ROAD TRAFFIC ACCIDENTS AND CONFLICTS ON SOME T - JUNCTIONS IN NAIROBI

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A thesis submitted in part fulfilment for the degree of Master of Science in Civil Engineering in the University of Nairobi.

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

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This thesis has been submitted for examination with our knowledge as University Supervisors.

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To Mwasiocha's family and all those engaged in safety research.

SUMMARY

The study was based on accidents and conflicts on some selected T-junctions in Nairobi. The objectives of the study were:

- to study accidents and conflicts on selected T-junctions with a view to understanding the problems of the junctions.
- to develop models which relate conflicts to traffic flow.
- to evaluate the vehicle types which contribute the largest number of conflicts.

Accidents data were collected from most police stations in Nairobi from which T-junctions were identified as one of the most accident prone areas. Six T-junctions were selected for the study. Conflict (which are near accident situations) studies were carried out on these sites. The other data collected included vehicular flow. Conflict studies showed that matatus (public transport vehicles) initiated more conflicts than any other vehicle type. A further study was therefore made on the matatu operation in Nairobi.

Data analysis involved relating accidents to conflicts, conflicts to vehicular flow and evaluating the vehicle type that initiated the largest number of conflicts. No

specific model was obtained relating accidents to conflicts, however plots of vehicle movements just before they were involved in the accidents were very similar to those of conflicts for the junctions studied.

Conflicts were found to be closely related to traffic flow. For all the sites, four models (curves) were fitted on the obtained data. These models were linear, power, cubic and logistic curves. The best model was selected based on its predictive accuracy. The cubic model was the best suited in predicting conflicts. This model was for Jogoo Road-Outer Ring Road junction. The model was:

$$C = -3.82+6.46\text{x}10^{-3}Q - 9.746\text{x}10^{-7}Q^2 - 4.596\text{x}10^{-11}Q^3$$

This equation was significant at 5% level with coefficient of determination (r^2) 0.944 and standard error (Exy) 0.32.

Matatu operation costs and revenues were reduced to costs incurred and revenue per day. These were compared. The results showed that most new matatus especially the twenty five seater matatus rarely made profits. This was seen as a possible explanation why matatus tend to overload and operate at high speeds so that they may offset the financial pressure on them.

The following conclusions were obtained from the study:

- conflicts and accidents showed similar patterns on each T-junction, however no simple relationship was established.

- conflicts and vehicular flow at the studied junctions were closely related and may be predicted by models.

- public transport vehicles especially matatus contributed the largest number of conflicts per vehicle type.

- matatu operators are compelled to overload, operate at high speed and ignore some traffic regulations in order to meet their financial obligations. This in some situations results in matatus initiating and/or cuasing considerable accidents and conflicts.

Conflict studies have proved to be a powerful tool for evaluating safety problems. This kind of study should be extended to other road sections and junctions. Since matatu operators are compelled by their financial obligation to use their vehicles intensively, it is recommended that a study be made to evaluate ways of reducing this pressure.

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CHAPTER 1

INTRODUCTION

Research into transportation safety started recently in the late 1950s, this was necessitated by the increased number of Road Traffic Accidents (RTAs) which were claiming a large number of lives in most countries of the world as motorization was increasing. The high number of the fatal accidents could also be associated with the increased travel and also the increased length of high quality roads which encouraged drivers to operate at high speeds. Road traffic accidents were recorded as early as the last century when Britain recorded two fatalities in 1896(1). These turned into thousands of deaths and injuries as motorization increased. The high number has prompted many researchers and several governments to carry out research to reduce these RTA deaths.

Conflicts (potential accidents) may be seen as un-accomplished accidents. They present accident conditions, they are more common than accidents and hence better to study. This study compares accidents and conflicts on some selected T-junction in Nairobi. Conflicts have also been related to the traffic flow on the selected T-junctions and models developed for these sites.

In Kenya matatus serve as a mode of public transport. It is claimed that this type of vehicle contribute to a large number of accidents on the Kenyan roads. A study on this type of vehicles has been done in order to understand their operation and financial obligations. This may assist to support or refute the claim that matatus contribute to a large number of accidents.

CHAPTER 2

LITERATURE REVIEW

2.1 World Trends in RTAs

The issue in highway safety has been the increased loss of life. Since 1913 the number of highway deaths in America steadily rose from 6,000 to 55,000 in 1968(2). In Great Britain over a period of ten years(1954 - 63) the total deaths due to RTAs was 61,452, 735,376 seriously injured while 2,278,606 were slightly injured(2). In 1931-2, 818 people were killed in Austria. By 1966-7 the deaths had nearly quadrupled (i.e. 3,200). In Kenya the general trend of RTAs has been upwards all the time. In 1953, 150 deaths were registered on the Kenyan roads, by 1983 the deaths had reached 1515.

The amount of travel has greatly increased. The mileage of high-standard highways increased and the safety quality of vehicles also increased. As a result the rate of fatalities has tended to decrease. In America the fatality rate dropped from 18.20 deaths per 100 million vehicle-miles in 1925 to 5.67 deaths per 100 million vehicle-miles in 1968. In Kenya the situation looks pathetic because the RTA deaths per 100 million vehicle-kilometres seem to be rising. In 1953 there were 0.1366 deaths per 10 million vehicle-kilometres yet in 1979 this figure had risen to 0.2328(4). When compared to the the U.S. figures the Kenya figures are lighter.

2.2 Research in Transportation Safety

Research in highway safety has been recommended for years, although the kind of research that is necessary has varied widely. One of the more popular concepts is that in-depth accident investigation as in aircraft accidents should lead to better understanding of the cause of the accidents which would lead to corrective actions.

The inadequacies of these concepts are: no single cause will emerge - several contributing factors will always be present, determining the condition of the driver or vehicle prior to the accident and "eye-witnesses" rarely agree on what happened. Although contributing factors to accidents are known, it is the effect of eliminating a factor that are not predictable(3).

Since higher levels of safety require a large amount of resources, research to improve the allocation of these resources effectively is needed. Capability for predicting RTA reduction and occurrence will greatly enhance both the results achieved and the level of resources required. Currently conflict studies are used to evaluate the safety of a situation on the road.

2.2.1 Accident Studies

In the mid 1930s highway safety became an emotion-charged social problem in America. This is because about

36,000 persons lost their lives on the American roads annually(2). In various countries research has been going on to predict the accident trends and evaluate preventive measures.

Smeed(5) in 1938 compared the data for road fatalities, vehicles and population from 20 countries, the majority of which were European and he derived a relationship given by the formula

$$F/V = 0.0003\ (V/P)^{-2/3} \qquad (2.1)$$

where F = Road fatality

V = Number of vehicles

P = Population

In Norway intensive research and campaign in the late 1960s, led to substantial reduction in RTAs. A large number of safety measures were introduced together with general change of attitude towards traffic safety. These measures introduced in the late 1970s were aimed at all road users. Some of these measures are:-

- traffic management in urban areas,
- mandatory use of safety belts,
- low speed limit,
- intensified police survaillance,
- public information and,
- use of crash-helmets for motor-cyclists.

These measures led to a drop from 560 fatalities in 1970 to less than 360 in 1980. At the same time the number of those injured in RTAs per million vehicle-kilometres dropped by 40%(6).

In Denmark, low speed limits were introduced, this not only improved the fuel consumption, but it also reduced the number of RTAs. As early as 1935 the Danish society for prevention of accidents promoted a general campaign and training activity directed especially to children who were taught a number of basic rules. Road rescue services do exist in Denmark which save several lives (7).

The Federal Republic of Germany (FRG) is guided by the conviction that road safety cannot be improved through stricter laws and heavy fines or penalties, but can be improved through mass education with scientifically backed measures (13).

2.2.2. Conflict Studies

The concept of a traffic conflict was initiated in the early 1960s and it raised a lot of interest in many countries. This was an opening of a tool for safety evaluation and the diagnosis of local safety problems. This tool was useful where accident data were either scarce, unsatisfactory or unavailable(8).

At an International Conference held in Oslo (1977) to calibrate the Traffic Conflict Technique (TCT)(8), it was agreed that, situations where braking or swerving begins 1.5 seconds or less before a potential collision be defined to be conflicts. This is applicable in urban areas where the speed limit is 50 km/h. The time-to-collision varies with speed limit, where the speed limit is 100km/h, 3 seconds is used as the time to record a conflict. Potential conflicts were mainly defined as wrong manoeuvres.

Conflicts or incident studies have been used to evaluate safety problems in several developed countries. These include U.S.A., Sweden, Finland, France, Germany and the United Kingdom. In research and training of shipping and aerial systems, conflict techniques have been used as the most important source of information (8).

Currently the Midwest Research Institute (MRI) in the U.S.A. is conducting a research project aimed at evaluating the relationship between specific types of conflicts and analogous accident types for specific intersection conditions.

In Israel a comparison of conflicts was made with traffic and pedestrian counts (V,P) and it showed that out of 245 conflicts (76 with pedestrians) the following explained 60% of the cases.

$$C = 1.3 + 0.35V + 0.013P \quad (r = 0.75) \qquad (2.2)$$

where C = number of conficts

V = number of vehicles

P = number of pedestrians

In this study it was noted that 71% of the conflicts occurred on roads with priority junctions(10).

Hakket(10) notes that "accident severity varies with circumstances. Serious accidents are associated with high speeds with low-traffic volumes, high pedestrian flow and night-time alcohol consumptions. Slight injury and non-injury accidents are associated with high traffic volumes, low speeds (rush-hours) condition. Since conflicts can be regarded as a very light form of traffic disturbance or accidents, it would be reasonable to assume that they are differently related to accidents of varying severities".

Güttinger (11) in Netherlands did observation over a long time on serious conflicts between child pedestrians and vehicles. Güttinger compared conflicts with accidents and was able to derive a relationship:

$$A = 0.43776 + 0.36713 c \qquad (2.3)$$

with $r = 0.8153$

where A = Accidents

C = Serious conflicts .

Fig.2.1 shows the scatter diagram of the data.

In Sweden, the National Road Administration has developed graphs which give the limits of the severity of conflicts relative to velocity and time(Fig.2.2)(12).

Early studies by Spicer(16) (1971-2) at two relatively high accident rate sites showed good rank correlation between serious conflicts and three year accident records classified both by time and day. Overall correlation was $r = 0.76$.

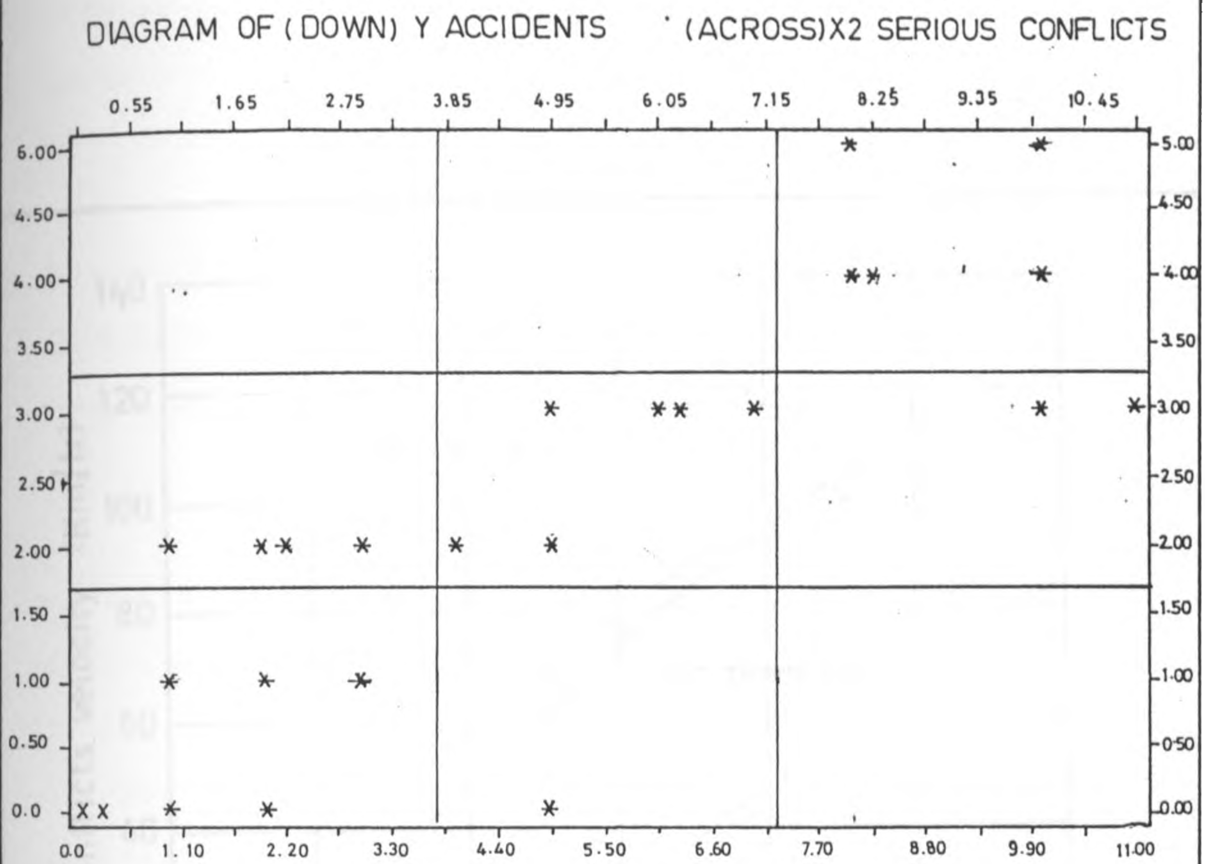
$$A = 0.47C \qquad (2.4)$$

where A = Accidents

C = Conflicts (Slight + Serious)

Spicer (et al 1980) did a six-month study of one particular T-junction and the results showed that daily counts of slight conflicts were closely related to flow levels ($r = 0.91$). The relation of flow with serious conflicts was much weaker with $r = 0.48$.

Spearman(17) showed that serious conflicts were a good indicator of accidents, his coefficients ranged



LATION (R)- 0.81525 R SQUARED - 0.66464 SIGNIFICANCE < 0.001
RR OF EST - 0.91962 INTERCEPT(A) - 0.43776 SLOPE (B) - 0.36713
ED VALUES - 25 EXCLUDED VALUES - 0 MISSING VALUES - 0

Fig 2.1 SCATERDIAGRAM OF ACCIDENTS AND SERIOUS CONFLICTS

Source:-

Guttinger V.A. Conflicts Observations in theory and observation. Paper presented at the international calibration of traffic conflicts Techniques (Oslo 1977).

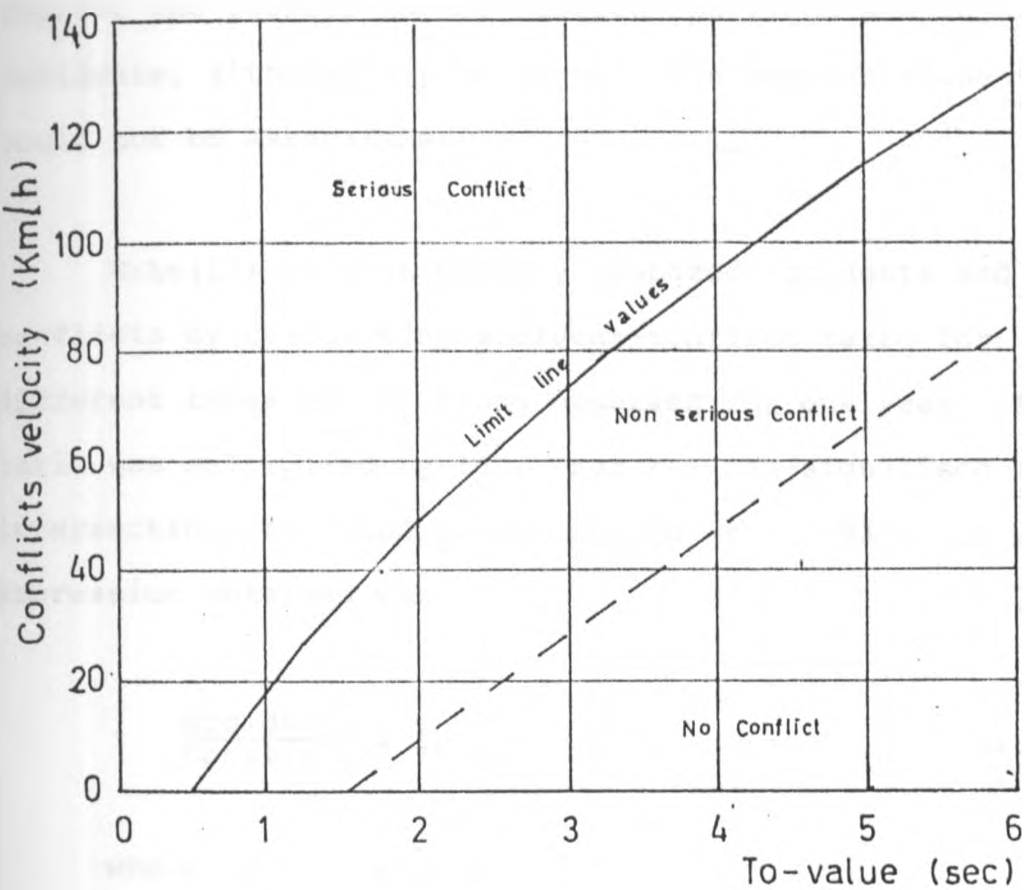


Fig. 2.2 LIMIT OF THE SEVERITY OF CONFLICTS

TO - VALUE: This is the time in seconds which would have clapsed from the exact time one of two roadusers in a conflict situation initiated either a deceleration or a veering motion and the time the two parties involved had reached the envisioned point of collision had both of them continued at the same same velocity and on the same course.

Source:

Mattssom M. The development and use of Traffic Conflict Technique on the Swedish National Road Network.

between 0.87 and 0.97 statistically significant at 1% level.

In France, the risk matrix was shown to greatly improve the correspondence between conflicts and injury accidents, although a precise relation between these two could not be established.

Erke(13) of West Germany compared accidents and conflicts by calculating accident-conflict ratio for different types of junctions observed for one year. The ratio was multiplied by 10^5. For ten non-signalised intersections he found a correlation $r = 0.93$. The expression obtained was

$$\frac{\text{Accidents}}{\text{Conflicts}} \times 10^5 = C \qquad (2.5)$$

where C = constant.

Currently Sweden and Finland are at the forefront in the conflict studies. These studies are used to evaluate unsafe situations. In Finland, if a site is improved by a particular measure the change in safety level is evaluated by comparing before and after conflict data. This is because accidents are rare and random. Kulmala(14) has shown that serious accidents are rarer than slight injury accident as shown in Fig.2.3 (a) and(b).

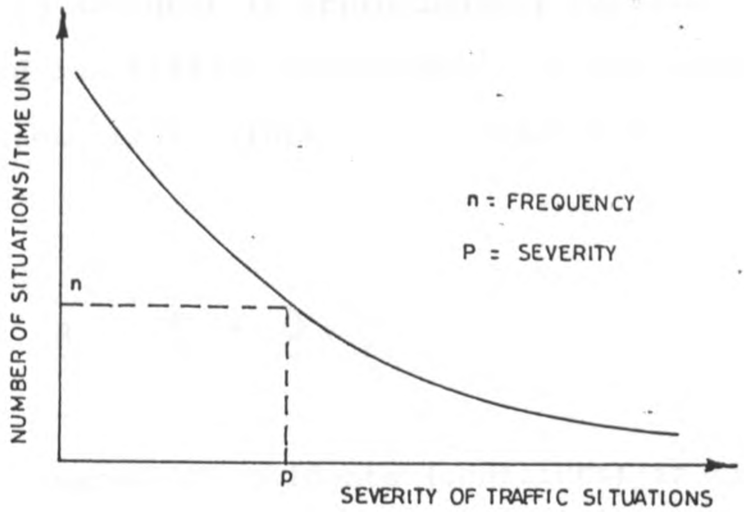


Fig. 2.3(a) THE FREQUENCY OF TRAFFIC SITUATIONS IN REGARD TO THEIR SEVERITY.

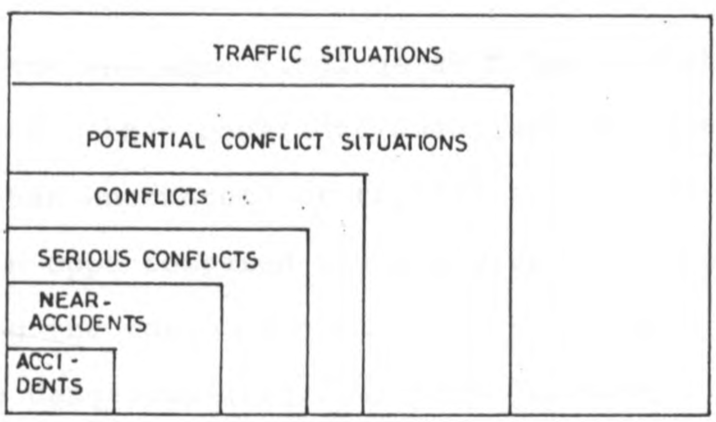


Fig. 2.3(b) TRAFFIC SITUATION CLASSIFICATION

Source:-

Kulmala Risto. Traffic conflict studies in Finland. Paper presented at a seminar on short term and area wide Evaluation of safety measures in Amsterdam, Netherlands (1982).

Kulmala believes that conflicts and accidents are closely related. That is why it is assumed that the probability to result in an accident is approximately constant in regard to road and traffic conditions. He measured traffic conflict risk (instead of accident risk) as follows:

$$R = \frac{A}{E} = \frac{A}{C} \times \frac{C}{E} \qquad (2.6)$$

where A = number of accidents (conflicts) in time T

E = Exposure to accidents/conflicts of the studied type in time T.

C = number of conflicts

R = Risk

Oppe(15) had the same findings as Kulmala that accidents are rarer than conflicts which are in turn less frequent than encounters or traffic situations (Fig.2.3). When Oppe compared the relative safety of two sites, using the ratio of conflicts, he found location 2 more dangerous (Fig.2.4) than location 1.

Recently completed work of Swan and Horwarth(16) of Nottingham University (1983) has provided further evidence of the relationship of serious conflicts to accidents. Their result indicatesthat the relationship varied with type of junction used in the study (8 un-signalised T-junctions were studied), a correlation

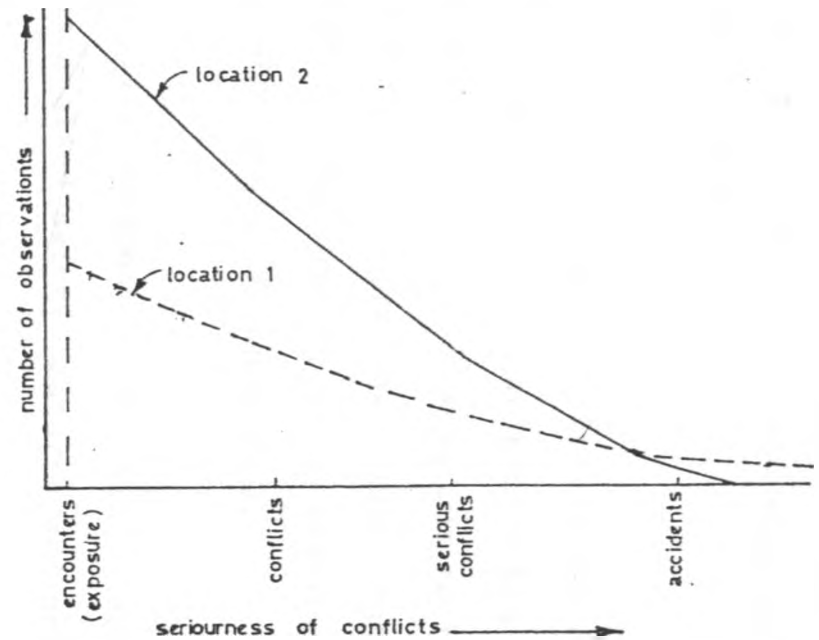


Fig. 2.4 COMPARISION OF THE RELATIVE SAFETY OF TWO SITES

<u>Source</u>:
Oppe S. Joint international study for the calibration of traffic conflict Technique (Netherlands). Oslo 1977.

of 0.87 was obtained between serious conflicts per vehicle and accidents per vehicle. Total inflow was found to have no significant correlation with accidents and serious conflicts.

Uses of conflict studies

As defined earlier, a traffic conflict does occur when a vehicle's action or manoeuvre threatens another vehicle/road user with the possibility of a collision. The study of conflicts has found wide application, some of which are listed below:

- Accident data are too scarce for detailed analysis and the information stored in the accident report often misses the relevant cue to reconstruct what exactly happened. Since conflicts are more common they turn out to be alternatives for they present accident conditions.

- Conflict studies can be used to evaluate quickly the applied safety measures and an indication of relatively new problems. This can be done by comparing the before and after studies.

- Conflict studies can be used to predict accidents, that have the same characteristics, as a surrogate measure since they occur more frequently.

- For newly designed intersections, conflicts may be used to evaluate their safety. A junction with high conflict rates is obviously dangerous.

- Conflicts may be used to gauge the level of service at a junction. A"conflict – free" junction may be classified as an efficient junction

- Conflicts can be used as a diagnostic tool in the identification of hazardous road sections (dangerous road locations or black spots).

It should be noted that conflicts are a much richer source of data, they offer the possibility of gaining more understanding of the road system and provide insight as to how and why counter measures work or do not work.

2.3 Research in Kenya

Kenya like most developing countries has not been giving much emphasis on road safety research. However, in the late seventies the Kenyan government started showing concern over the increasing RTAs.

Transport and Road Research Laboratory (TRRL) has studied fatalities of road accidents, vehicle ownership and population and is convinced that there is a relation between RTAs vehicle ownership and population(19).

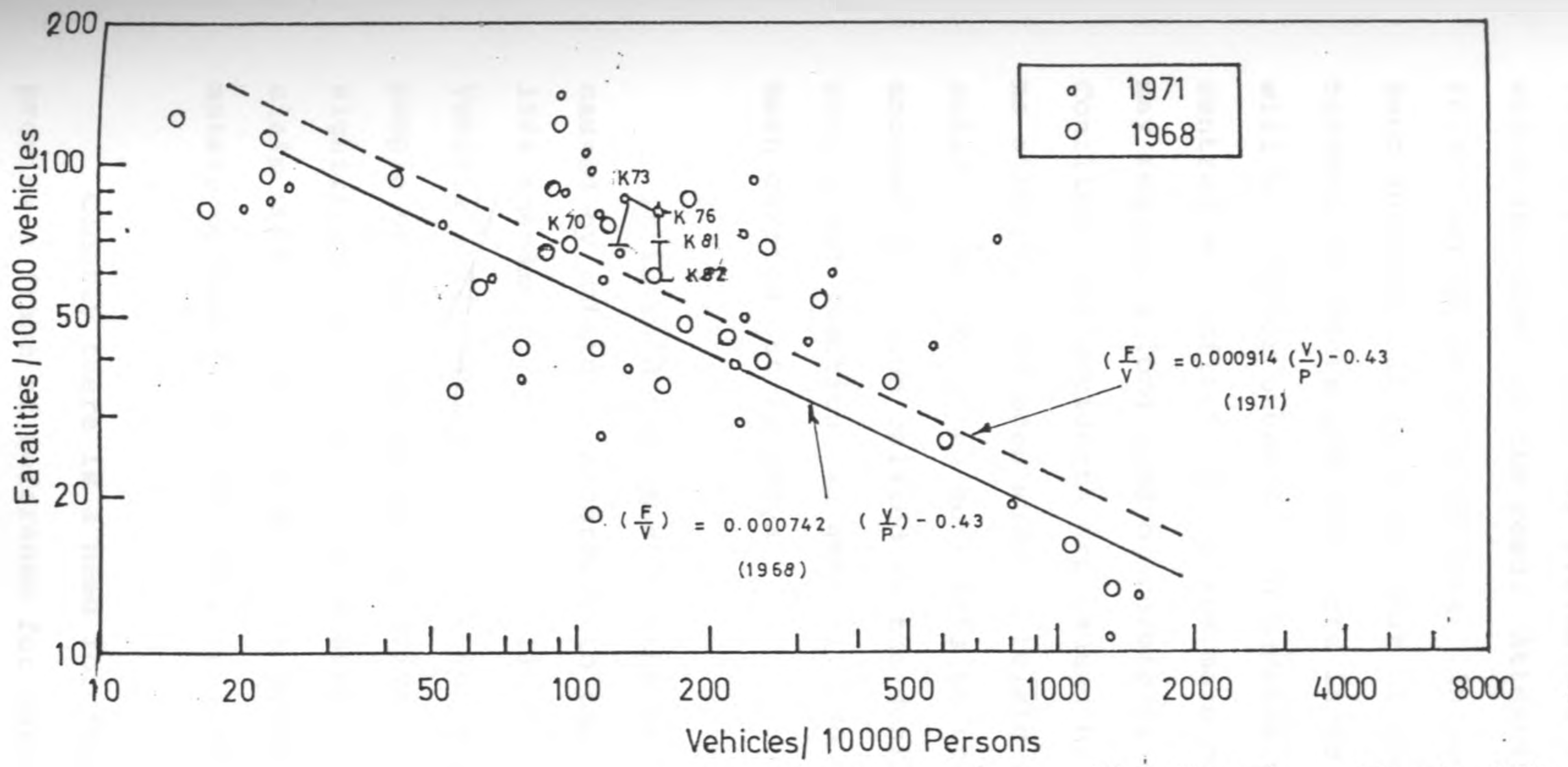
The equation and Kenya's position are shown in Fig.2.5 As can be seen Kenya's RTAs fatality rate has been above average compared to other developing countries.

Road safety research is carried out by the Road Safety Unit overseen by the National Road Safety Council. Studies done under the Nairobi Demonstration Project (NDP) showed that priority junctions in Nairobi accounted for about 48% of the total accidents in Nairobi(18). These findings happen to be the same as those found in Israel.

2.4 Appraisal of Previous Research

Road traffic accidents do not occur by chance. Each accident has a traceable cause. By studying a large number of accidents, it is possible to predict that under certain circumstances an accident is likely to occur.

Previous research has mainly been concerned with accidents relative to travel or deaths relative to travel. Remedial measures are far from being reached. This is because some of the measures are quite expensive to implement or take a long time before their results could be obtained. For example, to correct the human element requires a long time and well co-ordinated programmes. Most remedial measures are directed towards the engineering elements which are easy to study and implement. These measures are directed to the road and vehicles.



K70 = Kenya's position in 1970
K73 = Kenya's position in 1973
K76 = Kenya's position in 1976
K81 = Kenya's position in 1981
K82 = Kenya's position in 1982

Fig. 2.5 FATALITY AND VEHICLE OWNERSHIP RATES FOR DEVELOPING COUNTRIES 1968 and 1971

Source:-
M.O.T.C. National Road Safety Council of Kenya. Long-term Road Safety Programm (1984-1993) Feb. 1984.

Conflict studies present a very promising method of studying the safety of a road section. This study is also a powerful tool for evaluating quickly safety measures which are taken on the road. Attempts have been made to relate accidents to conflicts. In some cases there has been success. It is clear that if ever a clear relation between accidents and conflicts is to be found then this will be a major breakthrough because studies will be centred on conflicts which are more common. Such a study may require a long time of carefully done studies. Conflicts and accidents are caused by vehicles, but so far no attempts have been made to relate conflicts with vehicular flow. Relating conflicts to traffic flow introduces another dimension related to the design of roads, roundabouts and junctions in general. No conflict studies have been carried out in Kenya.

It is said that most of the accidents in Kenya are caused by matatus. According to the Traffic Act 1986 amendment, a matatu is defined as a Public Service Vehicle (PSV) having a seating capacity of twenty five people or less excluding the driver(25). However, no significant research has been done to show how true this claim is that matatus are accident prone or what compels matatu operators to use their vehicles the way they do.

Clearly there is a need for further research to provide a frame of reference for defining the cause of RTAs, relation between accidents and conflicts, relation between conflicts and traffic flow at junctions and also show why matatus contribute to more accidents as it is claimed.

2.5 Study Objectives

Priority junctions have shown high accident rating both in Nairobi, (Kenya) with 48% and Israel which had 71% accidents. This prompted this study to be based on simple unsignalised T-junctions. The objectives of the study are:-

- To study accidents and conflicts at selected T-junctions with a view to understanding the problems of the junctions.

- To analyse conflict data on the selected T-junctions with the aim of relating them to the vehicular flow.

- To evaluate the vehicles which contribute the largest number of conflicts.

- To study matatu operation with a view to justifying or refuting the claim that matatus contribute to more accidents than any other vehicles.

CHAPTER 3.

THEORY

3.1 General

This chapter derives mathematical models to be used in the data analysis. Preliminary data analysis indicated certain trends which seemed to suggest particular mathematical formulæ. For the conflict data analysis the models which may be used are polynomials, the power and the logistic functions. The exponential models may be used to calculate depreciation rates of vehicles. Further, statistical methods are stated that are to show the goodness of fit, significance levels of the model relationships etc.

3.2 Model Development

3.2.1 Linear Model (23)

This model will be used for data fitting and for comparing the observed and predicted data for linear functions. y varies with x such that,

$$y \propto x$$

also $dy \propto dx$

$$\frac{dy}{dx} = m$$

where m = constant

$$dy = m dx$$

by integration

$$\int dy = m \int dx$$

$$y = mx + c \qquad (3.1)$$

where m and c are constants for the line $y = mx + c$, m is the gradient and c is the y - intercept. Using m and c as regression constants then

$$m = \frac{n\Sigma yx - \Sigma y.\Sigma x}{n\Sigma x^2 - (\Sigma x)^2}$$

$$c = \frac{\Sigma y - m\Sigma x}{n} = \bar{y} - m\bar{x}$$

For perfect prediction and fit of models,

m is unity and c is zero. In the above equation n is the number of paired variables.

3.2.2 Cubic Models (22)

The cubic model is a curve with two bends. The third derivative of a cubic function varies linearly with the variable x.

$$\frac{d^3y}{dx^3} \propto x$$

$$d^3y \propto x dx^3$$

$$\int\int\int d^3y = \int\int\int A\, x dx^3$$

By continuous integration

$$y = A_o + A_1x + \frac{A_2}{2}x^2 + \frac{A_3}{6}x^3 \qquad (3.2)$$

This can be written as

$$y = a_o + a_1x + a_2x^2 + a_3x^3$$

The constants a_o, a_1, a_2 and a_3 may be solved by elimination method of the following equations

$$\Sigma y = a_on + a_1\Sigma x + a_2\Sigma x^2 + a_3\Sigma x^3$$

$$\Sigma yx = a_o\Sigma x + a_1\Sigma x^2 + a_2\Sigma x^3 + a_3\Sigma x^4$$

$$\Sigma yx^2 = a_o\Sigma x^2 + a_1\Sigma x^3 + a_2\Sigma x^4 + a_3\Sigma x^5$$

$$\Sigma yx^3 = a_o\Sigma x^3 + a_1\Sigma x^4 + a_2\Sigma x^5 + a_3\Sigma x^6$$

3.2.3. Power Model(21)

This model assumes that the variable y increases in a power form with x. The derivative of y increases with x as follows

$$\frac{dy}{dx} = \frac{by}{x}$$

$$\frac{dy}{y} = \frac{bdx}{x}$$

by integrating

$$\int \frac{dy}{y} = b \int \frac{dx}{x}$$

$$\ln y = b\ln x + k$$

let $K = \ln a$.

$$\ln y = b\ln x + \ln a$$

$$y = ax^{b}. \qquad (3.3)$$

Equation (3.3) is the power model.

3.2.4 Logistic Model(21)

This model assumes that there is a limit, L, when the variable y stops increasing. The model is S-shaped where y has the initial value of zero when x is minus infinity.

The derivative of y increases as x increases as follows

$$\frac{dy}{dx} = by(1-\frac{y}{L})$$

$$dy = bydx - \frac{by^2dx}{L}$$

$$\frac{Ldy}{y(L-y)} = bdx$$

$$\int \frac{Ldy}{y(L-y)} = b\int dx$$

$$= \int (\frac{dy}{y} + \frac{dy}{L-y}) = b\int dx$$

$$= Lny - ln(L-y) = bx + A$$

$$bx + A = ln (\frac{y}{L-y}) = -ln \frac{(L-y)}{y}$$

$$e^{-(bx + A)} = (\frac{L-y}{y})$$

$$e^{-bx}e^{-A} = (\frac{L-y}{y})$$

$$\text{let } a = e^{-A}$$

$$\frac{L-y}{y} = ae^{-bx}$$

$$L-y = y.ae^{-bx}$$

$$y = \frac{L}{1 + ae^{-bx}} \qquad (3.4)$$

Equation 3.4 is the logistic model.

3.2.5. Exponential Model (21)

Depreciation is a decay function whose rate is proportional to the existing values. This can be mass (for radioactive substances), price etc. If A is time in years and P is the price, then the variables are P and A.

$$\frac{-dp}{dA} = P$$

$$\frac{-dP}{dA} = bP$$

$$\frac{-dP}{P} = b.dA$$

$$-\int \frac{dP}{P} = b\int dA$$

$$-\ln P = bA + c.$$

$$\ln P = -(bA + c)$$

$$P = e^{-(bA + c)}$$

$$= e^{-bA}.e^{-c}$$

$$\text{let } e^{-c} = a$$

$$P = a\,e^{-bA} \qquad (3.5)$$

Equation 3.5 is the general exponential model. This model may be used to explain the value of a vehicle relative to age.

The depreciation rate is calculated by differentiating equation 3.5.

$$P = a\ e^{-bA}$$

$$\frac{dP}{dA} = a \times \frac{d(e^{-bA})}{dA} + e^{-bA} \times \frac{da}{dA}$$

$$\frac{dP}{dA} = -ab\ e^{-bA}.$$

This is the depreciation rate at a time A in years. To calculate the depreciation per day

$$\frac{dP}{dA_d} = \left(\frac{-a\ b\ e^{-bA}}{365}\right) \qquad (3.6)$$

3.3 Other Analysis

3.3.1 Data-smoothing

Where preliminary data analysis indicates that the unsmoothed data are widely scattered, data smoothing can be done using the moving averages, step smoothing, etc. For this study it was anticipated that step smoothing was to be used to minimise the scatter and lessen interference with the data. Step smoothing is calculated by calculating representative values for each increase of traffic flow. The table below is used to explain this method.

No. of conflicts	X_1	X_2	X_3	X_4	X_5	X_n
Traffic flow (veh/h	a_1	q_2	q_3	q_4	q_5	q_n

The representative number of conflicts for traffic flow between q_2 and q_4 veh/h, that is at a flow of $\frac{1}{3}(q_2 + q_3 + q_4)$ veh/h is given by;

$$= \frac{\text{Total number of conflicts}}{\text{frequency}}$$

$$= \frac{X_2 + X_3 + X_4}{3}$$

3.3.2 Conflicts per Vehicle

Conflicts were recorded depending on which vehicle initiated the conflict. It is anticipated that to measure the relative safety of each class of vehicle, conflicts per vehicle type will be a good measure.

Conflict per vehicle type may be calculated as follows;

$$\text{Conflict per vehicle type} = \frac{\text{All conflicts initiated by a particular vehicle type}}{\text{Total number of those vehicles}}$$

A vehicle class which initiates a high number of conflicts will tend to have a high number of conflicts per vehicle. Since conflicts tend to accidents it may be seen as a measure of safety.

The proportion of the vehicle type relative to the total vehicular flow may be calculated as follows:

$$\text{Percentage proportion of vehicle type} = \frac{\text{Total number of vehicle type}}{\text{All vehicles flowing through the junction.}} \times 100\%$$

3.4. Statistical Analysis

3.4.1 Simple Linear Regression (23)

Simple linear regression may be used to compare observed and predicted data. These form a pair of variables y and x. Assuming the estimated regression line is

$$y_i = a + bx_i \qquad (i = 1, 2, 3 \ldots n)$$

a and b are constants.

each pair of observation satisfies the relation

$$y_i = a + bx_i + e$$

where e is the residual.

The residual sum of squares is often called the sum of squares of the errors (SSE) about the regression line. Values a and b can be calculated by

$$SSE = \sum_{i=1}^{n} e_i^2 = \sum_{i=1}^{n} (y_i - a - bx_i)^2$$

$$\frac{\partial}{\partial a} (SSE) = -2 \sum_{i=1}^{n} (y - a - bx)$$

$$\frac{\partial}{\partial a} (SSE) = -2 \sum_{i=1}^{n} (y_i - a - bx)x$$

Setting the derivatives to zero (to minimize errors) and rearranging the terms

$$b = \frac{n \sum_{i=1}^{n} x_i y_i - (\Sigma x_i)(\sum_{i=1}^{n} y_i)}{n \sum_{i=1}^{n} x_i^2 - (\sum_{i=1}^{n} x_i)^2} \tag{3.7}$$

$$a_i = \frac{\sum_{i=1}^{n} y_i - b \sum_{i=1}^{n} x_i}{n} \tag{3.8}$$

For a simple linear regression the value of b tells how well the model predicts the data. Perfect prediction by any formula or model would result in a regression line whose slope is one (b=1). In such a case the value of a=0. Correlation coefficient(r) and the coefficient of determination (r^2) will all be unity.

3.4.2 Confidence Limits and Tests of Significance(23)

Apart from merely estimating the linear relationship between x and y for purposes of prediction, it may be desirable to draw certain references about the general quality of the estimated regression line. Standard Error is used to estimate error of scatter about a line. For computation of standard error (E_{yx}) the formula used is

$$E_{yx} = \left(\frac{\Sigma y^2 - a(\Sigma y) - b(\Sigma xy)}{n-2}\right) \qquad (3.9)$$

It is anticipated that the student t distribution will be used to test the significance of the models. This distribution is mainly used for observation, n<30

$$t = \frac{r(n-2)^{\frac{1}{2}}}{(1 - r^2)^{\frac{1}{2}}} \qquad (3.10)$$

where; r is the correlation coefficient

r^2 is the coefficient of determination.

The calculated value of t is compared with the value in t-distribution tables (appendix 1). Degree of freedom is given by n-1, if the calculated value is greater than the value in the table, then the model is significant and reliable for prediction.

Correlation coefficient is a measure of scatter between two variables x and y. This value varies between zero and one. Value of r=1 implies no scatter about a given line or curve with standard error $E_{xy} = 0$. The coefficient of determination, r^2, explains what percentage of the data has been explained. Values of r and r^2 are given by

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\left[[n(\Sigma x^2) - (\Sigma x)^2][n(\Sigma y^2) - (\Sigma y)^2]\right]^{1/2}} \qquad (3.11)$$

$$r^2 = \left[\frac{[n(\Sigma xy) - (\Sigma x)(\Sigma y)]^2}{[n(\Sigma x^2) - (\Sigma x)^2][n(\Sigma y^2) - (\Sigma y)^2]}\right] \qquad (3.12)$$

CHAPTER 4

DATA COLLECTION AND ANALYSIS

4.1 General

This study is concerned with road traffic accidents and conflicts on selected T-junctions in Nairobi. The nature of conflicts and accidents in the area of T-junctions especially in Kenya is very limited and it is desirable to develop models which would relate traffic flow to conflicts. For this study T-junctions were selected within Nairobi.

The study objectives were as follows:

- To study accidents and conflicts at selected T-junctions with a view to understanding the problems of the junctions.
- To analyse conflict data on the selected T-junctions with the aim of relating them to vehicular flow.
- To evaluate the vehicles which contribute the largest number of conflicts.
- To study matatu operation with a view to justifying or refuting the claim that matatus contribute more accidents than any other vehicles.

