the sides and top of the overpass was considered. This system had several advantages: -

A. Prevents vehicles from dropping elements.

B. Protect the pedestrians either from falling down or weather constraints.

C. Provides good ventilation for pedestrians.

For more details of this system, please refer to Drawing No. 2 in Appendix (C).

6.4.3 Construction materials

6.4.3.1 Sub-structure and super structure

The construction of any structure is usually divided into two major phases: -

1. Sub-structure: Includes the excavation for foundations, construction of foundations, etc. up to the ground level.

2. Super-structure: Includes the construction of columns, stairs, slabs, etc. Usually, while choosing the construction material, it is recommended to utilize materials from local resources. Herein, in Palestinian Territory, reinforced concrete structures are commonly used.

Two types of reinforced concrete structures are available; cast in situ and pre-cast concrete. The advantages of pre-cast concrete over the cast in situ were explained below: -

- **Advantages of pre-casting**

The cast in situ concrete generally limits the rate of construction to about one meter per day. With that in mind, it certainly seems advantageous to use pre-casting, which usually allows the construction of one section per day, about 3m.

Pre-casting of segments has several other advantages: -

1. Avoidance of missed shrinkage effects; a major part of the shrinkage occurs before the placing of the segments in the structure (because segments are stockpiled for several weeks).
2. Reduction of long-term deformations due to creep, which decrease with concrete age when first loaded.
3. Reduction of construction delays, construction of the substructure.

4. Removal of concrete from weather constraints as pre-casting is carried out in a factory.
5. Saving of labor in comparison with other construction methods.
6. It also offers an excellent guarantee of the strength characteristics of the concrete, as the segments are cast under factory conditions *(Mathivat, 1983)*.

Based on the previous discussion, the construction material for sub-structure was considered as cast in situ concrete, while super-structure element were considered as pre-cast concrete.

6.4.3.2 Overpass cover

The material for overpass cover was considered to satisfy the requirements of the covering system, as mentioned in section 6.4.2.

Lixan material was considered, which has the following advantages: -

1. Transparent.
2. Nice appearance.
3. Flexible and tough (non-breakable).
4. Available in the local market.

6.4.4 Finishing touches

- Lighting system was considered to provide pedestrians with security during night times.
- Steel rails were considered to be installed in the streets, to prevent pedestrians from crossing at grade. Otherwise, pedestrians tend to cross at locations they believe to be more direct *(ITE, 1998)*.

The designed cross section, length, and location of the rails were available in Drawing No. 3 in Appendix (C).

The length of steel rails was estimated on the following basis: -

- Alternative I:

The length of steel rails must cover a distance greater than the overpass length, to discourage the pedestrian from crossing at grade.

Estimation of this alternative, resulted in maximum handrail length equals to 190.0m for each direction of flow.

- Alternative II

Transportation Research Board (TRB), described the distance that drivers expect to walk from parking to their desired destination. They recommended 300.0-400.0ft, (90.0-120.0m). This means, if the length of steel rails will be determined on this basis, it will be twice the recommended value, which equals to 240.0m for each direction of flow.

Therefore, as the maximum actual distance was less than the recommended distance, the later was considered.

6.5 Facility cost (FC)

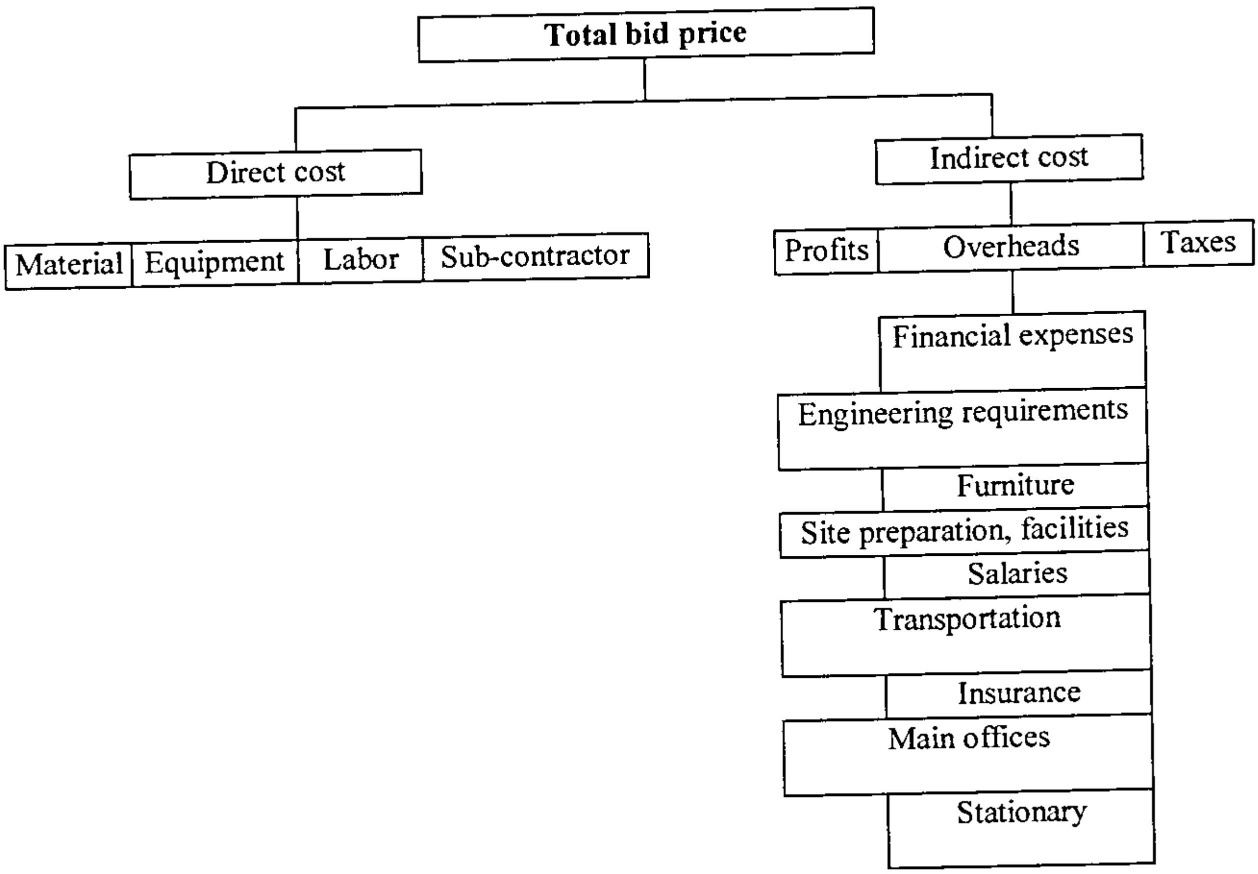
The cost of proposed overpass includes; construction costs, site preparation, finishing touches, operation and maintenance cost, in addition to steel rails *(ITE, 1998)*.

6.5.1 Overpass bid price

Construction costs, site preparation, finishing touches can be summed up by total bid price, which was estimated to be about U.S. Dollar 116,000.00, in year 2000 U.S. Dollar. The bill of quantity prepared to estimate this price was attached in Appendix (C). The cost appeared here was associated with the proposed overpass in front of Nablus Municipality.

The items included in this price were illustrated in Figure 6-3. Operation and maintenance costs were discussed in the following section.

Figure 6-3: Components of total bid price



It should be mentioned that profits and overheads were about 25 percent of total direct cost. Taxes composed of the Value of Added Taxes (VAT) which is equal to 17 percent.

6.5.2 Operation and maintenance costs

Usually, these costs composed of the following items *(ITE, 1998)*: -

1. Maintenance and repairs
2. Cleaning
3. Lighting

An annual operational and maintenance cost was considered as 1.5 percent of total bid price. This percentage was determined with reference to the experience of Nablus Municipality engineers.

It should be emphasized that the pre-cast concrete material has minimal maintenance cost relative to other materials.

6.6 Annual facility cost (AFC)

In order to develop benefit-cost guidelines, the facility annual cost was determined. Before estimating the annual costs, the cost was converted in terms of the 1996 U.S. Dollar, because the benefits were estimated in terms of same year U.S. Dollar. This was accomplished using equation 4.1, which yields in a total facility cost equals to U.S. Dollar 95,070.0 (1996 U.S. Dollar). As mentioned previously, this cost was estimated for the overpass in front of Nablus Municipality, which has a length of 59.0m.

For the purposes of guideline development, several lengths of overpasses were considered. Therefore, the overpass cost was estimated in terms of U.S. Dollar per meter length. This resulted in 1996 U.S. Dollar of 1267.0/L.M, excluding steel rails cost.

To determine the annual facility cost the following equation which was presented in Chapter Two was used *(Tarquin & Blank, 1976)*: -

$$A = P \left(\frac{i(1+i)^n}{(1+i)^n - 1} \right) \qquad \text{...........6.1}$$

where;

A: Equivalent uniform annual amount

P: Present worth

i: Interest rate

n: Number of interest periods, months, years, etc.

The term in the brackets called the capital-recovery factor. From Table 4-9, average interest rate was considered as 5.1 percent. The number of interest periods reflects the design period for the overpass. With reference to local consultants, design periods for concrete structures considered as 50 years.

Using previous information, the following costs were obtained: -

- Annual overpass cost (AOC) = U.S.$ 70.0/L.M.
- Annual maintenance cost (AMC) = F×AOC
- Annual steel rails cost (ARC) = U.S.$ 1,090.0

Annual facility cost (AFC) = AOC+AMC+ARC..........6.2

Where; F is a conversion factor which was used to convert the maintenance direct cost into annual maintenance cost.

F = Percentage of annual maintenance cost[1]/Capital-recover factor[2]

$$F = 0.015/0.0556$$

$$F = 0.2698$$

More details about the estimation of previous costs and conversion factor were presented in Appendix (A).

In Table 6-3 annual facility cost for some of the considered locations in Nablus City was summarized.

1: As was determined in page 122.

2: This factor was estimated based on equation 6.1.

Table 6-3: Annual facility cost for some of the considered locations in Nablus City

Location	AFC ($)
C-1 & C-4	6,415.0
C-2 & C-3	3,615.0
C-5	2,601.0
C-6 South	2,239.0
C-7	2,394.0
C-8 North	2,748.0
C-9 West	2,904.0
F-1	2,731.0
F-2	2,731.0
F-3 South	2,645.0
O-1	2,990.0
O-2	2,947.0
O-3	2,947.0
O-4	2,730.0
O-5	3,422.0

Refer to Figure 3-2 for key abbreviations.

In this chapter the annual cost associated with installing pedestrian-overpasses were determined. Combining the results of this chapter with those of previous chapters, benefits-cost guidelines were established as presented in Chapter Seven.

Chapter Seven

Guidelines for Installing Pedestrian-Overpass

7.1 Introduction

Previous chapters presented the benefits and costs associated with adding pedestrian overpasses. In this chapter the development of guidelines was presented.

Pedestrian overpass guidelines can be a set of specifications that define the boundary between two regions, the installation of overpass will lead to better service for that portion of the traffic stream that is of interest in one region. In the other region, the converse will also hold true. The concept of better service manifests itself by reducing the average or maximum delay, a reduction in the probability of stops or a reduction in accident potential *(King, 1977)*.

In this study, the guidelines were developed based on benefit-cost analysis. Consequently, the following guidelines were developed: -

1. Accidents guideline.
2. Pedestrians delay guideline.
3. Combination of guidelines.

7.2 Current pedestrian-overpass warrants

According to a 1988 synthesis study by Zegeer and Zegeer, state and local government agencies consider grade-separated crossings to be most beneficial under the following conditions *(ITE, 1998)*: -

- Where there is moderate to high pedestrian demand to cross a freeway or expressway.
- Where there are a large number of young children (i.e., particularly near schools) who must regularly cross a high-speed or high-volume roadway.
- On streets having high vehicle volumes and high pedestrian crossing volumes and where there is an extreme hazard for pedestrians, e.g., on wide streets with high-speed traffic and poor sight distance.
- Where one or more of the conditions stated above exists in conjunction with a well-defined pedestrian origin and destination (e.g., a residential neighborhood across busy street from a school, a parking structure affiliated with a university, or an apartment complex near a shopping mall).

While these criteria are somewhat general they do provide important factors for designers, planners, and developers to consider in determining where pedestrian facilities should be constructed.

More specific warrants were developed by Axler in 1984 for grade-separated pedestrian crossings *(ITE, 1998)*: -

1. The pedestrian hourly volume should be more than 300 in the four highest continuous hour periods if the vehicle speed is more than 40 mph and the proposed sites are in urban areas and not over or under a freeway. Otherwise, the pedestrian volume should be more than 100 pedestrians in the four highest continuous hour periods.
2. Vehicle volume should be more than 10,000 in the same four-hour period used for the pedestrian volume warrant or have an ADT greater than 35,000 if vehicle speed is over 40 mph and the proposed site(s) are in urban areas. If these two conditions are not met, the vehicle volume should be more than 7,500 in the four hours or have an ADT greater than 25,000.
3. The proposed site should be at least 600 feet from the nearest alternative "safe" crossing. A "safe" crossing is defined as a location where traffic control device stops vehicles to create adequate gaps for pedestrians to cross. Another "safe" crossing is an existing overpass or underpass near the proposed facility.
4. A physical barrier is desirable to prohibit at-grade crossing of the roadway as part of the overpass or underpass design plan.

5. Artificial lighting should be provided to reduce potential crime against users of the underpasses or overpasses. It may be appropriate to light underpasses 24 hours a day and overpasses at nighttime.
6. Topography of the proposed site should be such as to minimize changes in elevation for users of overpasses and underpasses and to help ensure that construction costs are not excessive. Elevation change is a factor that affects the convenience of users.
7. A specific need may exist for a grade-separated crossing based on the existing or proposed land use(s) adjoining the proposed development site that generates pedestrian trips. This land use should have a direct access to the grade-separated facility.
8. Funding for construction of the pedestrian overpass or underpass must be available prior to a commitment to construct it.

7.3 Benefit cost analysis

The lack of pedestrian-overpass warrants based on economical analysis brought out the concept of this thesis. In order to develop the required guidelines, the concept of benefit-cost ratio was adopted.

The benefit-cost ratio expresses the comparative worth of project by the ratio of the annual benefits to the annual costs *(Bhesania, 1991)*.

Thus;

$$\text{Benefit-cost ratio} = B/C \text{..........} 7.1$$

where;

B: Annual benefits of pedestrian accident and/or delay savings.

C: Annual construction costs of overpass.

Two types of benefits were considered, first, elimination of crossing pedestrian accidents, second, elimination of pedestrian waiting times to cross the roadway. For each type, the annual benefits were discussed in Chapter Four and Chapter Five, respectively.

Overpass construction cost was estimated in Chapter Six for each roadway width, under what so-called annual facility cost (AFC).

Based on this analysis, pedestrian accident and delay guidelines were developed. In addition, benefit-cost ratio was estimated for the proposed locations in Nablus City as presented in the following section.

7.3.1 Benefit-cost ratio for proposed locations in Nablus City

Utilizing the results obtained from Chapter Four, Five, and Six, benefit-cost ratio was estimated for the proposed locations in Nablus City.

In the case of pedestrian accidents Table 4-1 listed the number of accidents, casualties, and type of casualties. Based on casualty cost presented in Table 4-11, annual accident cost (AAC) was estimated. AFC for each location was presented in Chapter Six, then B/C was estimated and the results were summarized in Table 7-1 and illustrated in Figure 7-1.

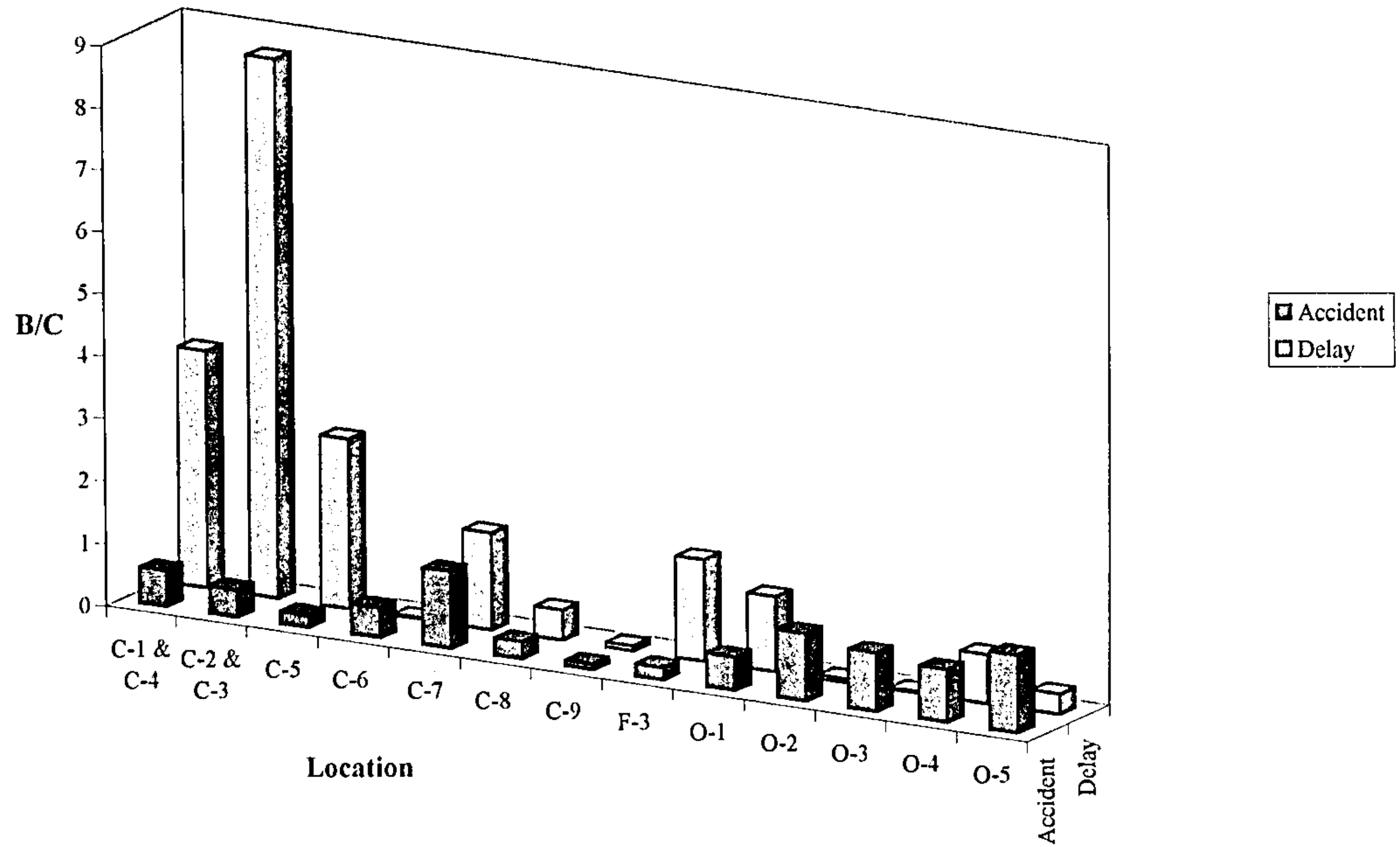
In the case of pedestrian delay, pedestrian waiting times for the selected locations were estimated and presented in Chapter Five. An annual benefit of delay (ADB) was estimated according to the methodology presented in Figure 5-7. AFC for each location was presented in Chapter Six. Utilizing this data, B/C was estimated and the results were presented Table 7-1, and Figure 7-1.

Table 7-1: Benefit-cost ratio for the proposed locations in Nablus City

Location	AFC	Accident guideline		Delay guideline	
		AAB	B/C	ADB	B/C
C-1 & C-4	6,415.0	3,703.0	0.58	24,303.00	3.79
C-2 & C-3	3,615.0	1,604.0	0.44	31,330.00	8.67
C-5	2,601.0	506.0	0.20	7,070.00	2.72
C-6	2,239.0	1,081.0	0.48	40.22	0.02
C-7	2,394.0	2,963.0	1.24	3,730.47	1.56
C-8	2,748.0	758.0	0.28	1,336.79	0.49
C-9	2,904.0	253.0	0.09	231.87	0.08
F-3	2,645.0	523.0	0.20	4,323.79	1.64
O-1	2,990.0	1,604.0	0.54	3,618.98	1.21
O-2	2,947.0	3,198.0	1.09	172.88	0.06
O-3	2,947.0	2,812.0	0.95	86.31	0.03
O-4	2,730.0	2,319.0	0.85	2,168.94	0.79
O-5	3,422.0	4,285.0	1.25	1,114.34	0.33

Refer to Figure 3-2 for key abbreviations.

Figure 7-1: Comparison of benefit-cost ratios for Nablus City



With respect to accident guideline, Haifa Street (O-5) recorded the highest B/C ratio, while the minimum B/C ratio was recorded at the west approach of Sufian-Hamdi Kan'an intersection (C-9).

Regarding the delay guideline, the highest B/C ratio was recorded at the locations in front of Al-Watani Hospital and in its opposite side (C-2, C-3), while the minimum B/C ratio was recorded at the south approach of Hitten intersection (C-6). These results indicated that the delay parameter is more critical than accident parameter within the CBD area, and vice versa.

7.4 Development of pedestrian-accident guideline (Guideline I)

Different issues related to pedestrian accidents were discussed and analyzed in Chapter Four. Based on this analysis and the concept of benefit-cost ratio, accident guideline was developed as presented in the following sub-sections.

7.4.1 Guideline based on accident history of the location

For each roadway width, the annual facility cost (AFC) was estimated, according to the methodology presented in Chapter Six. In order to determine whether the considered location was justified for installing pedestrian-overpass or not, the annual casualties cost must be greater than or equal AFC. Therefore, minimum number of annual casualties (C_{min}) was determined to satisfy this objective. For the purpose of guideline development, different roadway width (including median width) was considered (6.0m-49.0m).

This methodology was presented through procedure A, as follows: -

Procedure A,

1. Roadway width =.. $X_{i=a-n}$

   (In this study a = 6.0, n = 49.0m, an iterative process, as stated previously)

2. AFC (equation 6.2) =... Y
3. Cost of slight injury (Table 4-11) =...................................Z
4. Min. number of slight injuries required to justify overpass =......Y/Z
5. Repeat the steps 1-4 for different roadway widths.
6. Plot the points between the number of injuries vs. roadway width.
7. Repeat the steps 1-6 for all types of casualties.

Numerical example could be found in Appendix (A) to illustrate the previous methodology.

Based on the annual number of casualties, type of each casualty, and roadway width, the minimum number of casualties that justify the overpass can be read, as presented in Figure 7-2. If the actual number of casualties exceeds this value, the overpass is justified. Figure 7-2a &b were drawn only in order to make the curves more clear.

Figure 7-2: Accident guideline

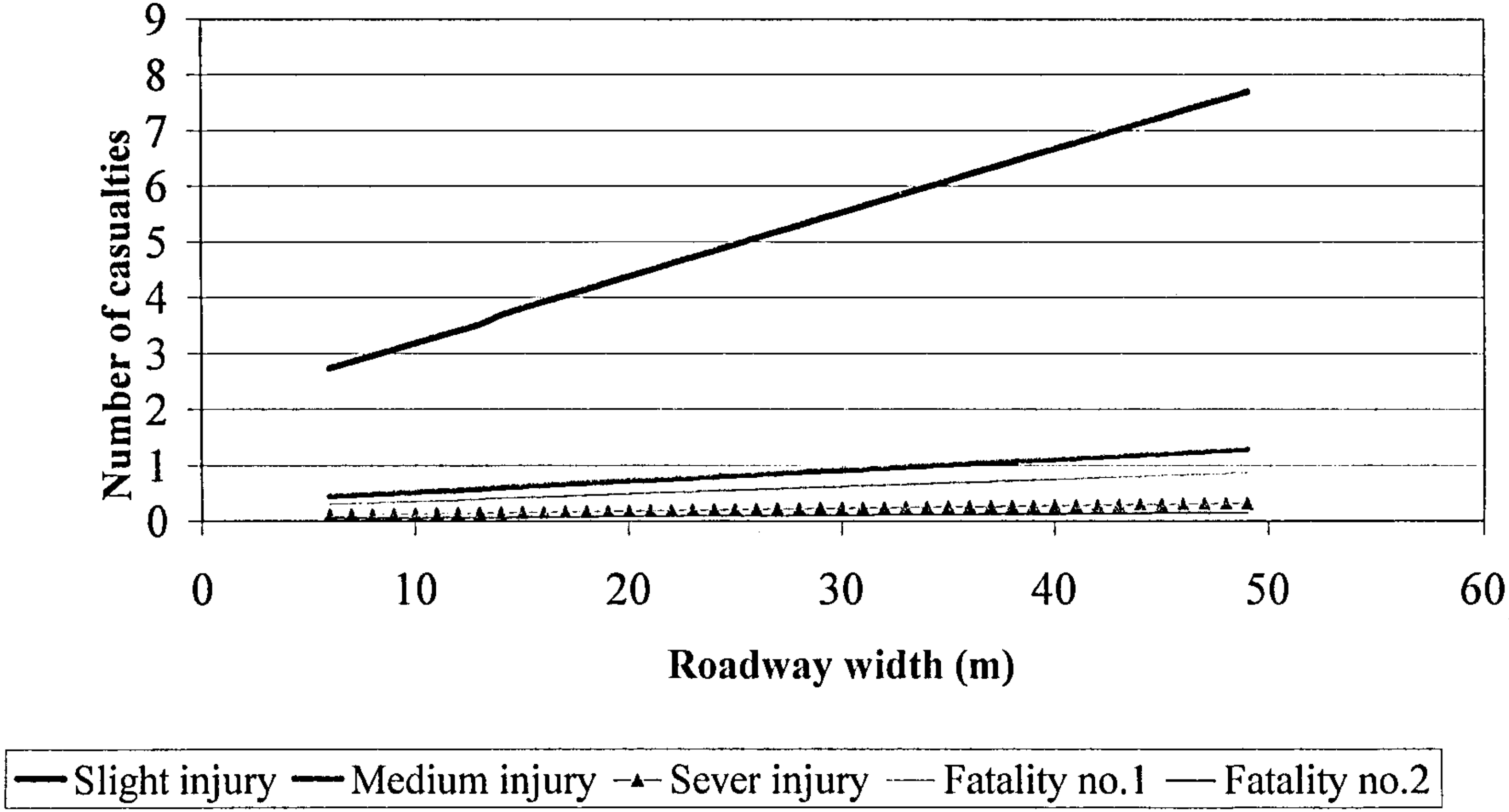


Figure 7-2a: Accident guideline (for injuries)

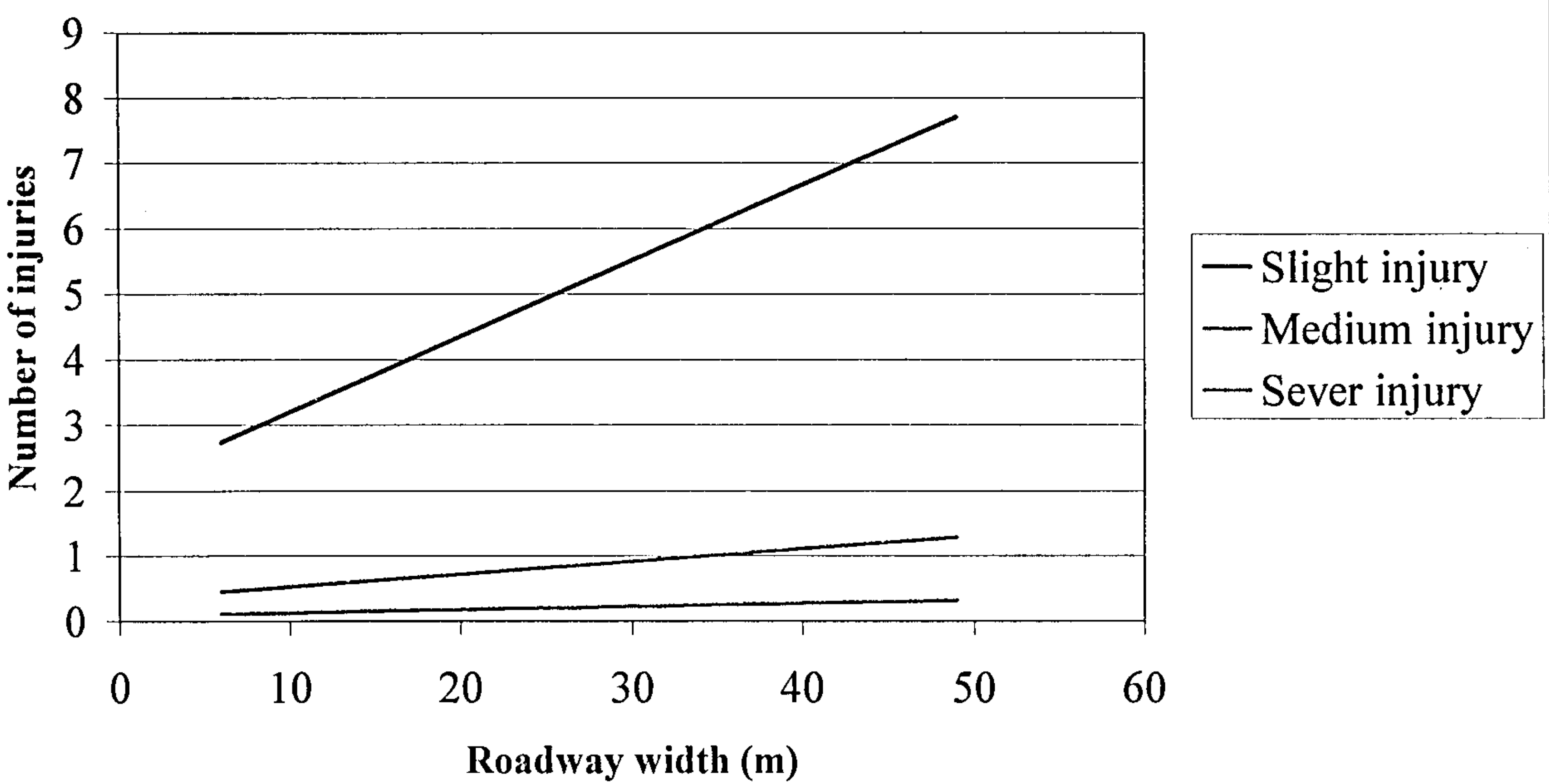


Figure 7-2b: Accident guideline (for fatalities)

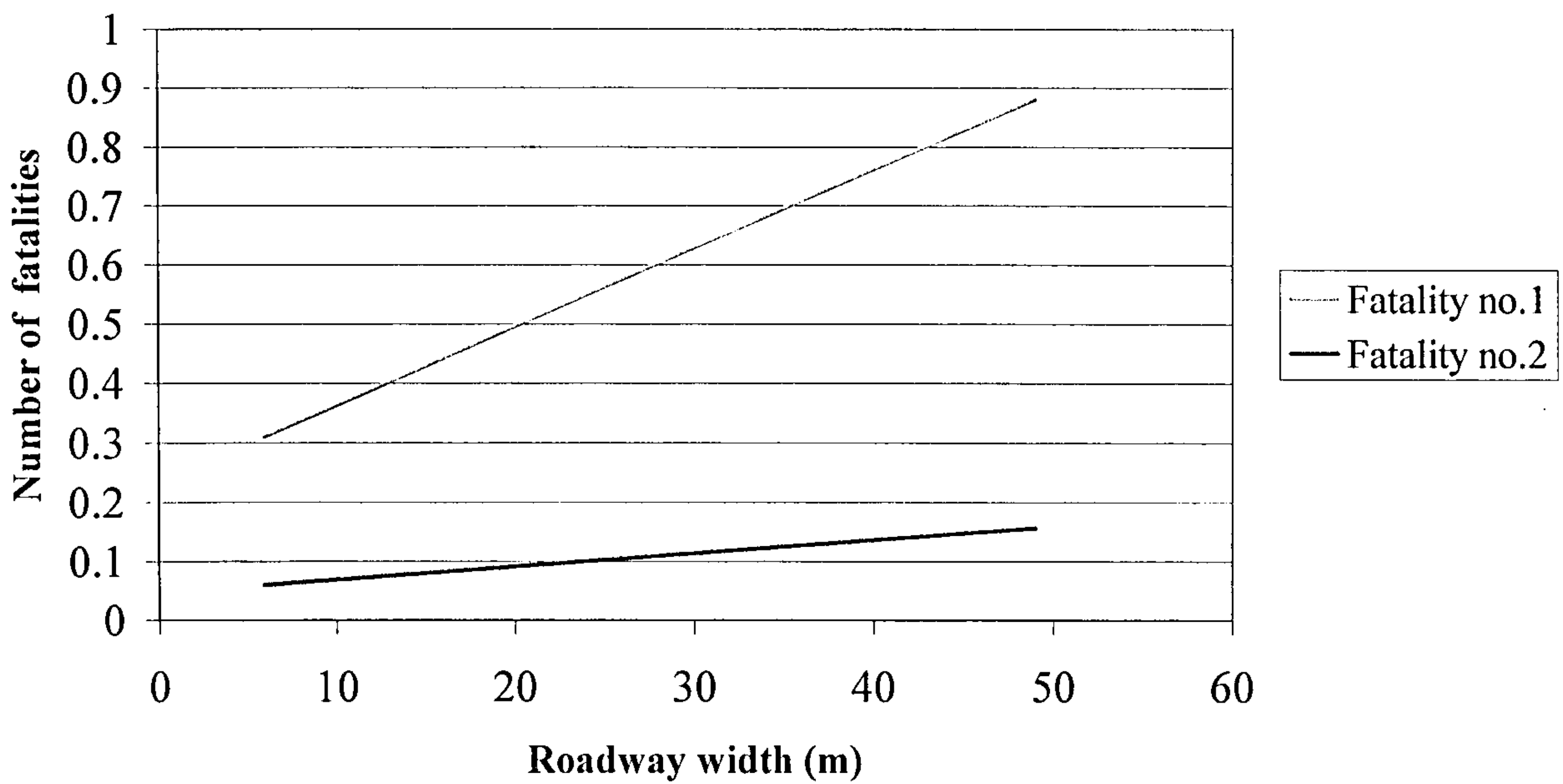


Figure 7-2 indicated that fatality no.1 was less critical than sever injury. This was because the cost of sever injury was more than the cost of fatality no.1, as was presented in Table 4-11.

