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Rural Road Accidents in Iran:

Analysis, Comparison and the Cost

by

Esmail - Ayati

A thesis presented for the degree

of

Doctor of Philosophy

The University of Aston in Birmingham

May 1988

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Summary

In the general introduction of the road-accident phenomenon inside and outside Iran, the results of previous research-works and international conferences and seminars on road-safety have been reviewed. Also a sample-road between Tehran and Mashad has been investigated as a case-study.

Examining the road-accident data and information, first: the information presented in road-accident report-forms in developed countries is discussed and, second: the procedures for road-accident data collection in Iran are investigated in detail.

The data supplied by Iran Road-Police Central Statistics Office, is analysed, different rates are computed, due comparisons with other nations are made, and the results are discussed. Also such analysis and comparisons are presented for different provinces of Iran. It is concluded that each province with its own natural, geographical, social and economical characteristics possesses its own reasons for the quality and quantity of road-accidents and therefore must receive its own appropriate remedial solutions.

The questions of "what is the cost of road-accidents" , "why and how evaluate the cost", "what is the appropriate way of approach to such evaluation" are all discussed and then "the cost of road-accidents in Iran" based on two different approaches: "Gross National Output"and"court award" is computed. It is concluded that this cost is about 1.5 per cent of the country's national product.

In Appendix 3 an impressive example is given of the trend of costs and benefits that can be attributed to investment in road-safety measures.

Key Words:

Road-accident
Iran
Data-analysis
Comparison
Cost

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List of Contents

Main Text of Thesis

Chapter One

Page

Page

Chapter Three

Page

Page

Page

Chapter Seven

Page

Page

Page

List of Tables

Page

Page

Page

Page

List of Figures

Page

Page

Page

Page

Page

Page

List of Sketches

List of Photographs

Page

List of Maps

Chapter One

Introduction and Review of Literature

1-1. Introduction

A feature of development of human society in the latest time is the steadily rising quantity and quality of changes, having a bearing on our lives and the necessity to adapt ourselves to them.

Public attitudes to road problems have changed a great deal over the last ten years or so. In Industrial Countries, concern has increased about the problems of the environmental impact of road transport (atmospheric pollution, visual impact, noise, etc). In all countries, the huge increases in the price of fuels have had effects with countless implications. In developing countries*, whilst the need still exists to build up an adequate road transport infrastructure, there have been increasing demands on scarce resources for other aspects of economic and social investment. In this situation, there is a worldwide need for a restatement of the place to be given to roads in the social and economic life of a country(61).

The characteristics of roads which are especially important in the context of the uncertainty(59) are their durability and their wide-spread effects. In practice, roads become permanent features of the

* There is no any specific definition for developing countries, but usually the countries of G.N.P. per capita below $1400, are categorized as developing countries. Other definitions based on the country's infrastructure and the level of education has been used too.

landscape -many existing roads in Europe are along lines laid down by the Romans 2000 years ago- so that a decision to build has effects which are virtually irreversible. These effects are both profound and pervasive. Roads users are travelling in order to meet a wide variety of economic and social needs, so the effects of roads penetrate to most areas of human activity. Even those individuals and organizations who do not use the road are affected via land use patterns and environmental effects.

These environmental effects by additional road capacities (air pollution, traffic sound, etc) are important and have been studied to be alleviated[(46)]. Road transport is also an unusual combination of the public and private sectors, with the public sector typically incurring less than 10% of the total transport cost (provision of the track) but thereby having a major influence on the 90% or more of costs which are incurred by the private sector (motorists and road transport). More details in the subject of road construction and vehicles operation costs are discussed in Ref (56).

As far as relationships between rural roads, development, safety and the cost of them for developing nations are concerned, case studies evidences point to certain characteristics which in conjunction with road investment may stimulate agricultural development[(27)].

Rural transport in the developing world is dominated by the motor-vehicle. Developing countries as a whole have 16 times more route kilometres of roads than railway and about 7 times more trucks and buses than railway wagons and carriages[(33)]. Although non-motorised road transport is very significant in a few countries (eg in South Asia) in most countries, the motor-vehicle provides the principal means of transport.

Relative to the developed world the developing countries are poorly supplied with transport facilities. For example, developed countries have in the order of twenty times more commercial vehicles per head of population and about thirty times more kilometres of improved roads per head than the developing countries[27].

By the entry of the motor-car into the lives of people, into the production process, transportation of loads and goods -especially into the independent conveyance of passengers- began the complicated process of adaptation of human society to the new technical phenomenon. This assimilation concerned not only the vehicle itself, but also the technical and special characteristics of roads, it took place as far as the habits, the conscientiousness and the entire psyche and behaviour of people are concerned -of drivers and passengers in vehicles, of pedestrians in towns, adults, children, young and old people. The motor-car began to influence more and more the thought and behaviour of people, their environment and their life style, the program of the working time and the utilisation of their leisure.

The motor-vehicles have revolutionised road transport and have brought inestimable benefits to the community. Unfortunately, these benefits have been obtained at the cost of an annually increasing number of persons killed and injured on the roads. World Health Organization estimate in twenty years ago[82] for annual global number of road deaths was 150000 and for the number of persons injured six millions. Jabbari's estimate in 1981 was 300000 deaths and 10 million casualties[37]. Since that time, WHO conclusion was that "the failure to contain this veritable epidemic is a matter of great concern".

No doubt, the formation of a highway system improves a country's standard of living. Productivity is increased with ease of access to markets and lower transport costs for goods are realized. However, the frequency and severity of highway accidents, as will be discussed in this research work, can diminish these benefits.

In previous research works and reports[3,4,46&83] it has always been emphasized that it is rarely ever possible to attribute the occurrence of a road-accident to a single factor. The cause will generally depend on the inter-action of a number of factors. Therefore, responsibility for road safety does not rest in any one academic field, but is spread over a truly multi-disciplinary area. However, these disciplines cannot work in isolation as the findings of their research can affect other areas. Also there are found interrelations among the accident rate and the elements of roads and volumes and structure of traffic flow[70].

Considering above, some of the most important road safety-related components have been taken to include[80]:

1- Specific road design and traffic engineering measures which have had an impact on road safety.

2- Measures to improve the conditions and design of vehicles.

3- Road user education programs.

4- Introduction or revision of highway legislation.

5- Traffic law enforcement.

6- Post-accident assistance.

7- Collection and analysis of traffic accident data, and

8- Road safety studies.

1-2. The Importance of Road Accidents

Social and economic cost of road-accidents and its great physical and psychological impact on individuals as well as societies, is one of the most important research topics these days. This importance in developing countries is many times greater. Because the number of accidents are generally increasing and the cost of accidents -direct and indircet- is also greater in comparison with developed countries (38&39).

Statistics relating to mortality show that road accidents are among the leading causes of death even in technically developed countries and that they are responsible for more deaths in the age-groups

15-25 than any other cause[82].

In the United States, the motor-vehicle mileage death rate in 1984, although the lowest on record [2.68], produced 29100 deaths over 43000 miles of interstate system, which carried about 350 x 10^9 miles of travel[52]. According to the U.S. Federal Highway Administration, this is about 20 percent of the total travel on all of the nation's roads.

Throughout the world, road traffic accidents are a serious public health problem[83]. In many developing countries, the problem is already severe and will become increasingly so as motorized transport increase.

The public health consequences of this situation are now serious in terms of the medical resources used to treat road accident trauma cases which in some countries occupy 10%[82] and in some developing countries occupy up to 30%[83] of hospital surgical beds.

Jacobs & Fonracre[38] estimated that road accidents cost averagely each of developing countries one percent of their total Gross National Product (G.N.P). The cost of motor-vehicle accidents in 1984 is estimated to be "at least" $47.6 billion in The United States[52].

The comparison of road accidents in developing countries and the number of diseases in those countries are also important to be considered. World Health Organization statistics show in 1973,there were 136,000 small pox,109,500 cholera, 130,000 louse born typhus and 1,300 polio in developing countries, but 800,000 cases of road-accidents.

As it will be seen in this research work, the lack of education and scarcity of financial and economic resources in developing countries, have caused the number of accidents to be rising. On the other hand, the majority of people at risk as car occupants are the professionals and the most valuable people for these countries. For example, the author's father who was a professor in the school of theology, University of Teheran, was killed in a car-accident in 1964. Also in recent years many important persons, members of parliament, jurnalists, military high rank officers, professors, judges, politicians and scientists have been killed in road accidents in Iran*.

In spite of the importance of this issue and considerable effects of safety on transport and accessibility policies(48&60) as the 1981 WHO conference in Mexico concluded, the ratio of resources devoted to safety research against the economic cost of accidents has since declined and continues very unfavourably with any other field of activity. The purpose of a transport policy is to make available to the users the most appropriate system at the lowest possible cost for the community(61). Therefore, the socio-economic cost of road-accidents should be carefully observed. Only by associating explicitly the costs with the prospective occurrence of road accidents and by developing explicit values and relating these with their avoidance, can highway transport planners in developing countries hope to achieve consistency, let alone efficiency, in the allocation of scarce resources for the improvement of road-safety.

Many reasons have been provided for the importance of road-accidents(39) in different research works and the efforts should be continued for better and deeper awareness that road safety is both a mo-

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* Ettela'at(second largest circulated daily newspaper in Iran), Edition 17781, 6th January 1986.

ral and economic problem that deserves attention.

The massive restoration and rehabiliation actions including "highway design for safety, roadside safety hardware, traffic control, special highway users programs, accident data uses, traffic control and management, motorist information systems" and planning for future works in highway safety as a "long range initiatives" in U.S.A[77] and other developed countries, all indicate the increasingly awareness of the impact of road accidents and the importance of road safety.

The evidence on the magnitude of the road accidents problem in developing countries is, despite serious limitations in available data, clearly sufficient to demonstrate[80]:

1- That road accidents in many developing countries are the second leading cause of death in the economically active age brackets.
2- That the economic value of road accident losses is typically of the order of 1-2% of G.N.P.
3- That accident rates per vehicle-km are vastly higher (10 to 15 fold) than those in developed countries.
4- That the problem appears to be steadily worsening despite the slowdown in growth of motorization and of annual distance travelled per vehicle which has been experienced in most countries since 1973.

Despite of all the important points outlined above,it must be borne in mind however, that it is sometimes difficult for planners and officials from more fully developed societies to understand the priorities faced by leaders within developing nations[63]. The first priority within rural and regional development is one of establishing reliable and usable roads for the greatest numbers of people. This is especially a concern when a nation such as Indonesia, with a population which is 30 millions more than Brazil (eg app. 180 millions), has tremendous demands on government funds for employment, education, agricultural development, and general social development. In this regard, considering the network requiring such needs,it is necessary to maximize the lengths of road by strict limitation of the capital costs to be incurred on a unit basis.This means that much of the road network may not be provided during the first years at a good standard. However, farmers would prefer to have their rice moved on a poor road rather than not at all. The population would prefer to have 10 km of reasonable road as compared with only one km of high quality road.

1-3. Review of Literature

Road safety in developing regions has started to appear on the agenda of international road safety conferences.

In 1965, in Alexandria, the World Health Organization convened an Inter-Regional Seminar on the "Epidemiology, Control and Prevention of Road Traffic Accidents". Then in 1967, the WHO Regional Office for Europe convened a meeting in Leningrad on the "Organization of Resuscitation and Casualty Services". In the same year another WHO symposium on "Human Factors in Road Accidents" met in Rome[82].

In 1979, formal consideration of what role the World Bank should have in the field of road safety was initiated in a seminar symposium[80]. That seminar involving technical experts from various countries and organizations and co-sponsored by the Pan-American Health Organization (PAHO), had two main aims. First, to assess the magnitude of economic and human losses involved in road accidents in developing countries and, secondly, to evaluate what is known about the effectiveness of the various counter-measure programs commonly used to reduce the frequency, severity, and consequences of accidents.

Between P.I.A.R.C* XVII World Road Congress in Sydney (Australia) in 1983** and P.I.A.R.C XVIII World Road Congress in Brussels (Belgium) in 1987, eight National Reports contributed to P.I.A.R.C committee general report: "Roads in developing regions"(60), describing both research and safety programme studies.

In parallel with this, road safety in developing regions has started to appear on the agenda of international road safety conferences. For example, "The 15th International Study Week on Traffic Engineering and the Driver, Venice, 1985" and also "The 2nd World Congress of PRI, Luxemburg, 1986" can be mentioned.

Some of the other important international meetings dedicated to the subject are:

- WHO/IAATM conference on road safety in developing countries, Mexico, 1983.
- The seminar on the same subject at the International Centre for Transport Studies in Amalfi, 1984.
- Possibly the most significant: The first road safety congress in Africa Organized by the ECA in 1984.
- Finally, the most recent conference debate on road safety and

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* Permanent International Association of Road Congress.

** In which the author took part as the head of the Iranian joint delegation of the Ministry of Road and Transport and University of Teheran.

infrastructure in XVIIIth P.I.A.R.C. congress, which spanned the whole range of more than 80 member countries, embracing both developed and developing regions.

Many developed countries are now assisting developing countries with their safety problems through technical assistance and studies/consultancies, often financed from bilateral or multilateral aid programmes. Some of the most important in accordance with their reports to XVIII P.I.A.R.C congress[60] are as following:

- In the United Kingdom the TRRL has continued its programme of research into road safety in developing countries funded by the U.K Overseas Development Administration. In addition to updating studies on rates and trends in general a microcomputer accident analysis system has been developed and is being used on a pilot basis in six countries.
- In Sweden a research work commisioned by the Swedish International Development Authority into problems of road safety in Southern Africa.
- A technical aid project in Thailand funded by the Japanese International Co-operation Agency.
- The Indian Roads Congress has been holding a series of regional workshops on highway safety throughout the country, and in 1986 organised an International Road Safety Seminar at Srinigar.
- The Germans are working in Malaysia, a relatively highly motorised country by developing country standards, and with a good accident data base and an active national road safety council.
- The Australian Road Research Board (ARRB) is trying to bring "recent advances in econometrics" to bear on the analysis of

road accident data. Although not specifically for developing countries or regions, the long term aim is to increase the understanding of contributory factors.

- The Spanish efforts seem to be concentrated not in the Third World, but in developing regions within an industrialized country. Safety is seen as a serious problem on low-traffic roads, with some 50% of the fatalities occurring on secondary roads, despite the fact that they carry only 15% of the total traffic.

As it can be seen, the increasing importance of the subject, and limited scope of the work and space available makes it impossible to go through all or even most of the relative literatures, but some of the most important ones are as mentioned above. Also some of them are mentioned as references in other parts of this research work. However, as Willoughby (Director TWD, Ref. 80) concluded:

"Only little can be said at this point about the efficacy of accident prevention/attenuation programs or of particular components in them."

Research has demonstrated that the causes of accidents are a complex interaction of vehicle, road, environment, and human factors. Some experts emphasize that most interventions programs which depend on altering human behaviour (e.g. prohibition of drunken driving, seat belts use and vehicle inspection) are difficult to enforce. But spot engineering improvements (such as speed-and traffic-control devices, traffic segration, intersection design, and elimination of accident "black spots") have proved generally effective. Therefore, research works and different studies have been conducted to define at least relative cost-effectiveness of different types of intervention programs[27,64&71].

1-4. Road Accidents in Iran

The reasons for severe consequences of road accidents in developing countries explained in different research works[27,37,38,39,56,60&71], are also possible to be more or less identified in Iran's road accidents. Additionally, there are some specific characteristics, which will be discussed in this research work. These are because, Iran is a big country with many different territories and people with their own natural, economical, historical and educational backgrounds. In this section of the introduction, major aspects of the road safety problems in Iran will be concisely reviewed.

1-4-1. Road Engineering in Iran

The total length of road network in Iran from 1949-73 is given in Ref.(37). The more recent information as the author of that research work mentioned in page 29 of his thesis, was not available for him at that time. Fortunately, however, a detailed information concerning the lengths and standards of different types of roads (motorway, major, minor, rural and access roads) in accordance with the Ministry of Road and Transport (M.R.T) specifications and definitions from 1978 to 1985 is given in the chapter three of this research work.

Several studies have shown very clearly that a practical measure of primary importance for the prevention of road accidents is improvement of the planning, design, construction and maintenance of roads[83]. Such studies have established that a width of 7 metres is absolutely necessary for two-lane roads to ensure road safety conditions, especially in places like Iran whose roads carry a large number of slow-moving vehicles, (see photos 1-1 and 1-2). Unfortunately, however,

Photo 1-1

Photo 1-2

there is a very long way to go before this requirement is likely to be met in Iran. Table 3-1 shows in 1985 from 140,743 km of total existed road network, 123636 km, i.e. 88%, is categorized as minor, rural and access roads.* In another word, 88% of roads are two lane ones, which in accordance with M.R.T specifications and standards have less than 7 metres width. Of course, rural and access roads usually are low-volume roads, but minor roads which consist (34,981 / 140,743) x 100 ≅ 25% of total roads, are those which normally connect populated areas, carry considerable volume of traffic, including slow-moving ones, but still possess less than 7 metres width.

Road safety can also be improved by an appropriate shoulder-width, roadside obstacles, improving horizontal and vertical alignment, and better sight distance. Unfortunately again, these important requirements are not met even in important major roads of Iran. One of the major reasons for the involvement of pedestrians in traffic accidents, especially on busy arterial roads in the vicinity of urban areas, is the absence of physical segration of pedestrians (see photo 1-10, Table 3-9 and fig.3-7).

Because of the author responsibilities in road sector, especially acting for two and half years as the planning deputy-minister of road and transport, he was supposed to have a personal road inspection in different parts of the country at least once,every other week. This responsibility provided a unique opportunity to observe almost all the road network system in such a big country. Nevertheless, however, for the sake of scientific considerations relating to this research work, he travelled 950 km in 1985 from Mashad to Teheran and examined the road between them

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* For definitions, see section 1-9.

and also the safety situation personally and carefully. Teheran is the capital with 7-8 millions population and Mashad the second largest city in northern-east corner of the country with app. 2 millions of population (see sketch 1-1). These two largest cities of the country are connected by two different roads. Road(a) passes through the midland, but road (b) which was inspected, passes through the northern provinces. This sample road is more important and usually contains heavier volumes of traffic, because of its scenic beauty and the economic importance of the northern teritories*.

Most parts of this 950 km road, are "major two-lane roads**" and serve a heavy traffic volume shown in scketch 1-1, (see photos 1-3, 1-4 and 1-5 for part b-1, photos 1-6, 1-7, 1-8 and 1-9 for part b-2, photo 1-10 for part b-3, photo 1-11 for part b-4, and photo 1-12 for part b-5).

As it can be seen, most parts of such a "major" road is a typical 7 metre asphalt road, with many deficiencies and short comings, the most important as follows:

1- The width is too narrow for its heavy volume of traffic.
2- In most parts, there are not sufficient horizontal and vertical alignment. In some parts not at all.

Part b-1 which is from Teheran to Amol, is called "Haraz road" and is well-known in the country as one of the most dangerous roads.

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* For more detail see the introduction of chapter 4, section 4-1.
** For definition, see section 1-9.

Road "a": Teheran-Mashad in the South.

Road "b": Teheran-Mashad in the North:

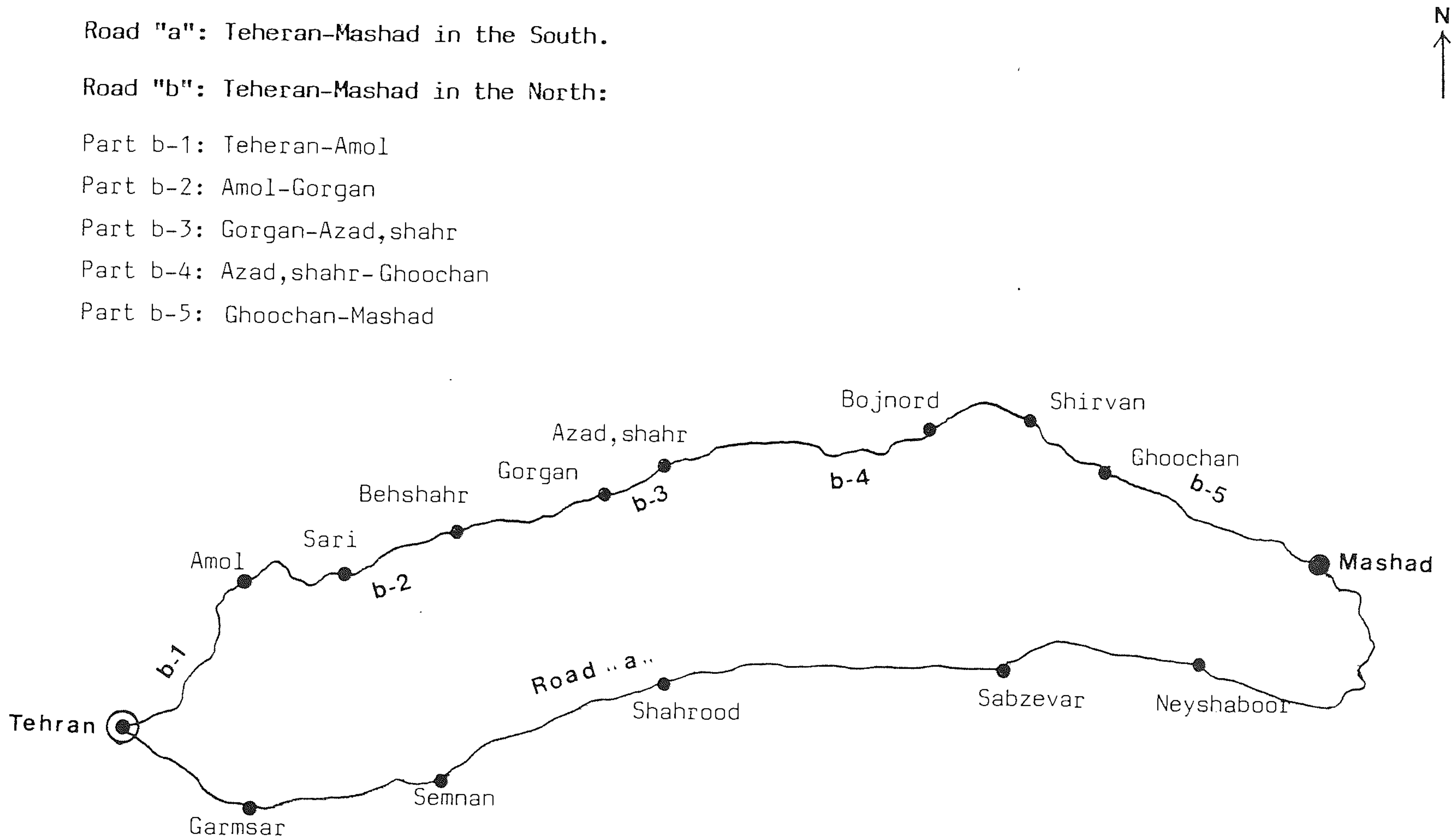
Part b-1: Teheran-Amol

Part b-2: Amol-Gorgan

Part b-3: Gorgan-Azad,shahr

Part b-4: Azad,shahr-Ghoochan

Part b-5: Ghoochan-Mashad



Sketch 1-1 : Two main roads of Iran between Teheran-Mashad.

Photo 1-3

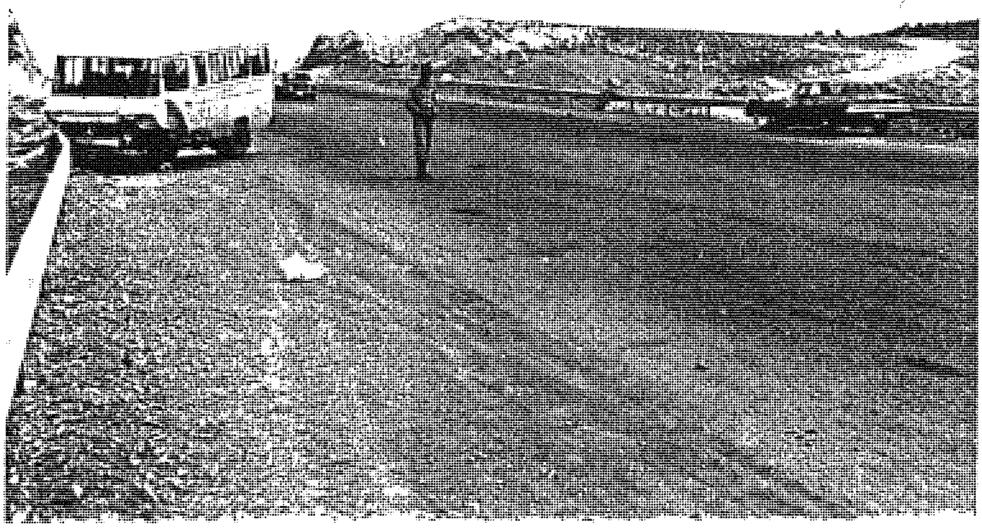


Photo 1-4

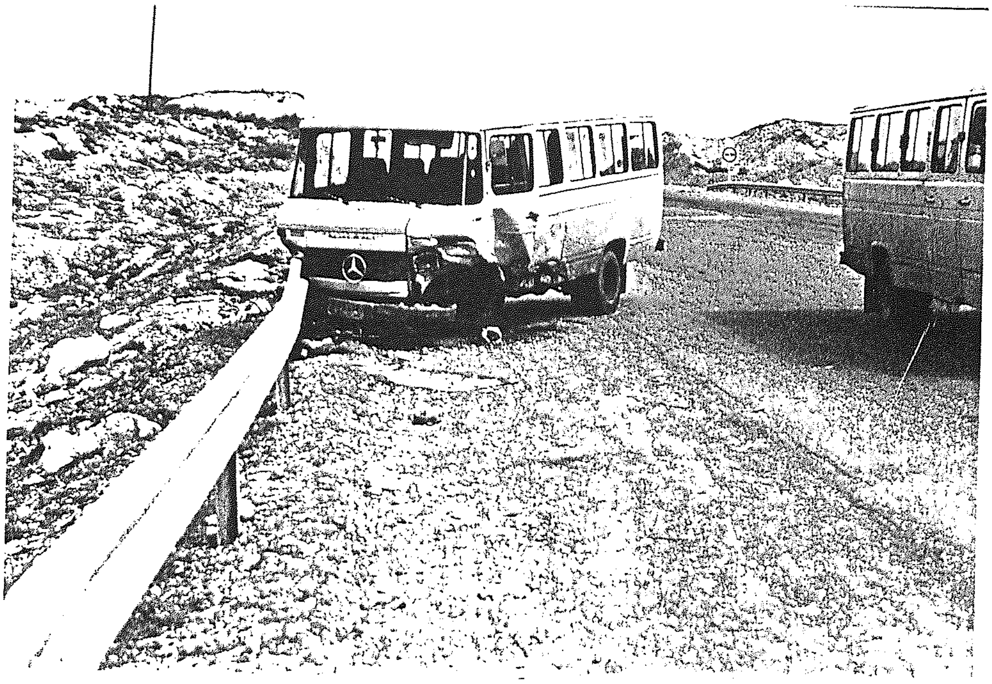


Photo 1-5

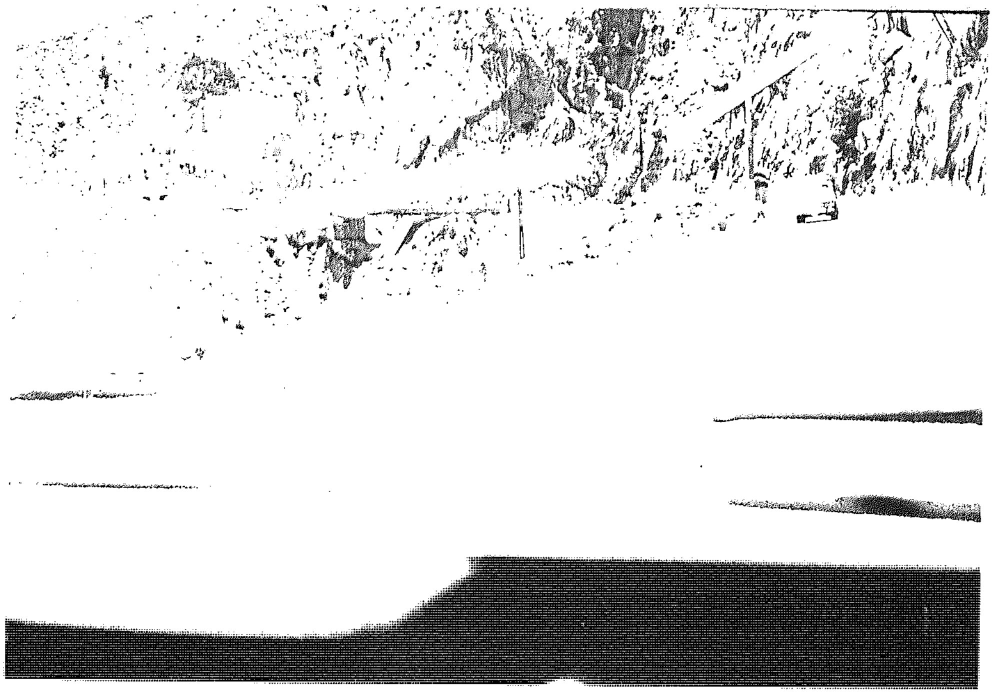


Photo 1-6

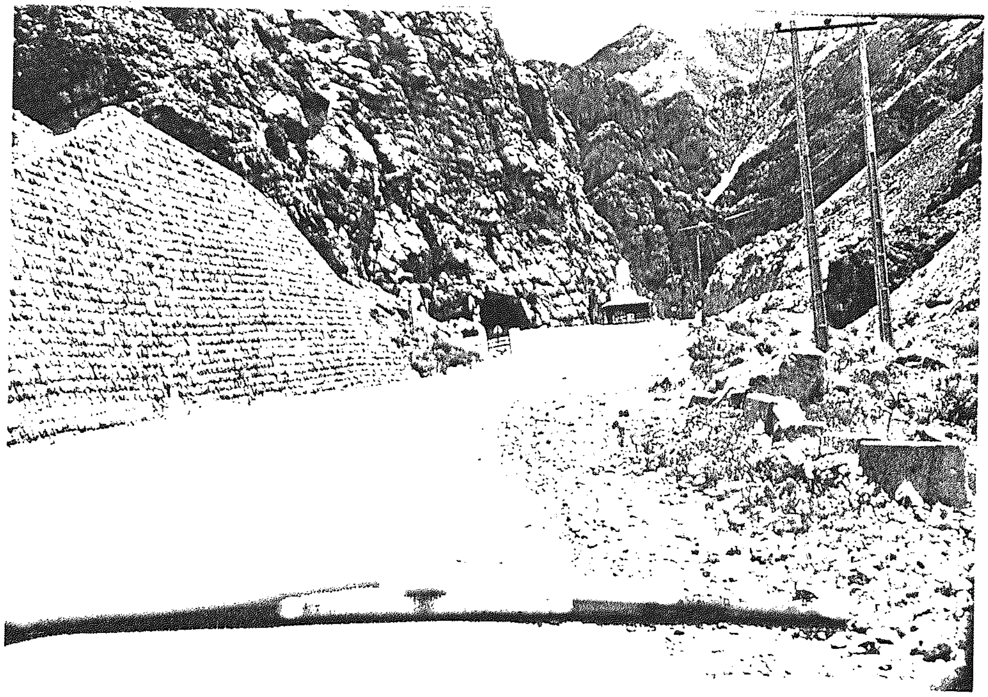


Photo 1-7

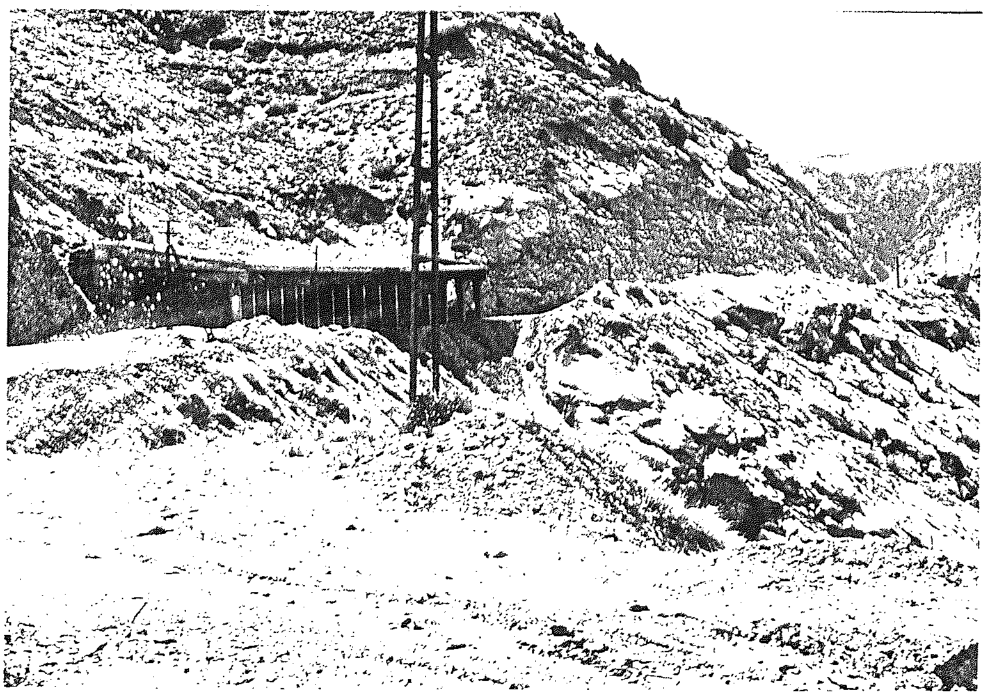


Photo 1-8

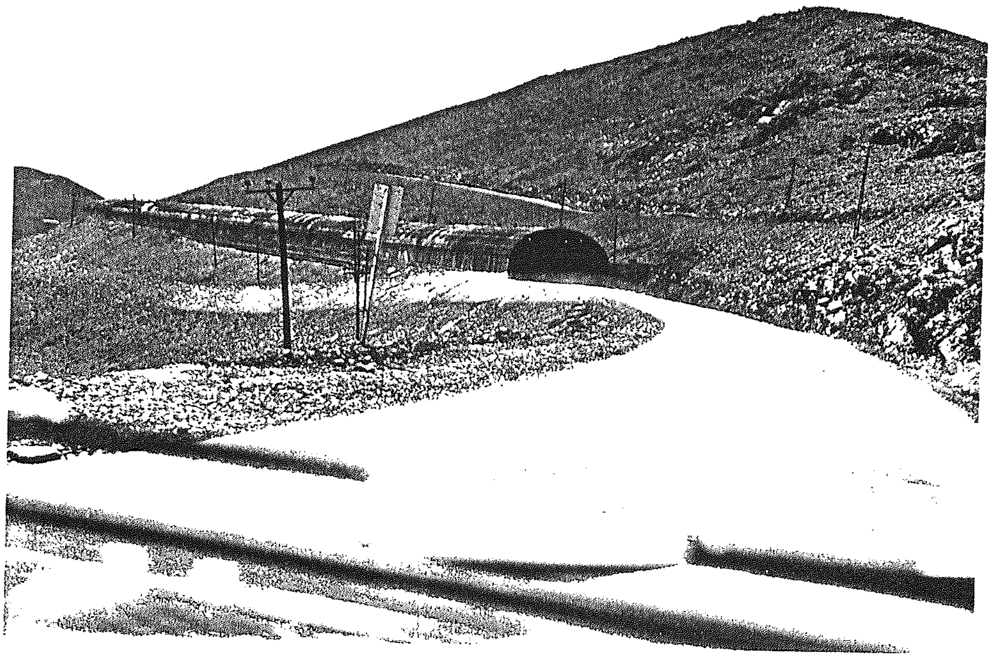


Photo 1-9

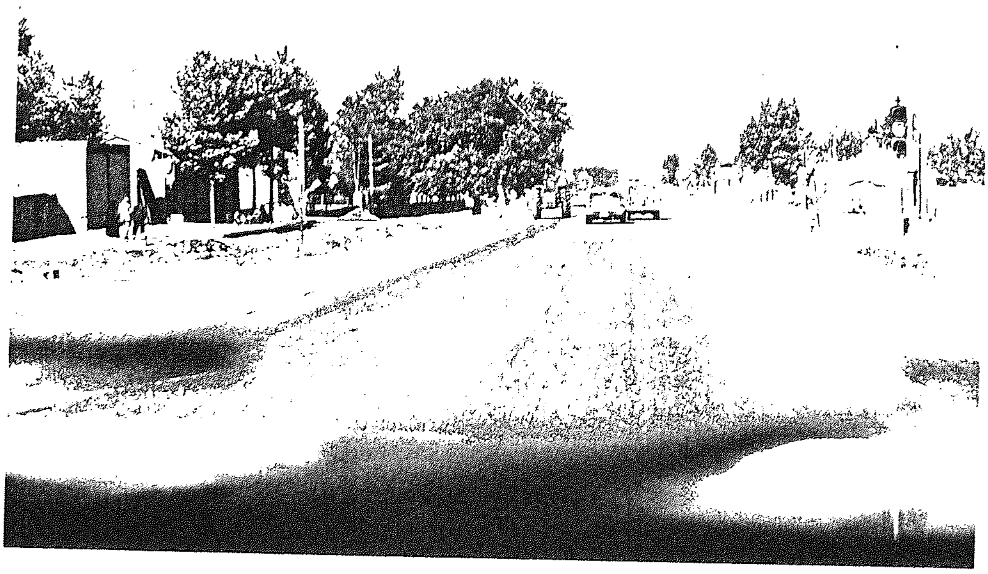


Photo 1-10

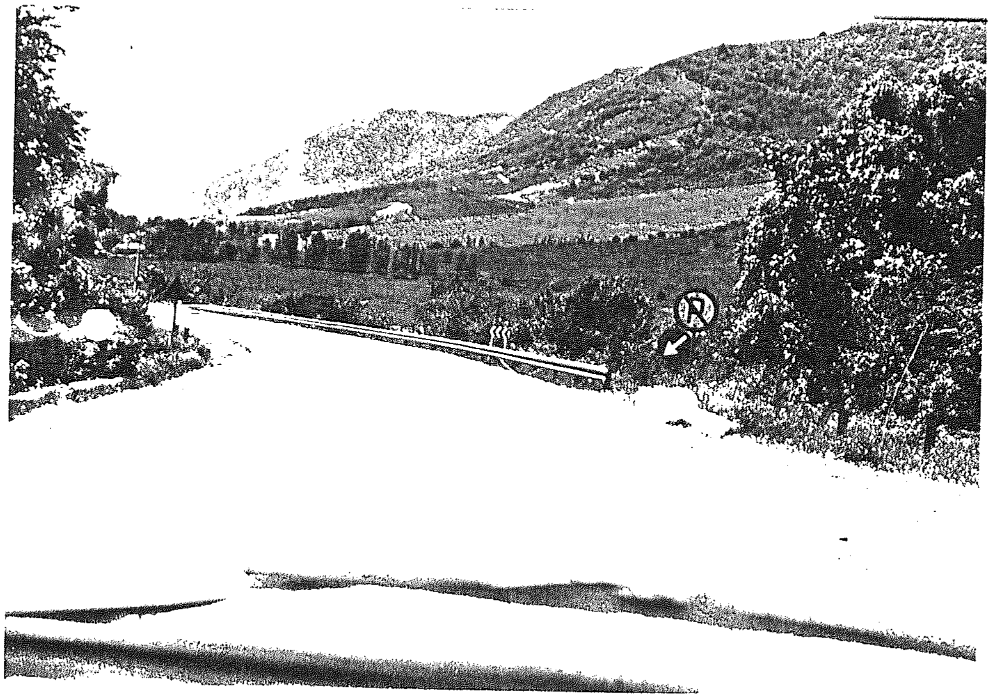


Photo 1-11

Photo 1-12

This is because the high "Alborz" mountains which is a natural huge separator of northern Caspian areas from mainland must be passed by this part of the road. Thousands of people have been thrown into the nearside deep valleys, or have been killed and injured under the fallen stones or have been buried under the fallen heavy avalanches in the winters. Photo 1-3 shows some sections of part b-1 which are widened, but still as it can be seen the road contains dangerous deficiencies in asphalt pavement and no alignments are observed (see also photos 1-4 and 1-5). The dangerous bend in photo 1-6, deficiency in shoulders in photo 1-7, and recent built avalanch-protectors in photos 1-8 and 1-9 are seen. Photo 1-11 shows some small sections which are properly designed, built and maintained. Photo 1-12 shows a typical unpaved rural road branching from this part. Photo 1-13 shows part b-5, between Mashad and Ghoochan, which is recently widened to a four-lane road, and photos 1-14 and 1-15 show different stages of construction for widening operation. This part because of width and vehicles' speed and no physical separation between traffic, has caused more severe accidents after widening and re-surfacing operation. For example at 2 o'clock in the morning of 14th June 1984 a severe fatal accident occurred near Ghoochan in which a Daf truck (H.G.V) passed over a Land Rover comming from opposite direction and then overturned in the opposite side of the road, killed one and injured four instantly. Two of the injured also died later, one before and one in hospital. Photos 1-16 to 1-21 show the scene of the accident from different angles. The causes for this fatal accident was declared by Road-Police* as follows:

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* For definition see section 1-9.

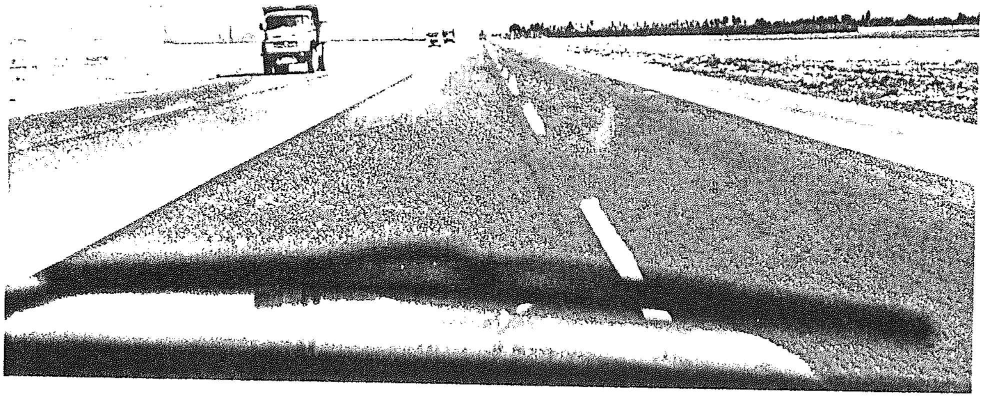


Photo 1-13

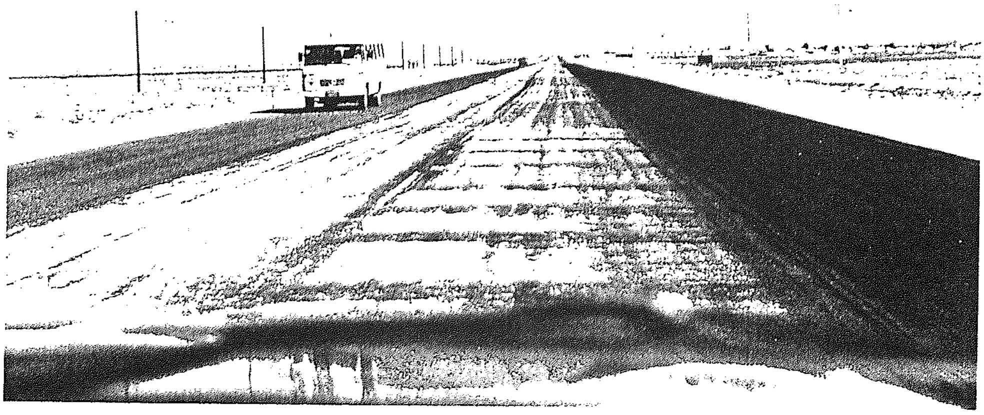


Photo 1-14

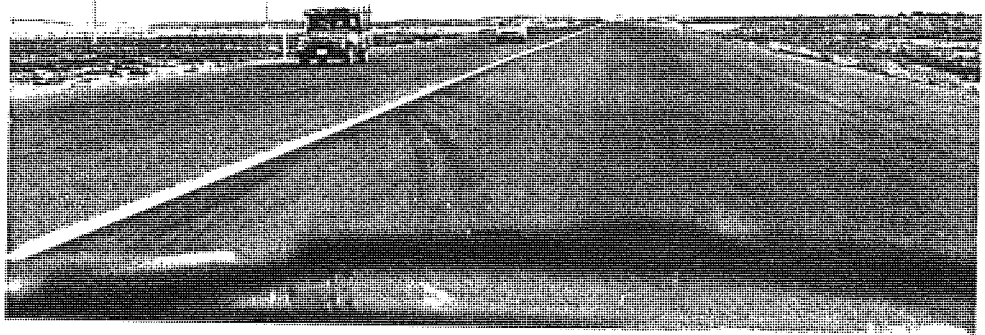


Photo 1-15

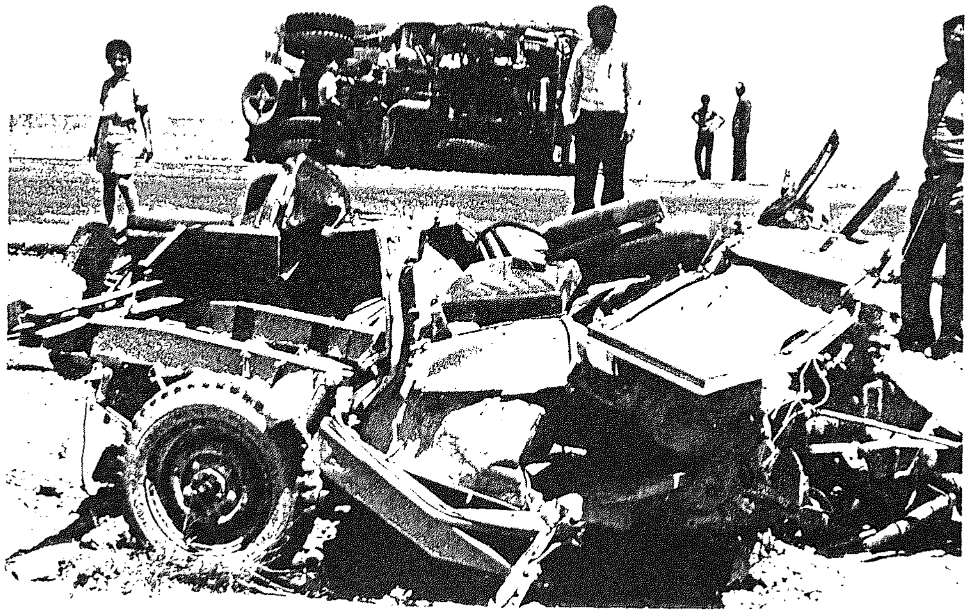
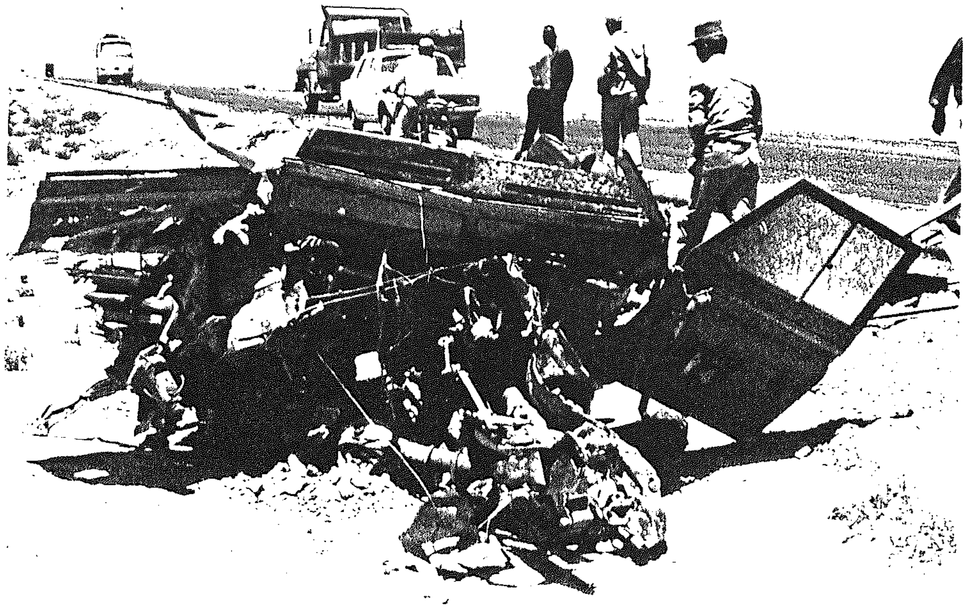


Photo 1-16



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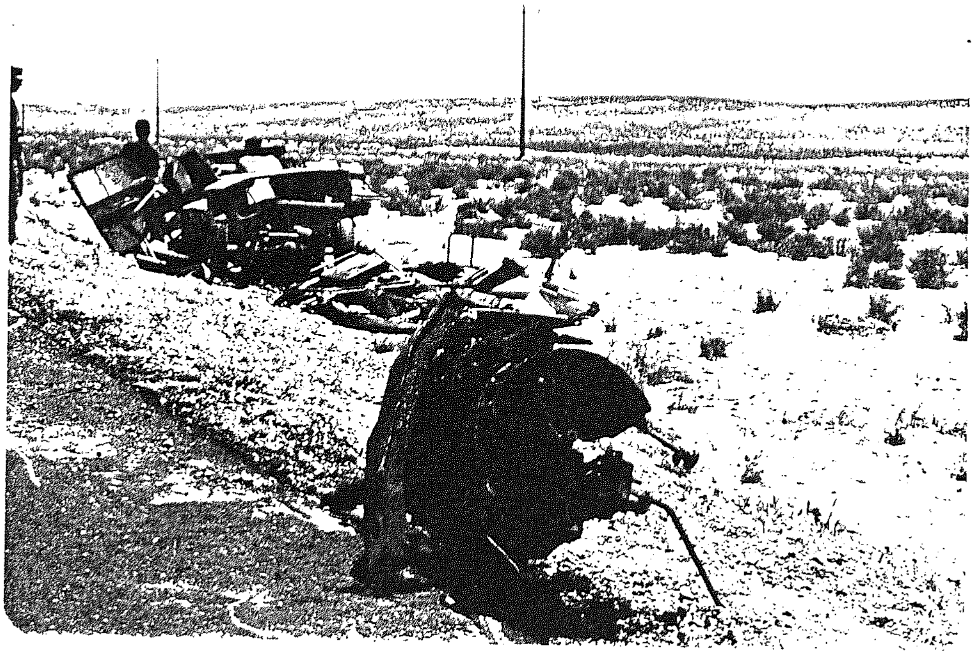

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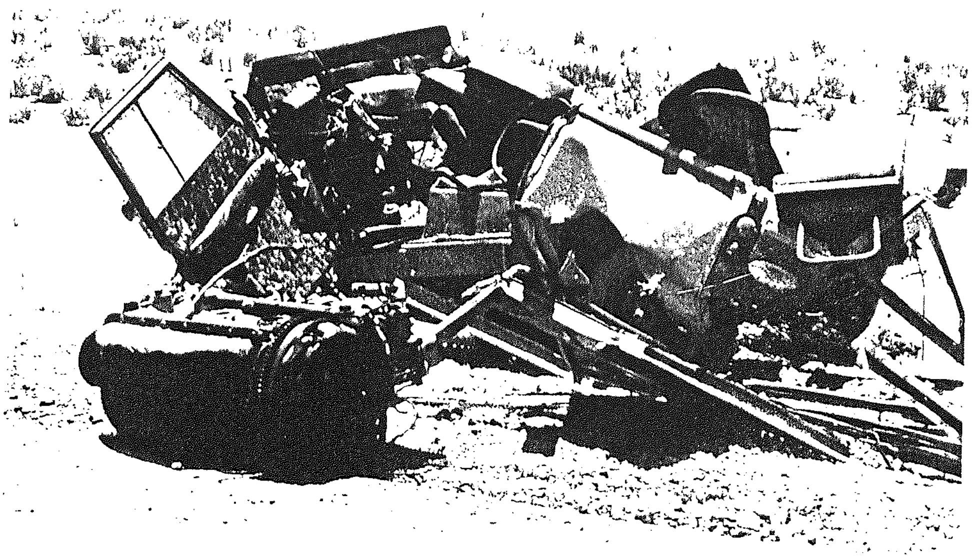

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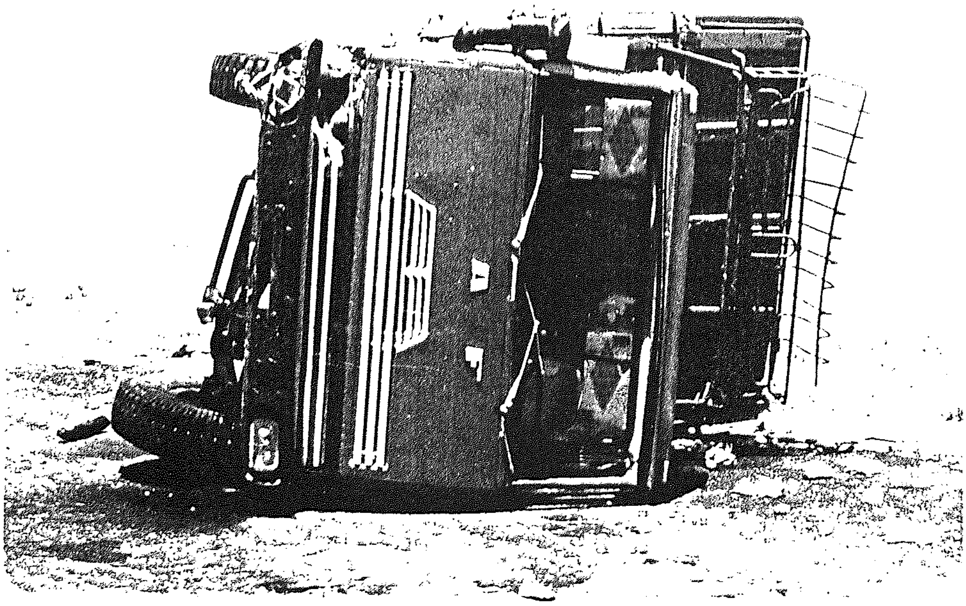

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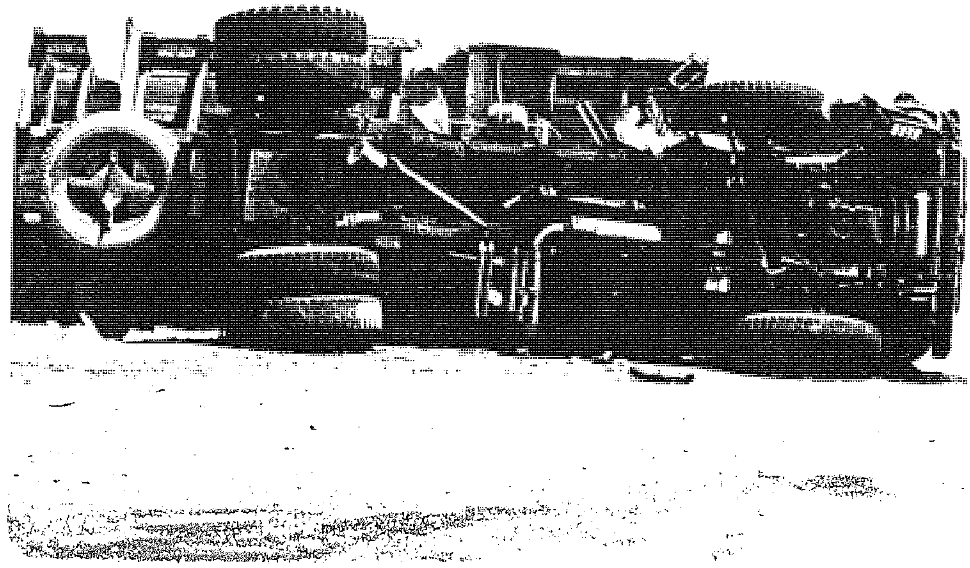

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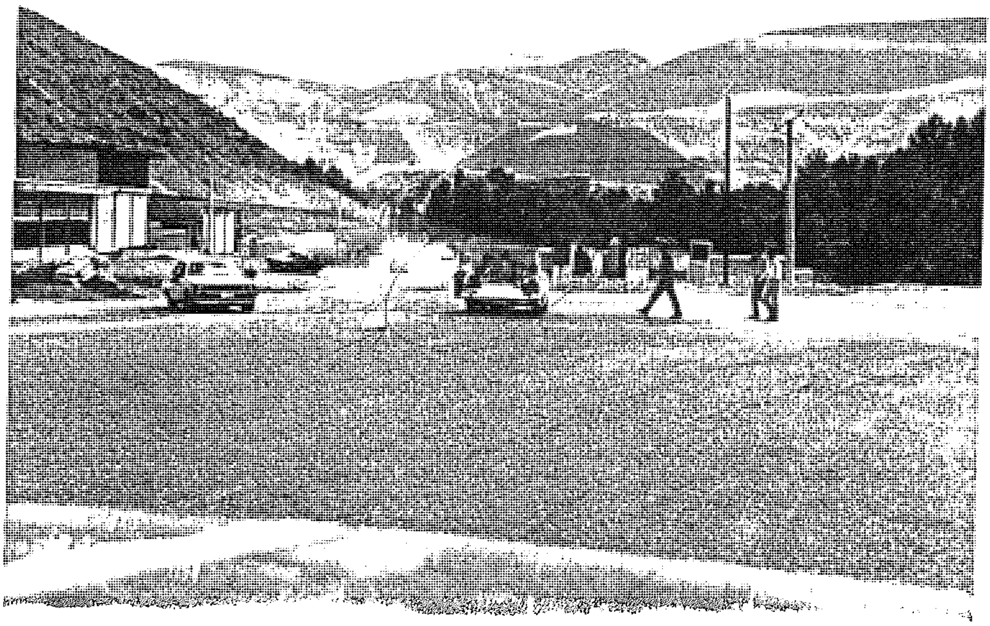

Photo 1-22

1- The lack of any means of traffic segregation, in such a high-speed road.