4.2 Selection of Sites

The initial stages involved data collection to facilitate the identification of the dangerous road locations ("black spots"). The Kenya Police, Nairobi area records about 3 500 - 4 000 RTAs annually of which 3 000 are injury and 300 are fatal. It was anticipated that a total of 6 000 accidents were to be handled for the years 1984 and 1985, however a total of 3 700 accidents were traced.

The data collection involved visiting each police station and reading through injury accident files with a view to getting the relevant details of each accident (summary sheet Appendix Form 5). Accidents which occurred when the driver was under the influence of alcohol were excluded. This was because when drivers are drunk, their concentration on the road is drastically reduced hence they may not reflect their skills or the problem related to the road.

The basic information required for each accident was:

- particular location of the accident and sketch,
- time and day of occurrence of the accident,
- weather conditions,
- kind of vehicles involved in the accident,
- number of casualties (injury and deaths) and their ages,

- road conditions,
- lighting conditions.

It was noted that after the accident data collection not all the anticipated data were available. The situation was worse at the Kilimani and Industrial Area Police Stations where only 30% of the expected files were available.

The main problems encountered during the data collection were:-

- Lack of the required files. Some files were in courts, others had been misplaced.
- The information in some files was contradictory, inaccurate or incomplete.
- Some sketches showing where the accidents occurred were missing.
- The police form for filling details of accidents (Form P41 - Appendix 3) was missing in most cases from the police files.
- Most police stations visited lacked an orderly method of storing files. This situation complicated the data collection.

After all the available data on RTAs in Nairobi was collected, preliminary data analysis was done by calculating the number of accidents perquarter kilometre for two years (1984 and 1985) on each road section. Dangerous road sections were identified as areas with ten or more RTAs per quarter kilometre. Table 4.1 shows the sections which qualified on this criterion (85% of all sections and junctions). Most junctions qualified as dangerous locations of which T-junctions were selected for this study because they were the most common junctions and were accident prone. Nearly 48% of accidents in Nairobi occurred at T-junctions. The criterion used to select the T-junctions which were studied was that no major alterations should have been done on these junctions to improve or reduce their safety level during the study period (1984-7). Table 4.1 shows the accident rating of the road sections and junctions in Nairobi. Table 4.2 shows the accident rating of the selected T-junctions for the study. Fig 4.1 shows the distribution and the location of the study roads and sites.

4.3 Study Sites and Data Collection

4.3.1 Study Sites

Six T-junctions were selected for accident and conflict study. These sites include:

Site 1. Jogoo Road - Outer Ring Road Junction

This site is near Donholm residential estate about 13 kilometres from the Nairobi city centre. Both Outer Ring and Jogoo roads are single carriageway two-lane roads at this section. The T-junction is flared without kerbs. The pavement edges have failed thereby reducing

Table 4.1 ACCIDENT RATING BY SEVERITY

Road Location		Number of accidents within a quarter kilometer for 1984-85
1.	Landhies	38
2.	Moi/Haile Selassie round about	32
3.	Gandhi/Langata	21
4.	Race Course/Ngara round about	20
5.	Moi Airforce gate	21
6.	Mumias-Outer Ring-Kariobang South	20
7.	Kenyatta/Uhuru round about	19
8.	Major Mureithi/1st Avenue	18
9.	Uhuru Highway near Intercontinental	17
10.	Koinange/Muindi Mbingu/Kenyatta Avenue	17
11.	Mumias/Rabai	13
12.	Langata/Muthaiti	13
13.	Ronald Ngala/Moi	13
14.	Kenyatta/Moi	12
15.	Haile Selassie/Racecourse section	11
16.	Juja road - 1st Avenue & Eastleigh	11
17.	Desai/Muranga junction	11
18.	Near Ratume bar	11
19.	GPO Bus stop	10
20.	Radiant Clinic	10
21.	Esso-Kibigori bar (Juja road)	10
22.	Chief camp (Juja road)	10
23.	Forest road/Muranga	8
24.	Landhies/Sakwa road	8
25.	Valley road	4
26.	Ngong road - Mugo Kibiru	8
27.	Jogoo - Outer Ring	12

TABLE 4.2(a) Selected Study Junctions

Site	T-Junction	No. of RTAs in two years
1	Jogoo-Outer Ring	10
2	Mumias - Outer ring	14
3	Juja - 1st Avenue Eastleigh	16
4	Mumias - Rabai	13
5	Langata - Muthaiti	13
6	Ngong - Mugo Kibiru	8

All these junctions are simple T-junctions which are un-signalised.

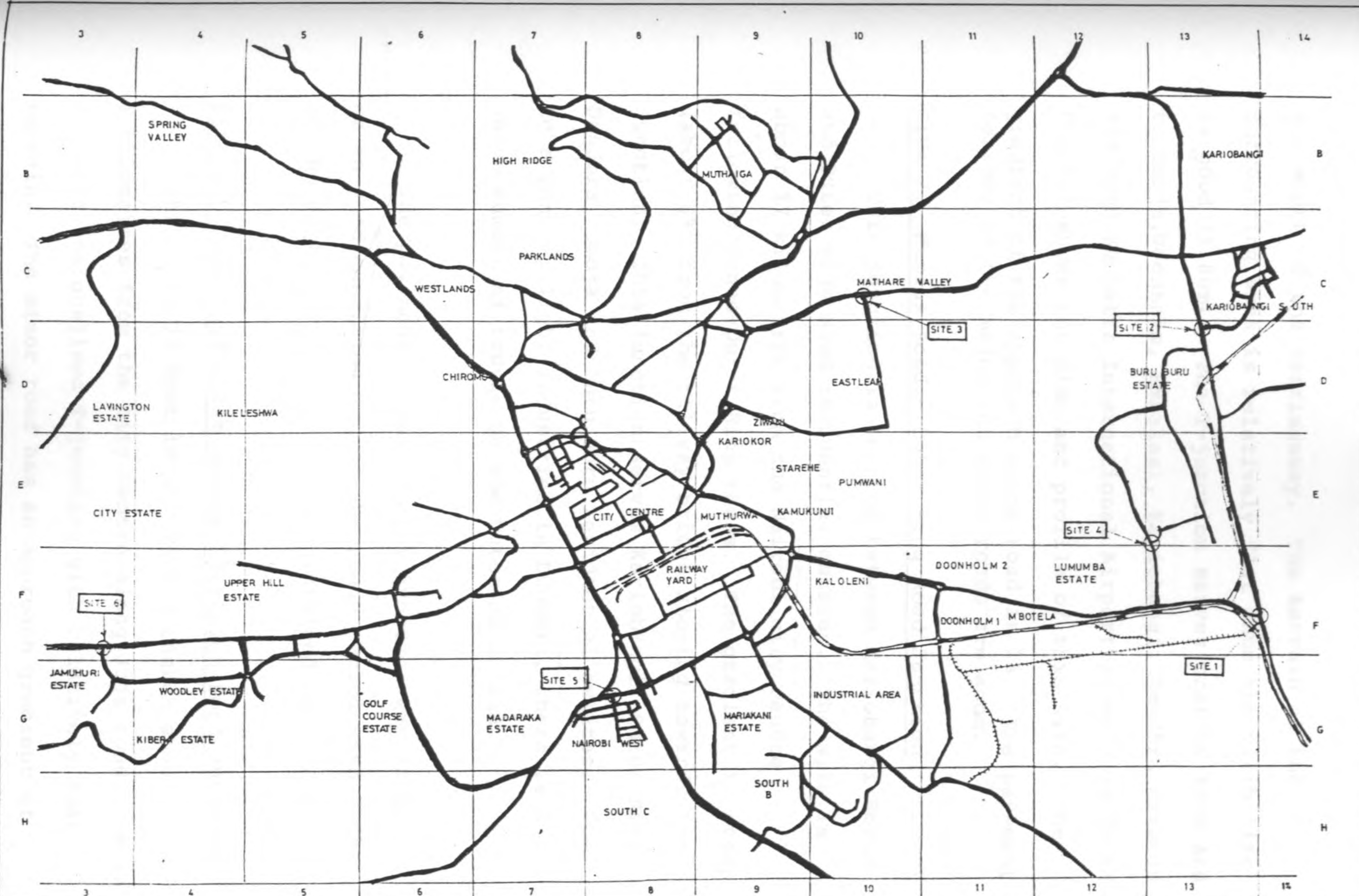


Fig.4.1 MAP OF NAIROBI SHOWING THE LOCATION OF THE STUDIED SITES

Source: Survey of Kenya

the width of the carriageway. The terrain of the surrounding area is relatively flat thus the visibility is good (> 80m). The T-junction serves traffic from and to Umoja,Doonholm, Embakasi, Kariobangi, Dandora estates and Jomo Kenyatta International Airport as well as Thika. Fig.4.2 shows the plan and profile of this site. The gradient of the approach minor road is 1%. The pavement surface of the major and minor roads are good.

Site 2. Mumias Road - Outer Ring Road Junction

This junction is located between Kariobangi South and Outer Ring Road residential estates. The site is about 17 kilometres from the Nairobi city centre following Jogoo-Outer Ring roads. The gradient is steep (about 6%) from the railway bridge sloping towards the junction. This junction serves Kariobangi, Outer Ring Dandora, Umoja and Buru Buru residential estates. Due to a zone of light industries in Dandora, there is a large number of trucks on the Outer Ring road.

The pavement surface at the junction was noted to be in good condition during the study period with kerbs at the edges. There were well maintained open drains.

Site 3. Juja Road - 1st Avenue Eastleigh Road Junction

This site is next to St. Teresa Church about 6 kilometres from the city centre along Juja road. It is a simple unsignalised T-junction with relatively flat terrain. The minor road has an approach gradient of

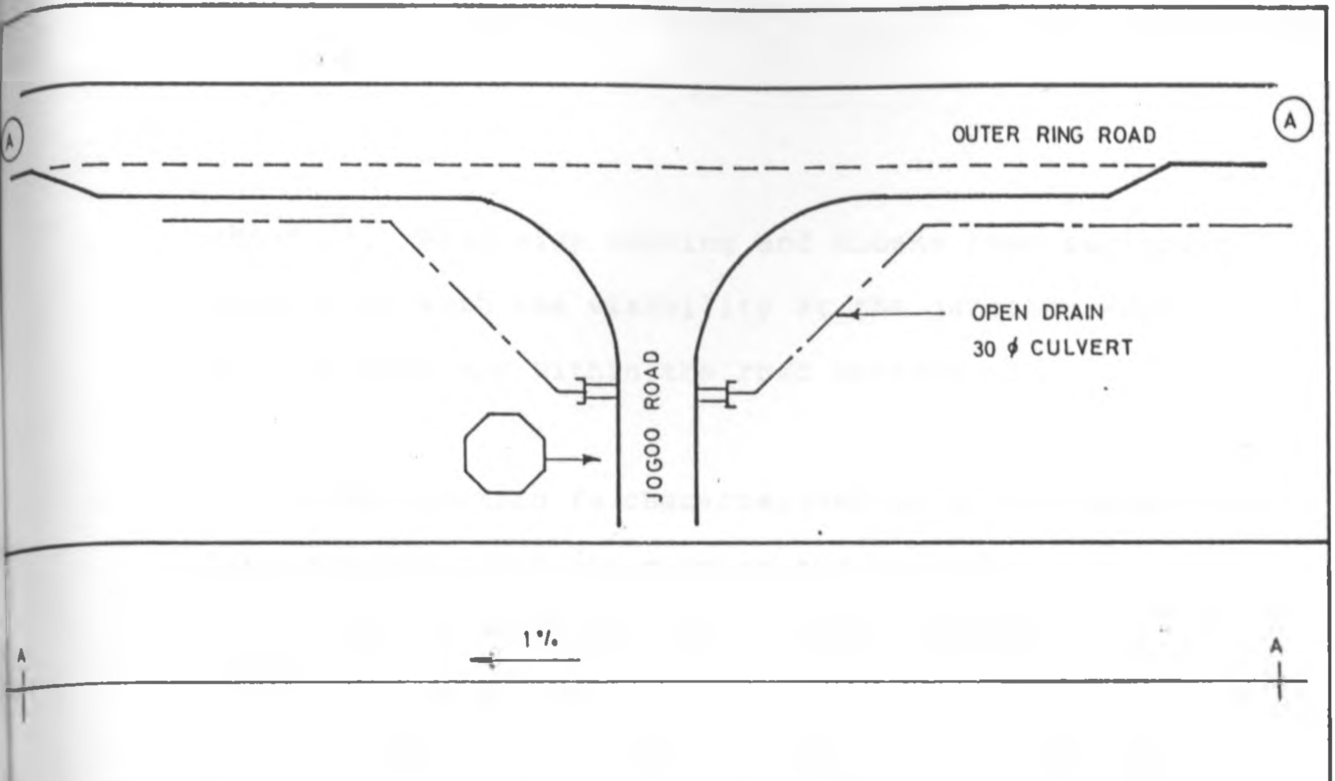


Fig. 4.2 PLAN AND PROFILE ALONG A-A OF SITE 1 | Scale 1:714

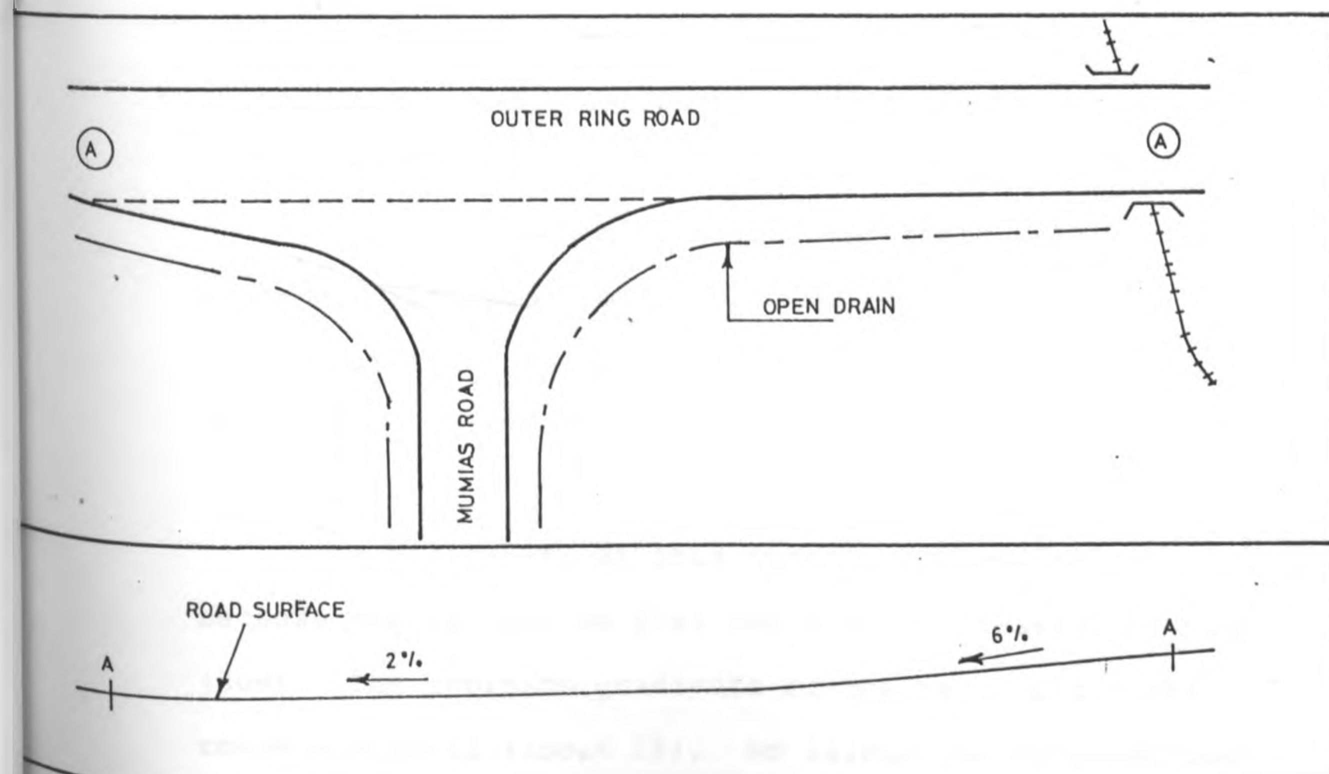


Fig. 4.3 PLAN AND PROFILE ALONG A-A OF SITE 2 | Scale 1:714

about 1%. Road-side fencing and kiosks have seriously interfered with the visibility at the junction area because they are within the road reserve.

The junction is characterised by high pedestrian flow especially in the morning and evening. These are residents from the densely populated Mathare valley who walk to and from the city centre. The shoulders of the junction are poorly maintained with inadequate pedestrian facilities. The access road opposite 1st Avenue was closed (fig.4.4).

Site 4 - Mumias Road - Rabai Road Junctions

This T-junction is between Buru Buru phase IV and Makadara residential estates. It is about 13 kilometres from the city centre following Jogoo Road. This junction serves residential areas mainly Buru Buru, Ofafa Jericho and Uhuru.

There is a petrol station near the junction area whereby during peak hours vehicles from Mumias road prefer diverting through instead of using the junction (Fig.4.5). This reduces traffic volume at the junction.

The visibility at this junction is good (> 200m) because the terrain is flat and the road reserve is wide (30m). The approach gradients of the major and minor roads are small (about 1%). No illegal development had been done on the road reserve.

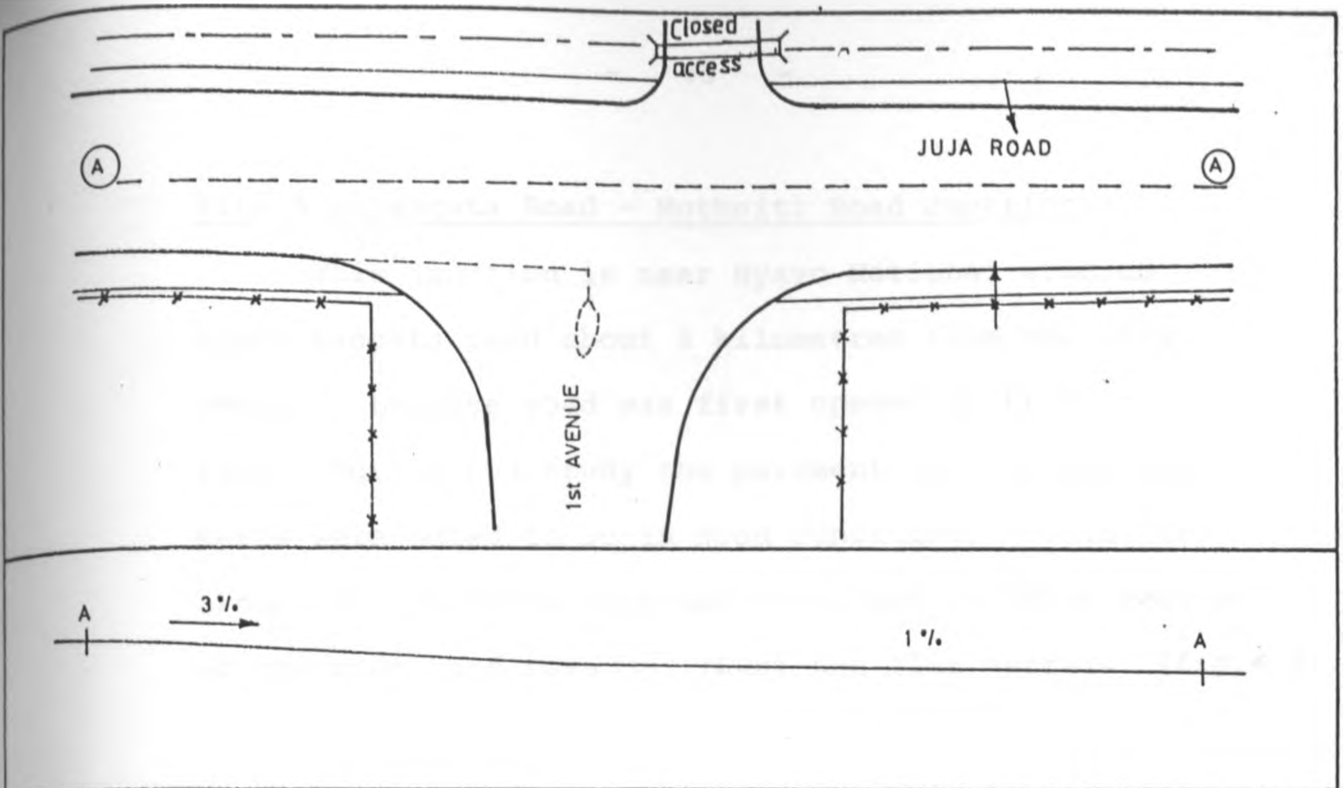


Fig. 4.4 PLAN AND PROFILE ALONG A-A SITE 3 Scale 1:500

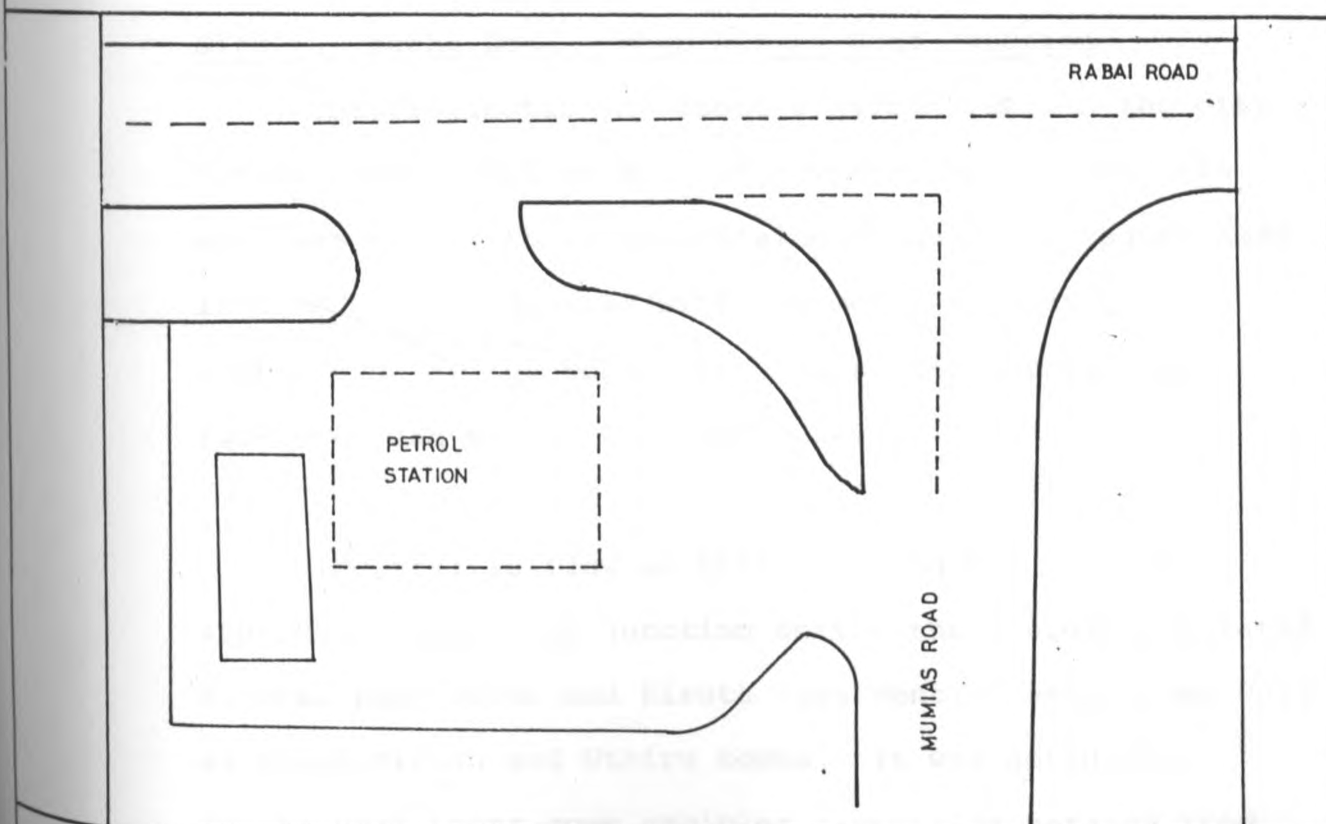


Fig. 4.5 PLAN OF SITE 4 Scale 1:500

Site 5 - Langata Road - Muthaiti Road Junction

This junction is near Nyayo National stadium along Langata road about 6 kilometres from the city centre. Langata road was first opened to traffic in 1965. During the study the pavement surface and the kerbs were noted to be in good condition. Visibility around the junction area was excellent (> 200m) because of the wide road reserve (60m) and flat terrain (fig.4.6).

Langata and Muthaiti roads are single carriageway two-lane roads. They have a high traffic flow (upto 2,100 veh/h) especially Langata road which serves Nairobi West, Langata, Madaraka, Ongata Rongai, Ngei and Onyonka Estates.

Site 6 - Ngong Road - Mugo Kibiru Road Junction

This T-junction is about 6 kilometres from the city centre along Ngong Road. The pavement surface at this site was good with well maintained shoulders. Ngong Road is a 10 metre wide road with one metre cyclist lane on either side of the road. It is a single carriageway two-lane road with a 60m road reserve.

The traffic flow at this junction was between 400-1800 veh/h. The junction serves the densely populated Kibera, Kawangware and Riruta residential estates as well as Ngong, Kikuyu and Uthiru towns. It was noted that during peak hours some vehicles especially matatus from

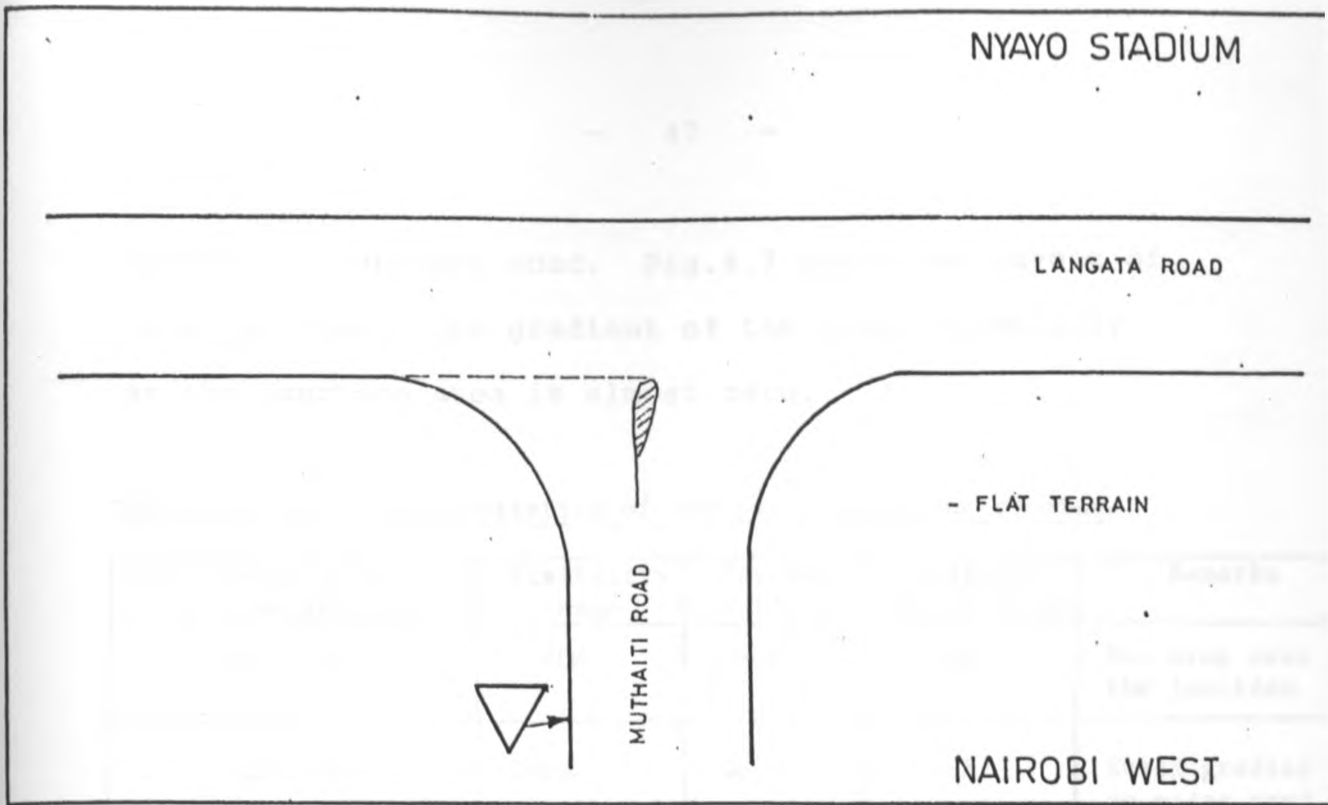


Fig. 4.6 LANGATA ROAD - MUTHAITI ROAD JUNCTION Scale 1:500

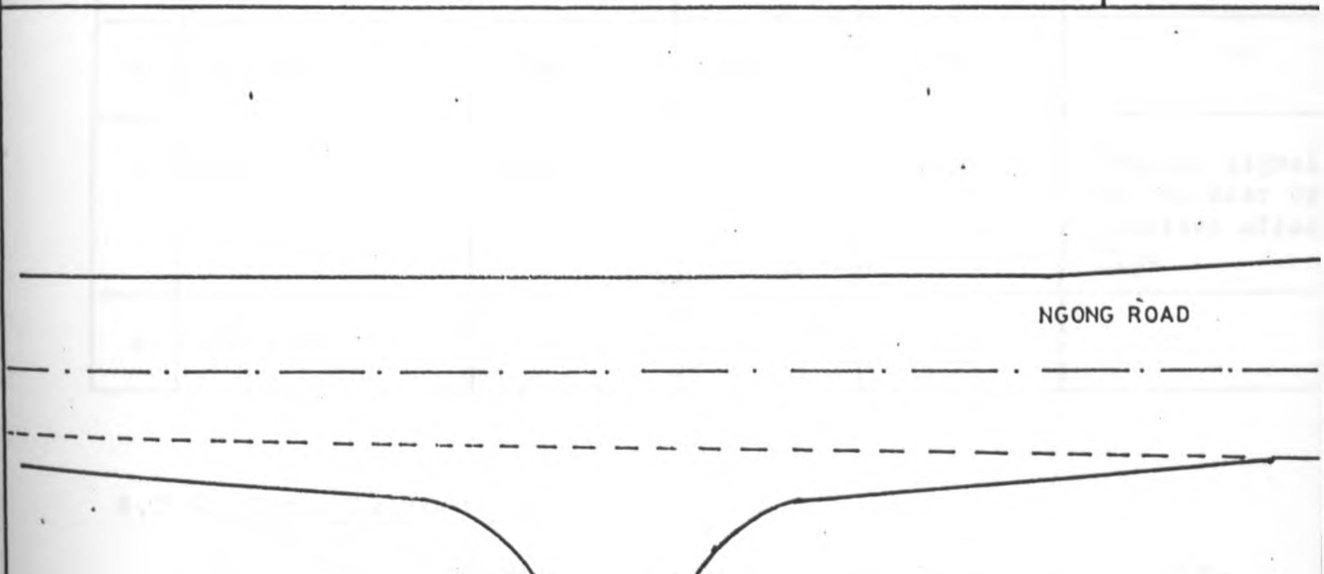


Fig. 4.7 NGONG ROAD - MUGO KIBIRU ROAD JUNCTION Scale 1:500

Kibera use Kabarnet road. Fig.4.7 shows the layout of this junction. The gradient of the roads especially at the junction area is almost zero.

Table 4.2 (b) - Characteristics of the six T-junctions studied.

Site	Range of Traffic flow veh/hour	Visibility range	Pavement Surface	Gradients Major Minor	Remarks
1	600 1700	80m	Good	1%	Bus stop near the junction
2	400-1700	100m	Good	6%	Steep gradied on major road
3	400-1800	Interfered with	Good	1%	high pedestrian flow upto 2000 people/hour
4	150-1800	>200m	Good	1%	-
5.	800-2100	>200m	Good	1%	Traffic signals on the near by junction affect flow
6.	400-1700	>200m	Good		-

4.3.2 Data Collection

Data collected was mainly on accidents and conflicts. Accident data were collected from Police files as explained in section 4.1. These data were used to identify the sites for the study of vehicle conflicts. Accident potential (referred to as conflicts for this study) data were collected from the six T-junctions in Nairobi (Table 4.2). These were junctions which proved most accident prone and no improvements had been done on them during the study period (1984-87).

Conflicts were divided into three categories depending on the reaction time available for the road users (driver, pedestrians) to adjust their speeds well enough before the potential collision. These conflicts were defined as follows.

Potential Conflicts

Potential conflict situations were defined to be situations where the participants adjust their speeds well enough before the potential collision. Potential conflicts should not be confused with situations where a driver responds to traffic signs e.g. field or situations like traffic jams, otherwise disobeying such signs may be seen as potential conflicts (traffic violations). The definition is quite subjective.

Slight Conflicts

Slight conflicts are situations where braking or swerving begins 1.5 seconds or less before a potential collision. In this case braking and/or swerving are controlled.

Serious Conflicts

They are situations where emergency braking and/or violent swerving are applied to avoid collision resulting in a very near accident situation. The braking and/or swerving which is uncontrolled begins about 1.5 seconds or less before a potential collision. Time to a collision varies with the speed limit. the 1.5 seconds used above applies to the urban areas where the speed limit is 50km/h.

Conflict data were filled in forms (Appendix 4) where a T-junction had been drawn on a grid system. This was to facilitate locating the conflict points. Vehicle conflicts were divided into six types depending on the vehicle manoeuvres and direction of approach of the conflicting vehicles (Appendix 4). Vehicles causing conflicts were classified depending on which vehicle initiated the conflict or made the wrong manoeuvre. The main information recorded on the vehicle-vehicle conflict form included, time when the conflict occurred, severity of the conflict, proximity i.e. distance between conflicting vehicles when evasive or braking action started (nose to tail), location on the grid and the vehicles involved in the conflicts.

Vehicle-pedestrian conflicts were studied. These conflicts were classified into three groups depending on the type of conflict, severity and the grid location (appendix 5). Classified vehicle counts were done in all the six junctions. Pedestrian counts were done at the same time. The study was done at the following times, 6.45 a.m. to 9.00 a.m, 11.30 a.m to 1.30 p.m. and 3.30 p.m. to 6.30 p.m. (at times to 7.00 p.m.). This gave a total of 9 hrs per day. Each site was studied for two working days of the week. This gave representative traffic situations.

4.3.3 Methodology

Conflict and traffic count data were collected by a total of eight people. Conflict data were observed by two people but one of them doing the recording. It was arranged in such way that two people observed conflicts to avoid the possibility of a conflict being skipped when recording is going on. In some situations the two observers assisted each other in identifying the severity of the conflict. Traffic flow was recorded by three people each recording traffic from one leg. Each enumerator handled ten bays of the manual counter to record the classified counts (Appendix 6).

The training of enumerators and conflict observers was done for five days. The first and second day involved training the group using notes prepared which defined their observation taks. Conflict observers were thoroughly trained and they were poeple who knew traffic regulations well. The third and fourth days were used to do some trial studies to check if the group understood their duties. The fifth day was used as a test for the group, they did the study without further assistance. After it was clear that the group new their duties well, especially conflict observers, the study was started. Throughout the study conflict observers were assisted and supervised.

4.4 Data Analysis

4.4.1 Accident and Conflict Data

When accident and conflict data were analysed it was not possible to obtain a relation between accident and conflict. This could be because the observation period for conflicts was short relative to the accident observation period. However accident and conflict data for the T-junctions in Table 4.2 were plotted showing movements of vehicles before they were involved in the accidents or conflicts. Using these plots it was possible to diagnose the problem on a T-junction.

The following abreviations have been used in figures 4.8 to 4.19.

1. Police Code

NIAR	None injury accident
IAR	Injury accident

2. Casualties

F	Fatal
SL	Slight injury
S	Serious injury

3. Participants

S	Saloon car
B	Bus
PC	Pedal cyclist
P	Pick-up
MA	Matatu
L	Lorries

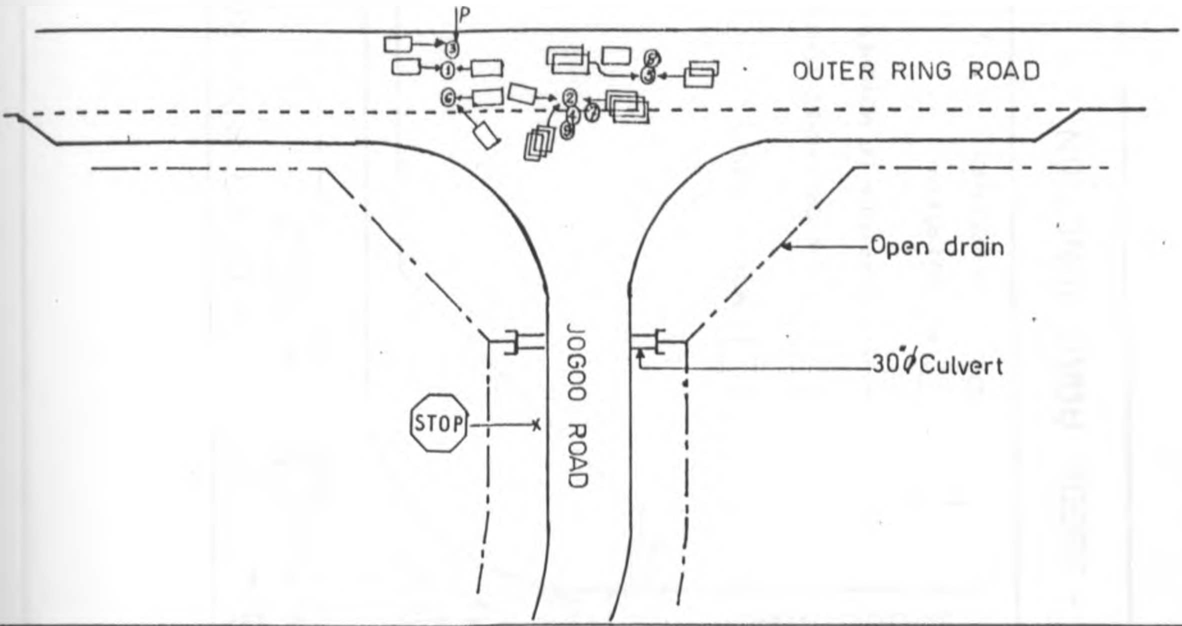
4.4.1.1 Jogoo-Road - Outer Ring Road Junction

Fig.4.8 and 4.9 show accident and conflict plots respectively on this junction. These figures suggest that most of the accidents or conflicts are between traffic on the minor leg and those on the major road (Outer Ring). This suggests that drivers from Jogoo road are pushing their way into the main road without stopping as it is required by the traffic sign (STOP).

Some conflicts and accidents at this jucntion occurred because drivers were overtaking at the junction area. This could be because there was no road marking at the junction to direct drivers. It was noted during the conflict study that drivers rarely used the flared section of the junction when turning into the minor road. This was either because the pavement edges had failed or because a section, of the flared part had been turned illegally into a stopping bay by matatus.

4.4.1.2 Mumias Road - Outer Ring Road Junction

Most of the accidents (71%) and conflicts (80%) at this junction involved vehicles from the railway bridge side (fig.4.10 - 4.11). The slope from the bridge section towards the junction was about 6% (Fig.4.3). This slope encouraged drivers to accelerate down the slope while drivers at the junction underestimate the speeds of the on-coming vehicles. Also from the accident and conflict plots it is clear that overtaking at the junction created problems to some drivers.