Based on the proposed guidelines and in any case, the average annual minimum number of each casualty required to satisfy the guideline should be greater than the values stated in Table 7-2.

Table 7-2: Least number of injuries for accident guideline

Severity	No. of injuries per year
Slight	2.7
Medium	0.46
Sever	0.12
Fatality no.1	0.31
Fatality no.2	0.06

The values in Table 7-2 and the ranking of curves in Figure 7-2 reflected the corresponding costs of each type of casualties. For example, the cost of slight injury was the minimum cost in comparison to other types of casualties (Table 4-11), thus, the minimum required number of slight injuries were higher than others, and so forth.

It can be concluded from Table 7-2 that the least number of sever injuries, for example, required to satisfy the accident guideline was approximately one sever injury in eight years at the specified location, i.e., an overpass should be installed if one sever accident occurs in eight years. Since the analysis of the proposed guidelines was based only on the concept of benefit-cost analysis and did not consider any other concepts, the results of Table 7-2 for sever injuries, fatality no.1, and fatality no.2 were not practical. This was because these results indicated that an overpass must be installed for most of the locations. Even in developed countries accident records remain active for approximately five years. Beyond that they are archived in a "dead file". Therefore, caution must be considered when the proposed accident guideline is used, since they were developed based only on economical analysis.

In Figure 7-2, each curve refers to different type of casualty. In the case that the location experienced different types of casualties at the same year, the following procedure could be used: -

Procedure B,

1. Actual roadway width =..W
2. Actual number of slight, medium injury,....fatality no.2 =..........A, B, C, D, & E.
3. C_{min} for each casualty type (Figure 7-2) = Cs_{min}[1], Cm_{min}, Csv_{min}, $Cf1_{min}$, & $Cf2_{min}$
4. Percentage satisfied for each casualty = A/ Cs_{min}, B/ Cm_{min} .....etc.

1: Minimum number of slight injury, and so forth.

5. If the summation of step 4 ≥ 100 percent, installation of the overpass is justified.
6. If not, it is not justified to install pedestrian overpass.

Numerical example could be found in Appendix (A) to illustrate the procedure B.

From the accident guideline, it was seen that as the width of roadway increases, the minimum required number of casualty increases. This is because as the roadway width increases the length of overpass increases, thus its associated cost increases. Hence, the benefits required to emulate the costs increase, consequently, the minimum required number of casualties increases.

7.4.2 Accident guideline applicability

The results of accident guideline is used in the following cases: -

1. If the user had been provided by accident history for the considered locations.
2. If this history includes information such as type of casualties and the number of each type.

3. If the average cost of casualty is available (such as the costs presented in Table 4-11).

4. If the roadway width is determined.

7.5 Development of pedestrian delay guideline (Guideline II)

Based on the methodology presented in Figure 5-7 different matrices were developed in order to estimate the annual cost of pedestrian delay (ADC). An example was presented in Appendix (D) for 10.0m-divided roadway.

7.5.1 Benefit-cost ratio (B/C)

Annual benefits of improvements were estimated on the basis of the assumption that; pedestrian using the overpass to cross the roadway will not wait for adequate gap to cross the roadway. Therefore, ADC was considered as annual benefits from savings in pedestrian delay (ADB), after the installation of the overpass.

For each roadway width, annual facility cost (AFC) was estimated, according to the methodology presented in Chapter Six.

Thus,

$$B/C = ADB/AFC \quad \ldots\ldots\ldots\ldots 7.2$$

Table 7-3 listed some values of B/C for 10.0m-undivided roadway and 10.0m-divided roadway. The values of benefit-cost ratio were higher in the case of undivided roadway, because the pedestrian waiting time at these roadways is higher than those at divided roadway.

7.5.2 Proposed pedestrian delay guideline

From the values presented in Table 7-3, B/C equal or greater than one indicated that, annual savings in pedestrian delay were equal or more than the costs associated with installing pedestrian overpass. Based on this analysis, it was justified to install pedestrian overpass for such cases.

In order to present the pedestrian delay guideline in a readable and simple way, each value of B/C was related to its corresponding traffic parameters. A curve was then drawn for 12-hour pedestrian volume vs. 12-hour vehicular volume. This curve divided the area into two regions, justified and not justified.

An example of pedestrian delay guideline was presented in Figure 7-3 and Figure 7-4, for the two cases presented previously. The complete set of guidelines could be found in Appendix (D).

From these guidelines, pedestrian and vehicular volumes that justified the installation of overpass, for each roadway width could be determined.

Table 7-3: B/C for 10.0m-undivided roadway and 10.0m-divided roadway

12hr. veh. vol.	2400	4800	7200	9600	12000	14400	16800	2400	4800	7200	9600	12000	14400
12hr. ped. vol.	**B/C for 10.0m undivided roadway**							**B/C for 10.0m divided roadway**					
200	0.01	0.02	0.04	0.06	0.09	0.14	0.20	0.00	0.01	0.01	0.02	0.02	0.03
400	0.02	0.04	0.08	0.12	0.19	0.28	0.41	0.01	0.01	0.02	0.03	0.05	0.06
800	0.04	0.09	0.16	0.25	0.37	0.55	0.81	0.01	0.02	0.04	0.06	0.09	0.13
1000	0.05	0.11	0.20	0.31	0.47	0.69	1.01	0.01	0.03	0.05	0.08	0.11	0.16
1400	0.07	0.16	0.28	0.44	0.66	0.97	1.42	0.02	0.04	0.07	0.11	0.16	0.22
1600	0.08	0.18	0.31	0.50	0.75	1.10	1.62	0.02	0.05	0.08	0.13	0.18	0.26
1800	0.09	0.20	0.35	0.56	0.84	1.24	1.82	0.02	0.06	0.09	0.14	0.21	0.29
2200	0.11	0.25	0.43	0.68	1.03	1.52	2.23	0.03	0.07	0.12	0.18	0.25	0.35
2400	0.12	0.27	0.47	0.75	1.12	1.66	2.43	0.03	0.07	0.13	0.19	0.28	0.38
2600	0.12	0.29	0.51	0.81	1.22	1.79	2.63	0.04	0.08	0.14	0.21	0.30	0.42
2800	0.13	0.31	0.55	0.87	1.31	1.93	2.84	0.04	0.09	0.15	0.22	0.32	0.45
3000	0.14	0.33	0.59	0.93	1.41	2.07	3.04	0.04	0.09	0.16	0.24	0.34	0.48
3200	0.15	0.36	0.63	1.00	1.50	2.21	3.24	0.04	0.10	0.17	0.26	0.37	0.51
3600	0.17	0.40	0.71	1.12	1.69	2.49	3.65	0.05	0.11	0.19	0.29	0.41	0.58
3800	0.18	0.42	0.75	1.18	1.78	2.62	3.85	0.05	0.12	0.20	0.30	0.44	0.61
4000	0.19	0.45	0.79	1.24	1.87	2.76	4.05	0.05	0.12	0.21	0.32	0.46	0.64
9000	0.43	1.00	1.77	2.80	4.22	6.21	9.12	0.12	0.28	0.47	0.72	1.03	1.44
11000	0.53	1.23	2.16	3.42	5.15	7.59	11.15	0.15	0.34	0.58	0.88	1.26	1.76
13000	0.62	1.45	2.55	4.04	6.09	8.97	13.17	0.18	0.40	0.68	1.04	1.49	2.08
17000	0.82	1.90	3.34	5.29	7.96	11.73	17.23	0.23	0.52	0.89	1.36	1.95	2.72
19000	0.91	2.12	3.73	5.91	8.90	13.12	19.25	0.26	0.58	1.00	1.52	2.18	3.04
21000	1.01	2.34	4.13	6.53	9.84	14.50	21.28	0.28	0.65	1.10	1.68	2.41	3.36
23000	1.10	2.57	4.52	7.15	10.77	15.88	23.31	0.31	0.71	1.21	1.84	2.64	3.67

Figure 7-3: Pedestrian delay guideline, 10.0m undivided roadway

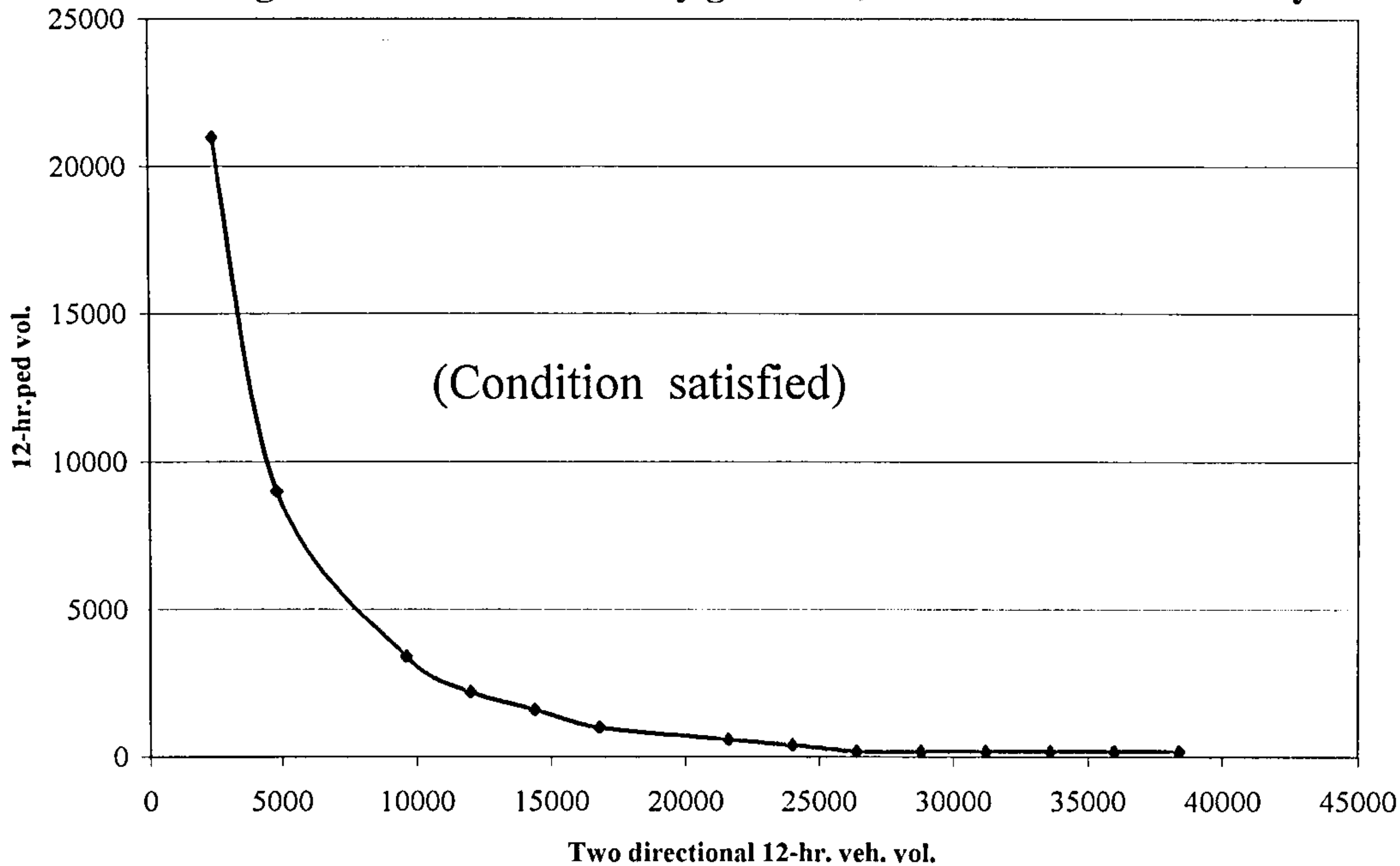


Figure 7-4: Pedestrian delay guideline, 10.0m divided roadway 1.0m median

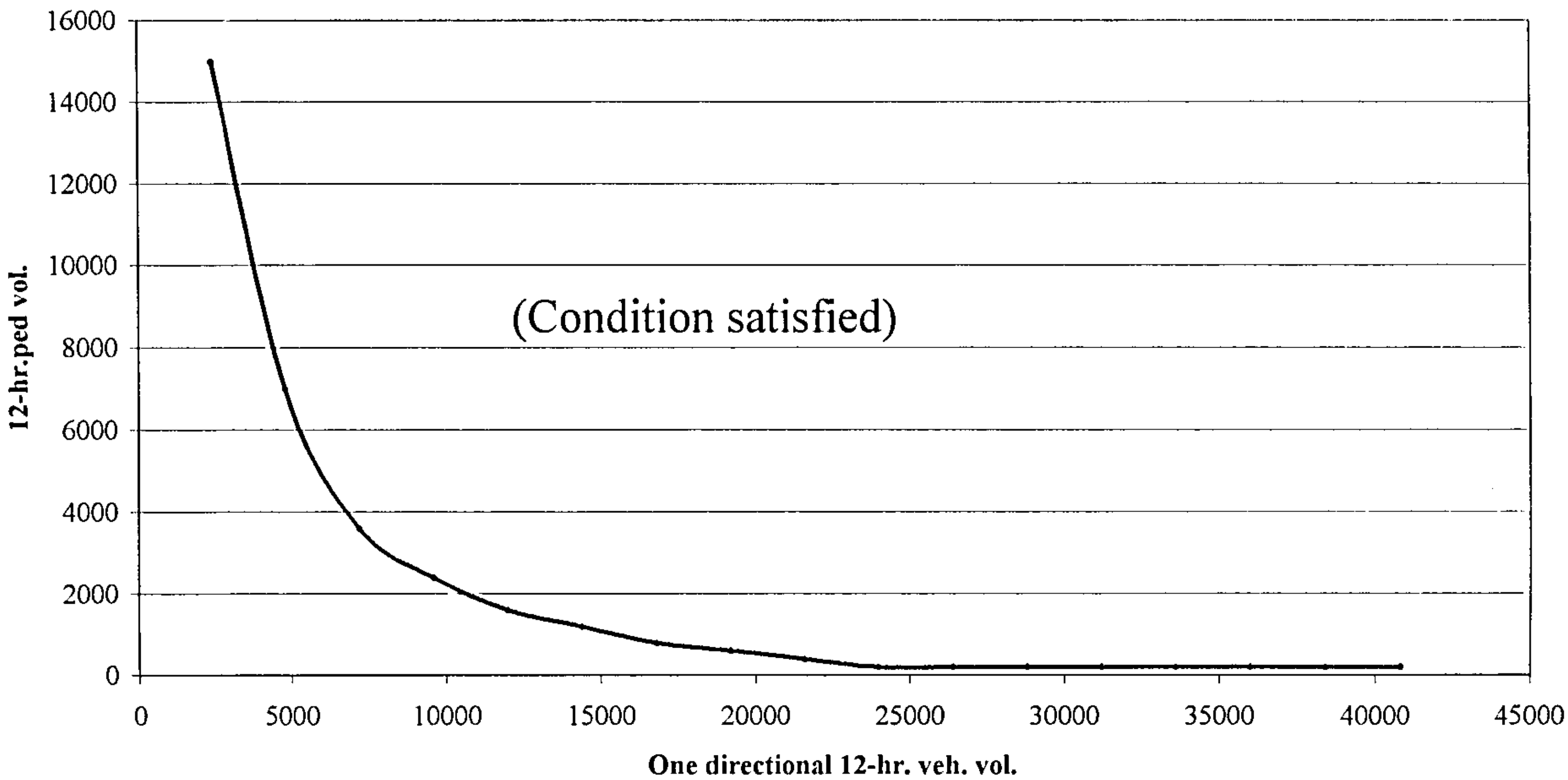


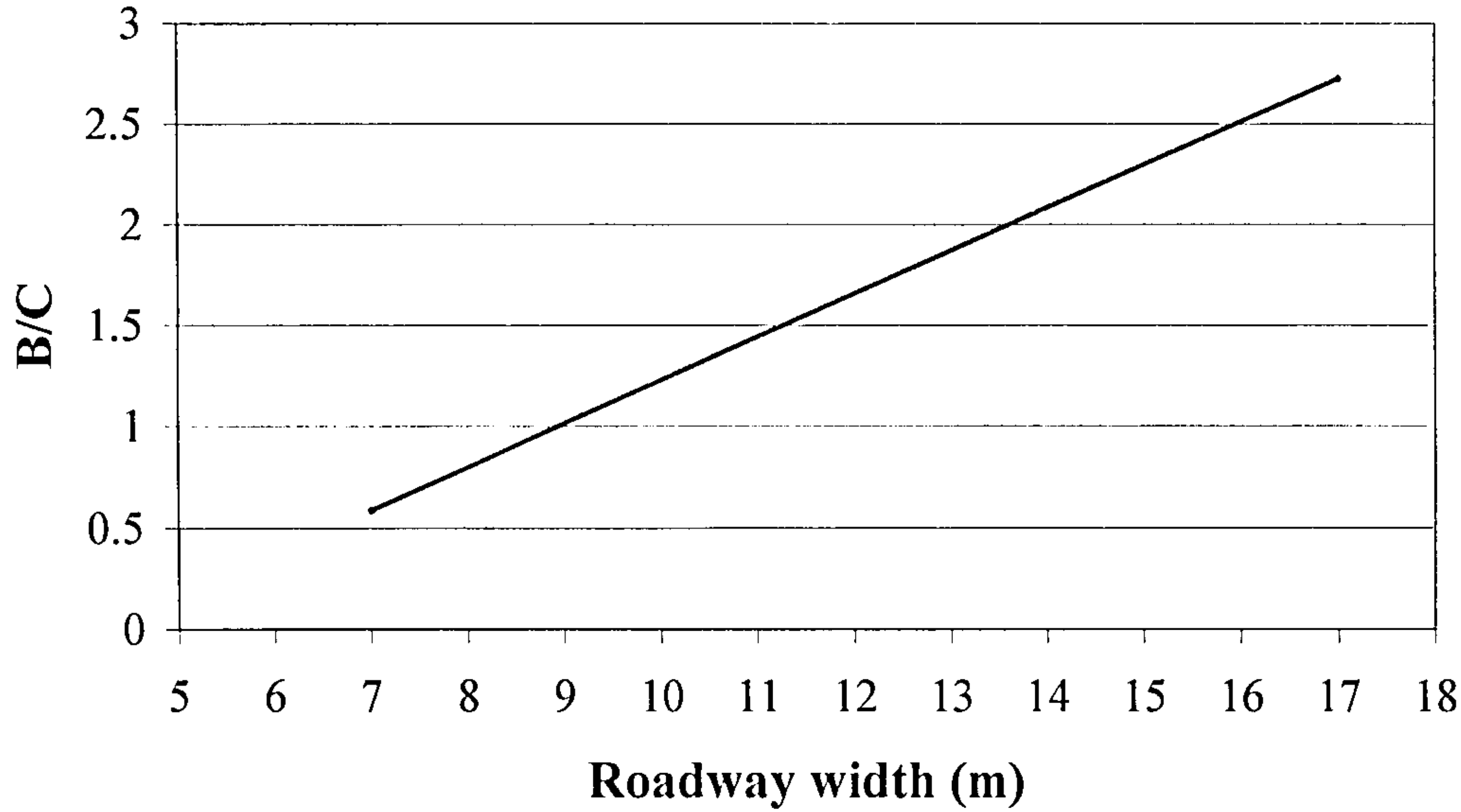
Figure 7-3 and Figure 7-4 indicated that as roadway width increases, waiting time increases, thus the annual savings (benefits) were increased. As a result the guideline could be satisfied at lesser values of traffic parameters.

At the same combination of vehicular and pedestrian volumes, as the roadway increases the benefits and costs increase, consequently the benefit-cost ratio is increased. Table 7-4 and Figure 7-5 illustrated an example for the change of roadway width with respect to B/C. This example was accomplished for 12-hour vehicular and pedestrian volumes equal to 2400.0 and 23,000.0, respectively.

Table 7-4: The change of roadway width with respect to B/C

Roadway width (m)	**B/C**
7.0	0.59
8.0	0.75
9.0	0.92
10.0	1.10
11.0	1.23
12.0	1.52
13.0	1.74
14.0	1.95
15.0	2.2
16.0	2.48
17.0	2.73

Figure 7-5: Change of roadway width with respect to B/C



The figure was built based on: 12-hr. vehicular volume = 2400 and 12-hr. pedestrian volume = 23000

To satisfy the conditions of the guideline for the overpass at low values of vehicular volumes, high pedestrian volume is required, and visa versa. This result was clear in the shape of delay guideline as it declines with the increase of vehicular volume.

At the same roadway width, the little increment of median width has a marginal effect on the resulted guideline, an example for 7.0m roadway width per direction was presented in Figure 7-6. As the difference between the median widths increases the difference between the value of traffic parameters required to justify the installation of overpass increases. This was illustrated in Figure 7-7 for 12.0m roadway width per direction.

For undivided roadways and in any of the proposed cases, the least combination of vehicular and pedestrian 12-hour volumes that satisfies the guideline was equal to 2,400.0 & 9,000.0, respectively. While in the case of divided roadways the least combination was equal to 2,400.0 & 15,000.0, respectively.

Thus far, the analysis for proposed guidelines had addressed the pedestrian delay that had occurred while pedestrian wait for acceptable gaps in traffic.

Figure 7-6: Delay guideline for 1.0 & 3.0m median width, 7.0m roadway width

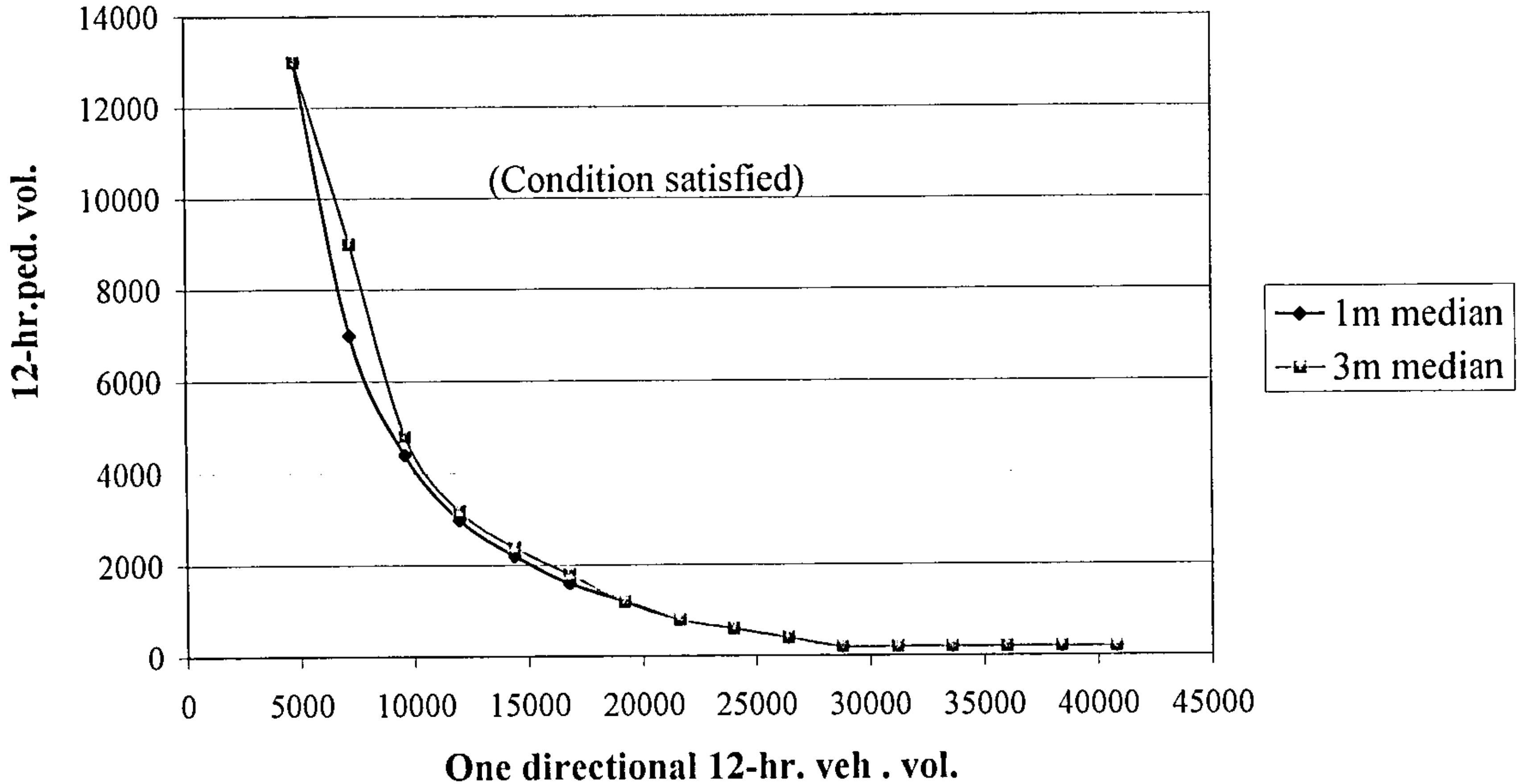
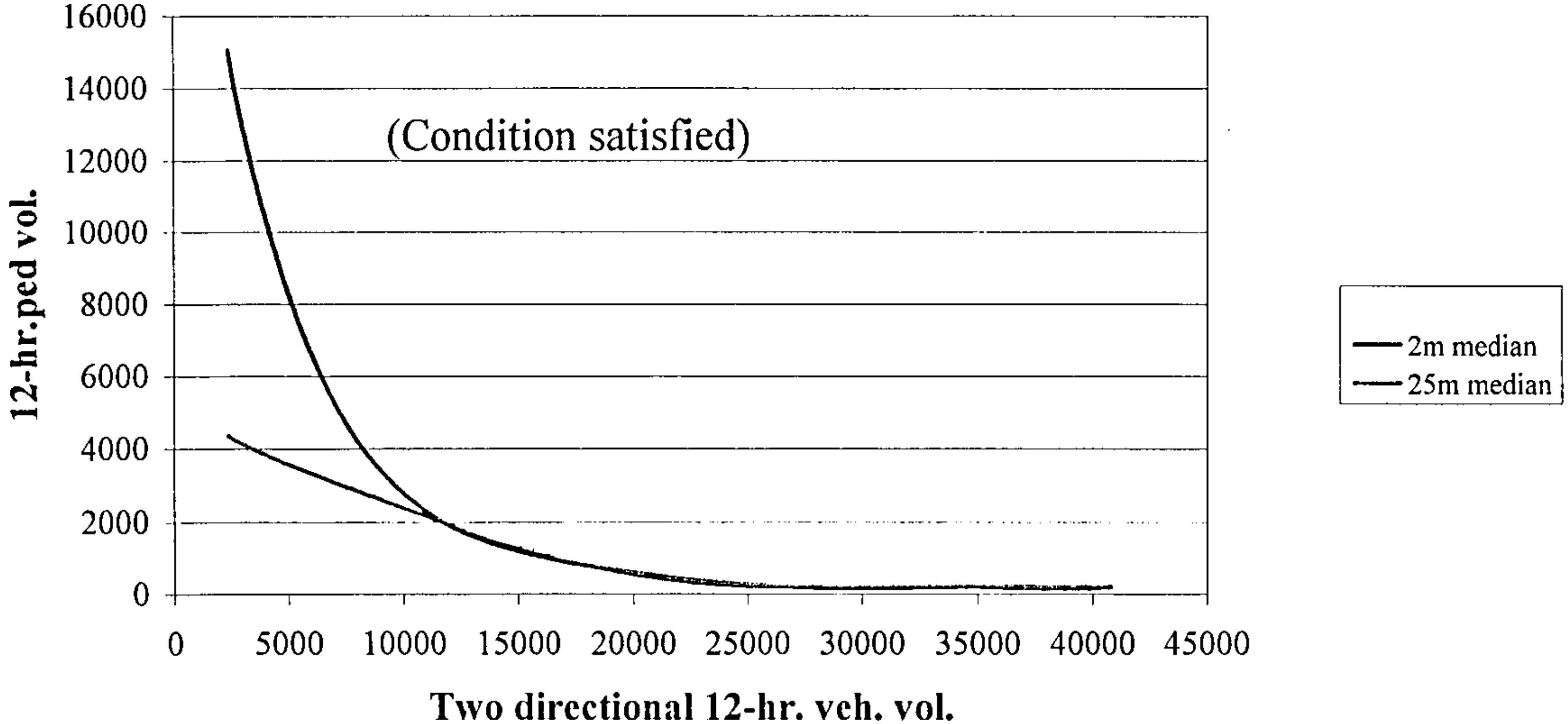


Figure 7-7: Delay guideline for 2.0 & 25.0m median width, 12.0m roadway width



7.6 Combination of guidelines (Guideline III)

In certain cases, pedestrian-overpasses occasionally may be justified where no single guideline is satisfied. But in certain cases a combination of two cases may justify the guideline in accordance to benefit-cost ratio. To determine to what extent each guideline was satisfied, the following equations were developed: -

$$A_E = n/n_{min} \ldots\ldots\ldots\ldots 7.3$$

$$D_E = Pv/Pv_{min} \ldots\ldots\ldots\ldots 7.4$$

where;

A_E: Extent of accident guideline.

n: Observed number of injuries.

n_{min}: Minimum number of injuries required to satisfy the guideline, (Figure 7-2).

D_E: Extent of delay guideline.

Pv: Observed pedestrian volume.

Pv_{min}: Minimum pedestrian volume required to satisfy the guidelines, measured at the observed vehicular volume, Appendix (D).

In the case of guideline combination the following equation must be satisfied: -

$$A_E + D_E = 1.0 \ldots\ldots\ldots\ldots 7.5$$

Equation 7.5 was developed based on the concept of benefit-cost analysis, which justifies the installation of overpass when the benefit-cost ratio is greater than or equal to one. Consequently, in the case of a single guideline, the benefits associated with that guideline forms 100 percent of the cost. While, in the case of guideline combination, the summation of both accident and delay savings (benefits) must be equal to 100 percent.

The concept of guidelines combination was presented in terms of equations and not in the form of figures as in the case of each separate guideline. This was because the inputs to the developed figures for accident guideline were not similar to those for delay guideline, which made the combination of those figures not easy. To clarify the concept of guidelines combination, numerical example was presented in Appendix (A).