2- The lack of alignment and informing signs.

3- Limited sight distance.

4- Drowsiness of both drivers at night.

1-4-2. Vehicle Safety in Iran

Vehicle safety measures can be both "primary" and "secondary" in nature[41], the former aim at preventing an accident occurring whilst the latter attempt to protect the road-user during the course of an accident. In Iran vehicles' parts are imported but assembled locally. Because of the reasons explained in the following chapters, the standard of safety in vehicles assembled and the standard of vehicle maintenance are both poor in Iran. Periodic inspection of heavy good commercial vehicles is common but there is no control on private light vehicles' technical standards. The way in which buses carrying people hanging on the outside of the vehicles in some developing countries like India, is not seen in Iran, but public and commercial vehicles' overloading, or lorries carrying large numbers of workers, are quite common in Iran, and even children are seen to be carried in the rear trunk of the passenger-cars (see photo 1-22). The way in which these vehicles are used leads to potentially dangerous situations. The application of restraint systems, especially the use of seat belts for vehicle occupants, and crash helmets for motorcyclists are extremely rare.

Motorcycling has been shown to be a particularly dangerous activity, no matter where to apply. Even in Great Britain the fatality rate (per million vehicle mile travelled) of motorcyclists in 1977 was almost 30 times greater than that for car drivers, despite the introduction of the compulsory wearing of helmets in 1973[41]. In Iran motorcyclists are a major casualty group, particularly in urban areas. Nontheless, there are plenty of cyclists who travel with high speed on roads and on overloaded vehicles (see photos 1-23 and 1-24). In accordance with Keyhan* of 25th May 1986, for example, a family of five (husband, wife and three children), travelling on a motor-cycle were killed and injured in a road accident in km. 15 of Teheran-Saveh road on 24th May 1986.

Photo 1-25 shows a family (husband, wife and baby child) are travelling on road on a motor-cycle.

Slow-moving vehicles as are shown in photos 1-26, 1-27 and 1-28 are also causes of accidents in developing countries, including Iran.

1-4-3. Traffic Law Enforcement in Iran

With the generally low standard of road-user behaviour that exists in Iran (see table 3-16), it is important that adequate traffic law enforcement is provided by police. Despite this, however, as in chapter two will be seen, the lack of sufficient road-police presence on Iran roads and the lack of sufficient equipment and training combined with socio-economic reasons have caused the traffic law enforcement to be comparatively relaxed in recent years. Little research has been carried out in this field to assess the potential of police enforcement for accident reduction in developing countries[41]. However, in chapter two of

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* Keyhan is the largest circulated daily newspaper in Iran, in Farsi language. Keyhan International is published in English.

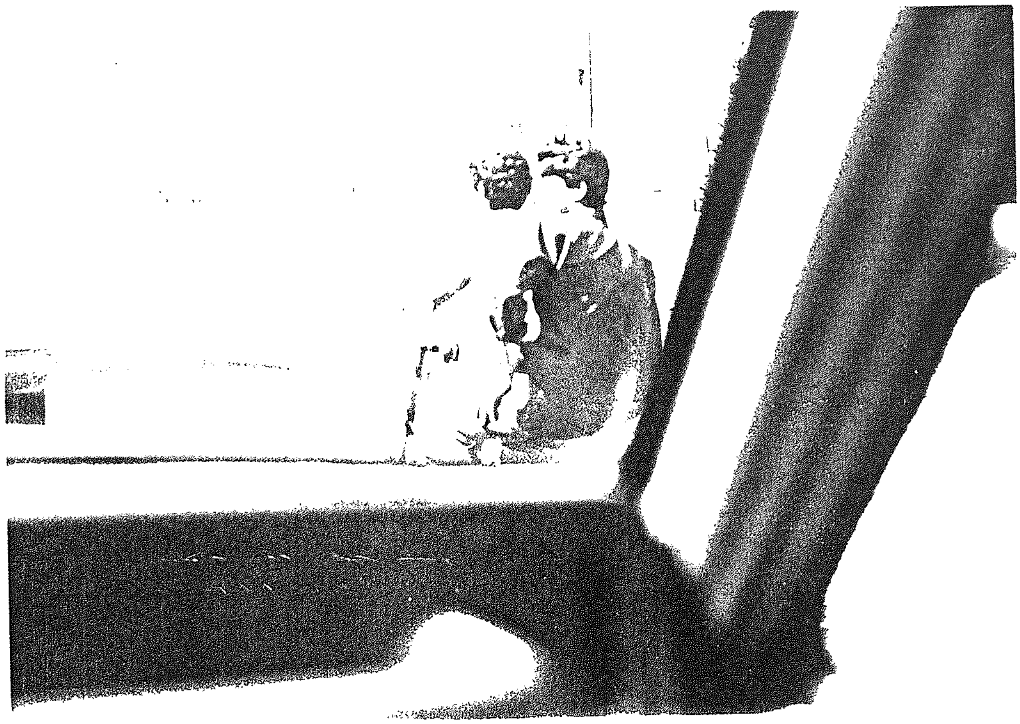

Photo 1-23

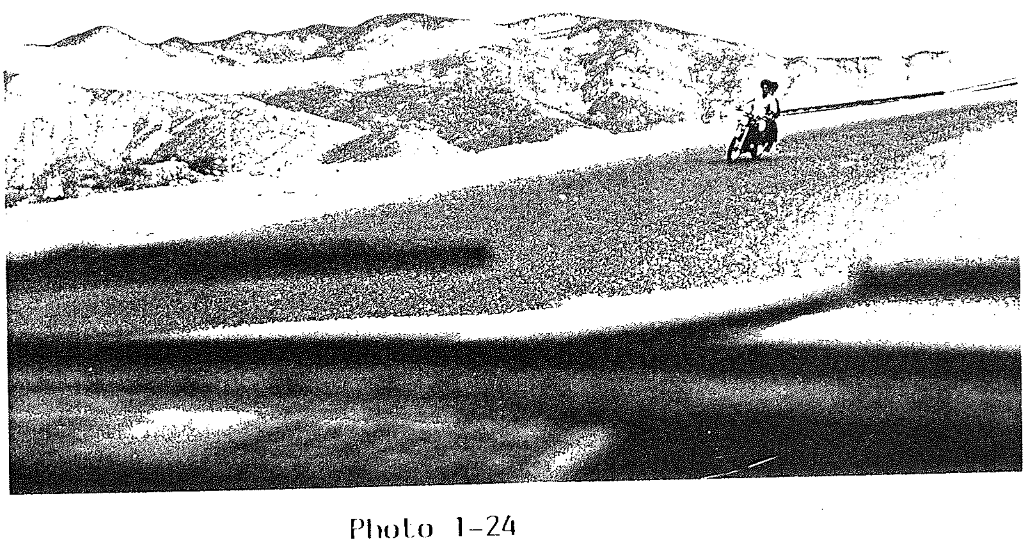

Photo 1-24

Photo 1-25

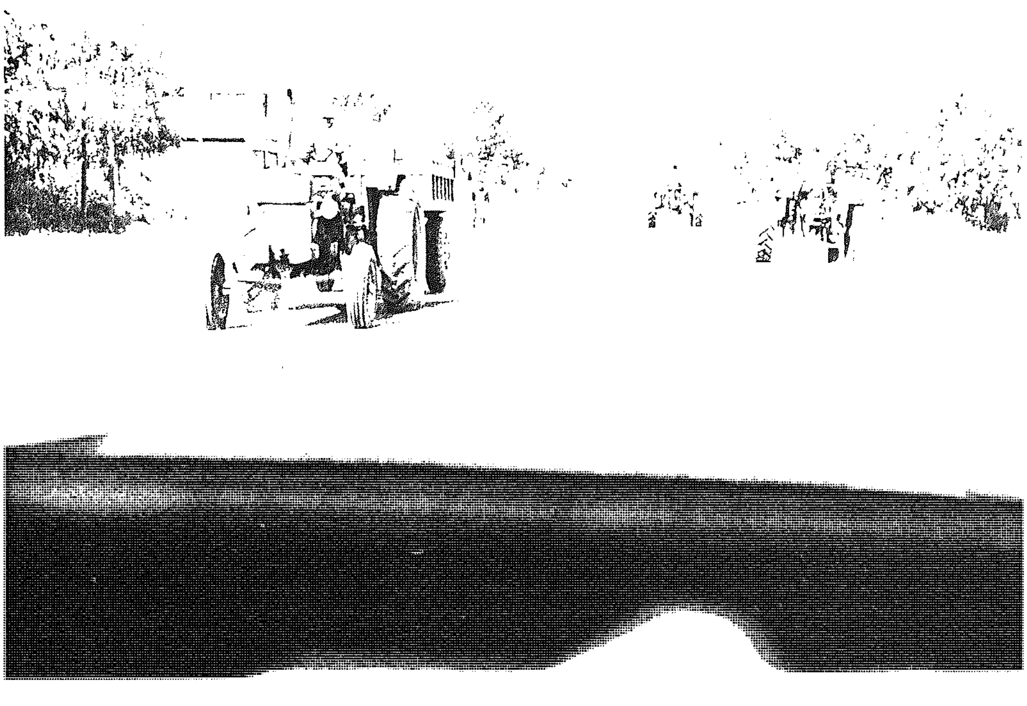

Photo 1-26

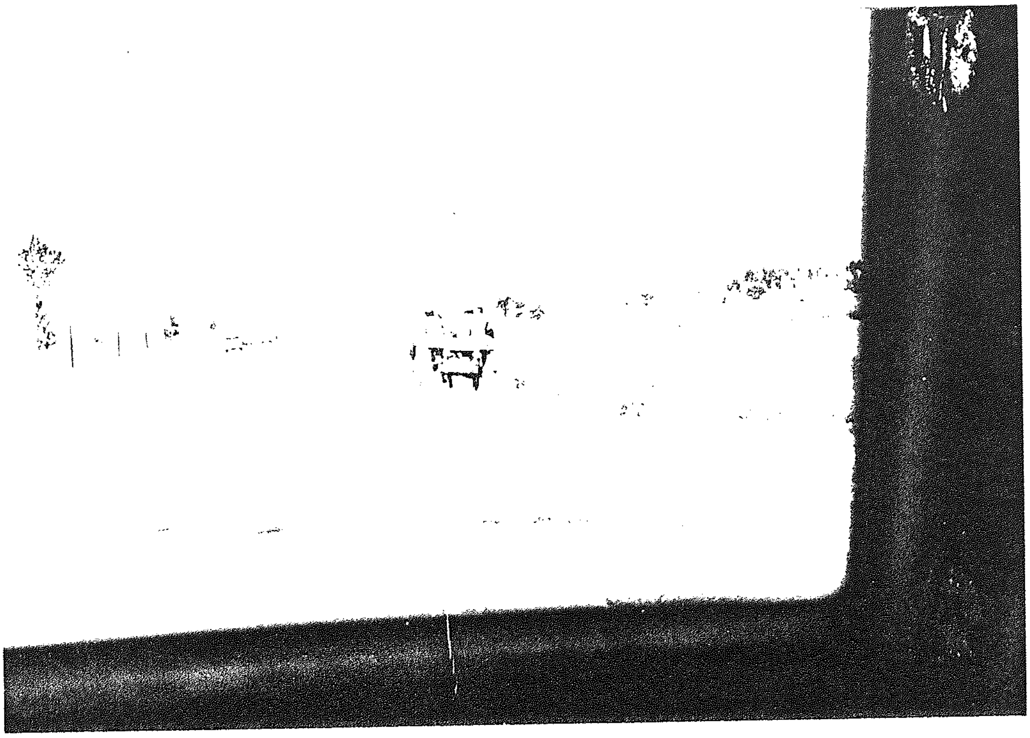

Photo 1-27

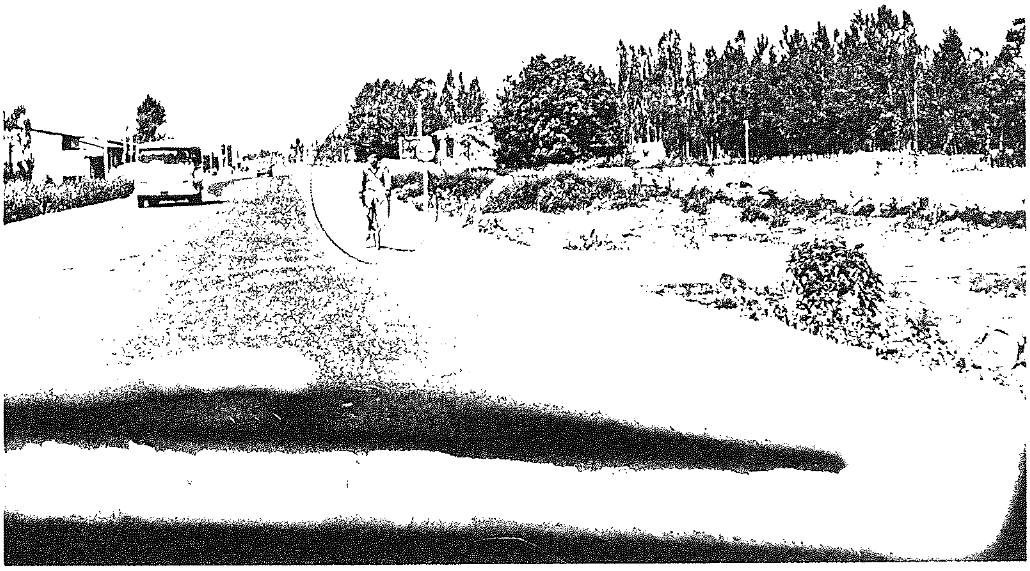

Photo 1-28

the research work, when discussing road accident data collection and reporting system in Iran, some information in this regard will be provided.

One of the problems with road-police organizing system in Iran is described in Ref.(50) as follows:

"The road-police is the only controller and supervisor for transport regulations and traffic law enforcement on the roads. Unfortunately, however, it is acting under another governmental organization* and at present time instead of controlling and supervising M.R.T maintenance and safety regulations, is concentrated on his own security activities. Therefore M.R.T.,is not in possession of any means to execute its own safety regulations on the roads."

Carrying family members in open vans (photo 1-29), improper overtaking in dangerous situation especially by heavy vehicles (photos 1-30, 1-31 and 1-32), non-authorized careless parking (photo 1-33), swing to left (photo 1-34), travelling without vehicle number-plate(photo-35) and similar severe violations, some of them in front of police are to be observed quite often these days on the roads in Iran.

Especially speeding which is proved to be one of the most important causes of traffic-accidents[20&84] is not controlled by police, except for heavy vehicles by controlling the time-limit between two road-police stations**, which is not a reliable method.

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* This problem will be discussed in detail in chapter two.
** For definition see section 1-9.

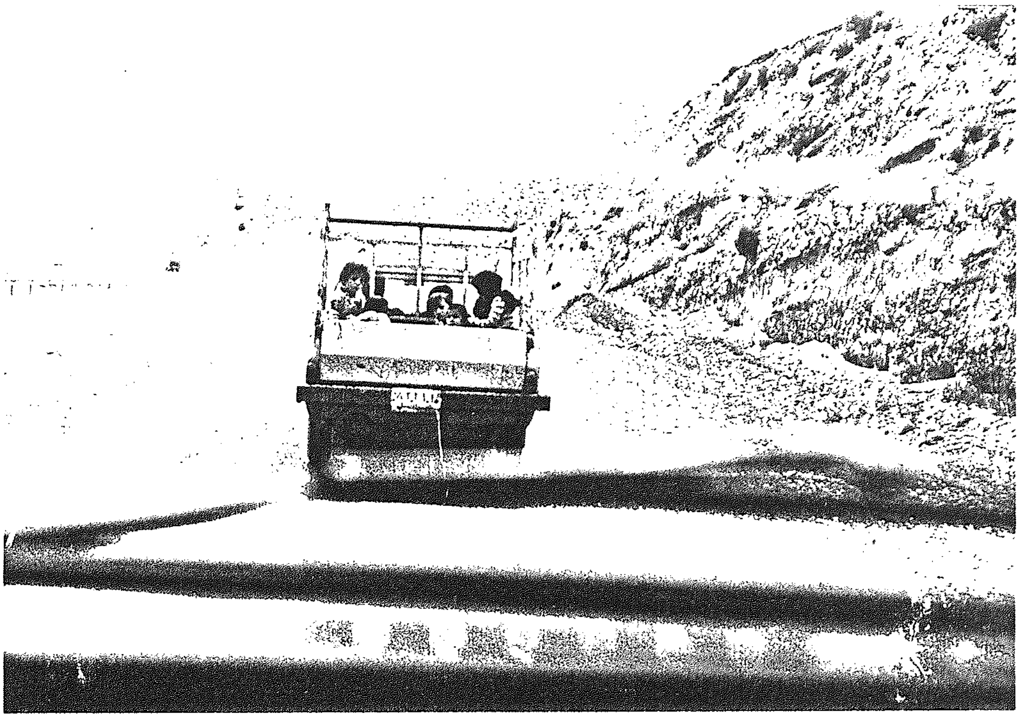

Photo 1-29

Photo 1-30

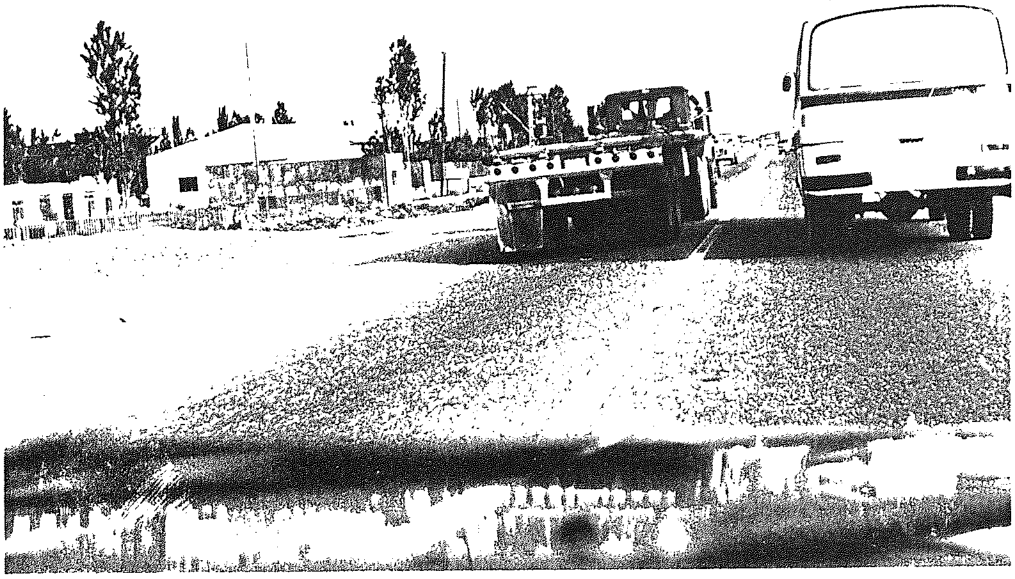

Photo 1-31

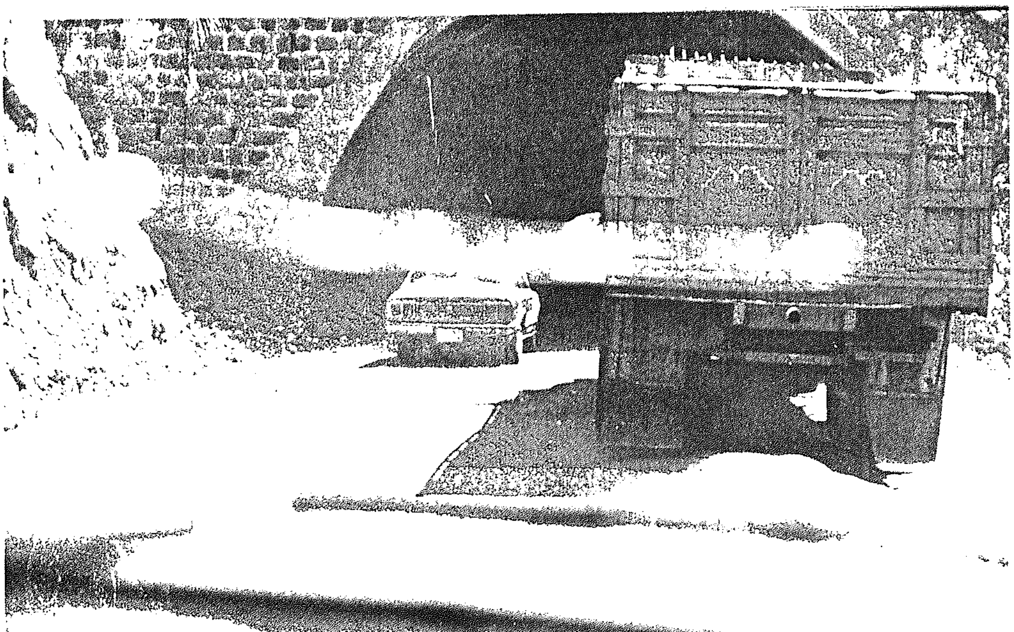

Photo 1-32

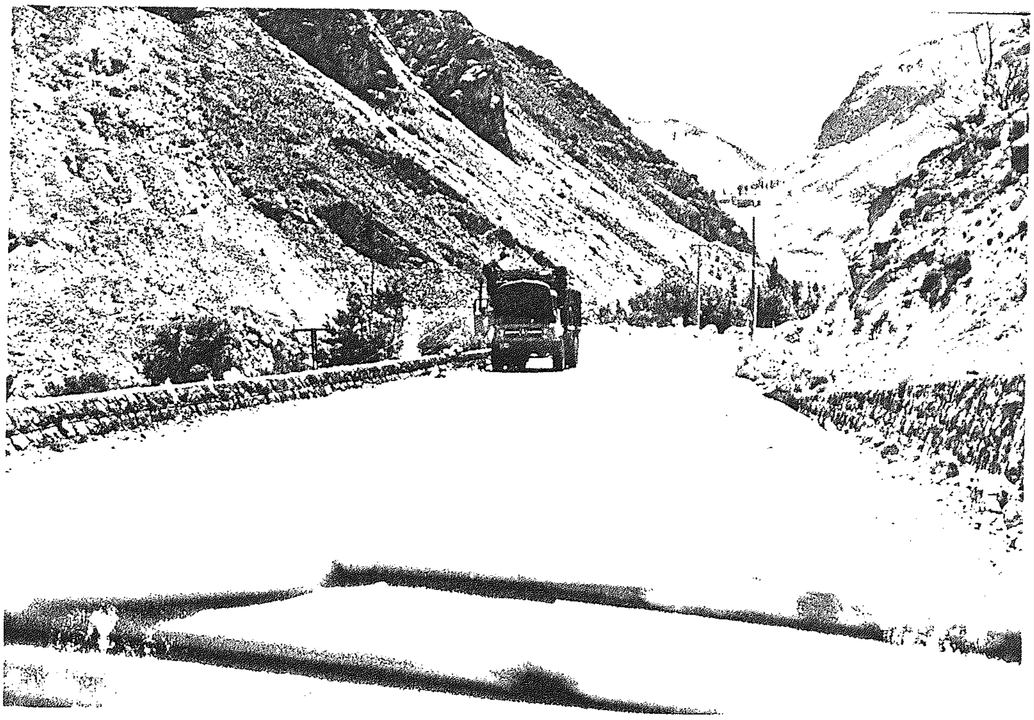

Photo 1-33

Photo 1-34

Photo 1-35

1-4-4. Education & Training in Iran

Human factors contributory to accidents, manifest themselves in ways which can be grouped under four main headings as follows[83]:

1- Manner of execution

2- Perceptual errors

3- Impairment

4- Lack of skill

WHO studies which is performed in collaboration with OECD, devides the manner of execution to "deficiency in action" (like too fast, improper overtaking... etc) and "deficiency in behaviour", (like irresponsible or reckless, frustrated, aggressive... etc). In total 2,042 accidents assessed in those studies, the majorities of errors were deficiencies in actions, and only 2% of the total being ascribed to deliberate aggressiveness or irresponsible behaviour. Unfortunately, however, this ratio is considerably higher in Iran (see sub-section 3-7-3).

The result of studies explained in Ref (82) shows in twenty years ago (1967) there were needs for further education and training even in developed countries. French police statistics, covering 85,000 accidents resulting in injuries in 1964, showed that 75 percent were caused by serious traffic infringement. Of all traffic fatalities in Italy in 1965, 58 percent were attributed to excessive speed, incorrect overtaking, and refusal of priority. It was said to be not uncommon for fights to take place between drivers in Italy at that time. In 1967 two such fights ended in deaths and convictions of homocide. Previously, this was also the situation in Iran, but fortunately it is not often seen such fights on roads and streets in Iran.

Fatigue, in both its physical and emotional components, is believed to be an important factor in increasing risk of accident involvement. Many cases have been reported in Iran, of accidents occurring as a result of loss of attention or falling asleep while driving (see subsection 3-7-4 and table 3-17). A number of studies have been carried out to determine the effect on vigilance of prolonged tasks of a repetitive kind[82]. The results of these studies are important in determining the effect of fatigue on various aspects of driving performance.

As far as the knowledge of traffic rules and regulations are concerned, there is also a great need for education and training.

In order to gain an understanding of drivers' knowledge of road safety matters in developing countries, drivers in Jamaica, Pakistan and Thailand were interviewed at roadside and asked questions about traffic rules and recommended drivers procedures[41]. The study found that there were gaps in drivers' knowledge but in only a few topics was there widespread lack of knowledge.

Major M.R. Partovi, a road police officer, in his interview with "Keyhan, Edition No.12578, 24th october 1985" declaring the result of a traffic law knowledge test on 800 drivers, said that: "Only a few of them could distinguish and understand the vertical alignment and informing notice-boards." This lack of knowledge is more noticeable among illiterate drivers which are mostly agricultural vehicles' drivers and some professional rural heavy vehicles' drivers. The command of Khorasan (the largest province in Iran with 330,000 square km area) road-police in his interview with Khorasan* edition No.10938 of 3rd

* Daily newspaper published in Mashhad and circulated in the province of Khorasan in Farsi language.

May 1987, said that Khorasan road-police in 1986 could organize studying and training classes for 14,000 students who lived around major roads, and also for 2,700 agricultural tractor drivers. "They did not possess even the preliminary traffic-knowledge", he mentioned.

1-4-5. M.R.T of Iran Activities for Roads' Rehabiliation, maintenance and Safety

After Islamic Revolution of 1979, most of the attentions were focussed on construction of new and especially rural roads. Because of this and also the lack of necessary facilities, the important issue of maintenance and safety was almost forgotten(50)*. From 1981, M.R.T and its related general-offices in the provinces, realizing the great damages sustained in the past years, took some steps for roads' rehabiliation, maintenance and safety. The most important are as follows(50):

1- **Changes in the system organization of related general-offices in the provinces:**

   With these changes, the responsibilities for maintenance and safety were concentrated in a separate department acting under a new deputy for each province general-officer.

2- **Increases of M.R.T related general-offices and maintenance departments in the country:**

   In the provinces of Fars, Khorasan,Systan & Baloochestan and also Mazandaran (see enclosed map of Iran), because of the vast areas they possess, two M.R.T general-offices were established in each. Also, the maintenance departments were in-

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* Also see section 4-2.

creased throughout the country. Nontheless,. however, because of the deficiencies especially in equipment, it has not been yet possible to activate all of the above mentioned organizations.

3- Providing new equipment for general offices:
During the years 1981-1984 more than 3,300 light and heavy different machines have been distributed between M.R.T related general-offices in the provinces. A great number of them are used for maintenance of roads and keep them open to traffic in winter.

4- Organizing seminars and training classes and perparing studying materials related to maintenance and safety for improving the standard of knowledge amongst M.R.T employees in the provinces and remote areas.

5- In 1983, a strong move was initiated in M.R.T, to mobilize all the possible means for improving safety standards in the road network. This move which was called "safety Gehad"*, was quite effective, in such a way that it could be claimed that the most existed deficiencies were caused by the scarcity of equipment, financial resources and trained manpower rather than negligence.

1-5. Justification of this Research Work

The justification of this research work is exactly the same as

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* Gehad means "holy war (or) holy challenge".

was mentioned as Jabbari's justification for his research in 1981[37]. As truely mentioned by him:

"The true extent of the road traffic accident problem in Iran is unknown, and due to lack of understanding of the problem among the official authorities, they imagine that nothing can be done towards road safety development with the existing situation, or if it is possible how it should be approached."

Since that time, fortunately, however, some useful steps have been taken for road-safety in Iran, (see sub-section 1-4-5), but to the extent of the author's knowledge no further research has been conducted.

Especially in the field of the cost of road-accidents in Iran, it is almost cetain that this is the very first attempt to tackle the subject. Also, for the comparison of road-accidents between different provinces of Iran it seems that nothing has been done before.

There is no doubt in beneficial results of the road-safety research works and related remedial measures in all countries. For example, in the United States of America there is a complete record of road-accident data since 1913. Based on the investigations performed and the research works done, and next employing the results in execution of remedial measures, the following results have been obtained[52]:

Death Rate
in the United States

Year	Per 10000 motor-vehicles	Per 100 million vehicle miles	Per 100000 population
1935	13.70	15.91	28.6
1960	5.12	5.31	21.2
1984	2.65	2.68	19.6

As it will be discussed in chapter five, the most reliable base of comparison, is vehicle-mile and this rate has decreased 67 per cent in a quarter of century (1935-1960) and 50 per cent in the next quarter of century (1960-1984) in the United States. This is in a situation that the number and severity of road-accidents have been increasing in developing countries.

Thus, comprehensive programs are required to address the severity of the problem. Such programs are needed to address all elements and do not substitute treatment of one element when corrective action should appropriately be concentrated on one of the other elements.

The basis for identifying problem areas and for developing sound application of corrective measures is a comprehensive traffic record system[(1)]. In chapter two the traffic record system of Iran is examined and due recommendations are made.

The other important issue in this relation is the cost of road-accidents for the countries and communities. The formation of a highway system improves a country's standard of living. Productivity is increased with ease of access to markets and lower transport costs for goods are realized. However, the frequency and severity of highway accidents can diminish these benefits. Motor-vehicle accidents in developing countries may have much greater real cost than has previously been recognized[(71)]. The cost of road-accidents in Iran to the best knowledge of the author, has not been yet considered in any research work. Therefore, a part of this research work is designated to this crucial issue, which has a direct effect on the country's road network planning.

1-6. Difficulties of Obtaining Information and Data for Research Works in Iran

Road-accident information and data--or for that matter, any kind of information and data- in developing countries, are scarce and difficult to obtain[41]. Iran is no exception. Some of the difficulties in Iran is explained in Ref.(37). Also the reasons for this situation and some applicable solutions were proposed by the author as a paper submitted to the first seminar of the universities of Iran for "investigating the difficulties of research in Iran universities", held in Mashad in 1985[6]. Some of the most significant points related to this subject are as follows:

1- The most of information and data, necessary for research works are not available in Iran. The facts and figures usually are not collected, or at least are not properly classified and filed. The society and especially the planners and decision-makers must be taught to understand the importance of information.

2- Those small portions of information, which do exist , are mostly found in governmental offices. But the usual attitude of responsible authorities in those offices is to treat all kinds of information secret. The author explained in his paper[6] to the Mashad seminar, that:

"In the same way that revealing classified information to non-authorised persons is harmful, hoarding the needed non-classified information is also harmful. In such a situation everything seems secret and suspicious, and solving the problems of a secret society is more difficult."

As an example, for the analysis of the road-accident statistics in this research-work, the vehicle-kilometres carried by roads in Iran, were needed. These information are not available in Iran, but to work out at least approximation, the author decided to obtain the figures for consumed fuel in road petrol-stations and by dividing it to an average of fuel used for each 1000 km., work out the needed figures for vehicle-km. Therefore, the author referred to "the Khorasan general-office, Ministry of Oil" to obtain the information, but he was said that an official letter from the University of Mashad (the research sponsoring body) is needed. That letter was provided, but he was then said that the matter must be referred to the Central Office of the Ministry of Oil in Teheran and an official permit should be asked. Since that time, which is more than a year, still no reply has been received from Teheran and the needed information has not been provided.

3- One of the obstacles is the moral situation of the society. Even amongst the educated people, the great need to research works for solving the problems is not properly felt and the ways for carrying out research works are not known. They should gradually understand that every problem in our life has a scientific solution, and that solution which must be the best optimum one, can only be found through conducting a scientific research work.

4- The universities and other research centres must be continously in contact with other parts of the society. The results of the performed research works should permanently be taken into the society and new information be taken back into the research centres. This process of trial and error must be kept active through better and closer relations between agricultural and industrial production and academic centres.

5- Much of the information for different research topics may actually exist in the country, but nobody knows where they are. The relations and exchange of information between different organizations are relatively poor. Of course, some remedial measures during last few years have been taken, but they seem to be deficient in quantity and quality. One of them, for example, "the offices of relations between industries and universities", which were established in the universities and factories, 5-6 years ago, but were not quite successful. The idea was good but the reasons for failure should be investigated. Also the relations between the universities in Iran and the research and academic centres abroad, have been substantially improved but still are not quite sufficient and satisfactory.

1-7. The Structure of This Research Work

Based on what was discussed in the preceeding sections of this chapter, the structure of this research work is based on:

1- Understanding the phenomenon of road-accident and its importance and impact in developed and developing countries.

2- Reviewing the literature related to this subject, including the international seminars and conferences and also different nations' contribution to the world safety studies.

3- Investigations for examining the quantity and quality of road-accident data and information in developing regions and in Iran, and trying to acknowledge the shortcomings. Then, proposing applicable ways to improve the data situation in Iran.

4- Comprehensive analysis of road-accident statistics of Iran.

5- Analysis of road-accident statistics of different provinces of Iran. Bearing in mind, that Iran is a big country (1,645,000 square kilometres of area), containing territories with many different natural characteristics and people with many different historical backgrounds and educations. All of these elements have their own effects on the nature of road-accidents and the effectiveness of remedial measures.

6- Comparison of the road-accidents of Iran with other nations and the comparison of road-accidents in different provinces of Iran.

7- Investigation of the meaning of "the cost of road-accidents" for different societies and individuals and reviewing the related literature. Investigation includes the physical and moral impact of road-accidents and short discussions about the cost-effectiveness of remedial measures.

8- Evaluation of the cost of Iran's road-accidents.

9- Conclusions, proposing recommendations for alleviation of the severe problem of road-accidents in Iran and suggestion of research topics for further research works in the related subjects.

1-8. The Way Ahead

Further progress in preventing road traffic accidents in Iran, requires a great degree of coordinated involvement by a wide range of public service authorities. Highway and other transport authorities of Iran have tried to develop and apply a considerable numbers of successful measures (see sub-section 1-4-5), but still many things are left to be done for road safety in Iran. These include:

1- Improvements in road layout and standards (often quite inexpensive, depending for their effectiveness on an understanding of basic behavioural factors),

2- Much better vehicle performance,

3- The collection and analysis of traffic and accident data, and

4- Realistic enforcement of engineering and legislative measures.

Public health authorities must also contribute to reduce traffic accident mortality and residual morbidity by developing services for the treatment of casualties. They also must try to play a greater part in developing means of preventing road traffic accidents rather than mitigating their consequences. Such involvement of public health authorities might include promoting a greater awareness of community health responsibilities in broader health education of the young- of which traffic education is an increasingly important part- and in dealing with illiterate and less educated people.

What is required in Iran- where skilled human resources are rather scarce- is the maximum cooperation between transport, health, police and education authorities for the benefit of all road users.

1-9. Some Definitions for This Research Work

For the purpose of this research work the following definitions were used:

1- "Developing Countries", "a fatal road traffic accident", "a serious injury road traffic accident", "a slight injury road traffic accident", "a serious damage road accident", "fatalities", "personal injury" and "vehicles" are defined as what is explained in section 2-2 of Ref.(37).

2- **Road Police:** is part of the armed forces in Iran, responsible to patrol the roads and highways to enforce the traffic law on all different type of roads and highways, to investigate the road-traffic accidents and make reports, and to observe and supervise the road-traffic for the best possible safety available.

3- **Road-police Station:** A road-police office located beside a road, acting as the centre point for controling the roads in the radius of its responsibility.

4- **Highway:** A wide road (usually having at least 6 to 8 lanes), in which its traffic is not intercepted by the traffic of other roads,but they overpass or underpass in different levels.Also its own opposite traffic are segregated by a physical separator (traffic island,traffic barrier,etc).

5- **Dual Carriage-way:** A wide road (usually 4 lanes), in which its opposite traffic are segregated by a physical separator.

6- **Major Road:** An asphalt paved road with at least 7 metres width and two shoulders, each of them minimum 1.5 metres width and also with certain engineering standards. This type of road usually connects the provinces' town centres and other main populated urban centres.

7- **Minor Road:** A two-way road with at least 5 metres of width, with a gravel or cold asphalt pavement and to some extent with some engineering standards. This type of road usually connects the small towns or big villages and other main rural centres.

8- **Rural Road:** A road with no minimum specific width or specific engineering standards. Usually with 3-5 metres of width, and with gravel pavement or no pavement at all. This type of road usually acts only as a mean of providing minimum access between small villages and other remote areas.

9- **Access Road:** A very narrow road, with no minimum specific width or specific engineering standard. Usually is only enough to pass one vehicle at a time. This type of road is to provide the minimum necessary access for very remote areas.

1-10. Money and Banking, Measures and Calendar in Iran (85)

1-10-1. Money and Banking

The unit of currency is the Iranian Rial (Rls 134=1£, July 1987). Ten Rials are one "Tooman". The Currency and Banking Act of 1960 requires a minimum gold and foreign exchange support for the note issue of not less than 40 per cent. The same act created a Credit and Currency Board, while parallel legislation authorized the establishment of a Central Bank which took over from Bank Melli (National Bank), the functions of note issue and exchange control. The major banks were nationalised in 1979 and by 1980 there were nine banks in all, practicing Islamic law in which no interest is allowed, though "guaranteed returns" are given.

1-10-2. Weight and Measures

Though some ancient weights and measures are still in use (unofficially) in rural areas and certain commodity markets, the metric system, adopted in 1933, is universally employed for governmental, general and international purposes. The misgal (one kilogram=640 misgal) is widely used for weighing precious metals.

1-10-3. The Calendar

The Iranian year begins on the spring equinox, March 21, and contains 31 days in each of its first six months, 30 days in the next five months and 29 in the twelfth month (30 in every fourth or leap year). The system started from the Hegira (the Prophet Mohammad's flight from Mecca, AD 622), so that 621 was subtructed to give the Gregorian year; (eg, March 21, 1986-March 20, 1987 was the Iranian year 1365).

The road-accident statistics provided by any organization in Iran are based on the Iranian year, which the first 9 months of it correspond to one English year and the last 3 months to the next English year. But for the sake of simplicity in this research work, however, it is assumed that instead of 9 months the total 12 months correspond to one English year. For example, when "the road-accident statistics in 1983" is mentioned, the exact meaning is "the road-accident statistics in the Iranian year of 1362", which is from 21 March 1983 to 20 March 1984.

Chapter Two

The Quantity and Quality of Road Accident Statistics in Iran

2-1. Introduction

Traffic-accident investigation - or for that matter, any kind of investigation - is mainly a matter of obtaining, recording, refining, and interpreting information.

Historical accident data is a significant source of information used by engineers to establish safety programs and implement safety countermeasures.

Accident statistics provide an essential tool for the formulation of road safety policy. They are compiled from thousands of individual accident records and collated at local and national level, and this work reflects great credit on the police and local authorities. These statistics help to guide the most effective allocation of road safety expenditure, and are an indispensable part of the fight to reduce the toll of road accidents.

Local governments, through their law enforcement agencies, gather this data during accident investigation. In developed countries accident reports are analysed nationally by reference to a great variety of characteristics and attendant circumstances and results are used extensively for research work and for guidance in the improvement of road safety in relation to roads, road users, vehicles, and traffic movement. Good examples of this include the annual testing of vehicles, crash helmets for motor cyclists and the proposed seat belt legislation in various countries[21].

Reliability in both the quality and the quantity of accident reports expected from any jurisdiction greatly increases the value of the data base used for safety studies. On the other hand, data discrepancies or deficiencies reduce the credibility of such studies and hinder the effort to make the best use of safety funds.

The importance of accuracy and precision of accident reports is because of their extensive usage. Local authorities make extensive use of road accident data. Engineers use it for establishing priority sites for remedial measures, and previous experience has shown that even low cost measures, such as changing the priority at a cross roads, can be extremely effective in reducing or eliminating accidents at particular sites, providing accurate and early information is available.

Also, road safety officers gain much of their evidence on which to base local and educational programs and training from the data which accrues from road accident statistics. The police, who collect this data, can also use it as a guide to the operational tactical deployment of their patrols in order to fulfil one of their primary roles, the prevention of accidents.

There are inherent weaknesses in traffic accident data. Council and others[18] cite examples including collection practices, reporting methods, data bias, and the nature of accidents.

Even in developed countries, literature review indicates that many researchers have found bias and inconsistency in traffic accident data. None of the previous studies documented the consistency of reporting from location to location or form year to year[74]. Willis, Turner and Colson[79], in evaluation of accident reporting histories, and also Turner and Mansfield in another paper, identified jurisdiction in Alabama, United States, whose accident reporting histories do not match the anticipated trends of the community and in turn suggested reasons for deficiencies in accident reporting. Correcting these kinds of deficiencies is expected to improve the data collection and analysis for all future safety investigations and evaluations.

A consistency problem in reporting arises from a failure to investigate accidents properly. Researchers know that only a portion of the accidents that actually happen are reported[57]. Only 89 per cent of insurance reported accidents were reported by police in one case in the United States, and only 47 per cent of motorcycle accidents in another[28].* An investigation of accidents in Sweden raised serious doubts about the accuracy of road accident statistics in the reporting of fatalities and injuries[11].

It is important, however, to remember that accidents are random events governed by the laws of probability and that unusual patterns are possible and normal under the laws of probability. Therefore, a road could receive some types of erratic accident histories through random chance, rather than through the road's reporting procedures. Not all the roads on such a category list could be termed deficient in reporting practices.

The reporting system must be able to collect the minimum amount

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* Footnote, next page.

of essential information for both local and national use while minimising processing costs and the burden of reporting of the police officer.

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*Also in The U.K. the proportion of injury accidents reported to the police was particularly low for pedal cyclists and motor cyclists where no other vehicle was involved(90).

2-2. Information Supplied in Road Accident Statistics in Developed Countries.

There have always been continuous intensive efforts in developed countries to improve both quantitavely and qualitavely the road accident statistics. The aim is to provide information that is better geared to present day and emerging needs of central and local governments.

2-2-1. Different Levels of Road Accident Investigation

As Baker, a practitioner in both investigation and accident reconstruction for more than 35 years in the United States mentioned in his fourth revision of Manual on traffic accident investigation(67), there are five levels of accident investigation as follows:

Level 1, Reporting

Level 2, At scene investigation

Level 3, Technical preparation

Level 4, Professional reconstruction

Level 5, Cause analysis

There are also laws, standards and administrative considerations used as a basis for traffic accident investigation.

In the past, in developed countries and even now in may developing countries, only two levels of police traffic accident data collection were, and still are, recognized: 1) **"Reporting"**, which required obtaining data for the official accident-report form; and 2) **"Investigation"**, which involved collecting any additional information. If the only information about the accident was that recorded on the report form, the accident had been reported but not investigated. This simple division of accident-information collection into two categories had, and still has, disadvantages. For one thing, designating the first category "reporting" rather than "investigating" is contrary to police concept. Police regard reporting an accident, however simple it may be, as part of investigation. Furthermore, distinguishing only two kinds of investigation lumps together all tasks in addition to reporting and so obscures the important differences between recording observations (measurements and photographs) and reaching conclusions about how an accident happened (interpretation and inference).

Therefore, five levels of accident investigation are now accepted as a recognized procedure in developed countries.

1) Reporting is the basic data collection intended to identify and classify a motor-vehicle accident and the persons, property, and planned movements involved. Only strict factual information is required and no opinions.

2) At scene investigation is examining and recording results of the accident and obtaining additional information at the scene which may not be available later and which supplements data obtained for the accident report. Only factual information is wanted and no conclusion required.

3) Technical preparation is the delayed data collection and organization for study and interpretation. Factual information, besides those obtained for (1) and (2) above, is required in an organized form, and elementary conclusions reached about circumstances of the accident.

4) Professional reconstruction is the effort to determine,

from whatever information is available, how the accident happened. Reconstruction was formally referred to as determining the "behavioural" and "physical" causes of an accident.

5) Cause analysis is the effort to determine, from whatever information available, including results of accident reconstruction, why the accident occured- that is, the complete combination of circumstances that caused the highway transportation system to break down at the time and place of the accident with resultant injury and damage. Cause analysis is largely unsystematized, without generally accepted methodology or forms for recording results. It is almost entirely inferential and by its very nature involves large elements of speculation.

2-2-2. Accidents Reported

In the United Kingdom, only accidents involving death or personal injury occurring on the public highway and in which one or more vehicle(s) are concerned are to be reported[21].

This includes: (a) Accidents on footpaths.

(b) Accidents on private roads to which the public have right of access.

(c) Accidents involving the boarding and alighting of public service vehicles.

(d) Accidents in which a PSV passenger already aboard a PSV is injured. This can occur with or without another vehicle, or pedestrian, being hit.

(e) Accidents to persons repairing their vehicles on public highways, if the injury is inflicted by the vehicle under repair.

(f) Accidents in which a pedal cyclist is involved in any way, including cases where pedal cyclists injure only themselves and/or pedestrians.

(g) Accidents on bridle paths or country tracks etc (where motor vehicles are lawfully allowed to use).

(h) Accidents in which a vehicle runs out of control and has an accident off the public highway.

It excludes:

(a) Damage only accidents.

(b) Accidents in car parks and picnic areas.

(c) Accidents reported to the police 30 or more days after their occurrence.

2-2-3. Vehicles Reported

Complete vehicles' details are required for each vehicle which was involved in, or contributed to, an injury accident. "Vehicles" include "pedal cycles and ridden or driven (but not led) horses" for this purpose.

Vehicles included are:

(a) vehicles in which the Driver/Rider/Passenger was injured, including pedal cycles (or ridden horses) from which the rider fell.

(b) Vehicles which suffered damage in the accident.

(c) vehicles which caused injury to a pedestrian (including parked vehicles on or off the carriageway into which a pedestrian walked).

(d) Vehicles which were in collision with another vehicle in the accident.

(e) Vehicles which did not suffer damage, nor caused nor contained casualties, but which in the opinion of the reporting officer contributed to the accident (including parked, stationary, temporarily held or moving vehicles).

Vehicles excluded are:

(a) Where a person has safely alighted from a vehicle but is subsequently injured when moving away from the vehicle. The vehicle from which the person alighted is to be excluded.

(b) In the case of collision between more than two vehicles, vehicles colliding after the impact which produces the injury should not be included unless they aggravate the degree or amount of injury.

2-2-4. Casualties Reported

Any person killed or injured in a road accident, has to be reported.

This includes: (a) A pedestrian who moves quickly to avoid being involved in an accident, is successful in that, but for example twists an ankle in the process.

(b) A pedestrian who injures him or herself on a parked vehicle.

It excludes: (a) Death/injury to babies unborn up to the time of the accident.

(b) Those who have a road accident as a result of illness (e.g. a heart attack) or death immediately prior to a road accident and whose injuries/death is not ascribed by the court to have been a result of the accident. Other casaulties in those accidents should be reported.

(c) Confirmed suicides.

(d) A pedestrian who witnesses an accident and suffers shock but who is not directly involved.

2-2-5. Variables Included in the Reports

In developed countries it is usual for accident variables, vehicles variables, casualty variables, police force codes, local authority codes and central government contracts to be mentioned by reference numbers in accident reports. These numbers are readable by computers and later can be easily analysed by them.

Accident variables include, but are not limited to, the Type of record (new or amended), Police force code, Accident reference number, Severity of accident, Number of vehicles involved, Number of casualties, Date, Day of week, Time, Local authority, Location (sometimes with Parish and Council areas), Road class and number and type of road markings, Speed limit, Junction details and type of control, Type of pedestrian crossing facilities, Light conditions, Weather conditions, Road surface condition, Special conditions at site, Carriageway hazards, and Overtaking manoeuvre patterns (often with visual aid).

Vehicle variables include, but are not limited to, the Type of record (new or amended), Vehicle reference number, Type of vehicle, Whether the velicle was articulated, the Manoeuvre being undertaken, Direction of vehicle movement, Vehicle location at time of impact, Skidding or jack-knifing, Whether the vehicle hit an object in the carriageway, Whether the vehicle left the carriageway, Whether the vehicle hit an object off the carriageway, the Vehicle suffix letter, the First point of impact, Any other vehicle hit, Any part(s) damaged, the Number of axles of the vehicle, the Maximum permissible gross weight of the vehicle.

Driver variables include the Sex of the driver, Age of the driver, Breath test, Hit and run.

Casualty variables include, but are not limited to, the Type of record (new or amended), Casualty reference number, Casualty class (driver, passenger, pedestrian, etc), Sex of casualty, Age of casualty, Severity of casualty, Pedestrian location, Pedestrian movement, School pupil casualty, Seat belt usage, Car passenger.

2-3. Means of Obtaining Reliable Statistical Data in Developing Countries

2-3-1. Difficulties Involved

The observations and points made in the preceding sections of this chapter are universal, appling to both developed and developing countries, but the developing countries face particular additional problems in their attempts to reduce the numbers of road traffic accidents and for obtaining reliable data. Many of these problems are endemic to the developing world, and are not restricted to roads or transport. They include lack of capital and foreign exchange, lack of skilled and trained manpower, lack of equipment, and lack of basic physical and organizational infrastructure. However, for the majority of developing countries there are the additional problems of rapid growth in the level of motorisation, population and urbanization, together with (in many countries) a deteriorating highway network,because the funds required for adequate maintenance and upgrading to keep pace with traffic growth are not available.

In such a situation the lack of necessary funds, equipment, manpower, suitable administration, and experience make the existing accident reporting systems relatively poor. Consequently, the picture portrayed by the statistics in these countries is certainly inadequate and usually an understimate because of underreporting[62].

As stated by Sabey[65], "The final step towards identifying vehicle features relevant to preventing accidents or reducing injury, establishing human factors susceptible to treatment, and investigating all the interacting factors betwwen the driver, the vehicle, and the road, can only be achieved by investigations in depth." Unfortunately, information on the factors involved in road accidents rarely exists in Third World countries[41].

An early survey by TRRL (Jacobs, 1975) of some 40 developing countries showed that the police operated fairly comprehensive accident data collection systems, but few countries analysed the data in any detail or used it to obtain a clear understanding of the accident situation, and very few used the information to identify "black spots" on the highway network. These points will be examined for Iran in the next section in this chapter.

2-3-2. Knowhow Transfer from Developed to Developing Countries

Over the past 40 years, developed countries have built up considerable experience in road safety theory and practice, which includes a fairly substantial body of research data. Potentially, this experience should be of value to developing countries in assessing priorities in their own road safety programs. However, a number of general reservations should be made and due account should be taken of the different social and economic conditions, because the nature of problems in developing countries may be considerably different from that in Europe or North America and the countermeasures that are effective in developed countries may be ineffective in developing countries, and possibly vise versa. In addition, countermeasures that are appropriate in developed countries, may, for financial reasons, be too expensive for straight transfer and a considerable amount of adaption may be required. Therefore, although research findings from developed countries can provide some guidance, the inevitable uncertainties surrounding their transfer to developing countries emphasises the need for caution in their application. As a direct consequence, there is a need to evaluate any countermeasures that are undertaken, thus, emphasising the value of mounting local or regional trials of any countermeasures and carefully monitoring their effectiveness before using them nationally.

2-3-3. The Use of Small Computers for Automated Traffic Recording and Storage Systems in Developing Countries

Perhaps the most exciting and remarkable innovation of this age is the development of general-purpose programmable microprocessors, or micro-computers. Despite their current performance limitations[68] small computers are rapidly becoming as common as hand-held calculators because of their low cost and small size. In fact, it is becoming increasingly evident that the only true limits to further size reductions may be human characteristics (e.g., finger size). Equally important will be the accessibility of virtually unlimited off-line storage capacities at extremely low cost.

In developed countries low-cost computers are used these days to support comprehensive traffic recording and storage systems to provide administrators, planners, engineers, and enforcement personnel with information to administer programs, design roadways, and enforce traffic laws in an effective way.

In view of the resource constraints of developing countries, the rapid developments in micro-computers in recent years opens up new possibilities in accident analysis, while their low cost and general robustness in difficult environments seems to make them well-suited for use in the Third World. A typical system is integrated with a simple pre-coded police accident booklet or form (Hills and Kassabgi 1984) and can handle data at the level of a county or large city. The software enables accident and casualty cross tabulations, individual accident records, histograms of accidents along particular routes and "stick diagrams" of accident locations to be rapidly generated.

Such systems can be expected to enable developing countries' administrations for the first time to build up reliable time series data so that the overall national accident picture can be monitored and the overall effectiveness of any remedial changes, whether in the field of highway engineering or elsewhere, assessed.

At the same time they provide local information for more detailed measures, particularly for "black spot" improvements where there is relatively much greater potential in the Thirld World than in the Industrialized World.

But in spite of all the promise of this new technology, some research work (68) carried out in the United States and elsewhere shows that the other side of the coin should be seen too. Reviewing the history of data processing use by law enforcement agencies over the past 15 years in developed countries reveals that the record is less than remarkable. In a recent article in a U.S. police magazine (74) the following can be noted:

"Some [police] departments have spent millions of dollars buying and installing elaborate data processing machinery, but have spent years trying to get their systems... in operating order. Others bought the systems with federal funds, and never even attempted to make effective use of them."

When, in a highly industrialized country, small computer users are warned "to understand the complexities and difficulties of software acquisition", and when "a basic lack of knowledge among senior level officers about what computers can, and cannot, do" is observed, and when even in the United States "inadequacy of police-specific software" is mentioned, one should be very careful of introducing this new and rapidly modified technology to developing regions. As Stenzel concluded, "Police data processing projects usually take longer than predicted, cost more than estimated, and produce less than expected."

2-4. The Present Situation of Road Accident Statistics in Iran

Not all the five levels of road accident investigation discussed in sub-section 2-2-1 exist in Iran. Even the two levels of reporting and investigating mentioned in that sub-section have only recently been introduced and implemented. Before that, and only then, for severe accidents, a concise report in the shape of a descriptive letter to the higher rank of police administration was prepared which was eventually used in court. Such a report did not have any special form and usually contained both descriptive facts observed by the police officer at the scene of the accident, and also his opinions and conclusions based on his own judgement. It is only in the last decade that accidents have been reported on special forms and sent to the central police statistical office in Teheran for analysis. The Ministry of Road and Transport (M.R.T) also analyses the data.

2-4-1. Road police stations in Iran

As discussed in sub-section 2-3-1, the rapid growth in the level of motorisation (see Table 3-3), population (see Fig. 3-2), and urbanization, together with the lack of necessary funds, equipment, manpower, administration and experience in many developing countries including Iran, have caused a difficult task for the road-police administration to control such a quantitively and qualitively complicated road-network with the minimum of presence and necessary facilities. The enclosed map shows the Iran road-police districts, and the numbers and positions of police-stations. This information is also listed in Table 2-1. As the total area of Iran is 1,645,000 square kilometres, it can be seen that little more than half (865,000 square kilometres) is actually under the surveillance of the road-police. The rest is mostly desert and undeveloped arid areas, or border areas which are patrolled by other armed forces, or in some areas simply not patrolled,because the few major roads have little traffic and there is no justification for spending money, equipments, or personnel on it.

From Table 2-1 and the enclosed map of Iran, it can be immediately realized that there is a great scarcity of road-police stations even in the half of the country which is surveilled, i.e. one police station per 9,000 square kilometres. For the whole of Iran the figure is one police station per 17,000 square kilometres.