ACCIDENT SUMMARY TABLE

NUMBER ON FIGURE.	POLICE CODE	DATE	TIME	CASUALTIES	PARTICIPANTS
1	IAR(F)/110/85	7-7-85	9.55 P.M	1.F	L/S
2	NIAR/25/84	1-6-84	8.55 P.M	–	S/S
3	IAR/107/85	14-7-85	6.15 P.M	1.SL	Ma/P
4	NIAR/112/84	13-11-84	10.30 P M	–	S/S
5	NIAR/93/84	6-10-84	5.00 P M	–	L/L
6	IAR/150/85	27-9-85	10.00 A M	2.SL	S/S
7	IAR/67/85	30-4-85	11.30 P M	1.SL	S/S
8	IAR/108/85	7-8-85	10.30 A M	2.SL	Ma/L
9	NIAR/78/84	10-9-84	2.30 P M		S/L

Fig. 4.8 ACCIDENT SUMMARY FOR JOGOO - OUTER RING JUNCTION

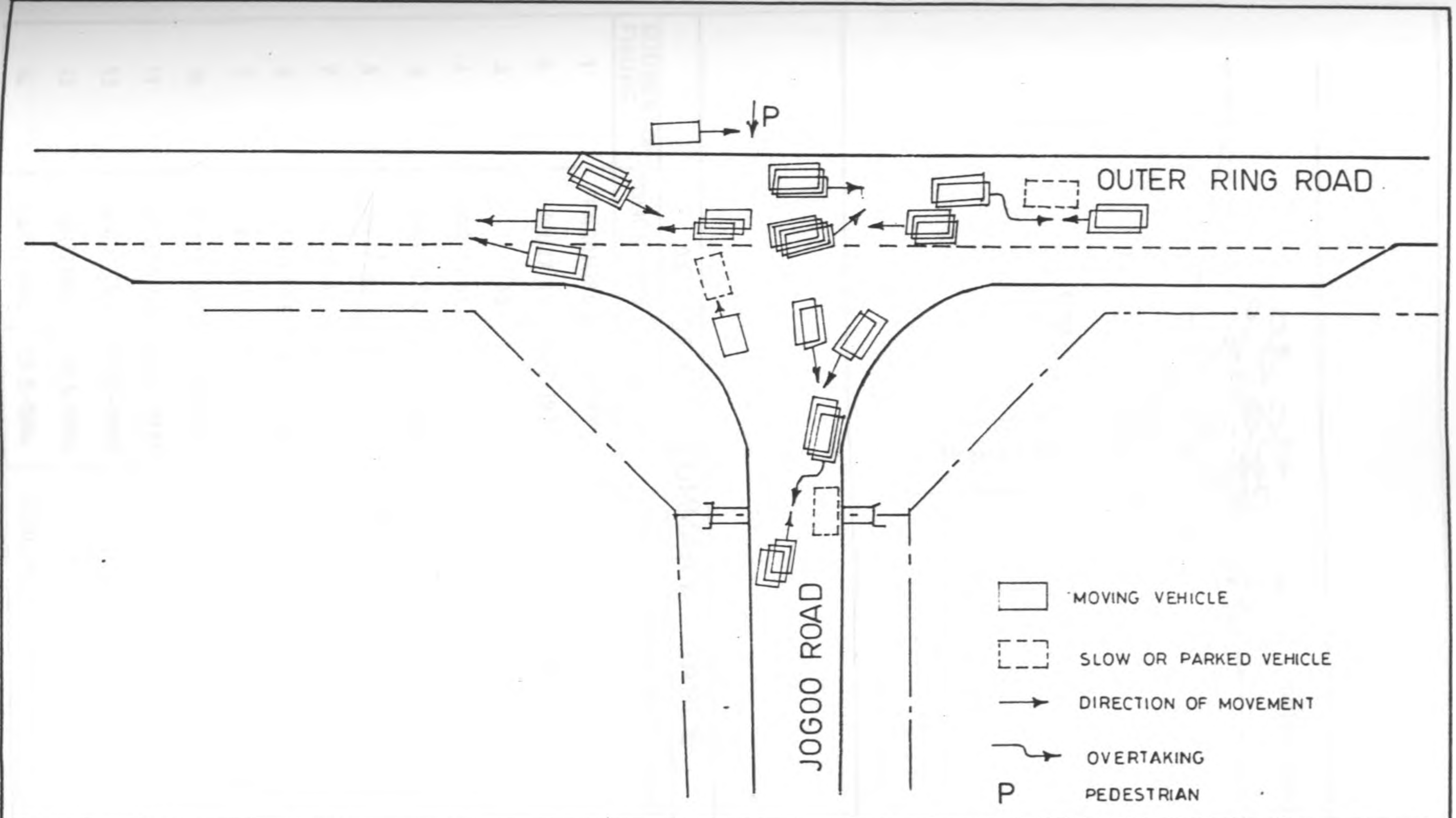
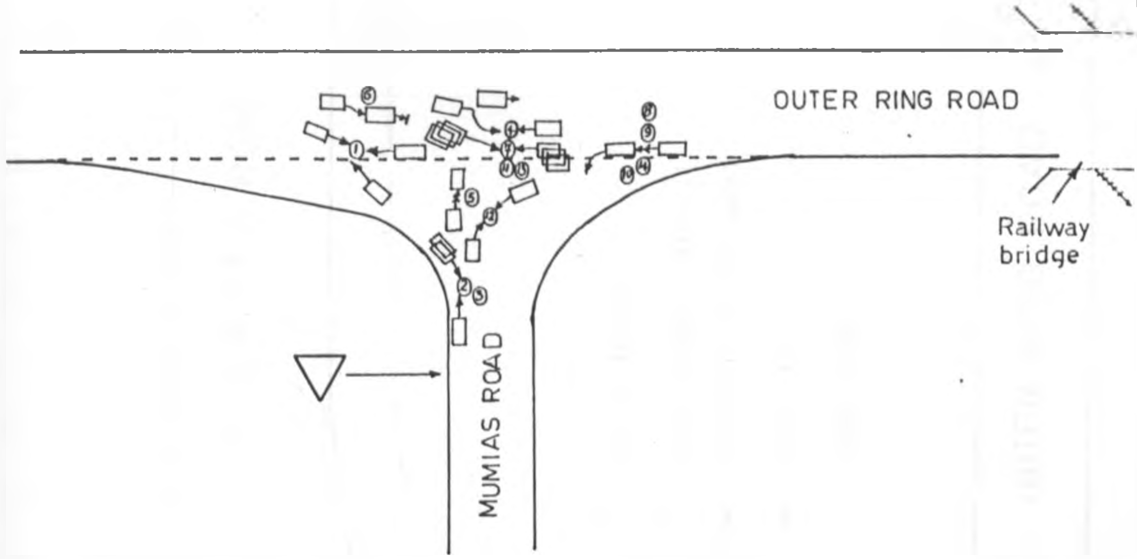


Fig. 4.9 SUMMARY OF CONFLICTS, ON OUTER RING - JOGOO ROAD JUNCTION



ACCIDENT SUMMARY TABLE

NUMBER ON FIGURE	POLICE CODE	DATE	TIME	COSUALTIES	PARTICIPANTS
1	I AR/114/85	13-7-1985	11.30 pm	3 SL	S/S/B
2	I AR/27/85	15-2-1985	5.30 pm	2 SL	S/PC
3	I AR/77/85	13 5 1985	5.30 pm	1 SL	L/PC
4	I AR/1/85	1 1 1985	4.30 pm	1 S	S/PC
5	NIAR/98/84	12-10-1984	8.20 pm		S/P
6	NIAR/30/84	6-6-1984	9.30 pm	-	S/S
7	IAR/85/84	21-9-1984	11.40 am	2S,4 SL	B/L
8	NIAR/49/85	18-8-1985	8.00 am	-	S/P
9	NIAR/83/85	26-9-1985	7.30 am	1 SL	S/L
10	IAR/120/85	24-7-1985	7.30 pm	1 SL	L/PC
11	IAR/69/85	3-5-1985	8 00 pm	1 SL	S/L
12	NIAR/13/85	11-5-1985	12.00 am	-	S/S
13	I AR/23/84	20-5-1984	12 40 am	SS	MA/S
14	IAR/23/84	13-5-1984	2.00 am	1S,1SL	S/S

Fig. 4.10 ACCIDENT SUMMARY FOR MUMIAS-OUTER RING ROAD JUNCTION

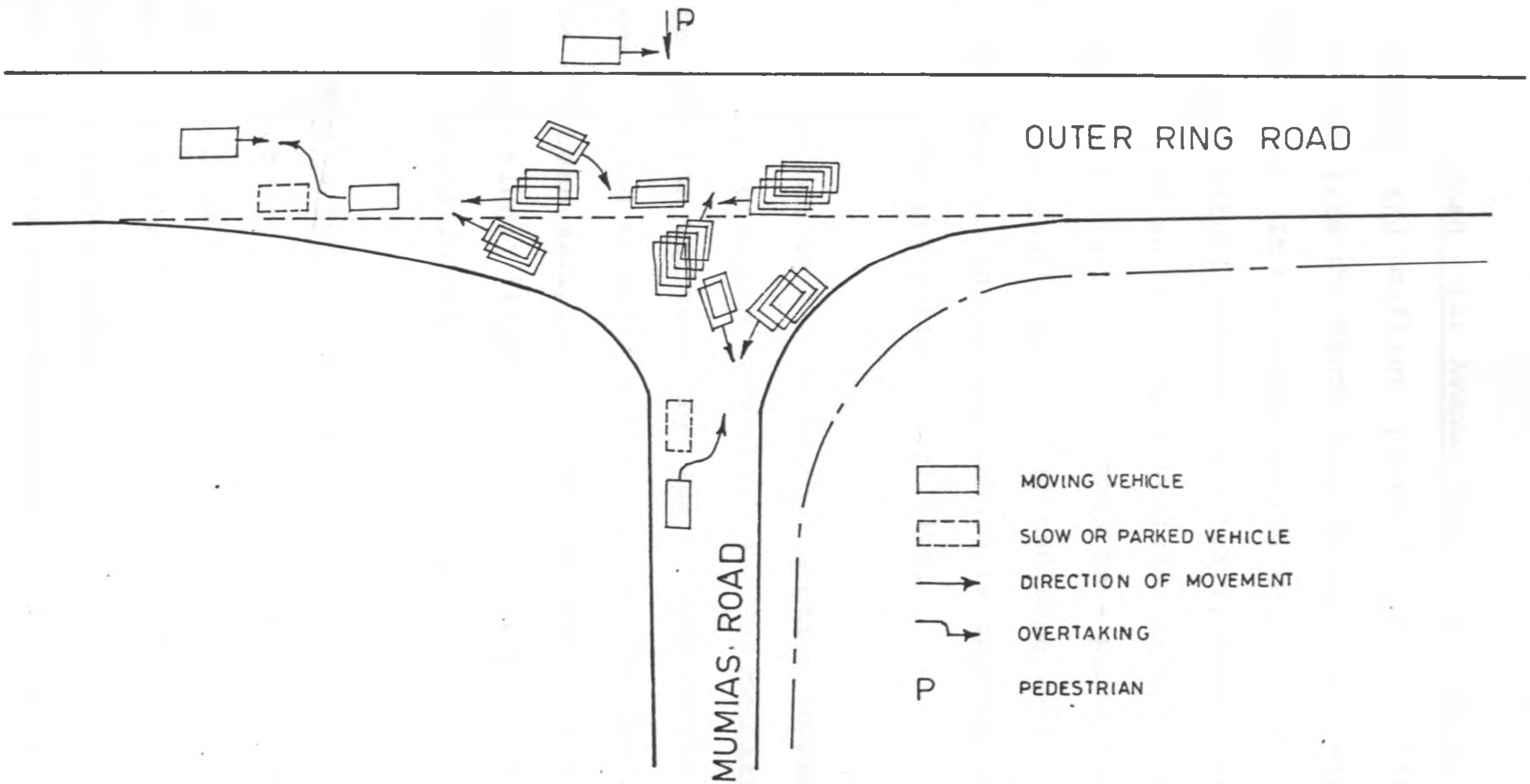


Fig. 4.11 SUMMARY OF CONFLICTS ON MUMIAS ROAD - OUTER RING ROAD

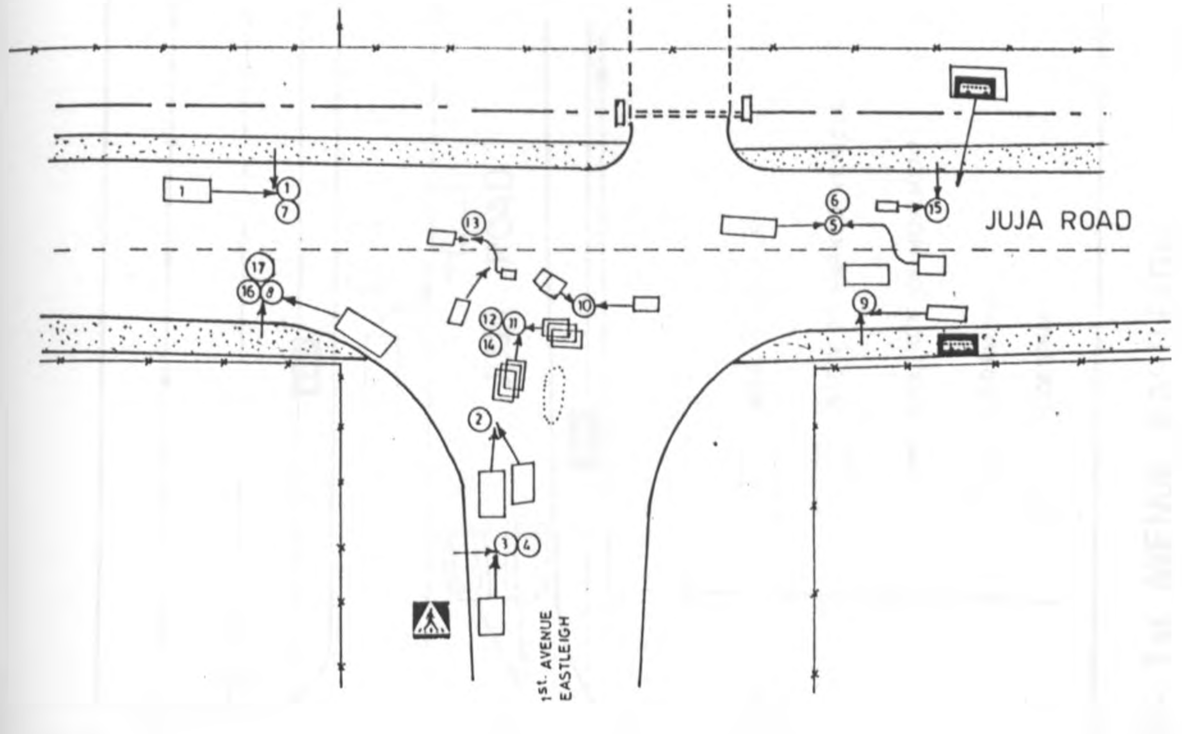
4.4.1.3 <u>Juja Road - 1st Avenue Eastleigh Road Junction</u>

Accident and conflict plots (Fig.4.12 - 13) suggest that vehicles from the minor road forced their way into the major road. It was noted during the conflict study that at times matatu conductors actually stop traffic on the main road so that their vehicles from the minor road may have a right of way. This is a problem of capacity at the junction, this forced some vehicles especially matatus to use the shoulders thereby interfering with the pedestrian facilities.

The two bus-bays next to the junction increased the number of conflicts considerably. The pedestrian flow at this junction was very high (up to 2000 people/hour). They were forced to walk on the road because the road reserve had been seriously interfered with by the erection of illegal "kiosks", hence increasing their chances of being involved in accidents.

4.4.1.4 <u>Mumias Road - Rabai Road Junction</u>

Accident and conflict plots (Fig.4.14-15) suggest that drivers from the minor leg enter the main road without giving the vehicles on the main road (which have the right of way) a chance to pass. Over 60% of the accidents at this junction occurred between 6.30 p.m. and 9.00 p.m. This suggests that there is a problem of lighting at this junction. Also from the accident/



ACCIDENT SUMMARY TABLE					
NUMBER ON FIGURE	POLICE CODE	DATE	TIME	COSUALTIES	PARTICIPANTS
1	IAR/62/84	2-3-1984	1.00 pm	1 SL	Pu/P
2	NIAR/102/85	2-9-1985	7.10 am	1 SL	MA/B
3	IAR/204/84	20-7-1984	1.15 pm	1 SL	MA/S
4	IAR/47/84	18-2-1984	12.30 pm	1 SL	Pr/P
5	IAR/55/85	12-2-1985	3.00 am	1 SL	S/S
6	IAR/164/85	20-4-1985	4.10 pm	1 SL	S/S
7	IAR/337/85	1-8-1985	1.45 pm	1 SL	S/P
8	IAR/259/85	25-6-1985	10.30 am	1 SL	S/P
9	IAR/409/85	—	11.00 am	1 SL	S/P
10	IAR/500/85	24-11-1985	12.00 pm	1 SL	S/S
11	IAR/482/85	11-11-1985	- Night	1 S	MA/P
12	IAR/19/85	17-1-1985	3.00 pm	4 SL	MA/L
13	IAR/55/85	12-2-1985	3.30 am	1 S	S/S/S
14	IAR/17/84	1-2-1984	7.50 am	2 SL	MA/S
15	IAR/282/84	9-5-1984	8.00 am	1 SL	Pr/P
16	IAR/272/84	18-9-1984	10.25 am	1 SL	S/P

Fig. 4.12 SUMMARY OF ACCIDENT ON JUJA ROAD - 1st AVENUE EASTLEIGH JUNCTION

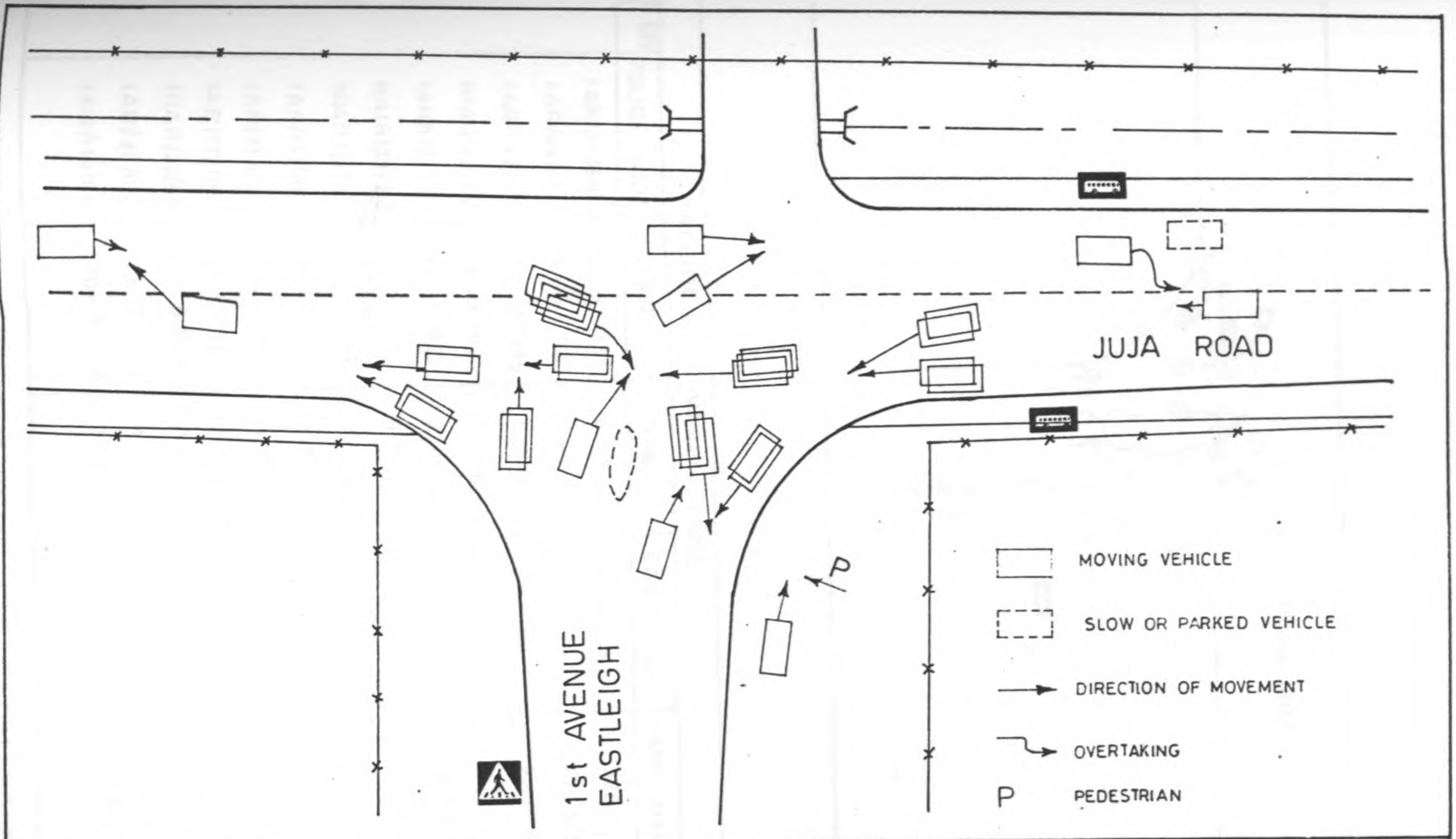
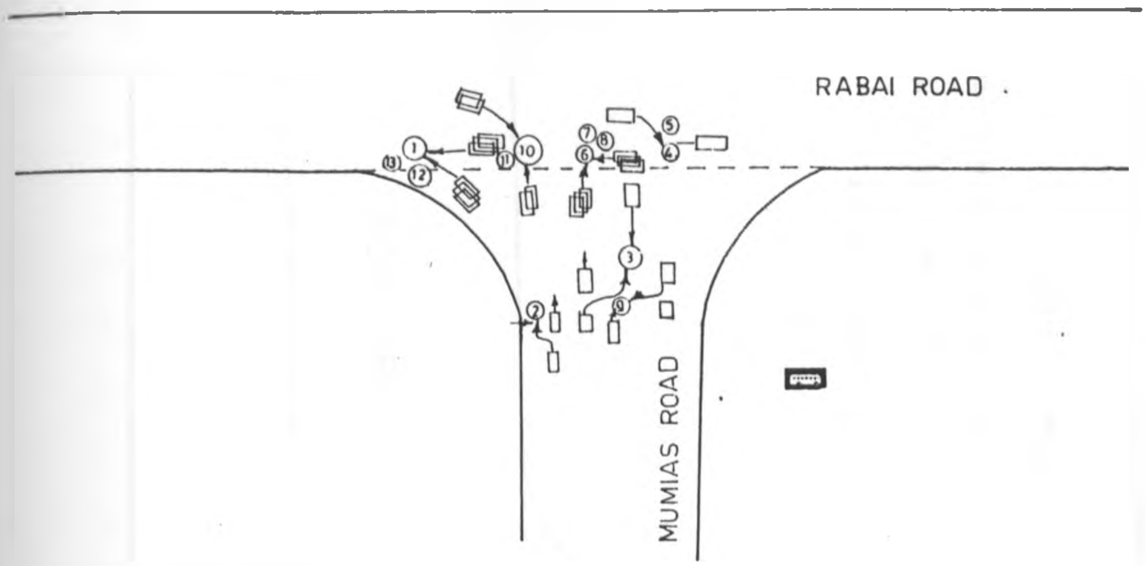


Fig. 4.13 SUMMARY OF CONFLICTS ON JUJA ROAD - 1st AVENUE EASTLEIGH



ACCIDENT SUMMARY TABLE

NUMBER ON FIGURE	POLICE CODE	DATE	TIME	CASUALTIES	PARTICIPANTS
1	IAR/24/85	12-2-1985	6.45 pm	2 SL	S/S
2	IAR/89/85	8-6-1985	8.15 am	1 SL	MA/S/PC
3	IAR/182/85	20-11-1985	1.00 am	1S /4 SL	MA/MA
4	NIAR/82/84	16-9-1984	8.15 pm		S/S
5	IAR/112/84	15-11-1984	2.00 pm	1 S	B/PC
6	NAIR/33/85	14-9-1985	8 00 pm		P/S
7	NIAR/21/85	18-6-1985	3.00 pm		B/P
8	IAR/151/85	27-9-1985	8.00 am	1 SL	S/S
9	IAR/91/85	10-6-1985	12.35 am	1S . 1 SL	MA /B
10	IAR/117/85	20-7-1985	8.30 pm	2 SL	S/S
11	NIAR/33/85	14-9-1985	8.00 pm		S/P
12	IAR/30/85	19-2-1985	8.00 pm	2 SL	MA/S
13	IAR/119/85	20-7-1985	7.30 pm	1 SL	MA/S

Fig. 4.14 SUMMARY OF ACCIDENT ON MUMIAS-RABAI ROAD JUNCTION

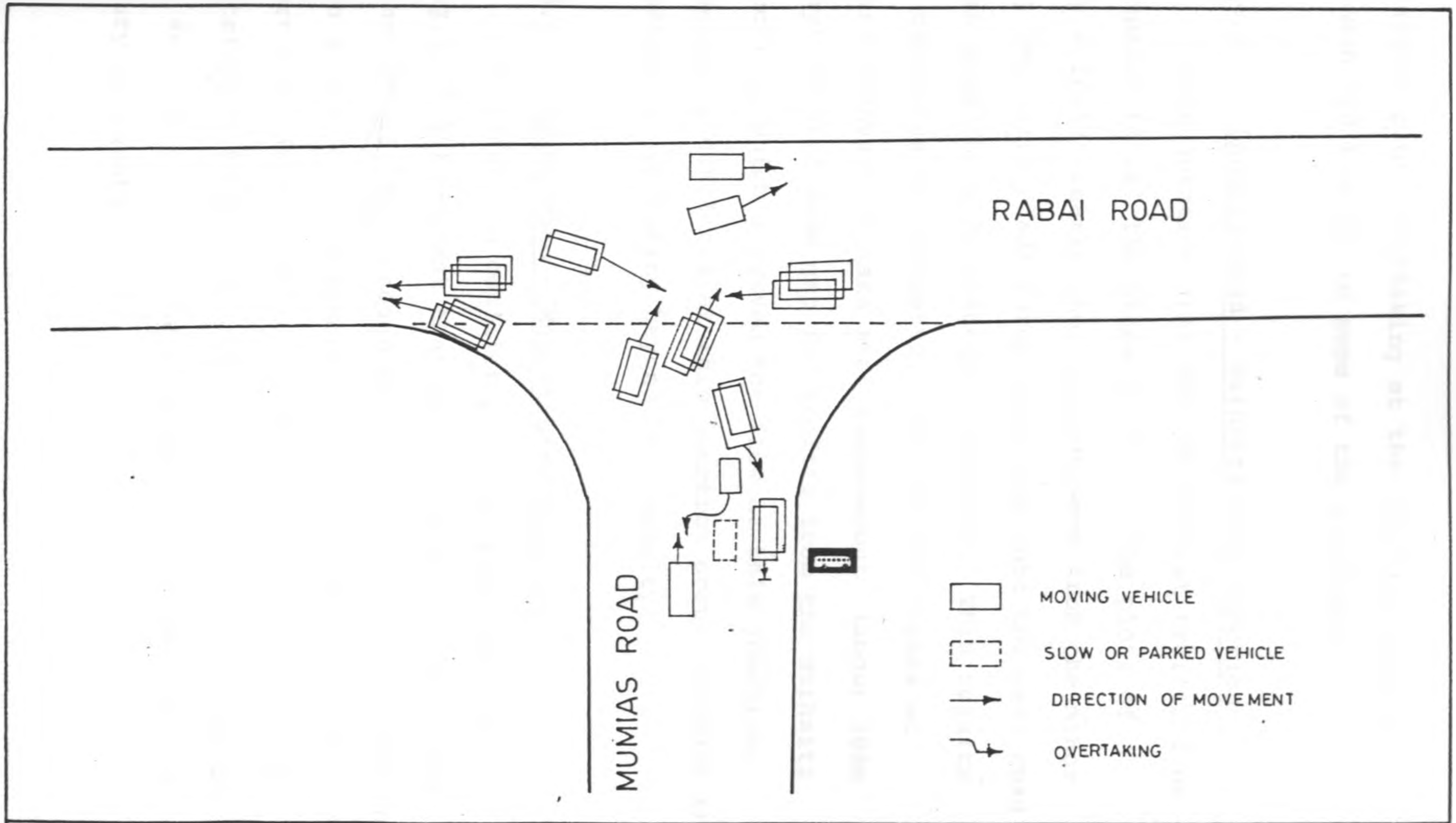


Fig. 4.15 SUMMARY OF CONFLICTS ON MUMIAS ROAD - RABAI ROAD JUNCTION

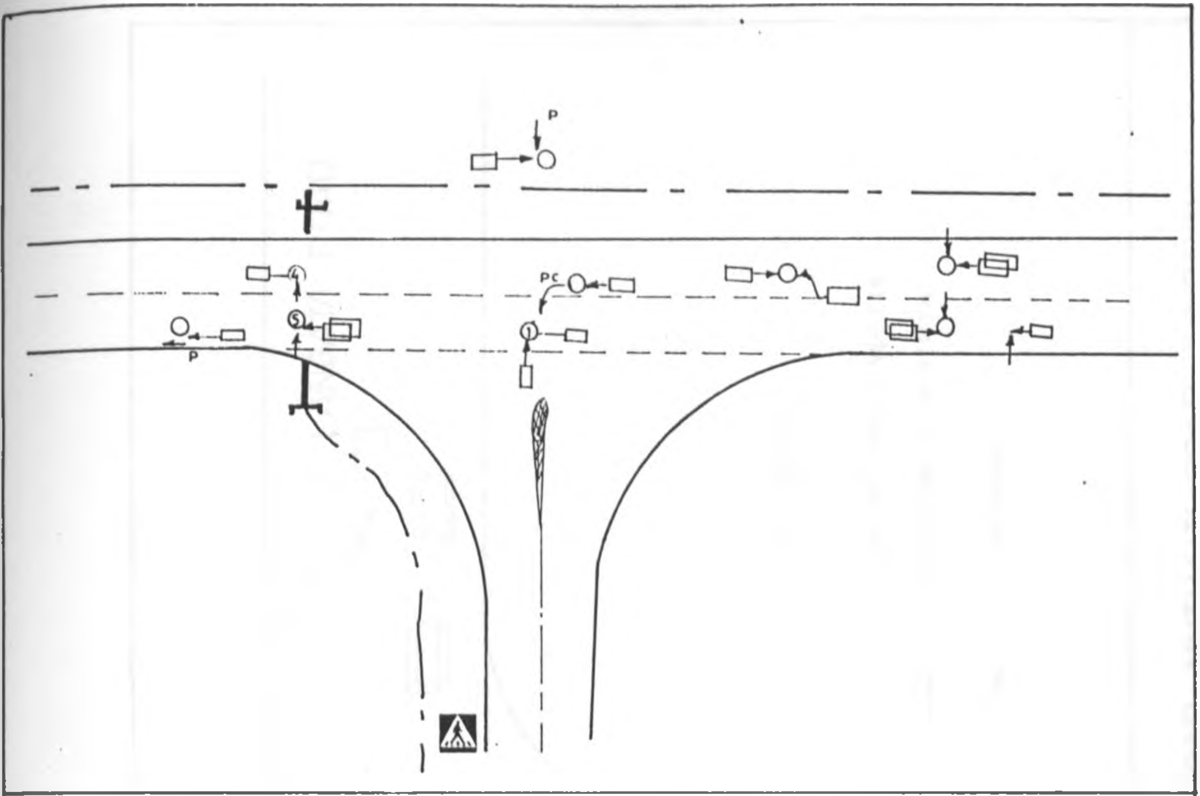
conflict plot, overtaking at the junction area is common and has led to some of the accidents.

4.4.1.5 Langata Road - Muthaiti Road Junction

This junction area had the highest traffic flow compared to all the sites studied. The plots of Fig.4.16-17 clearly show that drivers from the minor leg (Muthaiti road) force their way into the main road even when there is inadequate headway. This results in conflicts or accidents. The traffic lights at Uhuru Highway - Lusaka Road round-about (about 200m away) created some gap for traffic from the Muthaiti junction, which improved the flow at this junction. Apparently conflicts at this junction occur because the junction is operating beyond its capacity.

4.4.1.6 Ngong Road - Mugo Kibiru Road Junction

Accident and conflict plots at this jucntion (Fig.4.18-19) suggest that drivers from the minor leg either do not have enough headway to allow them into the main stream or they ignore traffic on the main road. Overtaking around the junction is also a factor which contributed to some accidents and conflicts. However, all accidents except one at this junction were slight injury accidents.



ACCIDENT SUMMARY TABLE

NUMBER ON FIGURE	POLICE CODE	DATE	TIME	CASUALTIES	PARTICIPANTS
1	IAR/61/84	12-6-1984	5.00 p.m.	1 SL	S/L
2	IAR/85/84	23-9-1984	10.30 p.m.	2 SL	S/S
3	IAR/51/84	18-8-1984	4.30 p.m.	1 S, 2 SL	Van/Ma
4	IAR/16/84	8-8-1984	8.05 a.m.	1 SL	L/B
5	IAR/19/84	14-2-1984	11.00 p.m.	1 SL	B/L
6	IAR/27/84	16-3-1984	5.40 p.m.	3 SL	B/Ma.
7	IAR/89/84	19-10-1984	12.15 p.m.	1 SL	Ma/P
8	NIAR/90/84	19-10-1984	5.20 p.m.		P/Ma
9	IAR/90/85	9-8-1985	6.30 p.m.	1 SL	Ma/Ma
10.	IAR/74/85	25-5-1985	5.15 p.m.	1 S	L/L
11.	IAR/69/85	30-5-1985	8.30 a.m.	3 SL	S/P
12	IAR/80/84	24-2-1984	8.00 p.m.	1 S	Ma/S

Fig. 4.16 SUMMARY OF ACCIDENTS ON LANGATA ROAD–MUTHAITI ROAD JUNCTION

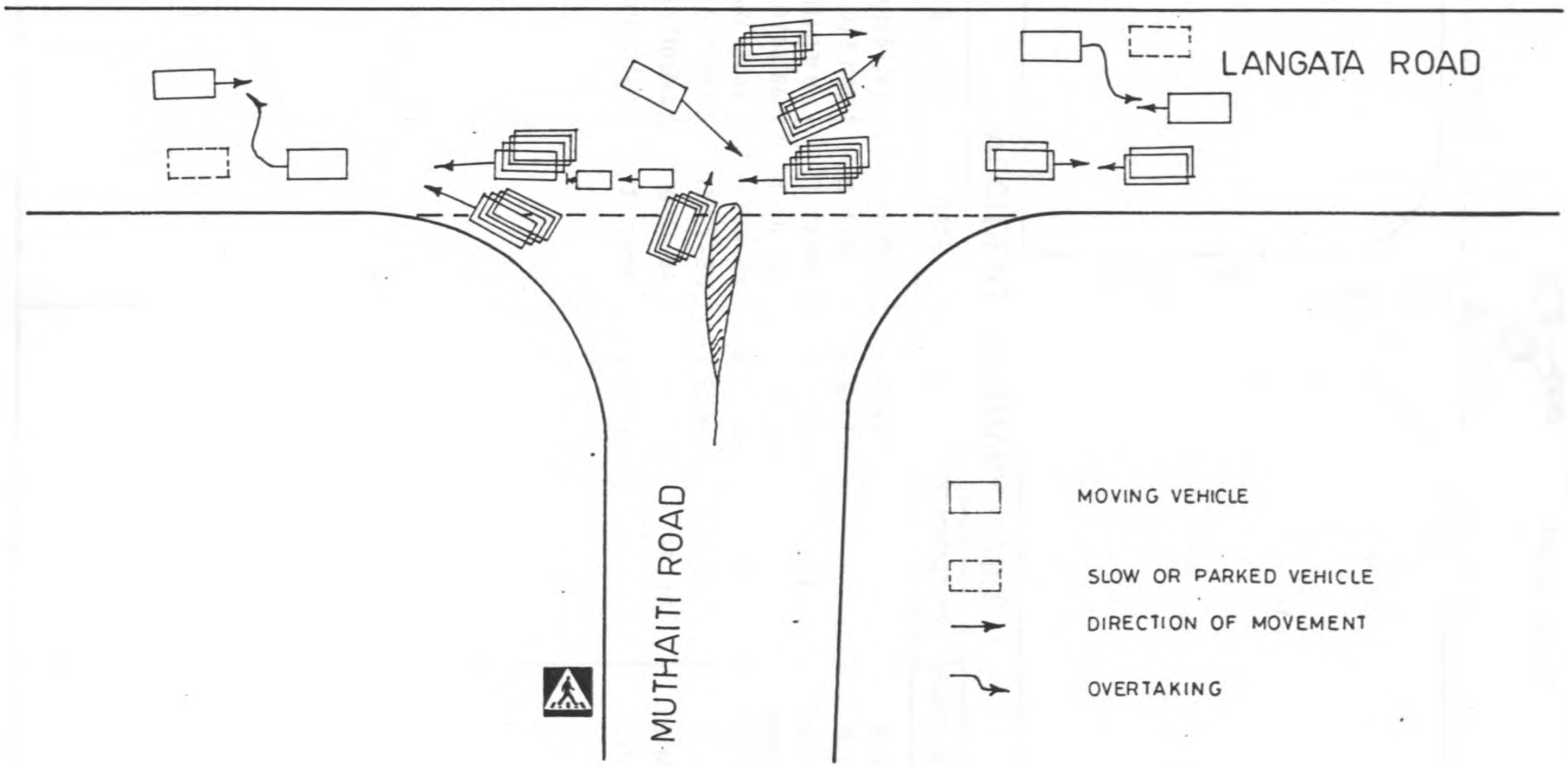
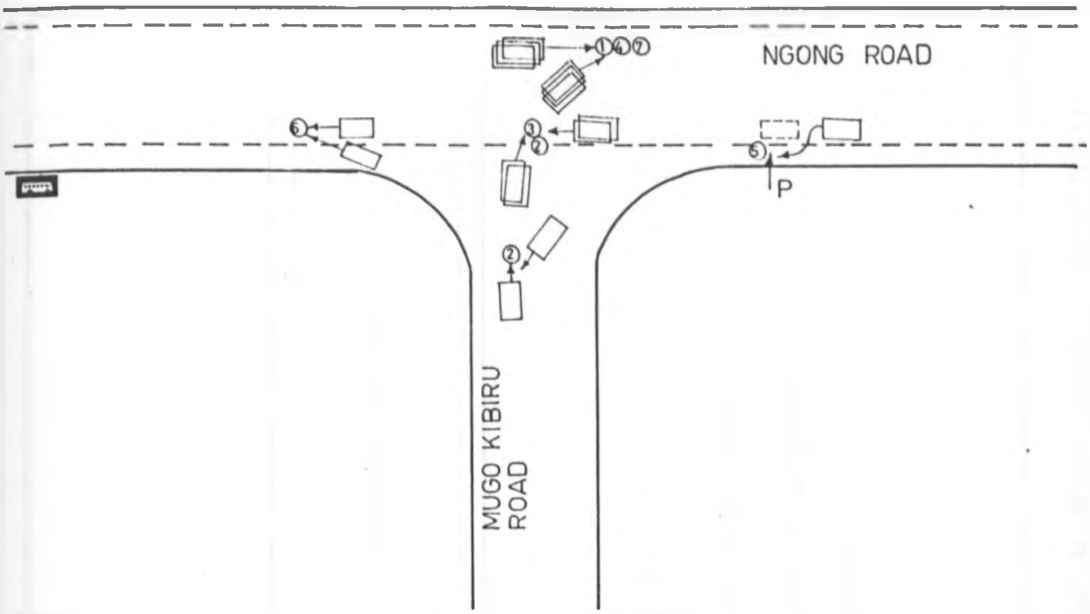


Fig. 4.17 SUMMARY OF CONFLICTS ON LANGATA ROAD - MUTHAITI ROAD JUNCTION



ACCIDENT SUMMARY TABLE

NUMBER ON FIGURE	POLICE CODE	DATE	TIME	CASUALTIES	PARTICIPANTS
1	NIAR/52/85	6-7-85	7.30 am	-	B/S
2	NIAR/5/85	21-1-85	10.00 pm	-	B/P
3	IAR/113/84	12-12-84	7.30 pm	2SL	Ma/S
4	IAR/68/84	1-6-84	5.30 pm	1SL	Ma/L
5	IAR/47/84	23-4-84	8.15 am	1SL	Ma/P
6	IAR/78/85	13-9-85	7.50 am	2SL	S/S
7	IAR/105/84	19-11-84	1.00 pm	1S,3SL	B/Ma
8	NIAR/31/85	3-4-85	3.00 am	-	L/S

Fig. 4.18 SUMMARY OF ACCIDENTS ON NGONG ROAD - MUGO KIBIRU ROAD JUNCTION

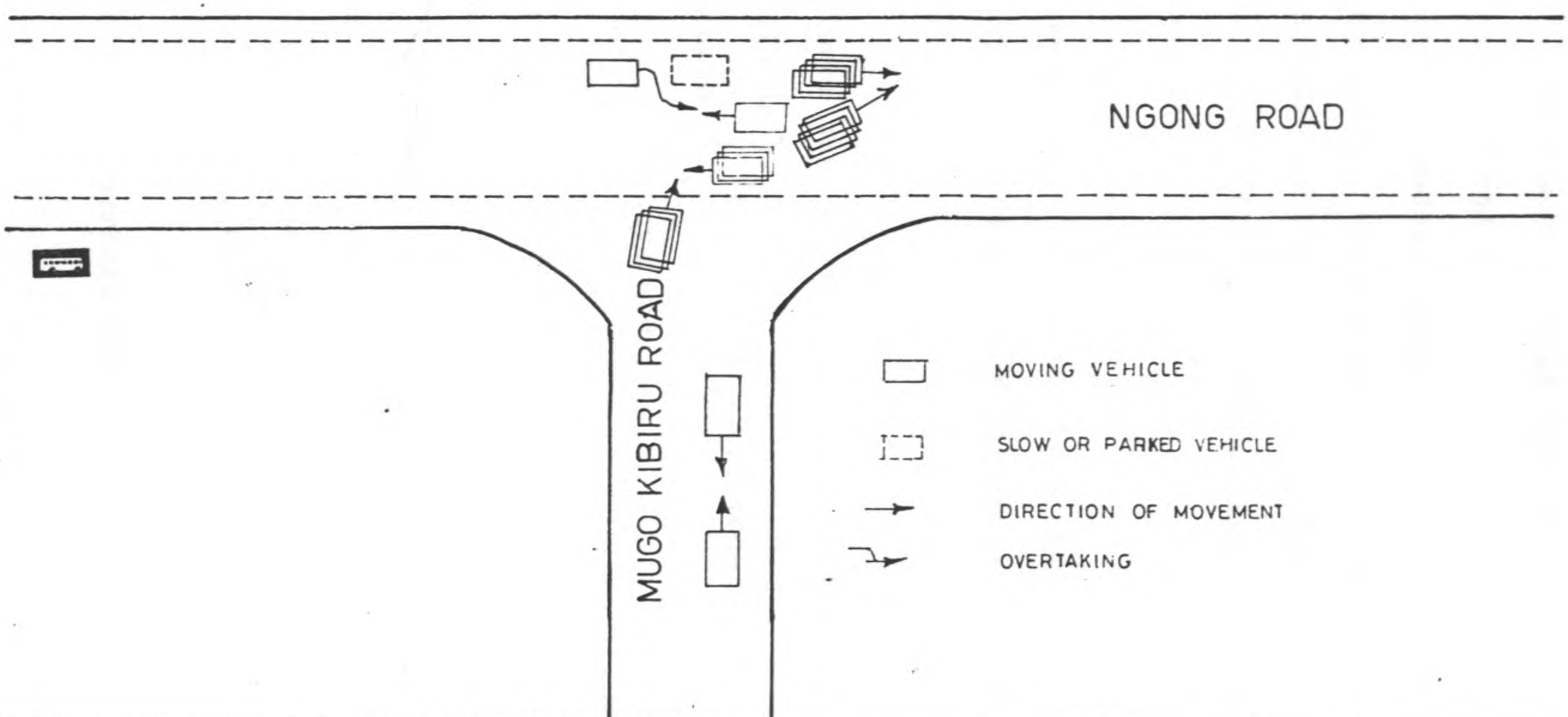


Fig. 4.19 SUMMARY OF CONFLICTS ON NGONG ROAD - MUGO KIBIRU ROAD JUNCTION

4.4.2.1 Conflicts Versus Traffic Flow

Conflict data were plotted against traffic flow. The unsmoothed data had a wide scatter. To facilitate the development of models these data were smoothed. Smoothing was done by calculating representative conflicts for every increase of 100 vehicles per hour. The general trend showed that conflicts increased with traffic flow up to a certain limit.

Four models were fitted to check which one fitted closely to the observed data for all the six sites. These models include:

- Power curve model
- Linear } Polynomial curve models
- Cubic }
- Logistic curve model

Figures 4.20-26 show the obtained models, the predicted data and the correlation factors. Regression analysis on the predicted (P) versus the observed (0) data was done and it is presented with the figures. Data from all the six sites studied were compiled and a general model for Nairobi was developed (Figure 4.26).

The following symbols have been used in Figures 4.20 - 4.26.

C_p = Predicted conflicts

C_o = Observed conflicts

r = Correlation coefficient

r^2 = Coefficient of determination

E_{xy} = Standard error

S.L = Significance level

C = Conflicts

Q = Vehicular traffic flow (vehicles/hour)

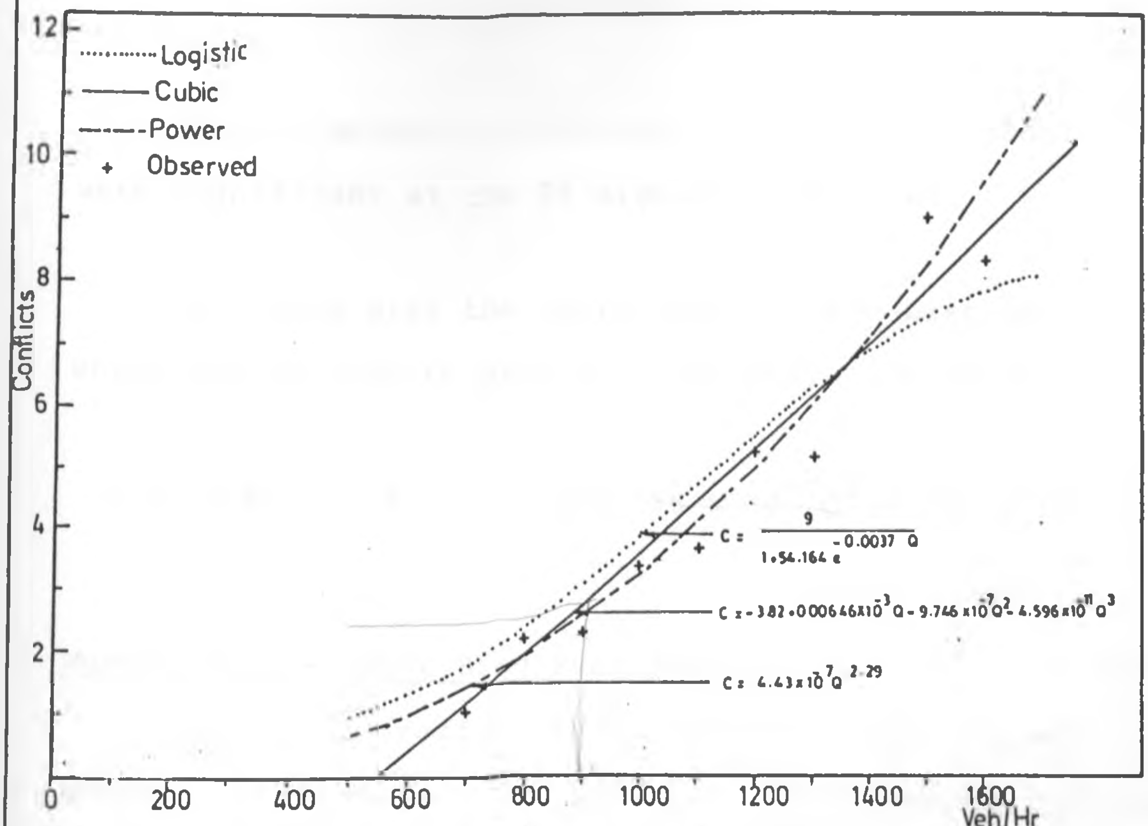
a_1, a_2, a_3, b = Constants

Total Conflicts Versus Total Vehicular traffic flow

Jogoo Road Outer Ring Road Junction

Total traffic flow at this junction ranged between 600-1700 vehicles per hour. Most of the traffic was composed of cars and vans. The models developed related total conflicts (C) and total vehicular traffic (Q) in the T-junction.