7.7 Guidelines application for Nablus City

The previously developed guidelines were applied for the selected locations in Nablus City, the results were summarized in Table 7-5.

Table 7-5: Pedestrian-overpass justified locations in Nablus City

Location	Accident guideline	Delay guideline	Combination of guidelines
C-1 & C-4		✓	
C-2 & C-3		✓	
C-5		✓	
C-6			
C-7	✓	✓	
C-8			
C-9			
F-1		✓	
F-2		✓	
F-3 North			
F-3 South		✓	
F-3 East			
F-3 West			
O-1		✓	
O-2	✓		
O-3			
O-4			✓
O-5	✓		

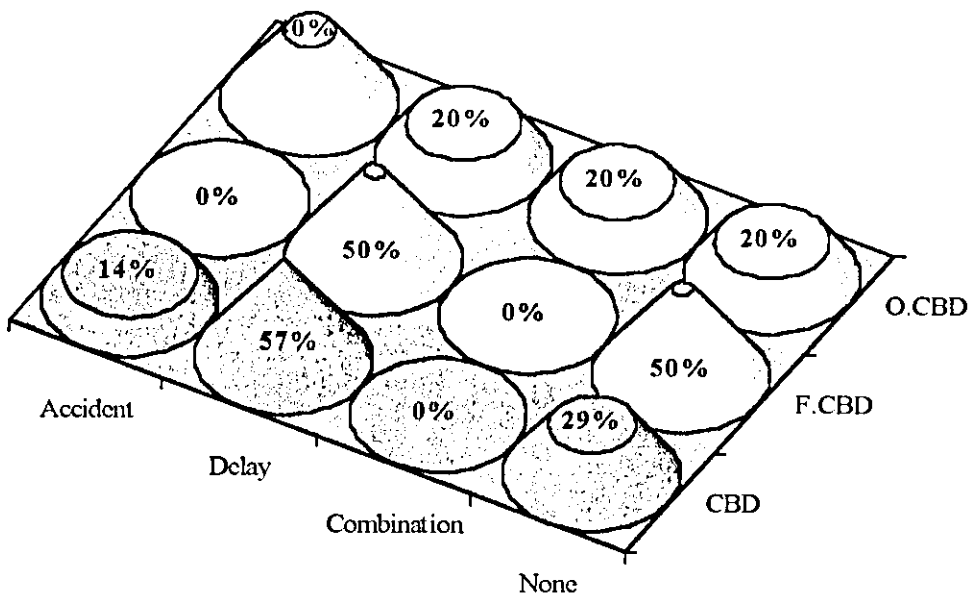
Refer to Figure 3-2 for key abbreviations.

About 73 percent of the selected locations were justified for installing pedestrian-overpasses. From those locations, about 53 percent were justified according to delay guideline, 20 percent according to accident guideline, while combination of guidelines formed 6 percent.

Based on accident guideline, the locations out of CBD area were more justified for installing pedestrian-overpass, than the delay guideline. While, for locations in the CBD area and at the fringes of CBD, delay guideline was more applicable than accident guideline as was stated before in Chapter four and five. This result was clarified in Figure 7-8.

These results were confirmed with the previous ones mentioned in Chapter Four and Five. Which stated that the CBD area experienced delay more than accidents, and vice versa for out of CBD area.

Figure 7-8: Ranking of guidelines by location for Nablus City



7.8 Guidelines statement

Based on benefit-cost analysis, this study proposed guidelines for justifying the installation of pedestrian overpass in unsignalized urban areas. These guidelines are as follows: -

Guideline I: Based on the pedestrian accident experience.

Guideline II: Based on pedestrian delay (waiting time).

Guideline III: Based on the combination of accident and delay guidelines.

7.8.1 Guidelines assumptions

The proposed guidelines were developed based on the following assumptions: -

- **General assumptions**

1. Annual facility cost equals to U.S. Dollar 1246.0/L.M, in 1996 Dollars.
2. The guidelines were applied for unsignalized urban areas.

- **Assumptions for pedestrian accident guidelines**

1. Cost of each type of casualty as presented in Table 4-11.

- **Assumptions for pedestrian delay guidelines**

1. Average pedestrian walking speed equals to 1.35m/sec.
2. Percentage of working trips equals to 37.5 percent.
3. Average working hours equals to 8.0 hours/day.

4. Average working days equals to 313.0 day/year.

5. Average daily wage equals to U.S. Dollars 16.55 in 1996 Dollars.

7.8.2 Required engineering studies

Pedestrian-overpass guidelines require engineering studies to determine the data that should be obtained to justify the installation of overpass.

- **Studies that provide such data for guideline I include: -**

1. Roadway width.
2. Accident history includes type, location, number of casualties, and severity for at least one year, or

- **Studies that provide such data for guideline II include: -**

1. Traffic volumes (vehicular and pedestrian).
2. Roadway inventory study (width, divided or undivided roadway, and median width).

For traffic volume survey, if there was no possibility to count for the full-required duration, the user may count during the peak hours, and utilize the expansion factors presented in Chapter Three to extend these volumes to the required volumes. Figure 7-9 shows a suggested form for tabulating the required data.

Figure 7-9: Proposed field study data sheet

Location:________________ Recorder: ________________

Date: ___________________ Day: ____________________

A. Accident

1. Pedestrian daily traffic (PDT) ___________

2. Roadway width _______________________m

B. Delay

1. 12-hour vehicular volume_______________

2. 12-hour crossing pedestrian volume _______

3. Roadway width________________________m

4. Divided roadway Yes________ No________

5. Median width__________________________m

7.8.3 Guidelines application

To determine whether the installation of overpass is justified, the data obtained from the field study and tabulated in Figure 7-9, must be compared with the minimum requirements of each of the developed guidelines. These requirements can be obtained as follows: -

- In the case of ***accident guideline***, Figure 7-2 provides the user with the minimum requirements.

- In the case of ***pedestrian delay guideline***, the figures in Appendix (D) must be used.

- To justify the installation of pedestrian overpass based on ***combination of guidelines***, procedure D was proposed as the follow: -

Procedure D,

1. Determine the extent of accident guidelines (A_E) and the extent of delay guidelines (D_E) using equations 7.3 and 7.4, respectively.
2. If the summation of A_E and D_E is greater than or equal to one, then the overpass is justified, otherwise it is not.

7.8.4 Altered assumptions

If the assumptions of actual case study differ from those implied in the developed guidelines, still the guidelines can be applied according to the following modifications: -

1. **Annual facility cost (AFC)**

1. Proposed AFC = ...X

2. Actual AFC = ...Y

3. AFC ratio (R_C) = ...Y/X

To obtain the required number of pedestrians that justifies the installation of overpass, multiply the proposed minimum pedestrian volume by R_C.

2. **Annual benefits of casualty or accident (AB)**

1. Proposed AB = ...Z

2. Actual AB = ...L

3. AB ratio (R_B) = ...L/Z

To obtain the required number of casualties that justifies the installation of overpass, divide the proposed minimum casualties by R_B.

3. Annual benefits of delay (ADB)

1. Proposed ADB = ...A

2. Actual ADB = ...B

3. ADB ratio (R_{DB}) = ...B/A

To obtain the required number of pedestrian that justifies the installation of overpass, divide the proposed minimum pedestrian volume by R_{DB}.

The annual benefits of delay may be changed in accordance to the change of the percentage of working trips, working hours and days, and average daily wage.

4. Average pedestrian walking speed (W)

If the average pedestrian walking speed decreases, the time required to cross the roadway increases, hence, the waiting time for pedestrian (benefits) increases. Thus, pedestrian-overpass is justified at lower values of traffic parameters, and vice versa.

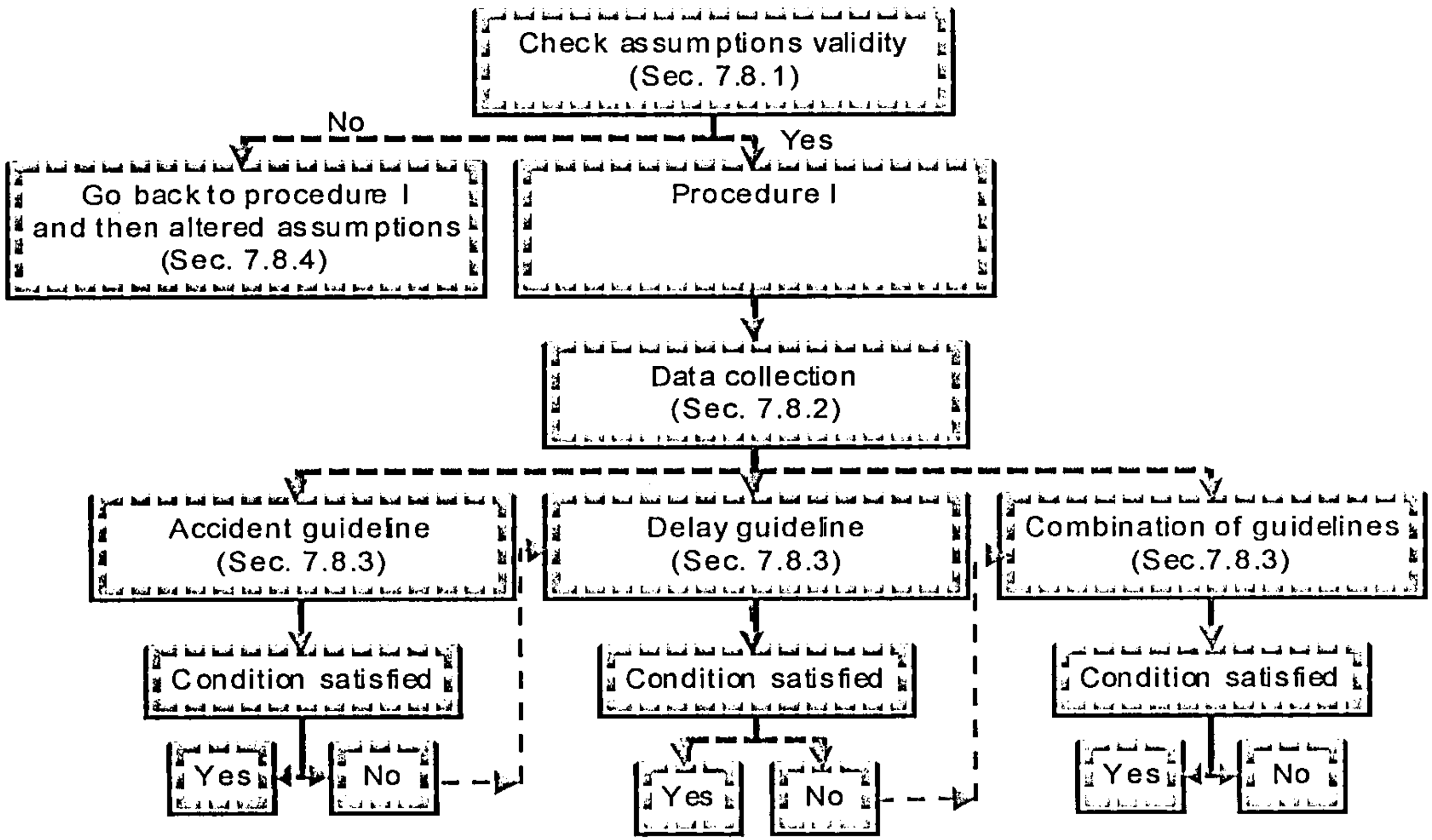
For different values of walking speed, the proposed minimum pedestrian volume can be modified according to the following percentages: -

For W = 1.0m/sec, use 50 percent reduction.

For W = 0.8m/sec, use 25 percent reduction.

The process described in Figure 7-10 guides the user to use the proposed pedestrian-overpass guidelines.

Figure 7-10: Guidelines for installing pedestrian-overpasses



7.9 Comparison with other warrants

Although the basics of the proposed guidelines and the current warrants "which were developed by Axler in 1984 *(ITE, 1998)*, and were presented in section 7.2" is different, it is interesting to note the major differences and similarities between them. This comparison was presented in Figure 7-11.

In addition, the current warrants were applied for the proposed locations in Nablus City. The results were summarized in Table 7-6.

Based on pedestrian volume warrant, the results indicated that 95 percent of the proposed locations were warranted for installing pedestrian overpasses, while 17 percent of the locations were warranted according to vehicular volume warrant. The difference between these results and those achieved by applying the benefit-cost guidelines (Table 7-5), emphasized the different basis of the current warrants and the proposed guidelines.

Figure 7-11: Comparison with other warrants

Current warrants	Proposed guidelines
1. Developed two principal warrants: pedestrian volume warrant and vehicular volume warrant.	1. Developed two principal guidelines: pedestrian accident guideline and pedestrian delay guideline.
2. Considered the four highest continuos period for pedestrian volume.	2. Considered the 12-hour pedestrian volume.
3. Considered the four highest continuos period for vehicular volume or ADT.	3. Considered the 12-hour vehicular volume.
4. Combined pedestrian & vehicular volume warrants with vehicle speed.	4. Vehicle speed was not considered.
5. No consideration for pedestrian walking speed.	5. Pedestrian walking speed was implied.
6. No consideration for roadway width.	6. Roadway width was considered.
7. Applied for urban and non-urban areas.	7. Applied for urban areas.
8. A physical barrier was considered as part of the design plan.	8. A physical barrier was considered as part of the design plan.
9. Artificial lighting should be provided.	9. Artificial lighting was provided
10. The proposed site should be at least 600ft. from nearest alternate crossing.	10. The proposed site was in the normal path of pedestrian movement.
11. General warrants.	11. More specific guidelines.

Table 7-6: Application of Axler warrants for Nablus City

Location	Pedestrian volume warrant	Vehicular volume warrant
C-1 & C-4	✓	✓
C-2 & C-3	✓	✓
C-5	✓	
C-6	✓	
C-7	✓	
C-8	✓	
C-9	✓	
F-1	✓	✓
F-2	✓	✓
F-3 North	✓	
F-3 South	✓	
F-3 East	✓	
F-3 West	✓	
O-1	✓	
O-2	✓	
O-3		
O-4	✓	
O-5	✓	

Refer to Figure 3-2 for key abbreviations.

Benefit-cost ratio analysis was utilized in this chapter for the purpose of pedestrian-overpass guidelines. The analysis considered the savings in pedestrian accidents and pedestrian waiting times as the benefits that will be accomplished after the installation of overpass, on the other hand, the construction and maintenance costs for the proposed overpass were considered. Based on the economic analysis, the guidelines were developed, analyzed, and applied at different locations in Nablus City.

Working through this study resulted in different conclusions and recommendations, which were presented in the next chapter.

Chapter Eight

Conclusions and Recommendations

8.1 Conclusions

Based on benefit-cost ratio analysis, the guidelines for justifying the installation of pedestrian-overpass were developed. These guidelines are pedestrian accident guidelines, pedestrian delay guideline, and combination of guidelines. The guidelines were developed based on different assumptions, and were applied for unsignalized urban areas.

Based on pedestrian-overpass guidelines, the following are concluded: -

1. Pedestrian accident guidelines were developed based on the past history of accidents.

2. Delay guidelines were highly affected by the provision of central median, which allows pedestrians to cross each direction separately.

3. Benefit-cost guidelines can be applied in different fields of the highway engineering as follows:-

3.1 Budget allocation process. Since the available budgets are limited and the fiscal constraints are growing, it is becoming very important to ensure that funding available for roadway improvements is efficiently utilized. Therefore, benefit-cost analysis is highly recommended in justifying overpasses.

3.2 Planning for new development which is intended to generate substantial volumes of pedestrians. Since pedestrian-overpass includes high capital investment, it must be incorporated into the early stages of planning.

3.3 Decision making process. The developed guidelines are an easy, direct and reasonable way to decide the proper locations for pedestrian-overpasses, based on benefit-cost analysis.

4. The proposed guidelines have the following important characteristics: -

4.1 Input parameters are simple.

4.2 The final outcome of the guidelines was performed in a set of figures, to simplify the application process.

4.3 It is flexible in its capabilities to accommodate altered assumptions.

5. The developed guidelines can be considered as a valuable tool for justifying the installation of pedestrian-overpasses.

6. The benefit-cost guidelines are reasonable tool for cases concerned with economic analysis.

7. For the study area pedestrian delay was found to be more critical than pedestrian accidents.

8. With respect to pedestrian delay model, it can be used to evaluate the pedestrian delay at unsignalized locations, thus the required improvement measures can be applied.

9. Based on this study (for urban areas), the delay guideline is the predominant justification for installing pedestrian-overpasses within congested locations (CBD), while the converse is true for accident guideline out of the CBD areas.

8.2 Recommendations

This study has proposed a systematic approach for developing guidelines to justify the installation of pedestrian-overpasses. Two main criteria were adopted to develop the benefit-cost guidelines. Consequently, other parameters must be considered for the purpose of guideline development. Further research on topics related to pedestrian-overpasses guidelines, can focus on the following recommendations: -

1. Recently, traffic signals were implemented in the Palestinian Territory, thus further developed guidelines must recognize the effect of signalized locations within the urban areas.

2. The savings of vehicular delay caused by pedestrian are another significant parameter which must be investigated.

3. The effect of vehicular operating cost can be also considered. This category includes fuel, oil, maintenance and repairs.

4. The delay guideline was based on statistical approach for delay estimate. It is highly recommended to measure the pedestrian delay from field study.

5. The limited traffic and accident data available constrained the development of accident prediction model. More data is required to develop reliable model.

6. While the study was performed, different issues were highlighted. These issues were: -

   6.1 Policy makers must apply different safety improvement measures to tackle the problem of high percentage of pedestrian accidents.

   6.2 Special awareness must be focused on time value.

7. To expand the scale of the study to accommodate non-urban areas.

8. Finally, it is recommended to extend the study of the proposed guidelines to establish warrants.

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Appendix (A): Numerical Examples

Chapter Four

<u>Section 4.4.1</u>

- Application of indemnity formula, *(Oaeda & Halabi, 1986)*: -

A personal injury has the following situation: -

- Percentage of inability due to the accident (P_i)= 10.0%
- Age (A) = 40.0 years.
- Net monthly wage (W) = 500.0 NIS

Application: -

Amount of indemnity $= P_i \times (65\text{-}A) \times W \times (\text{months/year})$

$= 0.10 \times 25 \times 500.0 \times 12$

$= 15{,}000.0$ NIS

Deduction = 40.0%

Net amount of indemnity = 9,000.0 NIS

Notes: -

1. The average life expectancy is assumed to be 65 year, which is the average common age. Therefor, the age is subtracted from 65 years. The result is the expected number of years that the person will live and work.
2. Deduction: since the indemnity is paying cash a certain deduction is made.

Section 4.4.2.1

- Sample calculation for the estimation of pedestrian accident cost (sever injury), **Table 4-11.**

Calculation: -

1. From Table 4-8 take the average cost value for different companies in a certain year, as follows:-

   1.1 Average cost value for sever injury in 1996 = 68780.0 New Israeli Sheqel (NIS)

   1.2 Average cost value for sever injury in 1997 = (44350.0+70238)/2

   = 57294.0 NIS

   The same process was followed for the other years.

1. Based on equation 4.1and Table 4-9, estimate the equivalent cost value for each year in terms of 1996 NIS, as follows: -

   2.1 Equivalent cost value for 1996 = 68780.0 (1996NIS)

   2.2 Equivalent cost value for 1997;

$$P = F\,[1/(1+i)^n] \quad \text{.......... (Equation 4.1)}$$

From Table 4-9 the interest rate value was determined as follows;

The cost value = 57294.0 which is in the range of 1000-99999 NIS, the corresponding interest rate = 11.0%.

Since the equivalent value was estimated from 1997NIS to 1996NIS, the number of interest periods = 1.0

Using equation 4.1;

Equivalent cost value for 1997 = 57294.0 [1/(1+0.11)*]

= 51616.0 (1996NIS)

This process was followed for the average cost value in each year.

2. The average value was estimated for different equivalent values; as follows: -

= (68780.0+51616.0+...../4)

= 59497.0 NIS

Note that 4.0 was the number of years from 1996-1999.

3. The average cost value for sever injury was estimated in terms of 1996 U.S. Dollars, as follows: -

From Table 4-10, the average exchange rate from NIS to U.S. Dollars in 1996 = 3.26

Then;

The average cost value for sever injury = 59497.0/3.26

= 18251.0 (1996 U.S. Dollars)

The steps from 1-4 were used for each type of injury as was summarized in Table 4-11.

---

*: Interest rate from Table 4-9

Section 4.4.2.1

- Sample calculation for the estimation of pedestrian accident cost at the locations in front of Nablus Municipality and in front of police station (C-1 &C-4), **Table 4-12.**

Calculation: -

1. The number of each type of injuries in different years were determined, *(Kobari, 2000)*. This was presented in brief data in Table 4-1.

For C-1 & C-4, the following accidents were recorded: -

Date	No. of accidents	No. of injuries	Slight injury	Sever injury
1996	1	1	1	
1997	1	1	1	
1997	1	1		1
1997	1	1	1	
1997	1	1	1	
1998	1	2	2	
1998	1	1	1	
1998	1	1	1	

2. For the year 1996, the cost of each injury type was determined from Table 4-11.

3. For the years 1997 and 1998 the cost of each injury type was estimated according to the same procedure described to estimate 1996 cost, as a result: -

- 1997 slight injury cost = 807.0 U.S. Dollars
- 1997 medium injury cost = 4808.0 U.S. Dollars
- 1998 slight injury cost = 792.0 U.S. Dollars

4. The cost of pedestrian accident at (C-1 & C-4) for each year was estimated by multiplying the values from the table in step 1 by the cost values in step 4, as follows: -

Year 1996 = 1*775

= 775.0 U.S. Dollars

Year 1997 = 3*807+1*4808

= 7229.0 U.S. Dollars

Year 1998 = 4*792

= 3168.0 U.S. Dollars

The steps from 1-4 were used for each location as was summarized in Table 4-12.

Section 4.4.2.1

- Sample calculation for the estimation of annual accident cost at the locations in front of Nablus Municipality and in front of police station (C-1 &C-4), **Table 4-13.**

Calculation: -

1. Based on the results of Table 4-12 and equation 4.2 the annual pedestrian accident cost was estimated, as follows: -

1.1 Annual pedestrian accident cost = $P \frac{i(1+i)^n}{(1+i)^n - 1}$.......... (Equation 4.2)

1.2 From Table 4-12 pedestrian accident cost (1996) = 775.0

(1997) = 7229.0

(1998) = 3168.0

1.4 Estimate the equivalent accident cost for each year in terms of 1996 using equation 4.1.

Equivalent cost of 1996 in terms of 1996 = U.S. Dollar 775.0

Equivalent cost of 1997 in terms of 1996 = 7229.0/(1+0.04)*

= U.S. Dollar 6950.0

*: Interest rate from Table 4-9

Equivalent cost of 1998 in terms of 1996 = $3168.0/(1+0.045)^{*}$

= U.S. Dollar 2901.0

1.5 Estimate the summation of step 1.3 = U.S. Dollar 10626.0.

1.6 Average interest rate = 4.42% (Table 4-9, in the range of U.S. Dollar 200.0-49,999.0).

1.7 Annual pedestrian accident cost = $10626 * \frac{0.0442(1+0.0442)^{*}}{(1+0.0442)^{3}-1}$

= U.S. Dollar 3860.0

*: Interest rate from Table 4-9

Section 4.4.2.2

- Estimation of accident cost

The data in Table 4-4 & Table 4-11 were applied to equation 4.4 as follows: -

$$\text{Cost of accident} = 775.0\times1.10 + 4616.0\times0.22 + 18{,}251.0\times0.06 + 6785.0\times 0.013 + 37{,}996.0 \times 0.013$$

$$\approx \text{U.S. Dollar } 3600.0$$

Section 5.8

- Sample calculation for the estimation of pedestrian delay cost at the locations in front of Nablus Municipality and in front of police station (C-1 &C-4) in 1996, **Table 5-8.**

Calculation: -

- Based on the flowchart presented in Figure 5-7 the cost of pedestrian waiting time was estimated, as follows: -

1. Estimation of pedestrian waiting time based on equation 5.1.

In the case of median availability (as for the considered location) W_p was estimated for each direction of flow, separately.

A- In front of Nablus Municipality (C-4)

A-1 Minimum headway Δ= 2sec.

A-2 Roadway width = 11.0m (Table 5-1).

A-3 Pedestrian walking speed = 1.31m/sec. (Table 5-2).

A-4 Crossing time (T) = 11/1.31

= 8.40 sec.

A-5 Vehicular volume q;

A-5-1 12-hr. vehicular volume in 1996 = 19520 (Table 3-2).

A-5-2 Average hourly volume (q) = 19520/12

= 1627 veh./hr.

= 0.452 veh./sec.

Troutbeck's model assumed that vehicular volume is divided into two directions. For the considered cases in this thesis it was assumed that the flow was divided equally, $q = q_1+q_2$

$q_1 = q_2 = 0.452/2$

= 0.226 veh./sec.

A-6 Proportion of free vehicles (α_i)

A-6-1 Lane width = 11/2

= 5.5m > 3.5

A-6-2 Constant *A* for q_1 = 3.4 (Table 5-3)

Constant *A* for q_2 = 7.5 (Table 5-3)

$\alpha_1 = e^{-3.4*0.226}$ (Equation 5.3)

= 0.46

$\alpha_2 = e^{-7.5*0.226}$ (Equation 5.3)

= 0.184

Substitute the above parameters in equation 5.1, pedestrian waiting time for (C-4) was equal to:

W_p = 55.64 sec./ped. (C-4) (Table 5-4)

B- In front of police station (C-1)

The same procedure described in item A was followed and the resulted waiting time was equal to:

W_p = 36.51 sec./ped. (C-1) (Table 5-4)

2. 12-hr. pedestrian volume = 4180 (C-1) (Table 3-4)

   = 3295(C-4) (Table 3-4)

3. Waiting time (C-1) = 4180*36.5

   = 152,570.0 sec./day

4. Waiting time (C-4) = 3295*55.64

   = 183,334.0 sec./day

5. Total waiting time = 152,570.0+183,334.0

   = 335,904.0 sec./day

6. Percentage of working trips = 37.5percent.

7. Total waiting time for working trips = 335,904.0 *0.375

   = 125,964.0 sec./working day

8. Working days per year = 313 day

9. Total waiting time for working trips per year

= 125,964.0*313/3600

= 10952.0 hr./working day/year

10. Time value = U.S. Dollar 1.94 (Table 5-6)

11. Annual cost of delay = 10952.0*1.94

= U.S. Dollar 21,242.0

Chapter Five

Section 5.8

- Sample calculation for the estimation of annual pedestrian delay cost at the locations in front of Nablus Municipality and in front of police station (C-1 &C-4), **Table 5-9.**

Calculation: -

The procedure followed to estimate the annual cost of pedestrian delay was the same as the one followed to estimate the annual accident cost, as was presented in the sample calculation for Table 4-13, section 4.4.2.1

Chapter Six

Section 6.3

- Sample calculation for the estimation of convenience measure, *R* at the locations in front of Nablus Municipality and in front of police station (C-1 &C-4), **Table 6-1.**

Calculation: -

- Convenience measure = Total time on the overpass/ Time on at-grade level (Figure 6-1).

1. Time on overpass = Time upstairs + Time on overpass slab + Time downstairs

1.1 Walking speed for going upstairs and downstairs were estimated based on a random sample of pedestrians at An- Najah University, the results were as follows: = 0.49m/sec (upstairs)

= 0.52m/sec (downstairs)

It should be noticed that the distance was measured horizontally which reflected the stair width.

1.2 Walking speed on the overpass = 1.35m/sec (Section 5.5.3, item 2)

1.3 Upstairs distance = No. of stairs * Stair width + No. of landings * Landing width, (Drawing No.1 Appendix C)

= 29*0.3 + 3*2.6

Upstairs distance = 16.5m

1.4 Downstairs distance = 29*0.3+3*2.6

= 16.5m

1.5 Overpass length = 53.0m (Table 6-2 exclude stair case width =3*2m)

1.6 Time upstairs = 16.5/0.49

= 33.70sec.

1.7 Time downstairs = 16.5/0.52

= 31.70sec.

1.8 Time on overpass slab =53/1.35

= 39.2sec.

1.9 Total time on the overpass = 33.7+39.2 +31.7

= 104.6sec

1.10 Time at-grade = Roadway width (Table 5-1)+ Median width *(Dornier & Universal Group, 1998)*

= 11+12+25 = 48.0m

= 48/1.35

= 35.5sec.

1.11 Waiting time (Table 5-4) = 36.5+55.63

= 92.13sec.

1.12 Convenience factor = 104.6/(35.5+92.13)

***R* = 0.82**

Section 6.6

- The estimation of annual facility cost (AFC)

1. Annual overpass cost (AOC) was estimated as follows: -

1.1 Total facility cost = U.S. Dollar 95,070.0 (1996 U.S. Dollar)

1.2 Overpass cost = U.S. Dollar 74,745.0 (1996 U.S. Dollar) excluding steel rails

1.3 Overpass length = 59.0m

1.4 Overpass cost per meter = 74,745.0/59

= U.S. Dollar 1267.0/m

1.5 Annual overpass cost (Equation 6.1) = $1267 * \frac{(0.051(1.051)^{50}}{(1.051)^{50}-1}$

= 1267*0.0556

AOC ≈ 70.0 U.S.$ 70.0/L.M

2. Annual steel rails cost (ARC) was estimated as follows: -

2.1 Steel rails cost = U.S. Dollar 24,000.0 (Year 2000 U.S. Dollar), (Bill of quantity, Appendix C).

2.2 Steel rails cost = U.S. Dollar 19,670.0 (1996U.S. Dollar), (Bill of quantity, Appendix C).

2.3 Annual steel rails cost = 19670*0.0556

$$ARC \approx 1{,}090.0 \text{ U.S.\$ /L.M}$$

3. Conversion factor (F) was used to estimate annual maintenance cost as follows: -

3.1 Maintenance direct cost (section 6.5.2) = 0.015*Overpass direct cost

3.2 Annual overpass cost (AOC) = Overpass direct cost * 0.0556

3.3 Annual maintenance cost (AMC) = Overpass direct cost*0.0556

From the above three equations

AMC = (AOC/0.0556)*0.015

3.4 Conversion factor (F) = 0.015/0.0556

= 0.2698

Chapter Seven

Section 7.4.1

I. Numerical example for Procedure A

Consider the following case: -

- Roadway width = 6.0m, stair cases length = 3.0×2 = 6.0m

Application: -

1. Annual facility cost (Equation 6.2) = 70.0×12 + 0.2698×(70.0×12.0) + 1,090.0

   Annual facility cost = U.S. Dollar 2157.0

2. Cost of slight injury = U.S. Dollar 775.0

3. Min. number of slight injuries required to justify the installation of the overpass

   = 2157.0/775.0

   = 2.70 injury/year

- Roadway width = 7.0m, stair cases length = 3.0×2 = 6.0m
    1. Annual facility cost (Equation 6.2) = 70.0×13 + 0.2698×(70.0×13.0) + 1,090.0
    2. Annual facility cost = U.S. Dollar 2246.0
    3. Cost of slight injury = U.S. Dollar 775.0
    4. Min. number of slight injuries required to justify the installation of the overpass

       = 2246.0/775.0

       = 2.90 injury/year

The same process was repeated for all considered roadway widths, and for all casualty types. Then the curves were drawn in Figure 7-2.

Section 7.4.1

II. Numerical example for Procedure B, when the location experienced different types of casualties.

Consider the following hypothetical case: -

- Actual roadway width = 15.0m
- Actual number of slight injuries = 2.0 injury/year
- Actual number of medium injuries = 1.0 injury/two years, (0.5 injury/year)

Application: -

1. Min. number of slight injuries required to justify the installation of the overpass

   = 3.8 injury/year

2. Min. number of medium injuries required to justify the installation of the overpass

   = 0.64 injury/year

3. Percentage satisfied for slight injury = 2.0/ 3.8

   = 0.53

4. Percentage satisfied for medium injury = 0.5/ 0.64

= 0.78

5. Summation of step 3 & step 4 = 0.53+0.78

= 1.31>1

Thus, the installation of overpass is justified.