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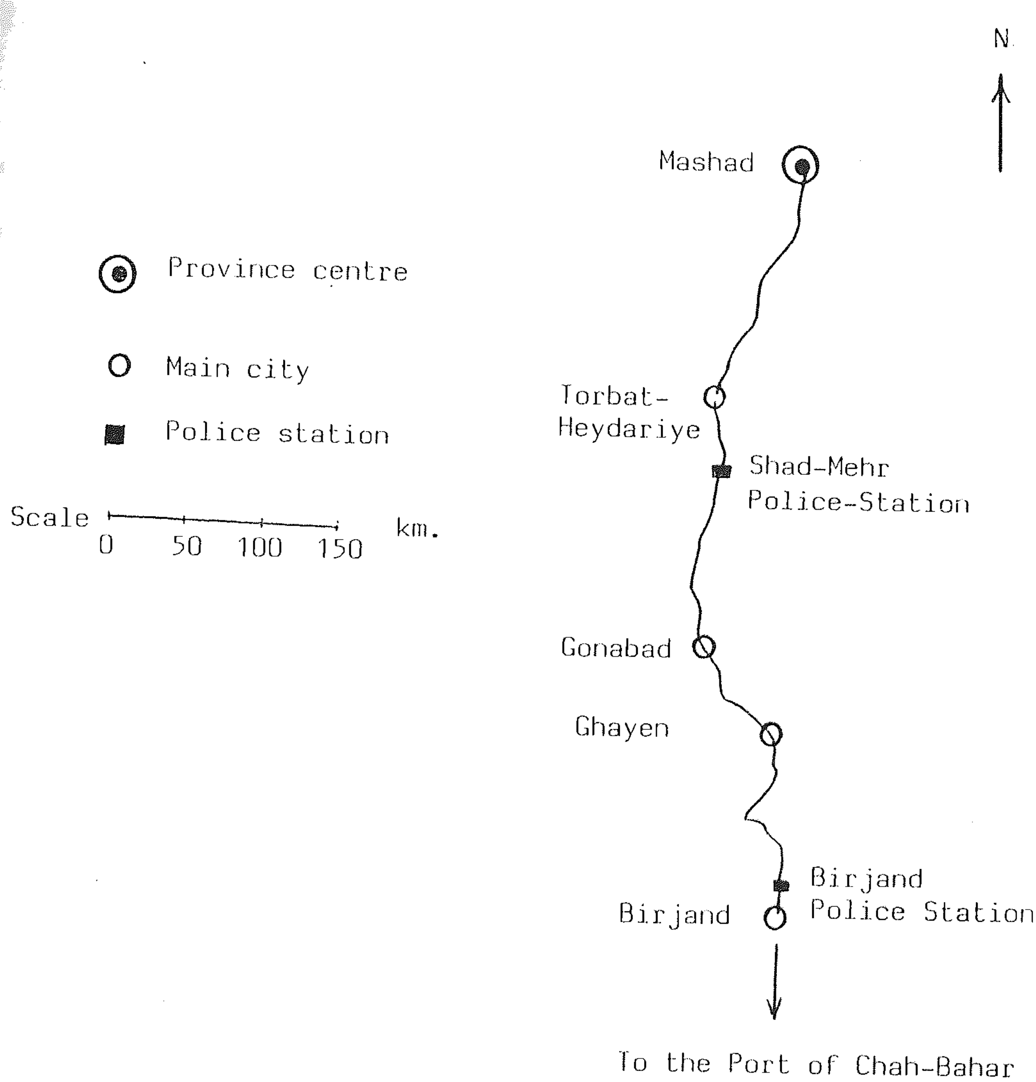
Map 2-1. Police District Areas and Police-Stations in Iran

In southern Khorasan, for example, the distance between Shadmehr road-police station in the south of Torbat-Heidariye to the newly established Birjand station in the north of Birjand is abouth 250 kilometres, and between these two points, there is a main road which connects Systan-&-Baloochestan and the especially strategic port of Chah-Bahar to a very important region of northern Khorasan and Mazandaran, (see scketch 2-1). This relative lack of police presence on roads naturally has disadvantages both in the implementation of necessary controls and making on-time reliable reports.

Table 2-1. Iran Road-police Districts and Stations, 1985

District No.	Approximate area, km^2	Pvovinces included	Number of police-stations
01	99000	Teheran, Central Zanjan	24
02	37000	East-Azarbayejan	7
03	28000	West-Azarbayejan	5
04&05	21000	Kordestan, Bakhtaran	3
06	26000	Guillan	4
07	53000	Khoozestan	4
08	126000	Fars, Kohkilooye	5
09	10000	Booshehr	1
10	91000	Kerman, Bandar-Abbas	4
11	35000	Systan-&-Baloochestan	3
12	148000	Khorasan	10
13	60000	Mazandaran	10
14	99000	Esfahan, Yazd, Chahar-Mahal	7
15	32000	Hamadan, Lorestan	7
Total	865000	Iran	94



Sketch (2-1): The scarcity of Police-Stations in the east of Iran.

2-4-2. Iran Road Accident Report Forms

In Iran, all fatal and injury road accidents, and all severe damage-only accidents if the case goes to court and/or is referred to an insurance company for compensation, must be accompanied by a police-report. Most insurance companies are state-owned, and it is only recently that Bimeh-Iran, the biggest state-owned insurance company in the country, will accept claims of less than 5000 Rials (approximately 45 sterling pounds, official rate) for small damage accidents without a police report.

2-4-2-1. Examining a Typical Road Accident Report Form

On the following pages, there is a typical police report of a road injury accident. The first page is a copy of the actual report, and then follows the English translation.

To assess the extent of the accuracy and reliability of this report the author made several different contacts with the general-office of the Ministry of Road and Transport in Khorasan. This general-office receives all reports on road safety matters in Khorasan and for the accident in this report they had additional information as one of the vehicles involved in this accident belonged to the Ministry and its driver was an employee. This is why they had a complete file for this accident and possessed a lot of information about details. It was found that the minibus driver later died in hospital.

Before proceeding to the investigation of different comments about this report, let us see the translation of the report itself:

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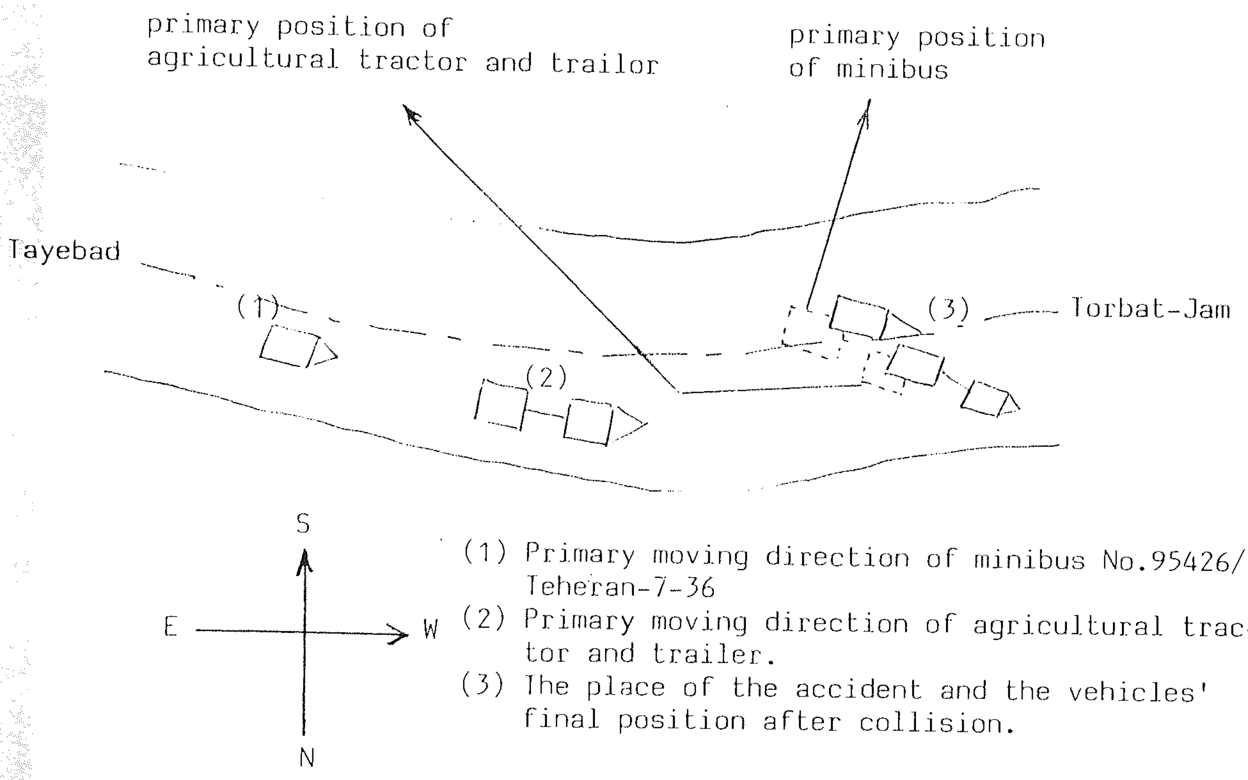
Translation of a Typical Road Accident Police-report in Iran

The Ministry of Interior (Home office)
The Islamic Republic of Iran Jandarmeri* road-police

Serial "B" No.18079

Accident place	The time of reporting	The time of accident	The kind of accident	Death numbers
Police.S.: Torbat-Jam	Hour 18:40	Hour 18:15	Fatal...	Driver.....
Road: Torbat-Jam Kilometre: 11	Day 26/8/65**	Day 26/8/65	Injury ✓.	Occupant....
			Damage...	Pedestrian..

The collision of a motor-vehicle with:—	Vehicle. ✓......	Getting of the road................
	Pedestrian......	Animals...........................
	Fixed-object....	Others............................



(1) Primary moving direction of minibus No.95426/ Teheran-7-36
(2) Primary moving direction of agricultural tractor and trailer.
(3) The place of the accident and the vehicles' final position after collision.

* Jandarmeri in Iran is the disciplinary division of the armed forces responsible for areas outside cities. Shahrbani is for inside cities. The Road-police was previously under the Ministry of Road and Transport, but now acts under the command of the Jandarmeri.
** 17 November 1986 is the equivalent British date.

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Vehicle No. 95426 / Teheran 2-7-36 Type: Minibus, Moving direction: East to west

Vehicle condition (after collision): not movable

Visibility obstructor(s): Hill

Parts damaged: *

Permitted speed at the place: *

Brake's print on road: Before collision: None / After collision: None

Distance gone after collision ---*** Examining speed ---

Examining speed brake's print on road --- Steep angle ---

Brake's acceleration --- Vehicle's acceleration considering brake's---

Road's friction factor --- The minimum speed: Before collision / After collision

The minimum distance to which vehicle windows' glasses are thrown---

The height of vehicle's windows ---

In which distance the driver has realized the danger ---

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Translation of ... cont.

Name of pedestrian---[£] Surname --- Age --- Pedestrian moving direction--- Pedestrian type of movement --- Pedestrian clothes' colour --- Pedestrian average speed --- The distance between pedestrian starting point to the point of collision --- the distance between collision point and the point where the pedestrian fell --- The parts of pedestrian body damaged --- The place of pedestrian passing --- The condition of pedestrian after collision ---

---

Other damages in excess of the vehicles' damages: None

Weather conditions: Clean and dry   Lighting conditions: Moonlight

---

Road class: --- Road condition: ---- Road obstructions: --- Road imperfections affecting in causing the accident: --- Road situation: --- Place type: --- Road width: Narrow[+]

Delineation type (e.g. roadmarkings): ....

Footnotes:

*) Not readable in Farsi copy of the report

**) For four wheeled motor vehicles' driving in Iran there are basically two types of driving licenses. The first grade is for driving heavy commercial trucks, trailers, and other long vehicles; the second grade is for other lighter vehicles. Agricultural tractors are excluded and have their own licenses.

***) All those questions asked in the accident reporting form, for which the answers were not available for the police officer, or difficult to obtain, or simply not needed in his opinion, are not answered and are marked by a dash. This will be discussed in the following pages.

£) As there is no pedestrian involved in this accident, all questions are answered by a dash.

+) This is the only question answered by the police officer about the road conditions.

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close before overtaking.

Officer name, surname, and rank

Junior lieutenant Hadi Davoodi

Signature...........
Station seal........

¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶

2-4-2-2. M.R.T. Khorasan General Office Views and Comments about This Report:

The author made different contacts and had discussions with the personnel of The General Office of the Ministry of Road and Transport in Khorasan about this report. They made several comments and had different criticisms. The main points are as follows:

1) This is a fatal accident and not an injury one, as reported by police. This is because the minibus driver died later in hospital.*

2) The minibus driver who died later, is not mentioned even to be injured in the report; and the police officer is claiming to have asked questions of the driver"s".

3) The bend in which the accident actually happened is much sharper than the scheme shown in the report. Also, the same police officer had already stopped the agricultural tractor and trailer on the bend and was talking to the tractor driver as the minibus approached. The police car was parked on the opposite

---

* There is no certain definition for road accident fatalities in Iran, but usually only those being instantly killed at the scene are classified by police as fatalities. It may be because of this reason that the police classified this accident as an injury one.

side of the road to the tractor and trailer and both were in the middle of the sharp bend. As the minibus entered the sharp bend, the driver could not see the parked police-car and tried to overtake the tractor. Suddenly he saw the police-car, turned sharply right to avoid hitting it and consequently hit the back of the tractor and trailer.

4) In the situation that the tractor and trailer had neither a numberplate, nor any lighting system in the rear, and its driver failed to produce any driving license, then how it is concluded in the report that "the essential reason for the accident was the minibus driver's unprecautiousness"?

2-4-2-3. Some Further Remarks Made by the Author:

1) There are some contradictions between M.R.T regional office authorities' views and the police report. Firstly, the report says both colliding vehicles were moving at the accident moment but M.R.T believes the tractor and trailer had been stopped by the police inside the bend. Secondly the report says the officer was informed of the accident by the hospital and immediately rushed to the accident scene, but M.R.T believes he was actually present there at that moment and had parked the police-car inside the bend, interrogating the tractor driver.

2) From the time that the road-police in Iran has been acting under the Jandarmeri instead of the Ministry of Road and Transport, it has naturally been more engaged with those parts of its duties directly ordered by the Jandarmeri.

These have been executing law and order on the roads rather than paying attention to the roads' and vehicles' technical matters or collecting necessary data for safety problems. In many countries a joint committee from the Ministry of Road and Transport, local government authorities and other related bodies, and of course the armed forces, supervise the road-police and determine its general system of work, duties and activities. The author has $2^{1}/2$ years of experience acting as the country's planning deputy Minister of Road and Transport, and has made it quite clear that to obtain reliable data and the best co-operation of the road-police for road safety issues, such a committee should be organized in Iran.

3) Most of the information asked in the reporting form, which is required to be supplied for such a severe accident, simply is not answered but filled by a dash.

4) Instead of supplying facts and figures, most of the report is the police officer's personal opinions and judgements. Additionally, the kind of information supplied is what the officer himself wished to be mentioned in the report. The other information that he thinks is not important enough, or irrelevant, or simply he does not wish to be mentioned, is ignored. Such a process hampers the usefulness of the forms for analysis of identical or similar cases.

5) The lack of classification and coding system in the report makes data extraction difficult and less accurate. Although a new official road-accident report form (as can be seen on

the next page) had been prepared in the road-police central statistic office in Teheran and was sent to M.R.T in 1984, very recently prepared reports such as the one discussed here are still made on older-type forms. The new form has a much better classification and coding system which is easier to extract information from it and easier for computer analysis. A brief translation of the information provided on the new form is as follows:

01- Accident code

02- Road-police station code

03- Accident date

04- Accident time

05- Police officer investigating code

06- Road width at the place of accident (metres)

07- The distance from the site of the accident to the nearest police station

08- The accident site axis code

09- The accident type (fatal, injury, or damage)

10- Casualties numbers (driver, occupant, pedestrian, military servant, foreigner)

11- Age and nationality of culpable person

12- Plate number of culpable vehicle (i.e., the vehicle driven by the culpable driver)

13- The owner of culpable vehicle

14- Plate number of unculpable vehicle

15- Type of collision (vehicle to vehicle(s), vehicle to pedestrian... etc.)

16- Details of collision (front to front... etc.)

17- Types of vehicles.

18- Essential and main reason for accident occuring (16 reasons are mentioned and from these one must be selected. Of the 16 reasons, 14 are concerned with poor driving, one is concerned with the vehicle, and one is named as "others")

19- Contributing factors in causing the accident.

a) Environment (climatic) factor

b) Vehicle factor (7 factors, maximum 2 can be selected)

c) Human factor (alcohol, drug, drowsiness, disabilities)

d) Road factors, including road imperfections and road situation (bends, roundabouts...etc.)

Although this form is better than the one which is commonly used, it still needs corrections and modifications which will be discussed in section 2-5.

6) As Jabbari(37) established in his research, and which the author can confirm during his long experience with road technical problems, the knowledge concerning the exact point at which an accident occurs (which is essential for further research and investigation, and especially for determining the location of black spots) is not precise enough in the police reports in Iran. This is mainly based on two reasons. Firstly, the police officer does not realize the importance of precision and accuracy in recording this piece of information and thinks that a

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guess of the distance from a neighburing town or police-station is enough; and secondly, all police reports and subsequent analysis in the central police statistical office, considers the police-stations as the centre points, and this assumption does not correspond with M.R.T. references. For example, as it was seen in sub-section 2-4-1, there are 15 road-police districts in Iran and in each district several police-stations exist. The statistics issued by the central road-police statistical office give the total road accidents and different analysis per area under the surveillance of each police station. But, to find out the quantity and/or quality of accidents in each section of a road, a review of all the individual accident reports must be undertaken, and this is not feasible.

7) The report is hand-written and parts of it are not legible.

2-5. Recommendations for Improving the Quantity and Quality of Road Accident Statistics in Iran

Although during the past few years a considerable amount of progress has been achieved in the police reporting system and also in the analysis of data in both the central police statistical office and the ministry of road and transport in Iran, there are still a lot of modifications and improvements necessary to catch up with the current minimum acceptable standards in developed countries. In general, the efforts made so far in Iran to tackle the problem of road accidents have been largely inadequate and lacking in balance and continuity. Inappropriate administration and insufficient funding militate against comprehensive and all-out action. The role of the road-police is to enforce traffic legislation, regulate the road traffic, and ensure road safety. In Iran, motor vehicle administration, including the licensing of drivers and vehicle registrations is also looked after by the police department. As far as the author is aware, no special accident investigation squad has so far been created for examining accidents especially fatal ones.

The comparison of sections 2-2 and 2-4 makes it clear that quantitavely more information with a better classification and coding system, and qualitavely more precisely and accurately prepared data, should be included in the police report forms. Also, it is necessary that the levels of reporting, at scene investigation, technical preparation, professional reconstruction, and cause analysis, should gradually be improved.

This is necessary to reduce the effect of the personal reporting officer's opinions and judgements, and improve the uniformity and objectivity of the collected data.

In order to achieve the above-mentioned objectives based on the discussions in the previous sections, the following recommendations are made:

1) The road-police division of the armed forces, instead of acting under the Jandarmeri (as was discussed before), should act under a joint committee of the Jandarmeri, M.R.T., and the Ministry of Health. Its minimum responsibility should be

to obtain the necessary data for the M.R.T., and report to the M.R.T.

2) The law enforcement academy curricula should be reviewed in the area of accident investigation and reporting. Officers should be aware of how data is used in engineering work and of the necessity for data to be of a uniform and high quality.

3) As police chiefs are not totally aware of the accident situation or of the summary reports and other devices available to assist them in identifying and alleviating hazardous situations, a training program should be instituted to improve their knowledge of the overall accident situation, high accident locations, summary reports, and reduction of the accident problem.

4) A national road accident statistics report form and an enclosed booklet containing instructions for the completion of road accident reports should be developed. A committee should also be set up for continuously monitoring, checking, and revising the form it might require. Such a standing committee is necessary to:

   a- Consider any problem arising in the implementation of the new road accident reporting system and make recommendations.

   b- Disseminate information on techniques and procedures developed in connection with the new system of accident reporting.

c- Consider any ammendments to the system that may be required in the course of time and make recommendations.

5) Reporting of accidents in the police jurisdictions should be standardized. It is extremely important that traffic accident data be compiled on a uniform basis by all levels of government. Uniform classification of traffic accidents and close cooperation among all agencies concerned with investigating and reporting traffic accidents will ensure the attainment of uniform accident statistics. The effect of individual opinions and feelings should be continuously reduced. It is recommended that one of the internationally recognized classification systems (for example see definitions and recommendations of the national safety council of the United States, Ref.58) be adopted. Road-police headquarters must continually emphasize the reporting requirements, and the reasons for them, to ensure that accident data is consistent and of high quality.

6) A program should be developed to evaluate the quantity and quality of the annual accident data submitted by the various jurisdictions. The mechanism should identify year-to-year variance. For example, a simple computer program could edit each year's accident reports and flag areas that show a large change in the number of reported accidents. Also, the quality of each item of accident data similarly should be evaluated.

7) A follow up study should be conducted on those sub-districts with some years (for example 5 years as in Alabama[79]) of erratic reporting histories. The reason for variability should be identified in each case, and countermeasures should be sug-

gested.

8) Reporting of accurate locations of accidents must be improved. This is essential for later studies of high accident locations and the implementation of remedial action. Various reference marker systems are in use for this purpose, and these are especially useful in rural areas where no distinctive features are available for reference in locating accidents. In New York, for example[58], all posts on expressways, and other limited access roadways are numbered.

Chapter Three

The Analysis of Road Accidents in Iran

3-1. Introduction

Data analysis and interpretation of results is totally dependent on the availability and accuracy of the data itself. Generally, in developing countries information and data are scarce and difficult to obtain. Iran road accidents' statistics is not an exception. At least three to four years of the author's life was spent compiling the related data which is presented and analysed in this and subsequent chapters. Then so, because of what was discussed in chapter 2, there are inaccuracies which should be considered in future research works.

The main object of the analysis presented here is to understand the different dimensions of the road accidents in Iran, the reasons for them, and to suggest any economical solutions.

In this chapter mostly the related data and statistics are classified and presented and then the subsequent results will be discussed more deeply in the following chapters.

3-2. Preliminary Investigation of Iran's Road Accident Statistics

In the analysis presented in this chapter, the four different factors which are effective causes of creating accidents are considered. These are the human factor, the road factor, the vehicle factor, and the environmental factor.

3-2-1. The Human Factor

Iran's road accident analysis clearly shows that most of the causes of accidents are human factors contributing to accidents. In fact, in 90-95% of Iran's road accidents, the human factor is the only cause, or part of the cause(s), of the accident (see table 3-16). These human factors can be divided into four groups* as following (the percentages inside brackets are the percents of each cause in relation to the total number of human caused accidents)**:

1. General driving manner

   a- Deficiency of actions: driving too fast (8%), improper overtaking (5%), following too close (14%), wrong path of vehicle , failure to observe other vehicles, signs, roadmarkings, etc. (15%).

   b- Deficiency in behaviour: irresponsible or reckless, frustrated, aggresive(15%).

2. Perceptual errors (13%)

   a- Looked but failed to see.

   b- Distraction or lack of attention.

   c- Misjudgement of speed or distance

3. Impairment(7%)

   a- Alcohol.

*)Another type of devision has been used as:
1-errors of ommision
2-perceptual failures
3-judgement failures
4-behavioural failures
For further detail,see Ref.(89)

**)Although as it was shown in chapter 2,there are deficiencies in road-police statistics, but because it is the only source of information available,our analyses have been based on that. However, this is the situation even in developed countries.

b- Fatigue.

c- Drugs

d- Illness

e- Emotional distress

f- Effective disability

4. Lack of skill(5%)

a- Inexperience

b- Lack of judgement

c- Wrong action or decision.

From tables 3-16 and 3-17 it can be seen that human factors in the Iran road police reports, and its statistic office, are grouped in two divisions. Item 3 above, i.e. "impairment" is in one group and the other three items are in another group. Table 3-17 shows that almost all of the 7% of the impairment factor is due to fatigue and drowsy driving. The shares of drinking and drugs are negligible.

A considerable number of heavy commercial vehicle drivers and bus drivers in Iran have more than one accident in one year[44]. On average, one in every four accidents involves a truck, and one in every twelve accidents involves a bus with an average of 12 injuries and 5 deaths and with an average direct cost of 4,500,000 Iranian Rials (37,500 sterling pounds, official rate)[53].

The Iranian daily newspaper Ettelaat, in its edition of 27 october 1985, interviewing Major Partovi, an Iran road police deputy, wrote that because of the huge violation of the traffic rules on the roads in Iran, the amount of fines obtained from drivers are steadily increasing. For example, as he mentioned, in the first six months of the Iranian year 1364 (21 March-20 September 1985), Iranian road drivers have paid 2500 million Rials (20 million pounds,o.r.) as fines for their traffic violations.

3-2-2. The Road Factor

The analysis presented in this chapter considers road factors as a cause of accidents from three different angles; width of roads, roads' situations, i.e., bend, roundabout, bridge ... etc; and roads' imperfections. The most important road imperfections considered are sign deficiencies and lack of enough markings and delineation, narrow roads, unevenness of the road surface, lack of a hard shoulder, slippery roads, lack of traffic-barriers and limited visibility by day and night.

Road engineering measures quantified in specific studies are as follows[83]:

1. Geometric design
   - a- Junctions: layout, alignment, sight distances, channelization, access control.
   - b- Horizontal and vertical alignment: curvature, super-elevation.
   - c- Cross sections: number of lanes, shoulder design, medians.
2. The micro- and macro-texture of the road surface.
   - a- Wet road performance.
   - b- Skidding resistance and speed.
   - c- Visibility by day and night.
   - d- Evenness and profile.

3. Markings and delineation

   a- Indicators of prohibitions or appropriate manoeuvres.

   b- Channelisations.

   c- Guidance.

4. Road signs and furniture

   a- Lighting.

   b- Traffic islands.

   c- Anti-dazzle screens.

   d- Safety fences and guard rails.

   e- Warning signs.

5. Traffic management

   a- Speed control and limits.

   b- Junction control.

   c- One-way systems.

   d- Parking.

3-2-3. The Vehicle Factor

Statistical analysis and investigations carried out by Deputy of road transport at the Iran Ministry of Road and Transport, indicates[53] that for each 100 motor-vehicles running on Iran's roads, only 28 have the minimum acceptable technical standards. The other 72, for different deficiencies and imperfections in their lighting system, brake system, tyres, and other technical faults, legally should not be permitted to run on the roads. Referring to table3-21, it can be seen that in 1983 the two factors of tyre faults (32%) and brake faults (25%) contribute 57% of the causes of vehicle-caused road accidents.

3-3. Roads in Iran

Table 3-1 and Fig.3-1 show the lengths of motor-ways, major roads, minor roads, rural roads, and access roads in Iran from 1978 to 1985. As can be seen from Fig.3-1, there is a sharp increase in the total road length between 1979 and 1983, from 63,015 km. to more than double; i.e., 138,148 km. Such an increase is not seen in the total length of motor-ways, major roads and minor roads (curve 2). The reason for this is that the high increase in total roads in Iran between 1979 and 1983 was mostly due to the addition of a considerable amount of rural and access roads in this period of time. This is a reflection of the socio-economic and even political atmosphere of the post-revolution in Iran. After the Islamic revolution of 1979 there was a revolutionary appetite for the fast development of rural and remote areas to bring modern facilities of access, electricity power, healthy drinking water and so on to remote villages where, for centuries, the inhabitants had been deprived of even the lowest standard of living. Even a new ministry named "Gehad-e-Sazandegi" composed of mostly volunteers was formed with the one duty of working for the development of villages and remote areas. Both this newly formed ministry, and the Ministry of Road and Transport, put their biggest effort into making new rural and access roads.

Fig.3-1 shows that after 1983 the trend changed. The reasons were a shortage of money because of falling oil prices and huge war expenses, and the new emphasis of the Ministry of Road and Transport on main roads and maintenance which had almost been forgotten in the previous years.

In relation to the road users' environment, two aspects which

Table 3-1.

Iran Roads' Lengths & Densities for the Years* 1979 to 1985

Type of road	YEAR 1978	1979	1983	1984	1985	1985 road density in km.per100km.^2
Motor-way	126	224	490	504	504	0.03
Major road	13155	13759	16519	16551	16803	1.02
Minor road	26126	27422	35040	34863	34981	2.12
Rural road	11329	12898	32493	34177	36293	2.20
Access road	8712	8712	53606	52362	52362	3.18
Total	59448	63015	138148	138459	140743	8.54
The density of roads, in km. per 100 km.^2	3.61	3.82	8.40	8.41	8.54	
The density of roads, excluding desert areas	4.95	5.25	11.54	11.54	11.73	

* Source: Iran Ministry of Road and Transport, the office of statistics.

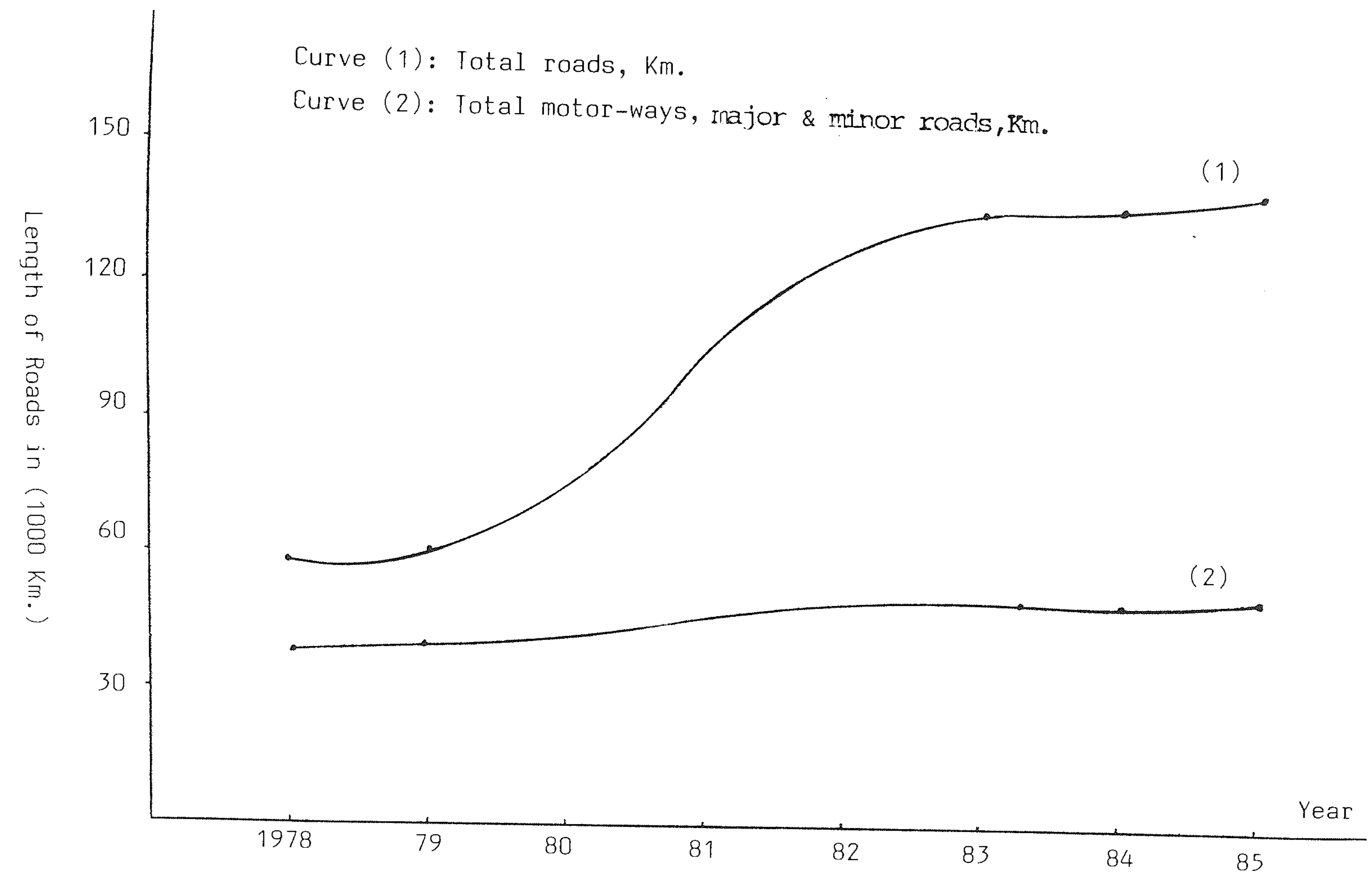

Fig. 3-1. Length of roads in Iran from 1978 to 1985.

relate to road safety, and largely fall within the province of road engineering, can be distinguished. **Firstly** the road itself and **se-condly** the vehicle. Most industrialized countries have laid down

Map 3-1. Roads in Iran

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relate to road safety, and largely fall within the province of road engineering, can be distinguished. **Firstly** the road itself and **secondly** the vehicle. Most industrialized countries have laid down standards for highways in the light of the traffic they are intended to carry, and in this they are guided as much by considerations of road safety as by such factors as the economic constraints imposed by the physical characteristics of the country. This makes it necessary to specify minimum geometrical characteristics (width, redius of curvature, superelevation, gradients, bends, etc.) which may evolve over the years in the light of changing vehicle design. A comprehensive study of geometrical standards was undertaken in the framework of the OECD road research programme(83).

In Iran, the Ministry of Road and Transport also has definite standards for different types of roads, and typical drawings for the road designs to be confined within this framework. But the necessities of rapid growth and development in recent years, and also the large transport requirements for a long lasting war have put a great burden of traffic on to Iran's roads. This traffic burden is much greater than the capacities of the roads both in terms of quantity and quality. Nonetheless, it should be stated that even neglecting the above mentioned factors, road traffic data is not properly considered in the design of roads.

Because of this, the roads in their early stages of service life deteriorate rapidly under unforseen heavy loads. Longitudinal and transverse cracks, and unbalanced settlements, soon appear and consequently heavy financial losses are incurred (see photo 1-3).

The Iran roads' traffic statistics(73) for the Zanjan-Takestan main road show that there was a growth in traffic of 56% in 1983, and for the Mianeh-Zanjan road it was even higher at 66%.** On another main commercial axis road from Ayoghly to Makoo in Azarbayejan province, up to 73% of heavy traffic has been registered. Reference (73) shows that each day more than 15000 "car equvalent's"* of traffic is travelling along the Zanjan-Takestan and Tabriz-Soofeian main axes (see sketch 3-1).

Although standards seldom pose problems when applied to the construction of new roads, they present a considerable burden when applied to an existing network and may entail excessive expenditure. Hence, the major thrust of the safety effort in regard to the existing network is directed towards identifying and tackling specific sections and hazardous locations (Black spots).

The road environment also plays an important role in determining the severity of accidents. Some equipment has been developed with the specific aim of reducing such severity. Crash barriers, initially designed to prevent vehicles from moving into the line of oncoming traffic, falling down a slope or hitting an obstacle, have subsequently been developed with a view to absorbing part of the energy of the impact in conditions less damaging to the vehicle and its occupants and less harmful to other road users.

Attention has also been paid in developed countries to the fixed roadside obstacles (trees, posts, barriers) which are respon-

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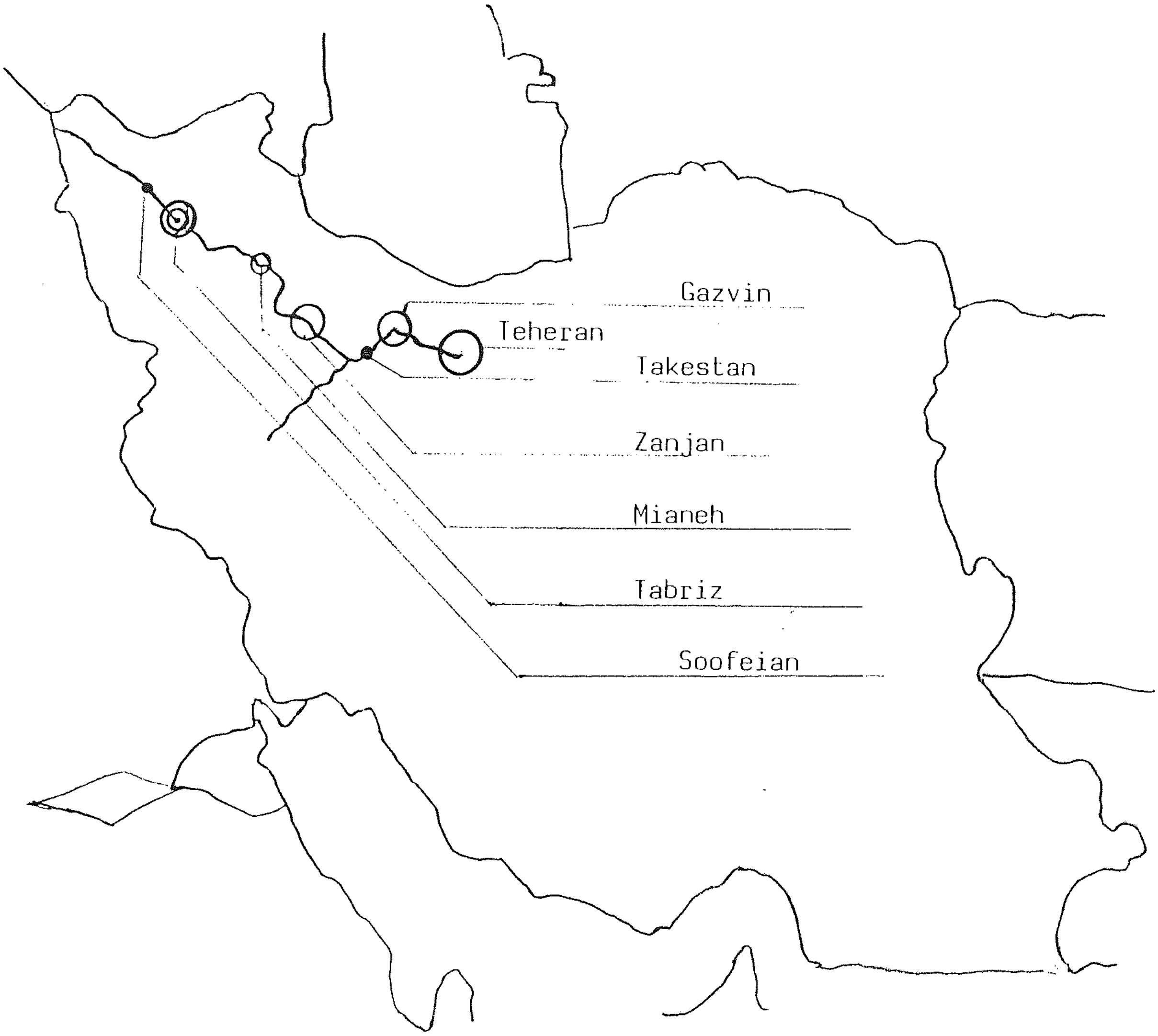
* In computing the "car equivalent" traffic within Iran, the M.R.T. standard is that each car is one, each truck or bus is equal to 1.8 cars, and each trailer and long-vehicle is equal to 2.5 cars.

** This specific road,which connects Europe via land to Iran,has had an exceptional situation and this figure does not represent an average traffic growth for the whole country.



Sketch (3-1): Zanjan-Takestan & Tabriz-Soofeian main axes.

sible for 10-20% of road accident fatalities in those countries[83], and countermeasures such as impact attenuators and safety embankments have been adopted in many countries. In Iran, 1.7% of road accidents in 1983 were the result of the collision of a vehicle into a fixed object (see Fig.3-9), but the author was unable to find what per cent of road fatalities is due to this reason to be able to make a comparison with industrialized countries.

The effect that Iran's road engineering standards will have on road safety and the reduction of **black spots**, bearing in mind the results of this research work about Iran's road accidents costs with a cost-benefit analysis, should be consdidered in more detail in future research works.

3-4. Motor-Vehicles in Iran

Table 3-2 and Fig. 3-2 show the quantity of Iran registered motor-vehicles and the number per 10000 population from the year 1977 to 1983. Fig. 3-2 shows that the total number of motor-vehicles, and its rate per 10000 population, have been steadily increasing. But the slope of these two curves, which are quite close to straight lines, are different, i.e., $\alpha \simeq 2\beta$. The rate of increase of total motor-vehicles during the above mentioned period is almost constant at an average of 7.84% for each year.

$$2678259=1702853(1+r)^6 \ : \quad r=7.84\%$$

The rate of increase of total motor-vehicles per 10000 population is again almost constant, but much lower at an average of only

Table 3-2. Total motor-vehicles in Iran (1977-1982) and its relation to population

Year	1977	1978	1979	1980	1981	1982	1983
P.Car	1161870	1278835	1367649	1463406	1539925	1604118	1687985
Truck*	218021	245362	260829	271510	280828	293229	306225
Ambulance	194	280	304	322	366	430	510
Bus**	37831	39978	42324	44825	48342	50802	55550
Van	17192	23051	27830	36999	42355	48375	56702
Motorcycle***	267745	282133	290346	372675	435309	472138	571287
Total motor-vehicles	**1702853**	**1869639**	**1989282**	**2189737**	**2347125**	**2469092**	**2678259**
Population in 10000	3465.7	3563.6	3664.9	3769.8	3878.4	3990.7	4106.8
Total motor-vehicles per 10000 population	491	525	543	581	605	619	652

* Including trailer and other long vehicles.

** Including minibus.

***Most light motor-cycles in Iran are not registered, although legally they are required to do so.

Source: The Ministry of Road and Transport, The Land Transportation Deputy Office.

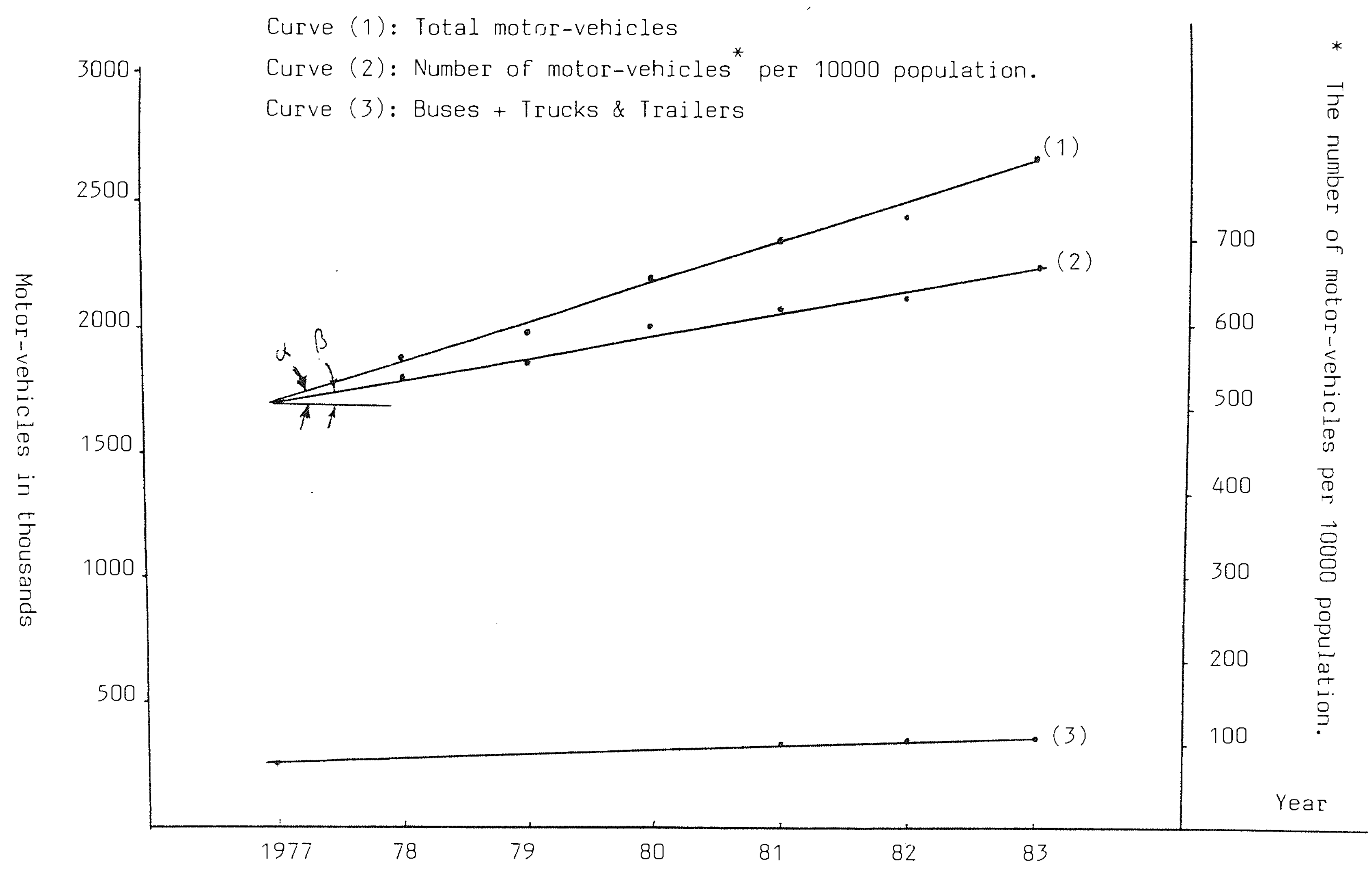


Fig. 3-2. Iran motor-vehicles' numbers in the past years.

about 4.8% for each year.

$$652=491(1+r)^6 \quad : \quad r=4.8\%$$

This situation is in spite of the fact that Iran has one of the highest rates of population increase in the world (see Fig.3-3).

In the industrialised world today, modern vehicle design achieves a high standard of safety, although there are still aspects of construction which can be improved to prevent accidents. The main need now is to secure a high standard of maintenance.

The World Health Organization (WHO) secretariat, in collaboration with OECD(83), divides the vehicles' contribution to road safety into passive and active.* As far as the passive safety is concerned, in addition to extensive research carried out on the interaction between vehicles and their occupants on impact, and the substantial modifications in automobile design as a result of this, one important phenomenon recently considered is that the occupants should be held firmly in their seats to avoid, or at least limit, impact with the interior of the vehicle. Two of the main items of equipment studied in this connection are the seat belt and inflatable bag. As regards users of two wheelers, the research effort has been primarily directed towards improving crash helmets. There has also been some progress in equipping cars with front bumpers that are less dangerous to pedestrians.

In Iran, 72% of motor-vehicles are illegally running on the roads(53), because they do not have the minimum technical standards. The wearing of seatbelts is not common at all among vehicle occupants, and the wearing of crash helmets among two-wheeled riders is very rare.

Recently, there has been increasing concern in developed coun-

* Passive and active safety standards,both can be improved by better design and better maintenance.

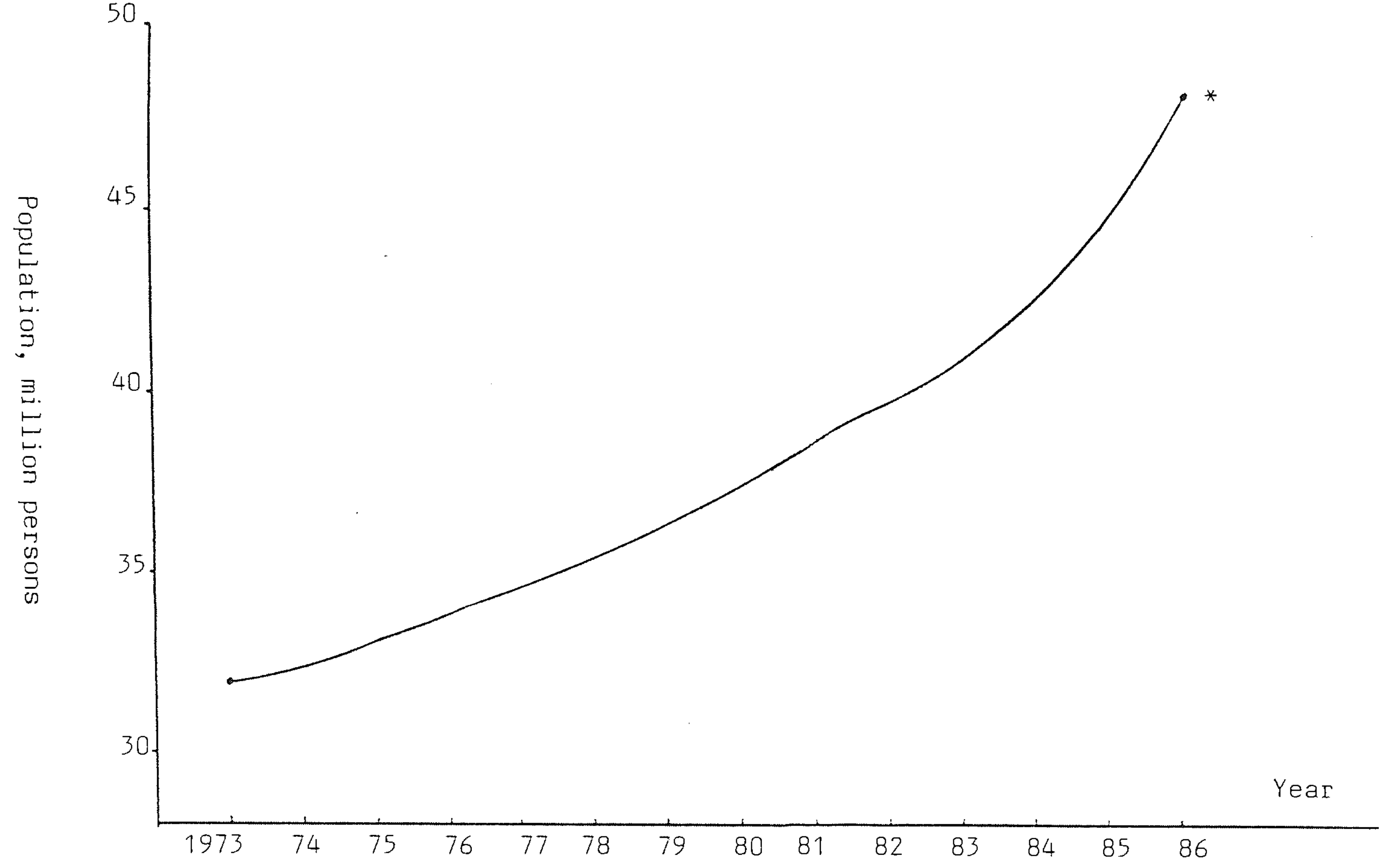


Fig. 3-3. Population growth in Iran.

* For the figures see Table 3-6.

Source: Ref.(36) and the Ministry of Planning and Budget, Office of the Statistics.

tries of the danger of heavy vehicles to other traffic. These are being fitted with safety bars to stop vehicles from being caught beneath them or to prevent pedestrians or cyclists from being crushed under the wheels. This question is no doubt of major concern to the developing countries and especially to Iran, where, because of the increasing traffic volume, every type of traffic is competing for road space.

As far as the active safety is concerned, vehicle characteristics can contribute to accident avoidance, e.g. the vehicle's stability, braking performance, and ease of handling. The experience of industrialized countries shows higher standards being set in this field both at the stage of design and approval of new models of vehicles, and also throughout the duration of their operating life so that their performance is not compromised by lack of maintenance. Two examples are: 1) the standards established for admissible tyre wear. 2) Several countries have introduced regular, mandatory mechanical checks (in some countries for all vehicles, but in others for trucks and public transport vehicles only).

In Iran there is no regulation for regular mandatory checks for private passenger cars and small private vans, but public transport vehicles (P.T.V) are tested every six months and heavy commercial vehicles (H.C.V) every year by the police technical department. However, because of the country's extra-ordinary situation (war and its economic burden) some deficiencies are ignored. Table 3-3 shows a yearly growth of 4-5 per cent in Iran's registered motor-vehicles. It should be noted that the actual figure is rather less, because vehicles that are not used any more because they are too old, or are

Table 3-3

Motor-vehicles newly registered in 1982 in Iran

Type of vehicle	number	Total existing in the country	per cent growth
Small cars	64193	1604108	4.00
Buses*	2460	50802	4.84
Ambulances	59	425	13.88
Trucks**	12401	293229	4.23
Different types of scootoers & vans	6020	48375	12.44
Total	85133	1996939	4.26

* Including minibuses.

** Including trailers and long-vehicles.

Source: Ref. (36)

not used after a severe accident, have not been deducted. Of course the difference is not much, because the war-economy requirements and scarcity of spare parts in the market necessitates the vehicles to be used until the last moment of their lives!

3-5. The Road Accidents in Iran in the Past Years, Their Quantity and Quality and the Casualties Resulted

As was previously explained in the chapter of introduction and review of literature, most of the relative road accident data and information is presented and analysed in this chapter. Then in later chapters this data and information will be used:

1- For more extensive investigations of the major issues of road accidents in different provinces of Iran,

2- For comparison with other countries of the world,

3- For evaluating the cost to the community.

It is worth mentioning that in 1983, the author took part in the 17th international meeting of the "Permanent International Association of Road Congress (P.I.A.R.C), in Sidney (Australia), as the head of the joint M.R.T and University of Teheran delegation. This was followed by his first visit to the University of Aston in Birmingham and to the Transport and Road Research Laboratory (T.R.R.L) in 1984. He then was elected as member to some technical committees of P.I.A.R.C*. He also was the head of the M.R.T delegation to the

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* Technical committee for the roads in developing countries, Finance and Economic Technical committee and also Bridge committee.

10th International Road Federation (I.R.F) meeting in Rio-de-Janiro (Brazil) in 1984.

All these events, combined with previous technical qualifications and experiences, provided a unique chance for assembling the most extensive file of data relating to Iran's road accidents ever collected. Unfortunately, the scope of this research does not allow for all of this data to be presented in this thesis. Therefore, only the relevant data will be discussed in this chapter.

The author hopes to exploit the remaining data for further research work in the future.

The information supplied by the statistics office of Iran's Road Police, is supplied based on the police districts' areas as was explained in chapter two. A sample sheet of data supplied by the police was presented and was translated in that chapter. The collection of the data from the different provinces of Iran, and all the analysis and computation of rates and costs, have been carried out by the author and are presented for the first time in this research work.

3-5-1. The Road Accident Statistics in Iran

The road accident statistics started to be officially collected and analysed from 1973 by the Iran Road Police. In the early years this was extremely primitive and insufficient in both quantity and quality. For example, as can be seen from Table 3-4, the figures for the "damage only accidents" are not available up to 1978. Even now, based on what was fully discussed in chapter two, there are a great number of inadequacies. These were explained in that chapter and scientific and feasible solutions were suggested.

Table 3-4 shows the number of road accidents in Iran from 1973 to 1985. The accidents are grouped and tabulated as fatal, injury and damage only accidents. The figures are also graphically shown in Fig. 3-4.

As can be seen from both Table 3-4 and Fig. 3-4, between 1978 and 1985 Iran's total road accidents increased by 98 per cent, from 17785 to 35191, i.e. an average yearly increase of

$$35191 = 17785(1+r)^7 \; ; \quad r = 10.2\%$$

In the same period the fatality and injury accidents increased by:

$$\frac{(1872 + 14747) - (1526 + 8589)}{(1526 + 8589)} \times 100 = 64\%$$

which yields to an average yearly increase of 7.3% .

It must be noted, however, that the real increase is a compound function, with complicated disproportionate variations. Therefore, the average yearly increases above are only some approximations, assuming the functions to be simple.

Fig. 3-4 also shows that although the rate of increase for fatality and injury accidents in curve (2), is almost constant, curve (1), which is for total accidents, has two sharp increases in the years 1979 and 1983. The first one is an astonishing increase of

$$\frac{28278 - 17785}{17785} \times 100 = 59.0\%$$

in one year. The rate of the second increase is

$$\frac{33351 - 28935}{28935} \times 100 = 15.3\%$$

in one year. Both sharp increases are explained as follows:

Table 3-4

The Road Accident Statistics in Iran

Year	Fatal** Accidents	Injury Accidents	Damage only Accidents*	Total Accidents
1973	1164	6557		
1974	1022	5759		
1975	1172	6598		
1976	1354	7198		
1977	1802	9653		
1978	1526	8589	7670	17785
1979	1889	12652	13737	28278
1980	1701	13033	13980	28714
1981	1526	12656	15728	29910
1982	1430	11668	15837	28935
1983	1813	13893	17645	33351
1984	1843	14021	19033	34902
1985	1872	14747	18572	35191

* Damage only accident statistics are not available for the years 1973-1977.

** A fatal accident is defined as an accident to have at least one death "at scene of the accident", in Iran. This is in contradiction with the standard definition, which includes deaths up to 30 days after the accident. Therefore, the fatalities given by road-police in Iran, is estimated as 70% of the real standard fatalities.