The fitted models have a good predicting power because their gradients and Y-intercepts were near unity and zero respectively. The power and the cubic models slightly under predicted the data as shown in Fig.4.20. Error analysis showed that the linear model had the largest errors (E_{xy} = 175.85) followed by the power models. Regression analysis showed that all the models (except the linear) had a good coefficient of determination



EQUATION	CONSTANTS	r	r^2	Exy	S.L
$C = aQ^b$	$a = 4.43 \times 10^{-7}$ $b = 2.29$	0.972	0.945	1.04	5%
$C = a_0 + a_1Q + a_2Q^2 + a_3Q^3$	$a_0 = -3.8199$ $a_1 = 6.460 \times 10^{-3}$ $a_2 = -9.746$ $a_3 = -4.586 . 10^{-11}$	0.972	0.944	0.32	5%
$C = \frac{L}{1+ae^{bQ}}$	$L = 9$ $a = 54.164$ $b = 0.0037$	0.965	0.931	0.72	5%
$C = a + bQ$	$a = -5.071$ $b = 0.00849$	0.939	0.882	175.85	5%

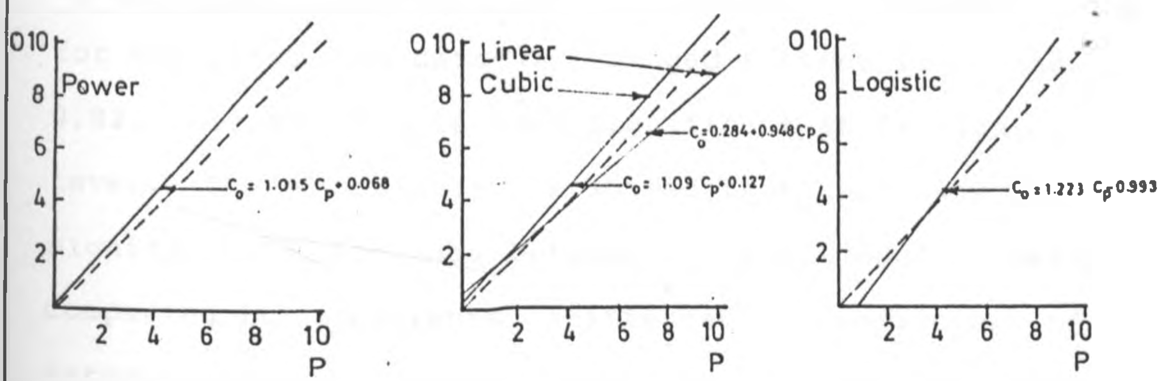


Fig. 4.20 TOTAL CONFLICTS VERSUS TOTAL TRAFFIC FLOW ON JOGOO ROAD - OUTER RING ROAD JUNCTION

(r^2) ranging between 0.931 and 0.945. All the models were significant at the 5% significance level.

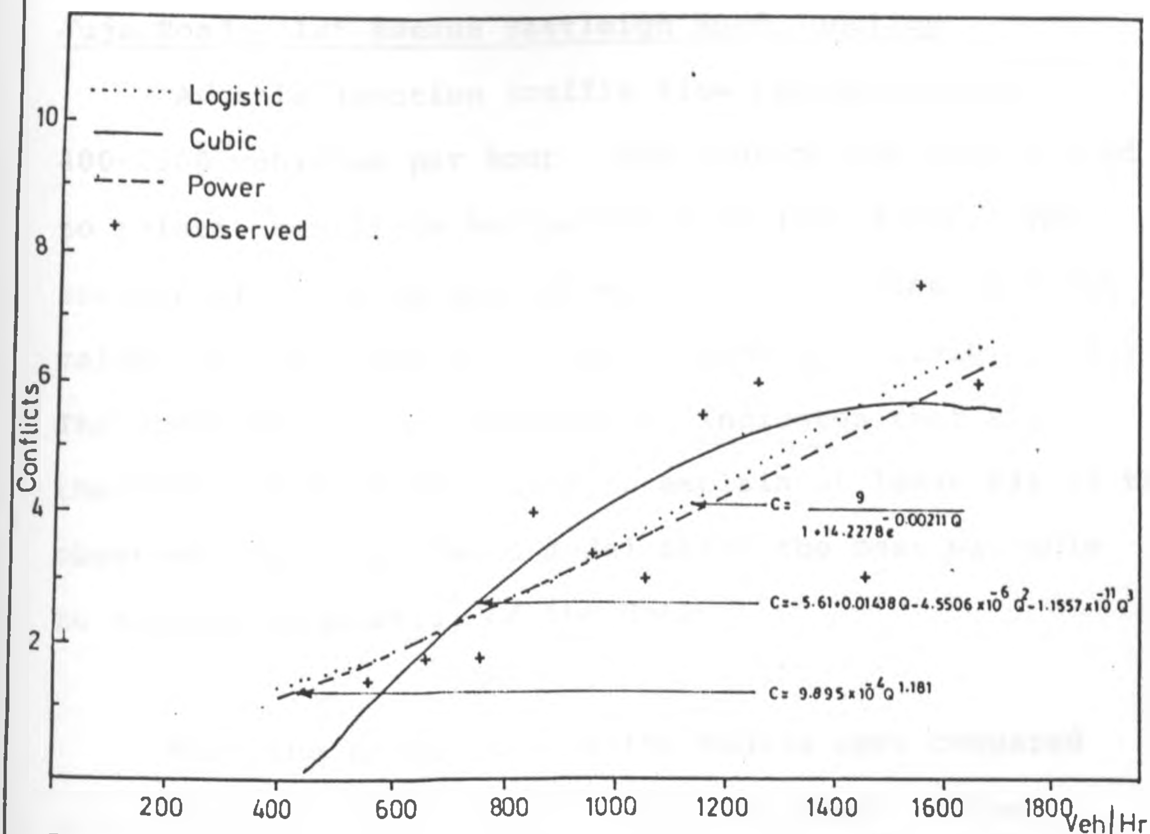
For this site the cubic model is the best model which may be used to predict conflicts. The equation is

$$C = -3.82 + 6.46 \times 10^{-3}Q - 9.736 \times 10^{-7}Q^2 - 4.596 \times 10^{-11}Q^3 \quad (4.1)$$

Mumias Road - Outer Ring Road Junction

The total traffic flow at this junction ranged between 400-1700 vehicles per hour. The observed conflicts showed a wider scatter compared to Jogoo Road - Outer Ring Road junction. the models developed (Fig.4.21) showed good prediction. The gradients and Y-intercept of the observed versus predicted graphs were close to one and zero respectively. Correlation values (which indicate scatter) for the predicted data (r^2) ranged between 0.806 and 0.82. All the models were significant at 5% significance level. The error analysis showed that there was no significant difference between the four models developed. Comparing the gradients, Y-intercepts, coefficient of determination and errors of the four models, the power model is the best to be used for predicting conflicts. The equation is

$$C = 9.895 \times 10^{-11} \times Q^{1.181} \quad (4.2)$$



EQUATION	CONSTANTS	r	r^2	Exy	S.L
$C = aQ^b$	$a = -9895\times10^{-4}$ $b = 1.181$	0.820	0.672	1.51	5%
$C = a_0 + a_1Q + a_2Q^2 + a_3Q^3$	$a_0 = -5.6069$ $a_1 = 0.01438$ $a_2 = -4.5506\times10$ $a_3 = -1.1557\times10$	0.806	0.649	1.59	5%
$C = \frac{L}{1 + ae^{bQ}}$	$L = 9$ $a = 14.2278$ $b = -0.00211$	0.819	0.670	1.52	5%
$C = a + bQ$	$a = 2.78$ $b = 0.00581$	0.818	0.670	1.53	5%

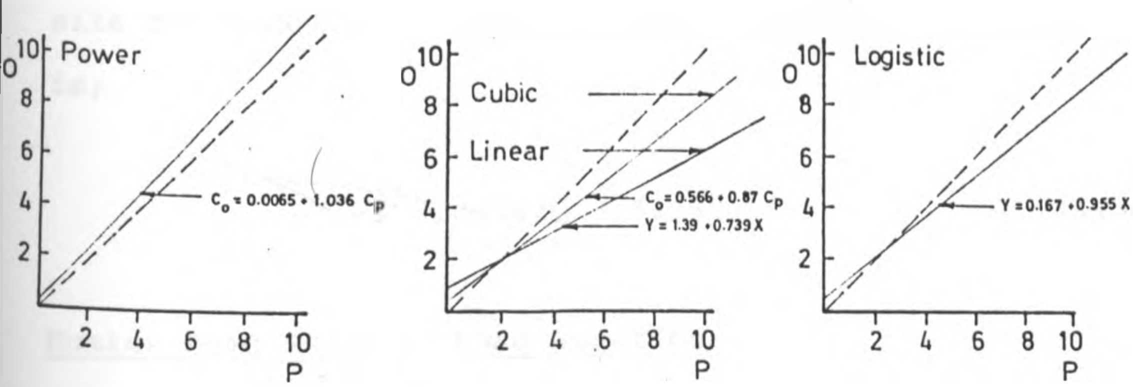


Fig. 4.21 TOTAL CONFLICTS VERSUS TOTAL TRAFFIC FLOW ON MUMIAS ROAD - OUTER RING ROAD JUNCTION

Juja Road - 1st Avenue Eastleigh Road Junction

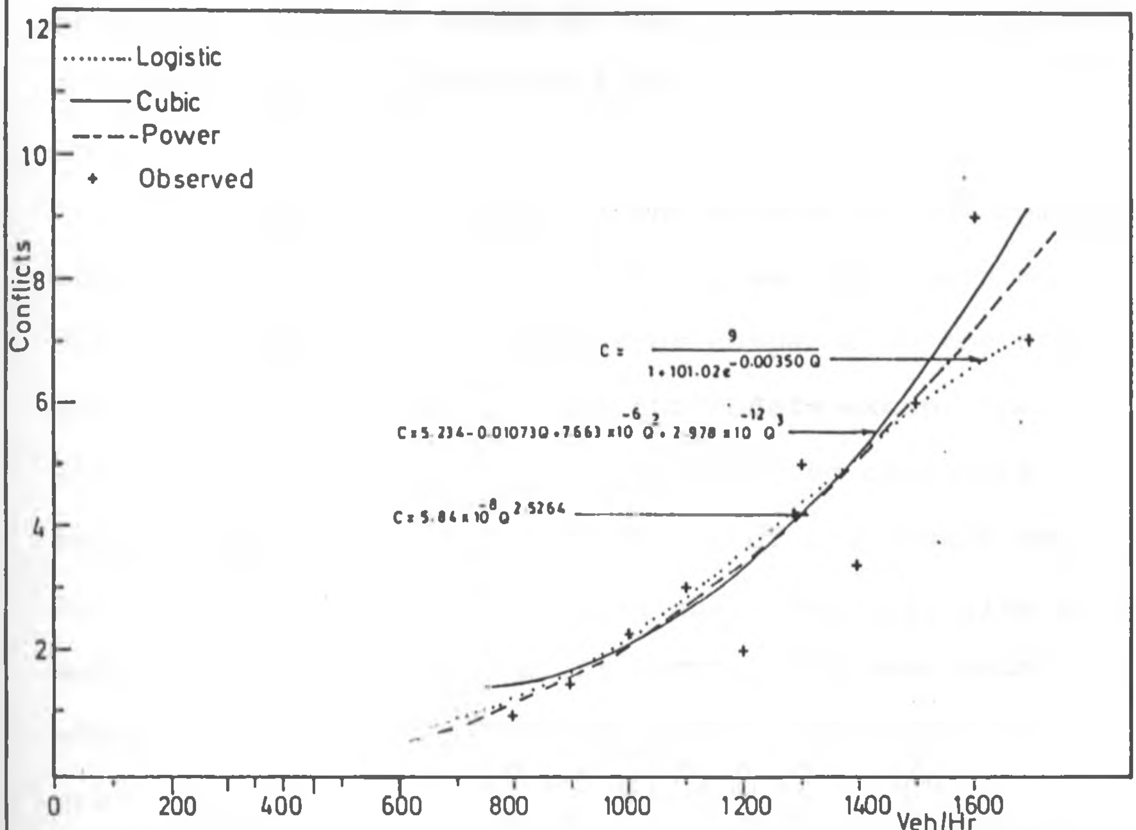
At this junction traffic flow ranged between 400-1800 vehicles per hour. The four models were fitted to relate conflicts to traffic flow (Fig.4.22). The scatter of the data was not wide as is evident from the values of the correlation coefficient (r = 0.910 - 0.939). The coefficient of determination indicates that all the models fitted were able to explain at least 84% of the observed data. The cubic model being the best was able to explain up to 88.2% of the data.

When the prediction of the models were compared i.e. comparing the gradients and intercepts of the predicted (P) versus observed (O) graphs the linear model had the best with gradient m = 1.00, followed by the power, cubic then the logistic model Fig.4.22. These models were all significant at 5% level. For this site the model which may be used to predict conflicts is;

$$C = 0.00782Q - 5.362 \qquad (4.3)$$

Mumias Road - Rabai Road Junctions

This junction had a high traffic flow in the morning and evening traffic peaks. The traffic flow ranged between 150-1800 vehicles per hour. The scatter of the conflict observation on the graph was not wide as



EQUATION	CONSTANTS	r	r^2	Exy	S.L
$C = aQ^b$	$a = 5.84 \times 10^{-8}$ $b = 2.5264$	0.91	0.829	1.34	5%
$C = a_0 + a_1Q + a_2Q^2 + a_3Q^3$	$a_0 = 5.234$ $a_1 = -0.01073$ $a_2 = 7.663 \times 10^{-6}$ $a_3 = 2.978 \times 10^{-12}$	0.939	0.882	0.92	5%
$C = \frac{L}{1 + ae^{Qb}}$	$a = 101.02$ $b = -0.00350$ $L = 9$	0.921	0.848	23.01	5%
$C = a + bQ$	$a = -5.362$ $b = 0.00782$	0.699	0.81	1.48	5%

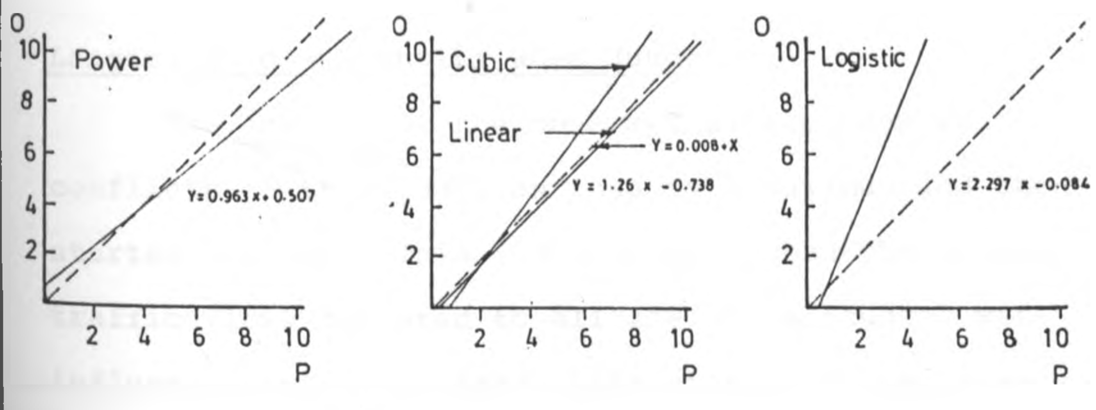


Fig. 4.22 TOTAL CONFLICTS VERSUS TOTAL TRAFFIC FLOW ON JUJA ROAD - 1st AVENUE EASTLEIGH ROAD JUNCTION

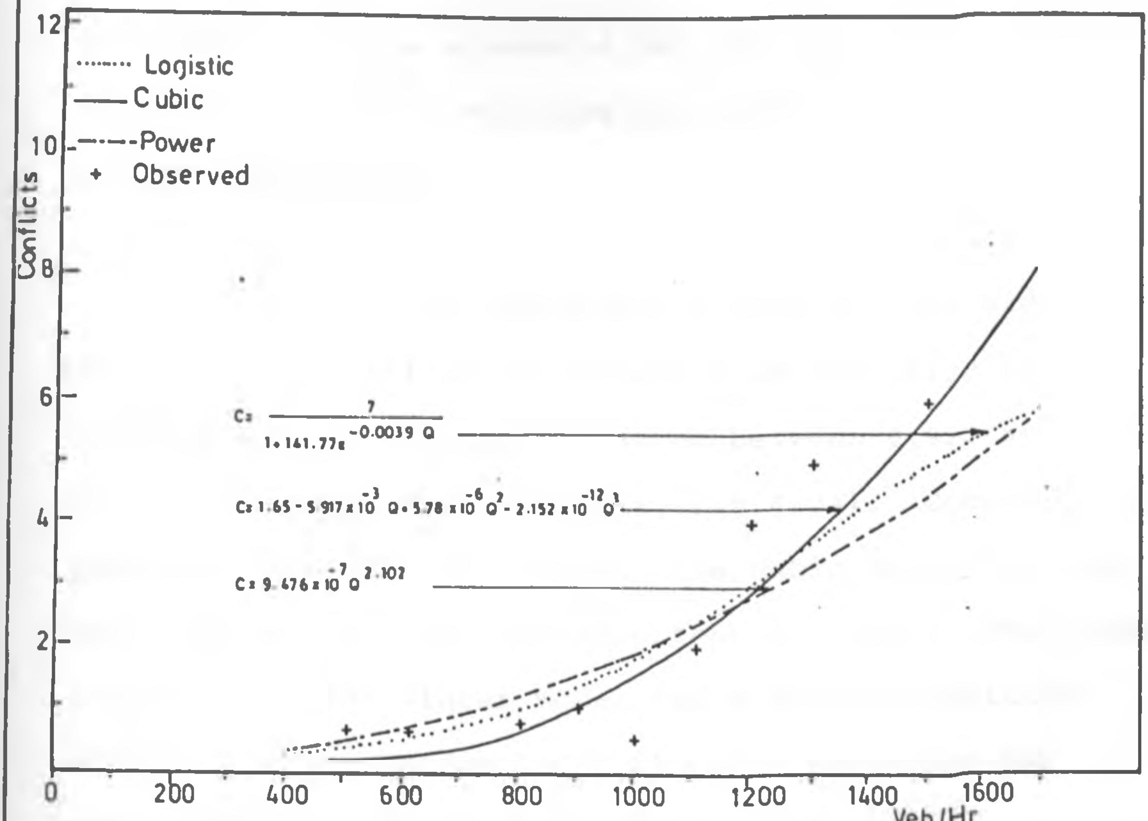
is evident from the value of the correlation coefficient (r ranged between 0.938 and 0.96) (Fig.4.23).

The predictive power of the models was low compared to sites 1, 2 and 3. The best model was the cubic model. The linear model had a large error compared to the other three models (Fig.4.23). All the models except the linear were over-estimating the predicted conflicts because the lines testing the power of the models were having their gradient less than one. For this site all the models were significant at 5% level. The best model which may be used for predicting the conflicts is the cubic model

$$C = 1.65 - 5.197 \times 10^{-3} Q + 5.78 \times 10^{-6} Q^2 - 2.152 \times 10^{-12} Q^3 \quad (4:4)$$

Langata Road - Muthaiti Road Junction

The scatter of the observed data showed that conflicts at this junction rose to a maximum and then started falling. This junction which had the highest traffic flow, compared to all the sites studied was influenced by the traffic light signals at the nearby Lusaka Road - Uhuru Highway roundabout. During the study it was noted that the traffic lights which were about 200m away influenced the flow at this junction greatly.



EQUATION	CONSTANTS	r	r^2	Exy	S.L
$C = aQ^b$	$a = 9.476 \times 10^{-7}$ $b = 2.102$	0.938	0.880	0.59	5 %
$C = a_0 + a_1 Q + a_2 Q^2 + a_3 Q^3$	$a_0 = 1.65$ $a_1 = -5.917 \times 10^{-3}$ $a_2 = 5.78 \times 10^{6}$ $a_3 = -2.152 \times 10^{12}$	0.958	0.917	0.403	5 %
$C = \frac{L}{1 + ae^{bQ}}$	$a = 141.77$ $b = -0.0039$ $L = 7$	0.960	0.921	0.39	5 %
$C = a + bQ$	$a = -1.833$ $b = 0.00417$	0.883	0.780	1.17	5 %

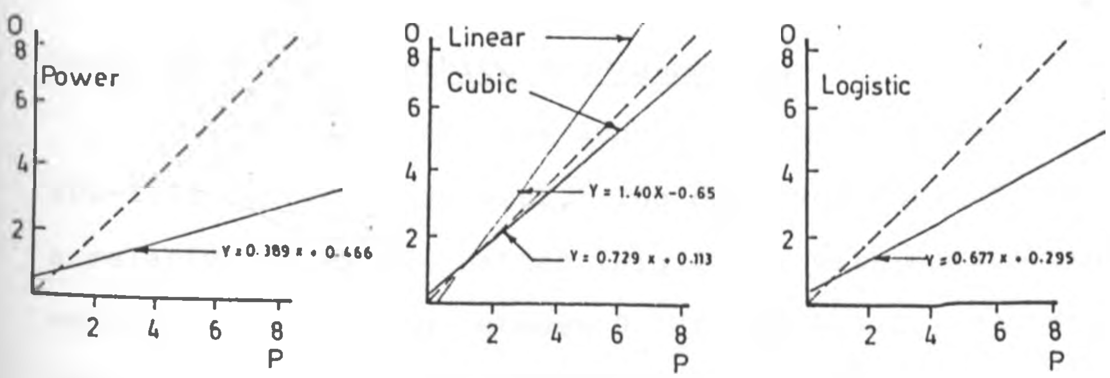


Fig 4.23 TOTAL CONFLICTS VERSUS TOTAL TRAFFIC FLOW ON MUMIAS ROAD - RABAI ROAD JUNCTION

The traffic lights created a big headway on the Langata Road, thus allowing vehiclesfrom Muthaiti Road to join Langata Road easily.

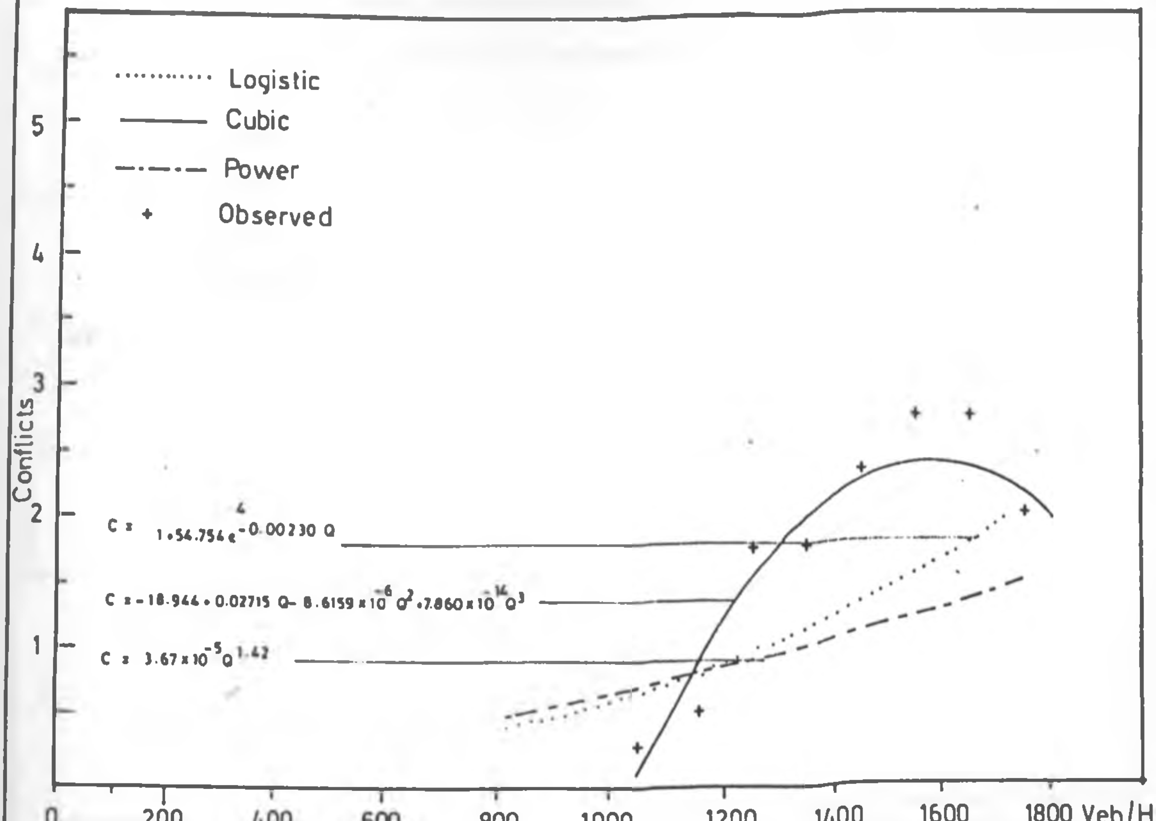
The scatter of the observed data was not wide (except for linear) as is evident from the value of the correlation coefficient (r ranged between 0.925 and 0.947, the linear model had r = 0.111, Fig.4.24). Comparing the predicted and observed values, the cubic model has the best gradient (1.134) and intercept (-0.199). This shows a good fit. The linear model had a poorer prediction with a negative gradient (-1.0). For this site the cubic model may be used to predict conflicts;

$$C = 18.944 + 0.02715Q - 8.6159x10^{-6}Q^2 + 7.86x10^{-14}Q^3 \qquad (4.5)$$

Ngong Road - Mugo Kibiru Road Junction

Traffic flow at this junction ranged between 400-1700 vehicles per hour. The observed data showed a relatively narrow scatter (Fig.4.25) with correlation coefficients ranging between 0.734 and 0.822. The models developed were all significant at 5% level.

The prediction of the models were tested by comparing the observed and predicted data. The logistic curve was found to be the best with gradient = 1.02



EQUATION	CONSTANTS	r	r^2	Exy	S.L
$C = aQ^b$	$a = 3.67 \times 10^{-5}$ $b = 1.42$	0.94	0.884	0.162	5%
$C = a_0Q + a_1Q + a_2Q^2 + a_3Q^3$	$a_0 = -18.944$ $a_1 = 0.02715$ $a_2 = -8.6159 \times 10^{-6}$ $a_3 = 7.860 \times 10^{-14}$	0.947	0.896	0.32	5%
$C = \frac{L}{1 + ae^{bQ}}$	$a = 54.754$ $b = -0.00230$ $L = 4$	0.925	0.856	-0.015	5%
$C = a + bQ$	$a = 1.778$ $b = -0.000289$	-0.111	0.013	1.02	95%

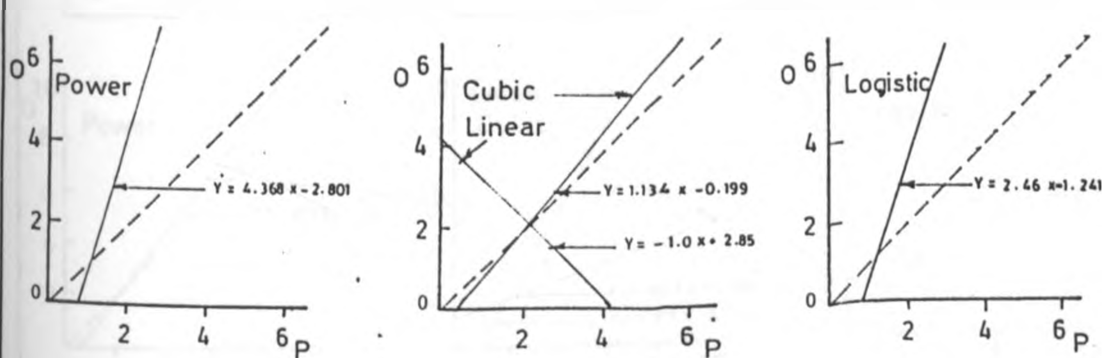
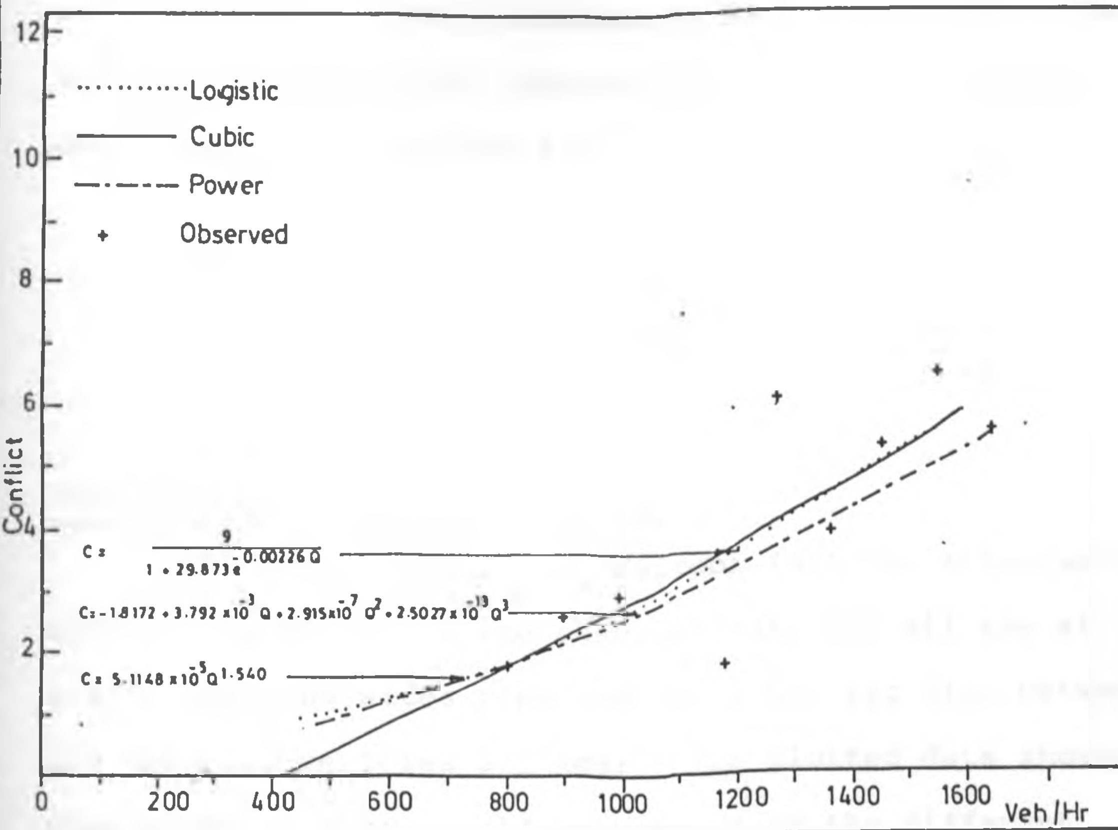


Fig. 4.24 TOTAL CONFLICTS VERSUS TOTAL TRAFFIC FLOW ON LANGATA ROAD - MUTHAITI ROAD JUNCTION



EQUATION	CONSTANTS	r	r2	Exy	S.L
$C = aQ^b$	$a = 5.1148 \times 10^{-5}$ $b = 1.540$	0.789	0.622	1.49	5%
$C = a_0 + a_1Q + a_2Q^2 + a_3Q^3$	$a_0 = -1.8172$ $a_1 = 3.792 \times 10^{-3}$ $a_2 = 2.915 \times 10^{-7}$ $a_3 = 2.5027 \times 10^{-13}$	0.734	0.539	1.09	5%
$C = \frac{L}{1 + ae^{bQ}}$	$a = 29.873$ $b = -0.00226$ $L = 9$	0.739	0.548	1.06	5%
$C = a + bQ$	$a = -1.53$ $b = 0.00381$	0.822	0.676	1.12	5%

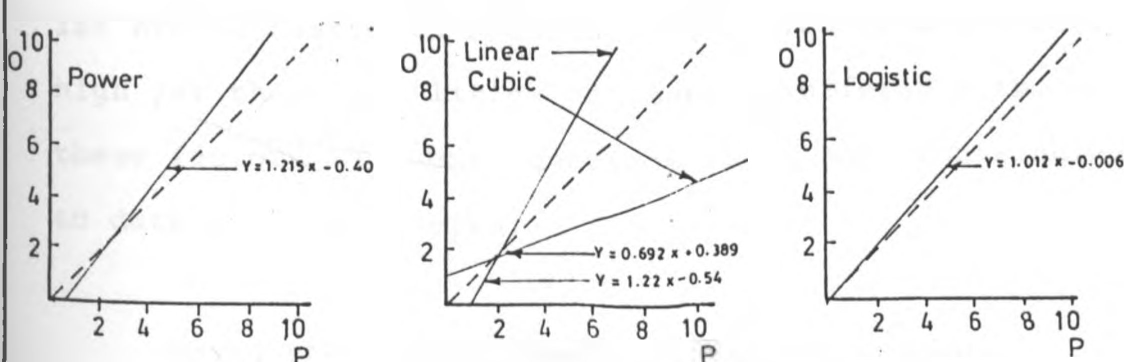


Fig. 4.25 TOTAL CONFLICTS VERSUS TOTAL TRAFFIC FLOW ON NGONG ROAD - MUGO KIBIRU ROAD JUNCTION

and intercept = 0.006, followed by the power model. For this site the logistic equation may be used to predict conflicts. The equation is:

$$C = \frac{9}{1+29.873^{-0.00226Q}} \qquad (4.6)$$

General Model for All the Sites

The general model for Nairobi (all the sites) was obtained by averaging the observed data for all the six sites. All the sites combined had a traffic flow between 150 and 2100 vehicles per hour. The plotted data showed a wide scatter. This could be because of the different environmental and social set up of the different sites. For example, Mumias Road-Outer Ring Road Junction had a steep slope at one side, Langata Road - Muthaiti Road junction the traffic lights were near-by, for Juja Road - 1st Avenue Eastleigh Road the pedestrian flow was very high yet their facilities had been interfered with. All these factors on these junctions could have contributed to data being scattered.

Among the models developed the cubic model predicted the data most consistently followed by the logistic model (Fig.4.26). The predicted versus observed graph of the cubic model showed a gradient 1.33 and intercept of -1.06. However the coefficient of determination $r^2 = 0.555$ was fairly low with significance level at 5%. The linear and power models had a low prediction power. For the general case in Nairobi the cubic model may be used. Its equation is:-

$$C = 3.015+9.639\times10^{-3}Q-3.405\times10^{-6}Q^2+1.075\times10^{-11}Q^3 \quad (4.7)$$

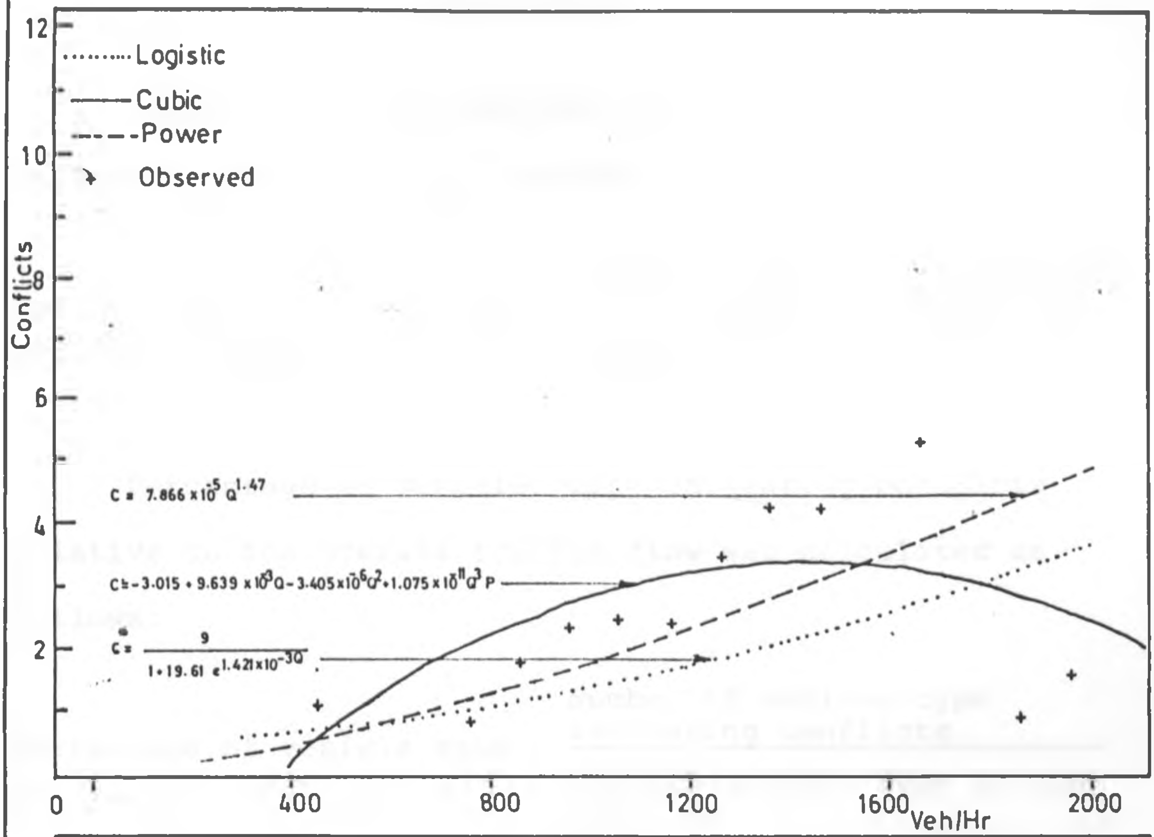
4.4.2.2 Vehicles involved in Conflicts

Vehicles which initiated conflicts were isolated and classified according to their types i.e. Cars, Pick-ups and Vans, Buses, Lorries and Matatus. Conflicts per vehicle type, percentage of vehicle type initiating conflicts relative to the overall traffic flow and percentage of vehicle type relative to the overall traffic stream were calculated and results plotted as histograms (Fig.4.27 to 4.33).

All the sites showed that public transport vehicles were fewer compared to other vehicle types. Saloon cars were the majority of the vehicles as is evident from Fig.4.32 which is a general case for the six sites.

Conflictsper vehicle type was calculated as follows:

$$\text{Conflicts per vehicle type} = \frac{\text{All Conflicts Initiated by that Vehicle type}}{\text{Total number of that vehicle type}}$$



EQUATION	CONSTANTS	r	r^2	Exy	S.L
$C = aQ^b$	$a = 7.866 \times 10^{-5}$ b 1.47	0.589	0.347	2.47	5 %
$C = a_0 + a_1 Q + a_2 Q^2 + a_3 Q^3$	$a_0 = 3.015$ $a_1 = +9.639 \times 10^{-3}$ $a_2 = -3.405 \times 10^{-6}$ $a_3 = 1.075 \times 10^{-11}$	0.745	0.555	1.33	5 %
$C = \frac{L}{1 + ae^{Qb}}$	a = 19.61 $b = 1.421 \times 10^{-3}$ L = 9	0.267	0.267	2.77	25 %
$C = a + bQ$	a = -0.154 b = 2.194	0.424	0.424	2.14	5 %

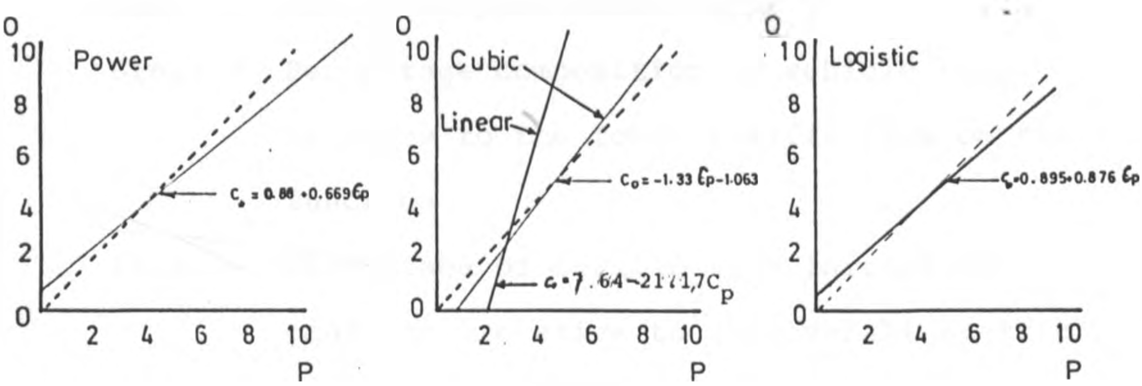


Fig. 4.26 TOTAL CONFLICTS VERSUS TOTAL TRAFFIC FLOW ON

Percentage of the vehicle type in the traffic stream was calculated as follows:

$$\text{Percentage of vehicle type (Vehicle composition)} = \frac{\text{Total number of vehicle type}}{\text{Total number of vehicle in traffic flow}}$$

Percentage of vehicle type initiating conflicts relative to the overall traffic flow was calculated as follows:

$$\text{Percentage of vehicle type initiating conflicts} = \frac{\text{Number of vehicle type initiating conflicts}}{\text{Overall traffic flow on the junction}}$$

The following colours were used to draw the histogram of fig.4.27 to 4.33 and they represent:

Blue = Conflicts per vehicle type

Green = Percentage composition of vehicle type relative to the total traffic flow on the function.

Pink = Percentage of vehicle type initiating conflicts relative to the overall traffic flow on the junction.