Section 7.6

- Numerical example for combination of guidelines

  (Based on equation 7.5)

Consider the following hypothetical situation: -

- Roadway width = 10.0m
- Observed number of accidents = 0.5 accident/year
- Two directional 12-hour vehicular volume = 5000.0
- 12-hour pedestrian volume = 800.0

Application: -

Minimum number of accidents required to satisfy guidelines conditions, (Figure 7-2)

= 0.69 accident/year

Extent of accident guideline (A_E) = 0.5/0.69

= 0.73

Minimum pedestrian volume required to satisfy the condition of the guideline, measured at the observed vehicular volume, Appendix (D) = 8000.0

Extent of delay guideline (D_E) = 800.0/8000

= 0.1

$A_E + D_E$ = 0.73+0.1

= 0.83<1

Therefor, the location is not justified to install pedestrian-overpass.

Appendix (B): Traffic Counts

Vehicular Volume

- Faisle Street in front of Police Station.
- Faisle Street in front of Al-Watani Hospital.
- Al-Ghazali Street on the opposite side of Al-Watani Hospital.
- Al-Ghazali Street in front of Nablus Municipality.
- Al-Hadadeen Street.
- Hetteen intersection.
- Al-Husien Roundabout in front of Al-Sied Exchanger.
- Al-A'del-Hamdi Kan'an intersection.
- Sufian-Hamdi Kan'an intersection.
- Faisle Street in front of Directorate of Education.
- ANZ Grindlays Bank intersection.
- Amman Street in front of the Yousef Tomb.
- Al-Quds Street in front of Al'nwar Hall.
- Rafedia Street in front of Al-Rawda Mosque and Ashoor Sweet.
- Haifa Street in front of Ein Refugee Camp.

Location: Faisle Street in front of Police Station
Source: Shaar, 97

Vehicular counts
Date: 1997

Time	East-West
8:00-8:15	362
8:15-8:30	352
8:30-8:45	390
8:45-9:00	350
9:00-9:15	363
9:15-9:30	361
9:30-9:45	375
9:45-10:00	300
13:00-13:15	392
13:15-13:30	400
13:30-13:45	391
13:45-14:00	371
14:00-14:15	450
14:15-14:30	391
14:30-14:45	340
14:45-15:00	257
Total	5845
12 hr. vol.	**16700**
ADT 97	**20875**

Location: Faisle Street in front of Police Station
Source: Dornier, 98

Vehicular counts
Date: July.14th.1998

P.H.V	**East-West**
Time	
7:45-8:45am	1508
2:00-3:00 p.m	1321
12 hr. vol.	**15080**
ADT98	**18850**

Location: Faisle Street in front of Police Station
Source: Qawareeq, 98

Vehicular counts
Date: Feb.7th.1998

Time	East-West	East-West	Avg. Volume
	1st. Count	2nd. Count	
7:00-8:00	1710	1286	1498
8:00-9:00	1471	1407	1439
9:00-10:00	1371	1333	1352
10:00-11:00	1435	919	1177
11:00-12:00	1425	1278	1352
12:00-13:00	1458	1049	1254
13:00-14:00	1468	890	1179
14:00-15:00	1500	1444	1472
Total	11838	9606	10722
12hr.vol	**17669**	**14337**	**16003**
ADT98	**22086**	**17922**	**20004**

Location: Faisle Street in front of Police Station
Source: Lafi, 99

Vehicular counts
Date: 1998

Time	East-West
7:00-8:00	1655
8:00-9:00	1585
9:00-10:00	1355
10:00-11:00	1511
11:00-12:00	1557
12:00-13:00	1534
13:00-14:00	1426
14:00-15:00	1392
15:00-16:00	1581
16:00-17:00	1716
Total	15312
12 hr. vol.	**18014**
ADT98	**22518**

Average vehicular counts

12 hr. vol.	**16366**
ADT98	**20457**

Location: Faisle Street in front of Al-Watani Hospital

Source: Touqan, 96

Vehicular counts

Date: Nov.1995

Time	East-West
7:00-7:15	396
7:15-7:30	427
7:30-7:45	608
7:45-8:00	582
8:00-8:15	465
8:15-8:30	414
8:30-8:45	378
8:45-9:00	379
9:00-9:15	410
9:15-9:30	457
9:30-9:45	487
9:45-10:00	436
14:00-14:15	274
14:15-14:30	436
14:30-14:45	434
14:45-15:00	415
15:00-15:15	450
15:15-15:30	473
15:30-15:45	437
15:45-16:00	490
16:00-16:15	493
16:15-16:30	433
16:30-16:45	475
16:45-17:00	478
Total	10727
12 hr. vol.	**20629**
ADT 95	**25786**

Location: Faisle Street in front of Al-Watani Hospital

Source: Shaar, 97

Vehicular counts

Date: 1997

Time	East-West
9:00-9:15	255
9:15-9:30	410
9:30-9:45	379
9:45-10:00	379
10:00-10:15	375
10:15-10:30	405
10:30-10:45	346
10:45-11:00	391
13:00-13:15	499
13:15-13:30	391
13:30-13:45	410

Time	East-West
13:45-14:00	450
14:00-14:15	449
14:15-14:30	463
14:30-14:45	438
14:45-15:00	400
Total	4240
12 hr. vol.	12114
ADT97	**15143**

Location: Faisle Street in front of Al-Watani Hospital
Source: Dornier, 98

Vehicular counts
Date: July.14th.1998

P.H.V	**East-West**
Time	
7:45-8:45am	1734
2:00-3:00 p.m	1488
12 hr. vol.	17340
ADT98	**21675**

Location: Al-Gazali Street the opposite side of Al-Watani Hospital
Source: Touqan, 96

Vehicular counts
Date: Nov.1995

Time	West-East
7:00-7:15	408
7:15-7:30	454
7:30-7:45	482
7:45-8:00	428
8:00-8:15	414
8:15-8:30	436
8:30-8:45	410
8:45-9:00	347
9:00-9:15	299
9:15-9:30	404
9:30-9:45	388
9:45-10:00	335
14:00-14:15	334
14:15-14:30	377
14:30-14:45	352
14:45-15:00	363
15:00-15:15	335
15:15-15:30	411
15:30-15:45	357
15:45-16:00	391
16:00-16:15	381
16:15-16:30	337
16:30-16:45	424
16:45-17:00	402
Total	9269
12 hr. vol.	**17825**
ADT 95	**22281**

Location: Al-Gazali Street the opposite side of Al-Watani Hospital
Source: Dornier, 98

Vehicular counts
Date: July.14th.1998

P.H.V	**West-East**
Time	
7:45-8:45am	1701
2:00-3:00 p.m	1309
12 hr. vol.	**17010**
ADT 98	**21263**

Location: Al-Gazali Street in front of Nablus Municipality

Source: Touqan, 96

Vehicular counts

Date: March.1996

Time	West-East
2:00-3:00pm	1671
6hr. vol.	9755
12 hr. vol.	**18759**
ADT97	**23449**

P.H.V	**West-East**
Time	
N.A	2028
12 hr. vol.	**20280**
ADT 96	**25350**

Average vehicular counts

12 hr. vol.	**19520**
ADT96	**24400**

Location: Al-Gazali Street in front of Nablus Municipality

Source: Lafi, 99

Vehicular counts

Date: 1998

Time	West-East
7:00-8:00	2054
8:00-9:00	1633
9:00-10:00	1750
10:00-11:00	1745
11:00-12:00	1782
12:00-13:00	1836
13:00-14:00	2133
14:00-15:00	2098
15:00-16:00	1927
16:00-17:00	2108
Total	19066
12hr. vol	**22431**
ADT98	**28038**

Location: Al-Gazali Street in front of Nablus Municipality

Source: Dornier, 98

Vehicular counts

Date: July.14th.1998

P.H.V	**West-East**
Time	
7:45-8:45am	2011
2:00-3:00 p.m	1828
12hr. vol	20110
ADT98	25138

Average vehicular counts

12 hr. vol.	**21270**
ADT98	**26588**

Location: Al-Hadadeen Street
Source: Shaar, 97

Vehicular counts
Date: 1997

Time	West-East
7:45-8:00	463
8:00-8:15	495
8:15-8:30	450
8:30-8:45	495
8:45-9:00	490
9:00-9:15	440
9:15-9:30	350
9:30-9:45	290
Total	3473
12 hr. vol.	**18279**
ADT97	**22849**

Location: Al-Hadadeen Street
Source: Dornier, 98

Vehicular counts
Date: July.14th.1998

P.H.V	West-East
Time	
7:45-8:45am	1486
2:00-3:00 p.m	1479
12hr.vol	**14860**
ADT98	**18575**

Location: Al-Hadadeen Street
Source: Qawareeq, 98

Vehicular counts
Date: Feb.17th.1998

Time	West-East	West-East	Avg. Volume
	1st. Count	2nd. Count	
7:00-8:00	1108	1700	1404
8:00-9:00	1200	1780	1490
9:00-10:00	1041	1430	1236
10:00-11:00	1009	1204	1107
11:00-12:00	1087	1328	1208
12:00-13:00	1088	1389	1239
13:00-14:00	1094	1400	1247
14:00-15:00	1300	1290	1295
Total	8927	11521	10224
12hr.vol	**13324**	**17196**	**15260**
ADT98	**16655**	**21494**	**19075**

Location: Al-Hadadeen Street

Average vehicular counts

12hr. vol.	**15060**
ADT98	**18825**

Location: Hetteen intersection
Source: Lafi, 99

Vehicular counts
Date: Nov.26th.1998

Time	West approach	North approach	South approach
6:54-15:54	1023	1146	489
12 hr. vol.	**1364**	**1528**	**652**
ADT98	**1705**	**1910**	**815**

Location: Al-Husien Roundabout infront of Al-Sied Exchanger
Source: Shaar, 97

Vehicular counts
Date: 1997

Time	Vehicular volume
8:00-8:15	280
8:15-8:30	218
8:30-8:45	165
8:45-9:00	193
9:00-9:15	220
9:15-9:30	230
9:30-9:45	203
9:45-10:00	210
13:00-13:15	148
13:15-13:30	190
13:30-13:45	206
13:45-14:00	235
14:00-14:15	245
14:15-14:30	263
14:30-14:45	191
14:45-15:00	206
Total	3403
12 hr. vol.	**9723**
ADT97	**12154**

Location: Al-Husien Roundabout infront of Al-Sied Exchanger
Source: Touqan, 96

Vehicular counts
Date: Nov.1995

Time	Vehicular volume
8:00-9:00	711
6 hr. vol.	4814
12 hr. vol.	9257
ADT95	**11572**

Location: Al-A'del-Hamdi Kan'an intersection
Source: Lafi, 99

Vehicular counts
Date: Nov.19th.1998

Time	South approach	West Approach		Time	North approach	East approach	
		West-East	East-West			East-West	West-East
7:07-15:52	3310	2228	2462	6:57-15:57	4066	1903	2839
12 hr. vol.	**4413**	**2971**	**3283**	**12 hr. vol.**	**5421**	**2537**	**3785**
ADT98	**5517**	**3713**	**4103**	**ADT98**	**6777**	**3172**	**4732**

Location: Al-A'del-Hamdi Kan'an intersection
Source: Dornier, 98

Vehicular counts
Date: July.14th.1998

P.H.V	South approach	West Approach		North approach	East approach	
Time		West-East	East-West		East-West	West-East
7:45-8:45 a.m	509	154	281	563	181	194
2:00-3:00 p.m	575	181	336	468	201	177
12hr.vol.	**5750**	**1810**	**3360**	**5630**	**2010**	**1770**
ADT98	**7188**	**2263**	**4200**	**7038**	**2513**	**2213**

Location: Al-A'del-Hamdi Kan'an intersection

Average vehicular counts

Time	South approach	West Approach		North approach	East approach	
		West-East	East-West		East-West	West-East
12 hr. vol.	**5082**	**2390**	**3321**	**5526**	**2274**	**2778**
ADT98	**6352**	**2988**	**4152**	**6907**	**2842**	**3472**

Location: Al-A'del-Hamdi Kan'an intersection
Source: Touqan, 96

Vehicular counts
Date: Nov.1995

Time	South approach	West Approach	North approach	East approach
6hr. vol.	2174	2438	3077	1729
12hr. vol.	**4181**	**4688**	**5917**	**3325**
ADT95	**5226**	**5861**	**7397**	**4156**

Location: Sufian-Hamdi Kan'an intersection
Source: Lafi, 99

Vehicular counts
Date: Nov.12th.1998

Time	North approach	East approach	Time	South approach	West Approach
6:54-15:54	4263	4222	6:54-15:54	3815	4346
12 hr. vol.	**6363**	**6301**	**12 hr. vol.**	**5694**	**6487**
ADT98	**7953**	**7877**	**ADT98**	**7118**	**8108**

Location: Sufian-Hamdi Kan'an intersection
Source: Touqan, 96

Vehicular counts
Date: Nov.1995

Time	North approach	East approach	South approach	West Approach
14:00-15:00	422	406	458	286
6hr. vol.	2339	2251	2539	1585
12 hr. vol.	**4499**	**4328**	**4882**	**3049**
ADT95	**5623**	**5410**	**6103**	**3811**

Location: Sufian-Hamdi Kan'an intersection
Source: Touqan, 96

Vehicular counts
Date: Nov.1995

P.H.V	North approach	East approach	South approach	West Approach
Time				
N.A	536	382	540	352
12 hr. vol.	**5360**	**3820**	**5400**	**3520**
ADT95	**6700**	**4775**	**6750**	**4400**

Location: Sufian-Hamdi Kan'an intersection

Average vehicular volume
Date: Nov.1995

Time	North approach	East approach	South approach	West Approach
12 hr. vol.	**4929**	**4074**	**5141**	**3284**
ADT95	**6162**	**5092**	**6426**	**4105**

Location: Faisle Street in front of Directorate of Education

Vehicular counts

Source: Dornier, 98

Date: July.17th.1998

P.H.V / **Time**	**East-West**	**West-East**	**Total**
7:45-8:45 a.m	1455	1312	2767
2:00-3:00 p.m	1238	1406	2644
12hr.vol	**14550**	**13120**	**27670**
ADT98	**18188**	**16400**	**34588**

Location: Faisle Street in front of Directorate of Education

Vehicular counts

Source: Touqan, 96

Date: March.1996

Time	**East-West**	**West-East**	**Total**
2-3pm	1190	1448	2638
6hr.vol	7788	9476	17264
12hr.vol	**14977**	**18224**	**33201**
ADT96	**18721**	**22780**	**41501**

Location: Grindlays Bank intersection   Vehicular counts
Source: Toukan, 96   Date: Nov.1995

Time	North approach	South approach	West approach	East approach
7:00-8:00a.m	504	1120	476	1112
6hr. vol.	3103	6897	2931	6847
12hr. vol.	**5968**	**13263**	**5637**	**13168**
ADT95	**7460**	**16578**	**7046**	**16460**

Location: Grindlays Bank intersection   Vehicular counts
Source: Lafi, 99   Date: 1998

Time	North approach	South approach	West approach	East approach
7:00-17:00	5987	10024	4006	8231
12hr.count	**7044**	**11793**	**4713**	**9684**
ADT98	**8804**	**14741**	**5891**	**12104**

Location: Grindlays Bank intersection   Vehicular counts
Source: Dornier, 98   Date: July.17th.1998

P.H.V	North approach	South approach		West approach	East approach
Time		South-North	North-South		
7:45-8:45 a.m	679	685	656	468	1176
2:00-3:00 p.m	704	515	708	407	918
12hr.vol.	**7040**	**6850**	**6560**	**4680**	**11760**
ADT98	**8800**	**8563**	**8200**	**5850**	**14700**

Location: Amman Street
Vehicular counts

Source: Dornier, 98
Date: July.15th.1998

P.H.V Time	East-West	West-East	Total
7:45-8:45 a.m	684	512	1196
2:00-3:00 p.m	476	590	1066
12hr.vol	**6840**	**5120**	**11960**
ADT98	**8550**	**6400**	**14950**

Location: Al-Quds Street
Source: Dornier, 98

Vehicular counts
Date: July.15th.1998

P.H.V Time	East-West	West-East	Total
7:45-8:45 a.m	567	438	1005
2:00-3:00 p.m	472	580	1052
12hr.vol	**5670**	**5800**	**11470**
ADT98	**7088**	**7250**	**14338**

Location: Al-Quds Street
Source: Traffic lab., 96

Vehicular counts
Date: March.28th.1996

Time	East-West	West-East	Total
12hr.vol	**4168**	**4136**	**8304**
ADT96	**5210**	**5170**	**10380**

Location: Al-Kfair-Qadri-Toukan intersection
Source: Dornier, 98
Volume Rafedia Street in front of Al-Rawada Mosque

Vehicular counts
Date: July.15th.1998

P.H.V Time	East-West	West-East	Total
8:30-9:30 noon	902	842	1744
12hr.vol	**9020**	**8420**	**17440**
ADT98	**11275**	**10525**	**21800**

Location: Al-Kfair-Al-Mrage intersection
Source: Dornier, 98
Volume Rafedia Street in front of Al-Rawada Mosque

Vehicular counts
Date: July.15th.1998

P.H.V Time	East-West	West-East	Total
8:30-9:30 noon	884	642	1526

Location: Al-Kfair-Al-Mrage intersection
Volume Rafedia Street in front of Al-Rawada Mosque

Average vehicular counts

P.H.V Time	East-West	West-East	Total
8:30-9:30 noon	893	742	1635
12hr. vol.	**8930**	**7420**	**16350**
ADT98	**11163**	**9275**	**20438**

Location: Haifa-Yafa intersection
Source: Traffic lab., 96
Volume on Haifa Street passes through Ein Refugee Camp

Vehicular counts
Date: April.4th.1996

Time	East-West	West-East
7:30-7:45	95	124
7:45-8:00	63	135
8:00-8:15	18	123
8:15-8:30	103	98
8:30-8:45	79	99
8:45-9:00	82	105
9:00-9:15	75	132
9:15-9:30	106	122
Total	**621**	**938**

P.H.calculation

Time	East-West	West-East	Total
7:30-8:30	279	480	759
7:45-8:45	263	455	718
8:00-9:00	282	425	707
8:15-9:15	339	434	773
8:30-9:30	342	458	800

Time	P.H.V
8:30-9:30	800

Location: Haifa-Yafa intersection
Source: Dornier, 98
Volume on Haifa Street passes through Ein Refugee Camp

Vehicular counts
Date: July.15th.1998

P.H.V	East-West	West-East
Time		
7:45-8:45 a.m	386	507
2:00-3:00 p.m	474	384

Location: Al-Salam Mosque intersection
Source: Dornier, 98
Volume on Haifa Street passes through Ein Refugee Camp

Vehicular counts
Date: July.15th.1998

P.H.V	East-West	West-East
Time		
7:45-8:45 a.m	478	458
2:00-3:00 p.m	598	535

Location: Haifa Street infront of Ein Refugee Camp Average vehicular counts

P.H.V Time	East-West	West-East	Total
7:45-8:45 a.m	432	483	915
2:00-3:00 p.m	536	460	996
12hr. vol.	**5360**	**4830**	**10190**
ADT98	**6700**	**6038**	**12738**

Pedestrian Volume

- Faisle Street in front of Police Station.
- Faisle Street in front of Al-Watani Hospital.
- Al-Ghazali Street in front of Nablus Municipality.
- Al-Hadadeen Street.
- Hetteen intersection.
- Al-Husien Roundabout in front of Al-Sied Exchanger.
- Al-A'del-Hamdi Kan'an intersection.
- Sufian-Hamdi Kan'an intersection.
- Faisle Street in front of Directorate of Education.
- Faisle Street in front of Vocational Training Center.
- ANZ Grindlays Bank intersection.
- Amman Street in front of the Yousef Tomb.
- Al-Quds Street in front of Al'nwar Hall.
- Al-Quds Street in front of the secondary intersection to Balata Refugee Camp.
- Rafedia Street in front of Al-Rawda Mosque and Ashoor Sweet.
- Haifa Street in front of Ein Refugee Camp.

Location: Faisle Street in front of Police Station
Source: Kilani, 97

Crossing pedestrian counts
Date: March.9th.1997

Time	On crosswalk	Away of cross walk	Total
8:00-8:15	50	40	90
8:15-8.30	62	45	107
8:30-8:45	60	60	120
8:45-9:00	67	52	119
9:00-9:15	80	60	140
9:15-9:30	82	62	144
9:30-9:45	86	70	156
9:45-10.00	87	62	149
Total	574	451	1025
1:00-1:15	87	45	132
1:15-1:30	71	85	156
1:30-1:45	67	56	123
1:45-2:00	50	28	78
2:00-2:15	71	23	94
2:15-2:30	66	39	105
2:30-2:45	21	9	30
2:45-3:00	31	12	43
Total	464	297	761
4hr. Vol.			1786
12hr. vol.			**5253**
24hr. vol. 97			**5837**

Location: Faisle Street in front of Police Station
Source: Kilani, 97

P.H for crossing pedestrian
Date: March.9th.1997

Time	Pedestrian volume
8:00-9:00	436
8:15-9:15	486
8:30-9:30	523
8:45-9:45	559
9:00-10:00	589
1:00-2:00	489
1:15-2:15	451
1:30-2:30	400
1:45-2:45	307
2:00-3:00	272

Location: Faisle Street in front of Police Station

P.H for crossing pedestrian

Source: Kilani, 97

Date: March.9th.1997

Time	Pedestrian counts
9:00-10:00am	589
1:00-2:00pm	489
12hr. vol.	**3927**
24hr. vol. 97	**4363**

Average pedestrian counts

12hr. vol.	**4590**
24hr. vol. 97	**5100**

Location: Faisle Street in front of Al-Watani Hospital
Source: Toukan, 96

Crossing pedestrian counts
Date: Dec.1995

Time	On crosswalk	Away of crosswalk	Total
9:00-9:15	53	174	227
9:15-9:30	37	152	189
9:30-9:45	51	166	217
9:45-10.00	53	174	227
10:00-10:15	53	171	224
10:15-10:30	52	167	219
10:30-10:45	55	180	235
10:45-11:00	61	200	261
Total	415	1384	1799

Location: Faisle Street in front of Al-Watani Hospital
Source: Toukan, 96

P.H for crossing pedestrian
Date: Dec.1995

Time	Pedestrian volume
9:00-10:00	860
9:15-10:15	857
9:30-10:30	887
9:45-10:45	905
10:00-11:00	939

Location: Faisle Street in front of Al-Watani Hospital
Source: Toukan, 96

P.H for crossing pedestrian
Date: Dec.1995

Time	P.H.V
10:00-11:00am	939
12hr. vol.	6260
24hr. vol. 95	6956

Location: Faisle Street in front of Al-Watani Hospital
Source: Lafi, 98

Crossing pedestrian counts
Date: 1998

Time	North-South	South-Norh	Total
7:00 -7:05	29	22	51
7:05 -7:10	30	9	39
7:10 -7:15	31	2	33
7:15 -7:20	47	15	62
7:20 -7:25	51	11	62
7:25 -7:30	49	8	57
7:30 -7:35	56	7	63
7:35 -7:40	57	12	69
7:40 -7:45	53	14	67
7:45 -7:50	57	9	66
7:50 -7:55	68	13	81
7:55 -8:00	50	8	58
8:00 -8:05	54	8	62
8:05 -8:10	37	12	49
8:10 -8:15	43	17	60
8:15 -8:20	59	5	64
8:20 -8:25	38	10	48
8:25 -8:30	42	16	58
8:30 -8:35	71	15	86
8:35 -8:40	66	4	70
8:40 -8:45	79	12	91
8:45 -8:50	42	21	63
8:50 -8:55	50	14	64
8:55 -9:00	57	12	69
9:00 -9:05	43	11	54
9:05 -9:10	63	10	73
9:10 -9:15	57	9	66
9:15 -9:20	69	20	89
9:20 -9:25	60	18	78
9:25 -9:30	63	13	76
9:30 -9:35	69	0	69
9:35 -9:40	49	0	49
9:40 -9:45	43	10	53
9:45 -9:50	76	8	84
9:50 -9:55	85	19	104
9:55 -10:00	54	16	70
10:00 -10:05	69	25	94
10:05 -10:10	70	25	95
10:10 -10:15	68	15	83
10:15 -10:20	61	14	75
10:20 -10:25	53	19	72

Location: Faisle Street in front of Al-Watani Hospital
Source: Lafi, 98

Crossing pedestrian counts
Date: 1998

Time	North-South	South-Norh	Total
10:25 -10:30	69	30	99
10:30 -10:35	78	10	88
10:35 -10:40	39	10	49
10:40 -10:45	65	6	71
10:45 -10:50	45	23	68
10:50 -10:55	36	14	50
10:55 -11:00	70	15	85
11:00 -11:05	66	24	90
11:05 -11:10	49	17	66
11:10 -11:15	65	18	83
11:15 -11:20	66	26	92
11:20 -11:25	35	10	45
11:25 -11:30	80	14	94
11:30 -11:35	40	28	68
11:35 -11:40	50	10	60
11:40 -11:45	51	11	62
11:45 -11:50	100	24	124
11:50 -11:55	40	9	49
11:55 -12:00	50	11	61
12:00 -12:05	49	15	64
12:05 -12:10	57	23	80
12:10 -12:15	49	25	74
12:15 -12:20	64	19	83
12:20 -12:25	38	9	47
12:25 -12:30	52	8	60
12:30 -12:35	54	16	70
12:35 -12:40	53	9	62
12:40 -12:45	59	20	79
12:45 -12:50	74	27	101
12:50 -12:55	60	21	81
12:55 -13:00	62	18	80
13:00 -13:05	70	23	93
13:05 -13:10	72	18	90
13:10 -13:15	58	19	77
13:15 -13:20	64	27	91
13:20 -13:25	60	18	78
13:25 -13:30	62	18	80
13:30 -13:35	58	12	70
13:35 -13:40	52	10	62
13:40 -13:45	46	18	64
13:45 -13:50	38	4	42
13:50 -13:55	42	13	55
13:55 -14:00	49	12	61

Location: Faisle Street in front of Al-Watani Hospital

Crossing pedestrian counts

Source: Lafi, 98

Date: 1998

Time	North-South	South-Norh	Total
14:00 -14:05	55	15	70
14:05 -14:10	33	8	41
14:10 -14:15	49	14	63
14:15 -14:20	54	10	64
14:20 -14:25	61	12	73
14:25 -14:30	33	9	42
14:30 -14:35	0	8	8
14:35 -14:40	0	5	5
14:40 -14:45	0	16	16
14:45 -14:50	0	7	7
14:50 -14:55	0	12	12
14:55 -15:00	0	5	5
15:00 -15:05	0	11	11
15:05 -15:10	0	4	4
15:10 -15:15	0	8	8
15:15 -15:20	0	7	7
15:20 -15:25	0	7	7
15:25 -15:30	0	8	8
15:30 -15:35	0	7	7
15:35 -15:40	0	9	9
15:40 -15:45	0	16	16
15:45 -15:50	0	9	9
15:50 -15:55	0	9	9
15:55 -16:00	0	9	9
16:00 -16:05	0	17	17
16:05 -16:10	0	8	8
16:10 -16:15	0	18	18
16:15 -16:20	0	6	6
16:20 -16:25	0	6	6
16:25 -16:30	0	9	9
16:30 -16:35	0	9	9
16:35 -16:40	0	14	14
16:40 -16:45	0	8	8
16:45 -16:50	0	17	17
16:50 -16:55	0	6	6
16:55 -17:00	0		0
Total	4989	1563	6552
12hr. vol.	**5423**	**1699**	**7122**
24hr. vol. 99	**6025**	**1888**	**7913**

Location: Faisle Street in front of Al-Watani Hospital
Source: Lafi, 98

P.H for crossing pedestrian
Date: 1998

Time	Pedestrian counts
7:00 -8:00	708
7:05 -8:05	719
7:10 -8:10	729
7:15 -8:15	756
7:20 -8:20	758
7:25 -8:25	744
7:30 -8:30	745
7:35 -8:35	768
7:40 -8:40	769
7:45 -8:45	793
7:50 -8:50	790
7:55 -8:55	773
8:00 -9:00	784
8:05 -9:05	776
8:10 -9:10	800
8:15 -9:15	806
8:20 -9:20	831
8:25 -9:25	861
8:30 -9:30	879
8:35 -9:35	862
8:40 -9:40	841
8:45 -9:45	803
8:50 -9:50	824
8:55 -9:55	864
9:00 -10:00	865
9:05 -10:05	905
9:10 -10:10	927
9:15 -10:15	944
9:20 -10:20	930
9:25 -10:25	924
9:30 -10:30	947
9:35 -10:35	966
9:40 -10:40	966
9:45 -10:45	984
9:50 -10:50	968
9:55 -10:55	914
10:00 -11:00	929
10:05 -11:05	925
10:10 -11:10	896
10:15 -11:15	896
10:20 -11:20	913
10:25 -11:25	886

Time	Pedestrian counts
10:30 -11:30	881
10:35 -11:35	861
10:40 -11:40	872
10:45 -11:45	863
10:50 -11:50	919
10:55 -11:55	918
11:00 -12:00	894
11:05 -12:05	868
11:10 -12:10	882
11:15 -12:15	873
11:20 -12:20	864
11:25 -12:25	866
11:30 -12:30	832
11:35 -12:35	834
11:40 -12:40	836
11:45 -12:45	853
11:50 -12:50	830
11:55 -12:55	862
12:00 -13:00	881
12:05 -13:05	910
12:10 -13:10	920
12:15 -13:15	923
12:20 -13:20	931
12:25 -13:25	962
12:30 -13:30	982
12:35 -13:35	982
12:40 -13:40	982
12:45 -13:45	967
12:50 -13:50	908
12:55 -13:55	882
13:00 -14:00	863
13:05 -14:05	840
13:10 -14:10	791
13:15 -14:15	777
13:20 -14:20	750
13:25 -14:25	745
13:30 -14:30	707
13:35 -14:35	645
13:40 -14:40	588
13:45 -14:45	540
13:50 -14:50	505
13:55 -14:55	462

Location: Faisle Street in front of Al-Watani Hospital
Source: Lafi, 98

P.H for crossing pedestrian
Date: 1998

Time	Pedestrian counts
14:00 -15:00	406
14:05 -15:05	347
14:10 -15:10	310
14:15 -15:15	255
14:20 -15:20	198
14:25 -15:25	132
14:30 -15:30	98
14:35 -15:35	97
14:40 -15:40	101
14:45 -15:45	101
14:50 -15:50	103
14:55 -15:55	100
15:00 -16:00	104
15:05 -16:05	110
15:10 -16:10	114
15:15 -16:15	124
15:20 -16:20	123
15:25 -16:25	122
15:30 -16:30	123
15:35 -16:35	125
15:40 -16:40	130
15:45 -16:45	122
15:50 -16:50	130
15:55 -16:55	127

Location: Faisle street in front of Al-Watani Hospital
Source: Lafi, 98

P.H for crossing pedestrian
Date:1998

Time	Pedestrian counts
9:45-10:45am	984
12:30-13:30pm	982
12hr. vol.	**6560**
24hr. vol. 98	**7289**

Average pedestrian counts

12hr. vol.	**6841**
24hr. vol. 98	**7601**

Location: Al-Gazali Street in front of Municipality
Source: Toukan, 96

Crossing pedestrian counts
Date: Dec.1995

Time	On crosswalk	Away of cross walk	Total
9:00-9:15	52	80	132
9:15-9:30	51	100	151
9:30-9:45	30	60	90
9:45-10.00	29	55	84
10:00-10:15	31	60	91
10:15-10:30	28	54	82
10:30-10:45	31	62	93
10:45-11:00	24	45	69
Total	276	516	792
12hr. vol.			**3300**
24hr. vol. 95			**3667**

Location: Al-Gazali Street in front of Municipality
Source: Toukan, 96

P.H for crossing pedestrian
Date: Dec.1995

Time	Pedestrian volume
9:00-10:00	457
9:15-10:15	416
9:30-10:30	347
9:45-10:45	350
10:00-11:00	335