Source: Iran Road-Police, The Office of Statistics

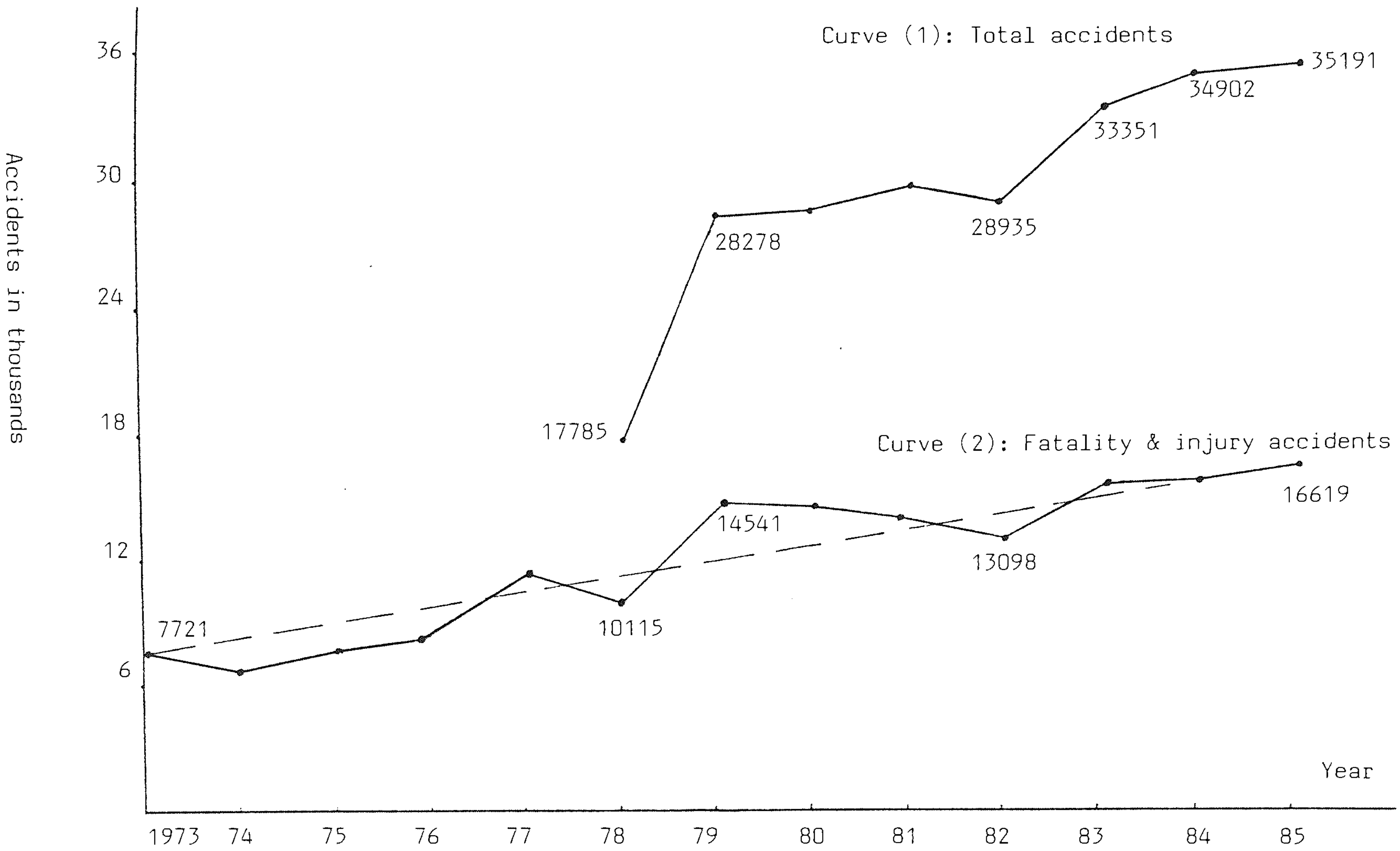

Fig. 3-4. Iran's road accidents for the years 1973-1985.

3-5-1-1. The Sharp Increase in Iran's Road Accidents in 1979

This unique sharp increase of 59% in the road accidents in one year, has two fundamental reasons:

<u>1- The low number of road accidents in 1978</u>

The first spark of the great Islamic Revolution in Iran, was observed in January 1978. By mid-1978 almost all people and industries, including all civil servants and ministerial offices, petrol producing refineries* and most of the public transport systems (air, land and sea), were in a nationwide strike. Factories, schools, offices and business centres were all closed. Therefore, naturally road traffic had sharply decreased. The total number of road accidents is not available for the year 1977 for comparing the magnitude of the decrease in 1978. But from table 3-4 the amount of decrease in fatal and injury accidents is

$$\frac{(1526 + 8589) - (1802 + 9653)}{(1802 + 9653)} \times 100 = -11.7\%$$

This decrease is clearly shown on curve (2) in Fig.3-4. As the two curves follow each others trends from 1978 to 1985, it is reasonble to assume that they also did between 1973 and 1978, and hence, the total number of accidents in 1977 was considerably higher than the 1978 figure.

<u>2- The high number of road accidents in 1979</u>

On 22nd of the Iranian calendar "Bahman 1357", which is equvalent to 13th February 1979, the government of the Islamic Republic

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* Refineries after of a short time of clousure, were ordered by the leader of the revolution to restart work, but only for domestic usage.

of Iran was established. The old law and order had collapsed, and the new law and order had not yet been established.

After the revolution,** the provisional new government was formed and immediately the schools, the factories, the commercial and business centres, the government offices and all other private and public sectors in the country were reopened. Thus, both urban and inter-urban traffic went back to its peak, but in the absence of the necessary law and order.

This vacuum of law and order was the most important reason for the very high number of traffic accidents (including road-accidents) in Iran.

As can be seen from Fig. 3-4, the road accidents stayed high and did not decrease in the following years. One of the reasons for this situation was the government's reluctance to confront people at that sensitive time with such issues. The other reasons will be discussed later.

Therefore, the sharp decrease of traffic accidents in 1978 and the sharp increase of 1979, which were both caused by great social upheavals, made an astonishing increase in total accidents of 59% in one year from 1978 to 1979.

The percentage increase in fatality and injury accidents in 1979 was

$$\frac{(1889 + 12652) - (1526 + 8589)}{(1526 + 8589)} \times 100 = 44\%^{*}$$

This was quite high, but less than the 59% increase of total accidents

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* See table 3-4.
**This coincides almost with the beginning of the year 1979.

in the same year. No reason for this difference in percentage increases has been established.

3-5-1-2. The Sharp Increase of Road Accidents in Iran During the Years 1983 and 1984

Almost 18 months after the new government was established in Iran, the war between Iran and Iraq started (in September 1980). One of the immediate measures taken by the government of Iran, was petrol rationing* all over the country. This measure substantially reduced road-traffic in general, and private passenger car journeys in particular.

Additionally, the price of petrol tripled** in the same year(1980).

Naturally both of these measures had a direct effect on the number of road accidents.

Fig. 3-4 shows that between 1979 and 1982, in spite of the problem of the lack of sufficient law and order in the country, the number of road accidents stayed almost constant at about 28-29000.

In 1983, the government lifted the rationing and the petrol

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* This rationing had many advantages for the community. The suffocating traffic pollution, especially in big cities, was heavily reduced. People transferred to public transport, rather than the habit of extensive usage of private-cars. The necessity to import a huge amount of motor-vehicle spare parts from abroad was reduced, and... many other advantages that can be fully investigated in further research work.

** From 10 to 30 Rials per litre (each sterling pound is equivalent approximately to 130 Rials, official rate. There will be an extensive discussion about the official rate, export rate and free rate in chapter 7 on the issue of the road accidents' cost. Also see footnote for sub-section 6-3-1, in chapter 6.

was again freely available in the petrol stations, with the same prices*. The private recreational and unnecessary private journeys, using the cheap and plentiful petrol, brought the traffic flows very high again with all the harmful consequences, including the high level of accidents which followed.

3-5-2. The Road Accident Casualties in Iran

Table 3-5 and Fig. 3-5 show the road accident casualties in Iran from 1973 to 1985. The statistics for the years before 1973 are not available.

The sharp increases in road accidents which were discussed in sub-section 3-5-1, can also be clearly observed in the number of road accident casualties in the years 1979 and 1983. The percentage increase of total road casualties in 1979 is (see Fig. 3-5):

$$\frac{23158 - 17166}{17166} \times 100 = 35\%$$

and the percentage of increase in road accident deaths is

$$\frac{2790 - 2198}{2198} \times 100 = 27\%$$

Comparing Fig. 3-4 and Fig. 3-5, it can be seen that after the sharp increase of road accidents in 1979, based on what was explained in sub-section 3-5-1, total accidents, fatality and injury accidents, and the number of fatalities, remained almost the same for 1980. Only the number of persons injured, continued to increase, the rates for 1979 and 1980 were:

$$1979: \frac{20368-14968}{14968} \times 100 = 36\% \qquad 1980: \frac{26307-20368}{20368} \times 100 = 29\%$$

---

* 30 Rials per litre, see footnote on previous page.

Table 3-5

The Road Accident Casualties in Iran

Year	Persons killed *	Persons injured	Total casualties
1973	1341	8700	10041
1974	1593	11340	12933
1975	1735	11207	12942
1976	2124	14383	16507
1977	2209	15168	17377
1978	2198	14968	17166
1979	2790	20368	23158
1980	2547	26307	28854
1981	2408	25199	27607
1982	2219	23656	25875
1983	2831	27569	30400
1984	2842	28355	31197
1985	2841	29647	32488

* See footnote on page 153

Source: Iran Road Police, The Office of Statistics.

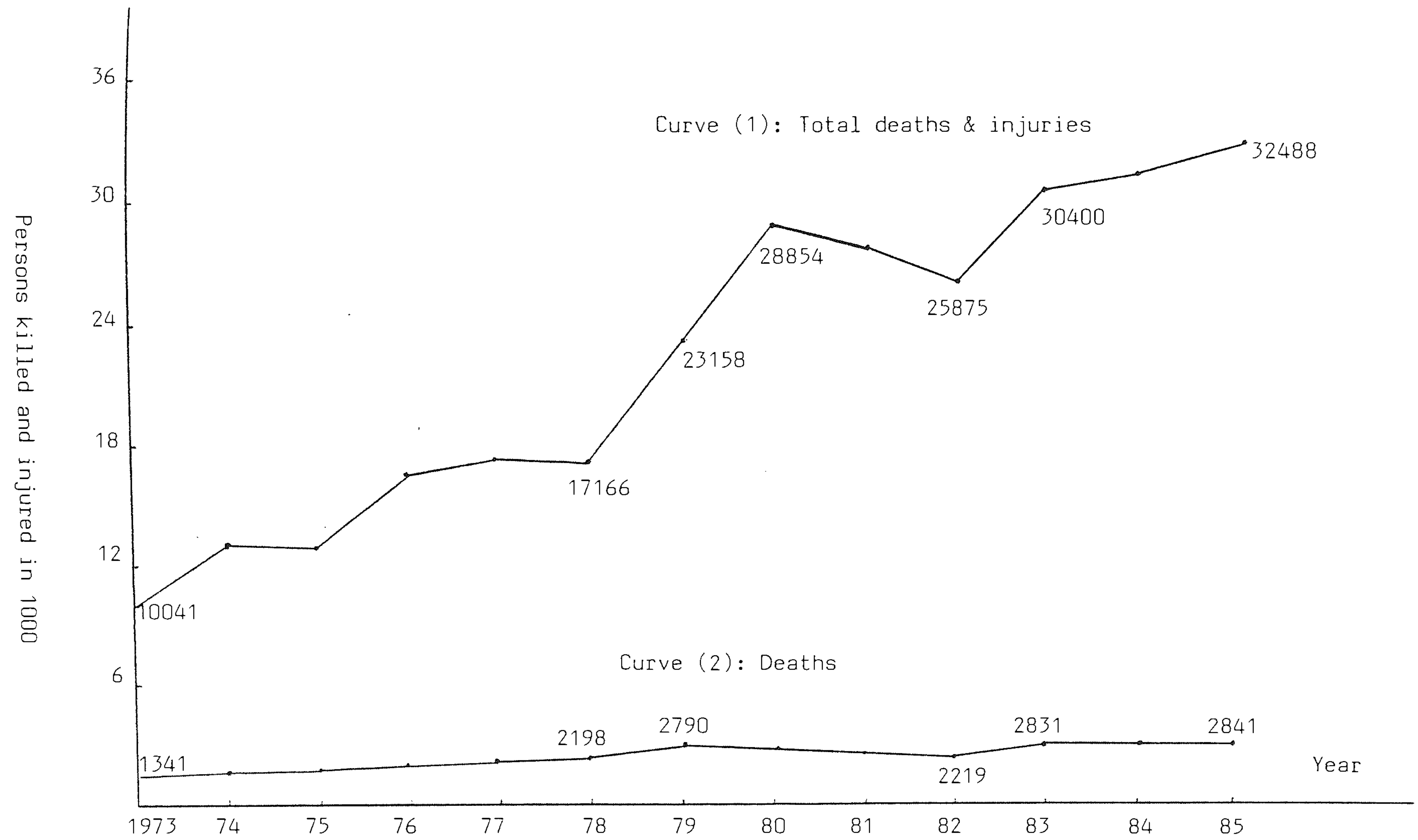


Fig. 3-5. Iran's road deaths and injuries for the years 1973-1985.

The 29% increase in the number of persons injured in 1980, as was explained before, does not correspond to other information and statistics available, nor is it compatible with the important governing socio-political elements of that year (see sub-section 3-5-1). This is one of those inconsistencies in traffic accident data which was mentioned in section 2-5 for correction and improvements of road-accident data (see also Ref.s (59) and (61) to reduce the possibility of data error.).

3-5-3. The Rate of Road Accidents in Iran

In order to understand the road safety situation and its standard in a country, or to make a rational and reasonable comparison between the safety standards of different countries, it is not enough to rely only on absolute figures of accidents and the consequent casualties. It is also necessary to calculate the rate of accidents and casualties.

In developed countries, different types of bases for derivation of such rates are employed. These bases are mostly population, the number of motor-vehicles, the length of roads and their average volume of traffic, and the vehicle-kilometres (or vehicle-miles).

All available relative data was examined in Iran, in the Central Police Statistics Office, in the Headquarters of the Ministry of Road and Transport, in the M.R.T. dependent offices, and in other places as were discussed in chapter one, but it appears that no attempt has so far been made for calculating the rate of road accidents. Therefore, this is the very first research work to derive these rates and try to make useful comparisons and suggestions in this and the following chapters.

In chapter 4, when comparing the road accidents in Iran with other countries, it will be explained that the best reliable base of comparison for rates, is the vehicle-kilometre. Unfortunately, the necessary data of vehicle-kilometres travelled on Iran's roads is not available. The author tried to obtain the volume of fuel used by motor-vehicles on Iran's roads and then make at least an approximation of the figures for vehicle-kilometres. But in spite of providing an official request from the Universityof Mashad (where the author is employed), and many months waiting, the Ministry of Oil is still refusing to provide the figures of fuel consumed by road-users in Iran.

Thus, the rates in this chapter, which are for the first time developed for Iran's road accidents and road casualties in this research work, are based on population and the number of motor-vehicles. In chapters 4 and 5 other bases, such as the length of roads and their A.D.T and C.A.D.T* will be employed.

In Table 3-6, the road accident death rates per 100000 population in Iran from 1973 to 1985 are shown. But in Table 3-7, as the data for the number of motor-vehicles before 1977 is not available, the rates of deaths per 10000 motor-vehicles are developed and tabulated for the years 1977-1983. Both these rates are shown diagramatically in Fig. 3-6.

The decrease of road accidents, and consequent casualties, in

---

* A.D.T. (average daily traffic) & C.A.D.T. (comparative average daily traffic). For more explanation see section 5-4,page 254.

Table 3-6

Road Accident Death Rates per 100000 Population in Iran

Year	Road accident Deaths	Population in 100000 persons	Deaths per 100000 persons
1973	1341	318.64	4.21
1974	1593	323.25	4.93
1975	1735	329.25	5.27
1976	2124	337.09	6.30
1977	2209	346.57	6.37
1978	2198	356.36	6.17
1979	2790	366.49	7.61
1980	2547	376.98	6.76
1981	2408	387.84	6.21
1982	2219	399.07	5.56
1983	2831	410.68	6.89
1984	2842	428.01*	6.64
1985	2841	445.34*	6.38

* A very recent census declared the population of Iran in 1987 as 48 million. The two figures in the Table for 1984 and 1985 are based on the assumption of a uniform increase between 1983 and 1987.

Source: Column 2: Iran Road Police, The Office of Statistics, and

Column 3: The Ministry of Planning and Budget, Organisation of Statistics.

Table 3-7

Road Accident Deaths per 10000 Motor-Vehicle in Iran

Year	Road Accident Deaths	Motor-vehicles (in 10000)	Deaths per 10000 Motor-vehicles
1977	2209	170.3	12.97
1978	2198	187.0	11.75
1979	2790	198.9	14.03
1980	2547	219.0	11.63
1981	2408	234.7	10.26
1982	2219	246.9	8.99
1983	2831	267.8	10.57

Source: **Column 2:** Table 3-5 and **Column 3:** Table 3-2.

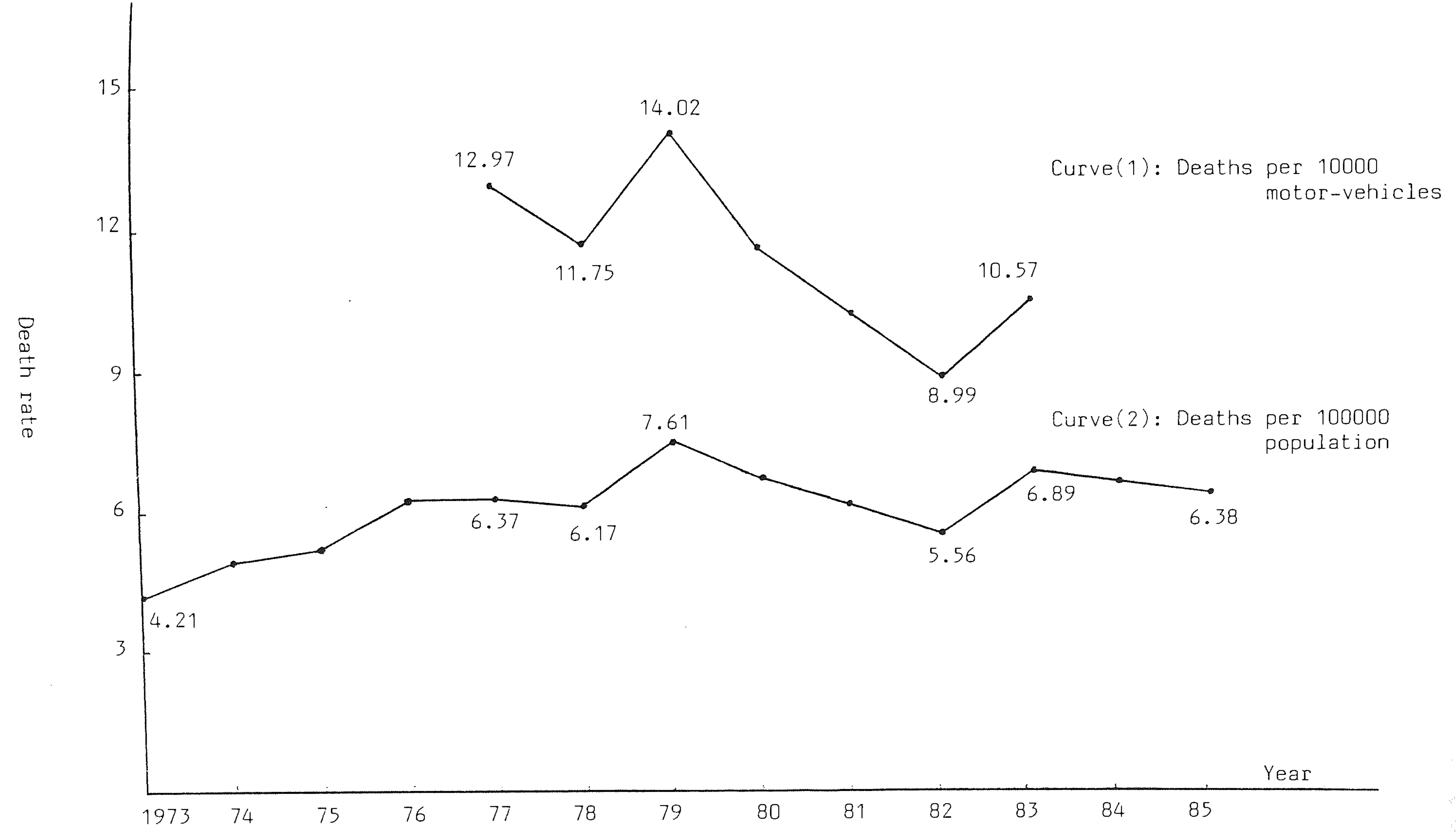


Fig. 3-6. Iran roads' accidents' deaths rate for the year 1973-1985.

1978, and also the following increase of 1979 and 1983 which were discussed in sub-sections 3-5-1 and 3-5-2, are also well observed in both definitions of rate of death, considered in this sub-section. The results are tabulated in Table 3-8 below.

Table 3-8

The sharp Decrease of the Road Accident Death Rate in 1978 and Its Sharp Increases of 1979 and 1983

Death Rate	Percentage Decrease in 1978	Percentage Increase in 1979	Percentage Increase in 1983
Deaths per 100000	$\frac{6.17-6.37}{6.37} \times 100$	$\frac{7.61-6.17}{6.17} \times 100$	$\frac{6.89-5.56}{5.56} \times 100$
Population	= -3.14%	= +23.34%	= +23.92%
Deaths per 10000	$\frac{11.75-12.97}{12.97} \times 100$	$\frac{14.03-11.75}{11.75} \times 100$	$\frac{10.57-8.99}{8.99} \times 100$
Motor-vehicles	= -9.41%	= +19.40 %	= +17.57 %

Source: Table 3-6 and Table 3-7.

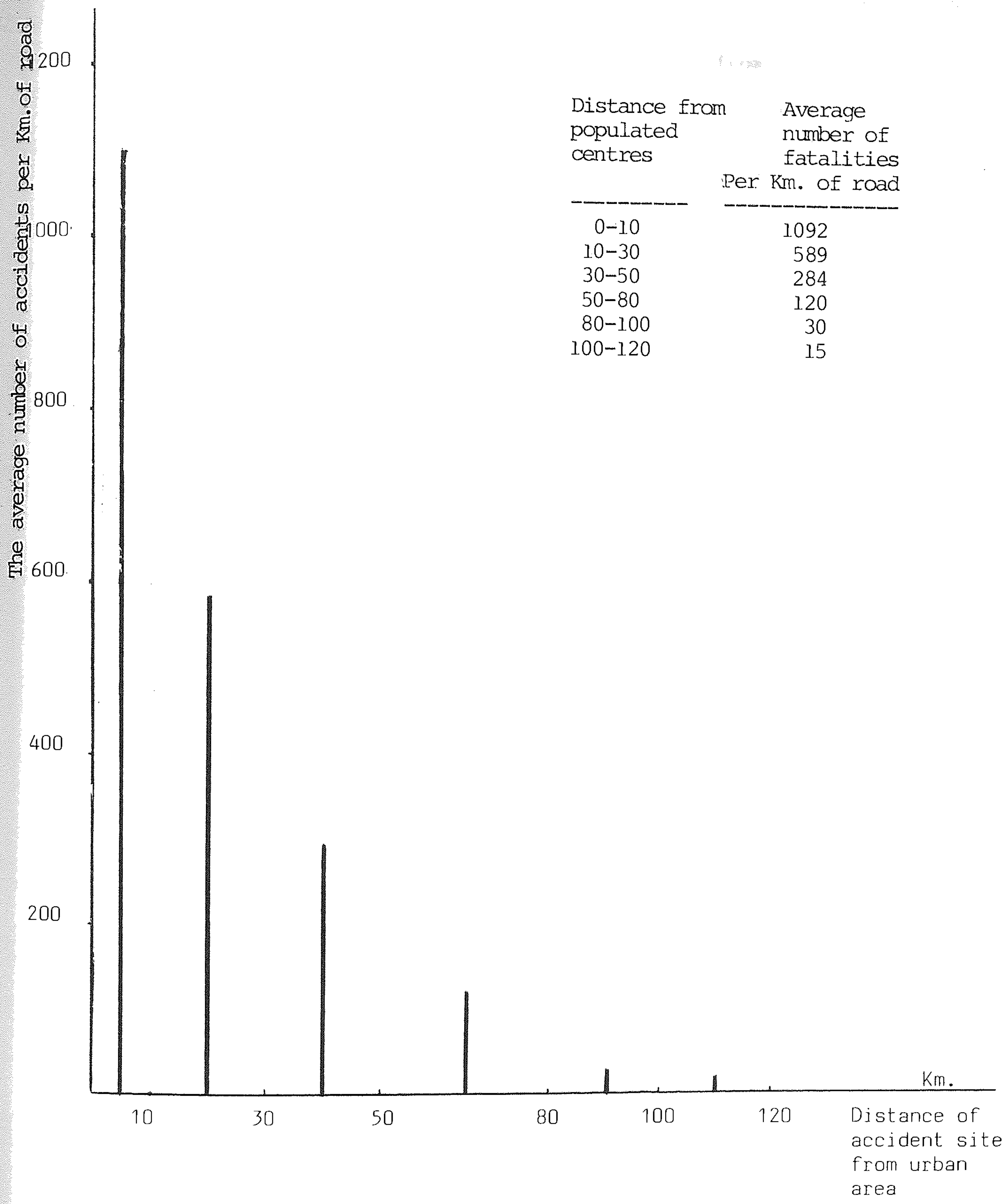
In chapter 4, when comparing Iran's road accidents with other nations, it will be seen that each of these rates has its own characteristics and limitations, which should be carefully considered. In other words, each rate must be used cautiously, in order not to lead to misinterpretation and misjudgement.

For example, the road accident rate of deaths per population in Iran, is generally smaller than industrialised countries. Whereas the death rate per motor-vehicles is 2-4 times larger. These will be fully discussed later.

3-5-4. The Distances of the Accident Sites from Urban Areas

One important and interesting piece of information about Iran's road accident analysis is the distances of the road accident sites from neighbouring cities and populated centres. The Iranian road police high commandant, in an official report to M.R.T.[44], pointed out that from 33351 road accidents in Iran in 1983, 28389 accidents, i.e. 85%, occured in the vicinity of 50 kilometres from cities and towns. The report concluded that with the scarcity of technical and financial resources it would be a proper decision for road planners to concentrate the new road construction projects (road widening projects and maintenance efforts mostly) in a radius of 50 kilometres from towns and cities.

Fig. 3-7 is based on the information[44] shown in Table 3-9 which shows the distances of the accident sites from urban areas.



Distance from populated centres	Average number of fatalities Per Km. of road
0-10	1092
10-30	589
30-50	284
50-80	120
80-100	30
100-120	15

Fig. 3-7. The distance of Iran's road accident sites from cities and towns, in 1983.

Table 3-9 The Distances of the Road Accident Sites from Neighbouring Cities and Populated Centres (1983)

From kilometre		00	to	kilometre	10	10924	Accidents
"	"	10	"	"	30	11789	"
"	"	30	"	"	50	5676	"
"	"	50	"	"	80	3590	"
"	"	80	"	"	100	599	"
"	"	100	"	"	120	296	"
"	"	120	to	higher distances		477	"

3-5-5. The Positions of Vehicles Involved in the Accidents

Table 3-10 and Fig.s 3-8 & 3-9 show the contact points of the vehicles and the positions of the parties involved in the accidents. The front to side position in 1983 with 29 per cent, in 1984 with 31 per cent and in 1985 with 32 per cent is the most frequent type of collision which occurs. Also in 1983, from 33351 cases of road accidents, 23800 cases (71 per cent) involved the collision of one vehicle into another single vehicle, and 1700 cases (5 per cent) involved the collision of one vehicle into more than one other vehicle. 4380 cases of pedestrian accidents accounted for 13 per cent of the 1983 total accidents. Also, collisions with a fixed object and with animals each has a share of 1.7 and 1.0 per cent respectively. 2300 cases of overturning and/or falling account for about 7 per cent.

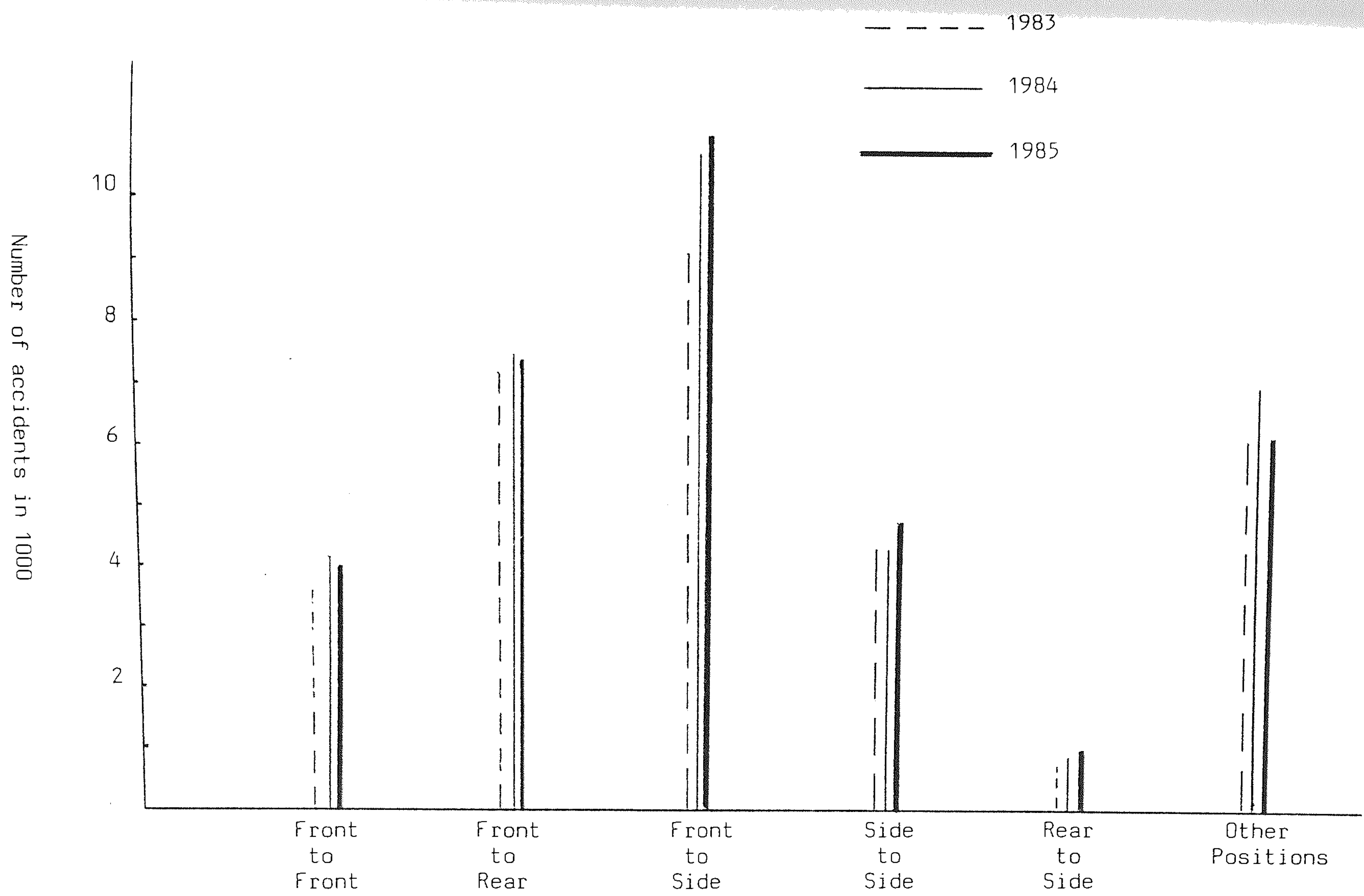


Fig. 3-8. The contact points of vehicles involved in Iran's road accidents.

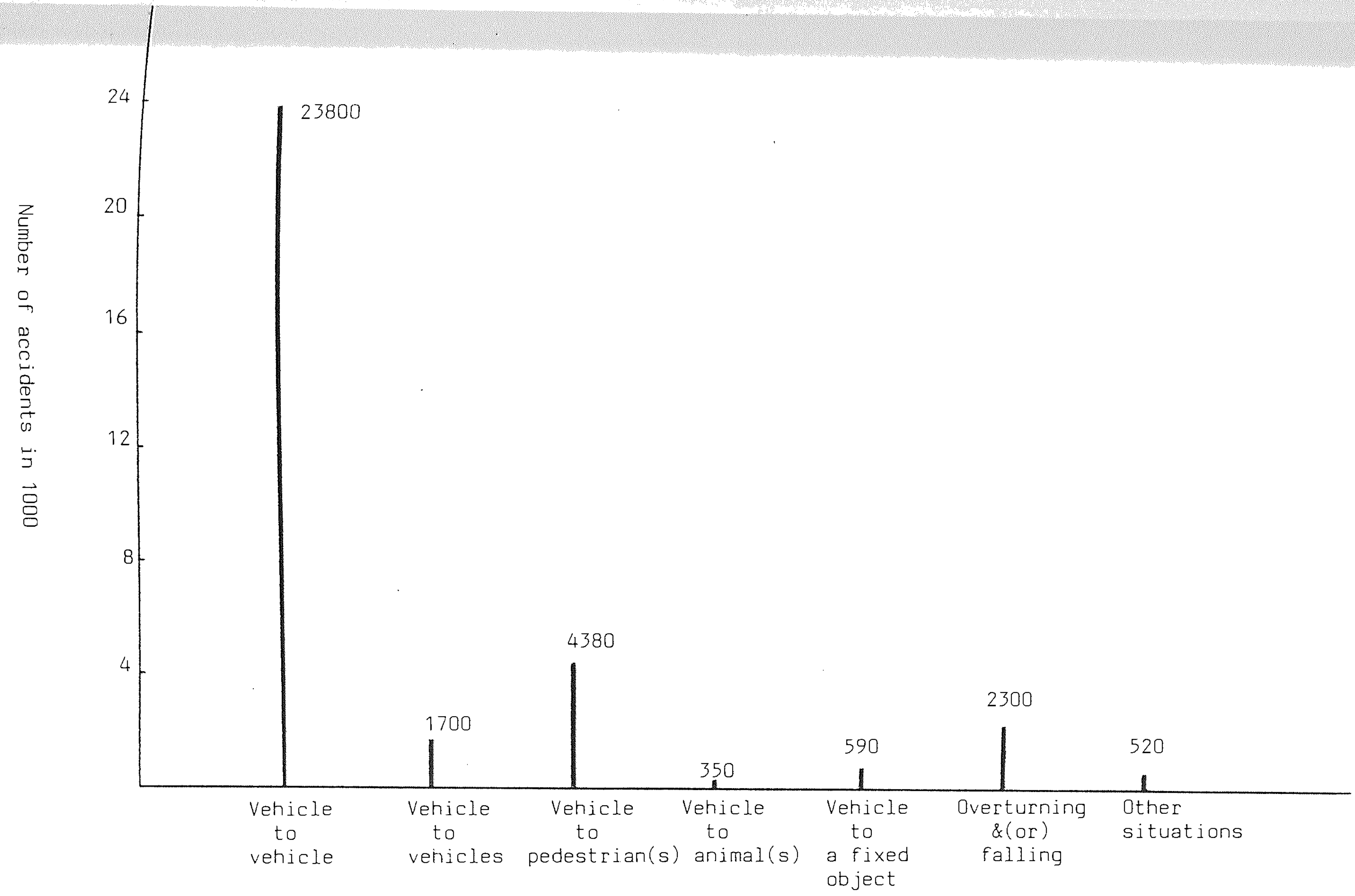


Fig. 3-9. The parties involved in Iran's road accidents in 1983.

Table 3-10

Iran Road Accidents, Involving More Than One Vehicle; Considering Their Positions at Collision

Year	Front to front	Front to rear	Front to side	Side to side	Rear to side	Other positions
1983	3704	7287	9194	4428	836	6158
1984	4227	7578	10772	4420	897	7048
1985	4086	7412	10995	4766	983	6146

3-5-6. Iran's Road Accidents by Time of Day

Table 3-11, and Fig. 3-10 show the frequency of road accidents in 1984 and 1985 by time of day. As can be seen, there are two peak periods. The first one is from 6.00 to 11.00 hour in the morning with 11466 accidents (32.8%) in 1984 and 11471 accidents (32.6%) in 1985. The information available is in long time spans (minimum of three hours) and these time periods are not uniform. Consequently Fig. 3-10 has been drawn showing the total number of accidents positioned at the mid point of each time period. The second peak period is in the evening from 15.00 to 20.00 hour with 11091 accidents (31.8%) in 1984 and 11259 accidents (32.0%) in 1985. Considering Table 3-11 it can be realized that in 1984, 88.5 per cent of road accidents happened from 6 o'clock in the morning to 8 o'clock in the evening.

No records could be found of road accidents during major ho-

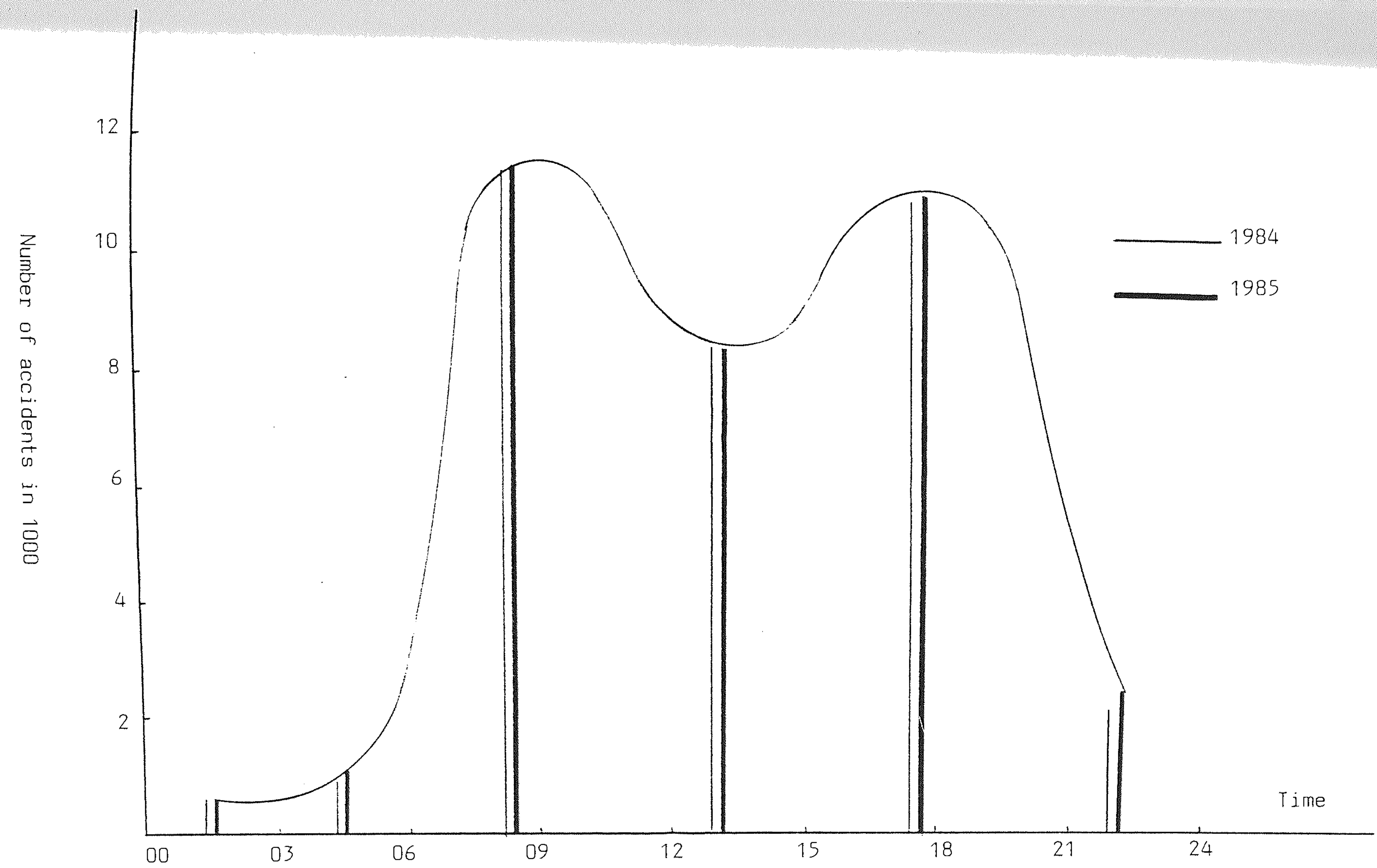


Fig. 3-10. Iran's road accidents by time of day (1984 and 1985).

lidays or during special ceremonies and/or events.

Table 3-11

Iran's Road Accidents by Time of Collision Occurence

Time of Day (Hour)	Number of Accident per Year 1984	1985
00-03	667	581
03-06	999	1107
06-11	11466	11471
11-15	8428	8427
15-20	11091	11259
20-24	2251	2364
Total	34902	35191

3-6. Interaction Between Road Accident's Contributory Factors

In most accidents, factors are present relating to the driver, the vehicle, and the road, and it is the interaction of these factors which often sets up the series of events which culminates in the mishap. Also it is widely accepted that "behaviour" of one or more road user(s) play(s) a part in almost all accidents. However, most accidents are multifactor events so that human failings are often accompanied by some deficiency in the road system or vehicle. Here a characteristic pattern of this interaction for the United

Kingdom is presented(65)and compared with similar figures for Iran. The interactive figures for Iran are approximate. Also Mackay in his paper "A system for analysing contributory factors in traffic collisions, 1968" (89) devides the factors to Environment, Vehicle, and Road-user. Then the figures in Table 3-12 are presented for The United Kingdom in 1968. As far as the total human factor is concerned there seems to be a relatively good compatibility between Mackay (1968) and Sabey(1975), i.e. 84.8% - 94.7%. But for "human factor alone" there is a sharp difference between two studies, i.e. 12.4% and 65.0%. With the scarcity of previous research-works and available data and information in Iran, it is very difficult and might be impossible to determine the percentage effect of each factor in causing the accidents. But by analysing the most frequent driving offences of Iranian drivers, it is not too difficult to conclude that the human factor is decisive in Iran's road accidents. Ref.(30) gives some approximate hints in this regard for Iran, which are appeared in Table 3-12.

Table 3-12. Interactions between contributory factors of road-accidents in The U.K(1968 & 1975) and Iran(1983)

C.F	U.K* 1968	C.F	U.K** 1975	C.F.	Iran*** 1983
En-Ve-Ru	16.4	Hu-Ro-Ve	1.2	mostly Human	60.0
En - Ru	48.8	Hu-Ro	24.0	mostly Road	22.0
Ve-Ru	7.2	Hu - Ve	4.5	mostly Vehicle	18.0
Ru	12.4	Hu	65.0		
En- Ve	4.8	Ro-Ve	0.3		
En	5.6	Ro	2.5		
Ve	4.8	Ve	2.5		
	100.0		100.0		100.0

En:Environment, Ve:Vehicle
Ru:Road-User , Ro:Road
Hu:Human

*) Source: Ref.(89)
**) Source: Ref.(65)
***) Source: Ref.(30)

3-7. Human Factors in Iran's Road Accidents

3-7-1. Road Accident Casualties

From 28355 persons injured in Iran's road accidents in 1984, 9434 persons (33.3%) were motor-vehicle drivers, 15078 persons (53.2%) were other motor-vehicle occupants, and 3843 persons (13.5%) were pedestrians and other non vehicle occupants, Table 3-14. The same figures for the year 1985 are 10290 (34.7%), 15294 (51.6%), and 4063(13.7%) respectively. Of the many cultural, psychological, and physiological factors which may determine road user behaviour, those best quantified are age, sex, and alcolol/drugs[82].

The age of people killed or injured on Iran's roads in 1983 are shown in Table 3-13, and Fig. 3-11. The range of 20-29 years of age with 37.7%, and 30-39 with 33.2% are the highest. The people aged 40-49 with 18.2% are the third group which are most at danger on Iran's roads. People between 20 and 50, which are the country's most useful and efficient human resources, account for 89.1% of road accident casualties.

3-7-2. Age and Sex of the Culpable Drivers Involved in Road Accidents

The age and sex of the culpable drivers, and the rate of them per one million persons in each age group, are shown in Table 3-15, and Fig. 3-12. As can be seen, the number of females found guilty are few in comparison with males. The difference is apparently due, at least partly, to the differences in the amount of driving done by the number of each sex group, especially on roads, and also to the differences in time, place, and circumstances of driving.

Table 3-13

Iran's Road Accident Casualties for Different Age Groups, 1983

Age group	Casualties**	Per cent
Less than 12	108	0.3
12-19	568	1.9
20-29	11462	37.7
30-39	10103	33.2
40-49	5535	18.2
50-59	2152	7.1
60-69	421	1.4
70 & more	51	0.2
Total	30400	100.0

** Casualties include both fatalities and injuries.

Table 3-14

Iran's Road Accident Injuries in 1984 and 1985

Year	1984	1985
Driver	9434	10290
Other occupant	15078	15294
Pedestrian* & other nonoccupant	3843	4063
Total	28355	29647

* Figures are for rural roads, and this is why that the percentage of pedestrian fatalities is only about 13.5%.

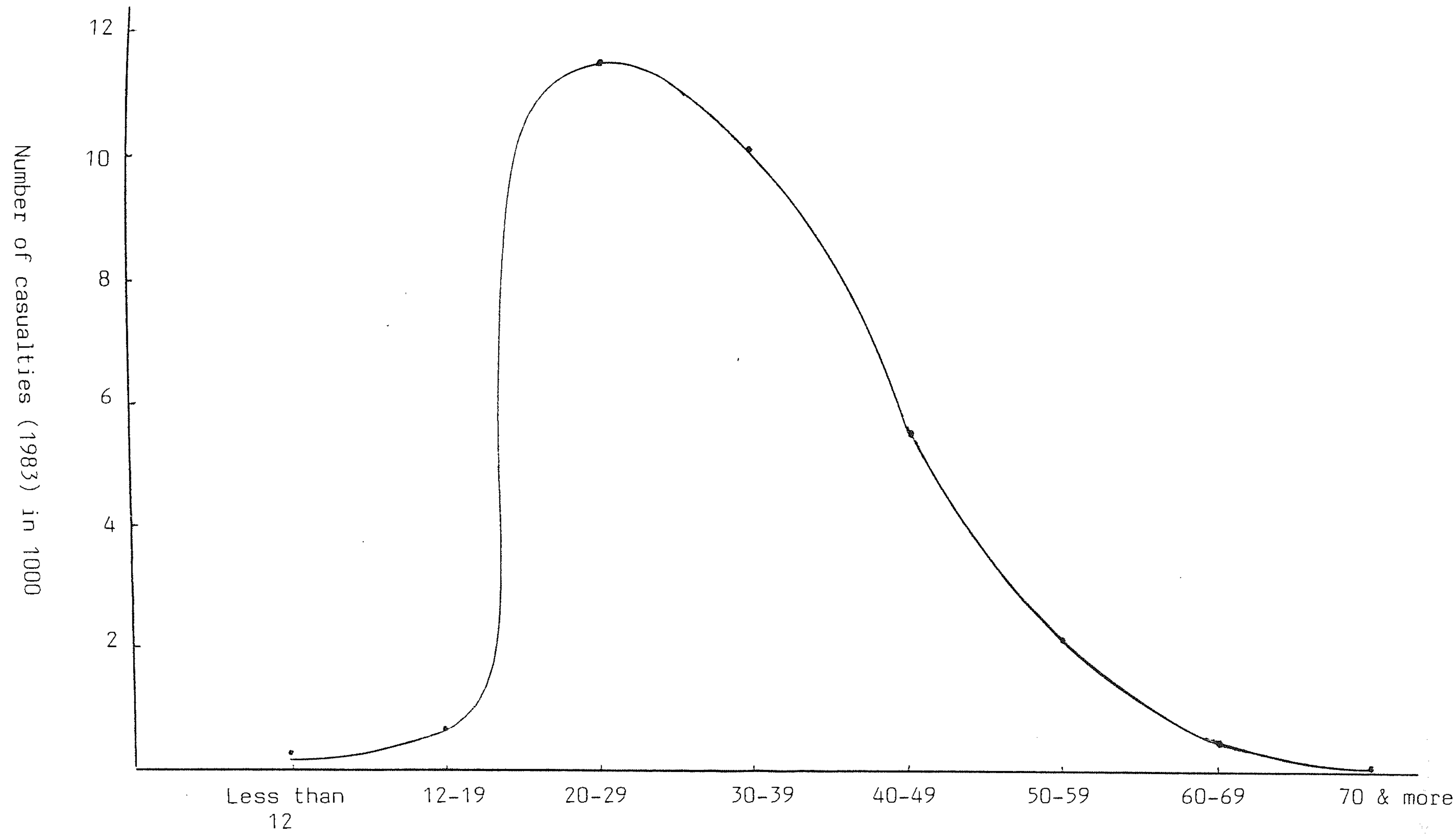


Fig. 3-11. Iran's road accidents' casualties for different age groups, 1983.

The World Health Organization findings for developing countries[82], in comparing the sexes, indicates that involvement rates per distance driven, and responsibility for accidents, are about equal for men and women. Their different driving habits and different characteristics do, however, lead to errors of different natures. In accidents involving women, lack of experience of driving is manifested by lack of skill, difficulty in manoeuvring, and distraction. In those involving men, the more frequent faults are driving too fast, unsafe overtaking, and impairment by alcolhol. These differences have implications for the planning of driver training schemes and education.

In Table 3-15, the age group with the maximum number of culpable drivers is 20-29 years, with 11200 cases which is 37.6 per cent of the total. The next age group, i.e. 30-39, has 9790 cases which is 32.9 per cent of the total. These two age groups change their positions when the rate per population is calculated. The age group 30-39,which is the second group in terms of the numbers of guilty drivers, becomes the first per one million of its population.

Considering the road users' behaviour, more emphasis tends to be given to age and sex, in particular, than to lack of experience, which is often associated with the young,rather than the old, and with women (who drive less) rather than men. The effects of inexperience can be illustrated in relation to the different modes of transport. Injury rates peak around the ages at which the different road users first come into contact with different modes of transport. The assessment of the World Health Organization[82] is as follows:

Type of road user	Age of peak rate (years)
Pedestrians	5-9
Cyclists	10-14
Motor-cyclists	16-19
Car-drivers	17-20

No information was found to investigate this idea in Iran. The only information which has been recently started to be collected by Iran's Road-Police Office of Statistic is that shown in Table 3-15. Hopefully this will be available more completely in the future for further research works.

Table 3-15

Iran's Road Accidents by Age and Sex of the Culpable Drivers Involved in 1983

Age group	Male	Female	Total	Population in thousands	Rate per million of popu.
Less than 12	125	29	154	17302	8.9
12-19	521	4	525	7713	68.1
20-29	11129	71	11200	5350	2093.4
30-39	9727	63	9790	2987	3277.6
40-49	5386	34	5420	2896	1871.4
50-59	2210	14	2224	2133	1042.7
60-69	380	3	383	1232	310.6
70 & more	57	1	58	1455	39.2
Total	29535	219	29754	41068	724.5

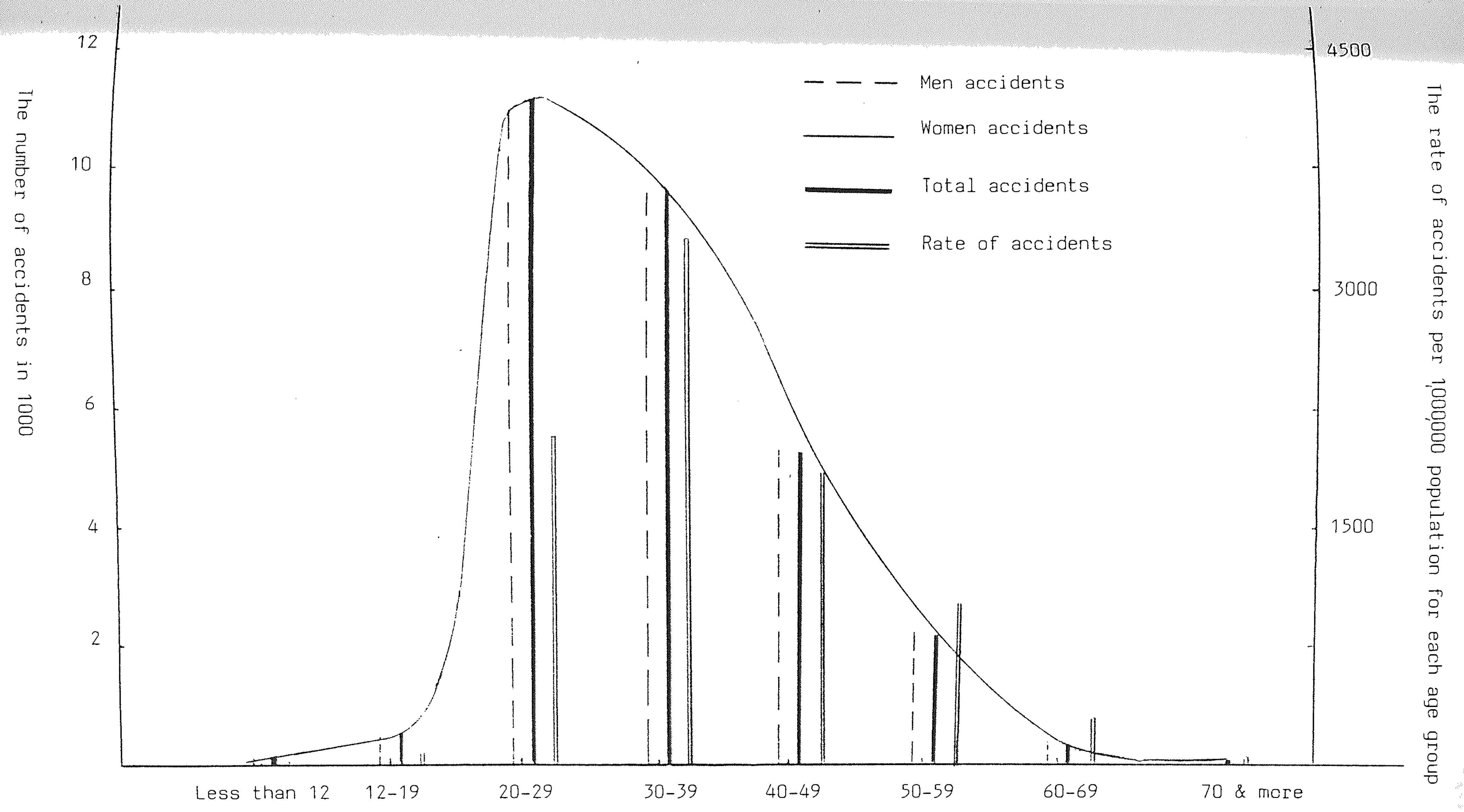


Fig. 3-12. Iran's road accidents, 1983, considering ages+sex of the culpable drivers involved.

3-7-3. Improper Driving

Although most accidents are caused by interaction of different factors, Table 3-16, and Fig. 3-13, relate just to the driver and show the principal kinds of improper driving which were factors in causing the accidents. Correction of these improper practices could have an important role in prevention. This does not mean that road and vehicle conditions may be disregarded.

As can be seen from Table 3-16, in 1983, 89 per cent, and in 1984, 96 per cent, of Iran's road accidents were solely or collectively caused by improper driving. There is an increase of 12.7 per cent in improper cases of driving in 1984 compared with 1983. Swinging to the right or left (especially driving left of centre) with 5133 cases (17.2%) in 1983, and violating the right of way (failing to yield) with 6160 cases (18.4%) in 1984, are the maximum repeated types of improper driving.

It is important to note that the lack of education and the lack of enough and effective police presence and control (see sub-section 2-4-1) cause events which are unusual and almost impossible to happen in the developed world. For example, the Khorasan daily newspaper*, in its edition No. 10917 dated 7 April 1987, writes that a bus (plate-number 11212/Gazvin-86) with 32 passengers on board overturned when its two drivers tried to change their seats whilst driving at high speed! Consequently one of the drivers and seven passen-

* A newspaper published in Farsi language in Mash-had, the second largest city in Iran and the centre of Khorasan pr.

Table 3-16

Iran's Road Accident Statistics Categorized by Type of Driving Behaviour

No.	The type of driving behaviour	1983 No.	1983 %	1984 No.	1984 %	per cent change
1	Following too close	4723	16	5812	17	+23.0
2	Violating right of way	4929	17	6160	18	+25.0
3	Lack of proper attention	4615	16	4752	14	+ 3.0
4	Inexperience & lack of control	1269	4	2210	7	+74.1
5	Unpermitted speed	2654	9	3664	11	+38.1
6	Wrong path, swing to right or left	5133	17	6044	18	+17.7
7	Reverse driving*	1250	4	1380	4	+10.4
8	Improper overtaking	1585	5	2178	7	+37.4
9	Others	3596	12	1322	4	-63.2
Total(human caused)		29754		33522		+12.7
Total number of accidents**		33351		34902		
per cent of accidents in which some kind of human error(s) somehow was(were) effective		89%		96%		

* In accordance with Iran driving regulation, the reversing vehicle involved in an accident bears the whole responsibility.