Using conflicts per vehicle type as a measure of the relative safety of a vehicle type it may be inferred from Figures 4.27 to 4.33 that public transport vehicles are quite unsafe. For example, using Fig.4.33 which

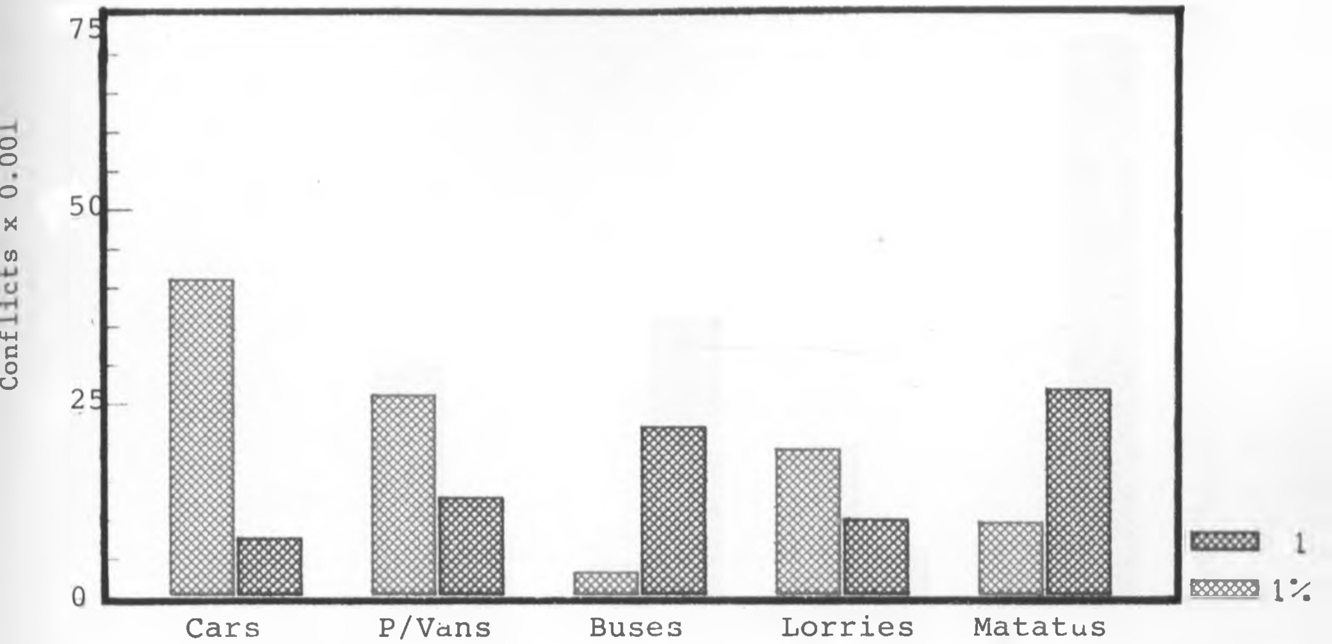


Fig.4.27(a) Conflicts and Percentage Composition per vehicle type, site 1

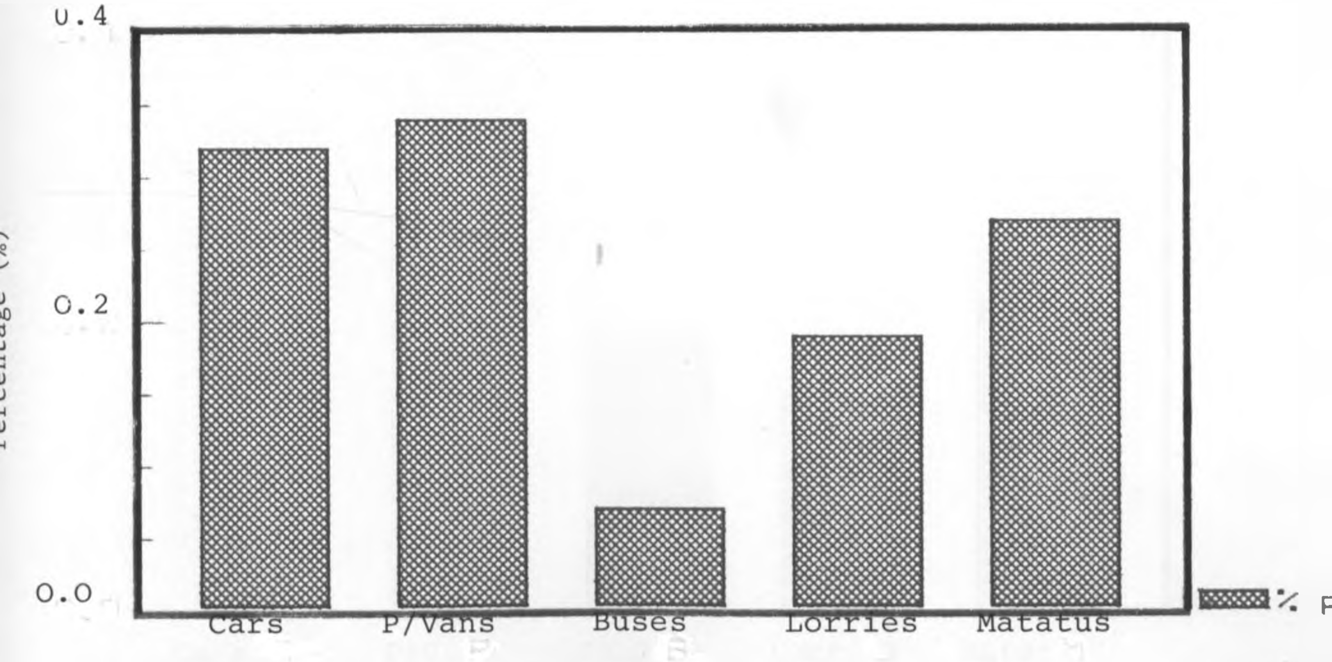


Fig.4.27(b) Percentage of conflicting vehicles relative to total traffic flow.

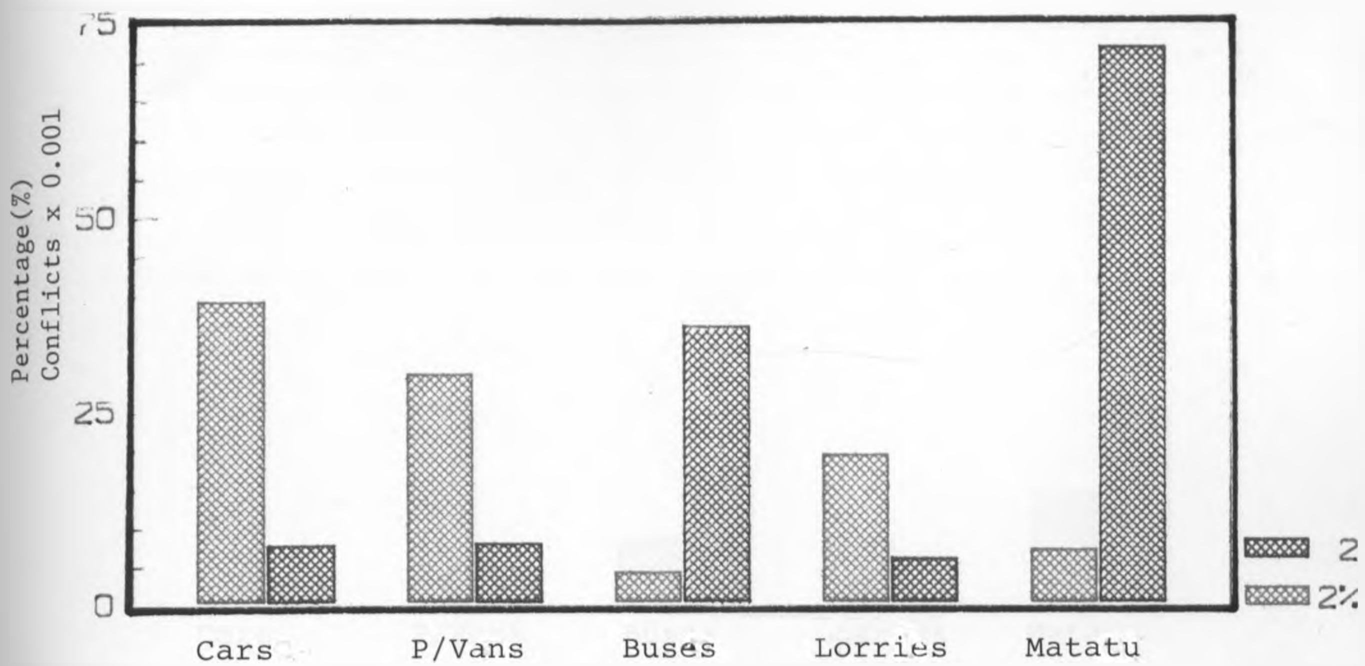


Fig. 4.28 (a) Conflicts and Percentage Composition per vehicle type,site 2.

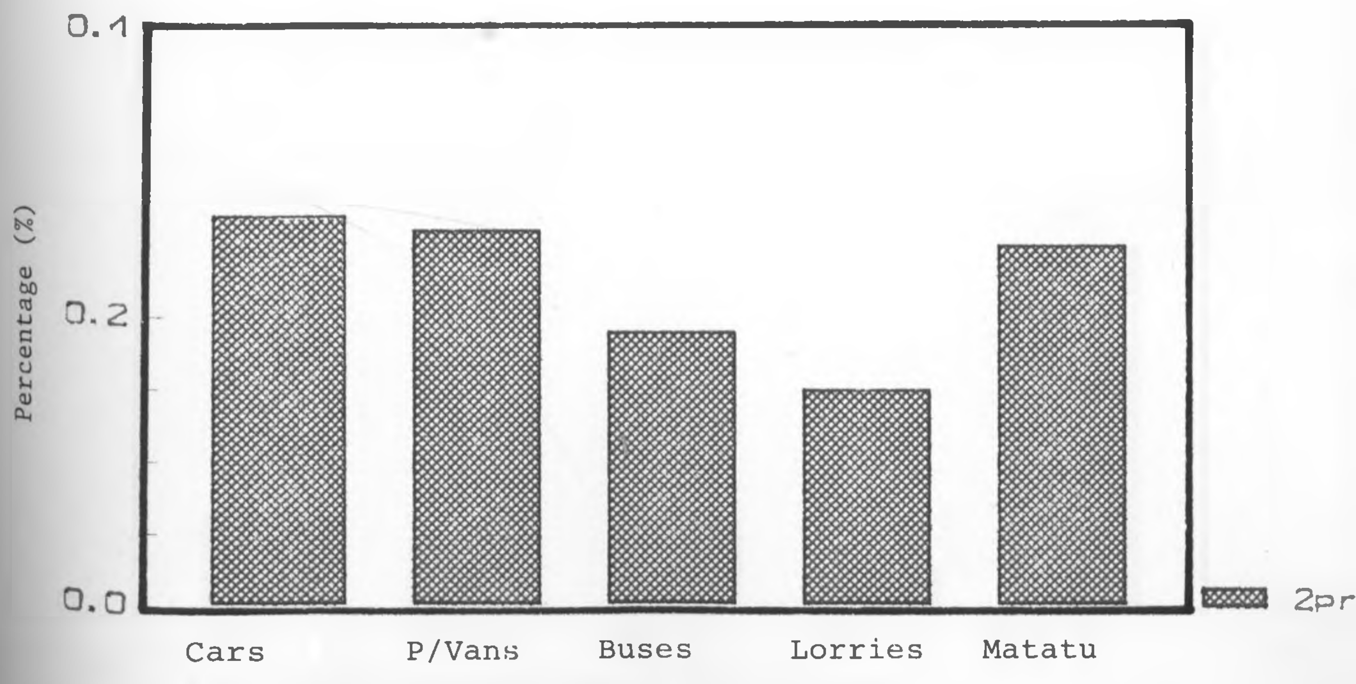


Fig.4.28(b) Percentage of conflicting vehicles relative to total traffic flow.

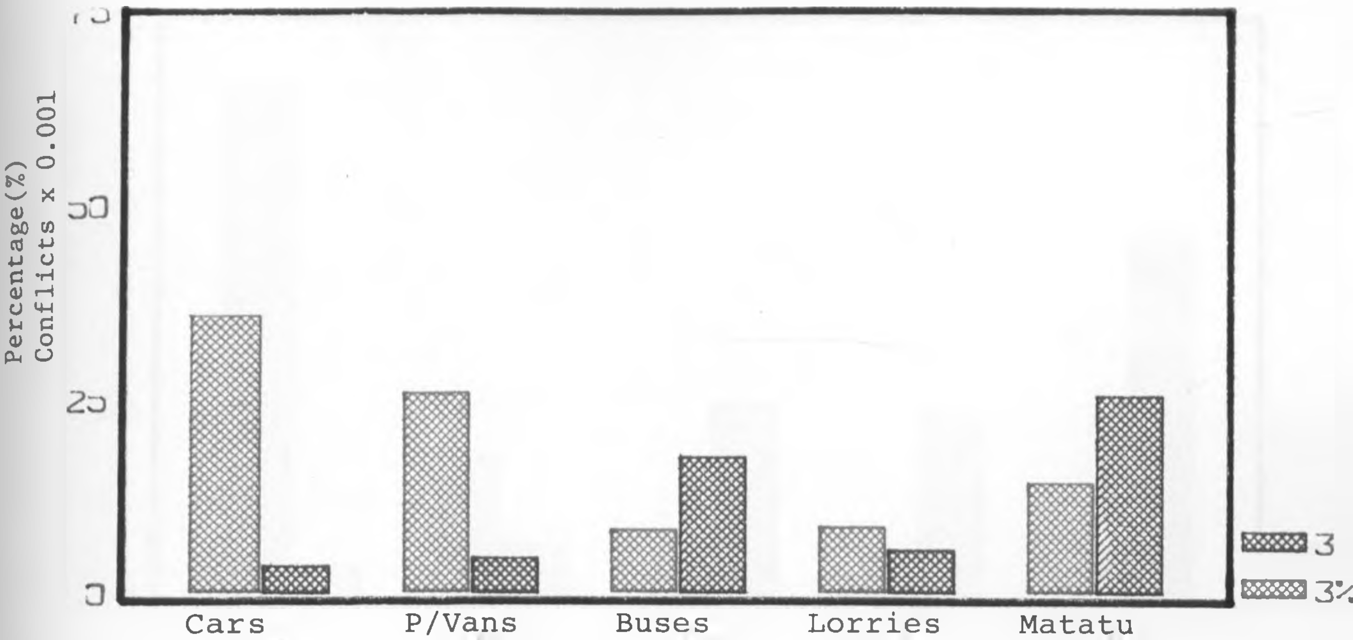


Fig. 4.29 (a) Conflicts and Percentage Composition per vehicle type,site 3.

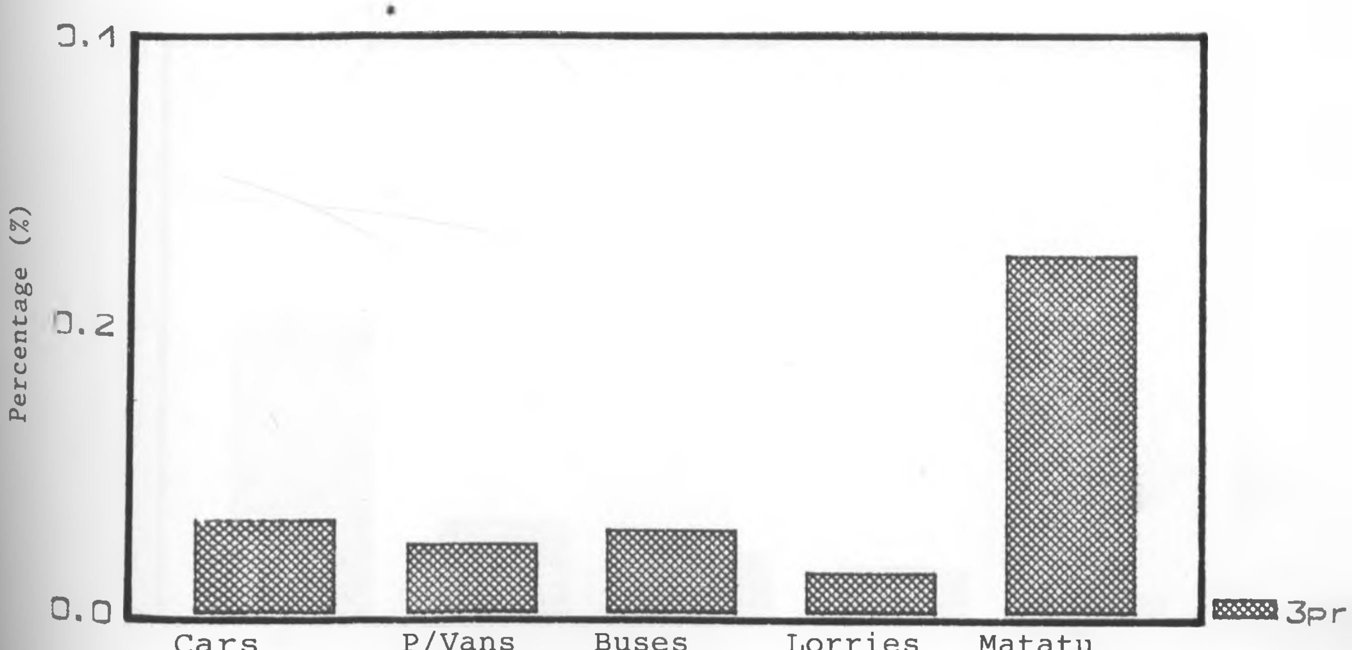


Fig.4.29(b) Percentage of conflicting vehicles relative to total traffic flow.

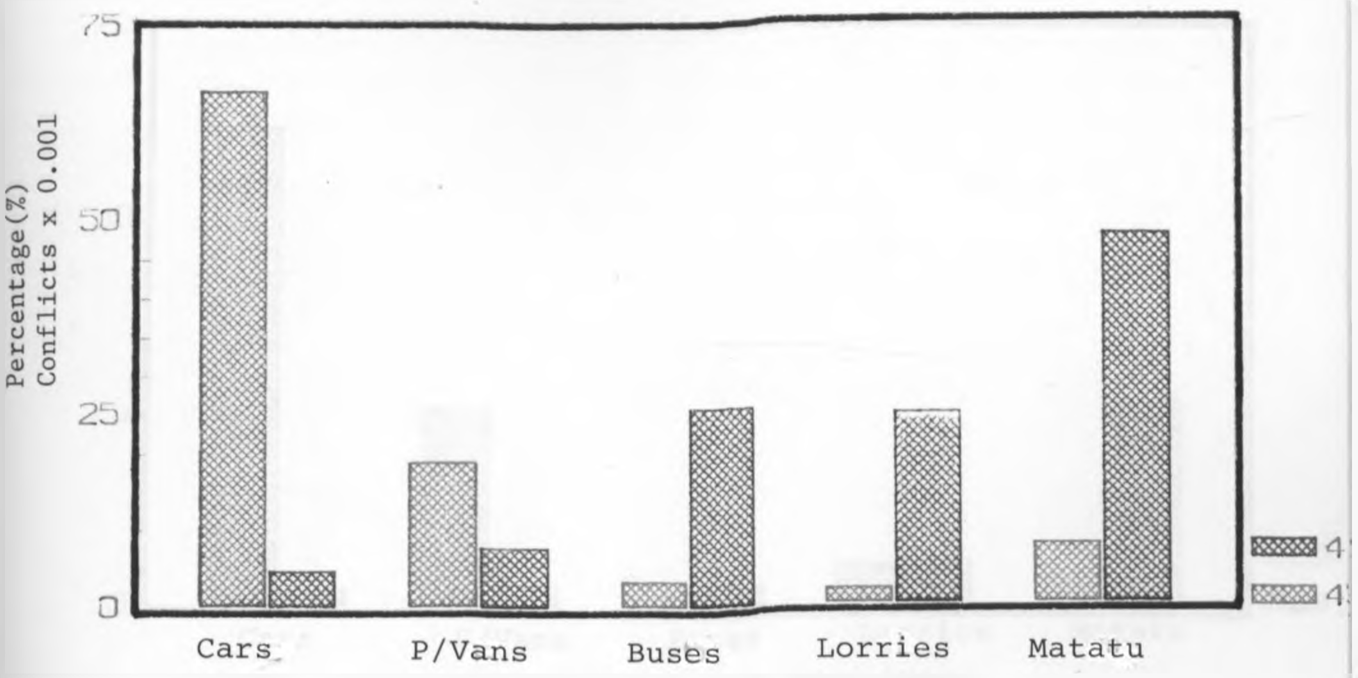


Fig. 4.30 (a) Conflicts and Percentage Composition per vehicle type, site 4.

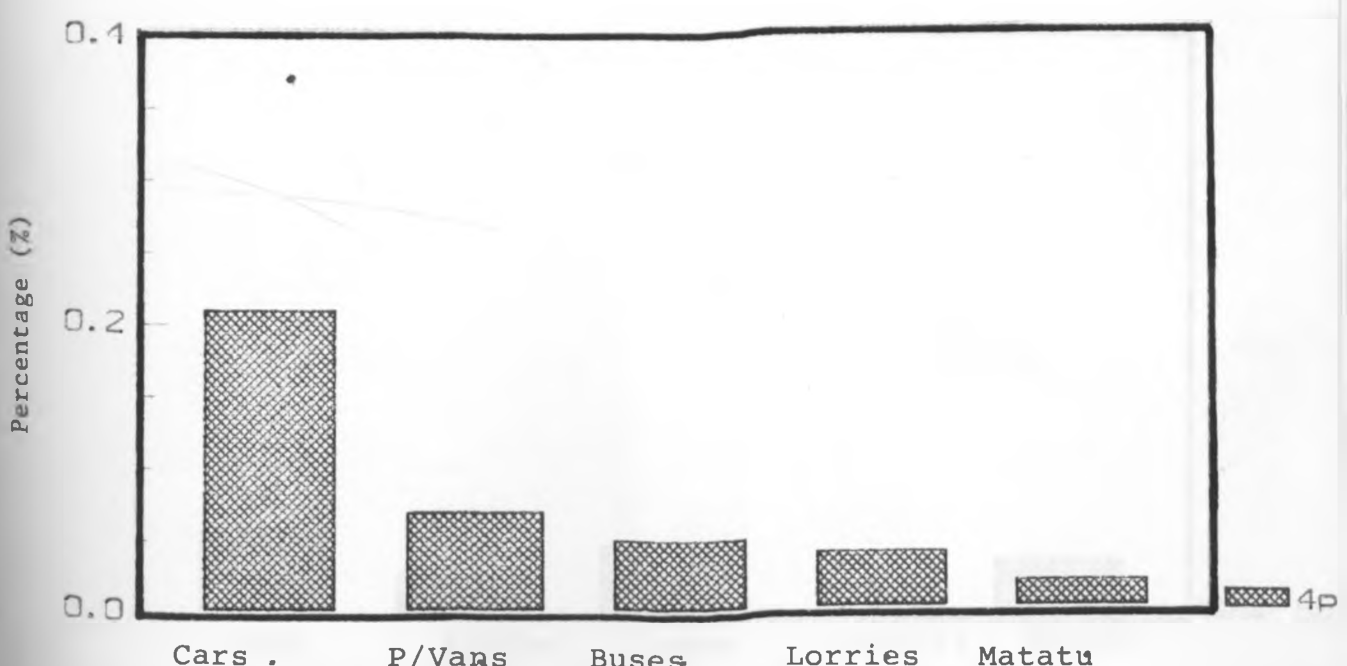


Fig. 4.30 (b) Percentage of conflicting vehicles relative to total traffic flow.

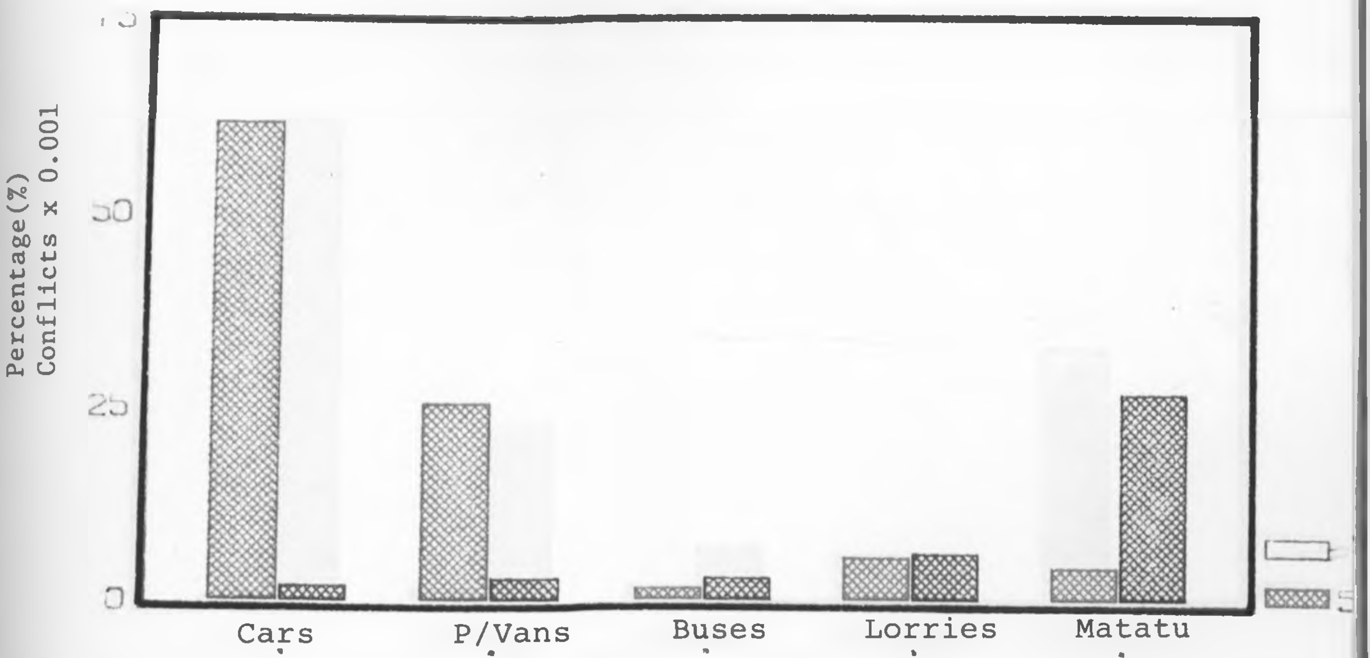


Fig. 4.31 (a) Conflicts and Percentage Composition per vehicle type,site 5.

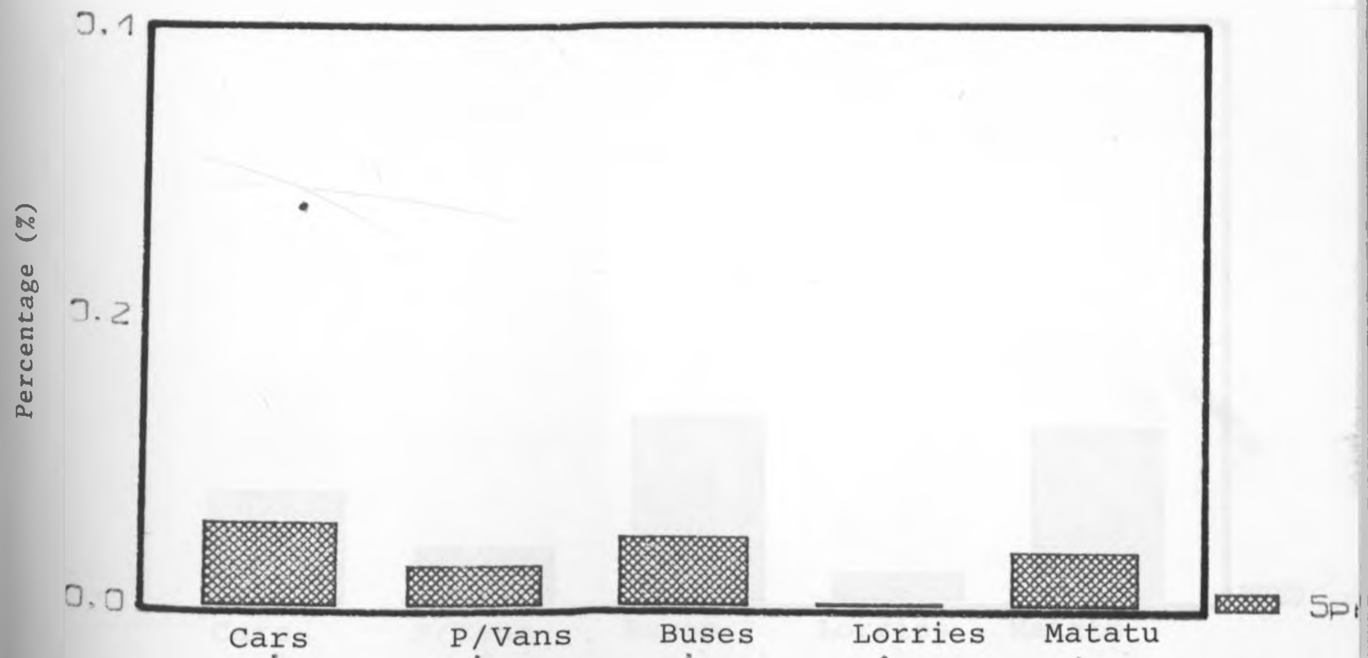


Fig.4.30lb) Percentage of conflicting vehicles relative to total traffic flow.

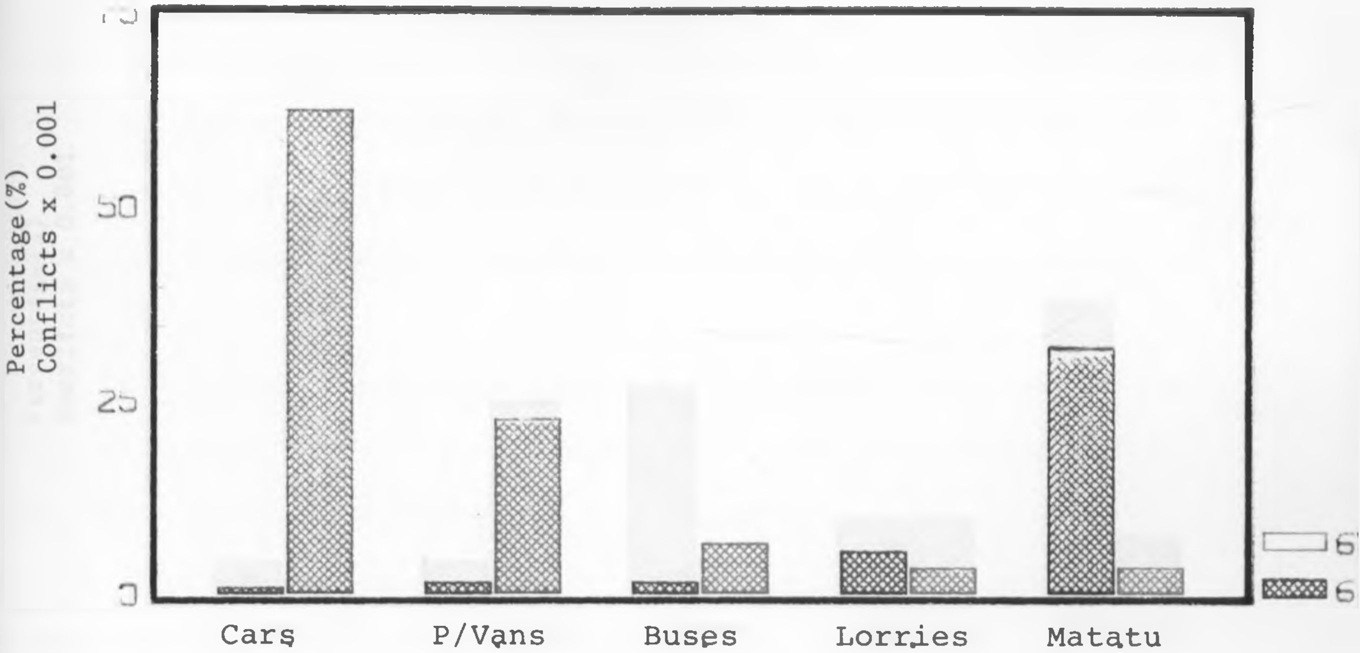


Fig. 4.32 (a) Conflicts and Percentage Composition per vehicle type,site 6.

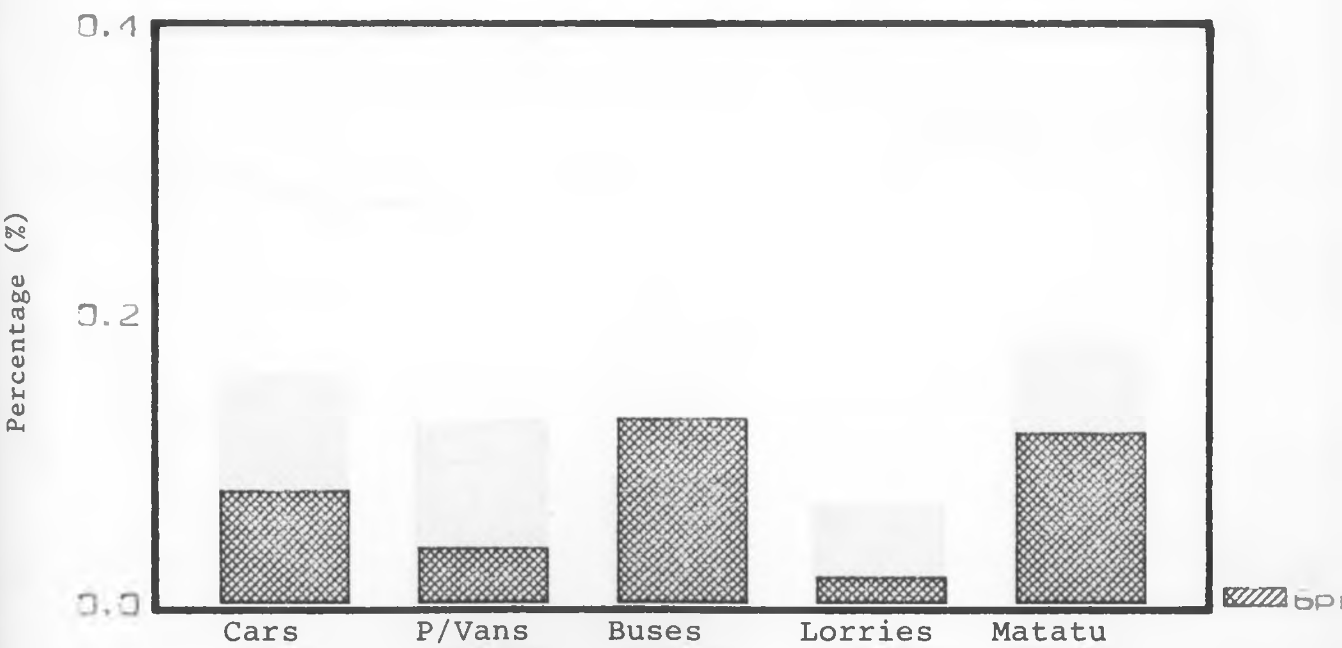


Fig.4.32 (b) Percentage of conflicting vehicles relative to total traffic flow.

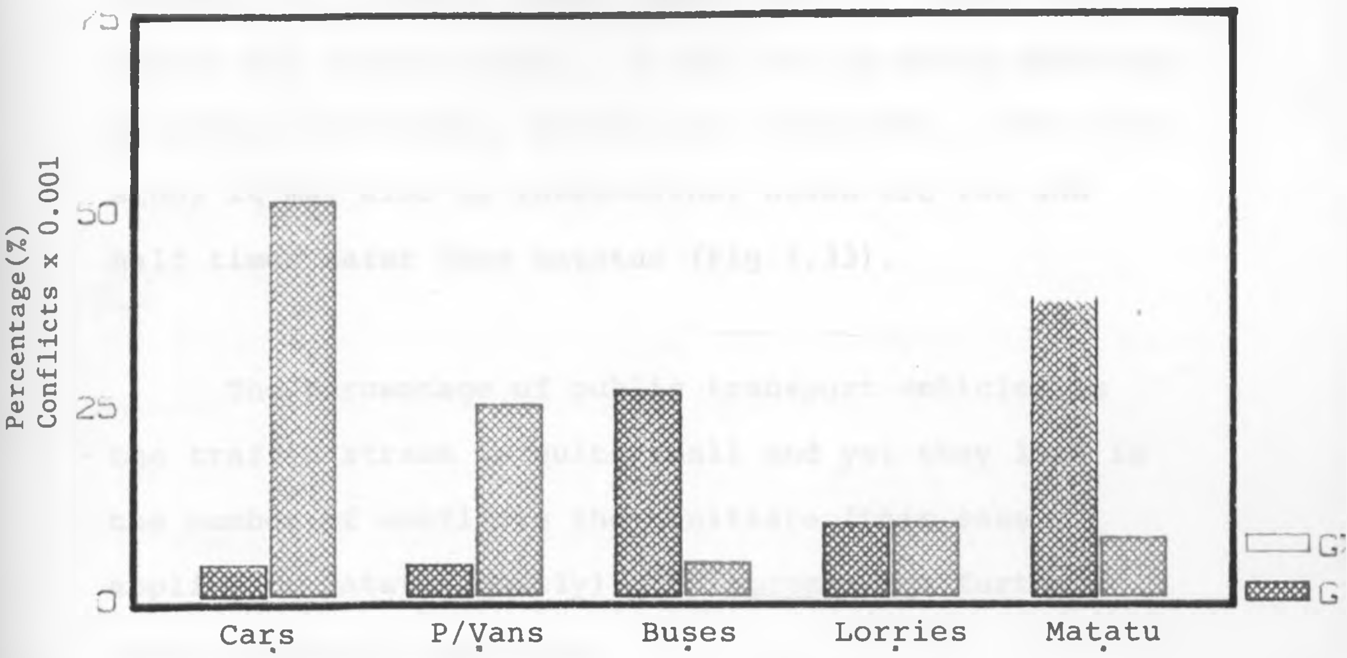


Fig. 4.33 (a) Conflicts and Percentage Composition per vehicle type,site G.

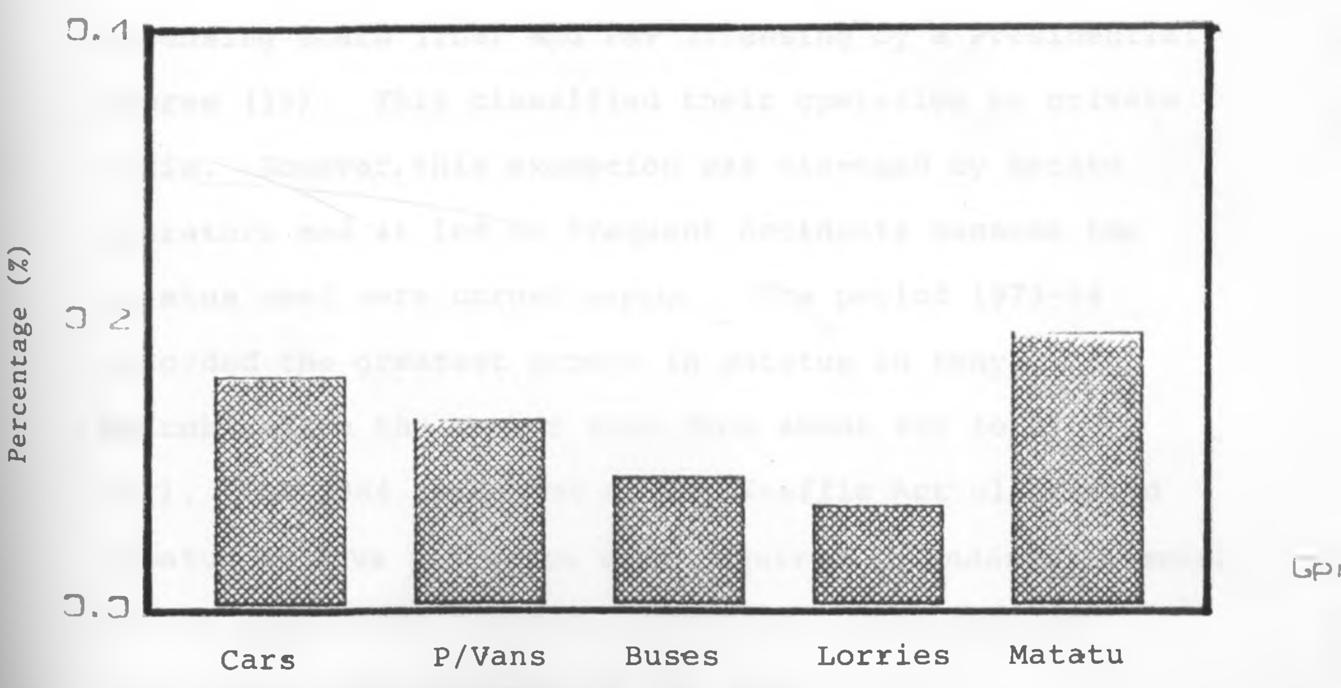


Fig.4.33(b) Percentage of conflicting vehicles relative to total traffic flow.

represents a general case for all the six junctions studied, it is about seven times safer to travel by a saloon car thanby matatu. A car has the added advantage of being comfortable, faster and convenient. From this study it may also be inferredthat buses are two and half times safer than matatus (Fig.4.33).

The percentage of public transport vehicles in the traffic stream is quite small and yet they lead in the number of conflicts they initiate (this case applies to matatus mostly). Thisprompted a further study on matatu operation.

4.5 Matatu Operation

Matatus had been operating in Nairobi since the 1950s as "illegal" Public Service Vehicles (PSV). In 1973 they were legalised and exempted from Transport Licensing Board (TLB) and PSV licensing by a Presidential Decree (26). This classified their operation as private taxis. However, this exemption was mis-used by matatu operators and it led to frequent accidents because the matatus used were unroad worthy. The period 1973-84 recorded the greatest growth in matatus in Kenya. In Nairobi alone the number rose from about 400 to 1700 (27). The 1984 amendment of the Traffic Act classified matatus as PSVs and hence were required to undergo an annual police supervised vehicle inspection. This has left relatively newer matatus on the road.

The analysis of the conflict data indicated that conflicts per matatu were relatively high compared to other types of vehicles. This prompted a further study on their operation within Nairobi. Because of the time constraint a small sample (40 Matatus) was taken to study the situation. The sample however gave satisfactory trends. The study involved interviewing drivers, conductors, touts, matatus owners, Matatu Vehicle Owners Association (MVOA), financing firms, insurance firms and vehicle dealers. The number of those interviewed is shown in table 4.3

Table 4.3 The number of people interviewed.

	MVOA H/Q	Matatu Owners	Drivers + Conductors	Finan-cing Firms	Insurance Companies	Vehicle Valuers	Vehicle dealers
Number Inter-viewed	3	10	40	3	4	2	3

4.5.1 <u>The Existing Situation in the Matatu Industry</u>

Matatu owners are brought together by their central bodies; MVOA and Matatu Association of Kenya MAK. MVOA is divided into branches which run their affairs independently especially financial affairs. The central body of MVOA only controls the branches in making collective resolutions in general meetings.

Each branch organises their parking and waiting bays in the city centre. Membership per matatu fee is paid once in the life time of a matatu and it varies from Kshs.1000 to Kshs.1600 per year depending on the branch. There is a daily subscription of twenty shillings.

Most matatu owners are not engaged in the running of the matatus, instead they leave them to drivers and conductors who man them. Data collected indicated that there was a minimum stipulated amount the driving crew had to collect by the end of the day. Targeted amounts varied depending on the capacity and route followed by the vehicles. Table 4.4 shows these average values which excludes fuel cost, driving crew allowance and salaries.

Table 4.4 Minimum stipulated amount per day

Route Followed	Parklands 12	Uthiru/Kangemi 22/23	Dandora 40/32	Kibera 8	Kawangware 46
Nissans (or vans) 18 passengers(Kshs)	700	600	-	-	800
Mini-Buses 25 passengers(Kshs)	-	1500	1400	1500	1700

It was found out that 95% of the driving crew was paid on a daily basis. This system was mainly preferred by the crew because they could change to another vehicle any time they so wished or whenever the previous vehicle was grounded either by mechanical problems or an accident.