Location: Al-Gazali Street in front of Municipality
Source: Toukan, 96

P.H for crossing pedestrian
Date: Dec.1995

Time	Pedestrian volume
9:00-10:00am	457
12hr. vol.	3047
24hr. vol. 95	3385

Average pedestrian counts

12hr. vol.	**3173**
24hr. vol. 95	**3526**

Location: Al-Gazali Street in front of Municipality

Source: Traffic lab, 99

Crossing pedestrian counts

Date:1999

Time	Pedestrian counts
6:00 -6:05	0
6:05 -6:10	1
6:10 -6:15	0
6:15 -6:20	2
6:20 -6:25	2
6:25 -6:30	2
6:30 -6:35	2
6:35 -6:40	2
6:40 -6:45	5
6:45 -6:50	3
6:50 -6:55	7
6:55 -7:00	6
7:00 -7:05	11
7:05 -7:10	4
7:10 -7:15	18
7:15 -7:20	16
7:20 -7:25	12
7:25 -7:30	10
7:30 -7:35	18
7:35 -7:40	15
7:40 -7:45	38
7:45 -7:50	23
7:50 -7:55	40
7:55 -8:00	45
8:00 -8:05	41
8:05 -8:10	39
8:10 -8:15	32
8:15 -8:20	37
8:20 -8:25	40
8:25 -8:30	45
8:30 -8:35	32
8:35 -8:40	21
8:40 -8:45	15
8:45 -8:50	1
8:50 -8:55	9
8:55 -9:00	12
9:00 -9:05	16
9:05 -9:10	44
9:10 -9:15	39
9:15 -9:20	48
9:20 -9:25	43
9:25 -9:30	58
9:30 -9:35	47

Time	Pedestrian counts
9:35 -9:40	51
9:40 -9:45	44
9:45 -9:50	32
9:50 -9:55	31
9:55 -10:00	54
10:00 -10:05	58
10:05 -10:10	36
10:10 -10:15	51
10:15 -10:20	30
10:20 -10:25	54
10:25 -10:30	36
10:30 -10:35	44
10:35 -10:40	38
10:40 -10:45	33
10:45 -10:50	51
10:50 -10:55	37
10:55 -11:00	29
11:00 -11:05	54
11:05 -11:10	49
11:10 -11:15	33
11:15 -11:20	46
11:20 -11:25	47
11:25 -11:30	40
11:30 -11:35	51
11:35 -11:40	29
11:40 -11:45	43
11:45 -11:50	41
11:50 -11:55	42
11:55 -12:00	22
12:00 -12:05	34
12:05 -12:10	34
12:10 -12:15	43
12:15 -12:20	36
12:20 -12:25	42
12:25 -12:30	34
12:30 -12:35	36
12:35 -12:40	36
12:40 -12:45	27
12:45 -12:50	26
12:50 -12:55	41
12:55 -13:00	39
13:00 -13:05	31
13:05 -13:10	22

Location: Al-Gazali Street in front of Municipality
Source: Traffic lab, 99

Crossing pedestrian counts
Date:1999

Time	Pedestrian counts
13:10 -13:15	18
13:15 -13:20	21
13:20 -13:25	29
13:25 -13:30	20
13:30 -13:35	21
13:35 -13:40	25
13:40 -13:45	12
13:45 -13:50	31
13:50 -13:55	26
13:55 -14:00	28
14:00 -14:05	34
14:05 -14:10	23
14:10 -14:15	24
14:15 -14:20	15
14:20 -14:25	32
14:25 -14:30	26
14:30 -14:35	22
14:35 -14:40	16
14:40 -14:45	16
14:45 -14:50	11
14:50 -14:55	18
14:55 -15:00	9
15:00 -15:05	4
15:05 -15:10	7
15:10 -15:15	5
15:15 -15:20	5
15:20 -15:25	12
15:25 -15:30	13
15:30 -15:35	14
15:35 -15:40	16
15:40 -15:45	17
15:45 -15:50	7
15:50 -15:55	6
15:55 -16:00	19
16:00 -16:05	6
16:05 -16:10	10
16:10 -16:15	6
16:15 -16:20	7
16:20 -16:25	11
16:25 -16:30	12
16:30 -16:35	11
16:35 -16:40	12
16:40 -16:45	8

Time	Pedestrian counts
16:45 -16:50	5
16:50 -16:55	6
16:55 -17:00	13
17:00 -17:05	11
17:05 -17:10	8
17:10 -17:15	15
17:15 -17:20	11
17:20 -17:25	14
17:25 -17:30	4
17:30 -17:35	11
17:35 -17:40	4
17:40 -17:45	21
17:45 -17:50	5
17:50 -17:55	7
17:55 -18:00	8
12hr. vol.	**3656**
24hr. vol. 99	**4062**

Location: Al-Gazali Street in front of Municipality

Source: Traffic lab, 99

P.H for crossing pedestrian

Date:1999

Time	Pedestrian counts
6:00 -7:00	32
6:05 -7:05	43
6:10 -7:10	46
6:15 -7:15	64
6:20 -7:20	78
6:25 -7:25	88
6:30 -7:30	96
6:35 -7:35	112
6:40 -7:40	125
6:45 -7:45	158
6:50 -7:50	178
6:55 -7:55	211
7:00 -8:00	250
7:05 -8:05	280
7:10 -8:10	315
7:15 -8:15	329
7:20 -8:20	350
7:25 -8:25	378
7:30 -8:30	413
7:35 -8:35	427
7:40 -8:40	433
7:45 -8:45	410
7:50 -8:50	388
7:55 -8:55	357
8:00 -9:00	324
8:05 -9:05	299
8:10 -9:10	304
8:15 -9:15	311
8:20 -9:20	322
8:25 -9:25	325
8:30 -9:30	338
8:35 -9:35	353
8:40 -9:40	332
8:45 -9:45	412
8:50 -9:50	443
8:55 -9:55	465
9:00 -10:00	507
9:05 -10:05	549
9:10 -10:10	541
9:15 -10:15	553
9:20 -10:20	535
9:25 -10:25	546
9:30 -10:30	524

Time	Pedestrian counts
9:35 -10:35	521
9:40 -10:40	508
9:45 -10:45	497
9:50 -10:50	516
9:55 -10:55	522
10:00 -11:00	497
10:05 -11:05	493
10:10 -11:10	506
10:15 -11:15	488
10:20 -11:20	504
10:25 -11:25	497
10:30 -11:30	501
10:35 -11:35	508
10:40 -11:40	499
10:45 -11:45	509
10:50 -11:50	499
10:55 -11:55	504
11:00 -12:00	497
11:05 -12:05	477
11:10 -12:10	462
11:15 -12:15	472
11:20 -12:20	462
11:25 -12:25	457
11:30 -12:30	451
11:35 -12:35	436
11:40 -12:40	443
11:45 -12:45	427
11:50 -12:50	652
11:55 -12:55	651
12:00 -13:00	668
12:05 -13:05	665
12:10 -13:10	653
12:15 -13:15	628
12:20 -13:20	613
12:25 -13:25	600
12:30 -13:30	586
12:35 -13:35	571
12:40 -13:40	560
12:45 -13:45	545
12:50 -13:50	310
12:55 -13:55	295
13:00 -14:00	284
13:05 -14:05	287

Location: Al-Gazali Street in front of Municipality

Source: Traffic lab, 99

Time	Pedestrian counts
13:10 -14:10	288
13:15 -14:15	294
13:20 -14:20	288
13:25 -14:25	291
13:30 -14:30	297
13:35 -14:35	298
13:40 -14:40	289
13:45 -14:45	293
13:50 -14:50	273
13:55 -14:55	265
14:00 -15:00	246
14:05 -15:05	216
14:10 -15:10	200
14:15 -15:15	181
14:20 -15:20	171
14:25 -15:25	151
14:30 -15:30	138
14:35 -15:35	130
14:40 -15:40	130
14:45 -15:45	131
14:50 -15:50	127
14:55 -15:55	115
15:00 -16:00	125
15:05 -16:05	127
15:10 -16:10	130
15:15 -16:15	131
15:20 -16:20	133
15:25 -16:25	132
15:30 -16:30	131
15:35 -16:35	128
15:40 -16:40	124
15:45 -16:45	115
15:50 -16:50	113
15:55 -16:55	113
16:00 -17:00	107
16:05 -17:05	112
16:10 -17:10	110
16:15 -17:15	119
16:20 -17:20	123
16:25 -17:25	126
16:30 -17:30	118
16:35 -17:35	118
16:40 -17:40	110

P.H for crossing pedestrian

Date:1999

Time	Pedestrian counts
16:45 -17:45	123
16:50 -17:50	123
16:55 -17:55	124
17:00 -18:00	119

Location: Al-Gazali street in front of Municipality
Source: Traffic lab, 99

P.H for crossing pedestrian
Date:1999

Time	Pedestrian counts
11:50-12:50am	652
12:00-1:00pm	668
12hr. vol.	**3711**
24hr. vol. 99	**4123**

Average pedestrian counts

12hr. vol.	**3684**
24hr. vol. 99	**4093**

Location: Al-Hadadeen Street
Source: Shaar, 97

Crossing pedestrian counts
Date: April.2nd.1997

Time	On crosswalk	Away of cross walk	Total
7:45-8:00	40	34	74
8:00-8:15	23	22	45
8:15-8.30	20	15	35
8:30-8:45	12	29	41
8:45-9:00	26	32	58
9:00-9:15	26	38	64
9:15-9:30	18	35	53
9:30-9:45	25	22	47
Total	190	227	417
12hr. vol.			**1738**
24hr. vol. 97			**1931**

Location: Al-Hadadeen Street
Source: Shaar, 97

P.H for crossing pedestrian
Date: April.2nd.1997

Time	Pedestrian volume
7:45-8:45	195
8:00-9:00	179
8:15-9:15	198
8:30-9:30	216
8:45-9:45	222

Location: Al-Hadadeen Street
Source: Shaar, 97

P.H for crossing pedestrian
Date: April.2nd.1997

Time	Pedestrian counts
9:00-10:00am	222
12hr. vol.	**1480**
24hr. vol. 97	**1644**

Average pedestrian counts

12 hr. vol.	**1609**
ADT97	**1788**

Location: Hetten intersection
Source: Lafi, 99

Crossing pedestrian counts
Date: Nov.26th.1998

Time	North	West	South
7:05 -7:20	31	6	43
7:20 -7:35	23	23	47
7:35 -7:50	32	27	64
7:50 -8:05	33	37	56
8:05 -8:20	21	22	59
8:20 -8:35	34	17	50
8:35 -8:50	10	24	64
8:50 -9:05	32	30	109
9:05 -9:20	68	46	79
9:20 -9:35	50	43	109
9:35 -9:50	34	20	100
9:50 -10:05	47	20	95
10:05 -10:20	33	15	52
10:20 -10:35	25	48	84
10:35 -10:50	30	49	133
10:50 -11:05	31	53	153
11:05 -11:20	39	42	122
11:20 -11:35	37	27	103
11:35 -11:50	21	18	83
11:50 -12:05	68	60	58
12:05 -12:20	46	41	56
12:20 -12:35	34	31	37
12:35 -12:50	22	39	54
12:50 -13:05	23	36	49
13:05 -13:20	41	28	68
13:20 -13:35	23	51	72
13:35 -13:50	9	32	68
13:50 -14:05	9	23	67
14:05 -14:20	17	27	60
14:20 -14:35	11	24	29
14:35 -14:50	19	40	68
14:50 -15:05	17	14	52
15:05 -15:20	10	21	48
15:20 -15:35	8	36	77
15:35 -15:50	18	32	84
Total	1006	1102	2552
12hr. vol.	1170	1281	2967
24hr. vol. 98	1300	1424	3297

Location: Hetten intersection
Source: Lafi, 99

P.H for crossing pedestrian
Date: Nov.26th.1998

Time	North	West	South
7:05 -8:05	119	93	210
7:20 -8:20	109	109	226
7:35 -8:35	120	103	229
7:50 -8:50	98	100	229
8:05 -9:05	97	93	282
8:20 -9:20	144	117	302
8:35 -9:35	160	143	361
8:50 -9:50	184	139	397
9:05 -10:05	199	129	383
9:20 -10:20	164	98	356
9:35 -10:35	139	103	331
9:50 -10:50	135	132	364
10:05 -11:05	119	165	422
10:20 -11:20	125	192	492
10:35 -11:35	137	171	511
10:50 -11:50	128	140	461
11:05 -12:05	165	147	366
11:20 -12:20	172	146	300
11:35 -12:35	169	150	234
11:50 -12:50	170	171	205
12:05 -13:05	125	147	196
12:20 -13:20	120	134	208
12:35 -13:35	109	154	243
12:50 -13:50	96	147	257
13:05 -14:05	82	134	275
13:20 -14:20	58	133	267
13:35 -14:35	46	106	224
13:50 -14:50	56	114	224
14:05 -15:05	64	105	209
14:20 -15:20	57	99	197
14:35 -15:35	54	111	245
14:50 -15:50	53	103	261

Location: Hetten intersection
Source: Lafi, 99

P.H for crossing pedestrian
Date: Nov.26th.1998

Time	North	Time	West	Time	South
9:05-10:05	199	10:20-11:20	192	10:35-11:35	511
12:05-13:05	125	12:35-13:35	154	13:05-14:05	275
12hr. vol.	**1327**	**12hr. vol.**	**1280**	**12hr. vol.**	**3407**
24hr. vol. 98	**1474**	**24hr. vol. 98**	**1422**	**24hr. vol. 98**	**3785**

Average pedestrian counts

Period	North	West	South
12 hr. vol.	**1248**	**1281**	**3187**
ADT98	**1387**	**1423**	**3541**

Location: Al-Husien Roundabout in front of Al-Sied Exchanger

Source: Kahrmana97

Crossing pedestrian counts

Date: 1997

Time	On crosswalk	Away of crosswalk	Total
8:00-8:15	32	50	82
8:15-8.30	44	106	150
8:30-8:45	33	38	71
8:45-9:00	44	70	114
9:00-9:15	49	90	139
9:15-9:30	78	113	191
9:30-9:45	75	136	211
9:45-10.00	68	134	202
Total	423	737	1160
1:00-1:15	105	92	197
1:15-1:30	89	119	208
1:30-1:45	80	117	197
1:45-2:00	60	82	142
2:00-2:15	102	106	208
2:15-2:30	76	81	157
2:30-2:45	35	56	91
2:45-3:00	78	88	166
Total	625	741	1366
4hr. Vol.			2526
12hr. vol.			**7429**
24hr. vol. 97			**8255**

P.H for crossing pedestrian

Date: 1997

Time	Pedestrian volume	Time	P.H.V
8:00-9:00	417	9:00-10:00am	743
8:15-9:15	474	1:15-2:15pm	755
8:30-9:30	515	**12hr. vol.**	**5033**
8:45-9:45	655	**24hr. vol. 97**	**5593**
9:00-10:00	743		
1:00-2:00	744		
1:15-2:15	755		
1:30-2:30	704		
1:45-2:45	598		
2:00-3:00	622		

Average pedestrian counts

12hr. vol.	**6231**
24hr. vol. 97	**6924**

Location: Al-A'del-Hamdi Kan'an intersection

Source: Lafi, 99

Crossing pedestrian counts

Date: Nov.19th.1998

Time	North	West
7:03 -7:18	23	17
7:18 -7:33	41	16
7:33 -7:48	63	48
7:48 -8:03	41	35
8:03 -8:18	61	41
8:18 -8:33	38	28
8:33 -8:48	36	80
8:48 -9:03	33	43
9:03 -9:18	39	56
9:18 -9:33	32	31
9:33 -9:48	36	34
9:48 -10:03	46	44
10:03 -10:18	27	53
10:18 -10:33	21	27
10:33 -10:48	25	30
10:48 -11:03	41	30
11:03 -11:18	26	44
11:18 -11:33	45	34
11:33 -11:48	82	37
11:48 -12:03	63	37
12:03 -12:18	60	64
12:18 -12:33	79	40
12:33 -12:48	107	37
12:48 -13:03	96	111
13:03 -13:18	69	62
13:18 -13:33	74	21
13:33 -13:48	39	37
13:48 -14:03	65	22
14:03 -14:18	43	23
14:18 -14:33	35	22
14:33 -14:48	45	18
14:48 -15:03	41	32
15:03 -15:18	76	58
15:18 -15:33	43	45
15:33 -15:48	124	74
15:48 -16:03	71	49
Total	1886	1480
12hr. vol.	**2193**	**1721**
24hr. vol. 98	**2437**	**1912**

Time	South	East
07:11 -7:26	14	40
07:26 -7:41	42	53
07:41 -7:56	58	44
07:56 -8:11	62	34
08:11 -8:26	83	51
08:26 -8:41	68	67
08:41 -8:56	100	45
08:56 -9:11	124	73
09:11 -9:26	101	64
09:26 -9:41	113	53
09:41 -9:56	105	56
09:56 -10:11	104	59
10:11 -10:26	122	49
10:26 -10:41	116	28
10:41 -10:56	106	38
10:56 -11:11	134	56
11:11 -11:26	113	49
11:26 -11:41	127	87
11:41 -11:56	233	72
11:56 -12:11	173	42
12:11 -12:26	161	53
12:26 -12:41	159	60
12:41 -12:56	215	79
12:56 -13:11	240	65
13:11 -13:26	249	78
13:26 -13:41	185	35
13:41 -13:56	117	52
13:56 -14:11	142	43
14:11 -14:26	123	51
14:26 -14:41	149	35
14:41 -14:56	75	36
14:56 -15:11	118	22
15:11 -15:26	104	40
15:26 -15:41	188	25
15:41 -15:56	202	40
	0	0
Total	4525	1774
12hr. vol.	**5262**	**2063**
24hr. vol. 98	**5846**	**2292**

Location: Al-A'del-Hamdi Kan'an intersection
Source: Lafi, 99

Time	North	West
7:03 -8:03	168	116
7:18 -8:18	206	140
7:33 -8:33	203	152
7:48 -8:48	176	184
8:03 -9:03	168	192
8:18 -9:18	146	207
8:33 -9:33	140	210
8:48 -9:48	140	164
9:03 -10:03	153	165
9:18 -10:18	141	162
9:33 -10:33	130	158
9:48 -10:48	119	154
10:03 -11:03	114	140
10:18 -11:18	113	131
10:33 -11:33	137	138
10:48 -11:48	194	145
11:03 -12:03	216	152
11:18 -12:18	250	172
11:33 -12:33	284	178
11:48 -12:48	309	178
12:03 -13:03	342	252
12:18 -13:18	351	250
12:33 -13:33	346	231
12:48 -13:48	278	231
13:03 -14:03	247	142
13:18 -14:18	221	103
13:33 -14:33	182	104
13:48 -14:48	188	85
14:03 -15:03	164	95
14:18 -15:18	197	130
14:33 -15:33	205	153
14:48 -15:48	284	209
15:03 -16:03	314	226

P.H for crossing pedestriar
Date: Nov.19th.1998

Time	South	East
7:11 -8:11	176	171
7:26 -8:26	245	182
7:41 -8:41	271	196
7:56 -8:56	313	197
8:11 -9:11	375	236
8:26 -9:26	393	249
8:41 -9:41	438	235
8:56 -9:56	443	246
9:11 -10:11	423	232
9:26 -10:26	444	217
9:41 -10:41	447	192
9:56 -10:56	448	174
10:11 -11:11	478	171
10:26 -11:26	469	171
10:41 -11:41	480	230
10:56 -11:56	607	264
11:11 -12:11	646	250
11:26 -12:26	694	254
11:41 -12:41	726	227
11:56 -12:56	708	234
12:11 -13:11	775	257
12:26 -13:26	863	282
12:41 -13:41	889	257
12:56 -13:56	791	230
13:11 -14:11	693	208
13:26 -14:26	567	181
13:41 -14:41	531	181
13:56 -14:56	489	165
14:11 -15:11	465	144
14:26 -15:26	446	133
14:41 -15:41	485	123
14:56 -15:56	612	127

Location: Al-A'del-Hamdi Kan'an intersection

Source: Lafi, 99

P.H for crossing pedestrian

Date: Nov.19th.1998

Time	North	Time	West	Time	South	Time	East
11:48-12:48	309	8:33-9:33	210	11:41-12:41	726	10:56-11:56	264
12:18-13:18	351	12:03-13:03	252	12:41-13:41	889	12:26-13:26	282
12hr. vol.	**2340**	**12hr. vol.**	**1680**	**12hr. vol.**	**5927**	**12hr. vol.**	**1880**
24hr. vol. 98	**2600**	**24hr. vol. 98**	**1867**	**24hr. vol. 98**	**6585**	**24hr. vol. 98**	**2089**

Average pedestrian counts

Period	North	West	South	East
12 hr. vol.	**2267**	**1700**	**5594**	**1971**
ADT98	**2518**	**1889**	**6216**	**2190**

Location: Sufian-Hamdi Kan'an intersection
Source: Lafi, 99

Crossing pedestrian counts
Date: Nov.12th.1998

Time	North	West	South	East
7:10 -7:15	2	5	1	4
7:15 -7:30	4	30	8	34
7:30 -7:45	32	9	8	29
7:45 -8:00	20	12	15	30
8:00 -8:10	17	6	7	16
8:10 -8:25	12	18	9	23
8:25 -8:40	25	10	12	19
8:40 -8:55	50	1	28	29
8:55 -9:10	20	8	25	16
9:10 -9:25	35	7	26	17
9:25 -9:40	31	2	42	15
9:40 -9:55	8	3	26	25
9:55 -10:10	25	0	38	21
10:10 -10:25	23	4	44	23
10:25 -10:40	20	3	43	12
10:40 -10:55	46	4	60	31
10:55 -11:10	27	0	49	44
11:10 -11:25	40	1	47	42
11:25 -11:40	27	4	58	26
11:40 -11:55	44	1	39	25
11:55 -12:10	42	0	48	31
12:10 -12:25	58	1	52	53
12:25 -12:40	40	4	47	60
12:40 -12:55	48	4	47	49
12:55 -13:10	37	4	66	27
13:10 -13:25	43	7	62	23
13:25 -13:40	49	1	42	32
13:40 -13:55	25	4	50	38
13:55 -14:10	39	2	41	19
14:10 -14:25	18	6	62	12
14:25 -14:40	27	2	33	14
14:40 -14:55	43	1	43	12
Total	977	164	1178	851
12hr. vol.	**1269**	**213**	**1530**	**1105**
24hr. vol. 98	**1410**	**237**	**1700**	**1228**

Location: Sufian-Hamdi Kan'an intersection
Source: Lafi, 99

P.H for crossing pedestrian
Date: Nov.12th.1998

Time	North	West	South	East
7:10 -8:10	75	62	39	113
8:10 -9:10	107	37	74	87
08:25 -9:25	130	26	91	81
08:40 -9:40	136	18	121	77
08:55 -9:55	94	20	119	73
09:10 -10:10	99	12	132	78
09:25 -10:25	87	9	150	84
09:40 -10:40	76	10	151	81
09:55 -10:55	114	11	185	87
10:10 -11:10	116	11	196	110
10:25 -11:25	133	8	199	129
10:40 -11:40	140	9	214	143
10:55 -11:55	138	6	193	137
11:10 -12:10	153	6	192	124
11:25 -12:25	171	6	197	135
11:40 -12:40	184	6	186	169
11:55 -12:55	188	9	194	193
12:10 -13:10	183	13	212	189
12:25 -13:25	168	19	222	159
12:40 -13:40	177	16	217	131
12:55 -13:55	154	16	220	120
13:10 -14:10	156	14	195	112
13:25 -14:25	131	13	195	101
13:40 -14:40	109	14	186	83
13:55 -14:55	127	11	179	57

Location: Sufian-Hamdi Kan'an intersection
Source: Lafi, 99

P.H for crossing pedestrian
Date: Nov.12th.1998

Time	North	Time	West	Time	South	Time	East
11:55-12:55	188	7:10-8:10	62	10:40-11:40	214	11:55-12:55	193
12:10-13:10	183	12:25-13:25	19	12:25-13:25	222	12:10-13:10	189
12hr. vol.	**1253**	**12hr. vol.**	**413**	**12hr. vol.**	**1480**	**12hr. vol.**	**1287**
24hr. vol. 98	**1393**	**24hr. vol. 98**	**459**	**24hr. vol. 98**	**1644**	**24hr. vol. 98**	**1430**

Average pedestrian counts

Period	North	West	South	East
12 hr. vol.	**1261**	**313**	**1505**	**1196**
ADT98	**1401**	**348**	**1672**	**1329**

Location: Faisle Street in front of Directorate of Education

Crossing pedestrian counts
Date: March.12th.2000

Time	Pedestrian volume
8:00-8:05	11
8:05-8:10	8
8:10-8:15	7
8:15-8:20	8
8:20-8:25	1
8:25-8:30	6
8:30-8:35	5
8:35-8:40	6
8:40-8:45	3
8:45-8:50	8
8:50-8:55	4
8:55-9:00	6
9:00-9:05	3
9:05-9:10	7
9:10-9:15	16
9:15-9:20	5
9:20-9:25	0
9:25-9:30	4
9:30-9:35	0
9:35-9:40	6
9:40-9:45	9
9:45-9:50	5
9:50-9:55	3
9:55-10:00	5
12:00-12:05	6
12:05-12:10	2
12:10-12:15	4
12:15-12:20	5
12:20-12:25	5
12:25-12:30	2
12:30-12:35	19
12:35-12:40	25
12:40-12:45	30
12:45-12:50	49
12:50-12:55	11
12:55-13:00	14
13:00-13:05	6
13:05-13:10	21
13:10-13:15	23
13:15-13:20	17
13:20-13:25	20
13:25-13:30	35
13:30-13:35	33

Time	Pedestrian volume
13:35-13:40	11
13:40-13:45	17
13:45-13:50	9
13:50-13:55	11
13:55-14:00	12
Total	463
12hr. vol.	**1090**
24hr. vol. 2000	**1211**

Location: Faisle Street in front of Directorate of Education

P.H for crossing pedestrian
Date: March.12th.2000

Time	Pedestrian volume
8:00 -9:00	73
8:05 -9:05	65
8:10 -9:10	64
8:15 -9:15	73
8:20 -9:20	70
8:25 -9:25	69
8:30 -9:30	67
8:35 -9:35	62
8:40 -9:40	62
8:45 -9:45	68
8:50 -9:50	65
8:55 -9:55	64
9:00 -10:00	63
12:00 -13:00	172
12:05 -13:05	172
12:10 -13:10	191
12:15 -13:15	210
12:20 -13:20	222
12:25 -13:25	237
12:30 -13:30	270
12:35 -13:35	284
12:40 -13:40	270
12:45 -13:45	257
12:50 -13:50	217
12:55 -13:55	217
13:00 -14:00	215

Time	P.H.V
8:00-9:00am	222
12:35-1:35pm	284

Location: Faisle Street in front of Vocational Training Center

Crossing pedestrian counts

Date: March.12th.2000

Time	Pedestrian volume
7:00-7:05	5
7:05-7:10	2
7:10-7:15	5
7:15-7:20	3
7:20-7:25	2
7:25-7:30	13
7:30-7:35	12
7:35-7:40	21
7:40-7:45	21
7:45-7:50	9
7:50-7:55	8
7:55-8:00	0
8:00-8:05	7
8:05-8:10	4
8:10-8:15	4
8:15-8:20	1
8:20-8:25	2
8:25-8:30	5
8:30-8:35	1
8:35-8:40	7
8:40-8:45	1
8:45-8:50	2
8:50-8:55	1
8:55-9:00	2
9:00-9:05	1
9:05-9:10	1
9:10-9:15	1
9:15-9:20	1
9:20-9:25	5
9:25-9:30	3
9:30-9:35	0
9:35-9:40	2
9:40-9:45	2
9:45-9:50	6
9:50-9:55	2
9:55-10:00	4
10:00-10:05	0
10:05-10:10	2
10:10-10:15	4
10:15-10:20	2
10:20-10:25	2
10:25-10:30	2
10:30-10:35	1

Time	Pedestrian volume
10:35-10:40	1
10:40-10:45	2
10:45-10:50	0
10:50-10:55	1
10:55-11:00	2
11:00-11:05	1
11:05-11:10	0
11:10-11:15	2
11:15-11:20	1
11:20-11:25	5
11:25-11:30	1
11:30-11:35	2
11:35-11:40	0
11:40-11:45	3
11:45-11:50	4
11:50-11:55	2
11:55-12:00	10
12:00-12:05	7
12:05-12:10	4
12:10-12:15	8
12:15-12:20	5
12:20-12:25	4
12:25-12:30	4
12:30-12:35	4
12:35-12:40	20
12:40-12:45	26
12:45-12:50	0
12:50-12:55	8
12:55-13:00	2
13:00-13:05	1
13:05-13:10	1
13:10-13:15	0
13:15-13:20	1
13:20-13:25	9
13:25-13:30	29
13:30-13:35	3
13:35-13:40	0
13:40-13:45	4
13:45-13:50	0
13:50-13:55	3
13:55-14:00	4
14:00-14:05	0
14:05-14:10	2

Location: Faisle Street in front of Vocational Training Center

Crossing pedestrian counts

Date: March.12th.2000

Time	Pedestrian volume
14:10-14:15	16
14:15-14:20	1
14:20-14:25	0
14:25-14:30	1
14:30-14:35	0
14:35-14:40	3
14:40-14:45	2
14:45-14:50	2
14:50-14:55	1
14:55-15:00	1
15:00-15:05	0
15:05-15:10	0
15:10-15:15	0
15:15-15:20	1
15:20-15:25	0
15:25-15:30	0
15:30-15:35	1
15:35-15:40	1
15:40-15:45	0
15:45-15:50	3
15:50-15:55	3
15:55-16:00	2
16:00-16:05	1
16:05-16:10	1
16:10-16:15	1
16:15-16:20	1
16:20-16:25	1
16:25-16:30	0
16:30-16:35	0
16:35-16:40	0
16:40-16:45	0
16:45-16:50	0
16:50-16:55	3
16:55-17:00	2
17:00-17:05	1
17:05-17:10	2
17:10-17:15	0
17:15-17:20	2
17:20-17:25	0
17:25-17:30	0
17:30-17:35	1
17:35-17:40	0
17:40-17:45	0

Time	Pedestrian volume
17:45-17:50	0
17:50-17:55	1
17:55-18:00	0
18:00-18:05	0
18:05-18:10	0
18:10-18:15	0
18:15-18:20	2
18:20-18:25	0
18:25-18:30	0
18:30-18:35	1
18:35-18:40	4
18:40-18:45	2
18:45-18:50	0
18:50-18:55	0
18:55-19:00	0
12hr. vol.	**233**
24hr. vol. 2000	**259**

Location: Faisle Street in front of Vocational Training Center P.H for crossing pedestrian

Date: March.12th.2000

Time	Pedestrian volume
7:00 -8:00	101
7:05 -8:05	103
7:10 -8:10	105
7:15 -8:15	104
7:20 -8:20	102
7:25 -8:25	102
7:30 -8:30	94
7:35 -8:35	83
7:40 -8:40	69
7:45 -8:45	49
7:50 -8:50	42
7:55 -8:55	35
8:00 -9:00	37
8:05 -9:05	31
8:10 -9:10	28
8:15 -9:15	25
8:20 -9:20	25
8:25 -9:25	28
8:30 -9:30	26
8:35 -9:35	25
8:40 -9:40	20
8:45 -9:45	21
8:50 -9:50	25
8:55 -9:55	26
9:00 -10:00	28
9:05 -10:05	27
9:10 -10:10	28
9:15 -10:15	31
9:20 -10:20	32
9:25 -10:25	29
9:30 -10:30	28
9:35 -10:35	29
9:40 -10:40	28
9:45 -10:45	28
9:50 -10:50	22
9:55 -10:55	21
10:00 -11:00	19
10:05 -11:05	20
10:10 -11:10	18
10:15 -11:15	16
10:20 -11:20	15
10:25 -11:25	18
10:30 -11:30	17

Time	Pedestrian volume
10:35 -11:35	18
10:40 -11:40	17
10:45 -11:45	18
10:50 -11:50	22
10:55 -11:55	23
11:00 -12:00	31
11:05 -12:05	37
11:10 -12:10	41
11:15 -12:15	47
11:20 -12:20	51
11:25 -12:25	50
11:30 -12:30	53
11:35 -12:35	55
11:40 -12:40	75
11:45 -12:45	98
11:50 -12:50	94
11:55 -12:55	100
12:00 -13:00	92
12:05 -13:05	86
12:10 -13:10	83
12:15 -13:15	75
12:20 -13:20	71
12:25 -13:25	76
12:30 -13:30	101
12:35 -13:35	100
12:40 -13:40	80
12:45 -13:45	58
12:50 -13:50	58
12:55 -13:55	53
13:00 -14:00	55
13:05 -14:05	54
13:10 -14:10	55
13:15 -14:15	71
13:20 -14:20	71
13:25 -14:25	62
13:30 -14:30	34
13:35 -14:35	31
13:40 -14:40	34
13:45 -14:45	32
13:50 -14:50	34
13:55 -14:55	32
14:00 -15:00	29
14:05 -15:05	29