** See Table 3-4

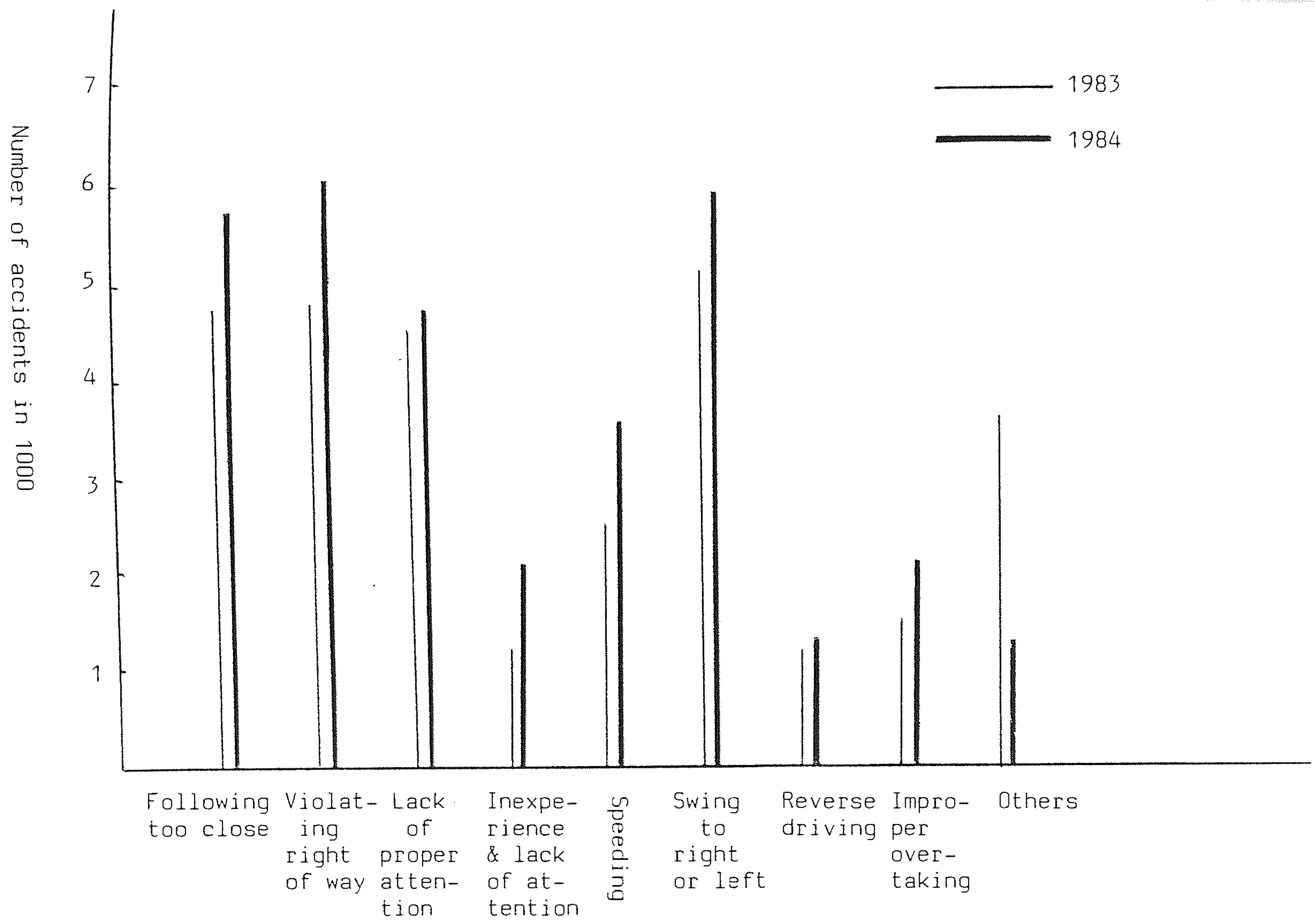


Fig. 3-13. Iran's road accidents caused by improper driving.

gers were killed and 25 were injured.

3-7-4. Alcohol, Drugs, Disability and Drowsiness

It is now well known that alcohol is one of the most critical factors affecting behaviour whilst driving. Its role is well established, and in many countries, high Blood Alcohol Concentration (BACs) are found in about 30-50 per cent of people involved in fatal road accidents[55].

Studies ranging across the major types of driving experience in the U.S.A, and confirmed by different research studies in the United Kingdom, have shown that drivers with high BACs are grossly over-represented in fatal and serious injury crashes, in comparison with samples of uninvolved drivers.

According to the OECD findings, between one-third and one-half of fatal road accidents among adults in different countries of the world involve drivers with a measurable alcohol and/or other drug presence. It has been fully argued that accident probabilities are always greater at any BACs above zero. Different studies show that BACs of 80/100 ml or higher are incompatible with safe driving and that the higher the concentration, the greater the incompatibility. Small increases in BACs abover 80 ml/100 ml result in disproportionately large increases in crash risk[83].

The accident probability for pedestrians in relation to alcohol intake has also been studied[52] and it has been found that adult pedestrians with BACs of 80 ml/100 ml or higher are usually responsible for initiating accidents.

The influence of alcohol has also been analysed in many experimental studies on human behaviour related to driving. For a given alcohol dose, the peak BACs achieved, and the duration of presence of alcohol, are affected by such factors as length of drinking time, contents of stomach and intestines, and the amount and concentration of alcohol consumed. Further, it has been found that a greater impairment occurs during the period when the blood alcohol curve is rising than when it is falling. In more psychological-oriented studies[82], it has been found that alcohol impairs lane discipline, especially in a divided attention situation such as a roundabout. The area which appears to be most sensitive to the effect of alcohol seems to be the central processing of information.

Although drinking any kind of alcoholic beverages is strictly forbidden by the Islam religion, before the Islamic revolution of 1979, in Iran, like many other moslem countries, alcoholic beverages were openly sold in the shops and served in restaurants and other public places. In those days the fatal and severe injury accidents caused by alcohol, especially during public holidays, were frequent and were increasing. But after 1979 in the **Islamic Republic of Iran;** it may be safe to claim that any person buying, selling, carrying or drinking alcoholic beverages with any content of alcohol in public places is identified and prosecuted consistently to the full extent of the Islamic law. This has caused substantial benefits for the community, including road safety.

Table 3-17, and Fig. 3-14, show that the number of road accidents in Iran caused by alcohol are few and sharply decreasing.

In industrialized countries, however, millions of law-abiding citizens drive under the influence of drugs other than alcohol every day(83), but whether this is a significant factor in the total picture of traffic safety and requires priority attention is an important but unresolved question. Some attempts have been made in developed countries to determine the frequency of drugs in drivers arrested for driving infringements and for drivers killed in crashes. Barbiturates and diazepam were the drugs most commonly found.

It appears that in developed countries, two-thirds of the drivers were impaired by alcohol and ten per cent had used other drugs (52). Case reports clearly indicate that alcohol and drugs are often used together.

In Iran, as far as the driving under the influence of drugs and alcohol is concerned, the situation is totally different. Table 3-17 shows that in the years 1984 and 1985 the reported numbers of road accidents under the influence of drugs were only 9 and 8 cases respectively. Also 15 and 8 cases of different combinations of drug and other impairments were reported in 1984 and 1985. No case of road accidents caused by a combination of drinking and drugs could be found in the Iran police's reports during those two years.

The very significant, and almost only considerable, type of impairment in Iran's road accidents is fatigue. "Ettela-at" one of the two most circulated daily newspapers in Iran (printed in Farsi, in Teheran), in its edition number 17814 dated 13 February 1986 page 5, warned that fatigue, nervous strains, and drowsy driving push our drivers to serious road accidents.

Tired and drowsy driving in 1984, with 2772 cases (95%), and in 1985, with 2416 cases (94%), was almost the sole cause of impairment in Iran's road accidents. The magnitude of this factor (Line 1) is so different from the other 9 factors that it was not possible to be shown in the same scale. Therefore in Fig. 3-14 only the other 9 factors are compared on the same scale. Small amounts of drinking alcohol or using drugs which cause tiredness and drowsiness, but are not detectable by police, are automatically present in lines (1) and (3) in Table 3-17. Based on what was explained the percentages of such cases presumably should be low.

Table 3-17

Iran's Road Accidents Caused by Alcohol, Drug, Disability and Drowsiness

	Year	1984	1985
1	Tired & drowsy driving	2772	2416
2	Effective disability**	49	73
3	Drug using	9	8
4	Drinking alcohol	22	18
5	1+2	55	11
6	1+3	9	5
7	1+4	11	6
8	2+3	6	3
9	2+4	4	2
10	Others	-*	17

* The figure for Line 10 is not available for the year 1984.

** This means those disabilities that have been effective in causing the accidents. For example if a driver's deafness has been effective in causing an accident, it is categorised in this group.

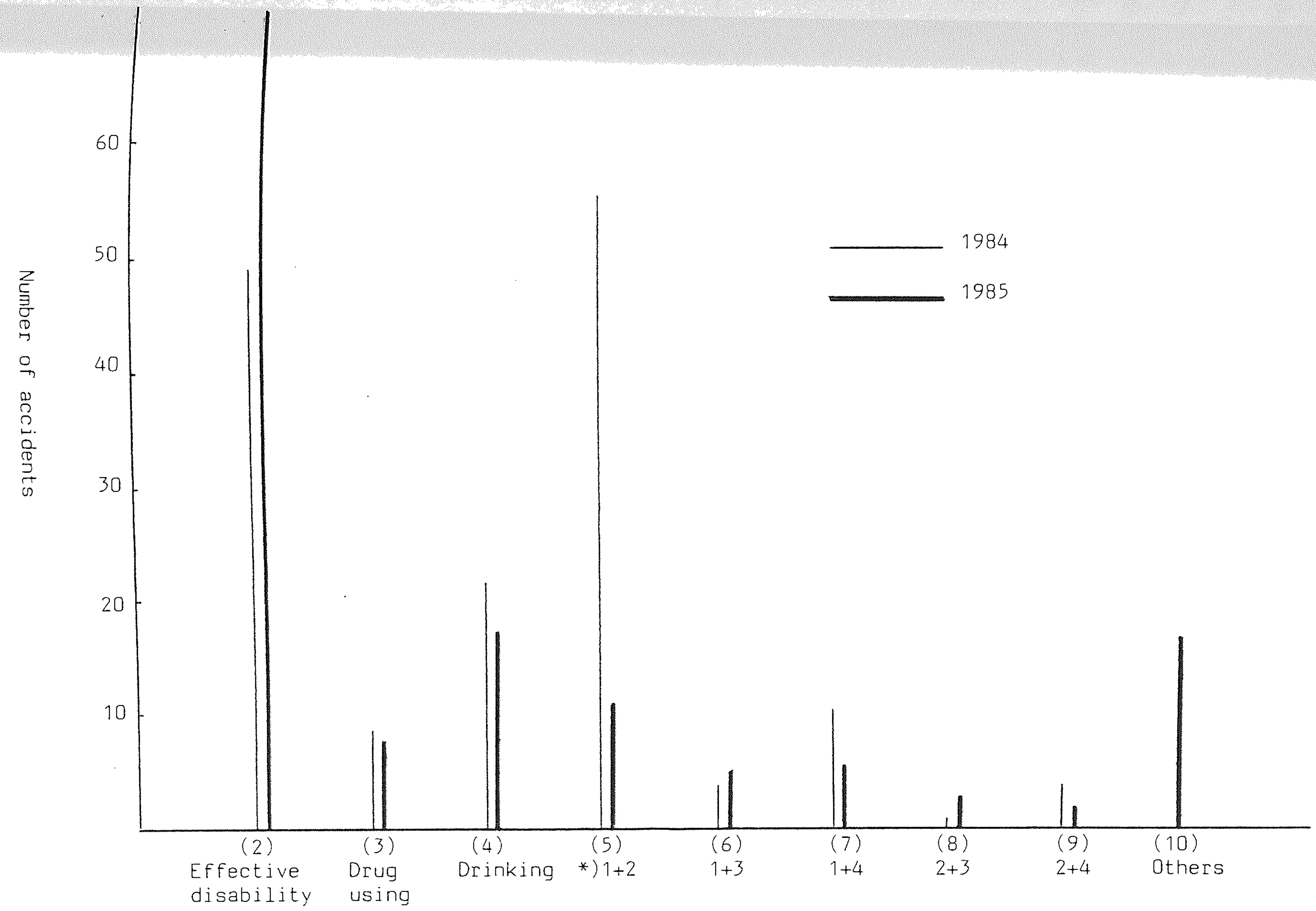


Fig. 3-14. Iran's road accidents caused by drinking, drugs, disability or drowsiness.

*) No.(1) is "tired & drowsiness" with 2772 (1984) and 2416 (1985) cases, which is not shown because of being out of scale.

3-8. Road Factors Causing Iran's Road Accidents

3-8-1. Accidents Per Width of Roads

Table 3-18 shows the number of Iran's road accidents in roads with different widths and also the rate of accidents per one hundred kilometres of each type of road. The width of roads has a complicated effect on the number and severity of accidents which occur on them.

Many narrow roads with heavy mixed traffic in Iran are the potential places for producing frustrated and impatient drivers and consequently improper overtaking and other traffic violations and eventually causing accidents. On the other hand, if wide roads, and especially motor-ways, are opened to traffic without previous driver training, and sometimes without the necessary lane delineation, signs, dividing guard-rails or islands, equipment, management and maintenance, then these also create increasingly severe accidents (see sub-section 1-4-1 for an example road and an example fatal accident).

Mr. Ahmad Ameri, who is the representative of 17 bus-driving cooperative companies in Iran, in his interview with Keyhan, the most circulated daily newspaper in Iran (published in Teheran in Farsi language), edition number 12578 dated 24 October 1985 page 5, declares narrow roads as one important factor in increasing road accidents.

Fig. 3-15, shows that during the years 1983, 84 & 85, the roads with widths of 6 to 8 metres contained 72 to 76 per cent of all Iran's road accidents. Roads with 9 to 12 metres widths, were second with

Table 3-18

Iran's Road Accidents per Different Width of Roads

Road width		Year/ 1983	1984	1985
5 metres & less	Accidents	1045	896	676
	per cent	3	3	2
6-8 metres	Accidents	25367	25646	25279
	per cent	76	73	72
9-12 metres	Accidents	3184	4172	5223
	per cent	10	12	15
13-19 metres	Accidents	2138	2671	3037
	per cent	6	8	8
19 metres & more	Accidents	1617	1517	976
	per cent	5	4	3
Total	Accidents	33351	34902	35191
	per cent	100	100	100

The Rate of Accidents per 100 km. of Each Type of Road

5 metres & less	1.00	0.85	0.64
6-8 metres	153.40	154.70	152.50
9-12 metres	18.80	24.60	30.80
13-19 metres	78.20	97.50	110.80
19 metres & more	144.60	135.30	87.10
Total	24.10	25.20	25.40

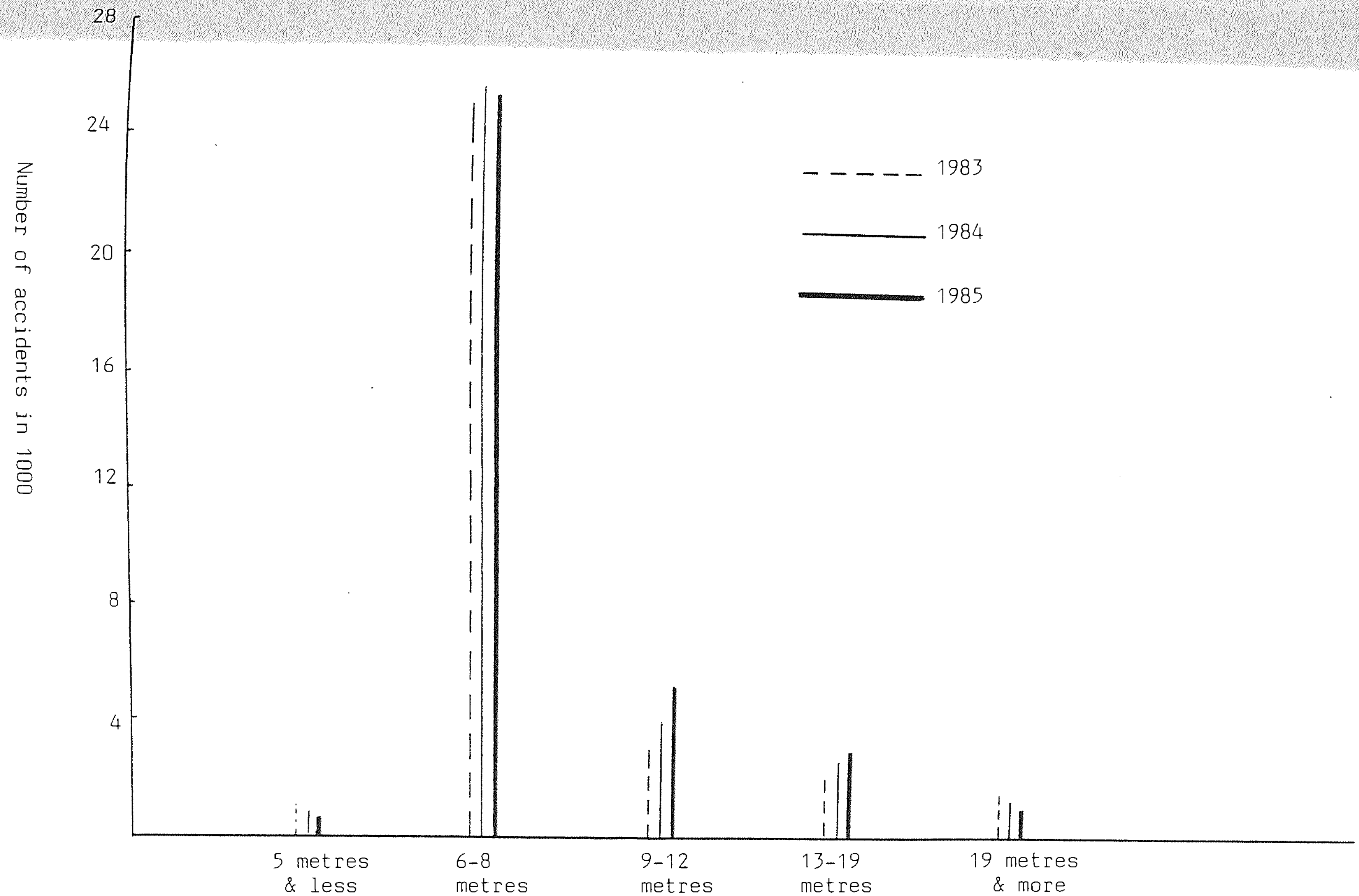


Fig. 3-15. Iran's road accidents per different widths of roads.

10-15 per cent, but the very narrow roads (5 m. and less) and the very wide roads (19 m. and more) had only 2 to 5 per cent each of the road accidents- 5 to 8 percent when combined. In comparing the total accidents for each type of road with their total lengths, then the rate of accidents per 100 km. of each range of width, gives a different picture. Here again the roads with 6-8 metres width have the maximum number of accidents per 100 km. of their length; i.e., about 153, but the second maximum rate for 1983 was quite close at 145 (see Fig. 3-16). The interesting point here is that it is the very wide roads with the width of 19 m. and more which have this second highest rate. However, this figure reduced slightly in 1984 to 135 and then reduced drastically in 1985 to 87.

One of the important reasons for the roads of 6-8 metres to have the highest rate of accidents per 100 km. of their length, seems to be their heavy volumes of traffic. These are the typical "major"* roads, which bear the heaviest volumes of traffic between the most populated centres of the country. The author believes that if the rate per (km. of length x volume of traffic) be examined in future research works, it is not certain that this type of road would have the highest rate, or at least the gap between the rates would not be so wide.

But the reason for very wide roads to have the second largest rate, very close to the first, seems to be the high speed and the lack of physical segregative means to separate the oncoming traffics and also the lack of sufficient delineation lines and informing signs.

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* For definition see section 1-9.

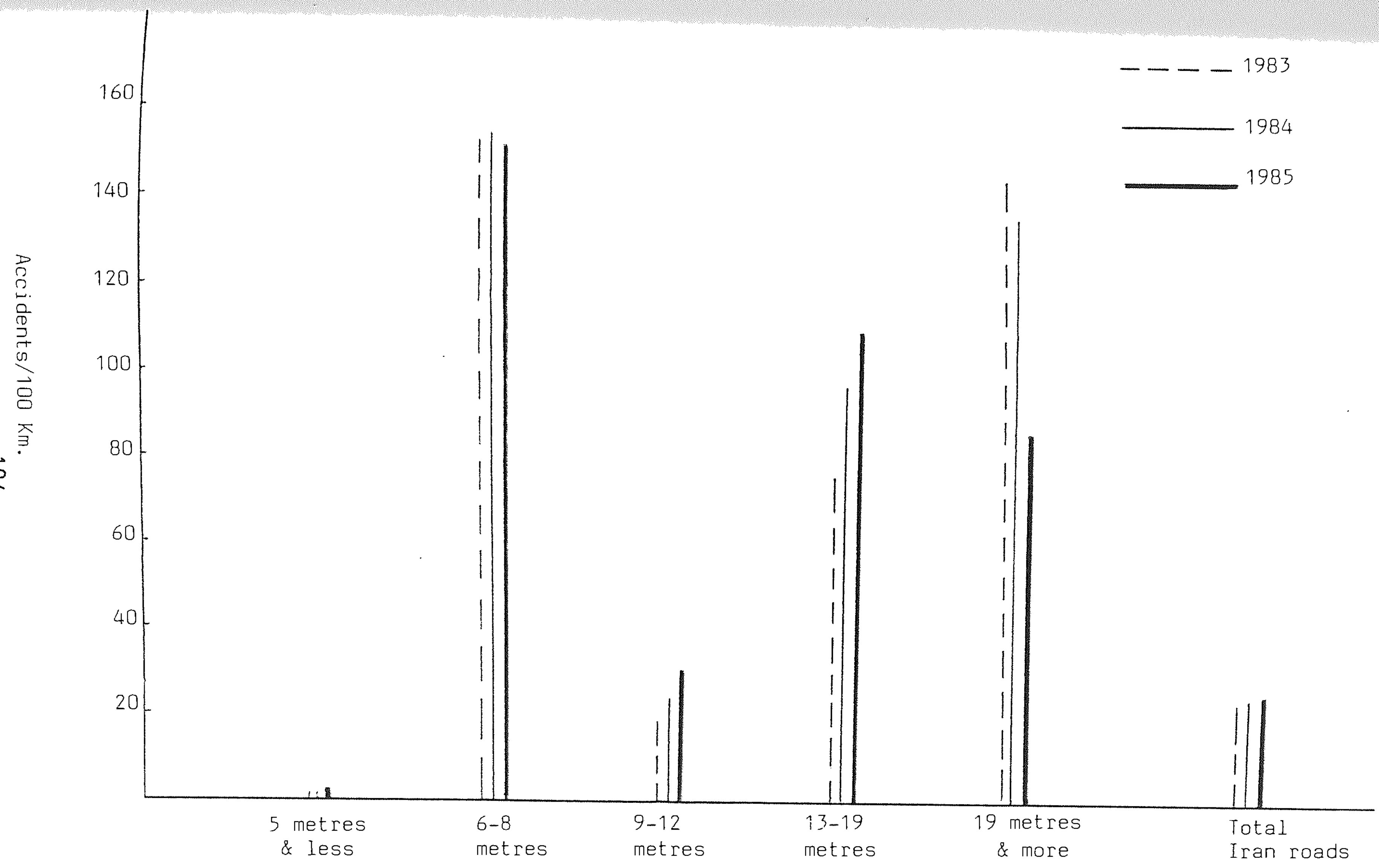

Fig. 3-16. Iran's accident rates per 100 Km. of each type of road.

These points were discussed in sub-section 1-4-1, explaining an example road and an example fatal accident. However, all these reasons and discussions must be carefully examined in further research works.

The rate of road accidents for each 100 km. of the total roads in Iran is almost constant during 1983 to 1985 at about 25. The rate for 6-8 metres roads is also constant but the rates for 9-12 & 13-19 metre roads are increasing and for wider than 19 metre roads is decreasing. Considering the fact that most of Iran's roads are rural and access roads (see Table 3-1 for the length of different types of roads), both the absolute total and the rate for these roads are quite low compared with the main interurban roads. In addition to low speed, two other reasons for this low rate is the low volume of traffic on these types of roads, also the fact that some accidents are not reported to the police in remote areas.

Considering the low volumes traffic of rural and access roads and therefore with an approximation, neglecting the "5 metres and less" roads from the country's network, the rate for total roads jumps from 25 to 65, a 150 per cent increase.

3-8-2. Accidents in Different Road Situations

Table 3-19 and Fig. 3-17 show Iran's road accidents for different road situations during the years 1983 to 1985. Some data, like the number of accidents in tunnels or bridges, was quoted for the first time in police reports in 1985. As can be seen, the junctions with 2328, 4485 and 5975 cases in 1983, 84 and 85 respectively have the maximum numbers of collisions. This consists of about 40 per cent of the total accidents which occured at particular sites on the roads.

The second notable point is that the number of road accidents on steep hills, at bends, at junctions, and at roundabouts, are all increasing. These increases show the necessity for immediate remedial measures in "black spots".

Table 3-19

Iran's Road Accidents for Different Road Situations

Different road situations	Year/	1983	1984	1985
Steep hill locations.	Accidents	1262	2117(+68%)	2305(+9%)
	per cent	23	20	15
At bends in the road.	Accidents	1177	2418(+105%)	3305(+37%)
	per cent	21	22	22
Steep hills & bends.	Accidents	530	1365	1777
	per cent	9	13	12
Junctions.	Accidents	2328	4485(+93%)	5975(+33%)
	per cent	42	41	39
Tunnels*	Accidents	*[Tunnel and Bridge figures for the years 1983 & 1984 are not available]		111
	per cent			1
Bridges*	Accidents			1209
	per cent			8
Roundabouts.	Accidents	268	408(+52%)	495(+21%)
	per cent	5	4	3
Total	Accidents	5565	10793	15177
	per cent	100	100	100

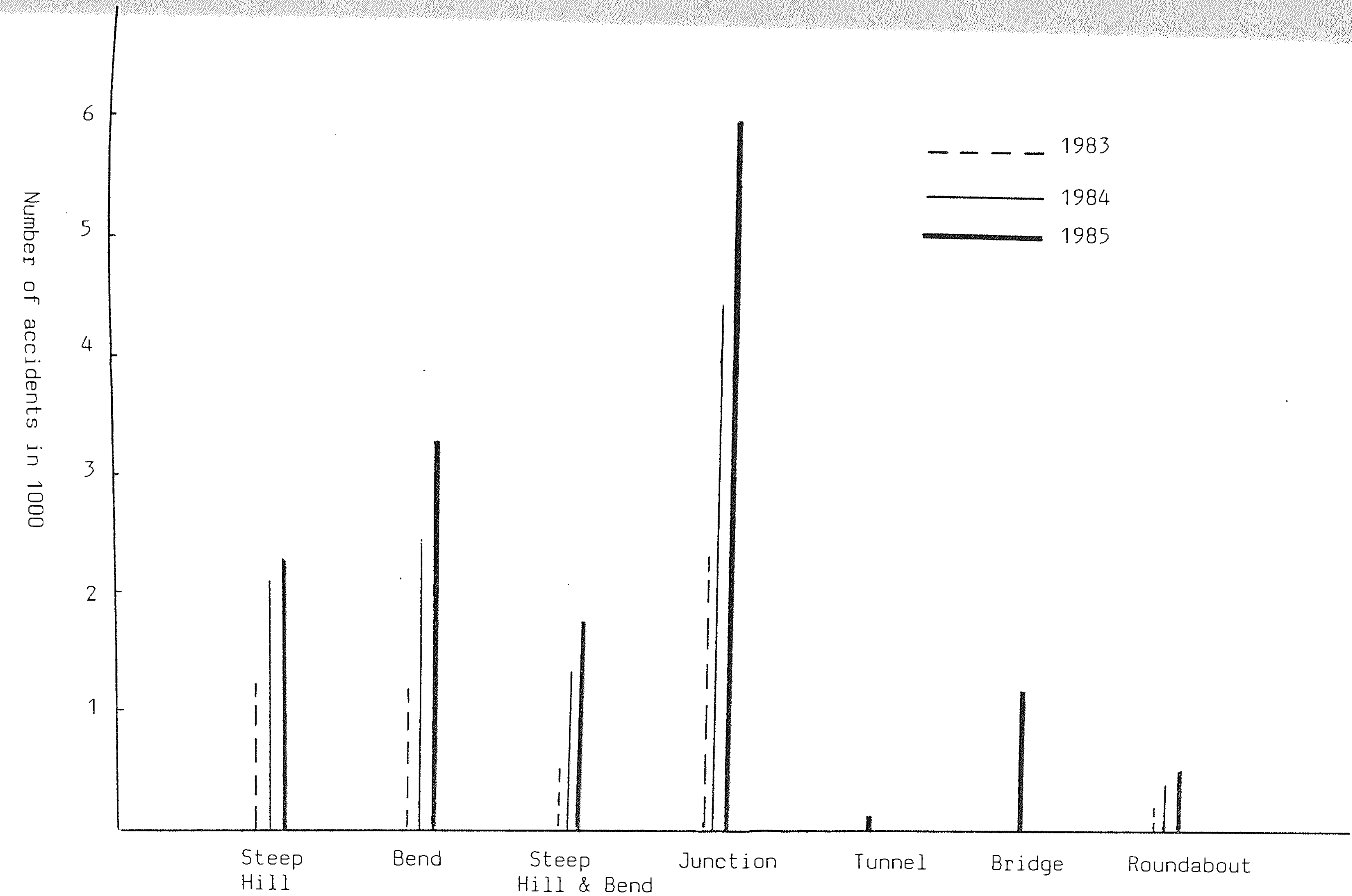

Fig. 3-17. Iran's road accidents for different road situations.

3-8-3. Accidents and Road Imperfections

Road imperfections, especially in high speed roads, are important factors in causing accidents.

As can be seen from Table 3-20 and Fig. 3-18, sign dificiencies and narrow roads are the two most important factors. In 13525 cases of road accidents in 1983, 15273 cases in 1984 and 19934 cases in 1985: sign deficiencies were solely or collectively (one of) the reason(s) for road accidents. The relative figures for narrow roads are 10139, 11055, and 11743 respectively. Both these factors have been increasing from 1983 to 1985. Sign deficiencies include all the different vertical and horizontal signs and delineation lines. Uneven roads, lack of shoulders, step in the road surface*, slippery road and lack of traffic-barrier have each been responsible for causing the accidents in 1244, 2464, 1363, 3810, and 2126 cases respectively in 1985.

3-9. Vehicle Factors in Iran's Road Accidents

3-9-1. Accidents and Type of Motor-Vehicles

Fig. 3-19 shows the number of accidents for each type of vehicle involved, and also the rate of accidents per 100,000 number of each type of vehicle. The types of vehicles listed in the above-mentioned Fig. are classified by body style, not by vehicle-use.

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* A step in the road surface is usually where a road has been resurfaced and the level of the new surface does not match up to the level of the rest of the road at either end of the new length of surfacing. This creates the existence of a step in the road surface.

Table 3-20

Iran's Road Accidents Caused by Road Imperfections*

		Year/ 1983	1984	1985
Sign deficiencies**	Accidents	13525	15273	19934
	per cent	39	39	47
Narrow road	Accidents	10139	11055	11743
	per cent	28	29	27
Uneven road	Accidents	2009	1313	1244
	per cent	6	3	3
Lack of shoulder or parking***	Accidents	3342	2553	2464
	per cent	9	7	6
Step in road surface	Accidents	1684	1259	1363
	per cent	5	3	3
Slippery road	Accidents	2224	5166	3810
	per cent	6	13	9
Lack of guard-rail	Accidents	2742	2229	2126
	per cent	7	6	5
Total	Accidents	35665	38848	42684
	per cent	100	100	100

* The accidents in which road imperfection(s) is (are) the only or part of the cause(s) of the accidents.

** Both vertical and horizontal, including delineation lines.

*** Also including defective shoulders and parking.

Note: In some accidents two or more kinds of road imperfections might be effective in causing the accidents. Thus the total here for each year could be greater than the total number of actual accidents in the same year.

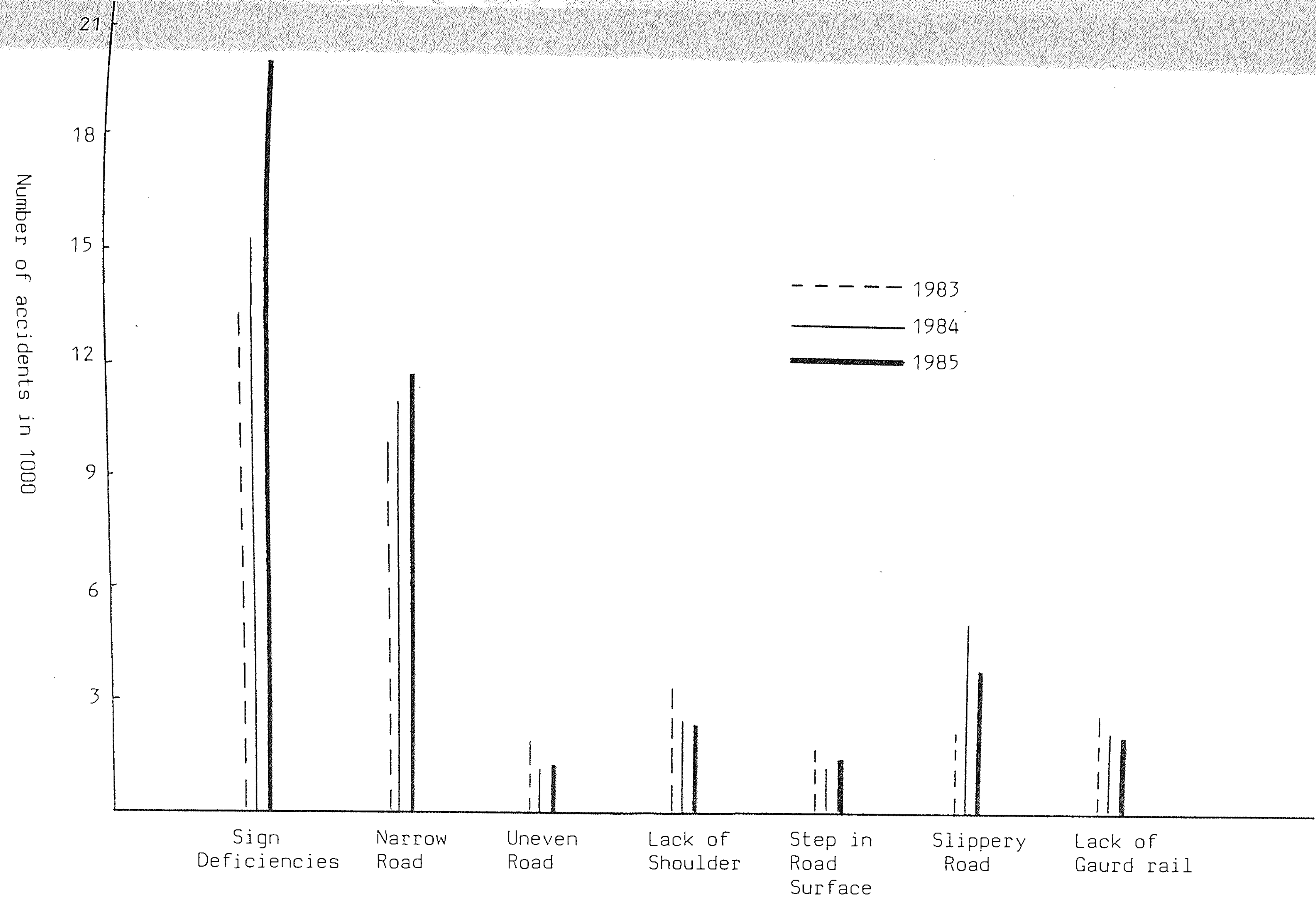

Fig. 3-18. Iran's road accidents caused by road imperfections.

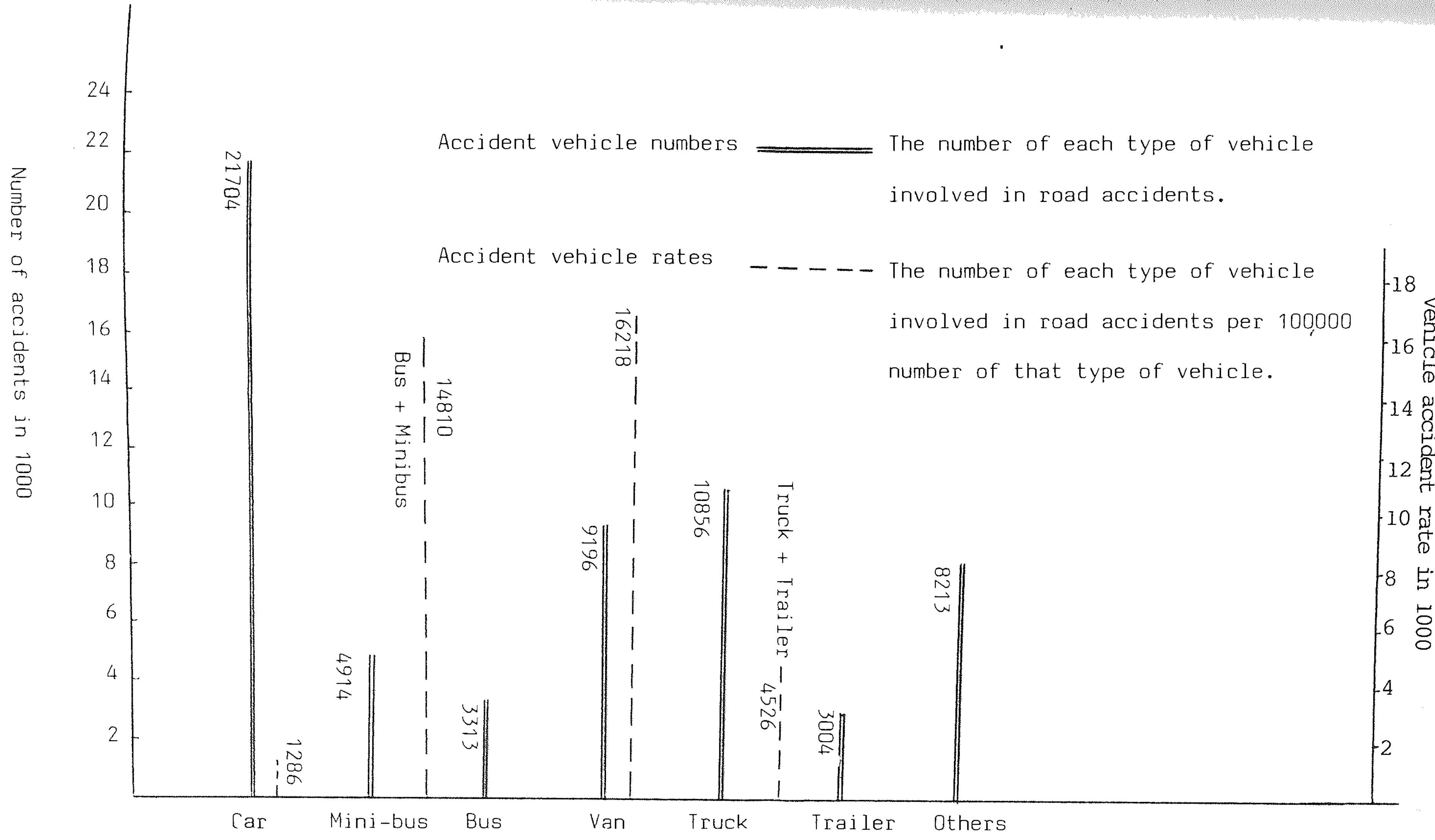

Fig. 3-19. The number of different type of vehicles involved in Iran's road accidents (1983).

For instance, "car" includes all passenger cars whether private or public, and all taxicabs. The truck category includes non-commercial and light trucks as well as commercial heavy trucks.

From Fig. 3-9 it can be noted that in 72 per cent of accidents, two vehicles (vehicle to vehicle), and in 5 per cent more than two vehicles(vehicle to vehicles), have been involved. This is why the total number of individual vehicles involved in road accidents are more than the number of accidents in the same year.

In 1983 cars comprised 63 per cent of registered motor-vehicles (see Table 3-2), but were involved in a smaller percent of the accidents (35 per cent). Buses and minibuses in one group, trucks, trailers and all kinds of long-vehicles in another group, and vans in a third group, all had more accidents than would be expected from their numbers on the roads. Trucks and long-vehicles, with 11 per cent of the registered motor-vehicles, were involved in 23 per cent of the accidents. But the worst categories were the van group and the buses and minibuses group. Each group had only 2 per cent share of the registered motor-vehicles but were involved in 15 and 13 per cent of road accidents respectively.

This can be verified from Table 3-21 and Fig. 3-19, by comparing the number of accidents per 100,000 number of each type of vehicle. Vans, with the largest record of road accidents, had 16,218 collisions per 100,000 of them. The next close record is buses and minibuses with 14,810, and then trucks and long-vehicles with 4,526. The least record belongs to cars with 1,286. The record of motorcycle accidents on roads is not available yet in Iran. But it would appear that increasingly a high number of their accidents occur in urban

Table 3-21

The Number of Each Type of Vehicle Existed in Iran

in 1983, Their Number of Road Accidents

and the Rate per 100000 of Each

Type

The type of motor vehicle	The number of each type	The number of each type involved in road accidents*	The rate per 100000 of each type
Passenger-car	1687985	21704	1286
Bus+Mini-bus	55550	8227	14810
Van	56702	9196	16218
Truck+Trailer & long-vehicles	306225	13860	4526

* As in most of the accidents, there are more than one vehicle involved (Fig 3-9), therefore, the total number of road accidents for different type of motor-vehicles is more than the number of road-accidents for the same year in Table 3-4.

Source: Column 2: Table 3-2 and Column 3: M.R.T of Iran, the Office of Statistics.

areas and on rural and remote roads rather than main roads.

The above mentioned high number of bus and minibus road accidents is causing the most severe damages and cost for the Iranian community. For example, in one of the most recent road accidents, the Khorasan* edition number 10915 dated 5 April 1987 quoted from the police-report: "On Mashad to Torbat-e-Heidarieh road(see the enclosed map of Iran) in the circumstances that thick fog had brought down visibility to a very low level; a bus full of passengers tried to make a completely unpermitted and unlawful overtaking and crashed over a small passenger car and instantly killed all four persons of a family inside it. Also some people inside the bus were injured." This problem will be examined in more detail, including its cost to the community, in the following chapters.

3-9-2. Accidents and Vehicles' Technical Faults

Between 1983 and 1985, vehicles' technical faults were responsible for 1820, 1899, and 1554 road accidents (table 3-22). As can be seen from Table 3-22 and Fig. 3-20 in 1983 and 1984 poor tyres, with 577(32%) and 637 (34%) cases respectively, was the most important vehicle technical fault in Iran's road accidents. But this factor decreased to 416 cases (27%) in 1985 and the brakes' fault kept its trend of increasing and rose to 564 cases (36%) to become the most important vehicle fault. Lack of tyre chains and other winter equipment, considering the large mountainous and very cold regions

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* Khorasan is a daily newspaper printed in Farsi in Mashad. This is the most circulated local newspaper in the province of Khorasan (the biggest province of Iran in north-east).

Table 3-22

Iran's Road Accidents and Vehicle Technical Fault(s)*

	Year/	1983	1984	1985
Lighting fault	Accidents	303	186	207
	per cent	17	10	13
Brake fault	Accidents	457	493	564
	per cent	25	26	36
Steering fault	Accidents	93	68	59
	per cent	5	3	4
Poor tyres	Accidents	577	637	416
	per cent	32	34	27
Lack of tyre chains and other winter equipment	Accidents	275	452	252
	per cent	15	24	16
Lack of windscreen wipers	Accidents	11	10	4
	per cent	-	-	-
Other vehicle technical faults	Accidents	104	53	52
	per cent	6	3	4
Total	Accidents	1820	1899	1554
	per cent	100	100	100

* The accidents in which technical faults(s) is(are) the only or part of the cause(s) of the accident.

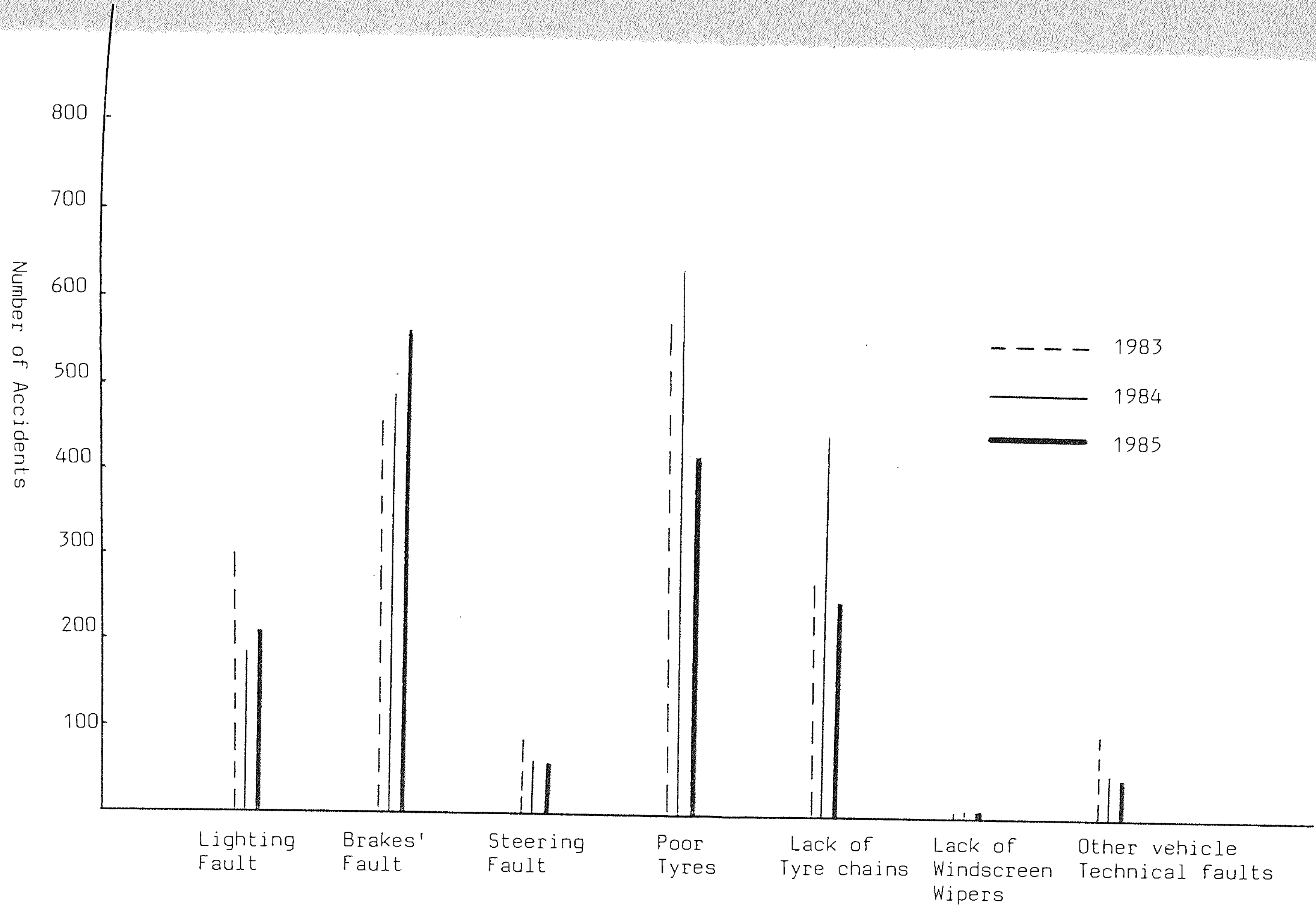

Fig. 3-20. Iran's road accidents caused by vehicle technical faults.

in Iran with long lasting winters, is another important factor. This factor alone or collectively caused 275(15%), 452(24%), and 252(16%) road accidents in 1983, 84 and 85 respectively.

3-10. Environmental Factors in Iran's Road Accidents

Environmental factors were partly and/or totally responsible for 8,204, 10,158, and 9,191 cases of road accidents in 1983, 1984, and 1985 respectively (see Table 3-23). Lack of adequate visibility and view obstruction or limitation was the most frequent cause with 2,869(35%)*, 4,681(46%), and 4,761(52%) between 1983 and 1985 respectively (see Fig. 3-21). Both the urban areas and cities' transport network and streets, and the interurban and rural roads, are not well equipped, and sometimes totally defenceless, against rain, so, it is not surprising that rain caused 2,898(35%), 2,972(29%), and 2,448(27%) cases of road accidents in 1983, 1984 and 1985 respectively and was the second most frequent environmental factor to cause road accidents. It must be noted that environmental factors in the Iran road-police reports have a rather limited definition, and in fact means atmospheric and meteorological factors. Therefore, some factors like slippery surfaces, road construction, defective shoulders, and improperly parked vehicles, which are categorised as environmental factors in the U.S.A[52] and perhaps in some other places, are excluded in Iran's data.

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* The percentage factors inside brackets are the percentages of the number of road accidents caused by this factor and not of the total number of accidents.

Table 3-23

Iran's Road Accidents and Environmental

(Meteorological) Hazards*

	Year/	1983	1984	1985
Rain	Accidents	2898	2972	2448
	per cent	35	29	27
Snow	Accidents	518	803	453
	per cent	6	8	5
Fog	Accidents	291	301	199
	per cent	4	3	2
Storm	Accidents	61	66	77
	per cent	1	1	1
Snowy storm	Accidents	64	109	58
	per cent	1	1	1
Rainy storm	Accidents	34	30	31
	per cent	-	-	-
Smoke	Accidents	53	18	19
	per cent	1	-	-
Light reflection	Accidents	1416	1178	1145
	per cent	17	12	12
Lack of adequate visibility	Accidents	2869	4681	4761
	per cent	35	46	52
Total	Accidents	8204	10158	9191
	per cent	100	100	100

* The accidents in which environmental (meteorological) hazards are the only, or part, of the accident reason(s).

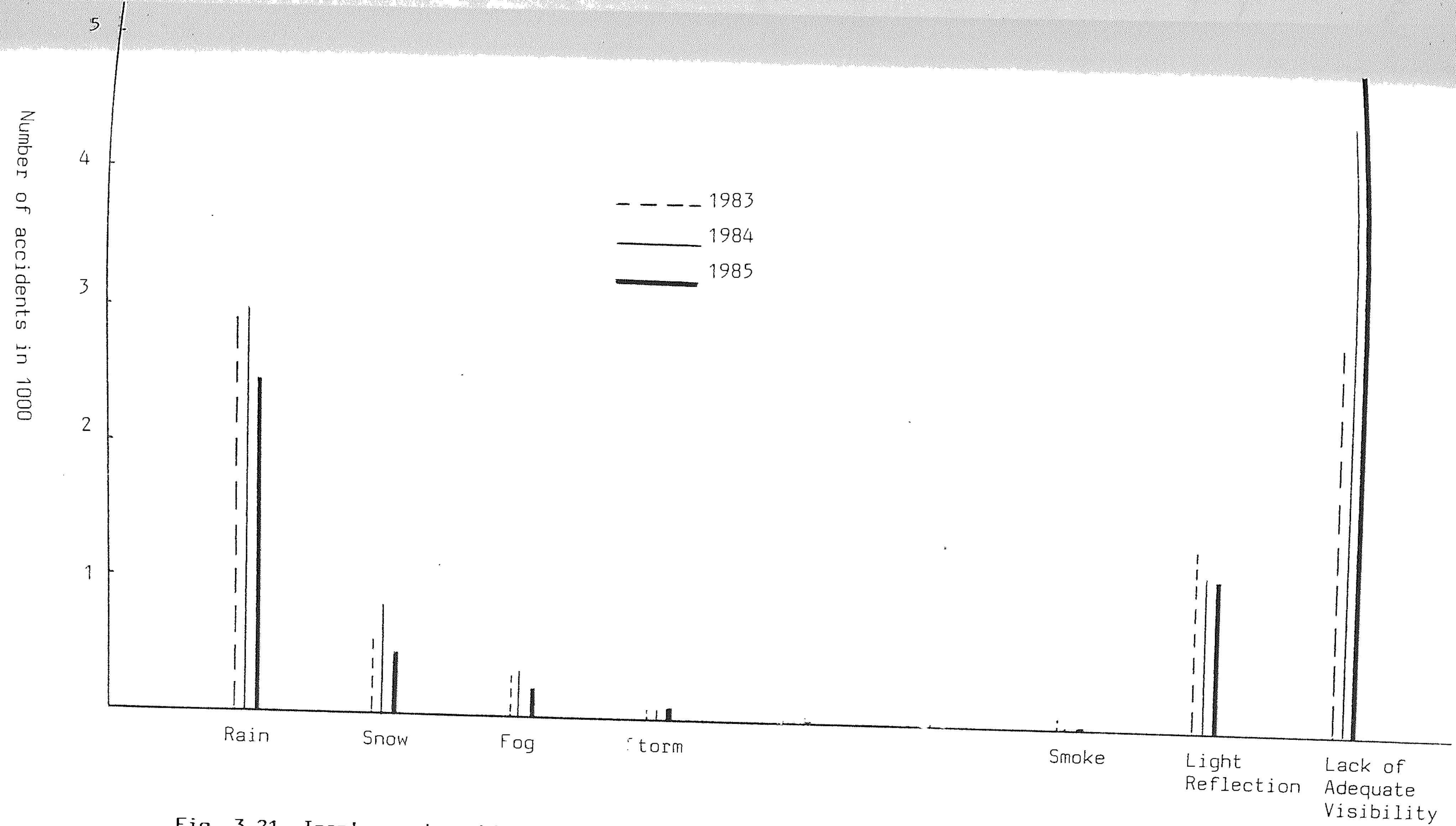


Fig. 3-21. Iran's road accidents caused by environmental (meteorological) hazards.

3-11. Conclusion

The analysis presented in chapter 3,showed the relative importance of each of the contributory factors in causing road accidents in Iran.

For human factor, general driving manner and fatigue are the most severe causes of the accidents.

For vehicle factor, vans and buses are involved six times more than their proportional numbers.

For road factor, the "major" 6-8 metre roads and also very wide roads(19 metres and more) have the highest rates of accidents.

For environmental factor, rain and the lack of sufficient visibility have caused the most number of road accidents.

Chapter Four

The Comparison of Road Accidents in Iran with Other Nations

4-1. The Basis of Comparison

Road accidents and the resulting death totals and injuries of different nations must be compared cautiously because of differences in the volume and kinds of traffic, number of vehicles, population density, definition of deaths; and other factors (for some definitions see section 1-9). The population rates shown provide one basis for adjustment but are not as useful as rates based on kilometres (or miles) travelled by motor-vehicles in each country, which are not available for all countries; or on vehicle registrations, which are not comparable.

4-2. The Comparison of Roads and Vehicles

Before comparing the road casualties in different countries, a comparison of the roads and vehicles in these countries is presented. Iran is member in Asian & Pacific Regional Countries' Transportation Organization (SCAP). Table 4-1 was presented by Iran deputy minister of road and transport to this organization meeting in Bangkok in

January 1985. This shows that between those countries Iran had a moderate population of roads with asphalt pavement, but it possessed the maximum annual increase in total roads during 1979-1984. At the same time the annual increase in asphalt roads in Iran was the minimum. This clearly shows the great effort put for making new rural and access roads in the past years and at the same time highlights some of the shortcomings in construction (and also maintenance) of main roads (for more details see section 3-3 and Ref. 50).

Fig. 4-1 shows number of four-wheeled vehicles for each kilometre of existing road for many developed and developing nations in 1983. Most of developed and some developing countries like Hejaz (Saudi-Arabia) and Jordan have more than 20 four-wheeled vehicles per kilometre of road. Some less developed countries like Niger and Ethiopia have only one to three vehicles per kilometre. Uganda has less than one. Hong-Kong has more than ten times that of Denmark and more than 300 times that of Uganda. Iran with the figure 15.2 is just in the lower half of the Table. Percentage growth of number of cars in use between 1979 and 1983 per 1000 persons for different nations are shown in Fig. 4-2. Iran with 10.1 per cent growth again is in the lower half of the picture. Some countries like Japan, Great Britain and France are close to Iran. In the top range of the Fig., some countries like Bots wana and Bolivia have more than 60 per cent growth and in the bottom range is Denmark with negative growth.