This method of payment guaranteed their income. It was also found out that some drivers (5%) were paid depending on the number of return trips they made per day. For a minibus payment was up to ten shillings per return trip hence the more trips a driver makes per day the more money he earns.

Financing institutions insist on buying of a new vehicle which must be comprehensively insured during the loan period. For the purchase of a matatu, financiers insist that buyers raise 50% of the loan so that the balance is paid within 18-24 months. The interest rate p.a is normally 18%. Before a prospective buyer is financed his background is investigated to check if there is an alternative source of income which can subsidise the re-payment in case the matatu business fails. Slowly financiers are tightening the financing terms of matatus in order to move away from the whole business. This is because for the last four years (1984-88) the prices of vehicles have almost doubled, hence repayment of the loans is increasingly becoming a problem.

Initially matatus were insured by individual insurance companies but because of their high accident rates, insurance companies started refusing insuring matatus. This necessitated the formation of the Kenya Motor Insurance Pool (KMIP) to save the matatu industry.

The pool insures public service vehicles and transport vehicles. Currently most insurance companies are agents of the KMIP hence they do not pay for accidents claims directly. All claims are forwarded to the KMIP.

There are three types of motor insurance and are categorised as follows:

- Third party insurance is aimed at covering passengers and properties damaged. This policy does not cover the vehicle itself, calculation of this policy is based on historic data of claims.

- Third party (fire and theft) covers passengers, properties damaged and the vehicle against fire and theft only (not accidents). Its calculation is as follows

  Policy = Third party policy + 7.5% the value of vehicle.

- Comprehensive insurance covers the vehicle, passengers and properties damaged. The calculation is based on the following formula.

  Comprehensive policy = Third party policy + 15% the value of vehicle.

4.5.2 Matatu Operation Costs

Matatus are PSVs owned by individual enterpreneurs. Their mainteinance varies from owner to owner. However they have a striking similarity in that they are intensively used. This is to ascertain that more trips are made per day either to make more profits or to break even.

Matatu operation costs were studied so that it could be possible to understand why matatus are used intensively to the extent that a new matatu rarely exceeds four years running on the road. Because of a constrain in the availability of resources, it was only matatus operating within Nairobi which were studied.

Matatus were divided into two major classes depending on their seating capacity. There were those with a seating capacity of eighteen and those with a seating capacity of twenty five. During the study it was noted that matatus especially those with a seating capacity of twenty five (mini-buses) were grossly overloaded up to seventy passengers). This greatly reduced the life and stability of these vehicles.

The twenty five seater matatus are usually bought new but most of the eighteen seater matatus which are mainly Nissans are bought from tour companies. In this study matatus were studied in two phases; when the vehicle was under the loan repayment period i.e. the first one and half years and when there was no loan repayments.

The depreciation rate of matatus is quite high because of the intensive use to which they are put. Components which have the highest rate of wear and tear re brakes, tyres and the gear box. Engine overhaul was quite common. Matatu depreciation rates were calculated by plotting the advertised prices against their ages (28). These prices assumed the willing seller willing buyer principle. Such a situation takes into account the market value of the vehicle relative to new vehicles. Regression analysis was done on the plotted data to produce a model of the variation of prices with ages of vehicles (Fig.4.34 and 4.35). The curves are the obtained models and are given by the following equations:

For the Twenty five seater matatu (minibus) (Fig.4.34)

$$P = 3.5356 \times 10^5 e^{-0.1367A}. \quad (4.1)$$

$$r^2 = 0.861$$

For the eighteen seater matatu (Fig.4.35)

$$P = 2.5929 \times 10^5 e^{-0.1294A} \quad (4.2)$$

$$r^2 = 0.821$$

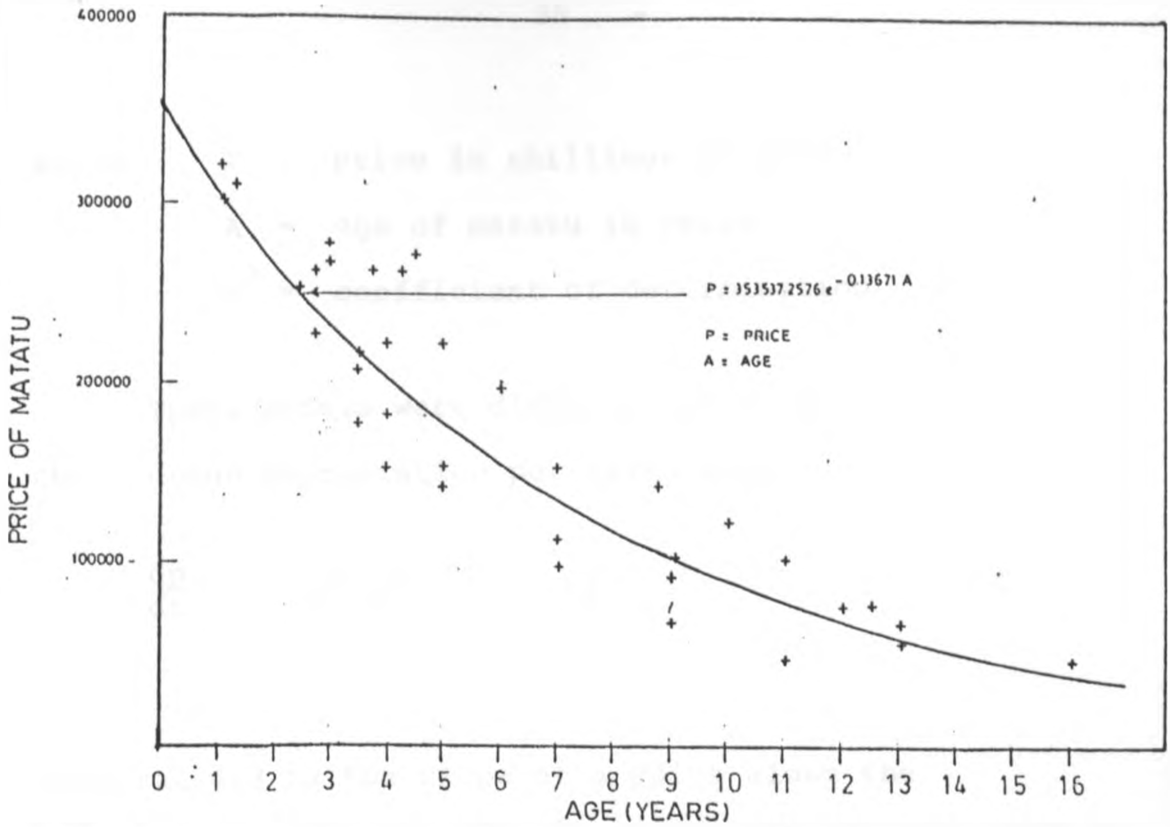


Fig. 4.34 PRICES OF TWENTY FIVE SEATER MATATU

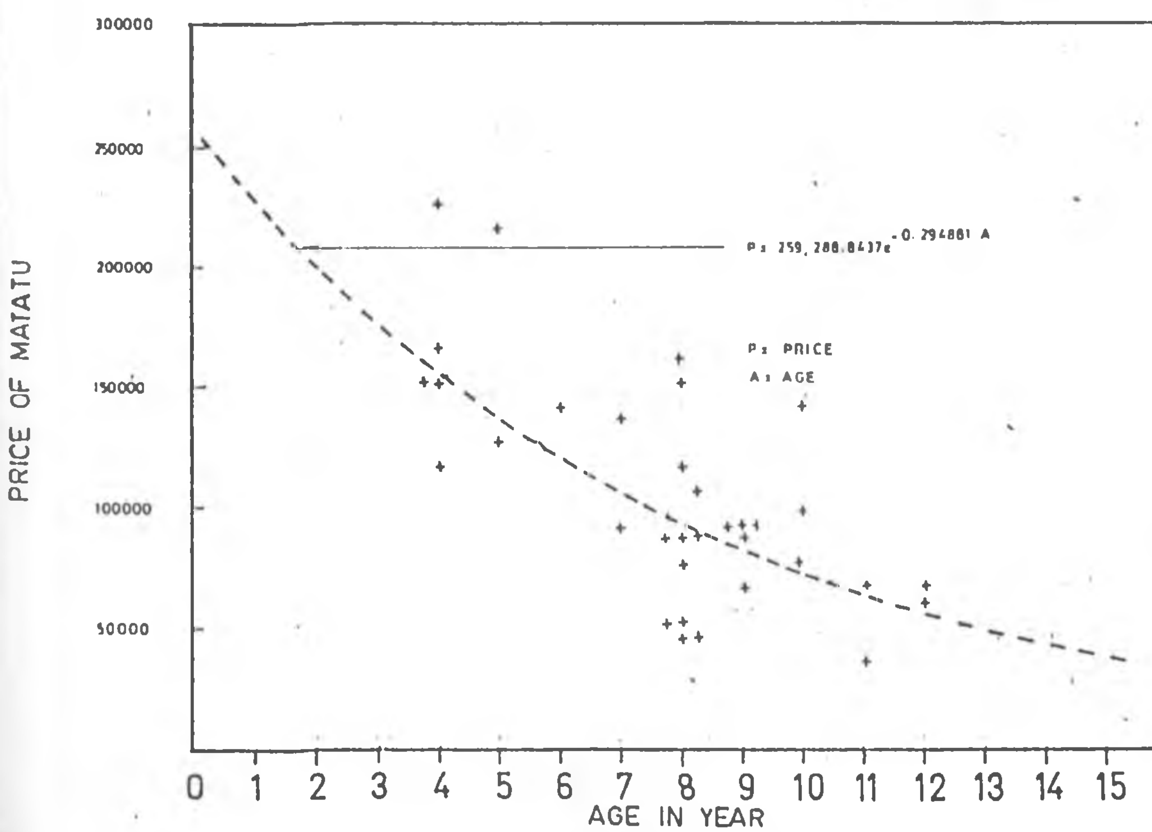


Fig. 4.35 PRICES OF EIGHTEEN SEATER MATATU

where P = price in shillings in 1988

A = age of matatu in years

r^2 = coefficient of determination

These models were differentiated to calculate the average depreciation per given time.

$$\frac{dp}{dt} = \left(\frac{p_2 - p_1}{t_1 - t_2}\right) = \frac{\Delta p}{\Delta t} \qquad 4.3$$

Equation 4.3 is the slope at a point along the curves. This also represents the depreciation per time Δt. For this study Δt was taken as 0.25 years. Therefore depreciation per day was obtained by dividing $\frac{dp}{dt}$ by 90 days.

Depreciation per day = $\left(\frac{dp}{dt} \times \frac{1}{90}\right)$. This was plotted against age (Fig.4.36). From the curves of Figure 4.36 it is possible to obtain the average depreciation per day of a matatu given its age and carrying capacity. For example, considering a four year old matatu, using Fig.4.36 a twenty-five seater depreciates at Kshs.80.00 per day while an eighteen-seater matatu of the same age depreciates at Kshs.60.000 per day. Fig.4.36 was used to obtain the depreciation values which were filled in Tables 4.5 and 4.6.

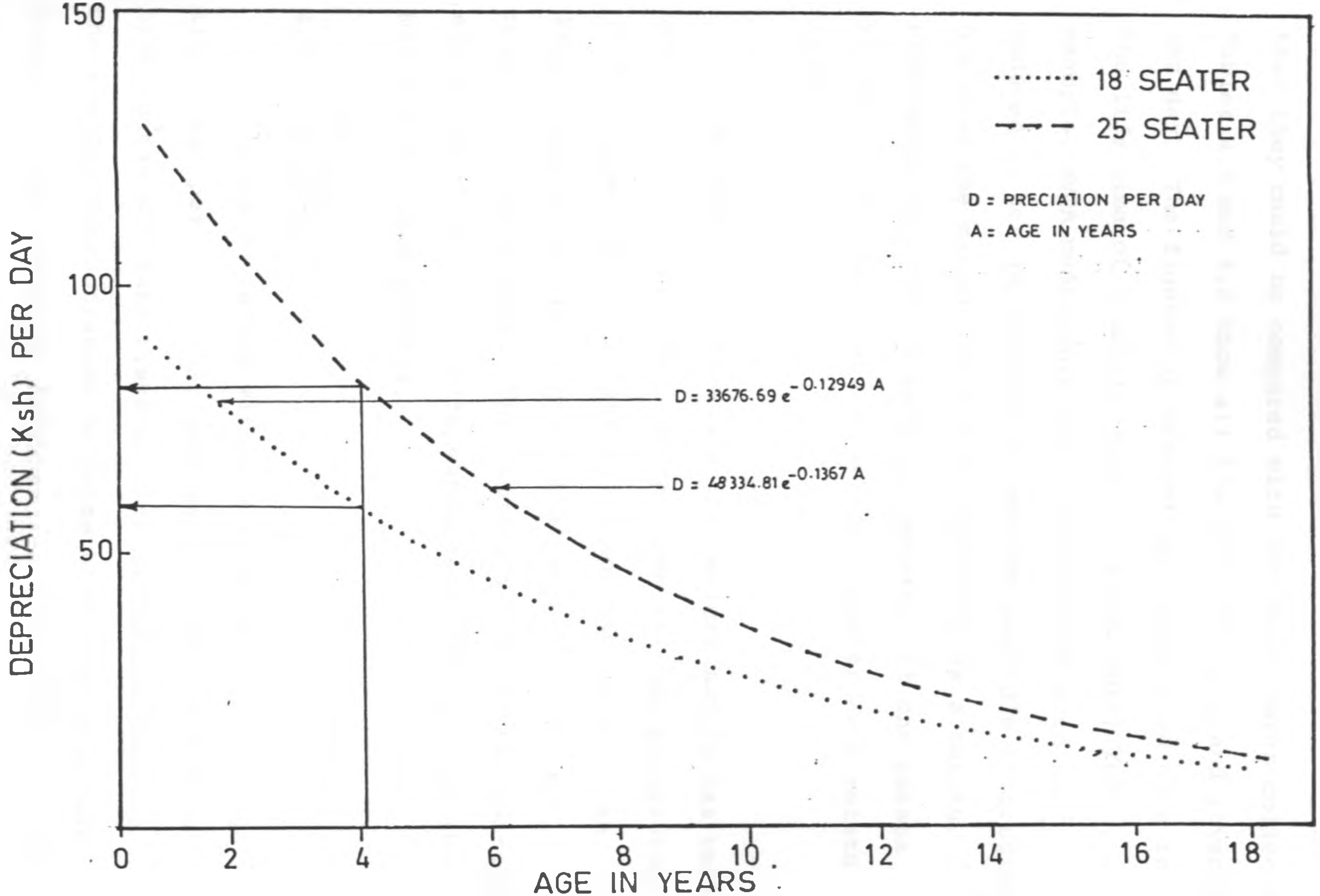


Fig. 4.36 DEPRECIATION OF EIGHTEEN AND TWENTY FIVE SEATER-MATATU

Operation costs were reduced to costs per day so that they could be compared with the daily fares collected. Tables 4.5 and 4.6 show all the reduced costs and revenues per day. The figures in bracket are costs paid once in the life time of a matatu (that is fixed cost) for example, MVOA membership fee. These costs were not reduced to per day because it was not possible to predict how long the matatu could stay operating as a matatu. MVOA membership fee is paid per matatu. If one person has more than one matatu be has to register each matatu separately.

In Tables 4.5 and 4.6 a theoretical matatu has been added which only carries the required or insured passengers. It is assumed that this matatu is not paying any loan. From these tables it is clear that such a matatu will never make any profit. This suggests that matatu operators are actually forced by circumstances to overload so they may realise some profits.

4.5.3 Findings

Matatus operating within Nairobi cover about 300 kilometres per day. This implies that matatus move at high speeds and take risks in some situations because the traffic concentration is quite high. Matatus have been noted for stopping anywhere along the road to pick passengers at the same time ignoring other motorists. The frequent stops and take-off introduce high wear and tear rates for the brakes, tyres and the vehicle in general.

Table 4.5: Summary of Matatu operation costs (Twenty-five seater)

	VEHICLE UNDER LOAN PERIOD						LOAN COMPLETED						Useing legal capacity
	KXX	KYP	KYG	KXV	KXZ	KXY	KWL	KWZ	KWN	KTL	KWA	KXA	
Age (years)	1.75	0.7	1.0	2.0	1.8	1.5	4.0	3.5	4.1	8	4.5	3.0	
1. COSTS													
Purchase price	(592000	(400000	550000	(520000	520000	(560000)	410000	420000	450000	-	450000	460000	-
Deposit	(140000)	252000	180000	(200000	240000	(200000)	-	-	-	-	-	(150000	
Instalment per day	750	650	750	533.3	520	616.67	-	-	-	-		(15000)	
Insurance	252.05	252.05	252.05	249.32	252.05	252.05	49.32	49.32	109.6	45.60	42.60	49.32	49.32
Road License	3.56	3.56	3.56	3.562	3.56	3.562	3.56	3.56	5.56	3.56	3.56	3.56	3.56
MVOA(a) Membership													
(b) Subscription	20	20	20	20	20	20	20	20	20	20	20	20	20
Payment period (months)	22	20	22	28	18	18	18	-	-	-	-	-	-
Fuel costs	400	400	400	400	450	400	450	400	400	400	450	420	400
Tyres	250	220	220	400	220	150	166.7	220	120.53	150	160.7	166.7	20
Salary	210	240	210	200	190	210	210	290	220	180	210	190	200
Allowance	100	90	105	110	110	90	110	105	130	80	85	100	100
Misc. Expenses	200	100	200	200	120	150	160	100	210	200	100	120	120
Maintenance	197.40	71.43	150	180	165	111.43	271.42	194	133.33	250	170	160	120
Overhaul	-	-	-	-	-	-	-	18.26	25.6	34.72	-	-	-
Axle differential	-	-	-	-	-	-	-	-	-	-	-	-	-
Gear Box	-	-	-	-	-	-	-	27.40	22.75	10.96	-	-	-
Working hours/day	12	14	14	16	15	13.5	12	12.5	13	12.5	16	14	12
depre./day	82.0	36.0	41.0	36.0	36.0	60.0	60.0	36.0	90.0	41.0			
Total	2495.01	2195.04	2465.61	2150.72	2160.61	2164.34	1522.58	1515.54	1773.37	1372.84	1329.88	1823.58	1232.88
2. REVENUE													
Max. per day	2500	2600	2800	2600	2400	2500	2450	2650	2300	2100	2200	2600	
Min. per day	1800	2100	2000	1800	2000	1700	1000	1600	1800	1400	1700	1700	
Working day/Week	7	7	6	6	7	6	7	6	6	5	6	7	
Trip/day	11	11	13	12	11	12	12	14	12	10	11	12	10
Distance	14	18	18	12	18	12	12	8	18	8	8	12	12
Route followed	40	22	22	46	22	46	46	8	22	8	8	46	46
Insured people	25	25	25	25	25	25	25	25	25	25	25	25	25
Practical Capacity	75	70	65	63	65	70	65	65	68	50	40	56	-
Av. fare collection	2150	2350	2400	2200	2200	2100	2100	2125	2050	1750	2150	2300	1125

Table 4.6: Summary of matatu operation costs (eighteen seater)

	KVA	KTQ	KVH	KTM	KTW	KWZ	KWV	KTJ	KYU	KVW
Age (years)	1.5	8	7	8	4	4	8	8	0.9	7
1. COSTS										
Purchase price	450000	140000	70000	130000	300000	350000	180000	130000	130000	160000
Deposit	180000	-	-	-	(170000)	-	-	-	-	-
Monthly instalment	583.33	-	-	-	(266.6)	-	-	-	-	-
Insurance	46.35	49.32	49.3	49.32	109.58	109.58	109.58	49.32	49.32	49.32
Road License	2.47	2.47	2.4	3.014	2.47	2.47	2.47	2.47	3.014	3.104
MVOA(a) Membership										
(b) D. fee	20	20	20	20	20	20	20	20	20	20
Payment period										
Fuel	600	600	50	600	450	400	350	450	400	450
Tyres	71.42	52.25	33.3	44.00	57.77	86.66	83.33	83.33	44.00	30.2
Salary	130.00	160.00	160.0	150.00	110.00	100.00	140.00	120.00	130.00	120.00
Allowance	50.00	60.00	80.0	70.00	60.00	30.00	30.00	60.00	60.00	50.00
Misc. Exp.	60.00	155.00	70.0	60.00	70.00	90.00	50.00	120.00	60.00	90.00
Ovehaul	-	15.00	-	-	20.00	-	-	21.60	-	21.33
Gear Box	-	16.34	-	24.00	9.50	-	-	18.67	-	-
Maintenance	28.57	61.43	61.0	125	57.14	48.52	79.17	71.42	60.0	90.0
Working hours/day	16	14	12.5	13.5	14.5	15	13	12	11	13.5
depre./day	82.0	36.0	41.0	36.0	36.0	60.0	60.0	36.0	90.0	41.0
Total	1751.08	1227.21	1017.2	181.33	1246.99	947.23	884.53	1052.21	918.33	964.23
2. REVENUE										
Max. per day	1800	1500	1370	1500	1500	1500	1450	1350	1750	1550
Min. per day	1450	1020	1070	950	1100	1200	850	900	1300	1150
Day on road/Week	7	6	-	7	6	6	6	7	6	5
Trip/day	11	16	11	14	12	16	13	10	13	14
Distance	15	10	10	10	6	6	6	15	10	6
Route followed	58	23	23	23	12	12	12	58	23	12
Insured people	18	18	18	18	18	18	16	16	18	16
Practical Capacity	22	22	20	21	22	22	20	21	21	20
Av. fare collection	1625	1260	1220	1225	1300	1350	1150	1075	1525	1350

Table 4.5 and 4.6 indicate that tyres are changed after an average of two months, brakes are adjusted and oil changed every week.

Table 4.7 presents a summary of matatu operation costs and revenues per day. From this table it is clear that some matatus never make profits at all. For some the profit margin is quite small (less than 200 shillings per day). When matatus are repaying back loans to the financing firms, they rarely make profits. To break even financially matatus have to be used intensively and overloaded. In case such matatus are involved in major accidents or major overhauls (which is likely because of the way they are used)· then it becomes absolutely impossible for the vehicle to be brought to the road because the owner might not have enough money as reserve for such unfortunate events. This explains why drivers prefer being paid on a daily basis so that their income is guaranteed and can move to the next moving matatu.That is also why financing firms have to ascertain alternative sources of income for matatu owners and are additionally tightening their terms on loans for matatus.

The study has shown (Table 4.7) that matatus repaying loans to financing institutions rarely break even financially. This is more common with the twenty five seater matatus because all these vehicles are bought with the initial

TABLE 4.7 : SUMMARY OF MATATU REVENUE/COST PER DAY

(a) TWENTY FIVE SEATER MATATU

Registration Number	Revenue per day(Ksh.)	Operation costs per day.(Kshs.)	Profits/Losses (Kshs)	
KXT	2150.00	2495.01	-345.01	Under the loan repayment period
KYP	2350.00	2195.04	154.96	
KYG	2400.00	2405.61	- 65.61	
KXV	2200.00	2150.78	49.28	
KXZ	2200.00	2160.61	39.39	
KXY	2100.00	2164.34	-64.34	
KXA	2300.00	1823.58	476.42	
KWL	2100.00	1522.58	577.42	Loan completed
KWZ	2125.00	1515.54	609.46	
KWM	2050.00	1773.37	276.63	
KTL	2750.00	1372.34	377.16	
KWA	2150.00	1329.86	820.14	
Using Legal capacity	1125.00	1232.88	-105.88	

(The negative value means that the particular matatu is making a loss.)

(The theoretical matatu is assumed not to overload and there is no loan repayment considered. In case loan repayment could be considered then the loss could be large.)

Table 4.7 (b) EIGHTEEN SEATER MATATU

Registration Number	Revenue per day (Kshs.)	Operation costs per day.(K.shs.)	Profits/Losses (Kshs.)
KYA	1625.00	1751.08	-126.08
KTQ	1260.00	1227.81	32.19
KVH	1220.00	1017.20	202.80
KTM	1225.00	1181.33	43.67
KWV	1150.00	884.53	265.47
KTJ	1075.00	1052.81	22.19
KYU	1525.00	918.33	606.67
KVW	1350.00	914.9	385.1
KWZ	1350.00	947.23	402.77
KTW	1300.00	1246.99	53.01

(Generally it is only possible to overload by a maximum of two passengers. This is because of the way the body is designed.)

purpose of serving as matatus. If such vehicles manage to repay all their loans before they cause an accident or before they are repossessed by the financiers then some profits may be realised. This also depends on their condition because if they were poorly maintained when loans were being repaid then the law enforcing authority may not allow such matatus to go through inspection units or even use the public roads.

Table 4.7 shows that the eighteen seater matatus make profits (up to 600 shillings per day). This is because such vehicles are bought from tour operators as second-hand vehicles and hence owners have no loans to repay. If such loans exist their repayment is low and their insurance is third party policy. Even for such vehicles which make profits, to do so they must be overloaded and run at high speeds.

Operating overloaded matatus at high speeds and also the taking of big risks by drivers increases the accident and conflict chances for matatus. This explains why individual insurance companies stopped selling insurance policies for matatus. The KMIP always makes losses despite the high premiums and each year it calls upon individual insurance companies to contribute so as to offset the accident claims. This also explains why insurance policies are quite expensive.

Matatu owners rarely realise that they are making losses because costs like, insurance, road licence, deposit for acquiring matatus comes once in a year. Some costs like depreciation, accident costs and overhaul are generally not considered. Hence they are convinced that the business is profitable.

CHAPTER 5

DISCUSSION

This study was carried out in Nairobi and was concerned with road traffic conflicts and accidents on selected T-junctions in Nairobi. The study was undertaken to evaluate the problems and at times indicate solutions of T-junctions using conflict and accident data. It was also anticipated that models were to be developed relating conflicts to traffic flow.

During the data analysis it was found that matatus initiated more conflicts than any other vehicle type. This prompted a further study on their operation costs. Section 5.1 discusses the accident data for the various junctions studied while section 5.2 discusses the results of the conflict study and matatu operations are discussed in section 5.3.

5.1 Accidents and Conflicts

When accident and conflict data were analysed it was not possible to develop a model relating conflicts to accidents. This could be because the observation period for conflicts was short. Movements of vehicles before they were involved in accident or conflicts were plotted, for most sites the accident plots were the same as conflict plots. Using these plots it was possible to identify problems of particular sites. Following are some of the identified problems of particular T-junctions.

5.1.1 Jogoo Road - Outer Ring Road Junction

The main problems of this junction were that matatus stopped to pick passengers at the junction, overtaking at the junction area, traffic from the minor road pushed into the main road without necessarily getting adequate headway and road markings were lacking.

The solution to the problems at this junction should include clear road marking, channelization at the junction, the present position of the bus bay should be relocated and reflectors erected near the junction. The possibility of using signalised traffic light should be considered, this will segregate the traffic flow from each leg of the junction.

5.1.2 Mumias Road - Outer Ring Road Junction

The steep gradient from the railway bridge side (Fig.4.3) seems to encourage the occurrence of accidents and conflicts at the junction. The solution to such a problem may be to relocate the junction or reduce the approach gradient to the junction.

5.1.3 Juja Road 1st Avenue Eastleigh Road Junction

This junction had a high vehicular and pedestrian flow. Traffic from the minor road was pushing too hard into the main road thus initiating conflicts, also as noted earlier the road reserve had been seriously interfered with by erection of illegal structures.

Some solutions to the problem of this junction include channelization of the junction, use of traffic lights, removing any structures erected within the road reserve and providing pedestrian facilities such as zebra crossings, side fencing etc.

5.1.4 Mumias Road - Rabai Road Junction

Some of the problems at this junction are associated with the nature of the human element, with some drivers overtaking at the junction area and some stopping at the junction area to pick passengers. Accident data suggests that lighting could be a problem at this junction because over 50% of the accidents occured between 6.30 - 9.00 p.m. Erecting reflectorised studs at the junction may help in improving visibility at night.

5.1.5 Langata Road - Muthaiti Road Junction

From the accident and conflict plots shown in Fig.4.16 and 4.17 it is clear that traffic from the minor leg is forcing its way into the major road. This clearly suggests that the junction is operating beyond its capacity. The solution to such a problem is to channelize the junction and use traffic lights which must be synchronised with those on the Uhuru highway roundabout.

5.1.6 Ngong Road - Mugo Kibiru Road Junction

The main problem at this junction is related to the human element. During the conflict study it was noted that some drivers especially matatu and bus drivers forced their way into the main flow even though the traffic flow along the main road was not high. However, this was the only junction with very few serious and slight conflicts, most of them were potential conflicts.

5.2 Conflicts and traffic flow

This section discusses the various models developed to predict conflicts given the traffic flow at a T-junction. The models developed for each site are compared to check which one explained the observed conflicts closely. On this basis the best model was selected and recommended for that site or traffic situation.

The following symbols have been used throughout Section 5.2.1;

m = gradient of observed versus predicted data graphs.

c = intercept of observed versus predicted data graphs

r = correlation coefficient

r^2 = coefficient of determination

E_{xy} = standard error

S.L = significance level

5.2.1 Total Conflicts versus Total Traffic Flow Jogoo Road - Outer Ring Road-Junction

Traffic flow at this junction ranged from 600 to 1700 vehicles per hour. Results of the models fitted are shown in Fig.4.20 whose summary is on Table 5.1.

Table 5.1 Comparison of models fitted on site 1

Model	m	c	r	r^2	E_{xy}	S.L.(%)
Power	1.015	0.068	0.972	0.945	1.04	5
Cubic	1.09	0.127	0.972	0.944	0.32	5
Logistic	1.223	-0.993	0.965	0.931	0.72	5
Linear	0.948	0.284	0.939	0.882	175.85	5

Table 5.1 shows that all the models developed predict well since their gradients and intercepts are close to unity and zero respectively. The power curve is a better model because its values are close to ideal values

followed by cubic, linear and the logistic models. The coefficients of determination show that all the models are equally good because their values are not significantly different (r = 0.88-0.945).

The error analysis suggests that the cubic predicted data had the smallest standard error than logistic, then power models. The error on the linear model was quite large. However, all the models were significant at 5% level.

For this site, within a total traffic flow ranging between 600 and 1700 veh/h, the cubic curve may be used to predict conflicts. This is equation 4.1.

Mumias Road - Outer Ring Road Junction

The summary of the analysis on this site which had a traffic flow between 400-1700 vehicles per hour is as follows in Table 5.2.

Table 5.2 Summary of models fitted in site 2

Model	m	c	r	r^2	E_{xy}	S.L(%)
Power	1.036	0.0036	0.820	0.672	1.51	5
Cubic	0.870	0.566	0.80	0.649	1.59	5
Logistic	0.95	0.167	0.819	0.670	1.52	5
Linear	0.739	1.39	0.818	0.67	1.53	5

The gradient and the intercept of the observed versus predicted data for the power model suggests that it predicts better than the logistic which is followed by the cubic then the linear models. Statistical analysis showed that the models were not significantly different because the values of r, r^2 and E_{xy} were similar for all the models as shown in Table 5.2. For this site equation 4.2 may be used to predict conflicts within a traffic flow of 400 to 1700 vehicles per hour.

Juja Road - 1st Avenue Eastleigh Road Junction

Table 5.3 summarises the conflicts data analysis for this site.

Table 5.3 Summary of fitted models for site 3

Models	m	c	r	r^2	E_{xy}	S.L (%)
Power	0.963	0.502	0.91	0.828	1.32	5
Cubic	1.26	-0.738	0.939	0.882	0.92	5
Logistic	2.297	-0.084	0.924	0.848	23.01	5
Linear	1.00	0.008	0.899	0.81	1.48	5

The fitting of the logistic curve looks poor judging from the steep gradient (m = 2.297). Errors on the predicted data in respect of the observed data seem to be large (E_{xy} = 23.01). This suggests that the logistic model should not be used at this site.

Linear and power models predict the conflicts fairly well judging from the gradients and intercepts (linear best with m = 1, c = 0.008). Coefficient of determination show that the models are not significantly different (ranged between r^2 = 0.828 to 0.882) and all the models were significant at 5% level. Within a traffic flow of 400 to 1800 vehicles/hour, equation 4.3 may be used to predict conflicts.

Mumias Road - Rabai Road Junction

Table 5.4 Comparison of models fitted on site 4.

Model	m	c	r	r^2	E_{xy}	S.L. (%)
Power	0.339	0.466	0.938	0.88	0.591	5
Cubic	0.739	0.113	0.935	0.917	0.403	5
Logistic	0.677	0.295	0.960	0.921	0.39	5
Linear	1.40	-0.65	0.883	0.780	1.17	5

Table 5.4 summarizesthe conflict data analysis. The gradient and intercept of the observed versus predicted data suggest that the models poorly predict the conflicts. The cubic function is slightly better with slope of 0.729 and intercept 0.13. Values of r, r^2 and E_{xy} for all the models were not significantly different.

For this site the cubic model (equation 4.4) may be used as a better model for prediction within a traffic flow of 150 to 1800 vehicles/hour.

Langata Road - Muthaiti Road Junction

Table 5.5 Comparison of fitted models for site 5

Model	m	c	r	r^2	E_{xy}	S.L(%)
Power	4.37	-2.80	0.94	0.884	0.142	5
Cubic	1.13	-0.199	0.947	0.896	0.34	5
Logistic	2.46	1.241	0.925	0.856	0.015	5
Linear	-1.0	2.85	-0.111	0.013	1.02	Not significant

This junction had the highest traffic flow ranging between 800 to 2100 vehicles per hour. It was noted that with a flow of up to 1050 vehicles per hour, there were no conflicts recorded at this site (Fig.4.24). This implies that the junction was safer compared to the other sites studied. This could be due to the influence of the traffic lights (about 200m away) on the Uhuru highway - Lusaka road roundabout.

At this junction conflicts rose to a maximum and then started decreasing. Table 5.5 summarizes the data anlysis. From this table the cubic model gave the best prediction with slope 1.13 and intercept -0.199, other models especially the linear predicted very poorly. All the models except the linear were significant at 5% level. Equation 4.5 may be used to predict conflict for this site.

Ngong Road-Mugo Kibiru Road Junction

Table 5.6 Comparison of Models fitted on site 6.

Model	m	c	r	r^2	E_{xy}	S.L(%)
Power	1.215	-0.40	0.739	0.546	1.49	5
Cubic	0.692	0.389	0.734	0.539	1.09	5
Logistic	1.012	-0.006	0.739	0.548	1.06	5
Linear	1.22	-0.54	0.822	0.676	1.12	5

Table 5.6 summarizes conflict data analysis for this site. Traffic flow ranged from 400 to 1700 vehicles per hour. The prediction of the logistic curve is better than the other models judging from the slope (1.02) and intercept (-0.006). Coefficients of determination, standard errors and correlation coefficients were not significantly different for each model. However, for this site the coefficient of determination was low (about 0.54) for all the models compared to the other sites studied. This shows that the observed data had a wide scatter. All the models developed were significant at 5% level. The logistic model (equation 4.6) may be used to predict conflict at this site.

<u>General case for all the T-junctions studied</u>

All the conflicts of the same traffic flow for all the six T-junctions studied were added and then averaged. This gave the representative conflicts for particular traffic flow. The obtained data showed wide scatter may be because sites of different social, topographic and environmental set up were combined together. For example Mumias Road - Outer Ring Road junction had a steep gradient from one side. Ngong Road - Mugo Kibiru Road junction was on a flat area and traffic light at Uhuru highway - Langata Road roundabout had an influence on the traffic flow on the adjacent Langata Road - Muthaiti Road junction.

The general case showed that traffic flow ranged between 150 to 2100 vehicles per hour. Conflicts rose to about seven and then started decreasing. The decrease could be because as the traffic flow rose, vehicles no longer had the chance of overtaking hence reducing the chances of initiating conflicts.

Table 5.7 compares the models fitted on the generalized case. Among the four models fitted the cubic model predicts conflicts best with gradient 1.33 and intercept -1.06. For all the models the coefficient of determination (r) was low (ranged between 0.51 to 0.745) showing that the scatter of the observed data was wide.

Comparing the four fitted models (Table 5.7) using their gradient, intercept, coefficient of determination, standard error and level of significance the cubic model is the best to predict conflicts for a general case in Nairobi.

Table 5.7 Comparison of models fitted on general case

Model	m	c	r	r^2	Exy	S.L.(%)
Power	0.669	0.88	0.589	0.347	2.47	5
Cubic	1.33	-1.063	0.745	0.555	1.33	5
Logistic	0.896	0.896	0.267	0.267	2.77	25
Linear	7.64	-21.17	0.424	0.424	2.14	5

The cubic model which may be used to predict conflicts for a general case in Nairobi is (significant at 5% level) shown as equation 4.7.

These models may be refined further such that given the same conditions as, gradients, pedestrian flow, sight distance, etc, they may be applied to other placed to predict conflicts on simple unsignalized T-junctions.

5.3 Matatu Operation

Table 4.7 summarizes the operation costs and revenues of matatus per day. From this table it is evident that matatus which are repaying loans to financial institutions do not make profits or if they do the profit margin is small (ranges Kshs.100 to 300). During the loan repayment period (normally 18-24 months) the particular matatus are comprehensively insured. Comprehensive insurance of a new twenty five seater matatu is Kshs.93,000 per year. If such a matatu is repaying back a loan at the rate of Kshs.18,000 per month, such matatu owners find it impossible to make profits, and thus matatu owners encourage their drivers to drive at high speeds, to overload, and ignore traffic regulations. These incentives may be in form of paying the drivers per day, giving them good allowances, paying them per trip or even stipulating a minimum required amount of revenue per day. These conditions definitely encourage drivers to use the vehicles intensively (many times carelessly, stopping abruptly anywhere on the road in total disregard of other motorists etc.). When a matatu completes repaying the loan it may be almost unroadworthy.

Completion of loan repayment is a big relief to matatu owners because, apart from the loan, the vehicle may be insured under third party policy which is Kshs.30,000 and 18,000 for twenty five and eighteen seater matatus respectively. However, by this time the vehicle maintenance costs will be very high because the matatu was being used intensively previously. Also in most cases the vehicle will be unroadworthy such that it may not be allowed to operate legally. Drivers and conductors interviewed said that an average of Kshs.100-200 was used per day to bribe their way through the police. This was entered as miscellineous costs in Tables 4.5 and 4.6.

Table 4.5 shows that most of the eighteen seater matatus which are mainly Nissan Urvans make profits. This is because such vehicles are bought as second-hand vehicles from tour operating companies and hence have no loans to repay. However, it is clear that such profits are realised after the vehicles have been used intensively. From Table 4.6 the only Nissan Urvan, KYP, which was bought new was making a loss because it was repaying a loan and it was comprehensively insured. However if the lumpsum paid at the time of purchase of some of the Eighteen seater matatu is discounted during the useful service life the profit margin reflected will be reduced.

In case an unfortunate event happens like an accident or engine-knock for a vehicle repaying a loan then it is obvious that such a vehicle could not have made enough profits to meet repair costs. In such a case if the owner does not have an alternative source of income then the vehicle will be grounded whereas the financier requires the loan repaid. This explains clearly why financing companies will always insist that one should have a security before he is financed. For the same reasons drivers and conductors insist on being paid per day.

When pressure to repay between new and old vehicles are compared, it seems that there is more pressure on new vehicles. This forces the owners to operate their vehicles intensively to break even financially. However, such cost pressures have side-effects in that they tend to make the vehicles accident prone. This seems to support Agoki's (29) findings that new vehicles are more accident prone than older vehicles. The proneness of matatus to accidents is made even clearer by the fact that insurance companies stopped insuring matatus because of their high claims.

Indirectly or directly financing companies, insurance companies and matatu drivers know that the business is risky. However, this fact is not clear to matatu owners who see a lot of money passing through their hands although the net profits are often elusive. Some matatu owners work hoping that the matatu might complete loan repayment while in good condition, which turns out not to be the case. It is possible that people enter the matatu business without knowing exactly what goes on in the business. What they know is that large sums of money are handled per day upto Kshs.2,800 and hope that the vehicle will be on the road throughout the year without having problems.

From Tables 4.5 and 4.6 it can be noted that matatu drivers work for between 14 - 16 hrs a day, this compounded by the noise encountered introduces fatigue and drastically reduces the concentration of the drivers.

Clearly for matatu operators or owners to realise profits the vehicles have to be used intensively. This explains why matatus were recorded as initiating the largest number of conflicts which are related to accidents. This confirms that matatus are actually accident prone vehicles by the way they are run.

The study seems to suggest that matatus should be eliminated from the road, but taking into account the role these vehicles play as a means of public transport, other alternatives of reducing the cost pressure should be considered. These include studying the possibility of reducing tax on such vehicles, increasing the loan repayment period, etc. Assuming that greed for money will not prevail this may reduce the intensive use of matatus, and hence improve safety on the roads.

CHAPTER 6

CONCLUSIONS

This study was undertaken with the following objectives in mind:-

- To study accidents and conflicts at selected T-junctions with a view to understanding the problems of the junctions.
- To analyse conflict data on the selected T-junctions with the veiw of relating them to vehicular flow.
- To evaluate the vehicles which contribute the largest number of conflicts.
- To study matatu operation with a view to justifying or refuting the claim that matatus contribute to more accidents than any other vehicle types because of the desire to make money.

The following conclusions have been arrived at from the study:

1. Accidents and conflicts (Fig.4.8 to 4.19) showed similar patterns on each T-junction. However, no simple relationship could be established between accidents and conflicts.
2. Conflicts and vehicular flow at the junctions studied were closely related. Among all the four models fitted the cubic model predicted conflicts well in most sites.

The site which had the best fitting of the model was Jogoo Road - Outer Ring Road junction. This model was cubic i.e.

$$C = 3.82 + 6.46x10^{-3}Q - 9.746x10^{-7}Q^{2} - 4.596x10^{-11}Q^{3}.$$

This equation was significant at 5% level, with coefficient of determination (r^2)0.944 and standard error (Exy) 0.32.

3. Public transport vehicles especially matatus contributed the largest number of conflicts per vehicle type on the T-junctions studied.

4. Matatu operators are compelled to overload, operate at high speed and ignore some traffic regulations in order to meet their financial obligations. This in some situations results in matatus initiating and/or causing considerable conflicts and accidents.

CHAPTER 7

RECOMMENDATIONS

1. Conflict studies should be done for longer periods (at least for one year) in order to facilitate the development of a model relating conflicts to accidents.

2. In this thesis only a small sample of matatus in Nairobi was studied in order to explain their operations. However, to present a more complete picture, matatus operating between towns (country side matatus) should also be studied.

3. In this study it was shown that most matatus especially new ones do not make profits because of the heavy financial obligations they have. Considering the very important role they play, ways of reducing the financial pressure should be studied. These may include, reducing the tax or custom duty on vehicles which will operate as matatus, increasing the loan repayment period etc. This may ultimately reduce conflicts and/or accidents on the road hence lowering the insurance premiums.

4. The possibility of eliminating matatus so that they may be substituted by buses especially in the city should be studied because buses have a larger capacity and a lower conflict and RTA involvement.

5. Conflict studies should be extended to other types of junctions and road sections for example, round-abouts, cross roads,etc.

REFERENCES

1. NORMAN, L.G.: Road Traffic Accidents: Epidemiology, Control and Prevention, Public Health Papers No.12. 1965.

2. Research on Road Traffic. Great Britain Road Research Laboratory. 2nd Edition 1965 (Her Majesty's Stationary Office, page 146.

3. J.O. ASALOR and E.A. ONIBERE (Vol.1) Accident reduction factor and its application in optimising road safety programmes (pg 200). Paper presented at the first international conference on Road traffic accidents in developing countries. (Benin Nigeria August 1986).