Location: Faisle Street in front of Vocational Training Center P.H for crossing pedestrian

Date: March.12th.2000

Time	Pedestrian volume
14:10 -15:10	27
14:15 -15:15	11
14:20 -15:20	11
14:25 -15:25	11
14:30 -15:30	10
14:35 -15:35	11
14:40 -15:40	9
14:45 -15:45	7
14:50 -15:50	8
14:55 -15:55	10
15:00 -16:00	11
15:05 -16:05	12
15:10 -16:10	13
15:15 -16:15	14
15:20 -16:20	14
15:25 -16:25	15
15:30 -16:30	15
15:35 -16:35	14
15:40 -16:40	13
15:45 -16:45	13
15:50 -16:50	10
15:55 -16:55	10
16:00 -17:00	10
16:05 -17:05	10
16:10 -17:10	11
16:15 -17:15	10
16:20 -17:20	11
16:25 -17:25	10
16:30 -17:30	10
16:35 -17:35	11
16:40 -17:40	11
16:45 -17:45	11
16:50 -17:50	11
16:55 -17:55	9
17:00 -18:00	7
17:05 -18:05	6
17:10 -18:10	4
17:15 -18:15	4
17:20 -18:20	4
17:25 -18:25	4
17:30 -18:30	4
17:35 -18:35	4
17:40 -18:40	8

Time	Pedestrian volume
17:45 -18:45	10
17:50 -18:50	10
17:55 -18:55	9
18:00 -19:00	9

Location: Faisle Street in front of Vocational Training Center P.H for crossing pedestrian

Date: March.12th.2000

Time	Pedestrian counts
7:10-8:10am	105
12:30-1:30pm	101

Location: Grindlays Bank intersection
Source: Lafi, 98

Crossing pedestrian counts
Date: Oct.28th.1998

Time	North	South	East	West
6:59 -7:04	2	1	7	0
7:04 -7:09	0	10	11	1
7:09 -7:14	2	16	6	4
7:14 -7:19	5	25	12	0
7:19 -7:24	16	13	10	5
7:24 -7:29	6	13	21	10
7:29 -7:34	30	26	16	11
7:34 -7:39	29	30	20	9
7:39 -7:44	8	16	14	19
7:44 -7:49	15	20	4	3
7:49 -7:54	12	6	13	5
7:54 -7:59	10	15	7	5
7:59 -8:04	4	12	9	4
8:04 -8:09	16	7	4	10
8:09 -8:14	9	6	6	3
8:14 -8:19	2	10	5	3
8:19 -8:24	9	12	7	6
8:24 -8:29	10	3	4	7
8:29 -8:34	5	6	5	5
8:34 -8:39	10	7	1	7
8:39 -8:44	6	15	6	9
8:44 -8:49	3	13	4	8
8:49 -8:54	8	9	2	10
8:54 -8:59	8	9	5	1
8:59 -9:04	6	10	2	3
9:04 -9:09	5	11	1	2
9:09 -9:14	5	5	2	3
9:14 -9:19	5	9	6	1
9:19 -9:24	10	8	2	6
9:24 -9:29	3	11	4	1
9:29 -9:34	9	16	0	1
9:34 -9:39	8	12	2	4
9:39 -9:44	7	9	4	5
9:44 -9:49	9	15	2	3
9:49 -9:54	14	17	5	4
9:54 -9:59	6	7	4	1
9:59 -10:04	5	9	1	0
10:04 -10:09	5	9	0	3
10:09 -10:14	5	15	0	1
10:14 -10:19	7	10	4	8
10:19 -10:24	7	13	3	7
10:24 -10:29	3	20	0	2

Location: Grindlays Bank intersection
Source: Lafi, 98

Crossing pedestrian counts
Date: Oct.28th.1998

Time	North	South	East	West
10:29 -10:34	1	20	1	9
10:34 -10:39	9	5	2	4
10:39 -10:44	6	8	2	1
10:44 -10:49	9	13	3	1
10:49 -10:54	8	8	2	2
10:54 -10:59	10	13	0	8
10:59 -11:04	3	24	4	18
11:04 -11:09	4	18	7	1
11:09 -11:14	12	29	10	6
11:14 -11:19	8	10	7	2
11:19 -11:24	7	34	2	3
11:24 -11:29	18	13	2	8
11:29 -11:34	17	16	7	10
11:34 -11:39	15	30	8	8
11:39 -11:44	14	35	11	18
11:44 -11:49	14	34	6	14
11:49 -11:54	17	34	6	4
11:54 -11:59	20	18	12	4
11:59 -12:04	8	23	4	2
12:04 -12:09	15	42	10	4
12:09 -12:14	17	36	12	6
12:14 -12:19	5	24	2	7
12:19 -12:24	13	37	8	6
12:24 -12:29	16	24	5	5
12:29 -12:34	21	26	40	20
12:34 -12:39	16	50	21	26
12:39 -12:44	26	97	13	6
12:44 -12:49	11	75	1	0
12:49 -12:54	19	64	1	1
12:54 -12:59	25	24	0	0
12:59 -13:04	17	43	0	1
13:04 -13:09	35	40	1	4
13:09 -13:14	13	61	3	3
13:14 -13:19	20	37	3	0
13:19 -13:24	26	40	5	4
13:24 -13:29	13	32	8	9
13:29 -13:34	15	34	8	12
13:34 -13:39	13	40	9	2
13:39 -13:44	7	14	6	4
13:44 -13:49	10	26	4	2
13:49 -13:54	9	26	2	4
13:54 -13:59	14	23	5	3

Location: Grindlays Bank intersection
Source: Lafi, 98

Crossing pedestrian counts
Date: Oct.28th.1998

Time	North	South	East	West
13:59 -14:04	7	28	1	8
14:04 -14:09	4	45	5	0
14:09 -14:14	10	38	4	4
14:14 -14:19	19	22	6	2
14:19 -14:24	15	21	3	2
14:24 -14:29	9	19	3	2
14:29 -14:34	17	28	9	3
14:34 -14:39	7	22	3	3
14:39 -14:44	3	6	1	2
14:44 -14:49	0	0	0	0
14:49 -14:54	0	0	0	0
14:54 -14:59	2	0	0	0
14:59 -15:04	0	0	0	0
15:04 -15:09	0	0	0	0
15:09 -15:14	0	0	0	0
15:14 -15:19	0	0	0	0
15:19 -15:24	0	0	0	0
15:24 -15:29	0	0	0	0
15:29 -15:34	0	0	0	0
15:34 -15:39	0	0	0	0
15:39 -15:44	0	0	0	0
15:44 -15:49	0	0	0	0
15:49 -15:54	0	0	0	0
15:54 -15:59	0	0	0	0
15:59 -16:04	0	0	0	0
16:04 -16:09	0	0	0	0
16:09 -16:14	0	0	0	0
16:14 -16:19	0	0	0	0
16:19 -16:24	0	0	0	0
16:24 -16:29	0	0	0	0
16:29 -16:34	0	0	0	0
16:34 -16:39	0	0	0	0
16:39 -16:44	0	0	0	0
16:44 -16:49	0	0	0	0
16:49 -16:54	0	0	0	0
Total	1013	2035	539	478
12hr. vol.	**1055**	**2120**	**561**	**498**
24hr. vol. 98	**1172**	**2355**	**624**	**553**

Location: Grindlays Bank intersection
Source: Lafi, 98

P.H for crossing pedestrian
Date: Oct.28th.1998

Time	North	South	East	West
6:59 -7:59	139	203	150	76
7:04 -8:04	153	209	147	86
7:09 -8:09	162	205	142	88
7:14 -8:14	162	199	141	87
7:19 -8:19	166	186	136	93
7:24 -8:24	160	176	130	95
7:29 -8:29	159	169	114	90
7:34 -8:34	139	150	99	86
7:39 -8:39	116	135	85	86
7:44 -8:44	111	132	75	75
7:49 -8:49	104	121	73	82
7:54 -8:54	100	124	65	78
7:59 -8:59	96	119	60	76
8:04 -9:04	97	118	52	74
8:09 -9:09	86	116	50	67
8:14 -9:14	82	119	50	65
8:19 -9:19	90	117	47	68
8:24 -9:24	84	116	44	63
8:29 -9:29	83	129	40	57
8:34 -9:34	86	135	37	56
8:39 -9:39	83	137	40	54
8:44 -9:44	86	137	36	48
8:49 -9:49	97	141	37	44
8:54 -9:54	95	139	39	35
8:59 -9:59	92	139	35	34
9:04 -10:04	91	138	33	34
9:09 -10:09	91	142	32	33
9:14 -10:14	93	147	34	38
9:19 -10:19	95	151	31	44
9:24 -10:24	88	163	29	40
9:29 -10:29	86	172	26	48
9:34 -10:34	86	161	28	51
9:39 -10:39	84	157	28	48
9:44 -10:44	86	161	27	44
9:49 -10:49	85	154	27	43
9:54 -10:54	81	150	22	47
9:59 -10:59	78	167	22	64
10:04 -11:04	77	176	28	65
10:09 -11:09	84	196	38	68
10:14 -11:14	87	191	45	69
10:19 -11:19	87	215	43	64
10:24 -11:24	98	215	42	65

Location: Grindlays Bank intersection
Source: Lafi, 98

P.H for crossing pedestrian
Date: Oct.28th.1998

Time	North	South	East	West
10:29 -11:29	112	211	49	73
10:34 -11:34	126	221	56	72
10:39 -11:39	131	251	65	86
10:44 -11:44	139	277	69	99
10:49 -11:49	147	298	72	102
10:54 -11:54	159	308	82	104
10:59 -11:59	157	318	86	98
11:04 -12:04	169	336	92	84
11:09 -12:09	182	354	97	89
11:14 -12:14	175	349	89	90
11:19 -12:19	180	376	90	94
11:24 -12:24	189	366	93	96
11:29 -12:29	192	379	131	108
11:34 -12:34	191	413	145	124
11:39 -12:39	202	480	150	122
11:44 -12:44	199	520	140	104
11:49 -12:49	204	550	135	91
11:54 -12:54	212	540	129	87
11:59 -12:59	209	565	117	84
12:04 -13:04	236	582	114	86
12:09 -13:09	234	601	107	85
12:14 -13:14	237	602	98	79
12:19 -13:19	258	618	101	76
12:24 -13:24	258	613	101	79
12:29 -13:29	257	623	104	86
12:34 -13:34	249	637	73	68
12:39 -13:39	240	601	58	48
12:44 -13:44	224	530	49	46
12:49 -13:49	222	481	50	49
12:54 -13:54	217	440	54	56
12:59 -13:59	199	444	55	56
13:04 -14:04	186	446	60	59
13:09 -14:09	161	444	63	57
13:14 -14:14	167	405	66	56
13:19 -14:19	162	389	66	58
13:24 -14:24	145	368	64	57
13:29 -14:29	149	364	65	51
13:34 -14:34	141	352	60	41
13:39 -14:39	131	318	52	35
13:44 -14:44	124	304	46	33
13:49 -14:49	114	278	42	29
13:54 -14:54	107	252	40	26

Location: Grindlays Bank intersection
Source: Lafi, 98

P.H for crossing pedestrian
Date: Oct.28th.1998

Time	North	South	East	West
13:59 -14:59	93	229	35	18
14:04 -15:04	86	201	34	18
14:09 -15:09	82	156	29	14
14:14 -15:14	72	118	25	12
14:19 -15:19	53	96	19	10
14:24 -15:24	38	75	16	8
14:29 -15:29	29	56	13	5
14:34 -15:34	12	28	4	2
14:39 -15:39	5	6	1	0
14:44 -15:44	2	0	0	0
14:49 -15:49	2	0	0	0
14:54 -15:54	2	0	0	0

Location: Grindlays Bank intersection
Source: Lafi, 98

P.H calculation for pedestrian counts
Date: Oct.28th.1998

Period	North		South		East		West	
	Time	P.H.V	Time	P.H.V	Time	P.H.V	Time	P.H.V
A.M	11:54-12:54	212	11:59-12:59	565	6:59-7:59	150	12:04-13:04	86
P.M	12:24-13:24	258	12:34-13:34	637	12:04-13:04	114	12:29-13:29	29

Location: Amman Street in front of Yousef Tomb

Crossing pedestrian counts
Date: March.13th.2000

Time	Pedestrian volume
8:00-8:05	5
8:05-8:10	9
8:10-8:15	5
8:15-8:20	4
8:20-8:25	2
8:25-8:30	10
8:30-8:35	4
8:35-8:40	1
8:40-8:45	6
8:45-8:50	6
8:50-8:55	4
8:55-9:00	1
9:00-9:05	5
9:05-9:10	5
9:10-9:15	4
9:15-9:20	6
9:20-9:25	3
9:25-9:30	4
9:30-9:35	5
9:35-9:40	4
9:40-9:45	10
9:45-9:50	7
9:50-9:55	6
9:55-10:00	19
12:00-12:05	6
12:05-12:10	20
12:10-12:15	4
12:15-12:20	2
12:20-12:25	6
12:25-12:30	3
12:30-12:35	9
12:35-12:40	11
12:40-12:45	14
12:45-12:50	8
12:50-12:55	7
12:55-13:00	10
13:00-13:05	1
13:05-13:10	5
13:10-13:15	3
13:15-13:20	18
13:20-13:25	6
13:25-13:30	13
13:30-13:35	28

Time	Pedestrian volume
13:35-13:40	7
13:40-13:45	4
13:45-13:50	6
13:50-13:55	8
13:55-14:00	5
Total	309
12hr. vol.	**1074**
24hr. vol. 2000	**1193**

Location: Amman Street in front of Yousef Tomb

P.H for crossing pedestrian
Date: March.13th.2000

Time	Pedestrian volume
8:00 -9:00	57
8:05 -9:05	57
8:10 -9:10	53
8:15 -9:15	52
8:20 -9:20	54
8:25 -9:25	55
8:30 -9:30	49
8:35 -9:35	50
8:40 -9:40	53
8:45 -9:45	57
8:50 -9:50	58
8:55 -9:55	60
9:00 -10:00	78
12:00 -13:00	100
12:05 -13:05	95
12:10 -13:10	80
12:15 -13:15	79
12:20 -13:20	95
12:25 -13:25	95
12:30 -13:30	105
12:35 -13:35	124
12:40 -13:40	120
12:45 -13:45	110
12:50 -13:50	108
12:55 -13:55	109
13:00 -14:00	104

Time	Pedestrian counts
9:00-10:00am	78
12:35-1:35pm	124

Location: Al-Quds Street in front of Al'nwar Hall

Crossing pedestrian counts

Date: March.14th.2000

Time	Pedestrian volume
7:00-7:05	9
7:05-7:10	3
7:10-7:15	3
7:15-7:20	5
7:20-7:25	5
7:25-7:30	8
7:30-7:35	2
7:35-7:40	5
7:40-7:45	4
7:45-7:50	5
7:50-7:55	5
7:55-8:00	5
8:00-8:05	6
8:05-8:10	3
8:10-8:15	10
8:15-8:20	8
8:20-8:25	8
8:25-8:30	3
8:30-8:35	5
8:35-8:40	5
8:40-8:45	2
8:45-8:50	3
8:50-8:55	7
8:55-9:00	7
9:00-9:05	8
9:05-9:10	6
9:10-9:15	6
9:15-9:20	2
9:20-9:25	1
9:25-9:30	8
9:30-9:35	4
9:35-9:40	5
9:40-9:45	8
9:45-9:50	4
9:50-9:55	2
9:55-10:00	5
10:00-10:05	6
10:05-10:10	8
10:10-10:15	10
10:15-10:20	7
10:20-10:25	3
10:25-10:30	8
10:30-10:35	4

Time	Pedestrian volume
10:35-10:40	5
10:40-10:45	7
10:45-10:50	3
10:50-10:55	8
10:55-11:00	3
11:00-11:05	2
11:05-11:10	5
11:10-11:15	3
11:15-11:20	1
11:20-11:25	2
11:25-11:30	2
11:30-11:35	5
11:35-11:40	2
11:40-11:45	6
11:45-11:50	4
11:50-11:55	1
11:55-12:00	3
12:00-12:05	6
12:05-12:10	6
12:10-12:15	3
12:15-12:20	2
12:20-12:25	2
12:25-12:30	4
12:30-12:35	2
12:35-12:40	3
12:40-12:45	9
12:45-12:50	3
12:50-12:55	4
12:55-13:00	2
13:00-13:05	6
13:05-13:10	3
13:10-13:15	6
13:15-13:20	8
13:20-13:25	9
13:25-13:30	7
13:30-13:35	2
13:35-13:40	4
13:40-13:45	6
13:45-13:50	2
13:50-13:55	1
13:55-14:00	10
14:00-14:05	13
14:05-14:10	4

Location: Al-Quds Street in front of Al'nwar Hall

Crossing pedestrian counts

Date: March.14th.2000

Time	Pedestrian volume
14:10-14:15	2
14:15-14:20	5
14:20-14:25	6
14:25-14:30	2
14:30-14:35	4
14:35-14:40	1
14:40-14:45	5
14:45-14:50	11
14:50-14:55	3
14:55-15:00	1
15:00-15:05	6
15:05-15:10	3
15:10-15:15	4
15:15-15:20	6
15:20-15:25	3
15:25-15:30	9
15:30-15:35	9
15:35-15:40	3
15:40-15:45	10
15:45-15:50	10
15:50-15:55	6
15:55-16:00	8
16:00-16:05	8
16:05-16:10	14
16:10-16:15	2
16:15-16:20	6
16:20-16:25	3
16:25-16:30	5
16:30-16:35	3
16:35-16:40	7
16:40-16:45	2
16:45-16:50	5
16:50-16:55	4
16:55-17:00	6
17:00-17:05	7
17:05-17:10	4
17:10-17:15	5
17:15-17:20	1
17:20-17:25	2
17:25-17:30	4
17:30-17:35	5
17:35-17:40	9
17:40-17:45	9

Time	Pedestrian volume
17:45-17:50	7
17:50-17:55	8
17:55-18:00	6
18:00-18:05	7
18:05-18:10	6
18:10-18:15	8
18:15-18:20	1
18:20-18:25	6
18:25-18:30	4
18:30-18:35	1
18:35-18:40	2
18:40-18:45	6
18:45-18:50	1
18:50-18:55	1
18:55-19:00	7
12hr. vol.	**459**
24hr. vol. 2000	**510**

Location: Al-Quds Street in front of Al'nwar Hall

P.H for crossing pedestrian

Date: March.14th.2000

Time	Pedestrian volume
7:00 -8:00	59
7:05 -8:05	56
7:10 -8:10	56
7:15 -8:15	63
7:20 -8:20	66
7:25 -8:25	69
7:30 -8:30	64
7:35 -8:35	67
7:40 -8:40	67
7:45 -8:45	65
7:50 -8:50	63
7:55 -8:55	65
8:00 -9:00	67
8:05 -9:05	69
8:10 -9:10	72
8:15 -9:15	68
8:20 -9:20	62
8:25 -9:25	55
8:30 -9:30	60
8:35 -9:35	59
8:40 -9:40	59
8:45 -9:45	65
8:50 -9:50	66
8:55 -9:55	61
9:00 -10:00	59
9:05 -10:05	57
9:10 -10:10	59
9:15 -10:15	63
9:20 -10:20	68
9:25 -10:25	70
9:30 -10:30	70
9:35 -10:35	70
9:40 -10:40	70
9:45 -10:45	69
9:50 -10:50	68
9:55 -10:55	74
10:00 -11:00	72
10:05 -11:05	68
10:10 -11:10	65
10:15 -11:15	58
10:20 -11:20	52
10:25 -11:25	51
10:30 -11:30	45

Time	Pedestrian volume
10:35 -11:35	46
10:40 -11:40	43
10:45 -11:45	42
10:50 -11:50	43
10:55 -11:55	36
11:00 -12:00	36
11:05 -12:05	40
11:10 -12:10	41
11:15 -12:15	41
11:20 -12:20	42
11:25 -12:25	42
11:30 -12:30	44
11:35 -12:35	41
11:40 -12:40	42
11:45 -12:45	45
11:50 -12:50	44
11:55 -12:55	47
12:00 -13:00	46
12:05 -13:05	46
12:10 -13:10	43
12:15 -13:15	46
12:20 -13:20	52
12:25 -13:25	59
12:30 -13:30	62
12:35 -13:35	62
12:40 -13:40	63
12:45 -13:45	60
12:50 -13:50	59
12:55 -13:55	56
13:00 -14:00	64
13:05 -14:05	71
13:10 -14:10	72
13:15 -14:15	68
13:20 -14:20	65
13:25 -14:25	62
13:30 -14:30	57
13:35 -14:35	59
13:40 -14:40	56
13:45 -14:45	55
13:50 -14:50	64
13:55 -14:55	66
14:00 -15:00	57
14:05 -15:05	50

Location: Al-Quds Street in front of Al'nwar Hall

P.H for crossing pedestrian
Date: March.14th.2000

Time	Pedestrian volume
14:10 -15:10	49
14:15 -15:15	51
14:20 -15:20	52
14:25 -15:25	49
14:30 -15:30	56
14:35 -15:35	61
14:40 -15:40	63
14:45 -15:45	68
14:50 -15:50	67
14:55 -15:55	70
15:00 -16:00	77
15:05 -16:05	79
15:10 -16:10	90
15:15 -16:15	88
15:20 -16:20	88
15:25 -16:25	88
15:30 -16:30	84
15:35 -16:35	78
15:40 -16:40	82
15:45 -16:45	74
15:50 -16:50	69
15:55 -16:55	67
16:00 -17:00	65
16:05 -17:05	64
16:10 -17:10	54
16:15 -17:15	57
16:20 -17:20	52
16:25 -17:25	51
16:30 -17:30	50
16:35 -17:35	52
16:40 -17:40	54
16:45 -17:45	61
16:50 -17:50	63
16:55 -17:55	67
17:00 -18:00	67
17:05 -18:05	67
17:10 -18:10	69
17:15 -18:15	72
17:20 -18:20	72
17:25 -18:25	76
17:30 -18:30	76
17:35 -18:35	72
17:40 -18:40	65

Time	Pedestrian volume
17:45 -18:45	62
17:50 -18:50	56
17:55 -18:55	49
18:00 -19:00	50

Time	P.H.V
9:55-10:55am	74
3:10-4:10pm	90

Location: Al-Quds Street in front of the secondary intersection to Balata Refugee Camp

Crossing pedestrian counts
Date: March.14th.2000

Time	Pedestrian volume
8:00-8:05	0
8:05-8:10	3
8:10-8:15	2
8:15-8:20	4
8:20-8:25	0
8:25-8:30	2
8:30-8:35	1
8:35-8:40	0
8:40-8:45	5
8:45-8:50	1
8:50-8:55	3
8:55-9:00	3
9:00-9:05	1
9:05-9:10	0
9:10-9:15	3
9:15-9:20	1
9:20-9:25	2
9:25-9:30	2
9:30-9:35	3
9:35-9:40	1
9:40-9:45	0
9:45-9:50	0
9:50-9:55	2
9:55-10:00	4
12:00-12:05	3
12:05-12:10	1
12:10-12:15	3
12:15-12:20	2
12:20-12:25	5
12:25-12:30	2
12:30-12:35	0
12:35-12:40	2
12:40-12:45	1
12:45-12:50	3
12:50-12:55	4
12:55-13:00	5
13:00-13:05	2
13:05-13:10	1
13:10-13:15	6
13:15-13:20	9
13:20-13:25	1
13:25-13:30	2
13:30-13:35	7

Time	Pedestrian volume
13:35-13:40	3
13:40-13:45	4
13:45-13:50	0
13:50-13:55	5
13:55-14:00	1
Total	102
12hr. vol.	**359**
24hr. vol. 2000	**399**

Location: Al-Quds Street in front of the secondary intersection P.H for crossing pedestrian to Balata Refugee Camp

Date: March.14th.2000

Time	Pedestrian volume
8:00 -9:00	24
8:05 -9:05	25
8:10 -9:10	22
8:15 -9:15	23
8:20 -9:20	20
8:25 -9:25	22
8:30 -9:30	22
8:35 -9:35	24
8:40 -9:40	25
8:45 -9:45	20
8:50 -9:50	19
8:55 -9:55	18
9:00 -10:00	19
12:00 -13:00	31
12:05 -13:05	30
12:10 -13:10	30
12:15 -13:15	33
12:20 -13:20	40
12:25 -13:25	36
12:30 -13:30	36
12:35 -13:35	43
12:40 -13:40	44
12:45 -13:45	47
12:50 -13:50	44
12:55 -13:55	45
13:00 -14:00	41

Time	Pedestrian counts
8:40-9:40am	25
12:45-1:45pm	47

Location: Rafedia Street in front of Al-Rawda Mosque

Crossing pedestrian counts
Date: March.15th.2000

Time	Pedestrian volume		
	Al-Rawda Mosque	Ashoor Sweets	Total
8:00-8:05	0	6	6
8:05-8:10	0	2	2
8:10-8:15	1	0	1
8:15-8:20	3	2	5
8:20-8:25	3	0	3
8:25-8:30	0	2	2
8:30-8:35	1	2	3
8:35-8:40	2	0	2
8:40-8:45	1	3	4
8:45-8:50	2	2	4
8:50-8:55	3	0	3
8:55-9:00	2	3	5
9:00-9:05	0	3	3
9:05-9:10	2	5	7
9:10-9:15	0	0	0
9:15-9:20	0	0	0
9:20-9:25	2	0	2
9:25-9:30	2	1	3
9:30-9:35	0	1	1
9:35-9:40	3	1	4
9:40-9:45	0	4	4
9:45-9:50	1	2	3
9:50-9:55	0	3	3
9:55-10:00	0	4	4
12:00-12:05	6	4	10
12:05-12:10	4	5	9
12:10-12:15	13	3	16
12:15-12:20	11	8	19
12:20-12:25	11	5	16
12:25-12:30	6	3	9
12:30-12:35	12	8	20
12:35-12:40	0	6	6
12:40-12:45	3	4	7
12:45-12:50	3	2	5
12:50-12:55	2	1	3
12:55-13:00	1	0	1
13:00-13:05	2	2	4
13:05-13:10	0	2	2
13:10-13:15	1	8	9
13:15-13:20	3	1	4
13:20-13:25	1	0	1
13:25-13:30	2	0	2

Location: Rafedia Street in front of Al-Rawda Mosque

Crossing pedestrian counts
Date: March.15th.2000

Time	Pedestrian volume		
	Al-Rawda Mosque	Ashoor Sweets	Total
13:30-13:35	1	1	2
13:35-13:40	4	2	6
13:40-13:45	4	3	7
13:45-13:50	6	3	9
13:50-13:55	5	0	5
13:55-14:00	0	0	0
16:00-16:05	0	3	3
16:05-16:10	2	4	6
16:10-16:15	1	1	2
16:15-16:20	2	6	8
16:20-16:25	0	2	2
16:25-16:30	1	3	4
16:30-16:35	1	6	7
16:35-16:40	1	8	9
16:40-16:45	2	1	3
16:45-16:50	1	1	2
16:50-16:55	1	13	14
16:55-17:00	3	7	10
17:00-17:05	0	14	14
17:05-17:10	5	3	8
17:10-17:15	2	13	15
17:15-17:20	5	3	8
17:20-17:25	0	3	3
17:25-17:30	1	9	10
17:30-17:35	3	6	9
17:35-17:40	9	5	14
17:40-17:45	4	5	9
17:45-17:50	5	2	7
17:50-17:55	0	2	2
17:55-18:00	1	4	5
Total	179	241	420
12hr. vol.	**269**	**338**	**607**
24hr. vol. 2000	**299**	**376**	**674**

Location: Rafedia Street in front of Al-Rawda Mosque

P.H for crossing pedestrian
Date: March.15th.2000

Time	Pedestrian volume	
	Al-Rawda Mosque	Ashoor Sweets
8:00 -9:00	18	22
8:05 -9:05	18	19
8:10 -9:10	20	22
8:15 -9:15	19	22
8:20 -9:20	16	20
8:25 -9:25	15	20
8:30 -9:30	17	19
8:35 -9:35	16	18
8:40 -9:40	17	19
8:45 -9:45	16	20
8:50 -9:50	15	20
8:55 -9:55	12	23
9:00 -10:00	10	24
12:00 -13:00	72	25
12:05 -13:05	68	25
12:10 -13:10	64	28
12:15 -13:15	52	36
12:20 -13:20	44	41
12:25 -13:25	34	43
12:30 -13:30	30	50
12:35 -13:35	19	55
12:40 -13:40	23	55
12:45 -13:45	24	55
12:50 -13:50	27	53
12:55 -13:55	30	49
13:00 -14:00	29	47
16:00 -17:00	15	44
16:05 -17:05	15	49
16:10 -17:10	18	42
16:15 -17:15	19	37
16:20 -17:20	22	34
16:25 -17:25	22	27
16:30 -17:30	22	23
16:35 -17:35	24	22
16:40 -17:40	32	23
16:45 -17:45	34	22
16:50 -17:50	38	22
16:55 -17:55	37	23
17:00 -18:00	35	25

Location: Rafedia Street in front of Al-Rawda Mosque

P.H for crossing pedestrian
Date: March.15th.2000

Time	Al-Rawda Mosque	Time	Ashoor Sweets
8:10-9:10am	20	9:00-10:00am	24
12:00-1:00pm	72	12:40-1:40pm	55
4:50-5:50pm	38	4:05-5:05pm	49
12hr. vol.	**300**	**12hr. vol.**	**229**
24hr. vol. 2000	**333**	**24hr. vol. 2000**	**255**

Average pedestrian counts

Period	Al-Rawda Mosque	Ashoor Sweets	Total
12hr. vol.	**285**	**284**	**568**
24hr. vol. 2000	**316**	**315**	**631**

Location: Haifa Street in front of Ein Refugee Camp

Crossing pedestrian counts

Date: March.13th.2000

Time	Pedestrian volume
8:00-8:05	2
8:05-8:10	4
8:10-8:15	4
8:15-8:20	3
8:20-8:25	5
8:25-8:30	8
8:30-8:35	16
8:35-8:40	2
8:40-8:45	9
8:45-8:50	4
8:50-8:55	4
8:55-9:00	11
9:00-9:05	13
9:05-9:10	5
9:10-9:15	2
9:15-9:20	7
9:20-9:25	6
9:25-9:30	6
9:30-9:35	12
9:35-9:40	4
9:40-9:45	5
9:45-9:50	13
9:50-9:55	8
9:55-10:00	17
12:00-12:05	22
12:05-12:10	24
12:10-12:15	20
12:15-12:20	23
12:20-12:25	25
12:25-12:30	25
12:30-12:35	17
12:35-12:40	17
12:40-12:45	31
12:45-12:50	30
12:50-12:55	25
12:55-13:00	19
13:00-13:05	10
13:05-13:10	9
13:10-13:15	13
13:15-13:20	26
13:20-13:25	26
13:25-13:30	26
13:30-13:35	28

Time	Pedestrian volume
13:35-13:40	49
13:40-13:45	30
13:45-13:50	19
13:50-13:55	14
13:55-14:00	14
Total	586
12hr. vol.	**2320**
24hr. vol. 2000	**2578**