In 1983 Iran had one of the lowest figures for first registration of four-wheeled vehicles per 1000 persons among the nations (see Fig. 4-3). The rate for United States with 51.1 vehicles was the maximum

Table 4-1

The Comparison of Roads in Scap* Countries

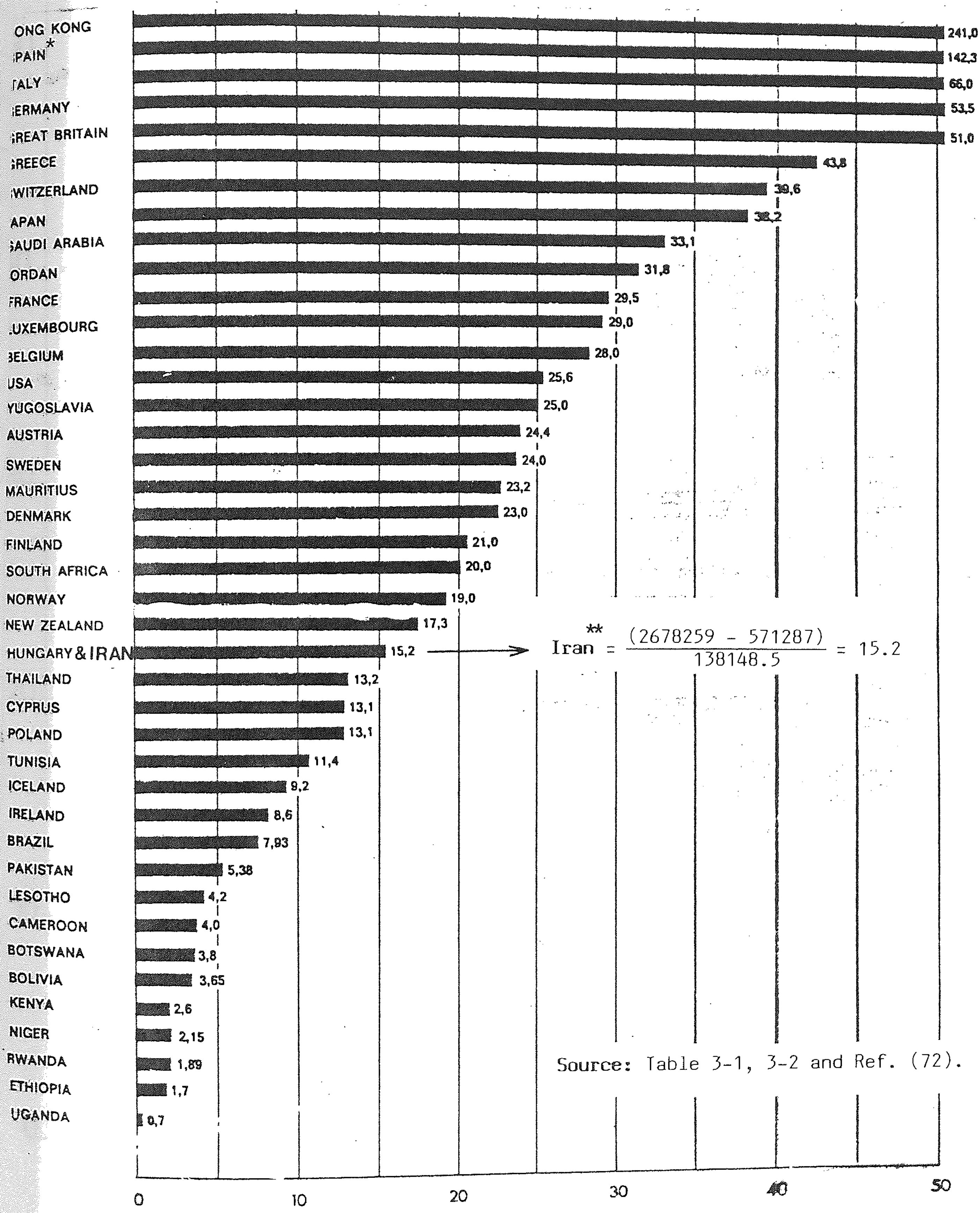
Country	per cent of asphalt roads	Per cent of annual increase in total roads	Per cent of annual increase in asphalt roads
Samoa	14	9.5	5.7
Afghanistan	15	0.9	1.8
Tailand	16	5.6	8.3
Siri Lanka	24	3.0	-
Korea republic	31	1.6	15.0
Iran	**31**	10.5 **	1.0
Berme	37	6.5	3.7
Indonesia	50	2.5	11.3
Pakistan	64	2.2	3.8
Malaisia	80	2.5	4.3
Hong-Kong	100	1.8	1.8

* Asian & Pasific Region Countries' Transportation Organization.

** (1979-1984) figures from 63000 Km. to 104000 Km.

Source: Speech of Mr. Karbasian, the head of Iran delegation to SCAP Transport Ministers Meeting in Hong-Kong, January 1985; 104000 Km. is different form the figure presented by M.R.T. statistic office (see Table 3-1).

Fig. 4-1
NUMBER OF FOUR-WHEELED VEHICLES PER KILOMETRE OF ROAD



* The accuracy of data for Spain and even for Italy is doubtful, because of the types of road included in the calculations.

** Light weight motor-cycles are not included.

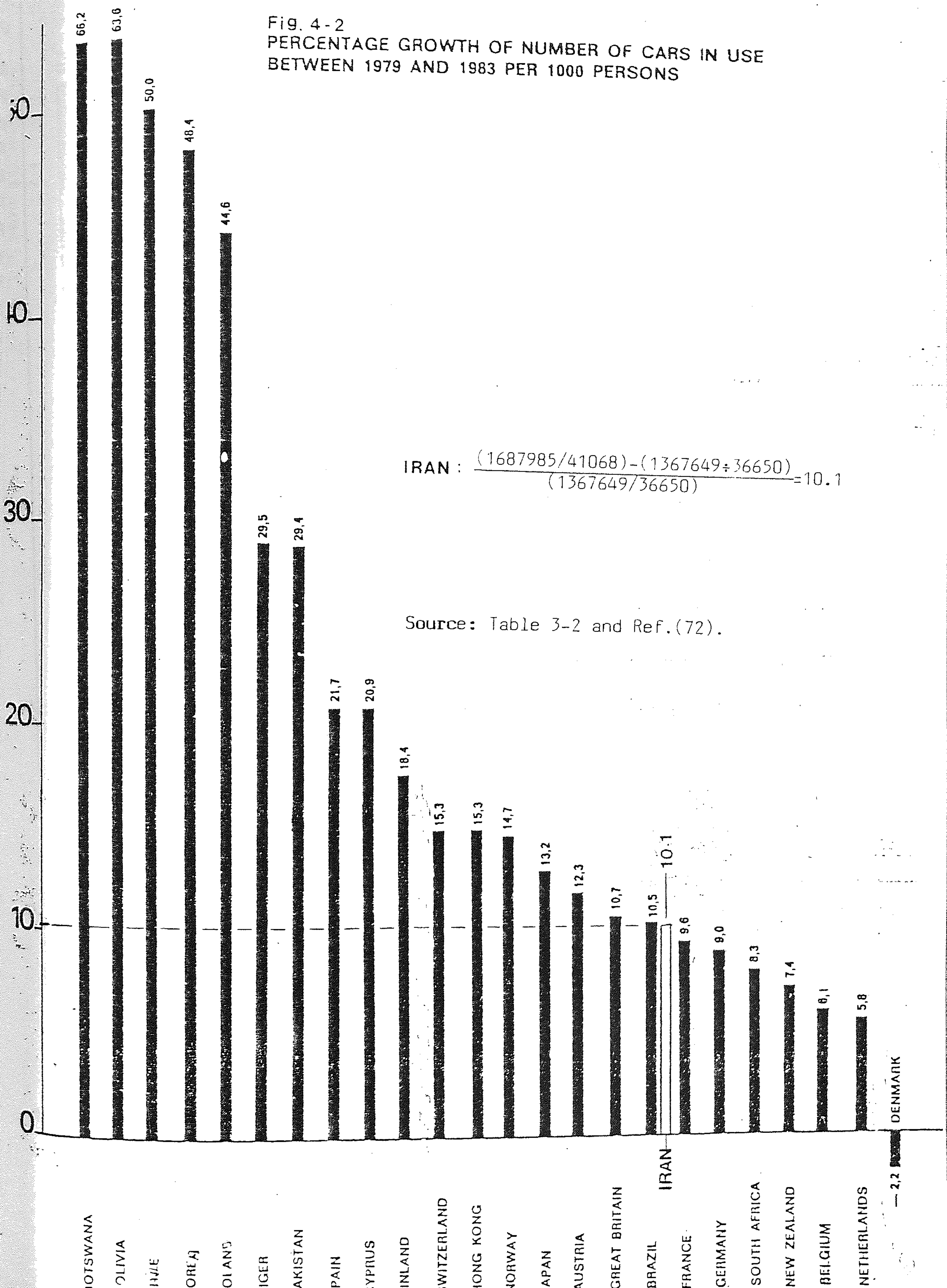
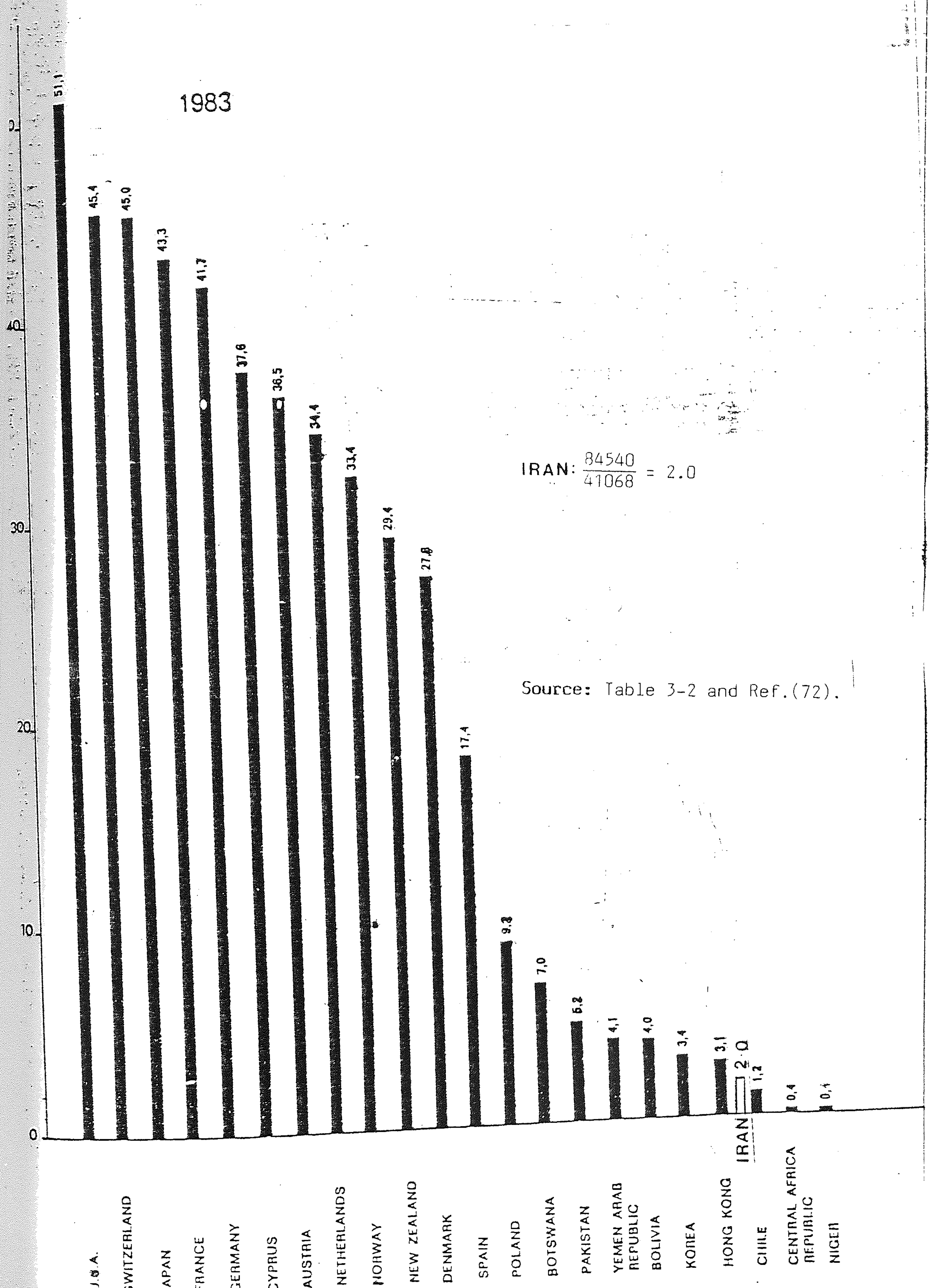


Fig. 4-2
PERCENTAGE GROWTH OF NUMBER OF CARS IN USE BETWEEN 1979 AND 1983 PER 1000 PERSONS

IRAN : $\frac{(1687985/41068)-(1367649\div 36650)}{(1367649/36650)} = 10.1$

Source: Table 3-2 and Ref.(72).

Fig. 4-3
FIRST REGISTRATIONS OF FOUR-WHEELED VEHICLES PER 1000 PERSONS



IRAN: $\frac{84540}{41068} = 2.0$

Source: Table 3-2 and Ref.(72).

with Central African Republic and Niger of 0.4, the minimum.

According to the World Health Organization(83), the number of motor-vehicles in Gulf States increased from almost 470,000 in 1971 to approximately 1,690,000 by 1976. This is equivalent to a 260% increase over five years. In Kuwait, the total number of registered motor-vehicles increased by 16% from 1977 to 1978. In Brazil during 1963 to 1972, there was a 29% rise in population, but the number of vehicles increased by 153%. In India, vehicle ownership is increasing yearly at a rate of 6.5%. In Singapore, the increase over a 10-year period was 127%.

Experience in the industrialized societies of Europe and North America indicates that the vehicle ownership curve does not begin to level off until a figure of 450 vehicles per 1000 population is reached. So, there is potential for further increases in the number of vehicles to occur in developing countries.

4-3. The Comparison of Percentage Changes in the Total of Fatality and Injury Accidents

A growing road vehicle population, combined with increasing trip rates and commodity flows, impose a heavy strain on national road systems. As a consequence of this increased traffic volume, there is now a serious problem of increasing numbers of traffic accidents. Again, according to World Health Organization publication, in Gulf States, for example, traffic accidents almost doubled from 1971 to 1976. In Nigeria, the mean rate of increase of accidents over a five-year period was about 15% per annum. In Brazil from 1963 to 1972, there was a 381% increase in accidents, more than double the proportionate growth in the number of vehicles.

Fig. 4-4 shows the comparison of percentage changes in the total of fatality and injury accidents between 1979 and 1983. Iran with 8 per cent increase is in the middle range among different countries. Some countries like Japan, although its traffic fatalities per vehicle-mile between 1979-1983 is almost constant(52), its total fatality and injury accidents in the same period had increased.

4-4. The Comparison of Deaths* and Injuries** and the Fatality Rates per Population, Vehicles and Vehicle-kilometres.

Research work carried out by the overseas unit of Transport and Road Research Laboratory (TRRL), has shown that road accident fatality rates (ie; deaths per 10000 vehicles licensed) are high in developing countries [Jacobs & Fouracre 1977; Jacobs & Hards 1978]; very often 20 times greater than for the countries of Western Europe and North America (see Fig. 4-5).

As can be seen, the accident rate in Iran of 11.76 for the year 1978 is closer to developed rather than developing countries; although it is still 3 to 4 times greater than in similar situations in the United States and the United Kingdom.

Considering the comparative accident rates, perhaps the more worrying is the fact that whereas fatality rates in developed countries have decreased steadily over the last twenty years, those in a considerable number of developing countries have increased. Fatality rate in Iran per vehicle has decreased from 12.97 in 1977 to 10.57 in 1983; but is still comparatively high (see Fig. 3-6).

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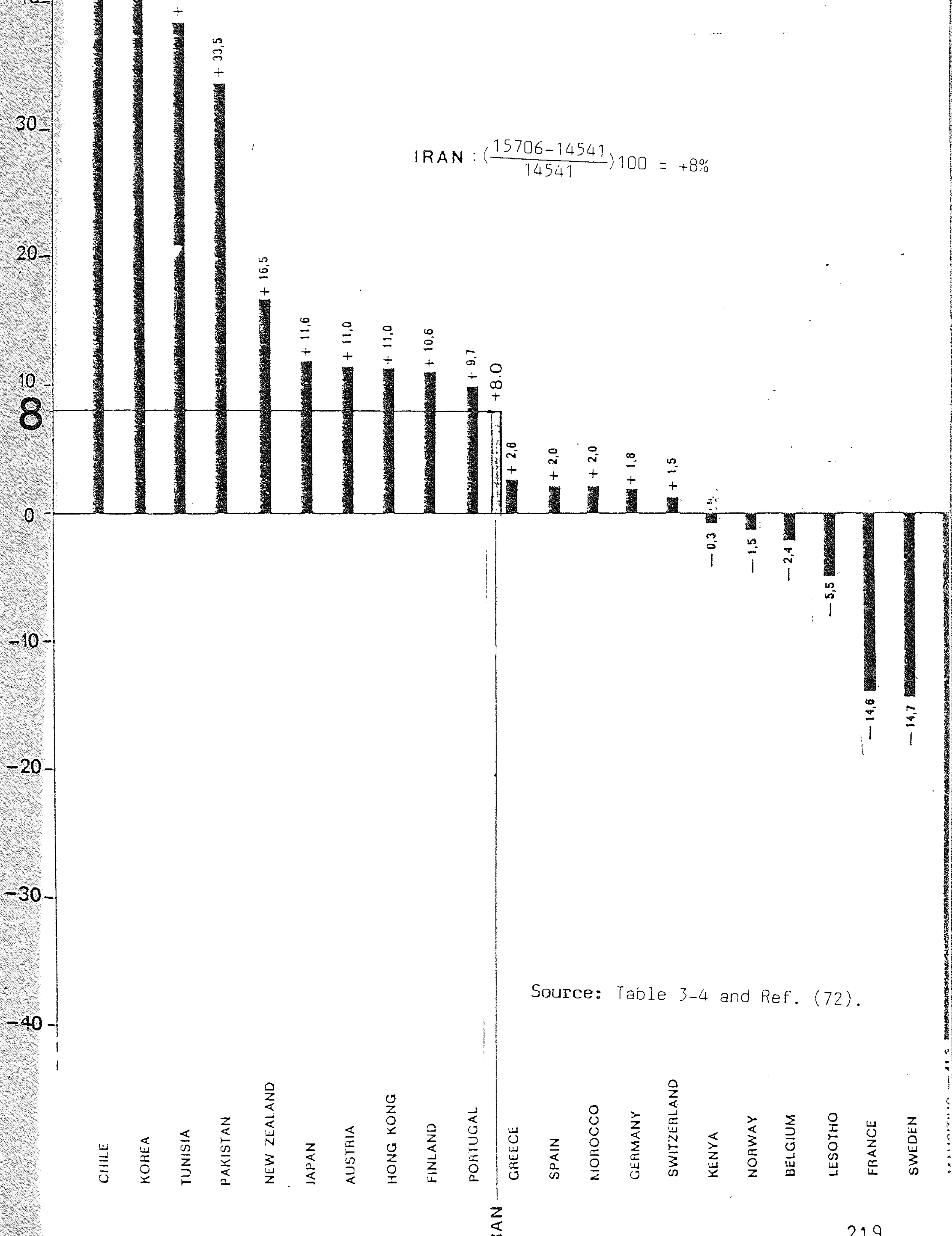
* For the definition of fatality and fatal accident, see pages 153 & 224.

** An injury accident is defined as an accident to have at least one injured person, who needs to refer to a medical centre for treatment. If the injured person be confined to bed in the medical centre, for at least one night, then the accident will be classified as a severe injury accident.

Fig. 4-4
PERCENTAGE CHANGES IN THE TOTAL OF INJURY ACCIDENTS BETWEEN 1979 AND 1983



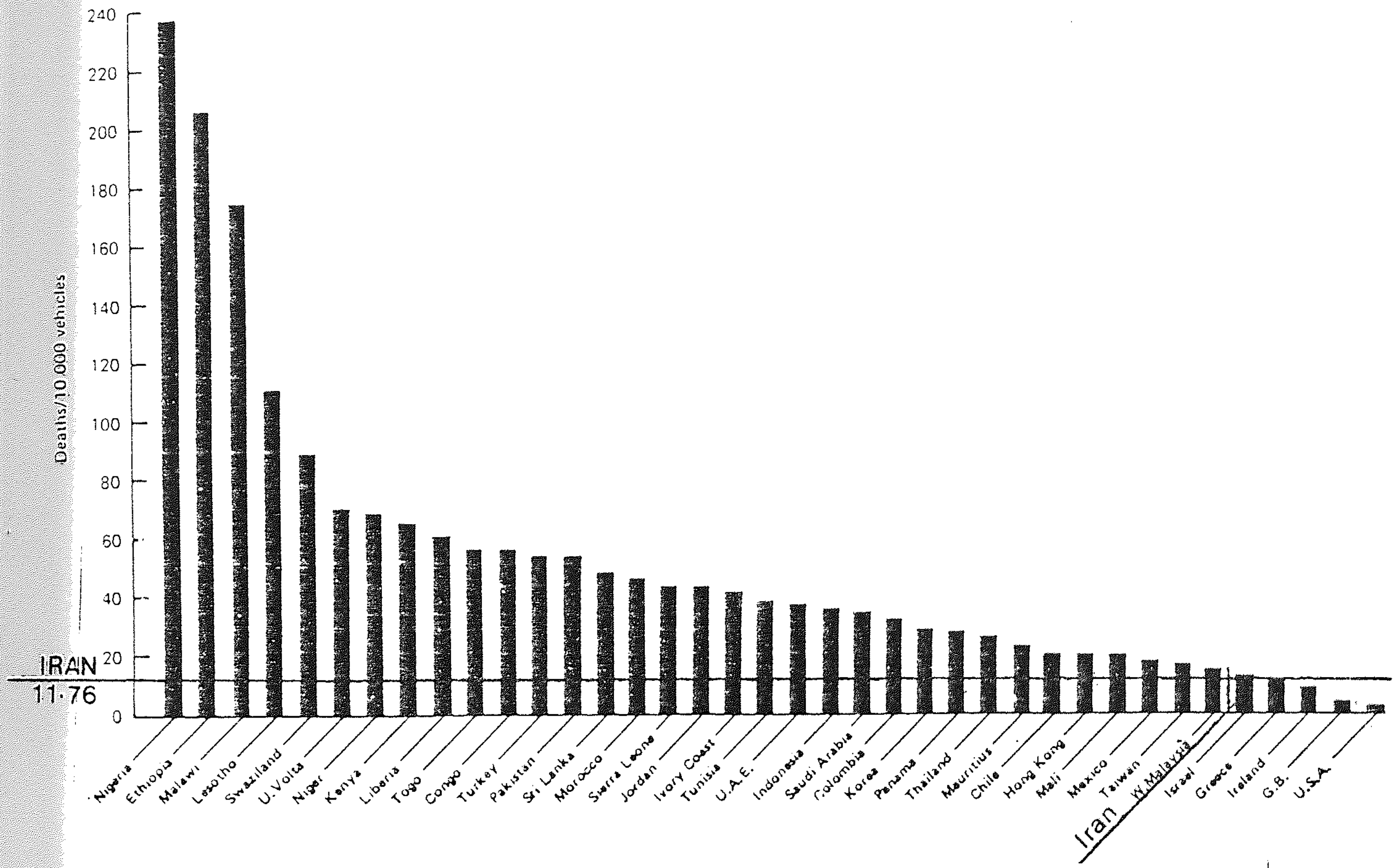


Fig.4-5. Fatality rates in various developing countries 1978.

Source: Ref (39) and Table 3-7.

Table 4-2 gives a comparison of road accident deaths and injuries and fatality rates per 10000 private passenger cars, between Iran and other 12 developed countries in 1980. The United States and the United Kingdom with 3.30 and 4.17 deaths have the best record and Iran with 25 seems far behind.

The rate of deaths per vehicle and per head of population when comparing some countries, shows a different picture. For example, comparing Iran with the United States; although the deaths rate of Iran per vehicle in recent years was 3-4 times greater than the United States, the rate per 100,000 population, with a figure around 11 (for both rural and urban traffic), is one half of the value for the United States, which is about 20 (see Ref. 52). This is partly because of lower average mobility of the people in Iran compared with that for people in the United States. The same phenomenon will be observed between different provinces of Iran in the next chapter.

Table 4-3 shows the fatalities and the fatality rate per unit of population among different nations. Comparing this Table with Table 3-6, which is for Iran, it could be noticed that the road death rate per 100,000 population in Iran increased during the years 1973 to 1985 from 4.21 to 6.38; but is still far less than most of the countries. Of course it must be noted that Table 4-3 shows total urban and inter-urban roads' deaths and rates; but Table 3-6 is only for rural roads. To have a similar approximate basis of comparison it is assumed here to have the one third of rural fatalities* in urban areas in Iran and therefore, the result is shown in Table 4-3.

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* This assumption is in agreement with the general trend of urban/rural casualties(52).

Table 4-2

The Comparison of Road Accident Deaths and Injuries in 12 Developed Countries with Iran in 1980

No.	Country	Deaths** persons	Injuries persons	The number of private passenger cars	Fatality rates*
1	Norway	362	10248	1395359	2.59
2	United States	51091	341100	155031841	3.30
3	United Kingdom	6239	329635	14960000	4.17
4	Holland	1997	56623	4200000	4.75
5	Denmark	690	15061	1423400	4.85
6	Italy	8528	220385	17400000	4.90
7	West Germany	13041	500463	22635000	5.76
8	Luxemburg	92	2279	157000	5.86
9	France	12543	339632	18440000	6.80
10	Belgium	2396	82304	3053400	7.85
11	Ireland	564	8504	641000	8.80
12	Greece	1225	25443	650000	18.85
13	**Iran**	2547	26307	1463400	17.40

* Deaths per 10000 private passenger cars.

Source: Coloumn 1 to 12, Wisbaden Statistic Office (West Germany), and Coloumn 13 Tables 3-2 and 3-5.

** See footnote on page 153.

Table 4-3

Motor-vehicle Deaths & Rates* per Population

by Nations (Total Urban & Rural)

No.	Nation	Year	Deaths	Rate*
1	Syrian Arab Republic	1981	155	1.7
2	Egypt	1978	854	2.1
3	Peru	1978	889	5.0
4	Paraguay	1982	207	5.6
5	Nicaragua	1978	168	7.0
6	Uruguay	1978	207	7.2
7	Israel	1983	436	8.2
8	Dominican Rep.	1982	541	8.3
9	Hong-Kong	1982	471	9.0
10	Sweden	1982	801	9.6
11	Chile	1982	1167	10.2
12	Norway	1983	428	10.3
13	England, Wales	1982	5241	10.6
14	Japan	1983	12708	10.6
15	Czechoslovakia	1982	1668	10.9
16	Bulgaria	1983	989	11.0
17	**Iran**	**1982**	2952a*	7.4
18	Finland	1982	557	11.4
19	Singapore	1981	281	11.5
20	Netherlands	1983	1689	11.7
21	Puerto Rico	1982	487	12.3
22	Scotland	1983	639	12.4

* $2219 \times 1\frac{1}{3} = 2952$

cont. next page

Table 4-3. cont.

23	Denmark	1982	663	13.0
24	Thailand	1982	6355	13.5
25	Argentina	1978	3853	14.6
26	Cuba	1977	1484	14.7
27	Hungary	1982	1636	15.3
28	East Germany	1976	2746	16.4
29	Canada	1982	4073b	16.5
30	El Salvador	1981	851	17.0
31	Ireland	1980	567	17.2
32	Spain	1979	6562c	17.7
33	Italy	1978	10354a	18.3
34	West Germany	1983	11209	18.3
35	Switzerland	1983	1180	18.4
36	Panama	1980	351	19.1
37	Greece	1982	1925	19.7
38	United States	1982	45779b	19.8
39	Costa Rica	1979	434	20.0
40	France	1981	11033d	20.4
41	Ecuador	1978	1817	21.8
42	New Zealand	1982	709	21.8
43	Australia	1981	3287	22.0
44	N. Ireland	1978	345	22.4
45	Belgium	1976	2463a	25.1
46	Austria	1983	1954	25.7
47	Portugal	1981	3340	33.2
48	Kuwait	1982	535	34.2
49	Venezuela	1978	4822	36.7

* Deaths per 100000 population; Source: Accident Facts, Ref.(18).
Death definition: In general, deaths are included if they occur within 30 days after the accident, but other time periods are used as follows: a) At accident scene only, b)one year, c)Twenty four hours, and d)three days.

To appreciate the relative scale of the traffic accident problem in a country, it is a common practice to relate accidents to demographic and other information and to compare the relationships between countries. The most meaningful for international comparison is the accident rate in units of accidents per million vehicle-kilometres. However, information on vehicle usage is rather difficult to collect, especially in developing countries. Sometimes this figure is calculated by multiplying the annual fuel consumption of a country by an estimated number of kilometres which a litre of fuel would take an average car.

The author tried to calculate at least an approximation of this rate for Iran, but because of the difficulties discussed in section 1-6, the necessary data were not available. The United States kilometre (mileage) death rate is generally the lowest among the fourteen selected developed countries. In Table 4-4 figures are the data compiled by the Motor Vehicle Manufacturers Association of the United States of America. Such a data on both travel and traffic deaths vary significantly between the different countries because of definitions and should be used cautiously; although the compiler says that he has made every effort to put the data for all countries on a comparable basis.

Mainly however, the comparison between countries is made in relation to their respective human and vehicle population. Fig. 4-5 shows the deaths per 10000 vehicles among 38 developed and developing countries, in 1978. Iran with the figure 11.76, which although has a much higher rate than U.S.A and U.K.; at the same time it has a much lower rate than for most of the countries compared. For instance, Nigeria

Table 4-4.

Traffic Fatality Rate per Vehicle-mile in Developed Nations*

Nation	1976	1977	1978	1979	1980	1981	1982
United States+	3.3	3.4	3.4	3.5	3.5	3.3	2.9
Norway	5.1	4.4	4.3	4.0	3.0	2.7	3.1
Finland	7.8	4.8	4.0	4.2	3.5	3.4	3.4
United Kingdom	4.4	4.3	4.2	3.9	3.7	3.6	3.4
Canada	4.8	4.6	4.5	4.7	4.3	4.3	3.8
Netherlands	7.1	7.2	6.1	4.7	4.7	4.3	3.9
Denmark	5.3	5.0	5.0	4.4	4.4	4.3	4.3
Australia	5.8	5.6	5.6	5.3	4.9	4.9	4.5
Japan	6.7	5.5	5.2	4.7	4.8	4.7	4.8
Italy	7.2	7.3	6.5	6.5	6.6	6.1	5.4
Germany	8.8	8.5	7.9	6.9	6.7	6.3	6.0
France	10.0	8.1	7.2	7.4	7.3	7.1	7.0
Belgium	12.4	10.0	9.9	8.7	8.6	7.9	7.3
Spain	12.9	13.0	13.6	12.6	12.1	11.4	10.2

* Rates based upon deaths occuring within one year after the accident.

\+ The death rate for the United States in both 1983 and 1984 was 2.7; the 1983 and 1984 figures are not available for the other countries.

Source: Motor vehicle facts and figures, 1985 edition.

has a about 20 times and Turkey more than 5 times more deaths per vehicle than Iran.

4-5. The Comparison of the Rate of Death per Population with the Rate of Vehicle Ownership

Fig. 4-6 presents an interesting comparison of the death rates with vehicle-ownership between different countries. It has been discussed before that because of different vehicle-ownership patterns and different customs and facilities provided for mobility in different countries, some quantities like the fatality rate per unit of population is difficult to make a straight forward comparison. Naturally in some countries like the United States and Australia with high rates of vehicle-ownerships, in the magnitude of 500 per 1000 persons, the death rate per human population is higher than the countries like Great Britain with almost similar safety standards and road classes but with nearly the half vehicle-ownership. But when in a country like Saudi-Arabia vehicle-ownership is about a half; ie., 250; but at the same time fatality rate is higher; naturally the lower standard of safety can be concluded.

Using data for road fatalities, vehicles and population for the year 1938 from 20 mainly European countries, Smeed [1968] derived a relationship expressed by the formula(41),

$$F/V = 0.0003\ (V/P)\hat{}-0.66$$

where F is the road fatalities, V is the number of vehicles and P is the population.

Using the data of Tables 3-2 and 3-5, the author derived this relationship for the years 1977-1983 for Iran:

Table 4-5

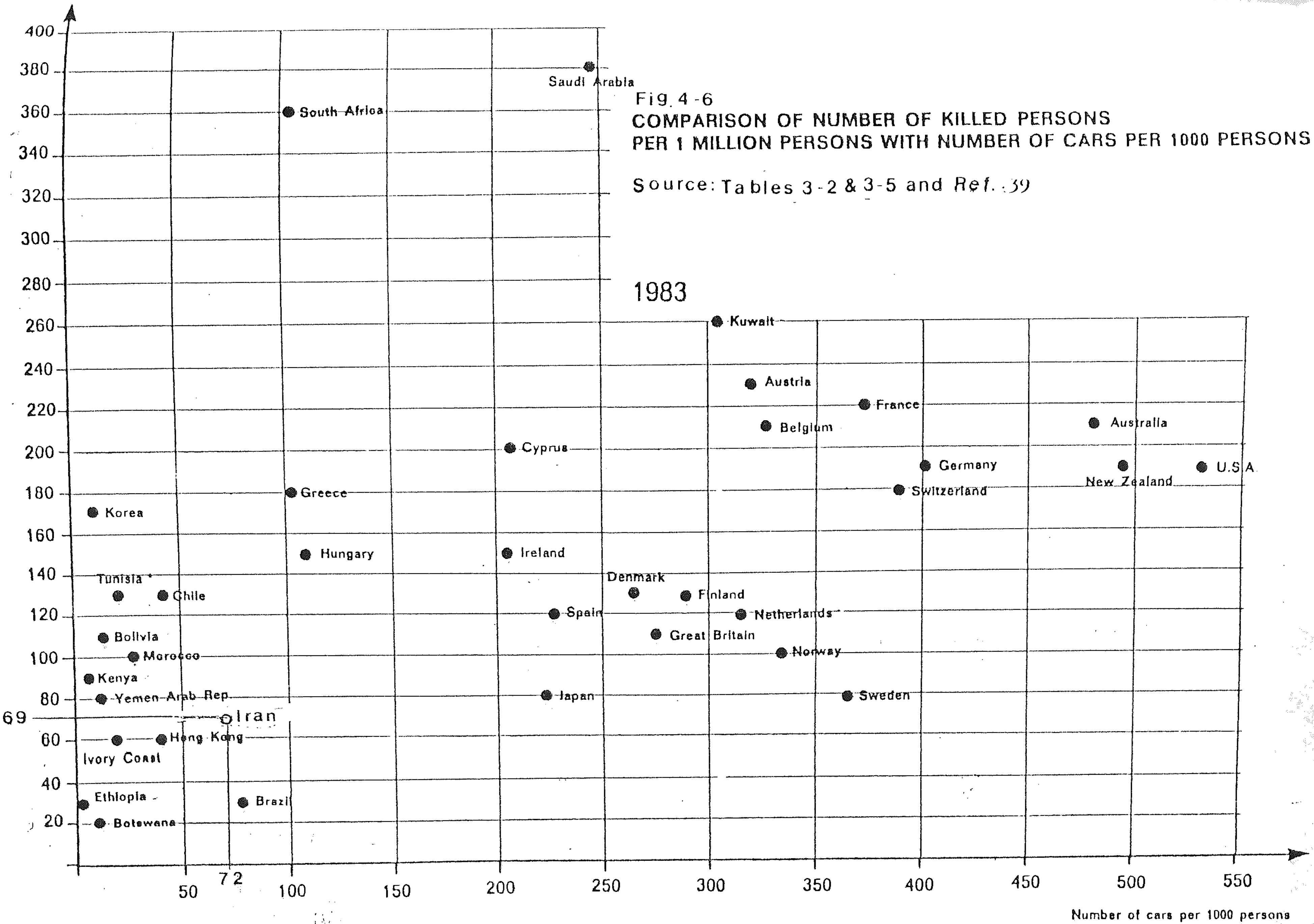
Iran Vehicle-Ownership and Fatality Rates

from 1977 to 1983

Year	V/P	F/V Suggested fourmula	F/V Actual
1977	491	12.83	12.97
1978	525	12.36	11.76
1979	543	12.13	14.02
1980	581	11.68	11.63
1981	605	11.41	10.26
1982	619	11.27	8.99
1983	652	10.95	10.57

Fig. 4-6
COMPARISON OF NUMBER OF KILLED PERSONS
PER 1 MILLION PERSONS WITH NUMBER OF CARS PER 1000 PERSONS

Source: Tables 3-2 & 3-5 and Ref. 39



Iran: $\frac{2956896}{41068} = 72$, $\frac{2831}{41.068} = 69$

$$F/V = 0.000236(V/P)^{-0.562}$$

Fig. 4-7 shows the above relationship curve and also actual data, each is shown by a dot.

Using the same method as Smeed, Jacobs and Sayer (1982) carried out analyses of fatality rates in developing countries for a number of years between 1965 and 1978. Relationships derived for these years, which were statistically significant at the 1% level are shown in Fig. 4-8 on a logarithmic scale; with the situation of Iran compared with others.

In Fig.s 4-7 and 4-8 some aspects are of particular interest. Firstly, it can be seen that among developing countries as vehicle ownership increases, the fatality rate decreases. That is countries with the lower levels of vehicle-ownership were those with higher fatality rates. Iran is not an exception, with one of the highest level of vehicle-ownership levels among developing countries it possesses one of the lowest fatality rates. Secondly, the slope of regression line for developing countries has increased. In other words, for the same level of vehicle-ownership, the fatality rate in 1978 was higher than 1965 for developing countries. Fortunately, this is not the case for Iran*.

Table 3-7 and Fig. 3-6; show the fatality rate in Iran, which decreased by a small amount between 1977 and 1983. In the above period the vehicle ownership has steadily increased in Iran but the fatality rate, i.e., fatalities per 10000 vehicles has decreased. It must be noted that in the same period fatality rate in Iran in a different interpretation, i.e., fatalities per 100000 population has increased (see Table 3-6).

* It also would appear that the risk to the average pedestrian (i.e. deaths/one million population) increases as car-ownership increases up to a certain level and then decreases(89).

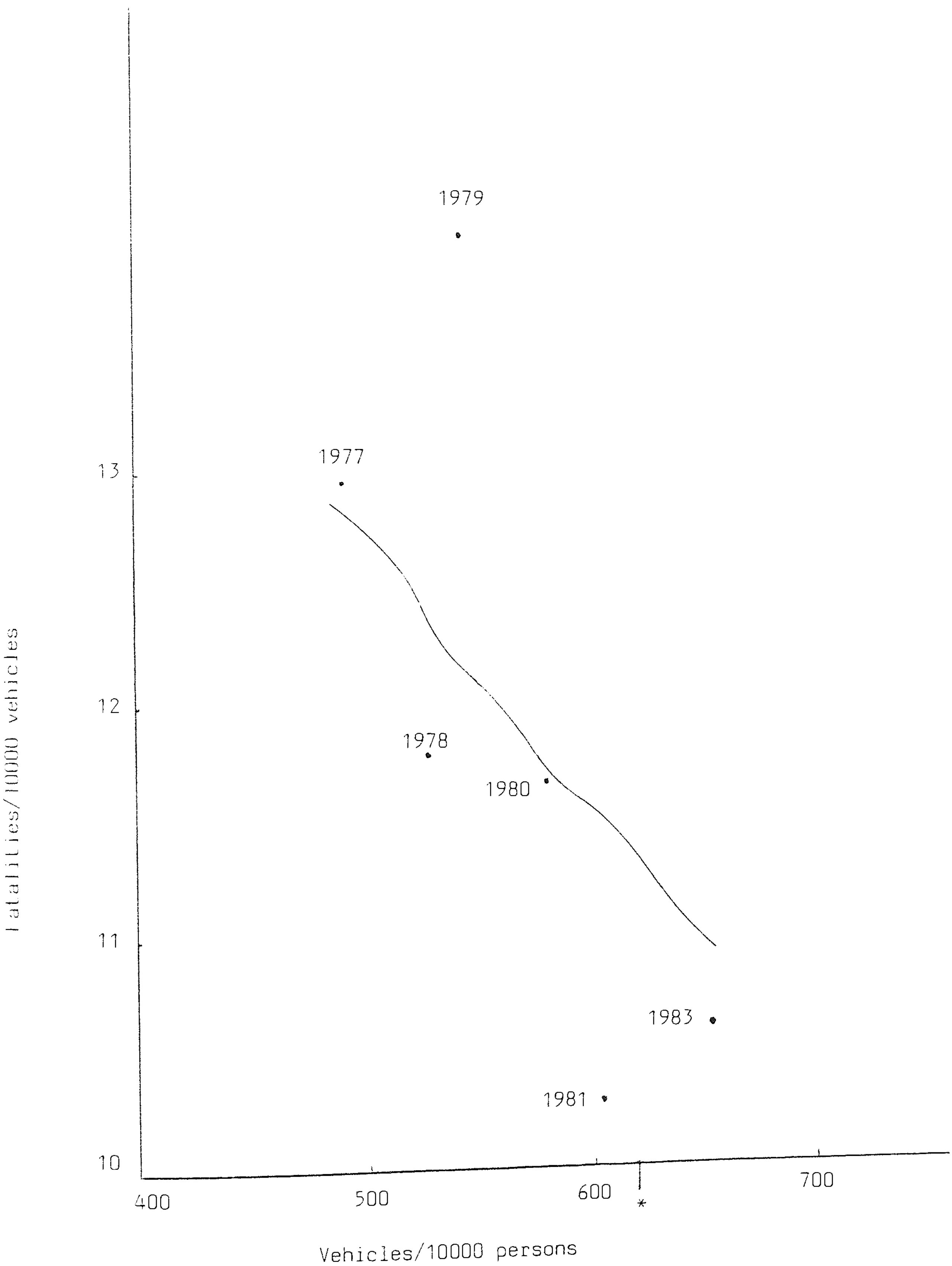


Fig.4-7. Relationships between fatality rates and level of Vehicle ownership in Iran from 1977 to 1983.

* The actual fatality rate for 1982 (8.99) falls below the shown axes.

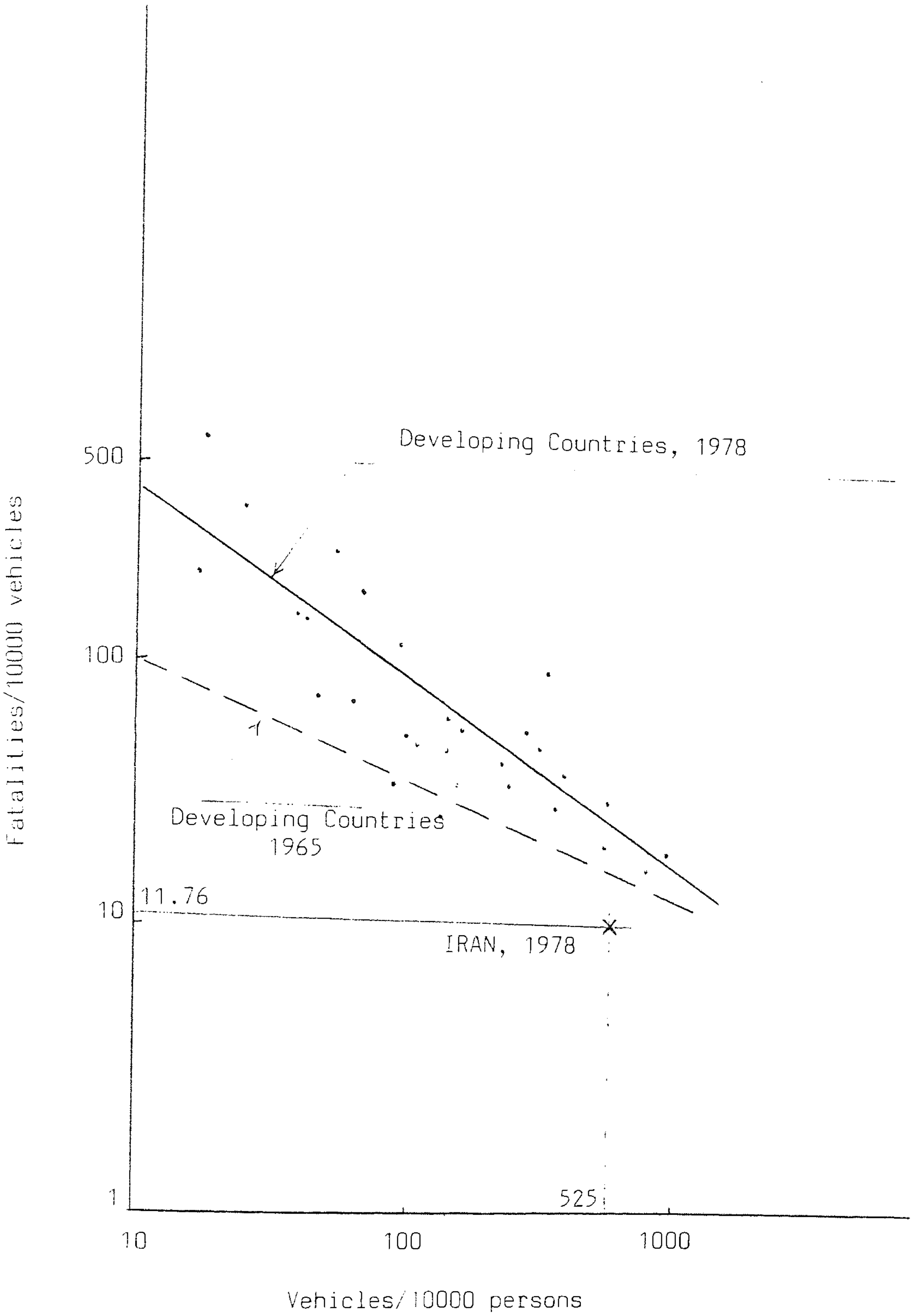


Fig. 4-8. Relationships between fatality rates and levels of vehicle ownership in Developing Countries.

In an earlier analysis by Jacobs and Fouracre [1976] the same group of countries used by Smeed in 1938 were taken and the analysis repeated for the years 1950, 1960, and 1970. The relationships derived were very similar indeed to those derived by Smeed. In other words, the relationship between fatality rate and vehicle-ownership would appear to be fairly stable in developed countries, whereas in developing countries the fatality rates increased for similar levels of vehicle-ownership over the period 1965-1978. This relationship in Iran is rather high but seems almost stable.

4-6. The Comparison of Iran Road Fatalities with Other Middle East Countries

The increasing rate of road accidents in other Middle Eastern countries seems worse than in Iran. The highest figure belongs[30] to Egypt with 91 deaths for each 10,000 motor-vehicles in 1979. The relative number for Iran is 14.03 (Table 3-7); whereas the number of registered motor-vehicles per each 10,000 population in Egypt is the low figure of 126 (Iran: 619 in 1982). The highest number of motor-vehicles per each 10,000 persons in Middle East belongs to Kuwait, which is as high as 4,266. Nevertheless the relative number of road fatalities in Kuwait is the lowest, i.e.; 9 in each 10,000 vehicle. Statistics show in only one year more than 14,000 lives have been lost in 12 Middle east countries. The official figure for six Gulf co-operative federation countries* show that only in the year 1982 a total of 135,000 road accidents have occurred in those

* Hejaz(Saudi Arabia), Gatar, Abu Dubi, Bahrain, Kuwait and Oman.

countries. In Iraq, with less than one million motor-vehicles between years 1979 and 1983 about 100000 road accidents have been reported.

One of the main reasons for this critical situation must be oil and increasing wealth without previous necessary education and training. Especially in the above-mentioned six countries because of cheap petrol an increasing number of people use private cars. In accordanee with a report prepared by an English research group supervised by Dr. Philip Cornol in 1982 in Bahrain; only in one decade 1970-1980 more than 43000 cars and trucks have been added to six Gulf countries' motor-vehicle stock. Even in Iraq, in which the relative usage of private passenger cars is smaller, in only one decade the number of motor-vehicles have increased ten times (in Iran, in 5 years 50% have increased [see Table 3-2] 5 times less). In addition to the increasing rate of private-car ownership, the rate of Heavy commercial Goods Vehicles (H.C.G.V) traffic has also considerably increased. Of course, in many of these countries some solutions have been proposed, but yet no considerable success can be seen. In Doha, the capital of Qatar, the maximum speed limit of 60 kilometres per hour is enforced as in the United Arab Emarates, the compensation amount payable to the killed person's family has been increased to 9000 U.S. Dollar and in Oman to $14000 (compensation issues in road accidents will be discussed when considering the "cost" in the following chapters). Although in U.A.E., in contrast to some other developing countries, driving licences are not issued too easily, statistics show about 10 per cent of drivers involved in an accidents in the country do not possess this document.

In the Kingdom of Jordan the cause of total deaths in 1978, 7 per cent and in 1979, 5.3 per cent, was the road accidents. Dr. Ahmad Bayooti's research in Kuwait University in 1979 shows that the young generation of age 20-25 mostly endanger themselves in dangerous traffic accidents. He also concluded that 55% of pedestrian fatalities in that country are women, of which 37% are under 14 years of age*.

A research team headed by Dr. Jacobs in 1982 declared that pedestrian fatalities in Middle East area is high about 45%, compared with 20% in UK., and two third of them are under 15 years of age. The similar figure for Iran in 1984 is:

((3843 / 28355) x 100) = 13.5%   and in 1985 is:

((4063 / 29647) x 100) = 13.7%   (see Table 3-14)

Table 4-6 shows the rate of car ownership and road accidents in some Middle East countries.

As it can be seen from Fig. 4-9 as the rate of car ownership increases, the rate of death per unit of motor-vehicle decreases in such a way that a curve very close to $y=A/x$ can be drawned.

If a line between the point which represents Iran and the origin of the co-ordinates is drawn, then all countries which are situated above this line have proportionally more, and all countries beneath this line have proportionally less fatality rate in comparison with vehicle- ownwership, than Iran.

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* Even in The United Kingdom,a very recent investigation(90),shows that the young people between 16 and 25 years of age were particularly susceptible to be injured in road accidents.

Table 4-6

Road Accidents' Statistics in Middle East Countries(1979)

Country	Year	The number of fatalities	The number of motor-vehicles*	Population in millions	The number of deaths per 10000 motor-vehicles	The number of motor-vehicles per 10000 persons
Tunnes	1980	988	253341	6.4	39.2	396
Jordan	1980	447	135271	3.1	33:0	436
North Yeman	1980	554	183920	5.8	30.0	317
Kuwait	1979	457	512000	1.2	8.9	4267
Oman	1978	289	75000	1.0	38.5	750
United Arab Emarat	1978	349			14.0	
Qatar	1978	143	800000	2.2	18.0	3636
Lybia	1978	1100	36000	3.0	33.0	1200
Bahrain	1978	90	56000	0.34	16.0	1642
Sudi Arabia	1978	2378	667000	7.4	35.7	901
Egypt	1978	4633	505000	40.0	91.7	126
Iran	**1981**	2790	**2000000**	**36.0**	14.0	555

* Excluding Motor-cycles.

Source: Ref.(30) and relative Tables in chapter 3.

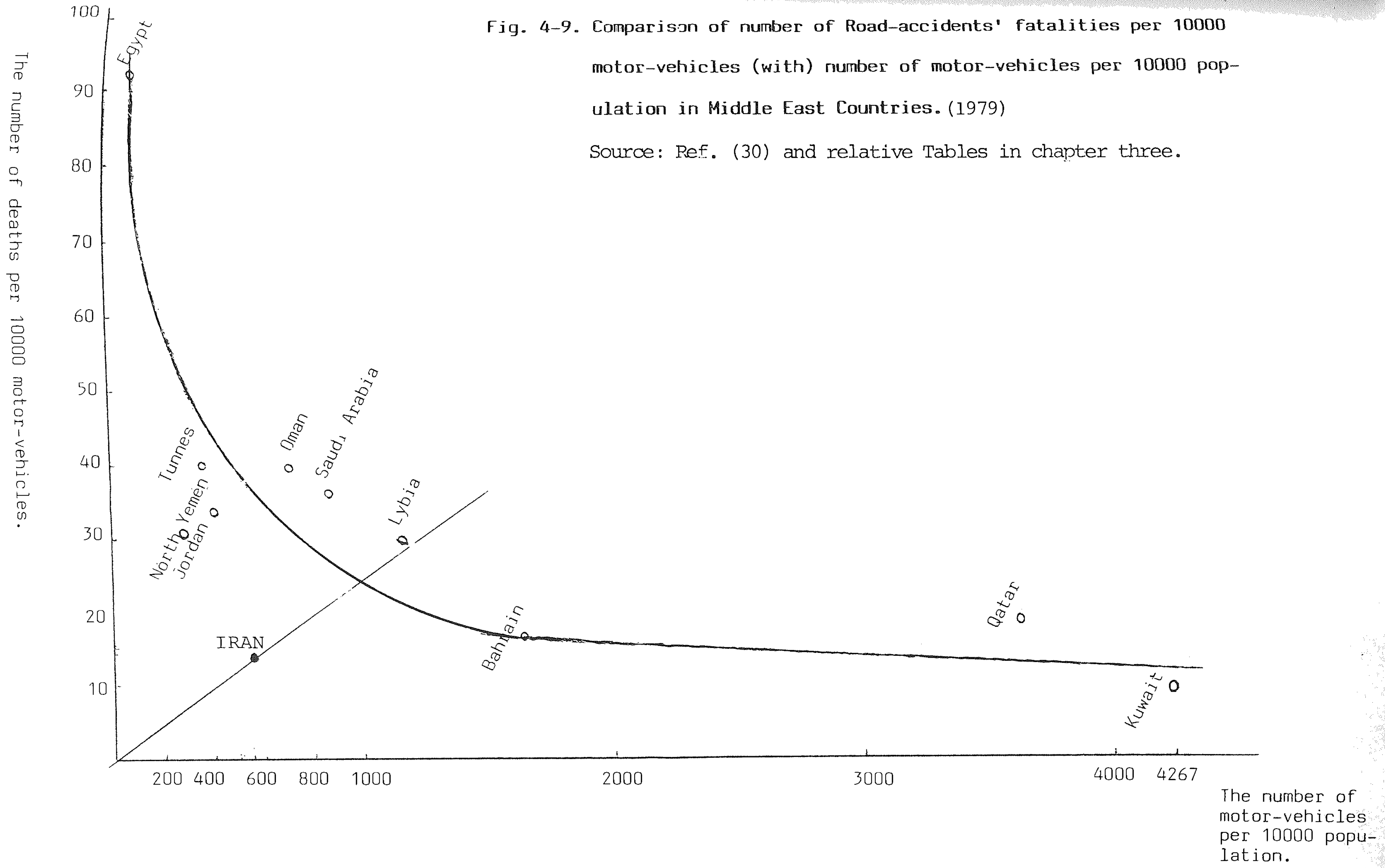

Fig. 4-9. Comparison of number of Road-accidents' fatalities per 10000 motor-vehicles (with) number of motor-vehicles per 10000 population in Middle East Countries. (1979)

Source: Ref. (30) and relative Tables in chapter three.

4-7. Conclusion

Although because of the differences in the accident reporting systems, registration of motor-vehicles and definitions of fatalities and severe injuries, amongst different countries, the comparisons must be dealt cautiously, nontheless however, the comparisons which were presented for the first time in this chapter, should be very helpful for at least a preliminary diagnosis of the situation of road accidents in Iran in comparison with other countries.

It was shown that with a 10% growth of the number of cars per 1000 population, although it is far from saturation figure(450 cars per 1000 persons), nevertheless the rate of growth is less than most of the countries. Percentage change of injury accidents is rather high (8%), but fatality rate per motor-vehicle is much closer to developed rather than developing nations. This is also verified in considering the relationship between fatality rate and vehicle-ownership in Iran and in developing countries.

Chapter Five

The Analysis of Road Accidents' Statistics for Different Provinces of Iran

5-1. Introduction

Little progress can be made on improving the road accident situation in a country until the problem itself has been clearly defined. To understand the phenomenon in a big country like Iran with a large variety of different climatic conditions and natural geography, it is necessary to collect and analyse road traffic accidents in different provinces and compare them with each other to be able to assess the effectiveness of remedial measures.

In this chapter, utilizing the results of previous chapters especially chapters three and four, an attempt is made to investigate road accident statistics individually in each province and in the same way that in chapter four Iran road accidents was compared with statistics for other nations, here, considering each province's individual characteristics, a comparison will be made for each province road accident statistics with other provinces.

As it will be seen both education, culture, behaviour, climatic factors and natural geography are widely different in the different provinces of Iran. Therefore, the reasons for road accidents are also different. For example, roads have had the most effect in causing the 27% of the accidents in Mazandaran and 56% in Kordestan[53]. Also dangerous and poorly designed bends have caused (independently or collectively with other reasons) 42% of Gillan and 63% of Systan & Baloochestan road accidents. In the same way tight bends have caused 16%, 19% and 31% of Mazandaran, Zanjan and Gillan road accidents respectively. The share of junction accidents is highest in Teheran (59%), Esfahan (64%) and Khoozestan (69%).

In appendix 2 six provinces of Teheran, Gillan, West Azarbayejan, Esfahan, Khorasan, and Systan & Bloochestan have been selected and for each of them, the road accident statistics analysis; including the type of accidents, different improper driving; different places of collisions, road imperfections, and the type of motor-vehicles involved in their road accidents are shown diagramatically. Each province selected is a representative of a region with its own natural, geographical, cultural and economical specialities.

Teheran, is small but as the most populated and developed province in the heart of the country contains the capital as its centre.

Gillan, a province in the north is the Caspian littoral; a green densely wooded region which absorbs millions of travellers and holiday makers throughout the country.

West Azarbayejan, a province in the far northern west; neighbouring Turkey. A mountainous province, very cold with heavy snow-falls in winter and its own cultural and native language of its people.

Esfahan, which is geographically quite in the centre of the country and also is recognized as the main centre of industry and economy.

Khorasan, the biggest province with the area almost equal the whole United Kingdom, in the border of Russia and Afghanistan and with very different climatic and natural resources.