4. National Road Safety Council of Kenya. Long term road safety programme 1984-194 (Feb. 1984). Ministry of Transport and Communications Pulication pg.5).

5. JACOBS, G.D., M.N. BARDSLEY and I. SAVER. Road Accidents Data Collection and Analysis in Developing Countries. Transport and Road Research Laboratory Report LR 676 1974 (page 15).

6. LAURIDEN H. Norwegian. Traffic Safety Effort Aimed at Developing Countries. A paper presented at the First African Road Safety Congress (FARSC) Nairobi. August 1984.

7. ULLA ENGEL AND THOMSEN L. The use of traffic-behaviour studies in Denmark. Danish council of Road Safety Research. (Paper presented at the International calibration of Traffic conflict techniques at Capenhagen 1983).

8. AAMUSSEM E. Introductory speech at Joint International study for the calibration of traffic conflict Techniques at Capenhagen (May 1983).

9. MIGLETZ J. and GLAUZ W.D. Traffic conflict techniques of the United States of America. Midwest Research Institute. (Paper presented at the International calibration study of Traffic Conflict Techniques, May 1983).

10. HAKKET A.S. Review of traffic conflict technique applications in Israel. Paper presented at the International Calibration study of traffic conflict techniques. (Capenhagen May 1983).

11. GUTTINGER V.A. Conflicts Observations in theory and Observations. "Advisie", Consultancy firm for Government and Management; Netherlands. Paper Presented at the International Calibration of traffic conflicts techniques. (Capenhagen May 1983).

12. MATTSSOM M. The Development and Usage of traffic conflict technique on the Swedish National Road Network. (Paper presented at the International Calibration Study of Traffic conflict Techniques - Capenhagen May 1983).

13. ERKE H. The traffic conflict technique of the Federal Republic of Germany. Paper Presented at the International calibration of traffic conflicts techniques (May 1983).

14. KULMALA Risto. Traffic conflict studies in Finland. Paper presented at Seminar on short-term and area-wide Evaluation of safety measures in Amsterdam, Netherlands. (May 1983).

15. OPPE S. Joint International study for the calibration of traffic conflict techniques (Netherlands). Paper presented at the International Calibration of traffic conflict techniques. (May 1983).

16. SPICER B.R. A pilot study of traffic conflicts at a rural dual carriageway intersection. TRRL Report LR410 (TRRL 1971)

17. SPEARMAN AND SPICER B.R. A study of traffic conflicts at six intersections. Crowthorne (Berkshire) Transport and Road Research Lab (TRAL) 1973 Rep. 551.

18. NAIROBI DEMONSTRATION PROJECT. (By KIMORI P.M.) Progress report June 1987. (Ministry of Transport and Communication report, 1987).

19. M.O.T.C. National Road Safety Council of Kenya Long-term Road Safety Programme 1984-1993 Feb.1984) (pg 21).

20. HORWARTH, C.I. How drivers respond to pedestrians and vice versa - close encounters of the fourth kind. Human factor in transportation research volume 2. pg. 56. In Academic Press London, 1981.

21. RALFS AND SOUTHERLAND. Analysis and Differential Equations Option 3 (Kenya) Kenya advance mathematics Project pg. 31-37, (1974).

22. R.R. Sokal and F.J. Rohlf. Introduction to Biostatistic. Published by F.H. Freeman and Company (San Francisco) - 1973 pp. 260-79.

23. ALAN JEFFREY. Mathematics for Engineers (Low priced Edition Fourth Edition 1976 pg. 56-59).

24. KIMORI P.M. Evaluation of Public Transport in Nairobi. M.Sc. part one report 1986, Nairobi University - Kenya, 1986.

25. LAWS OF KENYA (1986 amendment), The traffic act cap 403. Government Printer Nairobi.

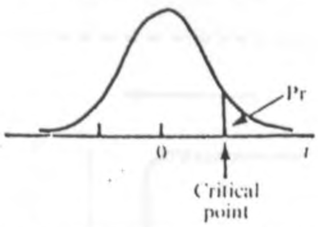
26. S. KAPILA and D. LAMBA, The Matatu mode of Public Transport in Metropolitan Nairobi. Mazingira Institute October 1982.

27. NGARI W.A. Nairobi City Council Matatus as a means of Public Transport, Nairobi transport report, 1986.

28. Daily News Papers (The STANDARD, THE DAILY NATION, KENYA TIMES) between June 1987 and January 1988.

29. AGOKI G.S. Characteristics of Road Traffic Accidents in Kenya. Ph.D. Thesis, University of Nairobi, 1988.

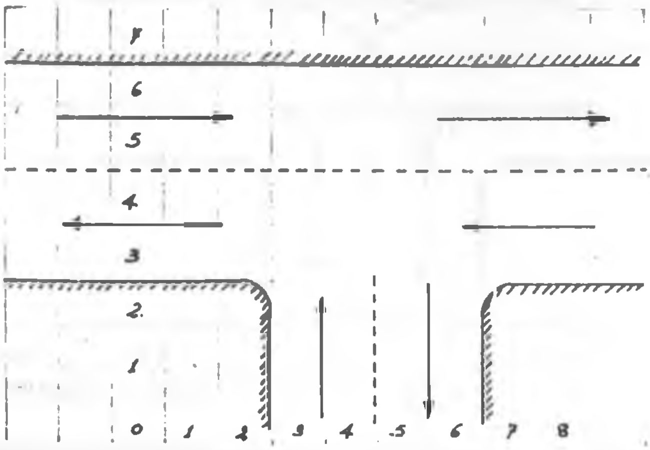
Student's *t* Critical Points



d.f. \ Pr	.25	.10	.05	.025	.010	.005	.001
1	1.000	3.078	6.314	12.706	31.821	63.657	318.31
2	.816	1.886	2.920	4.303	6.965	9.925	22.326
3	.765	1.638	2.353	3.182	4.541	5.841	10.213
4	.741	1.533	2.132	2.776	3.747	4.604	7.173
5	.727	1.476	2.015	2.571	3.365	4.032	5.893
6	.718	1.440	1.943	2.447	3.143	3.707	5.208
7	.711	1.415	1.895	2.365	2.998	3.499	4.785
8	.706	1.397	1.860	2.306	2.896	3.355	4.501
9	.703	1.383	1.833	2.262	2.821	3.250	4.297
10	.700	1.372	1.812	2.228	2.764	3.169	4.144
11	.697	1.363	1.796	2.201	2.718	3.106	4.025
12	.695	1.356	1.782	2.179	2.681	3.055	3.930
13	.694	1.350	1.771	2.160	2.650	3.012	3.852
14	.692	1.345	1.761	2.145	2.624	2.977	3.787
15	.691	1.341	1.753	2.131	2.602	2.947	3.733
16	.690	1.337	1.746	2.120	2.583	2.921	3.686
17	.689	1.333	1.740	2.110	2.567	2.898	3.646
18	.688	1.330	1.734	2.101	2.552	2.878	3.610
19	.688	1.328	1.729	2.093	2.539	2.861	3.579
20	.687	1.325	1.725	2.086	2.528	2.845	3.552
21	.686	1.323	1.721	2.080	2.518	2.831	3.527
22	.686	1.321	1.717	2.074	2.508	2.819	3.505
23	.685	1.319	1.714	2.069	2.500	2.807	3.485
24	.685	1.318	1.711	2.064	2.492	2.797	3.467
25	.684	1.316	1.708	2.060	2.485	2.787	3.450
26	.684	1.315	1.706	2.056	2.479	2.779	3.435
27	.684	1.314	1.703	2.052	2.473	2.771	3.421
28	.683	1.313	1.701	2.048	2.467	2.763	3.408
29	.683	1.311	1.699	2.045	2.462	2.756	3.396
30	.683	1.310	1.697	2.042	2.457	2.750	3.385
40	.681	1.303	1.684	2.021	2.423	2.704	3.307
60	.679	1.296	1.671	2.000	2.390	2.660	3.232
120	.677	1.289	1.658	1.980	2.358	2.617	3.160
∞	.674	1.282	1.645	1.960	2.326	2.576	3.090

VEHICLE PEDESTRIAN CONFLICT STUDY

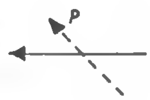
T - JUNCTION



Conflict type

1

2



3

4 Others

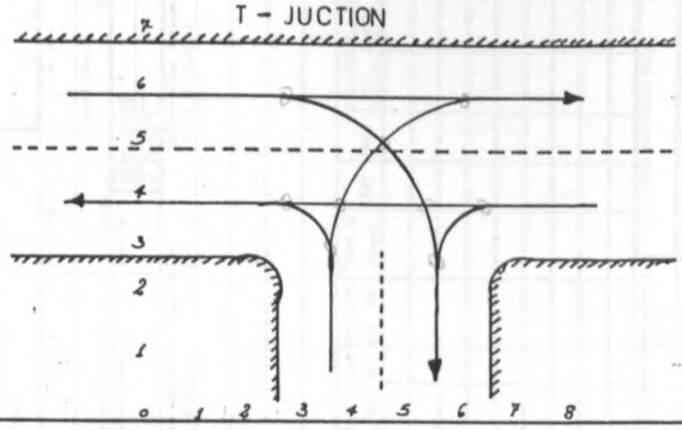
Date -------- Day ------ Site ------- Counter -------

Description of site -- Weather -------

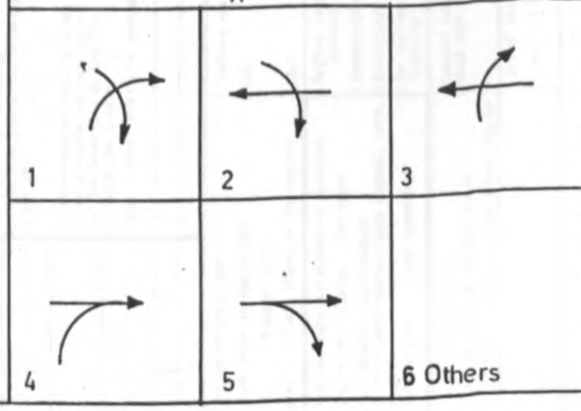
Time	Severity	Location	Conflict type	Time	Severity	Location	Conflict type

VEHICLE - VEHICLE CONFLICT STUDY

T - JUCTION



Conflict types.



Date ----- Day -------- Site ------Counter -------Weather --------------------

Description of site

(vissibility, topography)--

Time	Type of conflict	Severity s-serious m-slight P-Potential	Proximity. 1→ ≤1car length 2→>1≤2 " " 3→ >2 " "	Location (grid)	Comments. e g Vehicle initiating conflict and type of vehicle involved.	Grade.
			CARS			
			PICK-UPS & VANS			
			BUSES			
			LORRIES			
			MATATUS			

Sht---of ---

Names and addresses of witnesses

Precis of accident and remarks of the investigating officer

Draw a sketch plan of the accident site

Additional information on types of vehicles. Tick relevant vehicle/participant reference number

[1] [2] [3]country bus	[1] [2] [3]GK bus	[1] [2] [3]taxcab
[1] [2] [3]KBS	[1] [2] [3]institutional bus	[1] [2] [3]tanker
[1] [2] [3]other urban bus	[1] [2] [3]mini bus	

Has a notice of intended prosecution been served? []yes []no

When a police vehicle is involved this form must be despatched to the Commissioner of Police and the Divisional Transport Officer within 24 hours

Despatched to: Commissioner of Police; P.P.O. } Through D.T.O.; O.C.P.D. }

Date ....

Reporting Officer
Date .... Signature

Officer-in-charge Police Station
Date .... Signature

GPK (L)

Class of vehicles involved
"SC" Saloon car
"PU" Pickup, van
"LO" Lorry
"LT" Lorry + trailer
"BU" bus
"MA" Mataru
"MC" Motor-cycle
"BC" Bicycle
"OT" Other vehicle
"PED" Pedestrian

Position in vehicle
"FS" Front seat
"RS" Rear seat
"ST" Standing (inside)
"OB" On open body

Class of person
"PED" Pedestrian
"CY" Cyclist
"MC" Motor-cycle
"DR" Driver
"PS" Passenger
"PP" Pillion passenger
"OP" Other person

Tick [ ] where necessary

Copy "A" - Original for the File

Police 41

THE KENYA POLICE - TRAFFIC DEPARTMENT
ACCIDENT REPORT FORM

Acc. Reg. No.

Police Division	Police Station	Ch - Reg. No.	O.B. No.
Day, date and time of accident	Road Authority []MOTC []Municipality []Other	[]Urban []Rural	Speed limit kph
Location of accident (indicate milestone or nearest known place with distance)		Road No.	Total number of participants Total number of victims

Types of vehicles and other participants involved	Register Number	Name and address of owner/driver (state which)	Nationality	Brief details of damages
1 []SC []PU []LO []LT []BU []MA []MC []BC []OT []PED				
2 []SC []PU []LO []LT []BU []MA []MC []BC []OT []PED				
3 []SC []PU []LO []LT []BU []MA []MC []BC []OT []PED				

Name and address of injured person	Type of injury Fat.	Ser.	Sli.	Veh/part. ref. No.	Class of person	Age	Sex	Position in vehicle	Safety belt in use

Certificate of competence	Vehicle/Particip. No. 1	Vehicle/Particip. No. 2	Vehicle/Particip. No. 3
Driving licence No. valid/not valid			
Road licence No. valid/not valid			
Insurance company			
Ins. certificate No. valid/not valid			
P.S.V. licence No. valid/not valid			

Pedestrian accidents only

If pedestrian was crossing the road he/she was:
[]on pedestrian crossing
[]1-25m from pedestrian crossing
[]over 25m

If pedestrian was walking along the road he/she was walking:
[]in the direction of traffic
[]towards the traffic

Comments about pedestrian movement:

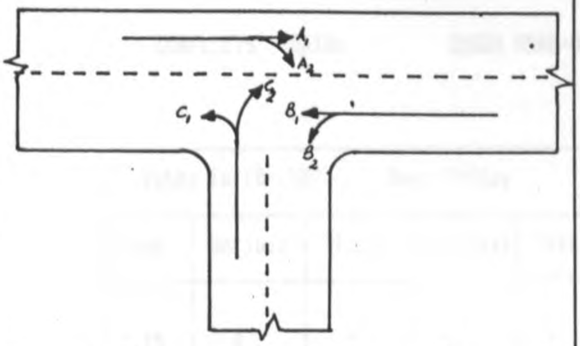
Road surface	Width of surface	Condition of road at the accident site	Surface was
[]tarmac []murram []earth		[]damaged If damaged, tick below as appropriate []not damaged []potholes []damaged edges []corrugated []loose stones on the surface	[]wet []dry

Accident site was:	Junction accidents only	Traffic signs and signals at junction	Railway level crossing
[]junction []not junction	Junction type was: []T-junction []4-leg junction []roundabout []other junction	[]give way []stop []no signs []no traffic light signals If there were traffic light signals, were they: []operating []not operating	[]uncontrolled []controlled []no railway crossing

Road works at the accident site	Weather conditions	Illumination	Apparent police cause code No.
[]yes []no	[]clear []cloudy []foggy []rainy	[]daylight []night time 6.45p.m.-6.15a.m. []street lights on []no street lights	

State who was primarily responsible for the accident	Alcohol involved
	[]yes []no

Summary of the Traffic flow at T - Junction



Date ______ Site ___, Day ________

Junction ______________________

Comments ______________________

____

____

Time	A			B			C			Over-all Flow.
	A_1	A_2	A	B_1	B_2	B	C_1	C_2	C	

Appendix 7

CONFLICTS DATA: JOGOO ROAD-OUTER RING ROAD JUNCTION

Date: 16-10-1987 Day: Friday

Time	Serious	Slight	Potential	Total
7.15	0	2	6	8
7.30	1	7	12	20
7.45	1	3	3	7
8.00	0	2	7	9
8.15	1	0	2	3
8.30	1	1	2	4
8.45	0	2	2	4
9.00	0	0	1	1
9.15	0	0	3	3
9.30	0	1	0	1
9.45	0	1	0	1
10.00	0	0	0	0
10.15	0	0	0	0
10.30	0	0	1	1
10.45	0	0	2	2
11.00	0	0	2	2
12.00	0	0	1	1
12.15	0	0	0	0
12.30	0	1	1	2
12.45	0	0	1	1
1.00	0	1	2	3
1.15	0	1	2	3
1.30	0	0	1	1
4.15	0	1	2	3
4.30	0	0	2	2
4.45	0	1	3	4
5.00	0	2	3	5
5.15	0	1	6	7
5.30	0	0	4	4
5.45	0	1	3	4
6.00	0	2	1	3
6.15	0	0	0	0
6.30	1	0	2	3
6.45	0	1	3	4
7.00	0	0	0	0

Date: 19-10-1987 Day: Monday

Time	Serious	Slight	Potential	Total
7.30	0	2	5	7
7.45	0	0	7	7
8.00	0	4	10	14
8.15	0	1	4	5
8.30	0	0	3	3
8.45	0	1	3	4
9.00	0	0	1	1
9.15	0	0	2	2
9.30	0	1	2	3
9.45	0	0	0	0
10.00	0	0	1	1
10.15	0	0	2	2
10.30	0	0	3	3
10.45	0	1	2	3
11.00	0	0	2	2
12.15	0	0	5	5
12.30	0	2	3	5
12.45	0	0	2	2
1.00	0	1	1	2
1.15	0	0	2	2
1.30	0	0	4	4
4.30	1	0	6	7
4.45	0	0	3	3
5.00	0	0	2	2
5.15	0	1	0	1
5.30	0	0	0	0
5.45	0	0	1	1
6.00	0	0	2	2
6.15	0	0	3	3
6.30	0	1	0	1
6.45	1	0	2	3
7.00	0	0	0	0

Appendix 7

CONFLICTS DATA : MUMIAS ROAD-OUTER RING ROAD JUNCTION

Date: 21-10-1987	Day: Wednesday			
Time	Serious	Slight	Potential	Total
7.30	0	0	1	1
7.45	0	2	6	8
8.00	0	0	8	8
8.15	0	2	4	6
8.30	0	0	2	2
8.45	0	3	2	5
9.00	0	1	1	2
9.15	0	0	1	1
9.45	0	0	1	1
10.00	0	0	0	0
10.15	0	1	0	1
10.30	0	1	0	1
10.45	0	0	0	0
11.00	0	1	3	4
12.15	0	0	7	7
12.30	0	0	2	2
12.45	0	0	1	1
1.00	0	0	0	0
1.15	0	0	1	1
1.30	0	0	0	0
3.45	0	0	1	1
4.00	0	0	2	2
4.15	0	0	1	1
4.30	0	1	0	1
4.45	0	1	1	2
5.00	0	0	3	3
5.15	0	0	6	6
5.30	0	2	0	2
5.45	0	0	2	2
6.00	0	0	0	0
6.15	0	0	0	0
6.30	0	1	1	2
6.45	1	0	2	3
7.00	0	1	0	1

Date: 22-10-1987	Day: Thursday			
Time	Serious	Slight	Potential	Total
7.00	0	1	5	6
7.15	0	3	0	3
7.30	0	2	6	8
7.45	0	2	4	6
8.00	0	3	4	7
8.15	0	1	2	3
8.30	0	0	1	1
8.45	0	1	0	1
9.00	0	1	1	2
10.15	0	0	0	0
10.30	0	0	0	0
10.45	0	0	1	1
11.00	0	1	0	1
11.15	0	1	1	2
11.30	0	0	0	0
11.45	0	1	1	2
3.00	0	0	0	0
3.15	0	0	2	2
3.30	0	0	0	0
3.45	1	0	1	2
4.00	0	1	0	1
4.15	0	0	0	0
4.30	0	1	0	1
4.45	0	0	0	0
5.00	0	1	2	3
5.15	0	1	1	2
5.30	0	0	3	3
5.45	0	0	0	0
6.00	0	1	3	4
6.15	0	0	3	3
6.30	1	0	1	2
6.45	0	1	2	3
7.00	0	0	1	1

Appendix 7

MUNIAS ROAD-RABAI ROAD JUNCTION

Date: 26-10-1987 Day: Monday

Time	Serious	Slight	Potential	Total
7.00	0	0	1	1
7.15	0	1	6	7
7.30	0	3	4	7
7.45	0	0	0	0
8.00	0	0	1	1
8.15	0	0	1	1
8.30	0	0	0	0
8.45	0	0	0	0
9.00	0	0	0	0
11.15	0	0	0	0
11.30	0	0	2	2
11.45	0	0	0	0
12.00	0	0	0	0
12.15	0	0	0	0
12.30	0	0	0	0
12.45	0	0	0	0
1.00	0	0	0	0
1.15	0	0	1	1
1.30	0	0	0	0
3.45	0	1	0	1
4.00	0	0	0	0
4.15	0	0	0	0
4.30	0	0	0	0
4.45	0	0	1	1
5.00	0	0	1	1
5.15	0	0	1	1
5.30	0	0	1	1
5.45	0	1	0	1
6.00	0	0	2	2
6.15	0	1	0	1

Date: 27-10-1987 Day: Tuesday

Time	Serious	Slight	Potential	Total
7.00	0	0	0	0
7.15	0	0	5	5
7.30	0	1	4	5
7.45	0	0	0	0
8.00	0	0	1	1
8.15	0	0	0	0
8.30	0	0	0	0
8.45	0	0	0	0
9.00	0	0	0	0
11.15	0	0	0	0
11.30	0	0	0	0
11.45	0	0	0	0
12.00	0	0	0	0
12.15	0	0	0	0
12.30	0	0	0	0
12.45	0	0	0	0
1.00	0	0	1	1
1.15	0	0	0	0
1.30	0	0	0	0
3.45	0	1	0	1
4.00	0	0	0	0
4.15	0	0	1	1
4.30	0	1	0	1
4.45	0	0	2	2
5.00	0	0	0	0
5.15	0	0	0	0
5.30	1	1	0	2
5.45	0	1	0	1
6.00	0	1	1	2
6.15	0	0	2	2
6.45	0	1	0	1
7.00	0	0	2	2

Appendix 7

CONFLICTS DATA : LANGATA ROAD-MUTHAITI ROAD JUNCTION

Date: 29-10-19870		Day: Thursday		
Time	Serious	Slight	Potential	Total
7.00	0	0	1	1
7.15	0	0	0	0
7.30	0	0	0	0
7.45	0	1	0	1
8.00	0	0	2	2
8.15	0	2	2	4
8.30	1	0	1	2
8.45	0	0	0	0
9.00	0	0	1	1
11.15	0	0	1	1
11.30	0	1	1	2
11.45	0	0	1	1
12.00	0	0	0	0
12.15	0	0	0	0
12.30	0	0	0	0
12.45	0	0	1	1
1.00	0	1	0	0
1.15	0	1	1	0
1.30	0	0	0	0
3.45	0	0	0	0
4.00	0	0	0	0
4.15	0	0	3	3
4.30	0	1	2	3
4.45	0	0	3	3
5.00	0	1	3	4
5.15	0	3	3	6
5.30	0	0	1	1
5.45	0	0	0	0
6.00	0	1	0	1
6.15	0	2	0	2
6.30	0	0	0	0
6.45	0	0	1	1
7.00	0	1	0	1

Date: 30-10-1987		· Day: Friday		
Time	Serious	Slight	Potential	Total
7.00	0	1	3	4
7.15	0	3	2	5
7.30	0	0	2	2
7.45	0	0	3	3
8.00	0	1	1	2
8.15	0	4	3	7
8.30	0	1	1	2
8.45	1	0	1	2
9.00	0	0	1	1
11.15	0	0	0	0
11.30	0	1	0	1
11.45	0	1	0	1
12.00	0	1	0	1
12.15	0	0	2	2
12.30	0	2	3	4
12.45	0	0	0	0
1.00	0	1	2	3
1.15	0	1	0	1
1.30	0	3	1	4
3.45	0	0	1	1
4.00	1	1	0	2
4.15	0	1	1	2
4.30	1	0	2	3
4.45	0	0	0	0
5.00	0	2	2	4
5.15	0	1	1	2
5.30	1	4	0	5
5.45	0	1	3	4
6.00	0	3	1	4
6.15	0	0	1	1
6.30	0	0	1	1

Appendix 7

CONFLICTS DATA: NGONG ROAD-MUGO KIBIRU ROAD JUNCTION

Date: Time	Serious	Day: Slight	Potential	Total
7.00	0	1	2	3
7.15	1	1	4	6
7.30	0	3	2	5
7.45	0	1	4	5
8.00	0	1	0	1
8.15	0	0	0	0
8.30	0	1	1	2
8.45	0	0	0	0
9.00	0	0	1	1
11.15	0	0	0	0
11.30	0	1	2	3
11.45	0	0	1	1
12.00	0	1	0	1
12.15	0	0	2	0
12.30	0	1	0	1
12.45	0	0	0	0
1.00	0	0	0	0
1.15	0	0	2	2
1.30	0	0	0	0
3.45	0	0	0	0
4.00	0	0	0	0
4.15	0	0	1	1
4.30	0	0	0	0
4.45	0	0	1	1
5.00	0	0	1	1
5.15	0	1	2	3
5.30	0	0	1	1
5.45	0	0	0	0
6.00	1	1	2	4
6.15	0	0	0	0
6.30	0	0	1	1
6.45	0	1	1	2
7.00	0	0	0	0

Appendix 8

Observed and predicted conflicts using the developed models

Jogoo Road - Outer Ring Road Junction					
flow	observed	Predicted conflicts			
(veh/h)	conflicts	linear	Power	cubic	logistic
650	1	0.48	1.21	0.688	1.50
750	2.15	1.29	1.66	1.511	2.11
850	2.27	2.18	2.10	2.35	2.707
950	3.29	3.97	2.92	3.22	3.505
1050	5.57	3.87	3.62	4.01	4.24
1150	5.21	4.67	4.42	4.82	5.8
1250	5.10	5.56	5.86	5.86	5.92
1350	7.0	6.42	6.39	6.57	6.59
1450	9.0	7.25	7.59	7.43	7.16
1650	8.33	8.11	8.79	8.39	-

Mumias Road - Outer Ring Road Junction					
flow	observed	Predicted conflicts			
(veh/h	conflicts	linear	Power	Cubic	Logistic
450	1.75	0	1.35	0.06	1.44
550	1.40	0.42	1.71	0.92	1.73
650	1.73	1.00	2.08	1.81	2.06
750	1.75	1.58	2.45	2.61	2.43
850	4.00	2.18	2.85	3.33	2.84
950	3.33	2.71	3.25	3.94	3.28
1050	3.00	3.34	3.66	4.46	3.76
1150	5.50	3.88	4.08	4.89	4.25
1250	6.00	4.41	4.50	5.23	4.74
1350	-	-	-	-	-
1450	3.00	5.65	5.36	5.38	5.71
1550	7.50	6.19	5.80	5.70	6.16
1650	6.00	6.81	6.24	5.68	6.57

Juja Road - 1st Avenue Eastleigh Road					
flow	observed	Predicted conflicts			
(veh/h)	conflicts	linear	Power	cubic	logistic
750	1.0	0.495	1.061	1.50	1.06
850	1.5	1.3	1.48	1.66	1.47
950	2.33	2.06	1.93	1.99	1.96
1050	3.00	2.87	2.53	2.44	2.51
1150	2.00	3.60	3.15	3.03	3.20
1250	5.00	4.42	3.93	3.85	4.00
1350	3.40	5.20	4.73	4.73	4.75
1450	6.00	5.98	5.71	5.76	5.52
1550	9.00	6.75	6.73	7.07	6.24
1650	7.00	7.33	7.80	5.68	6.90

Mumias Road - Rabai Road Junction					
flow	observed	Predicted conflicts			
(veh/h	conflicts	linear	Power	Cubic	Logistic
250	0.10	-	0.101	0.52	0.13
350	0.23	-	0.22	0.27	0.19
450	0.63	0.06	0.35	0.16	0.28
550	0.57	0.46	0.56	0.15	0.80
750	0.75	1.29	1.74	0.45	0.80
850	1.00	1.71	1.37	0.80	1.14
950	0.50	2.11	1.77	1.28	1.56
1050	2.00	2.55	2.14	1.76	2.09
1150	4.00	2.94	2.57	2.48	2.68
1250	5.00	3.38	3.09	3.33	3.39
1350	-	-	3.62	4.20	4.08
1450	6.00	4.22	4.22	5.19	4.65

2

Langata Road - Muthaiti Road Junction					
flow (veh/h)	observed conflicts	Predicted conflicts			
		linear	Power	cubic	logistic
1015	0.25	1.47	0.716	0.07	0.68
1150	0.50	1.44	0.81	0.89	0.82
1250	1.75	1.41	0.92	1.53	0.98
1350	1.80	1.38	1.02	2.01	1.15
1450	2.33	1.33	1.13	2.31	1.35
1550	2.75	1.30	1.24	2.44	1.50
1650	2.75	1.27	1.36	2.40	1.79
1750	2.00	1.24	1.48	2.09	-
1850	1.00	1.20	1.6	1.76	-
1950	1.75	1.18	1.73	1.25	-
2050	0	1.16	1.85	0.47	-

Ngong Road - Mugo Kibiru Road Junction					
flow (veh/h	observed conflicts	Predicted conflicts			
		linear	Power	Cubic	Logistic
850	1.55	1.81	1.69	1.62	1.68
950	2.33	2.08	2.00	2.05	2.01
1050	2.67	2.48	2.33	2.49	2.38
1150	-	-	-		-
1250	1.59	3.23	3.05	3.38	3.25
1350	5.60	5.61	3.44	3.83	3.73
1450	3.60	4.00	3.84	4.30	4.23
1550	4.90	4.39	4.25	4.76	4.74
1650	6.00	4.75	4.68	5.23	5.23
1750	5.13	5.12	4.90	5.47	5.49

General for all T-Junctions Studied					
flow (veh/h)	observed conflicts	Predicted conflicts			
		linear	Power	cubic	logistic
250	0.1	2.83	0.271	-	0.616
350	0.23	2.85	0.434	-	0.697
450	1.19	2.87	0.641	0.61	0.788
550	0.99	2.89	0.838	1.27	0.900
650	1.16	3.02	1.081	1.82	0.01
750	0.98	3.05	1.322	2.30	1.16
850	1.96	3.07	1.60	2.7	1.31
950	2.66	3.09	1.87	3.08	1.45
1050	2.75	3.12	2.182	3.36	1.67
1150	2.64	3.15	2.48	3.58	1.86
1250	3.89	3.17	2.81	3.74	2.10
1350	4.76	3.19	3.15	3.82	2.31
1450	4.79	3.27	3.49	3.83	2.57
1550	5.89	3.23	3.85	3.88	2.83
1650	6.02	3.25	4.20	3.65	3.11
1750	3.57	3.28	4.61	3.46	3.43
1850	1.00	3.29	4.99	3.23	3.71
1950	1.75	3.33	5.41	2.88	4.05

Appendix 9

Percentage of vehicle type relative to total traffic flow

Site	Cars	P/vans	Buses	Lorries	Matatus
1	41.2	26.4	3.3	19.3	9.8
2	39.3	29.8	4.23	19.47	7.23
3	36.18	26.11	8.47	8.96	14.70
4	66.90	19.03	3.65	2.33	8.09
5	61.93	25.74	1.85	5.89	4.59
6	62.68	22.89	6.86	3.73	3.84
Av.	51.37	25.00	4.73	9.95	8.04

Conflicts per vehicle type

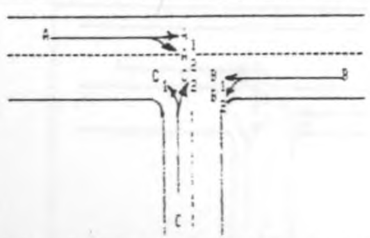
Site	Cars	P/vans	Buses	Lorries	Matatu
1	0.0078	0.013	0.022	0.010	0.027
2	0.007	0.008	0.036	0.006	0.072
3	0.004	0.005	0.018	0.006	0.026
4	0.005	0.008	0.026	0.025	0.048
5	0.002	0.003	0.003	0.006	0.029
6	0.001	0.02	0.019	0.006	0.032
Av.	0.005	0.005	0.027	0.010	0.039

Percentage by proportions of vehicles causing accidents

Site	Cars	P/vans	Buses	Lorries	Matatus
1	0.32	0.34	0.07	0.19	0.27
2	0.27	0.26	0.19	0.15	0.25
3	0.067	0.05	0.06	0.03	0.25
4	0.21	0.07	0.05	0.04	0.02
5	0.06	0.03	0.05	0.004	0.04
6	0.08	0.04	0.13	0.02	0.12
Av.	0.16	0.13	0.09	0.07	0.19

CLASSIFIED COUNT AT T-JUNCTION

Appendix 10



Date: 16-10-87 Day: Friday

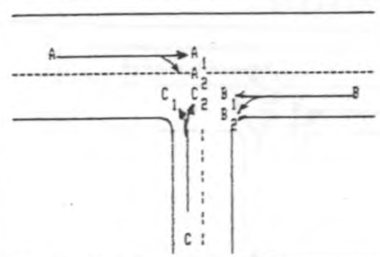
Site: 1 Junction: Jogoo\Outering

Comments: Flat, good visibility No. Curbs

Time	Cars		P&Vans		Buses		Lorries		Matatus		Cars		P&Vans		Buses		Lorries		Matatus		Cars		P&Vans		Buses		Lorries		Matatus	
	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
7.00																														
7.15	8	154	6	32	2	3	14	8	1	19	9	29	2	5	0	1	9	2	0	4	11	11	7	6	3	1	3	3	5	17
7.30	20	118	6	21	2	5	7	6	0	13	11	34	6	4	1	2	3	5	1	4	24	15	19	6	4	2	3	0	2	19
7.45	22	116	9	23	2	2	15	13	0	26	18	31	5	9	1	0	8	4	3	3	11	29	11	19	2	1	5	1	5	8
8.00	16	75	9	16	2	2	8	5	1	10	9	19	1	10	0	1	11	6	2	2	53	18	24	15	1	3	6	10	12	12
8.15	13	61	9	24	1	1	12	9	0	12	6	19	6	14	1	1	15	5	2	5	21	12	11	5	3	0	6	2	10	7
8.30	15	30	9	31	4	0	19	10	0	6	2	13	1	6	0	1	9	5	2	3	16	11	10	9	2	2	8	7	6	10
8.45	9	19	5	15	0	1	12	9	0	11	7	12	10	5	1	3	15	4	1	1	22	8	10	11	5	6	9	8	1	13
9.00	26	23	6	22	1	0	11	6	1	3	12	12	8	7	1	5	13	5	1	5	10	15	12	16	2	1	7	11	4	8
9.15	16	14	9	12	2	0	7	5	1	3	4	2	6	6	2	2	15	2	0	4	11	11	8	14	0	0	5	3	4	1
9.30	9	8	5	21	1	1	10	11	0	3	4	7	4	6	0	1	11	6	0	3	12	13	11	14	2	0	5	6	8	6
9.45	8	26	3	14	6	1	7	12	6	5	4	7	3	8	0	0	8	2	0	2	11	15	14	18	1	0	7	7	3	7
1000	3	14	4	9	1	0	8	15	0	2	4	7	3	11	0	1	9	7	0	5	14	12	8	7	0	0	3	8	3	3
1015	3	14	4	17	1	1	8	9	0	0	1	8	3	8	1	2	5	4	0	1	20	22	11	20	2	0	7	17	5	8
1030	4	6	7	10	1	0	16	7	1	3	3	14	5	7	0	1	13	6	0	4	9	7	5	16	0	0	7	13	1	3
1045	7	14	6	13	1-	1	13	7	0	3	4	11	3	8	1	1	10	10	1	4	18	21	11	25	0	1	10	27	3	7
1100	4	10	5	15	2	0	9	11	0	3	3	5	6	11	0	2	7	1	0	5	9	18	8	13	2	1	5	10	5	3
1215	5	23	6	16	0	1	11	14	0	3	3	10	4	10	0	1	14	5	0	3	7	28	8	17	3	0	6	11	3	5
1230	4	17	8	10	0	1	11	18	0	5	3	19	6	5	0	1	16	9	1	6	18	13	12	13	1	1	3	10	5	7
1245	4	-20	1	20	0	1	9	10	0	5	6	17	4	14	1	1	14	5	0	4	9	26	5	15	0	0	6	9	6	9
1.00	4	11	5	15	0	1	11	9	0	6	9	15	5	10	1	0	15	6	0	1	16	37	12	21	0	1	7	13	2	6
1.15	4	28	6	21	0	0	12	20	0	5	8	18	7	16	0	3	10	6	0	5	14	30	8	11	0	1	8	27	3	4
1.30	9	10	1	10	1	0	5	2	0	4	3	16	2	8	0	1	16	2	1	7	19	12	12	9	0	0	5	9	4	7
4.00																														
4.15	6	26	4	6	1	2	9	7	0	3	9	22	19	1	0	3	20	6	2	2	18	23	21	13	3	2	16	6	8	5
4.30	7	27	10	6	1	7	5	19	0	2	7	22	9	7	1	1	16	7	1	6	19	21	13	24	1	2	8	17	2	4
4.45	9	13	5	4	0	2	10	14	0	4	20	23	9	12	0	6	9	7	1	5	25	20	12	17	1	1	5	8	4	4
5.00	3	19	10	21	2	3	10	9	0	10	6	23	6	11	1	2	9	3	1	5	14	15	15	18	1	5	7	10	3	5
5.15	8	21	6	12	0	2	12	2	0	10	16	27	7	19	4	3	6	6	1	6	20	60	16	13	2	4	8	8	7	9
5.30	12	16	10	18	2	3	14	7	0	9	15	20	14	14	0	3	8	1	6	7	19	45	13	21	1	1	3	12	5	11
5.45	7	18	9	24	1	5	14	10	0	8	13	15	6	5	1	2	6	3	0	6	29	67	15	22	2	2	9	7	5	10
6.00	8	17	4	17	0	4	10	4	0	10	18	6	8	12	0	0	4	7	0	6	13	30	12	16	3	2	6	8	6	11
6.15	6	12	6	19	3	3	6	8	0	6	10	12	5	10	2	1	7	4	1	4	12	37	11	14	0	1	7	10	4	8
6.30	4	9	5	13	2	2	7	7	0	4	6	9	9	9	0	1	6	2	0	2	21	24	14	20	2	3	10	6	3	6
6.45	3	10	7	9	2	3	4	3	0	5	3	6	11	7	0	0	4	5	1	3	6	38	16	19	1	0	5	11	2	3
7.00	6	8	5	14	1	3	9	4	0	4	6	5	6	13	0	1	4	3	0	3	19	37	8	17	2	2	7	7	3	7

CLASSIFIED COUNT AT T-JUNCTION

Appendix 10



Date: 21-10-1987 Day: Wednesday

Site: 2 Junction: Mumias/Outer ring

Comments: Steep grade towards side B_1 fine weather

Time	Cars		P&Vans		Buses		Lorries		Matatus		Cars		P&Vans		Buses		Lorries		Matatus		Cars		P&Vans		Buses		Lorries		Matatus	
	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
7.15																														
7.30	41	39	29	16	2	3	19	3	11	8	27	3	17	4	2	0	16	0	4	1										
7.45	42	36	43	15	2	43	20	7	2	9	32	3	19	6	4	0	14	1	3	2	22	77	2	23	2	5	1	2	6	23
8.00	32	21	22	12	0	2	32	2	9	6	22	8	19	2	2	1	19	1	5	3	6	68	3	27	0	3	2	1	3	19
8.15	11	8	17	13	0	20	33	2	4	3	23	4	18	5	0	0	24	2	8	0	7	36	3	16	0	2	1	2	3	16
8.30	13	18	23	9	1	0	17	1	3	4	11	4	10	4	1	2	19	0	2	0	5	14	4	15	6	1	1	0	0	4
8.45	22	14	18	11	1	3	24	1	5	5	16	2	23	2	2	0	19	0	4	0	6	8	1	7	2	1	3	1	2	3
9.00	18	12	14	6	4	1	15	3	4	8	16	3	16	1	1	0	19	0	3	1	3	16	2	17	0	3	2	4	1	14
9.15	11	11	22	14	1	5	24	1	3	10	18	3	22	1	3	0	28	1	1	0	2	12	2	11	1	3	3	2	4	1
9.30	25	18	19	11	1	3	16	0	4	7	22	1	20	2	1	0	28	1	1	0	2	7	2	15	0	2	0	1	0	5
9.45	12	11	13	9	2	3	14	0	4	5	16	4	12	2	0	0	19	1	4	0	2	12	2	9	1	5	2	1	0	4
1000	11	12	26	19	3	3	21	2	3	10	16	2	12	0	1	1	14	0	1	0	1	11	1	13	1	3	1	2	3	0
1015	8	6	6	9	0	2	11	1	1	5	16	4	23	0	1	1	26	1	1	0	1	12	3	13	1	0	0	2	0	5
1030	15	4	10	14	0	2	13	4	0	3	6	4	18	0	0	0	21	0	1	0	1	13	0	16	0	4	0	2	0	4
1045	12	9	17	10	1	2	8	3	0	4	15	2	18	4	0	1	18	0	1	0	5	10	0	3	1	0	0	1	0	4
1100											22	3	8	2	0	0	18	2	0	1	1	7	3	6	1	1	1	1	0	7
1200																														
1215	14	7	17	23	0	5	26	1	3	5	23	5	33	7	1	0	39	2	2	0	1	10	3	11	1	3	2	1	0	4
1230	17	34	17	13	0	1	21	2	0	2	10	4	21	4	1	0	23	0	1	0	0	10	5	9	1	2	1	2	0	3
1245	22	10	18	14	0	5	20	3	0	3	26	4	22	2	0	0	33	4	2	0	2	19	6	16	0	4	1	1	0	3
1.00	22	16	15	-13	0	3	31	2	2	4	16	5	26	2	1	1	21	0	0	0	1	14	5	18	0	4	1	0	0	6
1.15	17	33	17	13	1	2	23	3	0	6	15	9	27	1	1	0	24	1	0	0	1	15	2	13	2	3	2	3	0	6
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3.30																														
3.45	21	10	15	6	1	5	25	1	4	6	17	5	20	3	1	0	16	1	3	0	5	17	5	17	0	6	0	7	0	6
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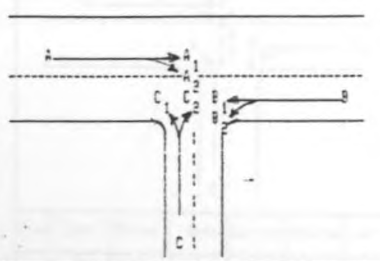
4.45	21	20	15	16	1	3	14	3	4	4	29	8	23	2	3	0	22	1	1	0	4	14	7	19	1	3	2	2	1	9
5.00	11	16	24	13	1	1	22	1	1	8	28	14	25	1	1	0	24	1	5	3	5	25	1	15	5	6	1	3	0	13
5.15	14	33	28	28	1	5	20	3	1	6	36	7	34	3	2	2	13	1	4	0	5	46	3	12	2	6	5	4	1	7
5.30	14	27	7	13	0	2	14	0	2	5	29	5	25	4	2	0	8	0	5	1	13	46	12	30	4	8	0	1	0	18
5.45	16	25	13	11	1	1	15	3	0	7	34	6	28	2	1	1	14	1	3	0	6	32	2	13	1	5	1	3	0	11
6.00	12	21	16	14	0	2	9	4	1	3	28	7	26	1	1	0	6	0	2	1	8	24	6	15	0	4	3	2	1	7
6.15	19	26	8	21	0	3	6	2	2	4	24	4	31	3	0	0	11	2	2	1	9	36	4	12	2	1	0	1	1	6
6.30	16	19	7	9	1	1	8	3	1	5	31	4	21	4	2	0	9	1	1	0	5	21	3	11	3	6	1	0	0	9
6.45	14	16	11	12	0	2	5	4	1	3	26	3	18	5	3	0	10	2	0	1	4	18	5	8	1	2	1	2	0	8
7.00																														