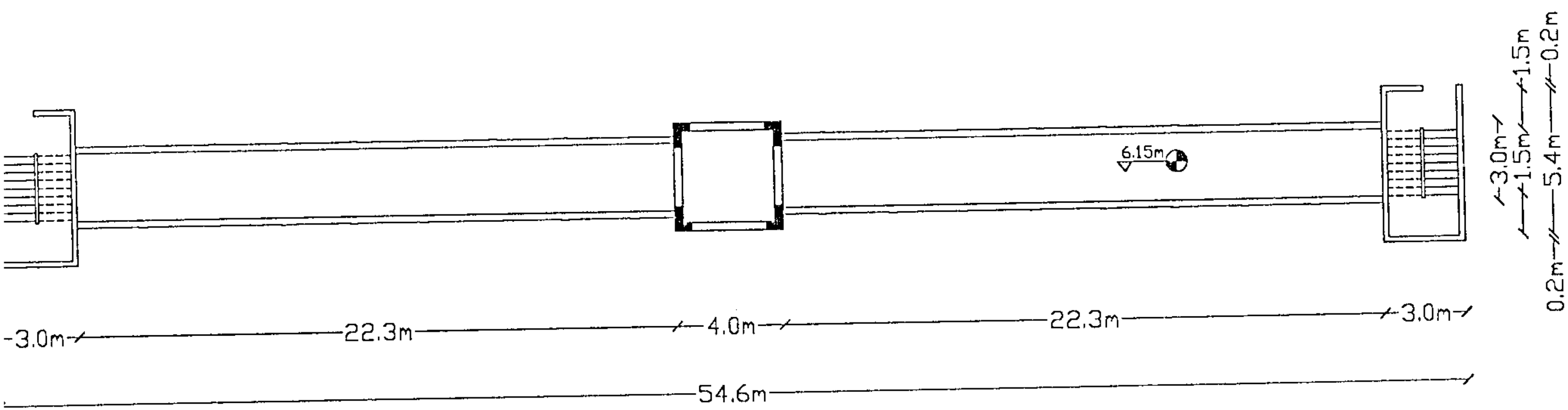
Location: Haifa Street in front of Ein Refugee Camp

Time	Pedestrian volume
8:00 -9:00	72
8:05 -9:05	83
8:10 -9:10	84
8:15 -9:15	82
8:20 -9:20	86
8:25 -9:25	87
8:30 -9:30	85
8:35 -9:35	81
8:40 -9:40	83
8:45 -9:45	79
8:50 -9:50	88
8:55 -9:55	92
9:00 -10:00	98
12:00 -13:00	278
12:05 -13:05	266
12:10 -13:10	251
12:15 -13:15	244
12:20 -13:20	247
12:25 -13:25	248
12:30 -13:30	249
12:35 -13:35	260
12:40 -13:40	292
12:45 -13:45	291
12:50 -13:50	280
12:55 -13:55	269
13:00 -14:00	264

P.H for crossing pedestrian
Date: March.13th.2000

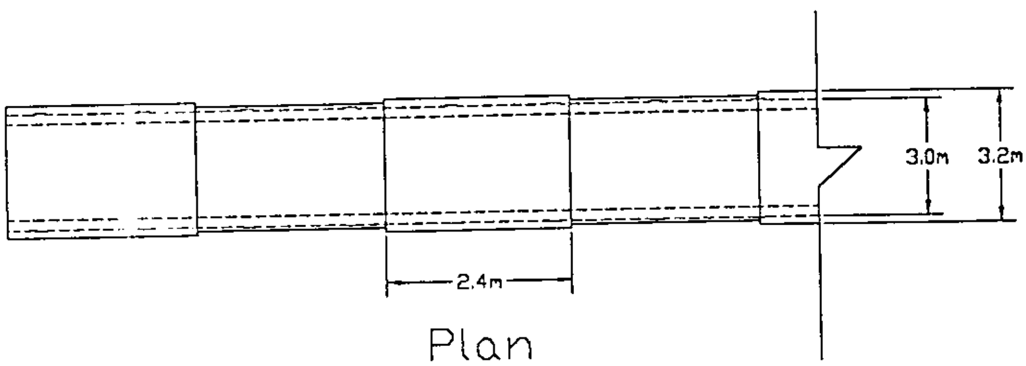
Time	Pedestrian counts
9:00-10:00am	98
12:40-1:40pm	292

Appendix (C): Overpass Drawings & Bill of Quantity

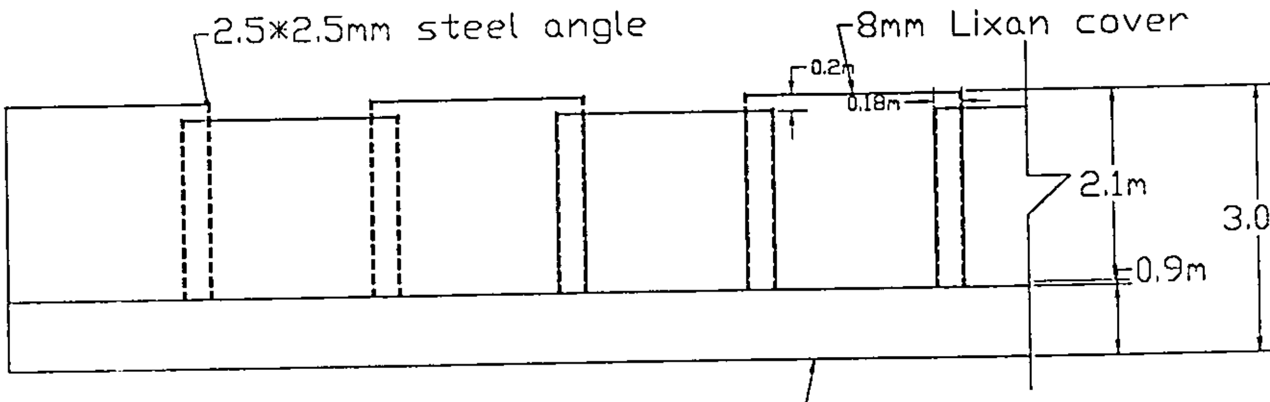


Title: Overpass plan

Drawing No. 1



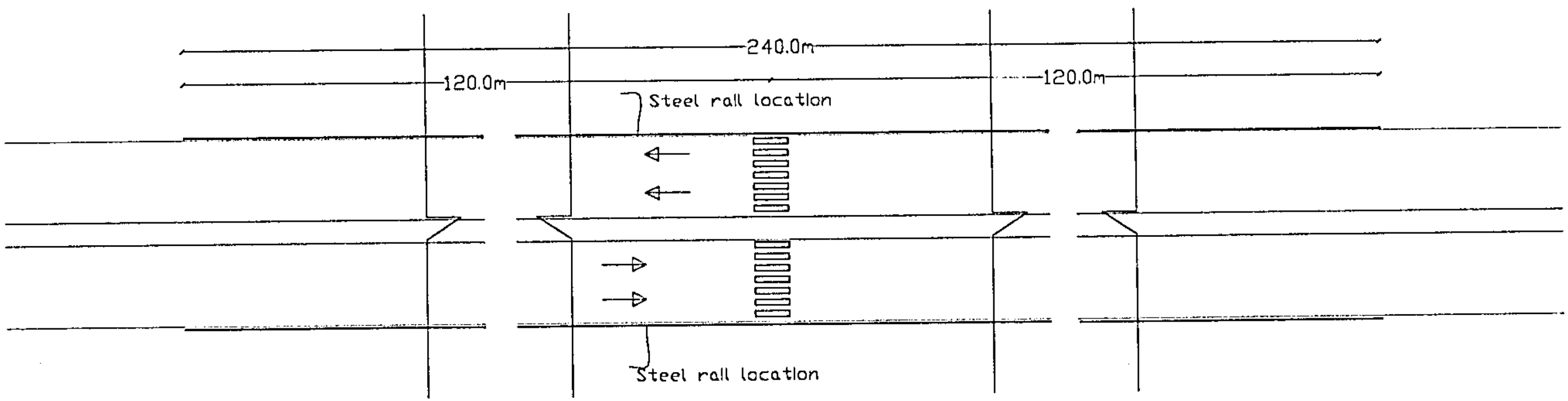
Plan



Elevation

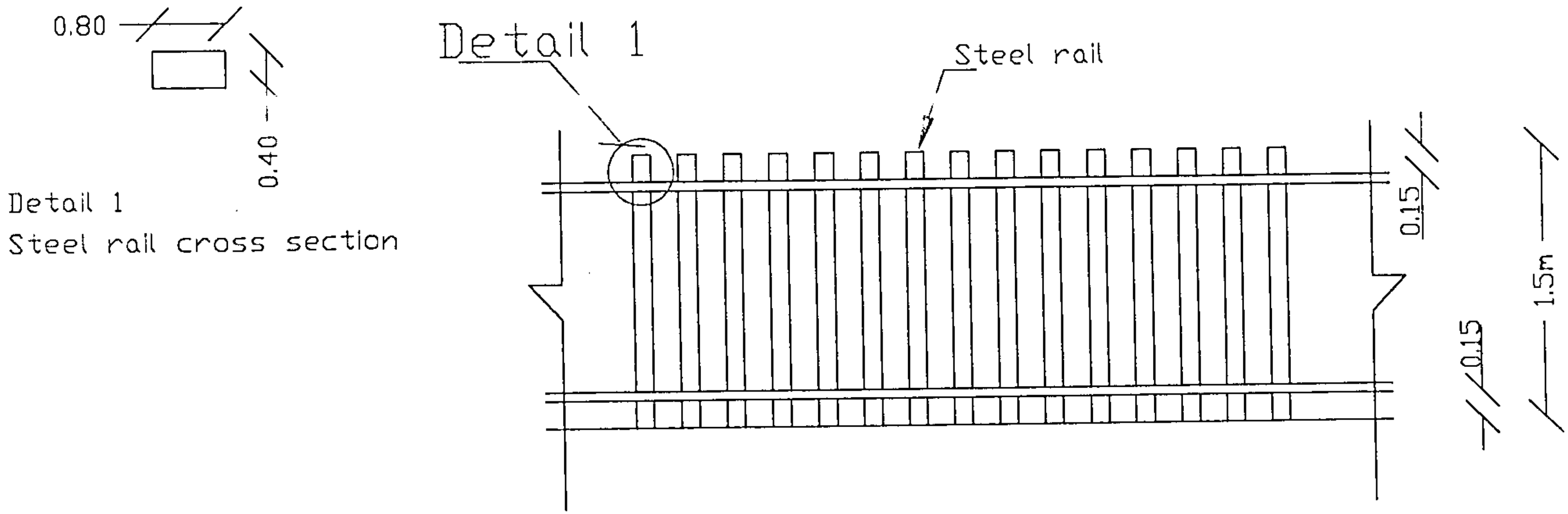
Title: Overpass cover

Drawing No. 2



Title: Steel rails location

Drawing No. 3



Title: Elevation for steel rails

Drawing No. 3

Pedestrian-overpass bill of quantity

Item	Description	Unit	Quantity	Unit rate ($)	Total ($)
A	**Sub-structure**				
A-1	Site preparation.				
A-1-1	Site excavation of soil wherever required. The rate includes excavation, load, transport, and unload surplus material to an approved dump location.	m^3	70.00	5.00	350.00
A-1-2	Supply and install selected imported backfill material, compacted at 20cm.	m^3	46.50	6.00	279.00
A-2	Concrete works				
A-2-1	Supply and cast plain concrete grade C15, under foundations and tie beams.	m^3	7.00	78.50	549.50
A-2-2	Supply and cast reinforced concrete grade C25 for foundation and tie beams.	m^3	10.00	107.00	1,070.00
A-2-3	Supply and cast reinforced concrete grade C30 for column's neck.	m^3	7.35	124.00	911.40
A-2-4	Supply, bent and install deformed high tensile steel reinforcement (grade 60) of different diameters.	Ton	3.55	560.00	1,988.00
A-3	Sundries				
A-3-1	Return to the original condition, including plain concrete C15, 10cm thick, wash aggregate, curb stone, etc.	m^2	70.00	36.00	2,520.00
B	**Super-structure**				
B-1	Supply and install pre-cast concrete, grade C40 for overpass, staircase, columns, and wherever required, the price includes all necessary materials to complete the work, as per drawings.	m^3	120.00	460.00	55,200.00
C	**Overpass cover**				
C-1	Supply and install steel structure for the overpass, 8mm thick roof panels similar to Lixan material for cover, the price includes necessary materials to complete the work.	m^2	291.50	80.00	23,320.00
D	**Finishing touches**				
D-1	Supply and install lighting fixtures, the price includes wiring, commissioning, etc.	L.S	1.00	5,000.00	5,000.00
D-2	Supply and fabricate steel rails for the roadway, the price includes the paint.	L.M	480.0	50.0	24,000.00
	Total				**115,188.0**

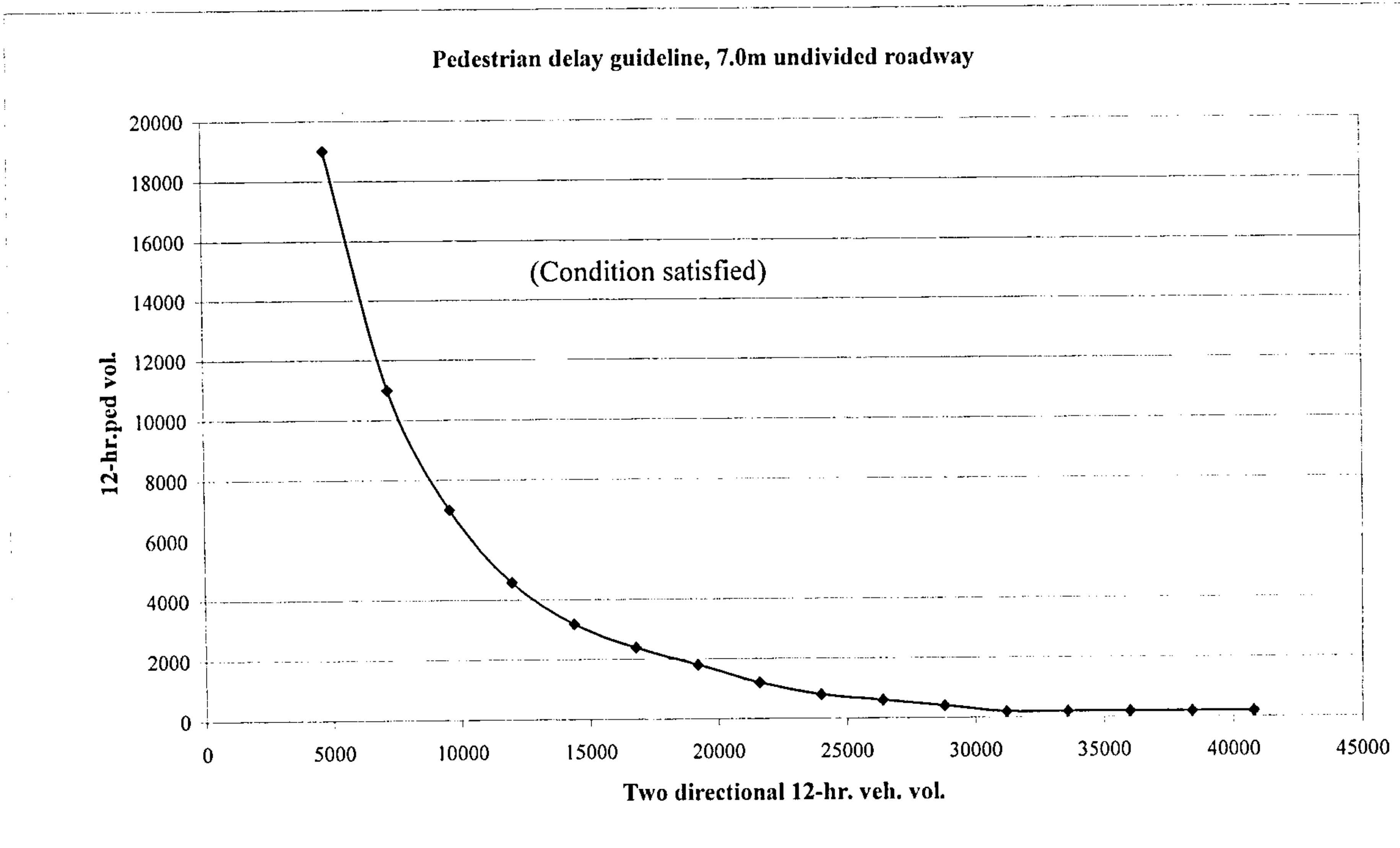
Appendix (D): Pedestrian Waiting Time Matrix & Pedestrian Delay Guidelines

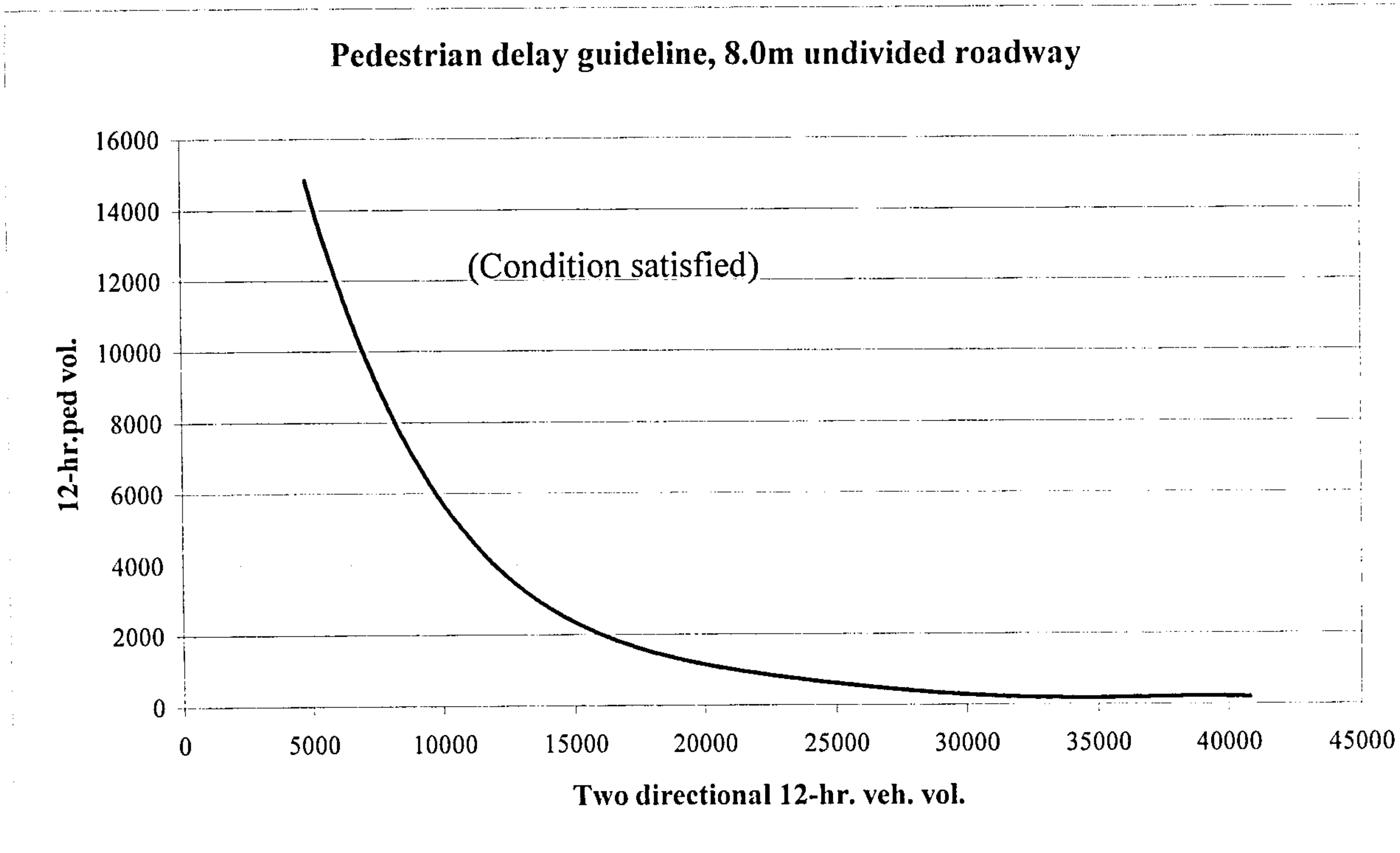
0.00	3000.00	3200.00	3400.00
2.87	459.57	1849.08	63655.80

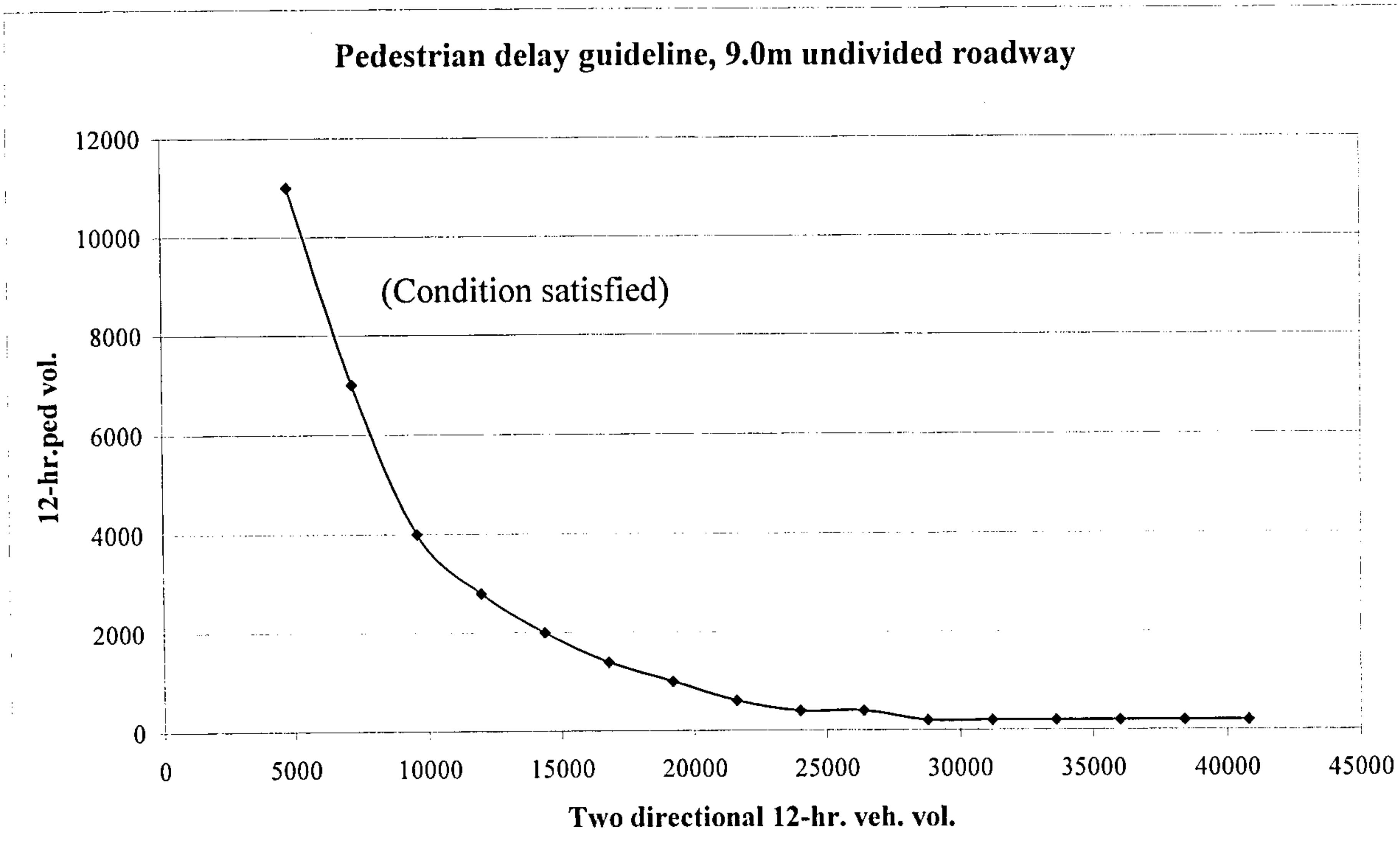
0.00	3000.00	3200.00	3400.00
14.93	34467.58	138680.83	4774184.65
29.85	68935.15	277361.66	9548369.30
44.78	103402.73	416042.49	14322553.94
59.70	137870.31	554723.32	19096738.59
74.63	172337.89	693404.15	23870923.24
89.55	206805.46	832084.99	28645107.89
04.48	241273.04	970765.82	33419292.54
19.41	275740.62	1109446.65	38193477.18
34.33	310208.19	1248127.48	42967661.83
49.26	344675.77	1386808.31	47741846.48
64.18	379143.35	1525489.14	52516031.13
79.11	413610.93	1664169.97	57290215.77
94.03	448078.50	1802850.80	62064400.42
08.96	482546.08	1941531.63	66838585.07
23.89	517013.66	2080212.46	71612769.72
38.81	551481.23	2218893.29	76386954.37
53.74	585948.81	2357574.13	81161139.01
68.66	620416.39	2496254.96	85935323.66
83.59	654883.96	2634935.79	90709508.31
98.51	689351.54	2773616.62	95483692.96
13.44	723819.12	2912297.45	100257877.61
28.37	758286.70	3050978.28	105032062.25
43.29	792754.27	3189659.11	109806246.90
58.22	827221.85	3328339.94	114580431.55
73.14	861689.43	3467020.77	119354616.20
522.40	1206365.20	4853829.08	167096462.68
671.66	1551040.97	6240637.39	214838309.15
820.92	1895716.74	7627445.70	262580155.63
970.17	2240392.51	9014254.01	310322002.11
119.43	2585068.28	10401062.32	358063848.59
268.69	2929744.05	11787870.63	405805695.07
417.95	3274419.82	13174678.94	453547541.55
567.20	3619095.59	14561487.24	501289388.03
716.46	3963771.37	15948295.55	549031234.51

.00	3000.00	3200.00	3400.00
.85	2996.76	12057.53	415088.83
.71	5993.53	24115.06	830177.66
.56	8990.29	36172.58	1245266.50
1.41	11987.06	48230.11	1660355.33
.27	14983.82	60287.64	2075444.16
7.12	17980.59	72345.17	2490532.99
.97	20977.35	84402.69	2905621.82
2.83	23974.11	96460.22	3320710.66
5.68	26970.88	-- 108517.75	3735799.49
8.53	29967.64	120575.28	4150888.32
1.39	32964.41	132632.81	4565977.15
4.24	35961.17	144690.33	4981065.98
7.09	38957.94	156747.86	5396154.81
9.95	41954.70	168805.39	5811243.65
2.80	44951.47	180862.92	6226332.48
5.65	47948.23	192920.44	6641421.31
38.51	50944.99	204977.97	7056510.14
11.36	53941.76	217035.50	7471598.97
34.21	56938.52	229093.03	7886687.81
57.07	59935.29	241150.56	8301776.64
79.92	62932.05	253208.08	8716865.47
02.77	65928.82	265265.61	9131954.30
25.63	68925.58	277323.14	9547043.13
48.48	71922.34	289380.67	9962131.97
71.33	74919.11	301438.19	10377220.80
99.86	104886.75	422013.47	14528109.12
28.40	134854.40	542588.75	18678997.43
56.93	164822.04	663164.03	22829885.75
85.46	194789.68	783739.31	26980774.07
13.99	224757.33	904314.58	31131662.39
42.53	254724.97	1024889.86	35282550.71
571.06	284692.61	1145465.14	39433439.03
899.59	314660.26	1266040.42	43584327.35
128.13	344627.90	1386615.70	47735215.67

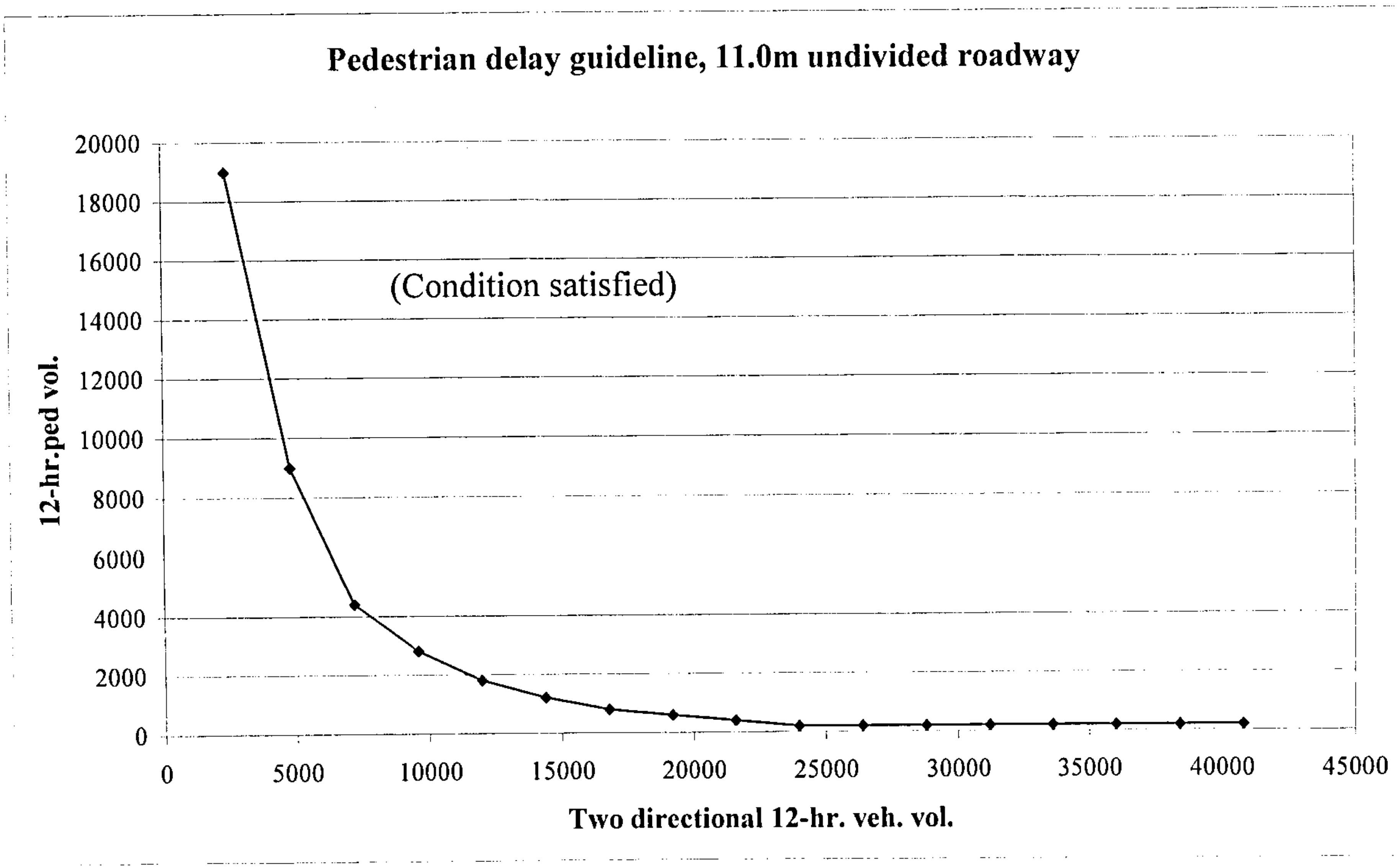
0.00	3000.00	3200.00	3400.00
6.65	6199.56	24944.01	858715.02
3.31	12399.11	49888.02	1717430.04
9.96	18598.67	74832.03	2576145.06
46.61	24798.22	99776.04	3434860.08
33.26	30997.78	124720.05	4293575.10
19.92	37197.34	149664.06	5152290.13
56.57	43396.89	174608.07	6011005.15
93.22	49596.45	199552.09	6869720.17
29.87	55796.01	224496.10	7728435.19
66.53	61995.56	249440.11	8587150.21
03.18	68195.12	274384.12	9445865.23
39.83	74394.67	299328.13	10304580.25
76.49	80594.23	324272.14	11163295.27
13.14	86793.79	349216.15	12022010.29
49.79	92993.34	374160.16	12880725.31
86.44	99192.90	399104.17	13739440.34
23.10	105392.46	424048.18	14598155.36
59.75	111592.01	448992.19	15456870.38
96.40	117791.57	473936.20	16315585.40
33.05	123991.12	498880.21	17174300.42
69.71	130190.68	523824.22	18033015.44
06.36	136390.24	548768.23	18891730.46
43.01	142589.79	573712.24	19750445.48
79.66	148789.35	598656.26	20609160.50
16.32	154988.91	623600.27	21467875.52
82.84	216984.47	873040.37	30055025.73
149.37	278980.03	1122480.48	38642175.94
515.90	340975.59	1371920.58	47229326.15
882.43	402971.16	1621360.69	55816476.36
248.95	464966.72	1870800.80	64403626.57
615.48	526962.28	2120240.90	72990776.78
982.01	588957.84	2369681.01	81577926.99
348.53	650953.40	2619121.12	90165077.20
715.06	712948.97	2868561.22	98752227.41

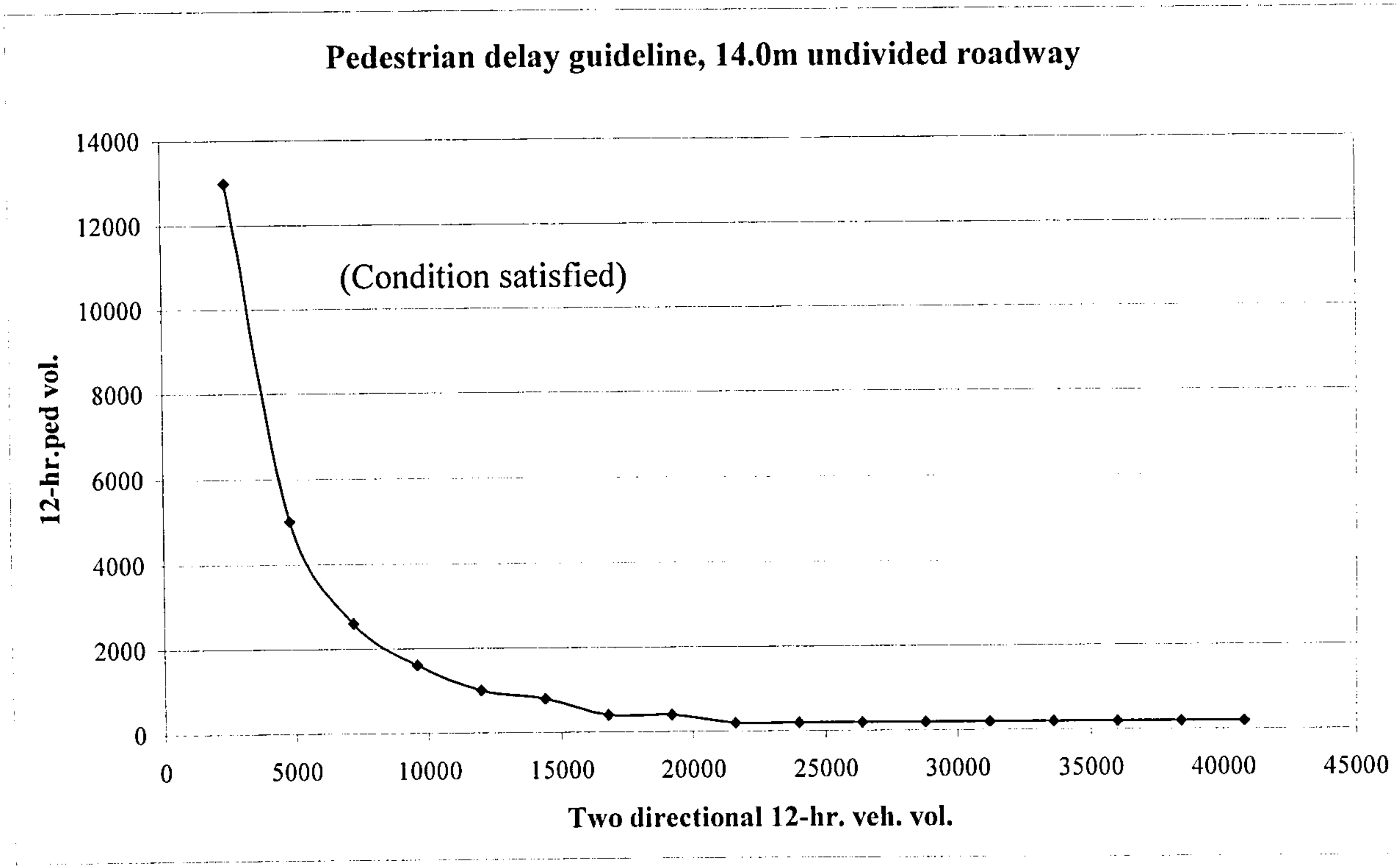

Pedestrian delay guideline, 7.0m undivided roadway
(Condition satisfied)
12-hr.ped vol.
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
Two directional 12-hr. veh. vol.