Systan & Baloochestan, a very special province; very remote and wild nature; in the southern east, neighbouring Pakistan and the Sea of Oman. Very hot and dry, but extremely important: politically, militarily and even economically.

5-2. Iran Provinces

Viewed from the air, Iran is primarily an arid plateau, across which extend from northwest to southeast range after range of lofty and arid mountains. Iran is dotted here and there with areas of intense cultivation around the towns. Along the shores of Caspian, the eye is met by a narrow strip of vivid green, which stands in marked contrast to the aridity of plateau. In the south the land drops down to the waters of the Persian Gulf and the Sea of Oman (see inclosed map of Iran).

Topographically Iran falls into four main regions(23):

Region one, which includes the provinces of:

[Teheran, Central, Zanjan, East & West Azarbayejan, Kordestan, Hamadan, Bakhtaran, Ilam, Lorestan, Kohkilooye, Chahar-Mahal, and parts of the provinces of "Khorasan, Semnan, Yazd, Esfahan, and

Kerman"]

is the central plateau, which ranges in altitude from 3000 to 6000 ft. From this vast tableland rise the endless series of mountain chains which constitute the three major ranges; the Alborz in the north, the Zagross in the southwest, and kopet-Dag in the north-east. The highest peak is Damavand (18371 ft), a volcanic cone in the Alborz range northeast of Teheran. Due to the altitude of the plateau, the climate of this region is extreme. Summers are hot, with the temperatures reaching in places from 110 to 115 d.F. (43 to 46 d.C.); winters are correspondingly severe, with heavy snow-fall, particularly in the mountainy areas. Rainfall varies widely from place to place, but rarely exceeds 10 in. (254 mm.) a year, except in Azarbayejan. Most of the rain falls in March and April.

Region two, which includes the provinces of:

[Gillan and Mazandaran (including Gorgan and Gonbad)]

is the Caspian littoral. Rain bearing clouds, driven by the pre-vailing northernly winds against the high barrier of the Alborz mountains, shed their burden almost exclusively on the northern slopes of the Alborz, giving the Caspian littoral a rainfall which varies from 50 to 60 in. (1270 to 1524 mm.) a year in Gillan and about 20 in. (508 mm.) in Gorgan (west of Mazandaran) but which may be as much as 100 in. (2540 mm.) in places.

Temperatures in this region rarely exceed 90 d.f.(32 d.c.), and frosts are rare in winter.

Region three, which includes the provinces of:

[Khoozestan, Booshehr, Hormozgan, and Systan & Baloochestan] is the Persian Gulf, and its hinterland. This region is humid in summer, its eastern part being affected by the southwest monsoon, and it is also the hottest region of Iran. Temperatures of 120 to 125 d.F. (49 to 52 d.C.) in July and August are not uncommon, and the temperature never drops to the freezing point even in winter. Average rainfall varies from 3 to 4 in. (75 to 100mm.) in Baloochestan.

Region four, which includes some parts of the provinces of:

[Khorasan, Semnan, Esfahan, Yazd, Kerman and northern parts of Systan & Baloochestan]

is the great desert. The two great salt deserts of Iran, the Dasht-e-Kavir and the Dastht-e-Loot, lie east and south of Teheran and extend almost the Afghan frontier. Between the deserts and the frontier lies the province of Systan, a low lying and often swampy area with an extreme temperature range and minimal annual rainfall.

Rivers, Lakes and Harbours

Iran is deficient in sizable rivers. The only navigable river is the Karoon, which flows from the Zagross mountains into the Persian Gulf. In the north the Sefid Rood (Qizil Uzun) rises in Kordestan and discharges into the Caspian.

The principal lake is the lake Oroomieh in Azarbayejan.

As far as the important ports and harbours are concerned, before Iran Islamic revolution of 1979 and the present war with Iraq, the only important port with having the access to open sea and also rail network was the port of Khoramshahr in Khoozestan province. This port was completely destroyed during this war. Now four important ports of Bandar-Emam Khomeiny, in Khoozestan; Bandar-Shaheed-Rajaee and Bandar-Shaheed-Bahonar both in Bandar-Abbas in Hormozgan province, and finally very recent built Bandar-Chah-Bahar in Systan-& Baloochestan province serve the country instead. Also three medium-size double purpose (commercial and fishing) ports are at their final stages of construction in Persian Gulf and the Sea of Oman . There are also some minor ports in the north in the Caspian.

Table 5-1 shows Iran provinces with their centre cities, areas, and 1983 population.

It is worth noting that the names of some provinces like Teheran, Esfahan and Kerman are the same as their city-centres; and some like Hormozgan, Systan & Baloochestan and East-Azarbayejan have different names from their city-centres which are for instance in this case Bandar-Abbas, Zahedan and Tabriz respectively.

Table 5-1

The Provinces of Iran (see also the enclosed map)

No.	Province	Centre	Area (km.^2)	1983 Population (in 1000 persons)
1	Teheran	Teheran	19118.4	7192
2	Central	Arak	39895.0	1301
3	Gillan	Rasht	14709.0	1822
4	Mazandaran	Sari	47375.0	2861
5	East-Azarbayejan	Tabriz	67102.4	3679
6	West-Azarbayejan	Oroomeeye*	38850.0	1688
7	Bakhtaran	Bakhtaran**	23666.0	1225
8	Khoozestan	Ahwaz	67282.0	2672
9	Fars	Shiraz	133298.0	2442
10	Kerman	Kerman	179916.0	1317
11	Khorasan	Mashad	313337.2	3938***
12	Esfahan	Esfahan	104650.0	2770
13	Systan&Baloochestan	Zahedan	181578.0	829
14	Kordestan	Sanandaj	24998.0	923
15	Hamadan	Hamadan	19784.0	1253
16	Lorestan	Khorram-Abad	28803.2	1074
17	Chaharmahal&Bakhteayari	Shahr-e-Kord	14870.3	476
18	Ilam	Ilam	19044.0	266
19	Kohkilooye&Boweer-Ahmad	Yasooj	14261.0	292
20	Booshehr	Booshehr	27653.0	428
21	Zanjan	Zanjan	36398.3	1309
22	Semnan	Semnan	90039.0	322
23	Yazd	Yazd	70011.0	424
24	Hormozgan	Bandar-Abbas	66870.4	568
	Total (Iran)		1643509.7+	41068

* Previous name: Rezaeeye

** Previous name: Kermanshah

*** About 2 millions population of Afghan immigrants mostly living in this province are excluded.

\+ Excluding Oroomeeye lake area, which is 4686 Km.^2.

Source: Ref.(36).

5-3. Iran Provinces' Roads in Detail

Table 5-2 shows different types of roads, their lengths, and the percentages of roads having asphalt pavement in differen provinces of Iran in 1983. Khorasan, the country's biggest province, with more than 18000 kilometres of different type of roads, possesses the longest network in the country. But neglecting access roads, then comparing the lengths, we see that Khoozestan with more than 8000 kilometres of main, side, and rural roads possesses the longest network. In Teheran province, which contains Teheran city, the country's capital, 41 per cent of roads have asphalt pavement; but similar figure for Lorestan is only 13 per cent. Fig. 5-1 shows that totally only a small portion of the country's roads have asphalt pavement- or any kind of pavement for that matter-(23%, see Table 5-2, this figure is less than scap figure, see Table 4-1).

Table 5-3 shows the rate of roads per population and per area and also per "area by population" in each province. The results of Tebles 5-2 and 5-3 are shown graphically in Fig. 5-1. It is interesting to note that although big provinces like Khorasan, Fars and Kerman have the longest networks of roads, their rate of roads per "population by area" is considerably less than for the small provinces. The relative figures for the above mentioned three provinces are 1.53, 2.83, and 4.17 Km. per "100 Km.^2 by 1000000 population"; whereas the average of this figure for seven small provinces of Chahar-Mahal, Ilam, Kohkilooye. Booshehr, Semnan, Yazd and Hormozgan is as high as 26.17. This means for instance, Khorasan possesses the biggest road network in the country, Still the above mentioned small provinces have more than "26.17:1.53∼17" times roads per unit area and per unit of pop-

Table 5-2

The Lengths of Road Networks in Different Provinces of Iran (1983)

Km. Type of road		Width(m.)	Teheran	central	Gillan
	Motor-way	19	178.0	63.0	-
MAJOR* ROADS	Carriage-way	19	127.7	20.0	-
	Wide	13-19	201.0	-	107.0
	Normal	09-12	701.5	613.5	311.0
MINOR* ROADS	Wide	09-12	175.2	58.0	277.5
	First class	06-08	222.3	308.0	448.8
	Second class	05	375.5	247.0	519.5
	Rural roads	05	1635.4	1386.5	453.3
ACCESS ROADS	With asphalt P.	05	1.2	275.0	-
	Without asp. p.	05	-	125.0	1973.3
Total roads			3617.8	3096.0	4090.4
Total asphalt roads			1495.7	1183.5	919.9
Per cent of asphalt roads			41	38	22

Type of road		Width(m.)	Mazandaran	East-Azarbayejan	West-Azarbayejan
	Motor-way	19	-	18.0	-
MAJOR ROADS	Carriage-way	19	41.5	29.0	16.0
	Wide	13-19	20.0	903.0	4.0
	Normal	09-12	1033.0	228.0	564.2
MINOR ROADS	Wide	09-12	151.5	611.7	31.5
	First class	06-08	1201.4	1848.0	181.8
	Second class	05	853.6	1885.5	866.1

* For definition, see section 1-9.

Table 5-2 cont.

	Rural roads	05	2179.02	1105.2	1296.9
ACCESS ROADS	With asphalt p.	05	115.9	-	171.0
	Without asp. p.	05	716.6	2752.0	484.5
Total roads			6312.7	9380.4	3616.0
Total asphalt roads			1962.9	2713.7	877.6
Per cent of asphalt roads			31	29	24

Type of road		Width(m.)	Bakhtaran	khoozestan	Fars
	Motor-way	19	-	-	-
MAJOR ROADS	Carriage-way	19	15.2	66.0	-
	Wide	13-19	-	435.0	-
	Normal	09-12	473.1	1014.0	1053.4
MINOR ROADS	Wide	09-12	24.6	364.0	112.0
	First class	06-08	433.1	1630.0	1137.6
	Second class	05	1375.1	1546.0	279.4
	Rural roads	05	1917.7	2938.5	2014.0
ACCESS ROADS	With asphalt p.	05	18.8	115.0	406.5
	Without asp. p.	05	291.6	4311.7	4217.9
Total roads			4549.2	12420.2	9220.8
Total asphalt roads			748.3	2445.0	2140.7
Per cent of asphalt roads			16	20	23

Type of road		Width(m.)	Kerman	Khorasan	Esfahan
	Motor-way	19	-	40.0	116.0
MAJOR ROADS	Carriage-way	19	26.0	87.0	200.0
	Wide	13-19	-	-	383.0
	Normal	09-12	1363.0	1684.0	583.0

Table 5-2 cont.

MINOR ROADS	Wide	09-12	819.0	202.0	366.0
	First class	06-08	1552.0	796.2	654.0
	Second class	05	507.5	1380.0	523.5
	Rural roads	05	765.9	2514.5	3790.0
ACCESS ROADS	With asphalt p.	05	-	476.0	401.0
	Without asp. p.	05	4839.0	11674.5	2685.5
Total roads			9872.4	18854.2	9702.0
Total asphalt roads			2984.0	2887.1	2376.0
Per cent of asphalt roads			30	15	24

Type of road		Width(m.)	Systan&B.	Kordestan	Hamadan
	Motor-way	19	-	-	-
MAJOR ROADS	Carriage-way	19	-	-	-
	Wide	13-19	12.0	-	-
	Normal	09-12	461.0	576.0	576.6
MINOR ROADS	Wide	09-12	-	-	-
	First class	06-08	1227.0	-	253.4
	Second class	05	336.0	1067.0	522.4
	Rural roads	05	336.0	468.5	1061.4
ACCESS ROADS	With asphalt p.	05	468.0	-	85.6
	Without asp. p.	05	6579.0	-	219.6
Total roads			9419.0	2111.5	2719.0
Total asphalt roads			1554.5	576.0	788.9
Per cent of asphalt roads			16	27	29

Table 5-2 cont.

Provinces' Names

Type of roads		Width(m.)	Chaharmahal	Lorestan	Ilam
	Motor-way	19	-	-	-
MAJOR ROADS	Carriage-way	19	-	-	-
	Wide	13-19	-	420.0	-
	Normal	09-12	-	-	175.0
MINOR ROADS	Wide	09-12	472.9	-	3.0
	First class	06-08	387.4	484.0	669.0
	Second class	05	522.2	243.0	485.0
	Rural roads	05	419.7	1121.0	661.5
ACCESS ROADS	With asphalt p.	05	-	-	-
	Without asp. p.	05	354.6	2881.3	953.0
Total roads			**2156.8**	**5149.3**	**2946.5**
Total asphalt roads			666.6	662.0	512.5
Per cent of asphalt roads			31	13	17

Type of roads		Width(m.)	Kohkilooye&B.	Booshehr	Zanjan
	Motor-way	19	-	-	65.0
MAJOR ROADS	Carriage-way	19	-	-	-
	Wide	13-19	-	-	249.0
	Normal	09-12	-	110.0	481.5
MINOR ROADS	Wide	09-12	15.0	-	-
	First class	06-08	386.0	711.0	253.0
	Second class	05	302.0	-	-
	Rural roads	05	562.5	989.0	2459.0
ACCESS ROADS	With asphalt p.	05	150.0	-	-
	Without asp. p.	05	455.5	904.0	1587.0

Table 5-2 cont.

Total roads		1871.0	2714.0	5968.5
Total asphalt roads		393.0	465.5	922.0
Per cent of asphalt roads		21	17	15

Type of roads		Width(m.)	Semnan	Yazd	Hormozgan
	Motor-way	19	-	-	10.0
MAJOR ROADS	Carriage-way	19	-	-	-
	Wide	13-19	-	-	-
	Normal	09-12	624.0	291.0	240.0
MINOR ROADS	Wide	09-12	50.0	25.0	-
	First class	06-08	378.8	217.6	1151.7
	Second class	05	-	38.5	-
	Rural roads	05	1183.8	765.4	468.3
ACCESS ROADS	With asphalt p.	05	-	207.0	-
	Without asp. p.	05	945.2	1290.0	474.5
Total roads			3181.8	2834.5	2344.5
Total asphalt roads			863.4	631.8	825.8
Per cent of asphalt roads			27	22	35

Total (Iran), 1983:

Motor-way	MAJOR ROADS: Carriage-way	Wide	Normal
490.0	628.4	2734.0	13156.8

Rural roads	MINOR ROADS: Wide	First-class	Second-class
32493.2	3758.9	16532.1	14748.8

Total: 138148.5

ACCESS ROADS: With asphalt p.	Without asphalt p.
2891.0	50715.3

Total with asp. p.: 31925.15, per cent of asp. roads: 23

Table 5-3

Iran Provinces' Roads in Comparison with Area and Population 1983

No.	Province	Total roads Km. per 100 Km.^2 area	Total roads Km. per (100 Km.^2 by million pop.)	Total roads Km. per 10000 population
1	Teheran	18.9	2.63	5.0
2	Central	7.8	5.96	23.8
3	Gillan	27.8	15.26	22.5
4	Mazandaran	13.3	4.66	22.1
5	E. Azarbayejan	14.0	3.80	25.5
6	W. Azarbayejan	9.3	5.51	21.4
7	Bakhtaran	19.2	15.69	37.1
8	Khoozestan	18.5	6.91	46.5
9	Fars	6.9	2.83	37.8
10	Kerman	5.5	4.17	75.0
11	Khorasan	6.0	1.53	47.9
12	Esfahan	9.3	3.35	35.0
13	Systan&Baloochestan	5.2	6.26	113.6
14	Kordestan	.8.4	9.15	22.9
15	Hamadan	13.7	10.97	21.7
16	Lorestan	17.9	16.65	48.0
17	Zanjan	16.4	12.53	45.6
18	Others*	9.1	26.17	65.0
Iran		8.4	0.20	33.6

* Seven small provinces.

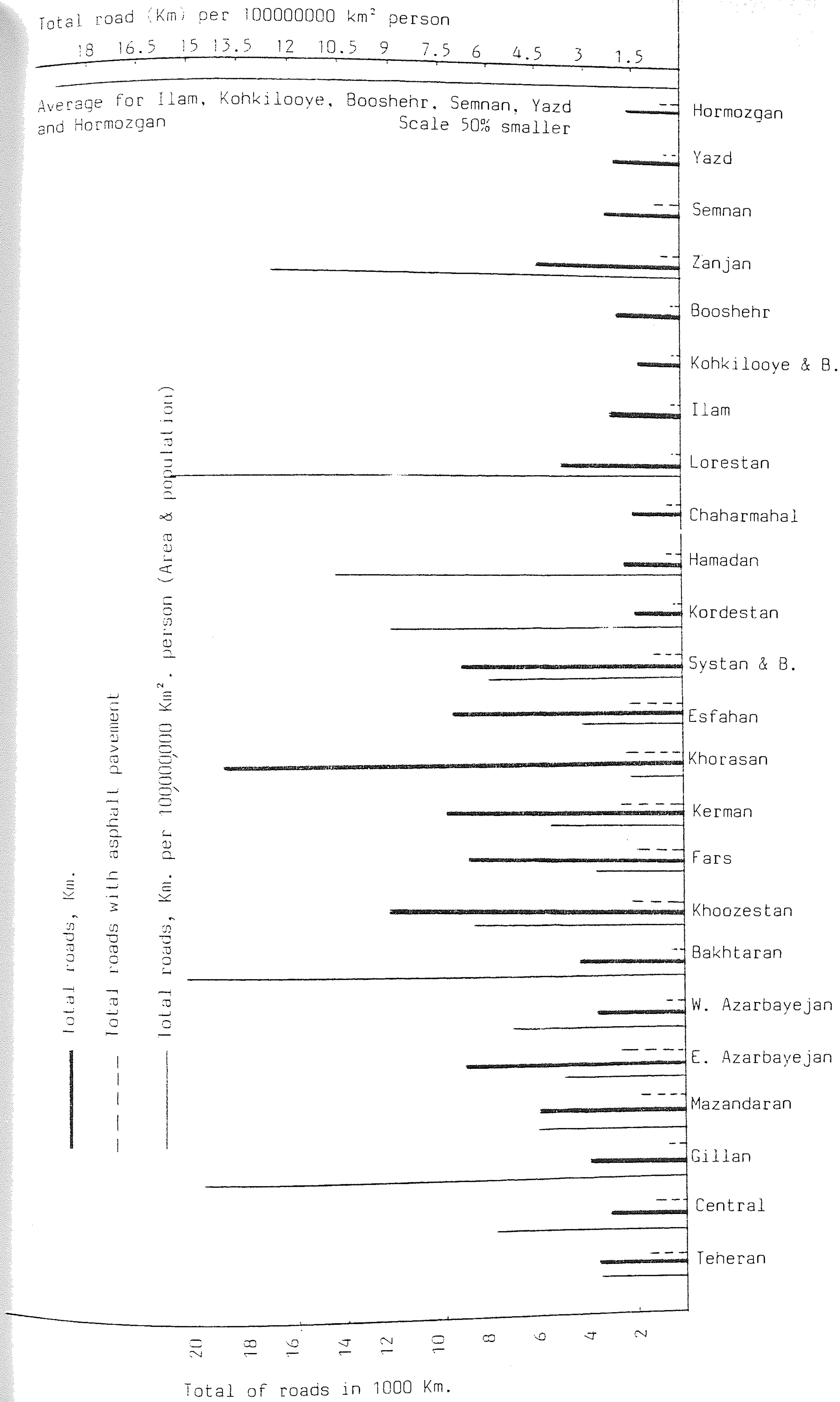

Fig. 5-1. Iran Provinces' Roads.

ulation. One might argue that although provinces like Khorasan and Esfahan are big, a considerable portion of their land is arid and covered by desert which is not developed and therefore has no need of roads. This answers why this work has been based on comparative rates on "area by population" rather than "area" itself; and secondly big arid areas although do not need roads as much as developed ones, at the same time cannot be totally neglected and for connecting developed areas and populated centres around them, utilizing natural resources and other economical and strategical means have traffic and need roads; but of course, with a lesser portions. This will be examined from a different angle in the next section.

After the seven small provinces; Lorestan, Bakhtaran, Central, and Zanjan have the highest rates of roads and; Teheran, Fars, Esfahan, and Khorasan have the lowest ones.

Iran provinces main roads are listed in appendix one.

5-4. Average Daily Traffic in the Provinces of Iran

Table 5-4 and Fig. 5-2 show average daily traffic, the per centages of heavy to total traffic, and their rates (average daily traffic per kilometre of existing roads) in different provinces of Iran. In the provinces of Lorestan, Central, Kerman, Zanjan, East-Azarbayejan, Hamadan and the group of seven small provinces; more than 40 per cent of the road traffic are Heavy Goods' Vehicles (H.G.V). This is mostly because of passing main country's commercial routes through some of them (Zanjan and Lorestan for example) and also because of reduced mobility of people in small passenger

Table 5-4

Iran Provinces' Average Daily Traffic (1983)

No.	Province	Small-vehicles' average daily traffic	Heavy goods' vehicles average daily traffic	Total A.D.T	Per cent of heavy total traffic	A.D.T. per Km. of road existed in the province (C.A.D.T
1	Teheran	176000	74800	250800	30	69.3
2	Central	22000	19800	41800	47	13.5
3	Gillan	96800	15400	112200	14	27.4
4	Mazandaran	144000	24200	168200	14	26.6
5	E. Azarbayejan	36300	29200	65500	45	7.0
6	W. Azarbayejan	19800	9900	29700	33	8.2
7	Zanjan	30300	24200	54500	44	9.1
8	Fars	54500	29000	83500	35	9.0
9	Esfahan	74800	34100	108900	31	11.2
10	Kerman	24200	20300	44500	46	4.5
11	Khorasan	24300	13700	38000	36	2.0
12	Kordestan	3300	800	4100	20	1.9
13	Bakhtaran	24600	11200	35800	31	7.9
14	Lorestan	15900	15800	31700	50	6.2
15	Khoozestan	52200	19700	71900	27	5.8
16	Systan&Baloochestan	4300	2100	6400	33	0.7
17	Hamadan	20900	14300	35200	41	12.9
18	Others (7 small provinces)	45100	36300	81400	45	4.5
Total		869300	394800	1264100	31	9.2

Source: Ref. (49)

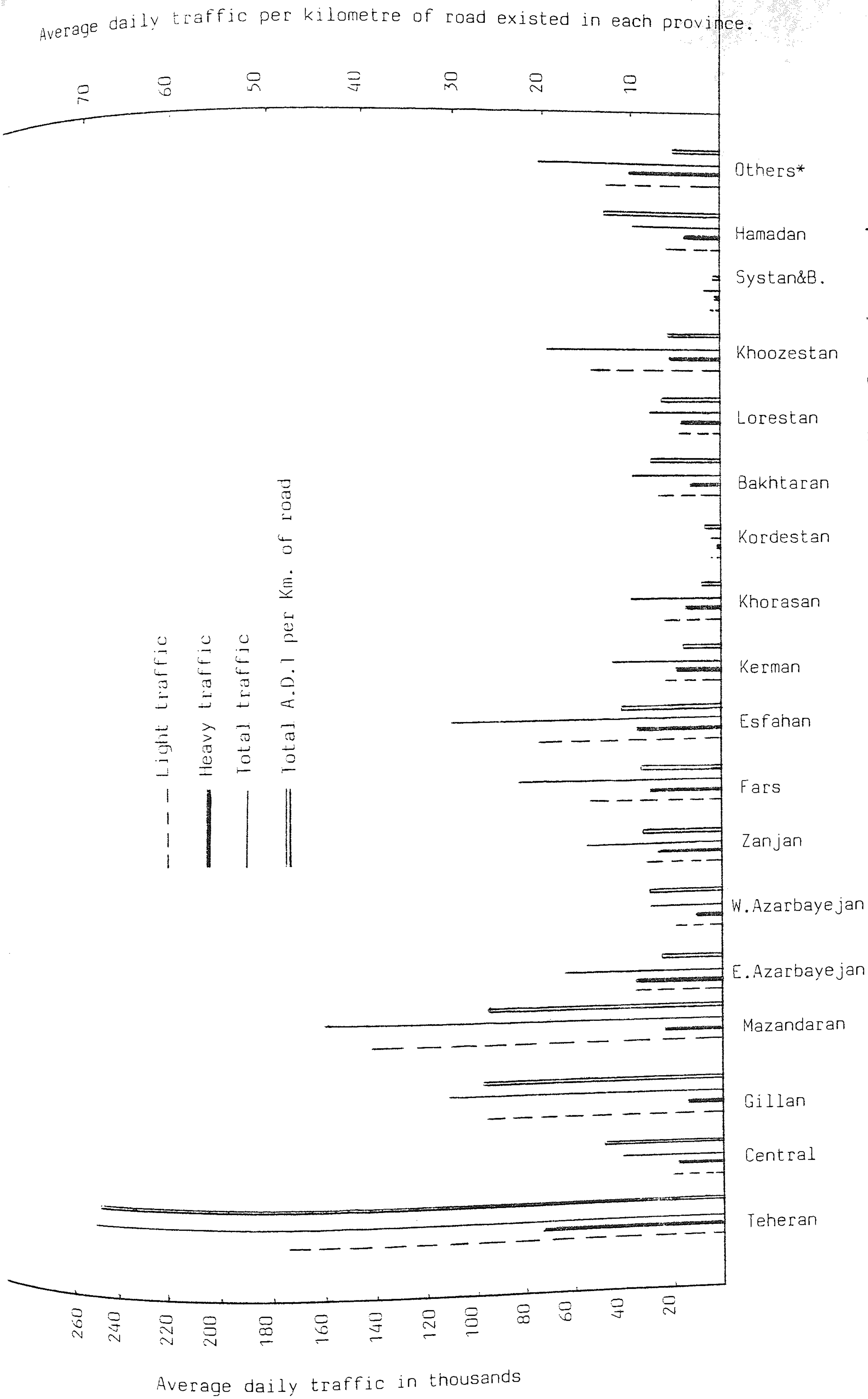

Fig. 5-2. Iran provinces' average daily traffic (A.D.T) and A.D.T per Km. of province road.

cars for private purposes in remote areas (Kerman and the group of small provinces for example). On the other hand, provinces like Teheran, Gillan and Mazandaran, because of the greater mobility of people in the shape of private travels and provinces like Kordestan because of not containing main commercial routes, have much less proportion of heavy commercial traffic.

The factor which seems to be strongest in causing accidents, is road traffic which is represented by the rate of traffic rather than the absolute number of traffic movements itself. One definition of traffic rate can be interpretated as average daily traffic per kilometre of existing roads. As can be seen from Table 5-4, in this sense the province of Teheran has the highest, (69.3) and the province of Systan & Baloochestan the lowest (0.7), rate of traffic in the country. In addition to Teheran, which because of the concentration there of the country's administrative, political, and economical system possesses extremely crowded roads, the provinces of Gillan and Mazandaran with the rates of 27.4 and 26.6 also possess relatively crowded roads. Referring to section 5-2, at least part of the reason can be realized. The provinces of Khorasan, Kerman and Systan & Baloochestan in the east, the group of small provinces in the centre and some remote provinces like Kordestan in the west, possess quieter roads.

Table 5-5 shows provincial traffic rates in a different base of comparison which is traffic per unit population and also in the third definition, which is traffic per combination of existing roads and population in each province. Some provinces like Gillan and Mazandaran

Table 5-5.

Iran Provinces' Rate of Road Traffic

No.	Province	A.D.T* Per 100 population	C.A.D.T** Per 1000000 population
1	Teheran	3.52	9.7
2	Central	3.22	10.4
3	Gillan	6.17	15.0
4	Mazandaran	5.83	9.2
5	E. Azarbayejan	1.78	1.9
6	W. Azarbayejan	1.76	4.9
7	Zanjan	4.16	7.0
8	Fars	3.41	3.7
9	Esfahan	3.92	4.0
10	Kerman	3.39	3.4
11	Bakhtaran	3.57	6.5
12	Kordestan	0.44	2.0
13	Khorasan	0.96	0.5
14	Lorestan	2.93	5.7
15	Khoozestan	2.69	2.2
16	Systan & B.	0.77	0.8
17	Hamadan	2.79	10.2
18	Others	2.92	1.6
IRAN		3.08	0.2

* Average Daily Traffic

** Comparative Average Daily Traffic = A.D.T per Km. of province existed roads.

in the Caspian area with pleasant climate and beautiful natural scenery each year host millions of people from other provinces and therefore possess a relatively higher traffic rate per unit of their own population. Some others like zanjan, because the country's important main highways pass through them, have the same situation.

5-5. The Road Accidents in Different Provinces of Iran

Table 5-6 and Fig. 5-3 show the road accidents in different provinces of Iran. Also the percentage of fatal accidents in all provinces in the year 1983 are shown.

Big provinces of Mazandaran, Khorasan, East-Azarbayejan and most populated provinces like Teheran and Gillan have the highest number of accidents. But remote provinces like Systan&Baloochestan, Kerman and West-Azarbayejan have the highest percentage of fatal accidents, i.e. 13, 11 and 10 per cent respectively. Although Hamadan and Zanjan, which are not far from centre of country's activities and the main routes that connect west and northern west of the country pass through them, possess rather high percentages of fatal accidents, i.e. 11 and 8 per cent respectively.

The percentage of fatal accidents generally in rather developed provinces with a more educated and trained people and better and more hospitals and accident services to treat accident victims are lesser.

Table 5-6 and Fig. 5-4 show the number of persons being killed or injured in different provinces of Iran, in the year 1983.

Table 5-6

Iran Provinces' Road Accidents (1983)

Reference: Iran Road Police, The Office of Statistics

No.	Province	Fatality Accidents		Injury Accidents		Damage Accidents	Total Accidents	Per cent of fatality Accidents
		Accidents	Persons killed	Accidents	Persons Injured			
1	Teheran	162	228	1813	3376	3327	5302	3%
2	Central	154	278	805	2073	1031	1990	8%
3	Gillan	84	120	1291	2260	1815	3190	4%
4	Mazandaran	166	282	2063	3661	2399	4628	4%
5	E. Azarbayejan	132	184	715	1475	1229	2076	6%
6	W. Azarbayejan	78	118	353	672	389	820	10%
7	Zanjan	160	296	796	1968	926	1882	8%
8	Fars	78	142	642	1276	830	1550	5%
9	Esfahan	160	228	1565	2668	1255	2980	8%
10	Kerman	58	72	252	510	212	522	11%
11	Bakhtaran	62	78	496	966	443	974	6%
12	Kordestan	16	30	129	336	111	256	6%
13	Khorasan	134	190	888	1919	1618	2640	5%
14	Lorestan	52	66	219	392	243	514	10%
15	Khoozestan	112	134	800	1457	946	1858	6%
16	Systan & B.	30	44	130	309	72	232	13%
17	Hamadan	65	102	300	664	262	628	11%
18	Others*	109	239	663	1587	537	1309	8%
	Total (IRAN)	1813	2831	13893	27569	17645	33351	5%

* Seven small provinces.

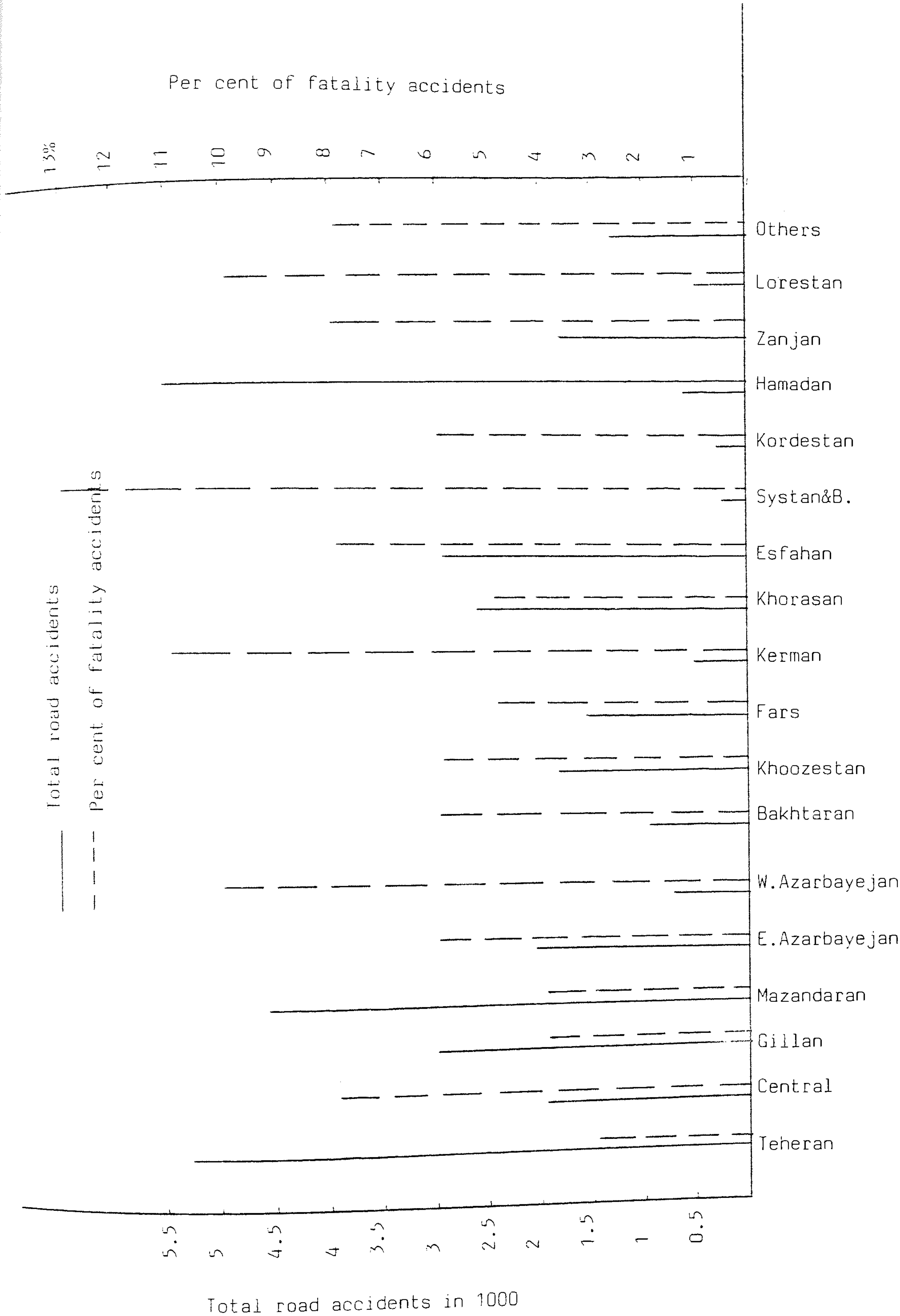

Fig. 5-3. Iran provinces' road accidents (1983).

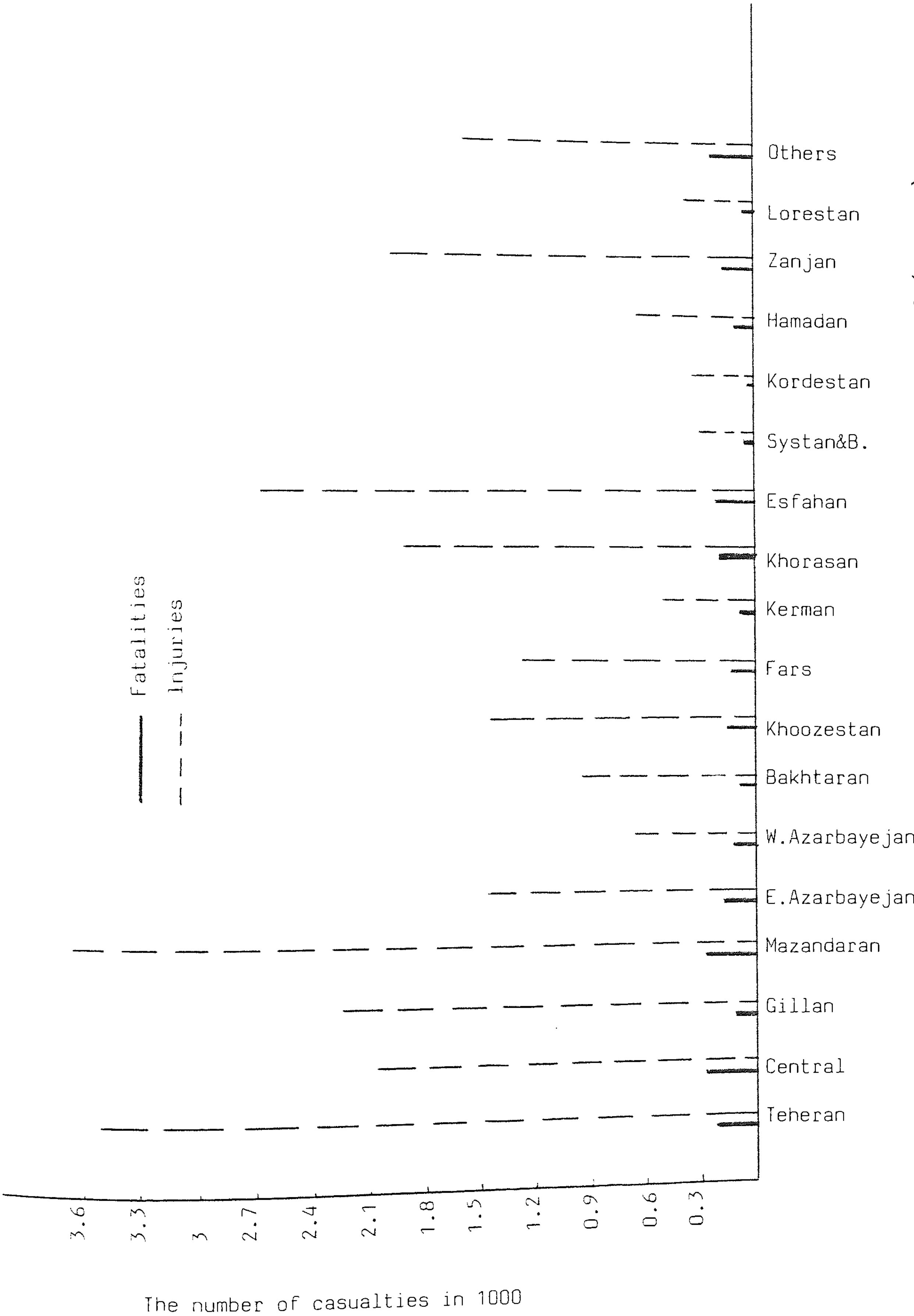

Fig. 5-4. Iran provinces' road accidents' deaths and injuries, 1983 (persons).

The average percentage increase in road accident deaths in 1984 in the country is +16.7% (see Table 5-7). But this percentage is very different in each province. The provinces of Teheran, Fars, Kordestan, Khorasan, Lorestan and Systan&Baloochestan have more than 50% increase, but in provinces of Central, Gillan, Mazandaran, West-Azarbayejan and Zanjan the road fatalities have decreased.

5-6. The Type of Road Accidents in Different Provinces of Iran

Tables 5-8 and 5-9 show the type of road accidents in different provinces of Iran. As it can be seen from Table 5-8, between 64 and 78 per cent of road accidents in all provinces are "vehicle to vehicle", except in Systan&Baloochestan in which this percentage is lower, equal 39 per cent. This is mostly compensated in the column of "overturning & (or) falling", in which Systan&Baloochestan has the highest percentage of 32.

"Vehicle to vehicles" road accidents (column2), and "vehicle to a fixed object" are also both rather high in Systan&Baloochestan.

Discussing different types of accidents, Lorestan contains almost the same situation as Systan&Baloochestan, but with a lesser intensity.

In the provinces of Esfahan, Bakhtaran, Lorestan, Mazandaran, Hamadan and West-Azarbayejan the highest percentage of pedestrians involving in the road accidents are observed.

Table 5-9 shows almost 10 per cent of total road accidents in different provinces of Iran are in the shape of "Front to Front", except in Systan&Baloochestan and in Lorestan that this percentage is almost doubled, i.e. about 20 per cent. "Front to Rear" type of

Table 5-7

Iran Provinces' Road Accidents in 1984 and Comparison with 1983

Source : Iran Road Police, the Office of Statistics.

No.	Province	Fatality Accidents		Injury Accidents		Damage Accidents	
		Persons Killed	Per cent Change	Persons Injured	Per cent Change	Accidents Number	Per cent Change
1	Teheran	302	+ 8.0	4142	+ 3.0	3600	+17.7
2	Central	184	-20.0	1771	- 0.1	899	-12.8
3	Gillan	76	- 6.7	1805	- 6.8	1756	- 3.2
4	Mazandaran	216	- 9.9	2974	-10.5	2579	+ 7.5
5	E. Azarbayejan	185	+ 8.7	1686	+15.7	1353	+10.0
6	W. Azarbayejan	102	-13.0	993	+ 7.8	372	- 4.3
7	Zanjan	216	-14.0	1957	- 0.5	983	+ 6.1
8	Fars	195	+ 2.0	1300	+ 1.9	933	+12.4
9	Esfahan	184	+15.0	1939	-18.0	1101	-12.3
10	Kerman	80	+11.0	514	+ 0.7	288	+35.8
11	Bakhtaran	112	+ 3.5	819	-15.2	464	+ 4.7
12	Kordestan	51	+ 0.0	455	+ 5.3	124	+11.5
13	Khorasan	282	+ 8.9	1834	+11.0	1827	+12.9
14	Lorestan	100	+ 1.5	699	+ 8.3	330	+35.8
15	Khoozestan	162	+21.0	2081	+ 3.4	1258	+33.0
16	Systan & B.	78	+ 7.2	450	+ 5.6	97	+34.7
17	Hamadan	112	+ 9.8	975	+ 6.8	285	+ 8.8
18	Others	205	+ 2.3	1961	+ 9.1	784	+46.0
	Total (Iran)	2842	+0.4	28355	+2.8	19033	+ 9.7

Iran Provinces' Road Accidents (1983), Considering Different Parties Involved at Collision

No.	Province	Vehicle to vehicle		Vehicle to Vehicles		Vehicle to pedestrian(s)		Vehicle to Animals		Vehicle to a fixed object		Overturning & (or) Falling		Other Situations		Total	Per Cent
		Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%		
1	Teheran	4117	78	264	5	527	10	24	-	105	2	212	4	53	1	5302	100
2	Central	1452	73	79	4	177	9	10	-	59	3	174	9	39	2	1990	100
3	Gillan	2361	74	159	5	478	15	32	1	32	1	96	3	32	1	3190	100
4	Mazandaran	3286	71	277	6	788	17	46	1	46	1	139	3	46	1	4628	100
5	E.Azarbayejan	1585	77	101	5	225	11	5	-	7	-	145	7	8	-	2076	100
6	W.Azarbayejan	533	65	33	4	131	16	17	2	8	1	82	10	16	2	820	100
7	Zanjan	1242	66	170	9	188	10	19	1	19	1	207	11	37	2	1882	100
8	Fars	1080	70	76	5	217	14	8	-	31	2	107	7	31	2	1550	100
9	Esfahan	2108	71	139	5	525	18	22	-	16	-	140	5	30	1	2980	100
10	Kerman	339	65	26	5	47	9	1	-	10	2	89	17	10	2	522	100
11	Bakhtaran	643	66	49	5	175	18	10	1	9	1	78	8	10	1	974	100
12	Kordestan	169	66	8	3	18	7	-	-	8	3	41	16	12	5	256	100
13	Khorasan	2007	76	79	3	291	11	26	1	53	2	158	6	26	1	2640	100
14	Lorestan	285	56	10	2	86	17	2	-	3	-	102	20	26	5	514	100
15	Khoozestan	1301	70	74	4	223	12	19	1	18	1	186	10	37	2	1858	100
16	Systan & B.	91	39	16	7	21	9	-	-	14	6	74	32	16	7	232	100
17	Hamadan	440	70	25	4	100	16	-	-	-	-	51	8	12	2	628	100
18	Others	839	64	65	5	183	14	13	1	26	2	144	11	39	3	1309	100
	Total (IRAN)	**23878**	**72**	**1650**	**5**	**4400**	**13**	**254**	**1**	**464**	**1**	**2225**	**7**	**480**	**1**	**33351**	**100**

Vehicle to vehicle: only two vehicles are involved in the accident
Vehicle to vehicles: more than two vehicles are involved in the accident.
Vehicle to animal(s) or a fixed object or pedestrian(s): only one vehicle is involved in the accident.

Table 5-9. Iran Provinces' Road Accidents Involving More Than One Vehicle, Considering Their Position at Collision (1983)

No.	Province	Front to Front		Front to Rear		Front to Side		Side to Side		Rear to Side		Other Positions		Total	Per Cent
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
1	Teheran	398	10	1293	32	1106	27	563	14	105	3	573	14	4038	100
2	Central	269	12	550	25	587	27	343	16	64	3	386	17	2199	100
3	Gillan	308	10	747	24	1030	33	437	14	70	2	519	17	3111	100
4	Mazandaran	614	13	983	22	1269	38	640	14	125	3	926	20	4557	100
5	E. Azarbayejan	267	13	452	22	560	28	310	15	55	3	376	19	2020	100
6	W. Azarbayejan	80	10	160	20	265	33	80	10	27	3	187	24	799	100
7	Zanjan	214	12	462	25	392	21	304	17	37	2	425	23	1834	100
8	Fars	187	12	285	19	493	33	211	14	25	2	312	20	1513	100
9	Esfahan	322	11	546	19	1047	36	337	12	64	2	589	20	2905	100
10	Kerman	60	12	80	16	140	28	78	15	14	3	135	26	503	100
11	Bakhtaran	138	16	162	19	277	33	99	12	10	1	156	19	842	100
12	Kordestan	35	14	49	20	49	20	35	14	6	2	76	30	250	100
13	Khorasan	273	11	585	23	747	30	404	16	92	4	415	16	2516	100
14	Lorestan	80	17	55	11	103	21	35	7	12	2	199	42	484	100
15	Khoozestan	205	11	324	18	571	32	265	15	62	3	384	21	1811	100
16	Systan & B.	39	21	150	8	21	12	21	12	-	-	86	47	317	100
17	Hamadan	66	11	90	15	159	26	96	16	33	5	170	27	612	100
18	Others	149	12	314	24	379	29	171	13	35	3	243	9	1291	100
	Total (Iran)	3704	12	7287	23	9194	29	4428	14	836	3	6158	19	31607	100

collision is high in Teheran province and rather high in other provinces with heavy traffic on their roads, (see Table 5-4).

5-7. Provinces' Road Accidents Caused by Human Factors

In section 5-6, it was seen that in Teheran and other provinces with high "comparative average daily traffic" on their roads, i.e. heavy road traffic, "Front to Rear" type of accidents are high. Here in the same way, Table 5-10 shows in such a provinces "Following too closely" possesses the highest percentages between different types of improper driving.

The percentage related to the "Lack of Attention" is also highest in these provinces.

"Inexperienced and loss of control", in Teheran province has the lowest percentage. This type of improper driving as may be understandable, has the lowest percentage in rather developed, and highest percentage in less developed provinces.

"Speeding" is effective in causing 9 per cent of road accidents in the country. This percentage is almost evenly distributed among different provinces, but Lorestan has exceptionally a very high figure of 26 per cent.

5-8. Provinces' Road Accidents Caused by Road Imperfections

Of the 33351 road accidents which occurred on Iran roads in 1983, 5565 cases of them (17 per cent) were in junctions, circles, or places in which road was steep, winding, or some form of combination of these. The per centage figures shown in Table 5-11 are the percentages of only

Table 5-10. Iran Provinces' Road Accidents (in which Improper Driving Is the Total or Part of the Cause of the Accident); for Different Types of Driver's Fault (1983)

No.	Province	Followed too closely		Failed to yield		Lack of attention		Inexperienced & lose of control		Speed too fast*		Wrong Path (swing to right or left)**		Reverse driving		Improper Overtaking		Other Improper driving		Total 1983	Total Per Cent
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
1	Teheran	440	23	244	13	402	21	28	1	128	7	296	16	74	4	48	2	248	13	1908	100
2	Central	336	14	362	16	384	17	166	7	190	8	354	15	94	4	150	6	304	13	2340	100
3	Gillan	464	21	562	18	630	20	94	3	122	4	610	19	102	3	138	4	268	8	2990	100
4	Mazandaran	762	17	624	14	766	17	122	3	422	9	818	18	166	3	340	7	560	12	4580	100
5	E. Azarbayejan	488	21	306	13	366	16	130	6	148	6	390	17	98	4	208	9	200	8	2334	100
6	W. Azarbayejan	122	15	132	16	110	13	40	5	104	12	114	13	38	5	64	7	116	14	840	100
7	Zanjan	302	17	282	16	330	18	110	12	102	6	260	14	86	5	116	6	214	12	1802	100
8	Fars	252	16	318	21	128	8	92	6	150	10	260	17	66	4	60	4	224	14	1550	100
9	Esfahan	282	12	708	22	446	14	80	3	378	12	424	13	140	4	128	4	578	16	3164	100
10	Kerman	48	10	86	16	78	15	40	8	54	10	146	28	12	2	24	4	34	7	522	100
11	Bakhtaran	117	11	96	10	186	18	66	7	80	8	214	21	26	4	82	8	149	15	1016	100
12	Kordestan	34	14	18	7	20	8	22	8	38	15	58	23	12	4	20	8	34	13	256	100
13	Khorasan	484	19	542	21	298	12	74	3	242	9	460	18	174	7	84	3	200	8	1558	100
14	Lorestan	38	8	62	13	74	14	34	6	134	26	104	20	20	4	8	2	40	8	514	100
15	Khoozestan	256	14	372	20	172	9	90	5	222	12	378	20	90	5	50	3	228	12	1858	100
16	Systan & B.	12	5	18	8	40	17	30	13	34	15	42	18	2	1	2	1	52	22	232	100
17	Others	286	22	197	15	185	14	51	4	106	8	205	16	50	4	63	5	147	12	1290	100
	Total (Iran)	4723	16	4929	17	4615	15	1269	4	2654	9	5133	17	1250	4	1585	5	3596	11	29754	100

* Includes "Speed too fast for conditions".

** Mainly swing to left (driving left of centre).

Table 5-11.

Iran Provinces' Road Accidents in Different Road Situations (1983)

No.	Province	Steep locations No.	%	Bend No.	%	Steep & Bend No.	%	Junction No.	%	Circle No.	%	Total	Per Cent
1	Teheran	84	21	24	6	24	6	238	59	30	8	400	100
2	Central	158	32	88	18	22	4	185	38	41	8	494	100
3	Gillan	76	17	181	42	35	8	138	32	4	1	434	100
4	Mazandaran	210	27	182	23	129	16	241	31	26	3	788	100
5	E.Azarbayejan	101	20	173	34	75	15	135	27	20	6	504	100
6	W.Azarbayejan	34	26	26	20	10	8	59	45	3	1	132	100
7	Zanjan	85	33	53	21	47	19	53	21	17	6	255	100
8	Fars	73	20	57	16	30	8	189	53	11	3	360	100
9	Esfahan	109	16	76	11	21	3	437	64	38	6	681	100
10	Kerman	21	30	17	24	9	19	17	24	6	9	70	100
11	Bakhtaran	29	28	21	21	15	15	27	27	9	9	101	100
12	Kordestan	21	56	6	17	4	10	7	17	-	-	38	100
13	Khorasan	124	19	108	17	36	5	340	53	38	6	646	100
14	Lorestan	21	16	42	32	40	31	25	19	2	2	130	100
15	Khoozestan	2	2	24	19	4	3	86	69	8	7	124	100
16	Systan & B.	10	27	24	63	-	-	2	5	2	5	38	100
17	Hamadan	53	32	28	17	8	5	55	45	2	1	146	100
18	Others	51	23	47	21	21	9	94	42	11	5	224	100
1983	Total	1262	23	1177	21	530	9	2328	42	268	5	5565	100

these type of road accidents, and not of the total accidents.

Steep roads in Kordestan, twisty roads in Systan&Baloochestan, Gillan, East-Azarbayejan and Lorestan, steep&twisty roads in Lorestan, junctions in big and developed provinces of Khoozestan, Esfahan, Teheran, Khorasan and Fars, and circles in Kerman, Bakhtaran, Central (Markazi), have had the highest percentage of road accidents.

As far as road imperfections are concerned in causing road accidents in different provinces of Iran, Table 5-12 shows sign deficiencies in Fars, Hamadan, Khoozestan, narrow roads in Mazandaran, Kerman, Zanjan, Teheran and Kordestan, lack of shoulder or parking in Bakhtaran and the lack of traffic barrier and separating islands in East and West-Azarbayejan, Central, Gillan and Mazandaran have had the highest effect in causing road accidents.

5-9. Provinces' Road Accidents per Type of Vehicles

Table 5-13 shows the road accidents in different provinces of Iran, per type of vehicles involved. As it was explained in sub-section 3-9-1, these are the number of different type of motor-vehicles involved in provinces' road accidents, and not the number of road accidents. For definition of the type of vehicles see sub-section 3-9-1.

Passenger-cars in the provinces of Gillan, Teheran and Mazandaran mini-buses and buses, in Kordestan, vans (which are very common for transportation of light goods in Iran), in Systan&Baloochestan, Kerman and Bakhtaran, trucks, in Lorestan and Khorasan, and trailers

Table 5-12. Iran Provinces' Road Accidents in Which Road Imperfection(s) Is (Are) the Only Part of the Cause(s) of the Accident (1983)

No.	Province	Sign deficiency		Narrow Road		Pit & Hollow existance		Lack of** Shoulder or parking		Uneven Road		Slippery Road		Lack of Guard rail		Total	Per Cent
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
1	Teheran	1828	41	1444	33	339	8	237	5	217	5	184	4	190	4	4439	100
2	Central	570	36	534	27	118	6	224	11	87	4	80	4	243	12	1856	100
3	Gillan	1940	42	1318	29	146	3	290	6	117	3	380	8	419	9	4610	100
4	Mazandaran	1244	25	1735	35	201	4	517	10	251	5	629	12	440	9	5017	100
5	Khorasan	1363	40	986	29	148	4	379	11	123	3	150	5	264	8	3413	100
6	Esfahan	1168	46	626	25	197	8	224	9	137	5	109	4	86	3	2547	100
7	Fars	1063	62	274	16	97	6	62	3	60	3	75	4	95	6	1726	100
8	E. Azarbayejan	603	27	685	31	150	7	250	11	119	5	160	7	240	12	2207	100
9	W. Azarbayejan	572	44	218	17	114	9	124	9	58	4	72	5	148	12	1306	100
10	Zanjan	773	34	769	34	82	4	310	14	74	3	90	4	180	7	2278	100
11	Bakhtaran	116	4	224	27	86	10	188	23	116	14	53	6	51	6	834	100
12	Kerman	124	25	167	35	31	6	76	16	27	6	19	4	38	8	482	100
13	Hamandan	271	50	111	20	8	1	68	12	12	2	31	6	45	9	546	100
14	Kordestan	95	38	83	33	24	10	22	10	-	-	8	3	18	6	250	100
15	Lorestan	158	41	86	22	21	5	30	8	38	10	27	7	29	7	389	100
16	Systan & B.	111	33	70	21	47	14	29	9	19	6	21	6	37	11	334	100
17	Khoozestan	987	49	404	20	117	6	183	9	162	8	51	3	109	5	2018	100
18	Others	539	38	404	28	83	6	129	9	66	5	85	6	110	8	1416	100
	Total (Iran)	**13525**	**39**	**10139**	**28**	**2009**	**6**	**3342**	**9**	**1684**	**5**	**2224**	**6**	**2742**	**7**	**35665***	**100**

* In some accidents two or more kinds of road imperfections might be effective in causing the accidents; thus the total here is greater than the total number of accidents in 1983.

** Also including defective shoulders or parkings.

Table 5-13. Iran Provinces' Different Type of Motor-Vehicle in Road Accidents (1983)

No.	Province	Car	%	Minibus	%	Bus	%	Van	%	Truck	%	Trailer	%	Others	%	Total	%
1	Teheran	4131	42	954	10	521	5	1011	10	1275	13	554	6	1283	14	9729	100
2	Central	1288	35	191	5	283	8	462	13	767	21	239	7	422	11	3652	100
3	Gillan	2727	47	448	8	209	4	811	14	734	13	106	2	819	12	5854	100
4	Mazandaran	3281	39	716	8	466	5	1393	16	1261	15	187	2	1189	15	8493	100
5	E. Azarbayejan	1015	27	273	7	263	7	475	12	958	25	483	13	343	9	3810	100
6	W. Azarbayejan	429	28	99	7	70	5	308	20	290	19	73	5	235	16	1504	100
7	Zanjan	1152	33	305	9	279	8	413	12	754	22	297	9	253	7	3453	100
8	Khorasan	1576	32	387	8	332	7	613	13	1184	24	106	2	646	14	4844	100
9	Fars	958	34	191	7	154	5	488	17	600	21	132	4	316	12	2845	100
10	Kerman	771	29	11	4	9	3	61	23	53	20	16	6	37	15	958	100
11	Systan & B.	59	14	7	2	22	5	161	38	77	18	26	6	73	17	425	100
12	Esfahan	1582	29	411	8	283	5	914	17	1039	19	202	4	1039	18	5470	100
13	Khoozestan	938	27	295	9	77	2	716	21	556	16	143	4	684	21	3409	100
14	Bakhtaran	514	29	191	11	51	3	407	23	308	17	81	5	235	12	1787	100
15	Lorestan	176	18	75	8	39	4	163	17	277	30	141	15	72	8	943	100
16	Kordestan	72	15	68	14	64	14	86	18	64	14	35	8	81	17	470	100
17	Hamadan	316	27	99	9	70	6	209	18	246	21	62	5	150	14	1152	100
18	Others	719	30	193	8	121	5	505	21	407	17	121	5	336	14	2402	100
	Total (Iran)	21704	35.5	4914	8.0	3313	5.4	9196	15.0	10856	17.8	3004	4.9	8213	13.4	61200	100
	Accidental vehicle rate*	1284		14809				16220		4527						1583	

* The number of each type of vehicle involved in road accidents per 10000 number of each vehicle type existed in the country.

and long-vehicles, in Lorestan and East-Azarbayejan have had the highest percentage of involvement in road accidents.