CLASSIFIED COUNT AT T-JUNCTION   Appendix 10



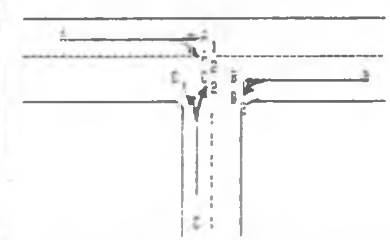
Date 23-10-1987   Day Friday

Site 3   Junction Juja/1st Avenue

Comments

Time	Cars		P&Vans		Buses		Lorries		Matatus		Cars		P&Vans		Buses		Lorries		Matatus		Cars		P&Vans		Buses		Lorries		Matatus	
	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
6.45																														
7.00	6	32	19	6	4	3	8	4	24	1	38	6	18	4	12	2	10	1	24	5	18	6	12	4	2	6	0	1	6	3
7.15	20	9	15	14	7	3	5	3	20	3	51	8	31	2	12	1	13	2	33	4	44	10	26	12	4	11	2	3	9	16
7.30	29	39	21	24	3	0	4	5	25	0	62	6	23	8	9	4	11	3	26	15	28	5	6	7	3	4	0	0	4	12
7.45	20	35	23	16	3	4	5	0	15	2	54	11	30	2	3	2	8	1	22	12	36	9	19	2	2	2	2	1	2	8
8.00	18	34	27	21	5	3	8	2	11	1	54	11	24	2	7	2	6	0	26	10	21	3	10	3	5	2	1	2	5	11
8.15	20	13	25	9	7	3	5	4	7	6	31	5	17	3	8	3	6	2	15	6	13	3	18	5	0	2	4	2	13	15
8.30	19	15	29	7	6	4	4	3	11	9	20	3	12	0	4	4	6	1	19	5	17	2	6	5	3	5	1	1	11	15
8.45	16	11	17	8	5	1	3	1	5	8	30	4	19	11	6	2	6	0	20	18	26	9	7	6	1	4	4	1	13	16
9.00	16	11	14	3	3	2	1	0	8	11	28	3	18	10	7	1	9	1	26	14	11	1	14	8	2	4	5	4	7	13
1100																														
1115	19	17	31	12	6	5	7	3	26	8	36	5	22	9	6	4	9	8	9	2	21	6	12	5	6	2	3	2	13	8
1130	18	8	20	8	4	0	3	0	1	6	26	2	20	4	5	1	10	1	6	10	20	3	13	5	2	1	1	1	4	8
1145	17	7	12	5	4	4	4	0	9	9	17	7	14	5	2	3	7	1	7	8	13	3	12	8	2	5	2	2	9	13
1200	19	9	18	10	3	1	5	0	5	6	22	2	28	6	5	2	17	4	9	5	13	2	14	6	2	2	2	0	14	9
1215	23	7	10	5	3	5	6	1	4	9	28	7	26	9	3	3	9	2	3	3	19	11	12	7	4	2	2	3	12	9
1230	20	10	35	11	4	2	5	3	7	7	32	2	26	12	7	1	5	1	6	6	22	3	16	7	2	2	4	3	17	8
1245	19	18	20	4	2	1	6	2	8	9	18	6	15	7	4	2	5	1	3	5	29	7	11	2	4	2	1	0	11	8
1.00	29	21	27	14	2	4	7	3	9	6	26	14	31	10	6	4	6	4	4	6	32	2	19	9	2	2	1	6	13	6
1.15	28	32	27	6	5	2	2	4	7	4	24	2	16	3	7	1	9	3	11	7	22	5	19	10	3	1	4	1	19	1
1.30	22	12	12	5	5	4	3	1	4	10	14	9	18	6	7	2	5	6	12	6	18	6	11	9	2	4	1	1	17	7
3.30																														
3.45	29	18	24	11	5	2	11	3	13	5	34	1	17	10	6	5	10	3	8	6	21	4	14	8	1	4	6	2	11	5
4.00	35	18	33	4	10	2	6	1	9	12	21	3	24	13	9	1	10	1	13	8	17	8	16	6	7	3	4	2	13	10
4.15	14	18	20	12	3	5	9	2	6	8	20	7	21	21	4	7	9	18	12	11	17	4	15	8	1	3	4	4	10	10
4.30	22	11	29	16	3	2	7	1	12	9	30	5	27	8	3	1	10	1	9	11	22	2	19	12	7	5	6	2	11	6
4.45	28	14	25	1	10	4	6	1	8	6	39	4	32	9	8	3	12	2	7	16	22	5	15	7	7	7	4	11	4	15
5.00	24	12	24	5	2	4	9	3	12	10	14	2	12	2	7	0	6	9	15	6	33	7	10	9	8	4	2	2	20	11
5.15	30	17	26	10	6	3	6	7	14	5	44	3	36	16	9	2	10	2	20	12	19	4	10	6	4	6	7	0	11	14
5.30	37	21	18	11	3	2	5	0	11	6	25	5	27	14	11	5	10	2	15	4	41	10	13	9	6	4	9	5	14	14
5.45	18	13	15	9	3	4	5	2	11	2	19	4	15	6	5	5	13	2	14	12	18	10	16	8	0	0	2	4	10	11
6.00	20	12	19	11	2	1	11	4	7	4	12	0	18	5	11	1	8	0	18	8	19	8	12	4	3	3	7	8	8	13
6.15	24	10	20	8	1	2	6	5	12	8	17	3	17	7	5	3	7	0	11	13	21	4	9	7	6	5	8	6	13	9
6.30	16	12	14	4	3	3	4	3	7	7	11	2	20	14	4	2	4	1	8	10	16	6	8	5	4	4	6	4	10	8
6.45	14	13	13	13	8	4	5	0	11	6	19	5	13	6	3	4	6	4	10	9	17	10	13	6	3	2	4	8	12	10
7.00	15	14	21	10	7	1	6	5	5	3											11	5	11	4	5	5	3	10	8	6

CLASSIFIED COUNT AT T-JUNCTION   Appendix 10



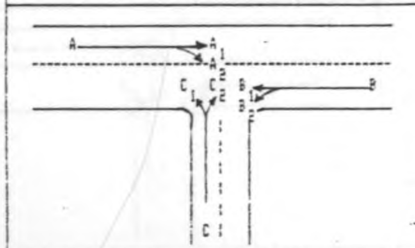
Date 22-10-1987   Day Thursday

Site 3   Junction Kumasi/Outer ring

Comments

Time	Cars		P&Vans		Buses		Lorries		Matatus		Cars		P&Vans		Buses		Lorries		Matatus		Cars		P&Vans		Buses		Lorries		Matatus	
	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
6.45																														
7.00	26	12	24	24	3	7	9	1	20	10	19	7	22	3	4	2	10	0	5	3	16	30	5	23	1	5	1	3	0	17
7.15	24	41	22	15	5	3	23	0	14	11	30	14	13	6	1	0	14	1	12	1	3	72	5	25	0	5	2	0	0	15
7.30	30	30	23	23	3	7	18	1	9	11	39	14	14	2	12	0	12	0	3	1	17	75	3	30	0	1	2	3	0	19
7.45	35	31	19	21	1	4	23	1	8	10	37	15	19	21	3	1	13	0	2	1	16	56	2	27	2	6	1	2	2	19
8.00	44	27	29	5	1	4	26	0	4	8	29	13	22	0	2	1	24	0	6	2	17	70	7	21	0	5	0	3	1	14
8.15	13	14	21	16	4	4	19	1	4	5	14	3	25	8	0	0	27	0	3	1	6	32	5	9	0	2	0	4	1	15
8.30	16	12	16	9	0	2	24	2	4	2	21	1	11	1	0	0	12	0	3	0	2	17	2	8	1	1	0	0	0	5
8.45	22	14	18	11	1	3	24	1	5	5	16	2	23	2	2	0	19	0	4	0	6	8	1	7	2	1	3	1	2	3
9.00	10	7	13	5	1	2	20	1	1	6	21	2	17	3	3	0	15	0	3	0	1	10	3	11	0	5	3	1	2	6
1015																														
1030	20	14	20	7	1	2	16	2	1	3	16	1	20	0	0	1	40	1	1	0	2	0	1	9	0	2	0	1	0	5
1045	10	8	4	9	0	2	14	0	3	3	16	1	17	4	0	0	15	0	1	0	3	6	0	6	1	1	0	3	0	4
1100	10	11	11	6	1	1	20	0	1	3	30	2	21	1	0	0	25	1	0	0	1	12	2	7	5	2	4	1	1	7
1115	6	9	23	11	0	3	23	2	2	4	12	2	23	1	1	0	24	0	0	0	1	9	1	14	1	2	3	0	0	3
1130	9	7	10	12	0	0	16	1	1	2	11	3	10	0	1	1	25	0	0	0	1	10	3	7	0	3	1	3	0	4
1145	15	4	17	10	0	6	18	3	0	5	21	3	10	0	0	0	20	0	1	0	5	12	4	11	1	1	5	3	0	6
3.00																														
3.15																					7	12	6	16	7	3	0	2	14	6
3.30	6	5	7	4	2	1	14	1	2	2	23	1	27	3	1	0	25	0	2	0	1	12	1	12	1	6	0	2	0	4
3.45	7	6	14	14	0	6	14	1	1	2	21	3	32	0	3	0	29	0	3	0	3	17	6	11	1	2	1	73	0	6
4.00	4	2	5	2	0	1	21	3	2	2	10	0	5	1	1	0	16	1	0	0	0	11	0	13	0	2	1	7	0	3
4.15	9	16	15	11	1	4	15	3	2	5	17	[illegible]	27	3	1	0	18	0	1	0	2	17	1	10	2	2	2	3	0	7
4.30	20	12	22	9	3	0	16	1	1	4	19	0	29	2	3	1	31	1	1	0	5	23	3	12	[illegible]	1	1	3	0	4
4.45	11	15	24	13	2	3	12	3	1	3	27	6	23	2	3	0	12	0	2	0	1	9	3	4	1	1	3	3	0	9
5.00	17	9	21	13	[illegible]	2	10	7	2	3	33	6	28	3	2	0	14	1	2	1	6	[illegible]	[illegible]	22	3	4	3	4	1	10
5.15	20	15	16	13	1	3	14	1	5	3	18	5	16	1	2	0	11	0	3	1	7	25	3	13	2	3	3	9	0	6
5.30	23	14	15	9	2	3	8	3	1	7	41	5	35	8	2	2	23	1	2	0	8	37	2	13	1	3	1	5	0	12

CLASSIFIED COUNT AT T-JUNCTION — Appendix 10



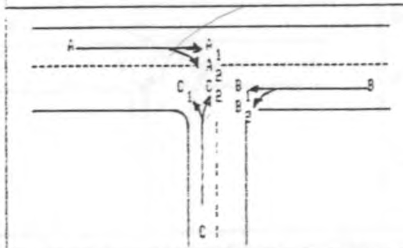
Date: 26-10-87 Day: Monday

Site: 4 Junction: Rabai/Mumias

Comments:

Time	Cars A1	Cars A2	P&Vans A1	P&Vans A2	Buses A1	Buses A2	Lorries A1	Lorries A2	Matatus A1	Matatus A2	Cars B1	Cars B2	P&Vans B1	P&Vans B2	Buses B1	Buses B2	Lorries B1	Lorries B2	Matatus B1	Matatus B2	Cars C1	Cars C2	P&Vans C1	P&Vans C2	Buses C1	Buses C2	Lorries C1	Lorries C2	Matatus C1	Matatus C2
6.45																														
7.00	4	4	2	5	0	3	1	1	1	9	19	5	5	7	1	0	1	0	1	0	68	16	18	7	6	4	0	2	7	8
7.15	12	14	9	3	0	2	0	1	1	7	39	11	5	1	0	0	2	0	1	1	126	39	18	4	1	1	0	0	1	1
7.30	7	11	5	5	0	1	0	0	0	9	35	13	14	3	3	1	0	1	0	0	166	73	22	8	2	2	2	1	10	1
7.45	9	5	0	3	0	1	1	0	0	2	14	4	6	2	0	1	1	0	1	0	81	35	11	3	1	0	0	0	2	2
8.00	1	5	0	1	0	1	0	0	0	5	17	2	2	1	1	1	0	0	1	0	64	17	7	0	0	1	0	0	6	1
8.15	4	7	2	4	0	0	0	0	0	6	7	3	3	0	1	0	1	0	0	1	58	8	12	0	1	0	1	0	6	1
8.30	4	4	2	1	0	1	0	1	0	2	11	1	0	6	0	0	1	0	0	1	41	2	10	1	1	2	1	0	5	0
8.45	1	2	0	0	0	1	0	0	1	4	7	1	8	3	0	1	0	1	4	2	22	2	8	2	2	1	1	0	5	4
9.00	1	1	2	5	0	2	0	2	0	1	8	0	0	1	0	0	1	0	1	0	20	0	9	0	1	0	2	0	6	2
1115	9	17	5	9	0	2	0	0	1	4	7	0	3	1	0	0	3	0	0	0	12	1	3	0	3	1	2	0	1	0
1130	3	8	2	4	0	0	1	0	0	3	9	2	11	0	0	1	2	0	3	0	16	0	10	1	2	0	2	0	6	1
1145	5	6	2	4	0	1	0	0	0	1	7	2	2	0	0	0	0	0	1	0	6	1	5	1	1	2	0	0	4	0
1200	7	13	1	0	0	0	0	0	0	1	12	0	3	0	1	0	0	0	1	0	5	0	3	1	0	2	0	0	2	2
1215	4	11	4	2	0	1	1	1	0	1	10	1	7	1	2	0	0	0	0	0	12	2	7	0	1	2	1	1	4	2
1230	8	15	5	4	0	1	0	0	0	0	6	2	1	0	1	0	1	0	0	0	20	0	4	1	1	2	0	0	3	0
1245	2	11	3	5	0	2	0	2	0	0	8	4	12	0	0	0	0	0	0	0	11	2	6	0	0	1	0	0	5	0
1.00	9	35	6	9	0	1	0	0	0	2	5	12	0	1	2	0	2	0	2	0	8	2	6	1	0	2	0	0	2	1
1.15	7	7	4	10	0	2	1	1	0	4	11	1	4	1	0	2	2	0	1	0	19	5	3	2	2	1	0	0	3	3
1.30	6	5	6	7	0	1	0	0	0	1	9	3	5	0	1	1	0	0	1	0										
3.30																														
3.45	12	8	8	1	1	2	1	1	1	4	10	6	3	1	0	0	0	1	2	0	12	1	4	0	1	2	0	0	1	0
4.00	6	9	1	2	0	2	0	1	0	3	10	1	2	0	0	0	0	0	0	4	13	1	2	3	1	1	1	1	1	2
4.15	5	16	8	6	0	1	1	1	0	2	1	3	3	3	0	1	1	0	0	0	10	1	3	5	2	0	0	1	4	1
4.30	7	10	1	5	0	2	2	1	0	0	8	6	3	3	0	0	0	0	0	2	20	3	6	3	1	2	1	4	3	3
4.45	16	16	5	3	0	1	0	0	0	3	4	4	4	1	1	0	0	0	1	1	13	1	6	2	0	4	0	1	9	0
5.00	15	39	4	5	1	0	0	0	2	6	6	5	6	2	1	1	0	0	2	3	7	8	2	1	0	1	0	0	5	0
5.15	32	51	14	22	0	2	0	0	0	5	5	10	1	0	0	0	0	0	1	1	14	6	6	1	2	2	0	0	9	0
5.30	36	6	7	10	0	1	0	0	1	7	6	6	9	3	1	3	2	0	0	0	16	3	9	3	3	0	0	0	7	0
5.45	41	96	3	21	0	1	0	1	0	7	12	17	7	0	1	0	2	0	1	0	15	5	5	3	3	3	0	0	6	1
6.00	32	67	10	9	2	0	0	1	2	6	5	7	2	7	2	0	0	0	0	0	10	4	5	3	0	0	0	0	3	0
6.15											8	16	4	4	1	1	1	0	1	1										
6.30											11	14	5	2	0	0	0	1	2	0										
6.45											5	4	3	1	1	0	1	0	1	0										
7.00											8	5	1	3	1	1	2	0	1	0										

CLASSIFIED COUNT AT T-JUNCTION — Appendix 10



Date: 28-1087 Day: Wednesday

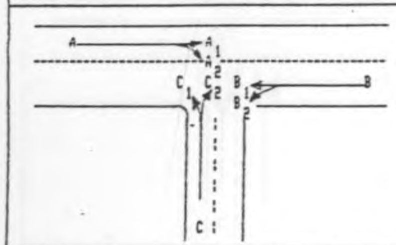
Site: 3 Junction: Juja/1st Avenue

Comments:

Time	Cars A1	Cars A2	P&Vans A1	P&Vans A2	Buses A1	Buses A2	Lorries A1	Lorries A2	Matatus A1	Matatus A2	Cars B1	Cars B2	P&Vans B1	P&Vans B2	Buses B1	Buses B2	Lorries B1	Lorries B2	Matatus B1	Matatus B2	Cars C1	Cars C2	P&Vans C1	P&Vans C2	Buses C1	Buses C2	Lorries C1	Lorries C2	Matatus C1	Matatus C2
6.45																														
7.00	15	27	10	19	4	6	6	8	4	26	30	16	21	12	6	5	23	1	20	14	9	3	9	2	1	8	4	2	9	6
7.15	6	17	4	16	9	3	6	8	14	17	41	10	33	9	7	4	8	1	27	9	16	2	12	3	5	1	1	3	6	3
7.30	32	28	16	10	3	5	7	3	29	7	64	11	40	14	10	6	9	3	36	6	59	21	17	13	17	15	1	13	10	15
7.45	44	30	19	35	25	4	14	13	13	23	66	7	25	5	12	4	5	2	20	8	92	29	31	22	13	19	6	18	15	28
8.00	27	36	32	24	9	9	6	7	36	16	51	7	19	5	8	6	9	2	27	7	73	20	28	22	26	17	6	3	3	7
8.15	34	28	25	20	1	6	1	2	16	3	41	9	17	9	5	2	14	1	19	10	22	1	7	5	4	6	1	6	6	5
8.30	7	22	10	9	8	1	13	4	19	6	25	8	14	9	7	3	12	3	34	11	14	6	5	9	4	4	2	5	13	12
8.45	12	11	13	15	10	0	10	4	17	6	20	9	18	5	6	6	8	4	13	12	8	0	7	1	2	5	3	1	8	11
9.00	13	15	9	7	4	0	6	2	14	10	27	3	19	9	5	3	6	3	15	12	8	1	5	3	4	3	0	2	14	18
1115	16	19	25	13	5	1	10	1	10	6	36	4	27	9	3	4	6	4	10	9	16	4	7	7	3	3	4	0	13	7
1130	19	14	28	15	7	7	15	2	9	7	35	7	30	13	7	10	21	3	8	7	20	2	12	11	3	0	0	0	8	5
1145	30	6	15	9	0	1	4	2	0	1	24	2	15	5	4	0	5	0	4	5	11	4	15	8	1	3	1	1	14	4
1200	6	17	23	12	10	5	7	9	3	15	11	2	25	7	2	2	6	1	4	6	23	10	14	4	7	0	3	1	6	5
1215	29	13	20	13	4	2	5	4	5	7	28	1	23	6	6	1	11	1	6	7	11	21	10	16	2	6	0	2	13	13
1230	14	15	6	22	3	3	5	2	7	6	16	7	21	4	4	5	5	5	3	3	19	7	12	3	7	2	3	10	2	7
1245	19	17	22	8	3	2	8	1	7	9	31	6	31	8	6	3	8	2	2	6	22	7	15	11	3	3	2	7	9	6
1.00	21	19	25	13	2	0	9	1	8	8	34	4	27	10	4	4	10	4	11	8	25	5	9	4	2	1	0	2	9	4
1.15	31	23	33	10	5	3	11	2	6	10	22	7	11	16	4	3	10	1	7	3	26	7	5	5	4	5	2	2	6	8
1.30	26	18	26	12	4	4	8	3	4	11	20	5	18	7	2	4	11	0	4	4										
3.30																														
3.45	24	11	18	8	5	4	7	1	9	7	18	7	19	5	9	4	8	1	7	6										
4.00	19	9	23	5	4	0	13	1	10	11	21	7	23	6	8	5	11	3	9	9	20	2	6	8	1	1	1	3	17	9
4.15	32	4	21	7	5	2	4	6	6	3	26	8	20	7	7	4	11	2	8	5	20	3	8	10	6	2	5	3	12	4
4.30	18	24	10	12	7	4	7	1	8	13	23	4	28	4	6	4	10	0	9	7	26	7	7	3	0	4	3	5	16	15
4.45	28	15	29	7	7	4	5	1	13	7	33	6	45	9	7	3	16	2	10	12	25	8	16	6	6	6	3	1	7	9
5.00	40	22	23	3	4	7	9	2	18	10	43	6	22	9	4	3	12	3	8	15	21	5	14	6	3	3	3	3	16	11
5.15	27	15	18	4	8	3	3	3	13	5	56	8	16	4	7	3	8	1	9	5	25	4	12	7	5	7	2	6	3	17
5.30	52	19	25	15	8	1	12	2	22	2	65	3	29	4	11	3	8	9	14	21	26	12	29	8	3	5	4	2	8	15
5.45	28	26	29	9	7	3	9	3	13	1	31	5	31	6	6	4	3	1	13	16	32	16	27	5	2	3	5	4	10	12
6.00	41	18	24	10	4	0	3	2	21	3	48	8	30	14	9	4	6	1	23	16	46	10	24	12	3	3	5	4	7	19
6.15	36	11	15	7	4	5	5	1	21	4	47	7	25	10	6	0	8	0	9	4	32	14	21	15	1	1	2	1	21	24
6.30	35	14	16	4	5	1	7	4	15	3	40	6	9	3	7	7	6	2	23	17	23	11	9	5	4	1	2	1	10	22
6.45	32	13	19	5	3	0	4	2	9	2	31	4	11	6	4	3	3	0	9	16										
7.00	28	16	14	2	2	2	6	0	9	4	24	5	14	4	2	5	5	1	8	11										

CLASSIFIED COUNT AT T-JUNCTION

Appendix 10



Date 30-10-87 Day Friday

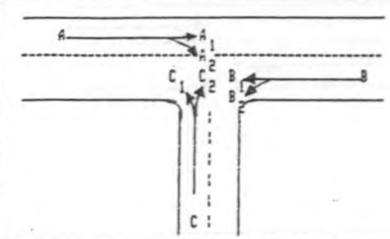
Site 5 Junction Langata/Muthaiti

Comments --

Time	Cars		P&Vans		Buses		Lorries		Matatus		Cars		P&Vans		Buses		Lorries		Matatus		Cars		P&Vans		Buses		Lorries		Matatus	
	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
6.45																														
7.00	22	2	4	3	0	0	5	0	7	0	27	9	27	4	1	2	12	2	7	3	13	10	7	5	0	4	0	0	4	4
7.15	[illegible]	2	19	0	1	0	6	0	5	0	45	12	18	8	2	2	4	2	2	9	26	14	3	9	0	3	1	0	6	1
7.30	83	0	24	0	1	0	2	0	4	0	57	8	27	9	1	3	15	3	0	9	50	24	10	5	1	2	0	0	2	1
7.45	76	[illegible]	34	0	3	0	6	0	4	0	76	47	42	6	1	3	8	0	1	11	69	33	22	7	0	0	0	1	5	1
8.00	93	0	27	0	1	0	9	0	0	0	107	4	38	11	0	1	8	3	6	9	52	30	10	11	0	3	0	0	6	0
8.15	131	1	30	0	2	0	11	0	0	0	68	12	37	10	2	3	6	1	1	8	33	23	7	6	0	2	0	1	4	0
8.30	65	0	25	0	0	0	25	0	1	1	80	21	48	20	1	3	15	0	4	8	28	20	5	5	0	2	0	0	2	1
8.45	96	0	31	0	1	0	9	0	1	0	92	36	43	16	2	3	8	1	2	6	9	8	3	7	1	1	1	0	1	0
9.00	60	0	19	1	1	0	3	0	1	0	55	21	28	12	2	2	16	0	2	6	12	16	6	3	0	2	0	0	4	2
1115	72	3	34	0	1	0	14	0	6	0	105	58	80	23	1	3	18	2	3	9	25	24	6	15	0	3	1	1	5	8
1130	41	0	20	0	1	0	11	0	2	0	83	27	57	78	0	3	20	2	0	5	18	11	8	13	0	3	0	3	1	2
1145	38	0	29	0	0	0	7	0	2	0	72	22	53	18	2	3	7	0	2	4	11	15	7	11	0	0	1	2	0	1
1200	35	2	22	0	3	0	13	0	0	0	82	39	53	12	1	2	17	0	1	5	12	10	1	5	0	1	0	1	2	1
1215	35	0	70	0	0	0	12	0	0	0	100	38	58	17	0	1	14	4	4	5	11	21	3	4	0	2	1	0	1	4
1230	18	1	21	0	0	0	13	0	3	1	91	40	40	14	1	0	14	3	3	4	20	7	3	3	0	2	0	1	0	4
1245	35	0	21	0	1	0	11	0	1	0	154	74	59	24	1	3	21	1	3	9	25	17	6	12	0	3	0	3	0	8
1.00	21	1	19	0	12	0	9	0	2	0	122	58	54	20	0	0	14	2	1	4	5	14	1	5	0	2	1	0	0	3
1.15	37	1	32	1	1	0	7	0	0	0	118	108	62	43	0	1	15	1	1	9	18	14	2	14	0	2	0	1	1	5
1.30	34	0	9	2	0	0	10	0	0	0	81	62	53	25	2	0	12	2	5	9	20	20	5	10	0	3	0	1	1	0
3.30																														
3.45	40	0	24	1	1	0	8	0	3	1	120	44	35	15	2	2	20	0	0	8	16	25	3	7	0	1	2	0	1	6
4.00	33	1	30	0	0	0	10	0	4	0	87	35	50	16	2	3	15	3	3	4	20	13	4	4	0	2	0	1	1	4
4.15	37	0	20	0	0	0	11	0	1	0	97	34	53	15	0	0	4	1	2	4	18	11	3	8	2	1	0	3	4	5
4.30	42	1	21	0	1	0	11	0	3	0	138	69	61	23	3	5	7	4	7	10	23	20	4	2	1	2	1	1	5	2
4.45	40	1	17	0	1	0	7	0	1	0	128	106	47	10	1	0	7	0	3	6	22	13	4	4	0	1	0	0	2	2
5.00	30	0	23	0	2	0	10	0	0	0	107	6	55	25	0	4	12	0	2	6	41	22	7	11	0	5	0	1	2	9
5.15	43	3	19	0	1	0	9	0	3	0	206	96	61	25	1	1	11	1	15	9	19	21	3	12	0	6	0	2	2	8
5.30	18	0	15	0	1	0	12	0	1	0	132	61	42	12	1	5	11	1	4	3	22	8	6	3	0	1	0	0	1	2
5.45	28	1	14	0	4	0	9	0	3	0	225	85	46	24	3	1	14	2	10	12	26	11	2	1	0	2	0	2	3	4
6.00	37	0	9	0	4	0	8	0	4	0	137	107	43	22	2	2	7	1	7	4	30	15	7	5	0	4	0	1	0	8
6.15	36	0	11	0	0	0	6	0	0	0	144	198	51	29	1	2	13	0	4	5	20	13	4	3	0	8	0	2	0	4
6.30	35	1	21	0	3	0	0	0	1	0	219	151	29	24	1	0	12	0	7	9	23	13	4	6	0	1	0	1	3	19

CLASSIFIED COUNT AT T-JUNCTION

Appendix 10



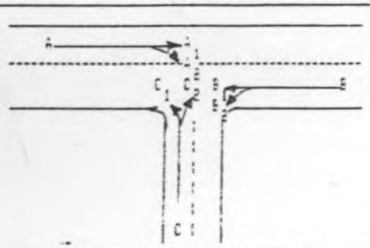
Date 27-10-87 Day Tuesday

Site 4 Junction Mumias/Rabai

Comments --

Time	Cars		P&Vans		Buses		Lorries		Matatus		Cars		P&Vans		Buses		Lorries		Matatus		Cars		P&Vans		Buses		Lorries		Matatus	
	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
6.45																														
7.00	3	10	2	5	0	1	0	0	1	9	20	7	6	3	3	0	0	0	1	1	84	10	14	1	2	2	4	0	8	1
7.15	8	10	6	11	0	3	0	0	2	6	36	0	6	1	1	0	4	0	0	1	154	38	31	9	2	2	0	2	7	2
7.30	18	22	1	7	0	1	1	1	2	2	48	15	7	1	2	1	3	0	1	1	167	51	15	5	0	0	0	0	4	2
7.45	7	11	1	2	1	2	1	0	0	1	19	6	1	5	0	0	1	0	2	0	114	42	20	1	1	2	0	3	0	1
8.00	14	7	1	4	0	1	1	0	0	7	26	7	1	2	2	0	2	0	1	0	75	19	14	4	3	1	1	0	2	1
9.15	9	9	2	7	0	0	0	0	1	5	22	5	1	1	0	0	0	0	1	1	47	5	10	1	3	2	0	1	8	0
8.30	8	10	2	5	0	0	1	1	0	2	12	2	4	1	2	0	0	1	2	2	26	1	7	0	1	2	1	0	8	4
8.45	1	2	3	8	0	3	2	2	0	3	6	1	1	1	0	0	0	1	2	1	17	3	13	3	0	2	1	0	3	3
9.00	10	8	2	4	0	1	1	2	0	1	7	1	2	2	0	0	0	0	1	1	19	4	6	2	2	0	0	1	5	2
1115											7	2	2	1	0	0	0	0	1	1	9	0	6	3	4	0	1	1	3	4
1130	6	11	0	2	1	2	1	1	0	1	6	1	3	1	1	0	0	0	0	0	11	1	3	1	0	2	1	0	0	1
1145	7	10	1	4	0	2	0	1	0	0	8	2	2	1	0	1	0	0	1	0	12	0	1	2	1	0	0	1	2	1
1200	9	13	0	5	1	3	1	1	0	1	10	2	4	2	1	1	0	0	1	0	13	2	3	1	2	2	1	0	1	3
1215	10	9	7	4	0	1	3	1	0	0	5	0	3	3	0	1	0	0	0	0	12	0	7	4	1	1	0	0	5	2
1230	6	14	1	7	0	0	0	0	0	0	3	4	3	1	0	1	0	0	0	1	6	0	5	1	0	1	0	0	3	1
1245	10	23	1	9	0	2	2	3	0	1	2	5	1	3	0	0	2	0	0	0	16	6	10	0	3	1	1	0	1	1
1.00	22	38	6	5	0	0	0	0	0	1	16	12	1	3	0	0	3	0	0	0	10	6	8	0	0	0	3	0	2	2
1.15	20	30	5	10	1	2	1	0	0	1	4	3	3	0	0	0	1	0	0	0	16	2	8	0	1	0	2	0	5	2
1.30	17	25	5	9	0	0	1	1	0	1	11	4	5	2	0	1	3	0	0	1	25	4	3	1	0	0	0	1	4	2
1.45																														
3.30																														
3.45	7	14	4	5	0	1	1	0	1	1	5	0	1	0	0	1	1	0	0	1	12	4	5	2	0	1	0	0	4	2
4.00	9	15	2	6	0	0	3	2	2	1	6	2	1	0	2	1	0	1	0	1	13	2	6	0	2	0	0	0	2	1
4.15	6	17	3	7	0	3	0	1	0	1	8	4	4	3	0	0	0	0	0	2	18	6	7	3	2	1	0	1	3	2
4.30	5	23	8	14	0	2	0	0	1	5	10	4	3	3	10	0	2	0	1	2	21	1	4	1	0	2	2	0	2	2
4.45	6	18	7	4	0	0	0	1	0	3	8	3	6	3	0	0	1	1	0	0	17	4	11	2	3	1	1	0	7	2
5.00	14	53	3	8	0	2	1	0	1	8	13	8	2	0	0	1	1	1	0	1	14	2	7	1	1	1	0	1	6	0
5.15	38	83	8	13	1	1	1	2	0	4	14	15	5	2	0	2	0	0	2	1	16	7	5	0	1	0	0	0	7	0
5.30	27	48	8	17	0	0	0	1	0	3	24	26	8	3	0	0	0	0	2	2	21	5	7	2	2	4	0	1	8	0
5.45	50	71	7	16	1	0	1	1	5	3											14	5	5	2	0	1	1	1	3	0
6.00	46	93	11	15	0	2	0	0	5	11	13	21	7	3	0	0	2	0	1	2	24	10	7	1	1	1	0	0	5	0
6.15	47	84	7	8	0	0	0	2	0	7	14	12	2	5	0	2	0	0	1	0	20	3	5	3	2	1	0	0	8	0
6.30	49	90	4	7	1	1	1	1	3	5	15	18	4	3	0	1	0	0	2	0	26	4	4	0	1	0	0	1	4	0
6.45	41	84	4	14	0	0	0	0	1	6	12	13	3	2	0	2	1	0	1	1	19	3	6	2	0	1	1	0	6	0
7.00	34	68	6	11	0	2	0	1	2	4	11	9	5	4	0	0	1	0	1	0	18	2	7	2	2	1	0	0	5	0

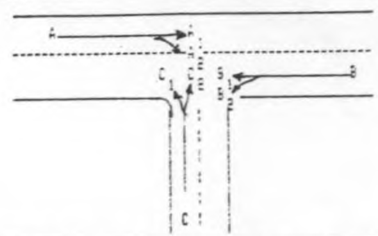
CLASSIFIED COUNT AT T-JUNCTION — Appendix 10



Date 2-11-87 Day Monday
Site 6 Junction Ngong/Mugo
Comments

Time	Cars A1	Cars A2	P&Vans A1	P&Vans A2	Buses A1	Buses A2	Lorries A1	Lorries A2	Matatus A1	Matatus A2	Cars B1	Cars B2	P&Vans B1	P&Vans B2	Buses B1	Buses B2	Lorries B1	Lorries B2	Matatus B1	Matatus B2	Cars C1	Cars C2	P&Vans C1	P&Vans C2	Buses C1	Buses C2	Lorries C1	Lorries C2	Matatus C1	Matatus C2
6.45																														
7.00	79	7	27	0	8	0	4	0	11	0	21	0	15	2	8	5	1	2	8	2	3	14	0	8	0	8	0	0	0	1
7.15	178	0	60	0	14	0	8	0	9	0	37	2	25	0	7	6	1	3	2	2	4	39	3	0	4	0	0	0	0	1
7.30	[illegible]11	0	68	0	10	0	4	0	5	0	28	0	11	1	17	5	0	0	5	1	2	29	0	6	0	6	0	4	0	5
7.45	2[illegible]2	0	59	0	7	0	7	0	4	0	135	4	23	1	8	2	1	0	9	1	2	4	1	0	13	0	5	0	0	1
8.00	134	2	53	0	10	0	5	0	3	0	71	2	23	1	12	6	4	0	3	4	5	19	1	5	0	5	0	0	0	1
8.15	190	2	25	1	5	0	5	0	2	0	64	5	25	1	8	6	7	2	4	4	0	20	0	4	0	4	0	0	0	1
8.30	172	2	50	0	6	0	4	0	4	0	64	5	35	2	8	3	4	1	3	1	0	21	0	3	0	6	0	1	1	0
1100																														
1115	63	0	48	0	9	0	8	0	2	0	81	4	42	4	7	5	7	1	5	3	6	9	0	5	1	3	0	1	0	5
1130	51	0	32	0	3	0	6	0	4	0	71	2	35	2	2	3	3	1	2	6	0	7	0	4	0	3	2	2	0	5
1145	48	0	30	0	5	0	6	0	3	0	72	3	26	1	9	3	8	0	5	3	0	5	0	4	0	3	0	1	0	1
1200	50	1	32	0	2	0	12	0	5	0	71	2	32	6	5	3	8	0	2	3	0	12	0	8	0	7	0	2	0	3
1215	44	1	25	0	4	0	6	0	0	0	76	5	34	0	4	1	10	0	3	0	1	12	0	10	0	4	0	2	0	7
1230	50	0	24	0	6	0	4	0	0	0	254	9	78	5	7	12	10	2	9	5	0	5	0	4	0	1	0	2	0	2
1245	75	2	20	0	4	0	7	0	3	0	203	6	46	4	6	5	13	0	6	3	1	7	0	5	0	7	0	1	0	2
1.00	97	0	24	0	6	0	4	0	1	0	144	9	37	3	6	4	6	1	3	2	6	17	2	10	0	10	0	1	0	2
1.15	57	0	32	0	7	0	7	1	1	0											1	10	0	3	0	4	0	0	0	1
3.30																														
3.45	86	3	48	2	4	2	8	2	8	5	101	7	43	4	5	6	9	0	4	2	2	18	3	15	0	6	0	1	0	3
4.00	31	0	17	0	4	0	4	0	4	1	96	1	30	1	5	6	7	1	4	3	4	14	3	4	0	6	0	1	0	0
4.15	71	3	34	1	3	0	4	0	6	0	166	4	59	0	7	2	4	0	1	1	2	8	1	4	0	3	0	5	0	4
4.30	77	0	33	1	4	0	2	0	3	0	100	1	39	3	8	7	4	0	3	3	8	14	3	4	0	3	0	1	0	3
4.45	56	2	20	0	6	0	5	0	1	0	100	6	67	3	4	5	3	0	5	2	1	12	1	0	0	3	0	0	0	1
5.00	63	1	37	0	4	0	2	0	2	0	137	7	53	2	5	2	7	0	3	2	0	10	0	5	0	10	0	2	0	3
5.15	161	1	33	0	9	0	6	0	14	0	201	12	46	3	4	2	7	0	7	0	3	12	2	7	0	5	0	4	0	7
5.30	88	0	31	1	17	0	4	0	8	0	191	8	61	3	9	9	6	0	12	1	1	7	0	1	0	2	0	0	0	1
5.45	53	0	15	1	5	0	2	0	1	1	137	14	44	0	6	3	8	0	1	0	0	10	0	7	0	5	0	0	0	4
6.00	92	3	22	0	6	0	4	0	3	0	141	7	31	5	13	8	9	0	8	2	1	27	1	9	0	12	0	0	0	7

CLASSIFIED COUNT AT T-JUNCTION — Appendix 10



Date 29-10-87 Day Thursday
Site 5 Junction Langata/Muthait:
Comments

Time	Cars A1	Cars A2	P&Vans A1	P&Vans A2	Buses A1	Buses A2	Lorries A1	Lorries A2	Matatus A1	Matatus A2	Cars B1	Cars B2	P&Vans B1	P&Vans B2	Buses B1	Buses B2	Lorries B1	Lorries B2	Matatus B1	Matatus B2	Cars C1	Cars C2	P&Vans C1	P&Vans C2	Buses C1	Buses C2	Lorries C1	Lorries C2	Matatus C1	Matatus C2
6.45																														
7.00	35	1	26	0	0	0	0	0	1	0	27	8	13	2	2	1	10	1	4	7	5	8	3	5	3	0	0	0	6	4
7.15	49	0	21	0	1	0	18	0	2	0	38	12	21	14	1	2	5	2	2	7	30	16	4	8	0	4	1	0	6	2
7.30	52	1	30	0	1	0	16	0	1	0	63	13	23	7	2	2	3	0	0	4	54	29	11	6	0	1	0	2	2	2
7.45	57	1	24	0	3	0	4	0	1	0	77	30	28	10	2	4	9	0	3	6	62	24	9	0	1	0	1	0	4	0
8.00	59	0	21	0	0	0	8	0	0	0	62	19	35	11	1	1	14	2	1	8	70	41	9	8	0	6	0	0	6	1
8.15	75	0	32	0	0	0	6	0	0	0	62	24	35	18	0	3	11	1	4	7	41	25	9	15	0	3	0	0	4	0
8.30	78	0	27	0	0	0	8	0	1	0	57	30	39	11	2	1	18	0	4	10	27	14	11	6	0	3	0	4	3	1
8.45	35	0	16	0	1	0	11	0	2	0	59	18	34	11	3	1	10	0	1	5	23	13	4	5	0	1	0	2	4	1
9.00	55	0	29	0	1	0	16	0	1	0	50	21	43	20	3	4	14	0	1	3	10	17	8	2	0	0	0	0	4	2
1100																														
1115	29	1	33	0	1	0	9	0	1	0	34	42	43	14	1	4	22	0	3	6	18	13	5	13	0	1	0	1	3	1
1130	48	1	50	0	0	0	16	0	0	0	113	28	47	20	0	1	14	1	2	3	10	11	3	10	0	2	0	1	3	1
1145	13	0	21	0	1	0	6	0	0	0	88	33	38	24	0	1	6	0	1	4	12	12	5	7	0	1	0	1	2	3
1200	12	0	18	0	0	0	7	0	0	0	75	26	57	0	0	4	7	1	0	6	15	13	5	5	0	1	0	0	0	2
1215	21	1	15	0	0	0	6	0	0	0	146	27	64	23	0	2	9	2	0	3	16	11	4	1	0	4	0	0	2	0
1230	26	1	26	0	0	0	7	0	0	0	51	38	16	16	0	0	13	1	3	6	13	9	2	7	0	1	1	0	0	3
1245	26	1	113	0	1	1	8	0	0	0	177	63	58	14	3	1	15	2	3	8	9	10	2	11	0	2	0	0	0	2
1.00	26	2	14	0	0	0	2	0	1	0	175	86	47	29	1	1	23	2	0	3	11	14	2	10	0	2	1	1	5	4
1.15	10	0	9	1	0	0	6	0	0	0	127	99	39	40	3	2	7	2	6	7	15	2	5	4	1	1	0	1	2	4
1.30	43	0	21	0	0	0	4	0	0	0	169	104	49	28	2	1	15	1	8	8	18	25	4	6	0	2	0	1	1	8
3.30																														
3.45																					34	28	2	6	0	2	0	4	0	4
4.00	42	3	21	1	2	0	10	0	5	0	126	42	68	20	4	6	10	1	12	7	28	12	7	9	1	4	1	0	2	2
4.15	35	0	38	1	2	0	12	0	0	0	85	42	41	18	0	3	10	2	4	7	21	8	1	7	0	2	1	0	2	2
4.30	29	0	28	0	0	0	11	0	0	0	125	40	44	31	5	2	13	0	3	6	15	13	8	7	0	3	0	0	0	4
4.45	49	0	39	0	0	0	7	0	0	0	114	52	46	19	2	1	12	2	21	6	12	9	5	7	0	2	0	0	1	5
5.00	32	1	26	0	0	0	10	0	1	0	144	51	59	14	1	3	12	3	1	4	15	8	5	2	4	0	1	0	0	7
5.15	15	0	14	1	2	0	[illegible]	0	5	0	235	97	75	30	4	5	16	2	4	9	25	0	11	0	1	0	0	0	3	0
5.30	2[illegible]										139	76	42	23	0	3	8	2	7	6	33	0	9	0	2	0	0	0	3	0
5.45											136	99	48	20	2	2	13	0	11	7	29	0	8	0	3	0	0	0	5	0
6.00											99	87	35	15	2	4	8	0	2	5	20	17	6	4	1	2	0	0	4	7
6.15											132	124	36	28	1	2	7	2	3	8										
6.30																														
6.45																														
7.00																														