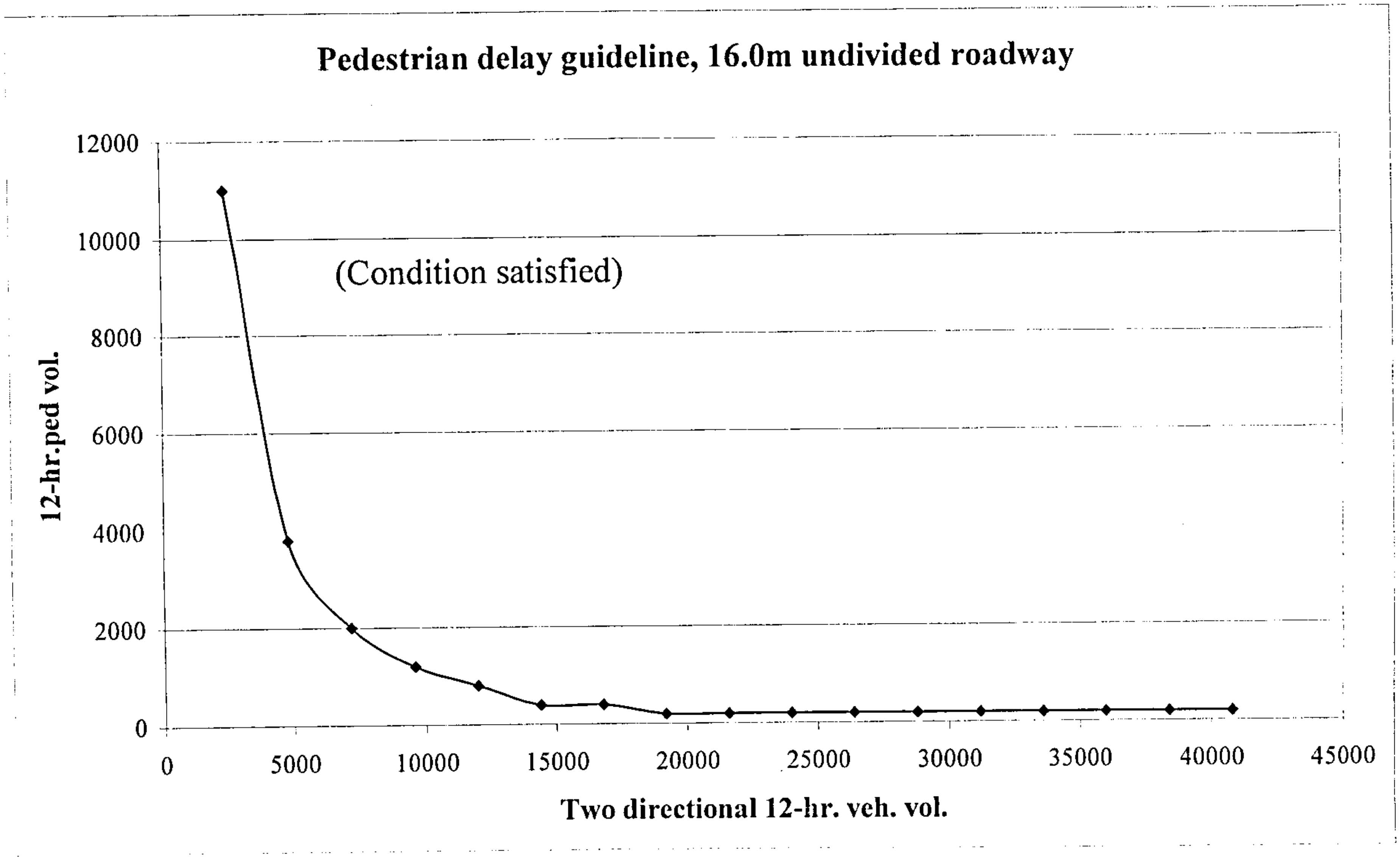

Pedestrian delay guideline, 8.0m undivided roadway
(Condition satisfied)
12-hr.ped vol.
16000
14000
12000
10000
8000
6000
4000
2000
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
Two directional 12-hr. veh. vol.

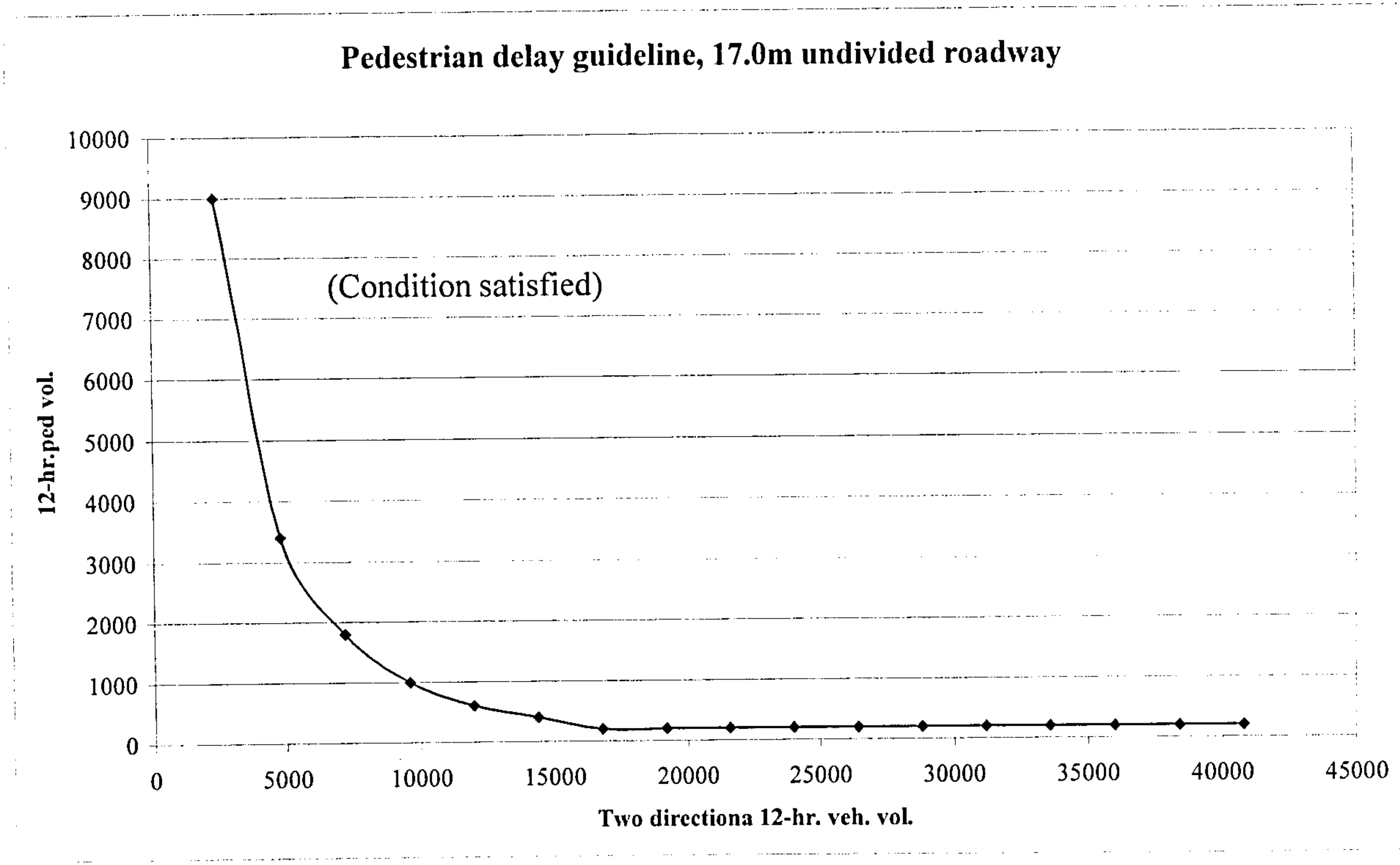


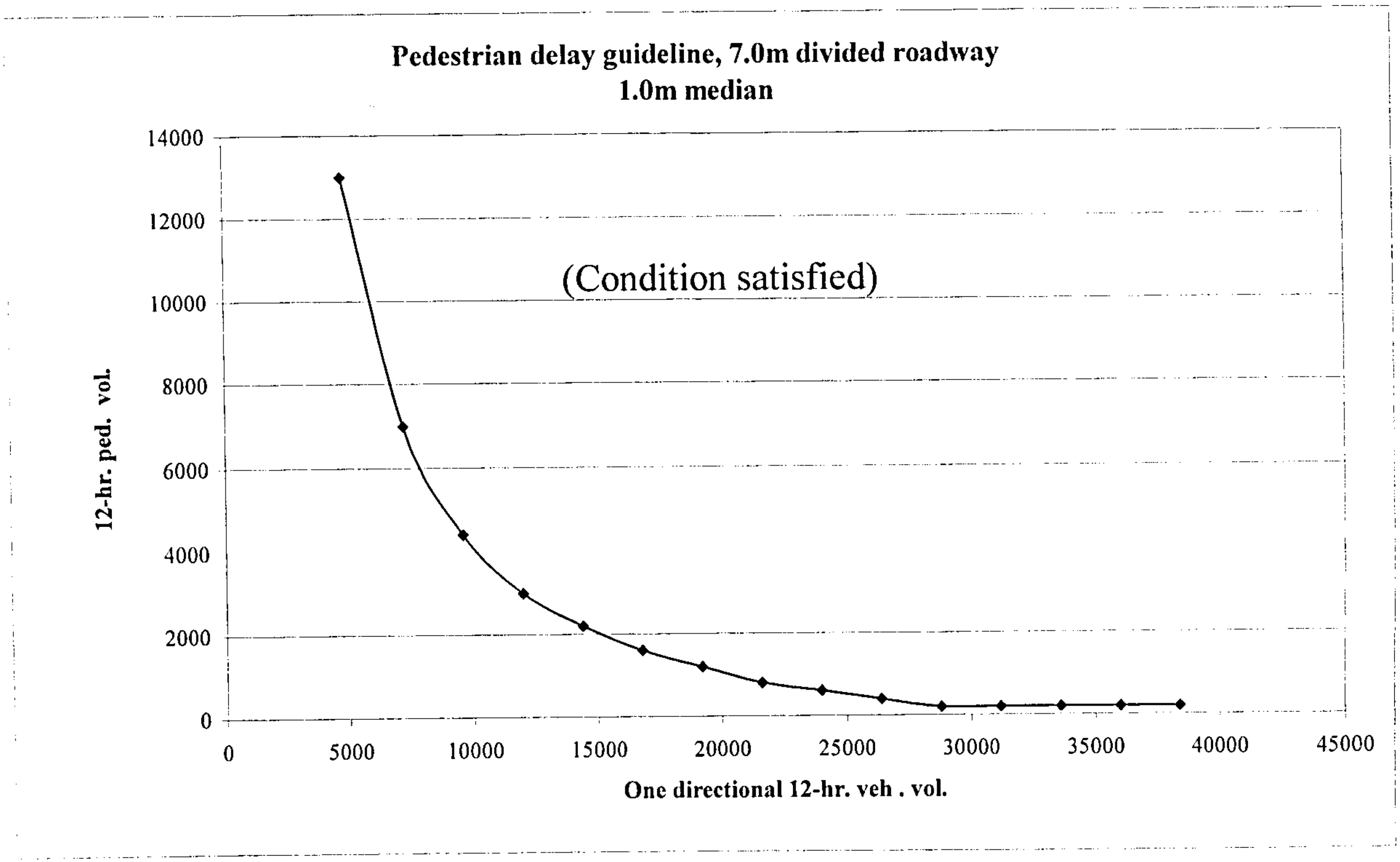
Pedestrian delay guideline, 9.0m undivided roadway
(Condition satisfied)
12-hr.ped vol.
12000
10000
8000
6000
4000
2000
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
Two directional 12-hr. veh. vol.

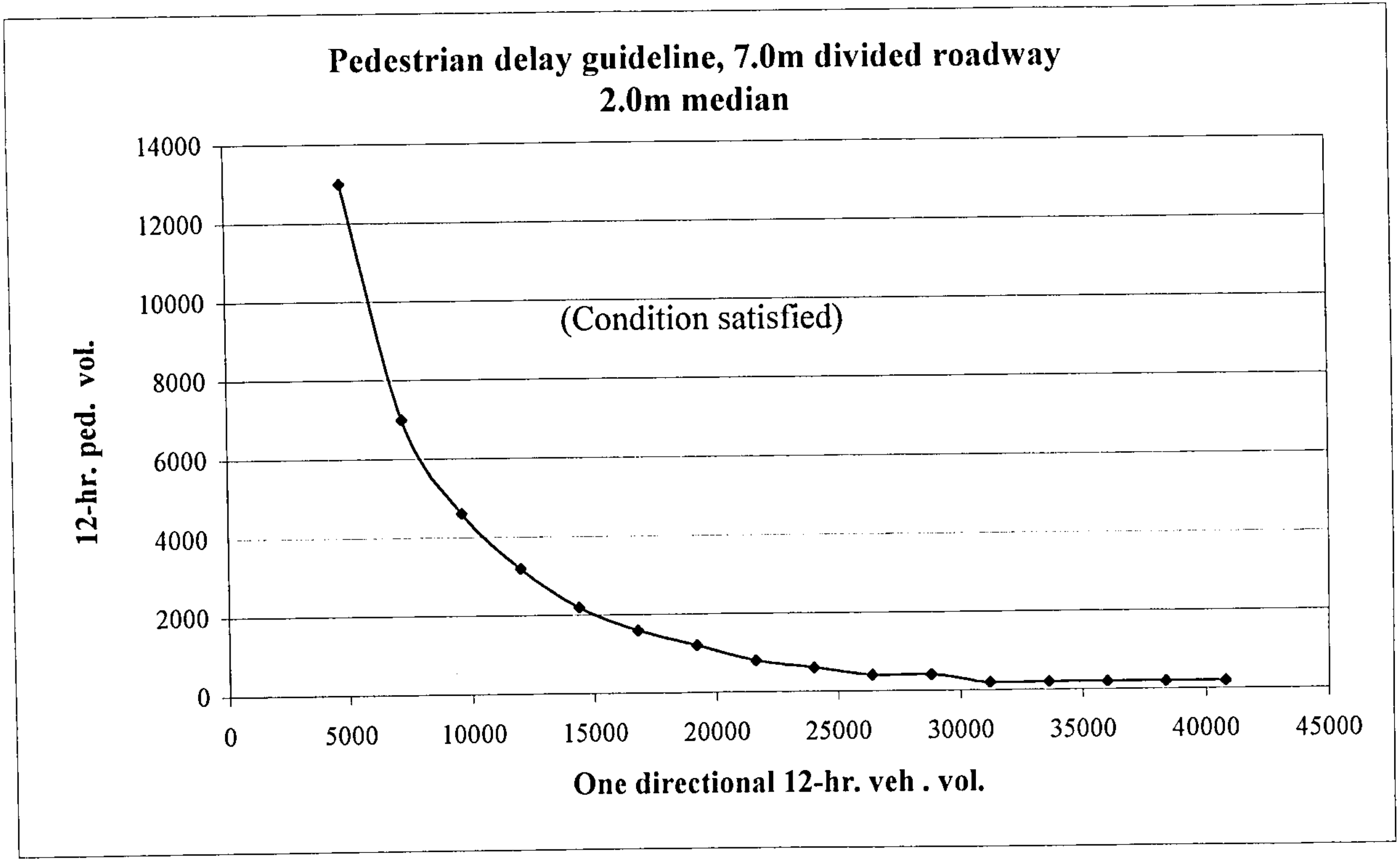

Pedestrian delay guideline, 11.0m undivided roadway
(Condition satisfied)
12-hr.ped vol.
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
Two directional 12-hr. veh. vol.

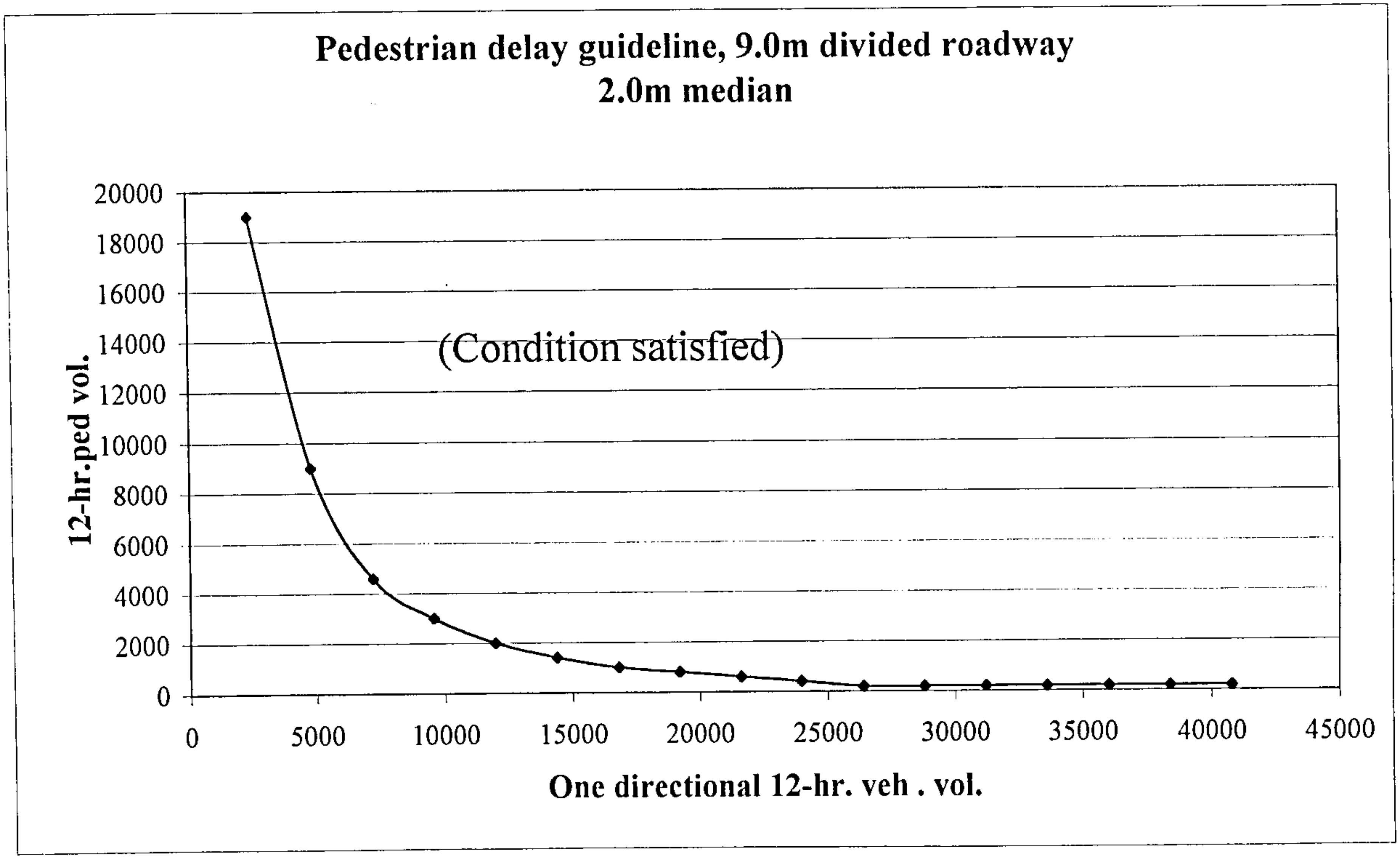

Pedestrian delay guideline, 14.0m undivided roadway
(Condition satisfied)
12-hr.ped vol.
14000
12000
10000
8000
6000
4000
2000
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
Two directional 12-hr. veh. vol.

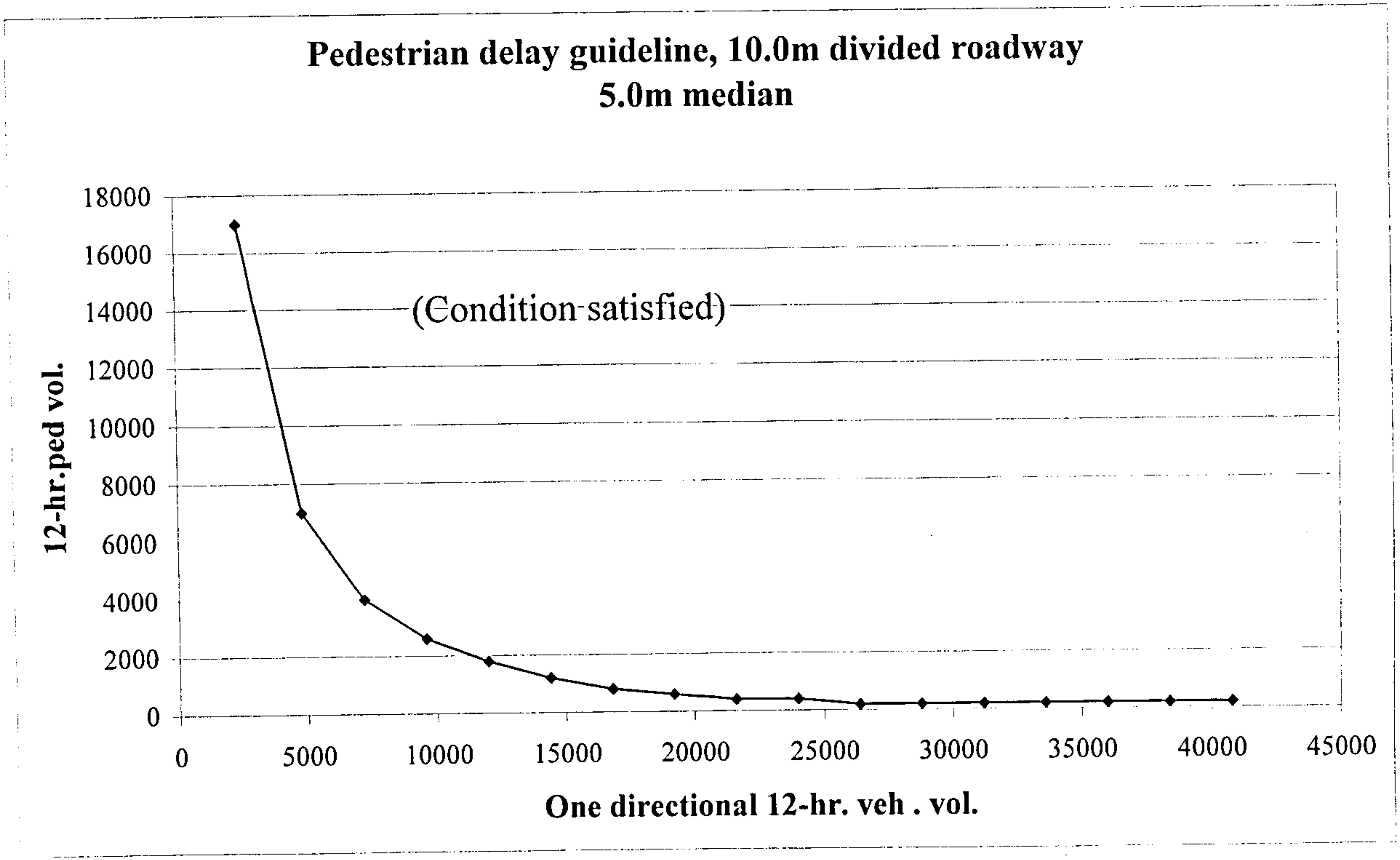

Pedestrian delay guideline, 16.0m undivided roadway
(Condition satisfied)
12-hr.ped vol.
12000
10000
8000
6000
4000
2000
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
Two directional 12-hr. veh. vol.

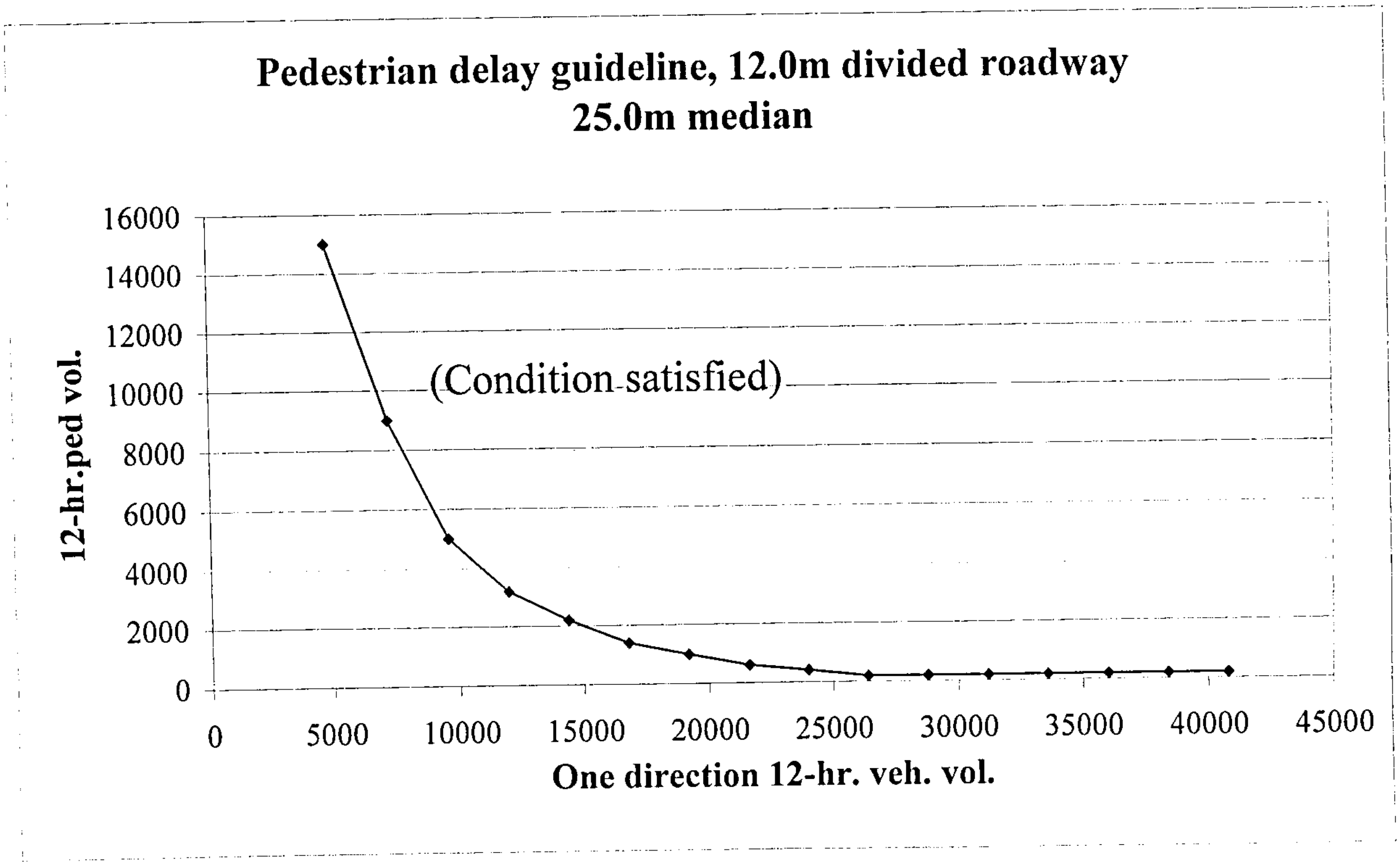

Pedestrian delay guideline, 17.0m undivided roadway
(Condition satisfied)
12-hr.ped vol.
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
Two directiona 12-hr. veh. vol.


Pedestrian delay guideline, 7.0m divided roadway
1.0m median
(Condition satisfied)
12-hr. ped. vol.
0
2000
4000
6000
8000
10000
12000
14000
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
One directional 12-hr. veh . vol.


Pedestrian delay guideline, 7.0m divided roadway
2.0m median
(Condition satisfied)
12-hr. ped. vol.
14000
12000
10000
8000
6000
4000
2000
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
One directional 12-hr. veh . vol.


Pedestrian delay guideline, 9.0m divided roadway
2.0m median
12-hr.ped vol.
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
(Condition satisfied)
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
One directional 12-hr. veh . vol.


Pedestrian delay guideline, 10.0m divided roadway
5.0m median
(Condition satisfied)
12-hr.ped vol.
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
One directional 12-hr. veh . vol.


Pedestrian delay guideline, 12.0m divided roadway
25.0m median
(Condition satisfied)
12-hr.ped vol.
16000
14000
12000
10000
8000
6000
4000
2000
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
One direction 12-hr. veh. vol.