5-10. The Comparison of Road Accidents in Different Provinces of Iran

Colonel Kianpoor, the commandant of Iran road police in his report to M.R.T.[44] declared Mashad (in Khorasan) and Robat-Karim (in Teheran), as the two regions in Iran with the worst record of road accidents.

The most important factor which shows how severe is the situation in each province, is the rate of road accidents and the rate of road casualties, not the number of accidents and casualties. Table 5-14 and Fig. 5-5 show the rates of road accident fatalities per unit of population, per average daily traffic (A.D.T.) and per comparative average daily traffic (C.A.D.T.)* in different provinces of Iran.

The rates of fatalities per different type of factor should be dealt with and be interpretated cautiously, for the reasons that will be explained. The most appropriate and reliable base of comparison for accidents and their resultant deaths and injuries in different countries or different provinces of a country, as was explained in chapter four, is vehicle-kilometre. But unfortunately this data is not available in most places of the world[52], including Iran.

The rate of road accidents per unit of population, could be sometimes misleading and when comparing the provinces or regions of one country, even less reliable than in the case of comparing dif-

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* For definition see Table 5-5.

Table 5-14

Iran Provinces' Rate of Road Accident Fatalities

Per Population and Per Traffic (Rate), 1983

No.	Province	Deaths per one million population	Deaths per 10000 A.D.T	Deaths per one C.A.D.T
1	Teheran	32	9.1	3.3
2	Central	214	66.5	20.6
3	Gillan	66	10.7	4.4
4	Mazandaran	98	16.8	10.6
5	E. Azarbayejan	50	28.1	26.3
6	W. Azarbayejan	70	39.7	14.4
7	Zanjan	226	54.3	32.5
8	Fars	58	17.0	15.8
9	Esfahan	82	20.9	20.4
10	Kerman	55	16.2	16.0
11	Bakhtaran	64	17.9	9.9
12	Kordestan	32	73.2	15.8
13	Khorasan	48	50.0	95.0
14	Lorestan	61	20.8	10.6
15	Khoozestan	50	18.6	23.1
16	Systan & B.	53	68.8	62.9
17	Hamadan	81	29.0	7.9
18	Others	86	29.4	53.1
	Iran	69	22.4	307.8

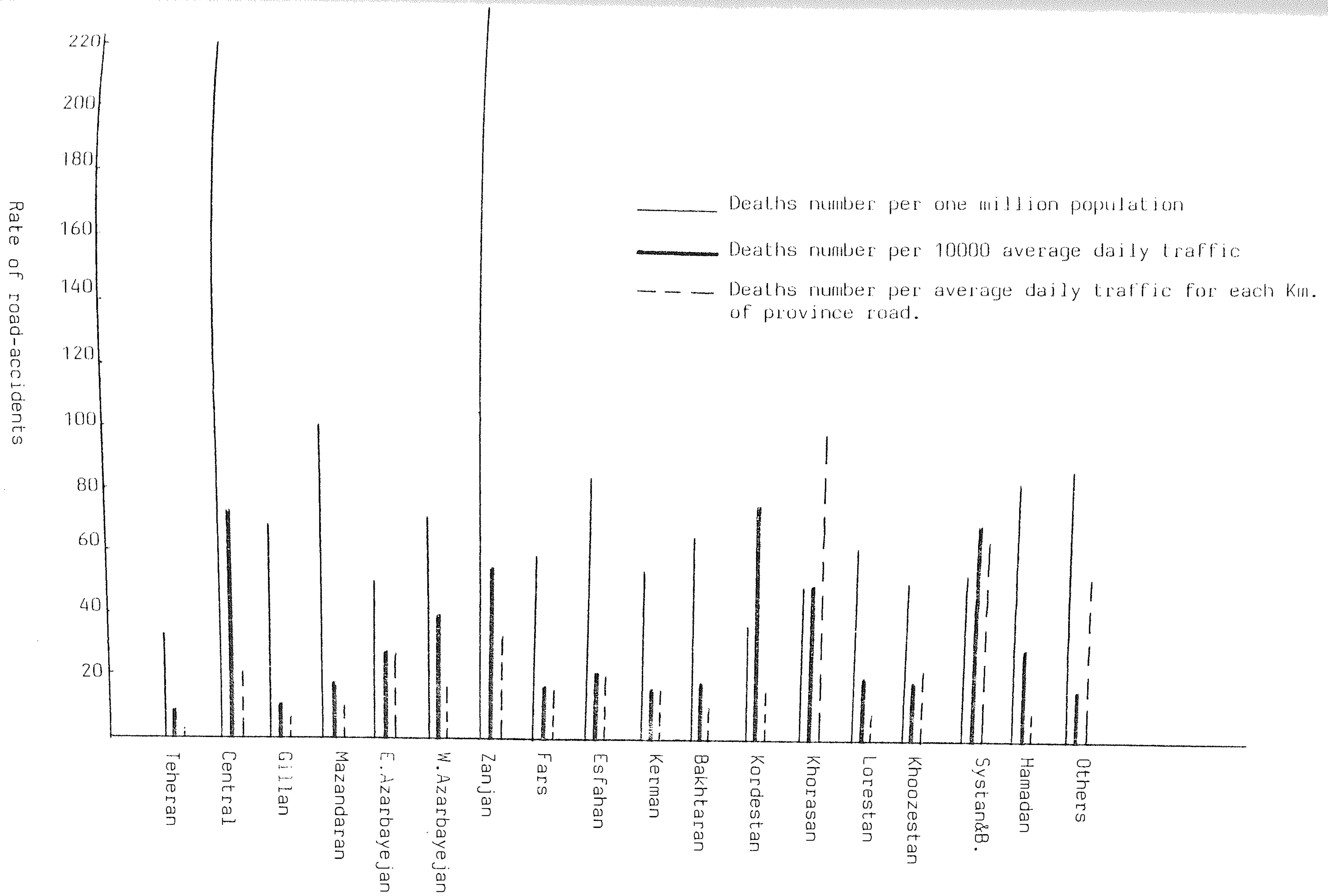

Fig. 5-5. Iran provinces' rates of road accidents.

ferent nations and countries. Because the mobility and travel of people between provinces and regions of one country is completely permitted, whereas between different countries such freedom is not usually available. This is why that in provinces like Central (which connects north-west and very important land commercial terminals from Europe to Iran), death rate per unit of population is about four times greater than average figure for the whole country, whereas the real situation is not that much worse in those two provinces.

In some provinces like Kordestan, the death rate per unit of population is low, but the rate per A.D.T. is high. In fact, it is interesting to note that Kordestan has the lowest death rate per unit of population and the highest death rate per A.D.T., in the country. This is at least partly because of lower mobility of people and low volume traffic on roads and at the same time, low level of safety standard in this remote and less developed province.

The provinces of Teheran and Kordestan, both have the lowest death rate per unit of population (32 deaths per one million population, see Table 5-14), but for totally different reasons. Teheran is the most populated province with the most educated and experienced people in the country and the highest rate of travel, but Kordestan, a remote province but its relatively small number of population, possesses one of the lowest levels of education in the country, and also because of many different social reasons, including poverty, travel much less.

Looking at the third definition of the death rate, which is death per comparative average daily traffic (C.A.D.T.) (see Table 5-8), again for the province of Kordestan, although it has the highest rate per traffic, but relatively low rate per C.A.D.T., i.e. per measure of busyness of its roads. It can therefore be concluded that although on Kordestan roads, in total there are low volume of traffic on roads, and the number of road accidents in comparison with this low traffic volume is high, but at the same time roads are relatively crowded. This means, that this deprived province does not even have enough roads to serve this low volume of traffic.

Chapter Six

The Cost of Road Accidents

6-1. Introduction

The high and rising toll of death, injury and material damage caused by traffic accidents has become a matter of serious concern both to politicians and to professionals involved in transportation planning and project appraisal. As a consequence, the authorities and planners are showing an increasing awareness of the need to evolve rational and systematic procedures for taking account of the cost of traffic accidents and the economics of safety measures.

One of the great benefits of such a cost computation is for systematic analysis of safety in highway investment appraisal. Classical methods of economic comparison of the cost of highway investments compared to the advantages it offers have been used. These are assessed on the basis of collective utility function whose parameters are most often set on the basis of individual preferences determined statistically. But the range of effects likely to arise is not fully covered yet[25].

Different research works in developed countries have estimated the effects of different projects and design features on accident rates[40], but a decision criteria of procedure which allows such effects to be weighed in relation to the other effects and characteristics of any potential project in order to decide whether or not the project should be undertaken, either has received less attention or, because of its complicated nature, has been less determined.

It is obvious that the estimates of safety effects, however, detailed and accurate, will be of little real use for project appraisal in the absence of a decision criteria for assessing the "value" of such effects.

Research works have established[12] that if the primary concern in transport project appraisal is to ensure an "economically efficient use of scarce resources*" (as is the case for example, in a standard cost-benefit analysis), then only by evolving criteria for assigning explicit (usually monetary) costs to accidents and explicit (again usually monetary) values to their prevention deserves serious consideration as a real solution. In that case safety effects can be incorporated directly into standard procedures of project appraisal. In short, if any significant components of benefit or cost are ignored in project appraisal, then this almost inevitably results in an inefficient and suboptimal allocation of scarce resources. The results of sensitivity experiences, as

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* An allocation of resources (and accompanying distribution of commodities) is said to be economically efficient if (a) no alternative allocation of productive resources would lead to an increase in the output of some commodity (or desirable end) without reducing the output of some other commodity(ies) and (b) no alternative distribution of commodities would increase the well-being of some individual without reducing that of some other individual(s).

will be examined in some examples in this chapter, indicate quite clearly that, far from being a matter of subsidiary importance, the size of accident costs and the expenses of accident prevention can (and, in most cases almost certainly will) have a marked effect both on the ranking of transport projects, in terms of net present value within mutually exclusive groups, and on the magnitude of net benefits generated by any given project.

In short, it would appear that the issue of the "appropriate" cost to associate with particular types of accidents, -or values to place upon their prevention-, is not one that can legitimately be ignored on the grounds that accident costs have little overall importance on project appraisal. They are potentially very important indeed.

At the same time, evaluation of these costs is generally accepted as being below their true level. This is caused by lack of information. Therefore, as Bridle, from the United Kingdom, suggested in the 17th World Road Congress[10] the values derived need to be kept under constant review. He mentioned that recently an independent committee in the United Kingdom recommended a 50% increase in the values for accidents used to evaluate highway investments.

The other important use of estimating and valuing the cost of accidents, is in the process of their legal and economical analysis. The last few decades have seen a rebirth of interest in accident law. In Iran, after the Islamic Revolution of 1979, the courts now investigate such cases in the full light of Islamic law (Shiaee Fegh-h, code of practice). This will be explained when evaluating the cost of road accidents in Iran. In Western Europe and in the

United States, popular reaction to the increasing costs of running a car and rising automobile insurance rates, as well as the attempt by some insurance companies to deal only with "preferred risks", has made traffic accidents and insurance controversial political issues.

As Calabres(12), established in his deep and lengthy discussion of this issue, "any failure to value the cost of accidents or even an under-evaluation of them, far from avoiding a decision, implies to leave the burden on the originally suffered party".

Also for finding ways of reduction of the accident costs, it is essential first to value them, and since any system of primary* accident cost reduction is ultimately a system for determining the de-

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* The terminology used here is that which is used in most economics text books, for dividing "the reduction of accidents' cost" into primary, secondary, and tertiary reductions.
The **Primary** reduction is the reduction of number and severity of accidents. This can be achieved either by forbiding specific acts or activities thought to cause accidents, or the activities can be made more expensive and thereby less attractive to the extent of the accident costs they cause. From these two not clearly separable but different methods, flow two very different approaches. These are "general" and "specific" deterrences, which are sometimes called "market" and "collective" deterrences.
The **Secondary** reduction method, concentrates on reducing the societal costs resulting from accidents. Compensating victims "after" the accidents is crucially important, but is called "secondary" only in the sense that it does not come into effect until after earlier primary measures to reduce accident costs have failed. This secondary method is accomplished through shifting of the accident losses either by "risk (or loss) spreading" or "deep pocket" methods. Deep pocket notion holds that secondary losses can be reduced most by placing them on the categories of people least likely to suffer substantial social or economic dislocations as a result of bearing them, usually thought to be the wealthy. The principal difference between this method and loss spreading is that this method implies that partial spreading can reduce secondary costs better than total spreading if the right people are made to pay.
Tertiary reduction cost involves reducing the costs of achieving primary and secondary cost reductions.
For further explanation and illumination refer to Ref.(12) and similar textbooks.

Table 6-1

World Bank Estimation for

Time-Price in Developed and Developing Countries*

The nature of the journey	Percentage of the average hourly wage	
	Developed	Developing
Work to work	50-100	50
Home to work	25-50	25
Leisure	0-25	0

Indeed, the concept which minimises the value of time gained or lost in developing countries, states that the value of the marginal displacement factor between income and time "θ" is low, given the relative importance of the available time "H" considered as unlimited (or tending toward infinity) in relation to the income "R". Expressing this in another way, a relative variation of the time available(dH), does not automatically result in an increase in income (dR). In fact this is true only for road users who receive a very low salary or who are unemployed. Therefore, the above minimization will receive some alleviation in the calculation of road accidents cost for Iran.

6-3-4. The cost of Pain, Suffering, Psychological Injuries and Sentimental Damages

These are elements for which there is no ready market value. One such element is pain and suffering, another is the "loss of

* The value of journey time depends on many factors, including the nature of the journey. The effect of this factor, has been tried to be considered in World Bank estimations as is shown in Table 6-1.

it may be that a wider view of the consequences of potential accidents is called for and, in a caring society, will almost certainly need to include components that take account of human suffering as well as damages.

The selection of an appropriate definition of accident costs and values of accident-prevention, therefore, appears to be crucial. This selection of a definition must take place with reference to the goals and sub-goals of overall economic and social policy of any particular community.

As far as the planners in their project appraisals are concerned, four broad classes of objectives are identified as follows:

1- "National output objectives", such as maximisation of Gross National Product (G.N.P.).
2- "Macro-economic objectives", such as maximisation of the level of employment, minimisation of the rate of inflation, etc.
3- "Social welfare objectives".
4- "A mixture of the first three objectives"- this is the objective normally used.

For more simplicity in the majority of cases, two broad classes of overall objectives, i.e. either national output objectives, or the rather wider class of social-welfare objective, are the ones used. It will be seen in this chapter that for every particular objective, the definition and valuation method is different.

The approach for defining and valuing the road accident costs may be based on either "general deterrence" or "specific deterrence" methods, (for definition see footnote on page 282).The aim of general deterrence is to let individuals, acting through the marketplace, decide which acts or ativities to forego because of the accident costs they cause. The ideal general deterrence solution to the "what is the cost" question would be to have a market in accident victims. If people were willing to offer their persons and properties to be injured or destroyed for a price, we would have a pure market determination of the value of accident costs. Such a market does not, of course, exist in any meaningful sense. The aim of general deterrence, therefore, will be to value accident costs in a way that is as near to the market way as possible, and the collective decisions under general deterrence will take account of individual valuations as much as possible. Also in this method, cost valuations, where no market valuations are available, will rely on what market valuations exist elsewhere.

There are uncertainties in both approaches (general and specific), but if each approach is sufficiently modified, the distinction will not be worth making. This will be considered in each individual component of road accident costs in the following section.

6-3. The Components of Road Accident Costs

Six major components which comprise road accident costs, are distinguished in this research work. These are as follows:

1- The costs of destroyed or damaged objects with a market value.

2- The costs of physical injuries (excluding permanent disabilities).

3- The cost of time wasted in road accidents.

4- The costs of pain, suffering, psychological injuries and sentimental damages.

5- The costs of lives and permanent disabilities.

6- The costs of administrative expenditures.

Each major component is essentially a direct or indirect cost and each has sub-divisions. But first it is necessary to examine the major components.

6-3-1. The Costs of Destroyed or Damaged Objects with a Market Value

The essential cost valuation deals with damage of those objects that have a fairly definite market value. Generally speaking, this is the area of property damage. Since cars are bought and sold on the open market, the lack of a supply of cars to be given as "victims" of accidents, does not matter as it is straightforward to extrapolate from the value given to cars in market transactions to their value in accident situations. This is always the case with property that is not in some sense unique.

The object is to arrive at a close approximation of the value the market would have given to the destroyed object in a free buy-and-sell transaction*, and the value the market gives to repair

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* In the specific case of Iran in recent years, the heavy burden of war expenses and falling of the oil prices, have caused more or less some shortages in most commodities. This has caused great differences between the official rate of exchange of the Rial (Iran currency), and other strong foreign currencies in the world. This difference (up to ten times) is not only for indivi-
cont. in the next page

the damages. The more something has a market equivalent, the easier it is to rationally contemplate its destruction. Here, some technical difficulties in their pure economical meaning, such as "how to use depreciation figures for extrapolation" or "how to deal with the individual's attachment to specific items of property", which are outside the scope of this research work as long as they do not harm the anticipated accuracy, will be neglected.

6-3-2. The Cost of Physical Injuries (Excluding Permanent Disabilities)

The problem of finding adequate valuation of physical injuries is a complex one. There are elements in most physical injury situations that can be valued reasonably well by extrapolating from market values determined in non-injury situations, e.g. working hours lost. There are also elements that can be valued in a market way, because they can be satisfactorily repaired. And the costs of repairs (such as medical expenses[(64)]) are, on the whole, good market indications of their minimum value. However, elements for which there are no ready market values, and virtually all are included

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Footnote, cont. from the previous page
duals on the black market, but also recently for the government. For many export and other transactions it sells the foreign currencies that have higher prices, and this is called "preferential" prices. In accordance with the currently imposed Central Bank regulations, individuals bringing foreign currencies from abroad into the country, can also sell them on the free market.
This situation has caused a double price system, which are called the "state price" and the "free price". The Central Bank of Iran, for evaluation of the yearly rate of inflation, has adopted a combined system of taking care of all these different prices. These will be discussed in the next chapter.

in physical injury situations like "pain and suffering" or "loss of dignity", will be discussed later.

6-3-3. The Cost of Time Wasted in Road Accidents

In this sub-section only the cost of time wasted in road accidents is considered. The cost of working hours lost due to injuries are included in sub-section 6-3-2. Also the cost of administrative post-accident times will be discussed in sub-section 6-3-6.*

The calculation of the value of people's time is complicated, and there is no unanimity about rules to be adopted. It totally depends on the individual person and the economic situation of the community in which he or she lives.

In the case of developing countries, usually the price of time, either in highway investment cost-benefit appraisals, or in calculation of the cost of time-consuming events (like accidents), is often ignored. This is mainly because of "the importance of unemployment" in these countries(13). But as will be examined here, the behaviour of road users in developing countries, in a cost-benefit study of highway investment, connot be treated as something different. For road users in these countries, the value they give to time savings is invariably calculated on a wage or individual remuneration basis, for the same reasons as those of road-users in developed countries. Nevertheless, the importance given by road-users to their own time must also be take into account. This is to allow for their behaviour, and can be concluded from a road-user's "rational behaviour" in selecting the least time-consuming road for travelling

* The cost of delays to other users of facility is also included in this part.

between points A and B. This rationalization also means that he or she will try to use the time saved in the best possible way, and increase 1) output, 2) consumption, or 3) leisure. The degree of such "rational behaviour" depends on the amount of individual capability of carrying out an evaluation of, and a comparison between, the different possibilities available.

The method selected as the theoretical basis for the evaluation of the cost of time wasted in road accidents, is the one developed by Noureddin[54], and presented to the 17th World Road Congress in Sydney in 1983. First a short explanation of the theory is presented and then important issues in this relation will be discussed.

6-3-3-1. The Theoretical Basis for Evaluating the Cost of Time

The argument is based on a road-user's model of behaviour. His or her satisfaction is defined by a utility function "U", which depends on his or her consumption schedule of the various goods XK(K=1...n) and his or her leisure time, "L".

$$U=U(X1...Xk...Xn,\ L)$$

In addition if "T" is the quantity of time devoted to work by the consumer, P1...Pk...Pn... the value of economic goods and "W" the wage rate, the budget is expressed as follows:

$$\sum_{k=1}^{n} Pk.Xk=R'+WT=R$$

("R′" non-salaried income, "WT" total salaried income and "R" total income).

Which means the whole income is expended on consuming "n" above-mentioned goods.

In the same way the time limit can be expressed in a mathematical argument. The consumption of the various goods takes time. Suppose "t" is the time necessary for the consumption of a series of goods "k". The total time at the consumer's disposal is limited to "H". Thus the time limit equation can be expressed as follows:

$$H = \sum_{k=1}^{n} tk.Xk + L + T$$

Solving the two limit equations for the "optimum" condition* results:

$$\lambda = \frac{\partial U}{\partial R}, \quad \omega = \frac{\partial U}{\partial H}$$

Where "λ" is the marginal utility of income,

"ω" the marginal utility of time

∂U= differential of total utility

∂R= differential of total income

∂H= differential of total time.

If the wasted times in road accidents are supposed to be compensated by their "right values", then the consumer's total utility should be constant, i.e. dU=0, which results:

$$\theta = \frac{\omega}{\lambda} = \frac{-dR}{dH}$$

Where "θ" is the marginal displacement factor between income and time, that is to say the supplement of income which should be allocated to the individual to compensate for a loss of available time equal to "1".

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* For detailed calculations see Ref. (54)

6-3-3-2. Important Issues in the Evaluation of the Cost of Time

There are some important and basic issues in evaluation of the cost of time that must be considered carefully. These are as follows:

1- In some countries (like Great Britain and the United States), it is thought that the average value attributed by road users to time saving, or lost to time wasting, varies with the motives for the journeys, according to whether it applies to journeys during, or outside, working hours. In other countries (such as France and Belgium) one value is only considered[(13)].

2- A distinction must be made between the value attributed by road users (individual value), which directly reflects their behaviour, and the value attributed by the state which is a value that represents benefits for the whole community (non-road users included), which is usually used in highway investment project appraisal.

3- The individual value is related to each one's level of income. In developing countries, this level of income is usually related to the average hourly rate of pay in these countries. Variable coefficients are applied as well according to the motives for the journey.

4- In World Bank projects' appraisal, estimates are based essentially on values adopted by other countries, providing adjustments as to the income index per person (PIB/person).

5- In the process of evaluation of the time gained or lost, sometimes there is a distinction between individuals in charge of heavy vehicles, working as professional drivers, and users of light vehicles.

As regards the category of persons who are "professional drivers" and who are generally engaged in the driving of heavy vehicles, then the relationship is very close as the time gained or lost corresponds directly to the wage. Conversely, in the case of non-professional drivers, this relationship is less appparent.

6- In most developing countries including Iran[35], there are appreciable disparaties between the level of incomes. This is especially considerable between wage earners (workmen and employed), and non-salaried people (self employed). This difference amounts to one or two times in Algeria, Morroco, Tunnisia[54] and 4 to 5 times in the case of Iran[35]*. Therefore the index mentioned in "3" above (PIB/person) in such places needs some modification. Clearly it is more logical to allow for an average figure between the salaried-incomes and non-salaried remunerations rather than the average salary or the income index per person.

7- A study by the World Bank[13], carried out on the question of time saving (or lost), indicates two different criteria for developed and developing countries as shown in Table 6-1, below:

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* It is worth mentioning that in Iran with a high inflation rate, the difference is becoming wider. At the same time, the average direct tax on an employee's salary is about 10-15%, whereas the average direct state tax on a self-employed remuneration is only 2-3% (16).

Table 6-1

World Bank Estimation for

Time-Price in Developed and Developing Countries

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Home to work	25-50	25
Leisure	0-25	0

Indeed, the concept which minimises the value of time gained or lost in developing countries, states that the value of the marginal displacement factor between income and time "θ" is low, given the relative importance of the available time "H" considered as unlimited (or tending toward infinity) in relation to the income "R". Expressing this in another way, a relative variation of the time available(dH), does not automatically result in an increase in income (dR). In fact this is true only for road users who receive a very low salary or who are unemployed. Therefore, the above minimization will receive some alleviation in the calculation of road accidents cost for Iran.

6-3-4. The cost of Pain, Suffering, Psychological Injuries and Sentimental Damages

These are elements for which there is no ready market value. One such element is pain and suffering, another is the "loss of dignity" caused by such things as a scar or missing limb, even where the loss involves no physical pain.

The object is to monetize the nonmonetizable, thus enabling market choices for or against accident-causing activities to be made.

The problem here is that since general deterrence* operates through the market, it must seek to give things money values, but money values are not necessarily adequate representation of these types of damages. In a pure economical term, it is said "there is no adequate supply side to the accident victim market".

How then are these elements to be valued? Essentially there are two possible approaches. They are briefly discussed here, but each has complicated advantages and disadvantages, which are outside the scope of this research work.

1- the first possibility is to derive from bargaining situations, market valuations of the risk of such damages which could then be applied in non-bargaining situations. For example, assume there is a difference between the wages of two different groups of workers. They do exactly the same work and possess the same qualifications and skills. But the workers in group one, are exposed to a five per cent danger (one from each twenty workers) of suffering a certain pain for the rest of their life if they work for ten years in their working atmosphere. If the workers

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* See footnote on page 282 .

in both groups are assumed to have perfect mobility freedom to change their jobs between the two groups, then it is possible to conclude that any wage difference between the two groups is due to the difference in risk of suffering from that certain pain. Then from the different risk figures and the wage differential, the market value given in that bargaining situation, to a severe human sufferer, can be derived.

2- In the second approach it is recognized that no adequate direct extrapolation can be made, from those few market values available and therefore seeks to make, by a collective judgment, a guess as to what value a true market would give to various injuries.

In general, the aim of both methods in theory is to arrive at the amount that the actual injured party, had he or she been properly and fully aware of the risk, would have received in exchange for bearing that risk.

All these efforts involve elements not fully convertible into money, thus any device which converts them into money, will not be fully adequate. Nontheless, in practice some valuations of their cost is inevitable.

The difficulty of exercising such a valuation is because of the uncertainties that exist. These are mostly based on:

1- Individuals differ in reaction to pain and suffering.

2- Average or scheduled figures on pain and suffering rarely exist and are not likely to be accurate.

3- The people's reactions to taking risks before and after accidents are different. Since they do not care about the real danger (especially in developing countries with generally a low standard of education), they would mostly contract away their rights to such compensation in exchange for payments for bearing the risk before the accidents.

It can be concluded therefore, that as far as the cost of road accidents are concerned, the problem of nonmonetizable costs, though substantial, is not unmanagable.

6-3-5. The Cost of Lives and Permanent Disabilities

The discussions and conclusions in sub-section 6-3-4, are valid here too. But in this subject there are more practical solutions, which will be discussed in this sub-section.

Here, again converting nonmonetizables into money terms is, after all, simply a convenient way of reducing different items to the same scale of values, so that they can be compared and values chosen.

Monetization is necessary to any market choice among the different items and the comparison must be made if an intelligent collective decision is to be obtained. Regardless of whom bears the burden of the losses of the accidents, "so long as it is not the victim", an evaluation of his or her loss must be made in order to remove it from the victim.

It is accepted however, that human life is not something to be valued in money terms. Some people even go so far as to argue that it is morally repugnant to attempt explicit evalution of the safety of human beings. But it will be shown here that any decision by governments. for or against the projects which are in any kind related to safety, means putting a value on human life. This is highlighted by introducing the concept of "implicit value of accident avoidance" or "implicit value of life". This can be best explained by an example:

Suppose that a planner must choose one of the two alternative projects, which, for simplicity, are taken to have identical capital costs, but which differ in their anticipated effects on accident rates and vehicle operating cost savings. Specifically, assume that the projects have the following characteristics, outlined in Table 6-2.

Table 6-2

Characteristics of Two Mutually Exclusive Projects

Project Name	Capital Cost	Net saving in Annual Operating Cost	Expected Reduction in Fatalities per Annum
Project A	£ 10M	£ 1000000	2
Project B	£ 10M	£ 250000	17

A planner who opts for projcet A, clearly reveals an implicit value of life, less than £50000, simply because by rejecting B in favour of A, he implicitly indicates that the additional fifteen lives saved per annum under B, are "not worth" the loss of £750000 savings in annual operating cost relative to A. Conversely, selection of projcet B, reveals an implicit value of life of "at least" £50,000.

Using this kind of reasoning it is possible, by examining past decisions for and against projects or legislations with different potential safety effects, to place upper and lower bounds on implicit values of life and safety.

Consistency in the treatment of accident effects in the past decisions, requires that such implicit values should have broadly similar orders of magnitude. But studies in the United Kindgom* and in the United States**, indicate grossly inconsistent implicit values of life in the past decisions affecting safety. The upper and lower bound of implicit values for life in the United Kingdom in the past decisions, is between £1,000 and £20M***. The sense in which this inconsistency implies inefficiency in the allocation of scarce resources can be seen most clearly by noting that a straightforward transfer of resources from some projects to other ones, on balance, saves lives at no additional cost.

Thus, any decision for or against a project that has significant safety effects necessarily places an upper or lower bound on the relevant implicit value. Therefore, anyone who argues that the explicit valuation of life or safety is not

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* See Card and Mooney (1977).
** See Carlson (1963).
*** £1000 is related to a decision not to legislate for the child-proofing of drug containers, and £20M is related to a decision in applying stringent safety standards to high-rise apartments.

feasible, warranted, or moral, must face the fact that even if safety effects are not explicitly valued, some form of implicit valuation is unavoidable.

6-3-6. The Cost of Administrative Expenses

It is well known that the handling of after-accident legal procedures and compensation of the victims always represents administrative expenses. The most important are the cost of police administration and the cost of the legal system -whatever it may be - and insurances. More generally, these are the expenses of deciding liability and evaluating damages. There is nothing especially difficult about the valuation and allocation of these administrative costs, which in theory can be reduced to monetary values. But while they do not involve many items that are theoretically nonmonetizable, they include some types of costs, that in practice, are very hard to value (e.g. what would be the cost of getting the judges needed to eliminate the court congestion that results from accident cases?). Nevertheless, most of what has been said about accident cost valuations is applicable here, including the relevance of the expense of valuing them and the relative merits of collective market prices.

One important point should be clarified here again. Those parts of the administrative -and for that matter- any other costs, which are for improving safety and preventing road accidents, are not considered as accident costs, although it can be argued that if there were not the accidents, there would not be the safety expenditures.

But because of the reasons mentioned before in this research work, when it is said "the cost of road accidents", it does not mean "the cost of road accident preventions", but it means the cost of road accidents. For example, those parts of the highway police patrol costs, which are for traffic control and other safety measures, will not be included in the calculations of the cost of road accidents in this research work. But those costs which are related to post-accident investigations will be included.

6-4. Why Evaluate the Cost?

(Possible Procedures for Taking Account of the Safety Effects Cost and Road Accidents' Cost)

As was explained in previous sections of this chapter, in most developing countries the cost of road accidents is totally ignored. In some other countries like Iran, the safety effects in projects' appraisal are not totally ignored, but equally, there cannot be observed any attempts of any kind for explicit evaluation of these effects and cost, relying instead upon an "informal weighing" of such effects based upon "educated good sense" and judgement. This informal judgement might either be that of the planner himself, or alternatively, of the relevant politician or government department. For instance, in the case of Iran, in which the author was a member of M.R.T. High Technical Advisory Committee, from 1983 to 1985, this type of decision making is well observed. This Committee has a weekly meeting, in which almost all high level M.R.T.

technical responsible persons, including most Minister's deputies and advisors, attend. There are not any pre-evaluations of safety effects to be brought into the committee's meetings, but instead the committee makes its recommendations to the Minister, based on general information supplied and its member's knowledge and experiences. The final decision to "accept" or "reject" a project, is made by the M.R.T. Minister. Of course, this decision is affected by budget limitations imposed by the Parliament (which is called Majless), and also outside political and social pressures, especially ones of the Majless members and its road and transport committee.

This type of decision-making and some other usual methods, as will be discussed in this chapter, lead to inconsistency and inefficiency. There is only one method, which is the solution to this problem, but different possible methods of approaching this subject will be discussed first.

There would appear to be five different reasonably sensible approaches for taking account of the cost of road accidents in project appraisal, and other decision making criteria, as follows:

6-4-1. To Ignore the Estimates and Valuations

This is to ignore the estimates and valuations, on the ground that there is no obviously "correct" way to evaluate safety-effects and especially the value of human life.

This means that because it is not possible to make a correct evaluation of the cost, completely neglect it! It was explained in sub-sections 6-3-4 and 6-3-5, that this cannot be justified as a wise and reasonable argument. To the extent that these effects are beneficial, the projects' appraisal will tend to be undervalued, and where harmful, overvalued. It was shown in earlier parts of this chapter, that if any significant components of benefit or cost are ignored, then this will inevitably result in an inefficient and suboptimal allocation of scarce resources, and make the accidents' victims bear the costs.

6-4-2. To Rely on Informal Weighting of Effects

This is not to ignore the estimates, but equally not to attempt any kind of explicit evaluations, (as was explained for the present situation of decision-making in Iran), but instead, rely on informal weighting of the effects, based on the decision makers' personal judgements and rough evaluations.

Serious potential limitations as a means of achieving allocative efficiency, because of leaving the assessments to informal judgements, are inevitable in this approach.

The serious inconsistency in the treatment of effects and costs, between different planners, are well observed in places like Iran. The author's experiences as the Planning Deputy to the Governor-General of Iran's biggest province (Khorasan), Executive Deputy to the Managing Director of The Port and Shipping Organisation of Iran (PSO), and Planning Deputy-Minister in M.R.T., made it quite clear that by changing authorities and decision-makers in high-level positions, the tastes and judgements are changed, and the efficiency is changed. Thus, empirical evidence confirms a priori expectation that leaving the assessment of safety effects and accidents' cost to informal judgement is likely to lead to serious inconsistency and allocative inefficiency.

6-4-3. To Base the Decision Upon Legally or Conventionally Imposed Safety Standards

Under this approach, there would effectively be a prior "screening-out" of projects that failed to meet the specified safety standards. Thereafter, however, safety effects would effectively be ignored in the comparison of those projects judged to be "acceptably safe".

While this is an apparently straightforward way of solving the problem, safety standards suffer from two very serious limitations:

1- Their use begs the vitally important question of the criteria on which such standards should be set and from whose point of view.

2- The use of safety standards takes no account of the cost of meeting such standards, which can vary widely with circumstances.

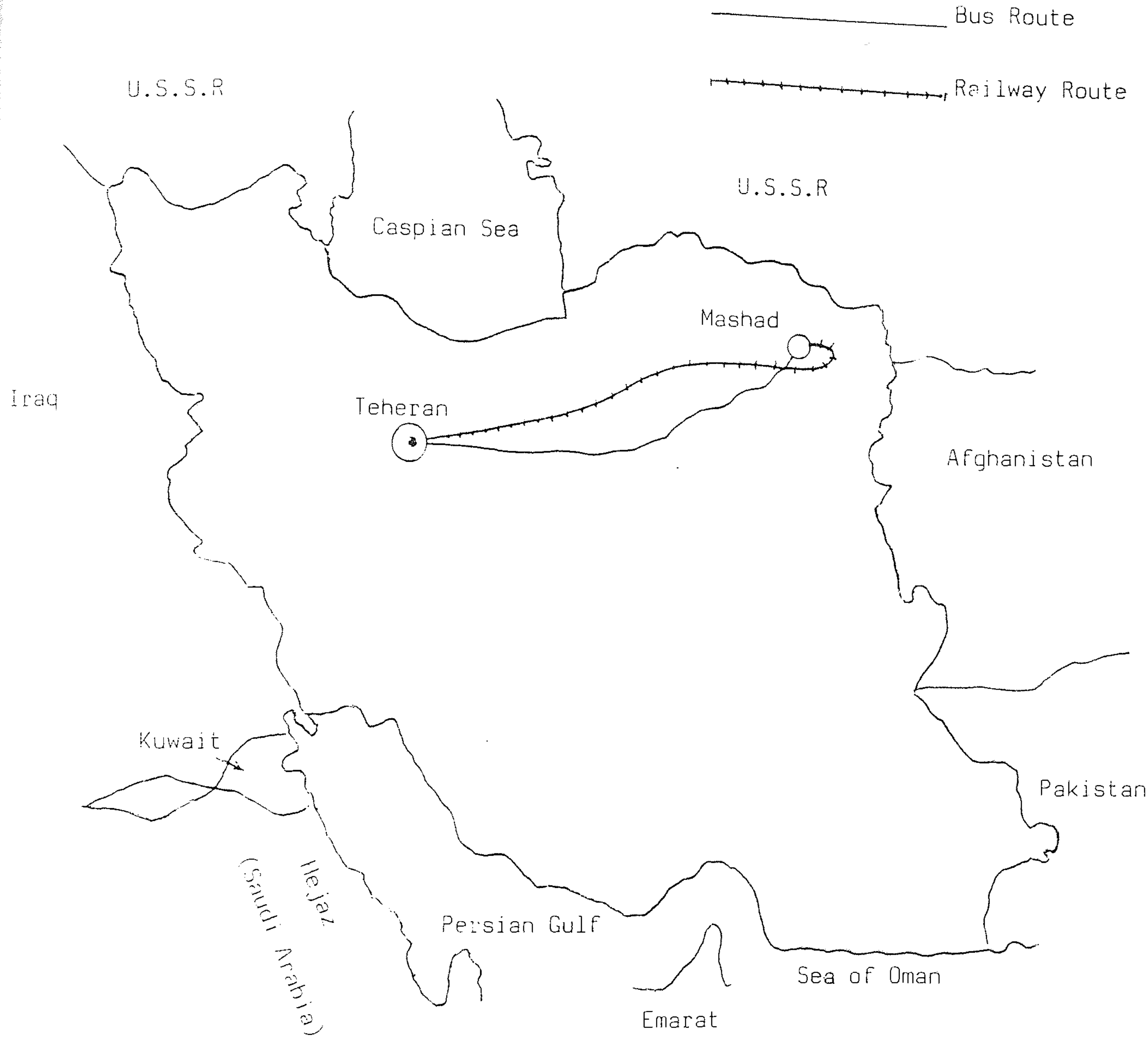
3- The imposition of a uniform safety standard, involves a serious inconsistency of valuations. This point is explained through a simple but illuminating example:

Suppose the government of the Islamic Republic of Iran, is deciding its policy on safety of inter-urban public transport. The country's two major cities, i.e. Teheran (the capital with almost 7 million population) and Mashad (the centre of Khorasan province, the second largest city with the population of approximately 2 million, and situated in the north-east of the country), are linked by parallel public transport modes -trains and buses- (see sketch 6-1). Each has approximately equal annual passenger loadings of 800 x 10^6 passenger-kilometres, (the distance between the two cities is approximately 1000Km., and each year nearly 400,000 passengers travel between them by each mode, i.e. trains and buses. Therefore, 400,000 x 2 (for return journey) x 1000 $\simeq$ 800 x 10^6 passenger.Kms.).

In 1983, the annual fatality rate for the buses is assumed to be 0.2 deaths per 10^6 passenger.Kms*, while the corresponding rate on the rail-ways was ten times less, i.e. 0.02 deaths per 10^6 passenger-Kms.

Now, suppose that the annual cost of reducing these fatality rates to various levels has been estimated as shown in Table 6-3 below:

* As was explained in chapters three, four, and five, the fatality rates per vehicle-kilometre and per passenger-kilometre, are not available in Iran, but the figures presented in this example are purely to illustrate a point and can be looked at as acceptable approximations which are derived from the author's long experience in Iran's road and transport sector.



Sketch 6-1. The two transport roads between Teheran and Mashad.

Table 6-3

Assumed Costs of Reducing Fatality Rates on Two Transport Modes Between Teheran and Mashad

Mode of Transport	Fatality Rate per 10^6 P.Km.	No. of Fatalities P.a.	Annual cost of reducing fatality rates £ 1000
RAILWAY ROUTE	0.020	16	Nil
	0.015	12	90
	0.010	8	240
	0.005	4	440
BUS ROUTES	0.20	160	Nil
	0.10	80	1000
	0.05	40	2200
	0.04	32	2700
	0.03	24	4160
	0.02	16	4600
	0.01	8	6100

At this stage, the government has decided to impose a uniform safety standard on the two transport modes and, since each involves approximately 800 million passenger-kilometres per annum, this implies an equalisation of both the numbers and rates of fatality. The level selected is 0.02 death per 10^6 passenger-Km., on each mode, i.e. bringing the safety level for buses up to that of the trains at an annual cost of £4,600,000.

If now the value of accident prevention implied by the situation on the railway is considered, it will be found that this must be less than £22,500 per fatality, because whereas the government was willing to spend up to £4,600,000 per annum on improving the bus system (to achieve a fatality rate of 0.02 rather than 0.20), i.e. spending up to £32000 for saving a life in bus transport mode, it was apparently not willing to spend an additional £90,000 per annum to reduce the rate on the railway from 0.020 to 0.015, i.e. spending £22,500 for saving a life in the rail transport mode.

Suppose however, that the govenment could be persuaded to abandon its absolute safety standard and simply transfer £440,000 of its annual safety budget from buses to trains. The comparison of the results in each decision is shown in Table 6-4. These results clearly show that by relaxing absolute safety standards, the government could save 4 extra lives at no extra cost. The use of safety standards in this case, and the consequent inconsistency of implicit valuations of accident prevention, can therefore be seen in a real sense.

It should be noted that this would not be so if the government were to apply a uniform valuation of accident prevention rather than a uniform safety standard.

If it is argued that the real justification for applying uniform safety standards lies in considerations of equity and fairness, such arguments might be answered in the following ways:

1- It will not be inequitable to seek an allocatively efficient arrangement with accident rates of 0.005 in railways and 0.030 on the

Table 6-4

The Comparison of Safety-Fund Spending in

Keeping or Relaxing Absolute Safety Standards

The two modes of transport and total results		Keeping absolute safety standard of 0.02 fatality per 10^6 pass. Km	Relaxing absolute safety standard and transferring £440000 of the annual safety budget from buses to trains
TRAINS	Budget spent (in 1000)	Nil	440
	Rate obtained	0.02	0.005
	Lives saved	Nil	12
BUSES	Budget spent (in 1000)	4600	4160
	Rate obtained	0.02	0.03
	Lives saved	144	136
TOTAL	Budget spent (in 1000)	4600	4600
	Rate obtained	0.02	0.005-0.03
	Lives saved	144	148

buses and give the passengers freedom to choose the mode on which they travel.

2- While equity is undoubtedly an important consideration, it is not usually taken to predominate over efficiency.

6-4-4. To Use Some Form of Cost-Effectiveness Analysis

Basically, cost-effectiveness analysis attempts to maximise the extent of achievement of a particular desirable goal or objective within a prespecified budget or, equivalently, to minimise the expenditure needed to achieve a prespecified goal.

If it was the case that overall road safety expenditure was predetermined, and if, in addition, the problem was simply to allocate this expenditure amongst competing schemes, each of which affected nothing but safety, then cost-effectiveness analysis, would undoubtedly be the appropriate tool of analysis. It would be simple to rank the schemes in terms of cost-effectiveness and then, starting with the most cost-effective project, work through the list until the budget was exhausted. However, there are two serious limitations which make this method of restricted use as a general solution to the problem as follows:

1- Cost-effectiveness analysis provides no indication of the appropriate size of the safety budget.

2- Cost-effectiveness analysis ceases to provide an answer to the problem of project selection whenever projects provide more than one kind of benefit, with the "mix" of benefits differing between projects. In such circumstances some common unit is required with which to weight or aggregate benefits, and this is precisely what cost-effectiveness analysis does not do. This is in marked contrast to cost-benefit analysis which will be explained in sub-section 6-4-5 and is the only solution to this problem.

To highlight the restrictions explained above, consider a situation in which a transport budget of one million sterling pounds must be spent on one of the two mutually exclusive schemes, each of which precisely exhausts the budget, but which would yield the following "mixes" of operating cost savings and safety effects, as shown in Table 6-5:

Table 6-5

Characteristics of Two Mutually Exclusive Schemes

Scheme Name	Capital Cost	Total savings in operating-cost	Expected Number of serious injuries avoided
Scheme A	1.0M	999990	2
Scheme B	1.0M	990000	200

With a predetermined budget, it might seem that cost-effectiveness analysis could be used to decide which scheme to adopt by comparing the "net" cost (capital cost minus operating cost savings) per serious injury avoided for each of the two schemes. For scheme A this would be £5.00, while for scheme B it would be ten times more, i.e. £50.00. Scheme A is, in this sense, more cost-effective than B. Should scheme A therefore be adopted? Suffice it to note that anyone who recommends the adoption of A is effectively committed to the view that 198 additional serious injuries avoided under B are not worth the loss of £9,990 of operating-cost savings. Surely, few people would subscribe to that argument.

Cost-effectiveness analysis nevertheless, does have a valuable role to play in ranking different road design features when their sole effect is to improve safety. However, it should be stressed that once the most cost-effective safety features have been incorporated into the design of potential road-projects, the final selection of projects typically offering a range of benefits in addition to safety cannot be handled by cost-effectiveness analysis.

6-4-5. To Evolve Criteria for Assigning Explicit Costs to Accidents and Explicit Values to Their Avoidance (Cost-Benefit Analysis)

If the primary concern in transport project appraisal is to ensure an "economically efficienct use of scarce resources", then only this fifth approach deserves serious consideration. Also, if the primary concern in the legal process of accidents is to compensate the victims in a real sense, then only this approach can be sought as the real solution.

All other approaches are likely to lead to inconsistency and inefficiency in a situation in which a straightforward reallocation of resources, "at no extra cost overall", would avoid deaths and reduce injuries.

The key question is then how such costs and values are to be defined in principal and estimated in practice? This will be explained in the following section.

6-5. How to Evaluate the Cost?

(Different Methods of Defining the Cost of Road-Accidents, Their Implication for Project Appraisal and the Best Method for Developing Countries)

6-5-1. Different Methods Proposed

At least six different methods have been proposed [26] for defining the cost of accidents or the value of accident-prevention in general (and traffic accidents, in particular), as follows:

1- The "gross output" (or "human capital") approach

In this method the cost of a traffic-accident is the sum of real resource costs (such as vehicle damage, medical and police costs) and the discounted present value of the victim's future output. In some variants of this approach a significant sum is added to the output loss and resource costs to reflect the "pain, grief and suffering" of the accident victim and those who care for him or her.

Estimates of "gross output" costs and values are usually based on average output or earnings data together with appropriately estimated damage, medical and police costs as was explained in detail in the preceding section of this chapter.

2- The net output approach

This differs from the first approach only to the extent that the present value of the victim's future consumption is subtracted from the gross output figure.

3- The life insurance approach

This is when the cost of an accident, or the value of accident-prevention, is directly related to the sums for which "typical" individuals are willing to insure their own lives. This approach in places like Iran and most other developing countries where the people do not realize the importance and real value of their safety (as was discussed before), is less applicable.

4- The court award approach

In this approach, the sums awarded by the courts to the surviving dependents of those killed, as a result either of crime or of negligence, are treated as indicative of the cost that society associated with the accident or the value that it would have placed on its prevention.

As explained before, after the Islamic revolution of 1979, the code of practice for all judicial cases in Iran's courts is the Islamic code of practice (Shiea, Fegh-h*). In this code the amount of compenstion in cases of both crime and negligence, are clearly defined. As this part of the discussion will have a determining importance in the calculation of the cost of road accidents in Iran,

* Footnote next page.

a real case judged by an Islamic court will be translated and discussed in the next chapter.

5- The "implicit public sector valuation" approach

In this approach an attempt is made to determine the costs and values that are "implicitly" placed on accident prevention in safety legislations or in public sector decisions taken either in favour or against investment programs that affect safety.

Implicit costs and values are estimated along the lines described earlier in this chapter.

Footnot from previous page:

* "Fegh-h", is the name of the code of practice for Muslims in all their different aspects of life, and even before birth and after death. "Shiea", is the name of a branch of Islam, in which 95-96% of Iranians believe. "Shiea, Fegh-h" which is believed to be the order of God for the human way of life, is derived from four fundamental sources. These are:
  1- "Ghoran", the Muslim's holy book.
  2- "Sonnat", the way of life of the prophet Mohammad and 12 holy Emams (the prophet successors).
  3- "Edumae", the unity of verdicts among who derive Fegh-h.
  4- "Wisdom", which takes account of the special necessities of each age and epoch, for the well-being of Muslim's societies.
  The ability of deriving Fegh-h from those 4 basic sources of information is called "The ability of Estenbat", and is gained usually after 30-40 years of studying, lecturing and practising in special theology schools. Those who gain this ability are called "Faghih".** Among "Faghihs", very few are distinguished as "the most well-informed" and are called "Marjae or Marjae-e-Taghlid". Emam Khomeini, the leader of Iran's Islamic revolution, for example, is one of the "Marjae"s, in the Islamic world.

** or Ayatollah

6- The "willingness to pay" approach

This is founded on the fundamental premise that allocative decision-making in the public sector should reflect the interests and wishes of those individual citizens who will be affected by the decisions. Accordingly, the value of safety improvement is defined in terms of the amount that people are willing to pay for it, the cost of a deterioration in safety being defined as the amount people would require in compensation for the increase risk.

6-5-2. The Implication of Different Accident Costing and Evaluation Methods for Project Appraisal

There are not enough estimates, or data available, in developing countries to be able to make a judgement about the implications of different accident costing and evaluation methods for project appraisal in those countries. But from available estimates in developed countries, two points are well established:

First: The different methods yield significantly different numerical costs and values.

Second: To the extent that significant differentials emerge, such differences "matter" for project appraisal.

For the first point, some estimates from developed countries, related to the cost of one statistical fatality*, is presented in

* A situation in which a number of people are exposed to independent increments of risk, such that the expected loss of life is one, is said to involve one "statistical fatality". Thus, for example the exposure of one million people to an incremental risk of death of 10^-6 each, involves one statistical fatality.

Table 6-6. For the second point, any of thousands of project appraisals in which the valuations of accidents' costs has had a definite effect, can be considered.

6-5-3. The Relation Between Different Valuation Methods and Different Planners' Objectives

In section 6-2 four broad classes of various objectives for the cost evaluation in project appraisal was explained. Also, in sub-section 6-5-1, different methods for defining the cost of traffic-accidents were observed.

The use of each of the methods for each of the objectives, or any combination of methods for any combination of "mixed" objectives, possesses its own advantages and disadvantages. The complete results are summarized in Table 6-7. These results suggest that, in selecting an appropriate accident costing (valuation) method, planners and politicians in any particular developing country must first ask themselves whether their economic and social objectives are more closely approximated by G.N.P maximization or by the wider goal of social welfare maximization?

If the former is the case, then matters are fairly clear cut in that average output or earnings data- suitably modified to take account of factors such as unemployment rates, - together with data concerning the damage, police, and medical costs of accidents, will provide the basis for estimating the cost of traffic accidents of varying severity and the value of accident-prevention.

If however, the wider goal of social welfare maximization is

Table 6-6

Estimates of the Cost of a Statistical Fatality by

Different Methods Explained in 6-5-1, for Developed Countries*

No.	Costing/Valuation Method	1988 Dollar*** Conversion.	Cost(Value) of one Statistical Fatality for specified year.
(1)	**Gross Output Approach:**		
1-1.	Including subjective components: Dawson [1971]	200,000	$ 120,000.00
1-2.	Including subjective components, but increased 50% and with reduced discount rate applied: U.K. Department of Transport [1979]	300,000	$ 225,000.00
(2)	**Net Output Approach:**		
2-1.	Excluding subjective components: Reynold [1956]	75,000	$ 25,000.00
2-2.	Including subjective components: Dawson [1976]	115,000	$ 76,000.00
(3)	**Life-Insurance Basis:**		
3-1.	Fromm [1956]	2,800,000	$ 930,000.00
(4)	**Court Award Basis:**		
4-1.	Abraham and Thedie [1960]	220,000	$ 83,000.00
4-2.	Shepherd [1974]	1,600,000	$1,000,000.00
(5)	**Implicit public sector valuation:**		
5-1.	Card and Mooney [1977]	4,380 to 88M	$ 3,000.00 to 60M
(6)	**Willingness-to-pay Approach:**		
6-1.	No specific author**		$ 2,100,000.00

* Source: Ref. (86).
** Perhaps an average figure of some unofficial sources.
*** Assuming an average annual rate of inflation of 3.5%(i.e. in 20 years,the value half).

held to be more important (as is the case in Iran), then matters are rather less straightforward. The long-term solution to the problem is to set about collecting the relevant data (individual, and hence aggregate willingness to pay). In the short-term, however, there would seem to be no alternative but to effect a fairly drastic compromise. This will be examined in the next chapter.

Table 6-7 The Relevance of Various Accident Costing (Valuation) Methods for Different Decision-Making Objectives

	National output objective	Other macroeconomic objectives	Social welfare objective	Mixed objectives
Gross output	dr	ru	pi	pr
Gross output + subjective costs	pi	pi	pr	pr
Net output	pi	ru	pi	ru
Net output + subjective costs	pi	pi	ru	ru
Life-insurance	di	pi	pi	pi
Cout-award	ru	pi	ru	ru
Implicit public sector	ru	ru	ru	ru
Willingness to pay	pi	pi	dr	pr

Key: dr= definitely relevant
ru= relevance uncertain
di= definitely irrelevant
pr= possibly relevant
pi= probably irrelevant
Source: Ref.(86).

Chapter Seven

The Cost of Road-Accidents in IRAN

7-1. Introduction

In chapter six, the issue of the cost of road accidents was discussed in detail. It was seen that the definiton of costs or values depends crucially upon the use to which they are to be put. National output objectives, macro-economic objectives, social welfare objectives, and a mixture of them, were distinguished as the four broad classes of objectives for evaluation of the cost of road-accidents. Also the components of road accident costs, the different proposed approaches for their evaluation and essentially the question of necessity of road accident costs evaluation (possible procedures for taking account of the safety effects and road accidents' cost) were examined. The discussions of chapter six resulted that: if the primary concern in transport project appraisal is to ensure an "economically efficient use of scarce resources", then only the approach based on cost-benefit analysis deserves serious consideration. This means to evolve criterion for assigning explicit values to their avoidance. Also, different methods of defining the cost of road accidents, their implication for project appraisal and the best method for developing countries were discussed.

Exploiting the definitions, discussions and the results obtained in chapter six, together with the results of the analysis of Iran road accidents in previous chapters, enable us to tackle the issue of "the cost of road accidents in Iran" in this chapter. The issue which in most (if not all) developing countries including Iran, has received no attention yet. It is worth noting, however, that this chapter is generally concerned with the cost of road accidents and specifically these costs for the Iranian community. But further research works will be needed to evaluate the cost of different prevention methods.

For example a comparison has been made(64) between five studies of the cost-effectiveness/benefit of certain engineering countermeasures. This comparison shows in California with spending $33,300 in reconstruction one life has been saved, while at the same time with spending only $350 in road-sign improvement one life has been saved. These results confirm that certain low-cost remedial measures such as road-markings, signing, delineation and improved skid resistance can be highly cost-effective in reducing accidents*. such studies should be conducted for Iran in future research-works. After that, the combination of the two research works can be employed for appraisal of the related safety projects in Iran.

* See appendix 3, for an impressive example.

7-2. Review of the Literature and the Cost of Road Accidents in Different Countries

7-2-1. Reynold Analysis of the Cost

The cost of accidents can be conveniently summarized by using as a basis the framework developed by Reynolds[24] as follows:

(a) The direct tangible costs which cause a diversion of current resources:

- damage to vehicles and other property (including any temporary loss of use and damage to goods in transit);

- the cost of medical treatment (including the cost of ambulance services);

- any administrative costs which can be attributed to the occurrence of an accident, e.g., the costs incurred by insurance companies, the police, and the law;

- the cost of delays to other users of facility.

(b) The indirect costs to the community as a whole:

- the net reduction in the output of goods and services due to injury and death and the loss of consumption of those killed,

- the transfers of income within the community following any net reduction in output due to injury or death;

- the economic effects of a smaller active population with a different age-sex structure due to injury or death.

(c) The intangible social costs:

- the pain, fear, and suffering associated with the occurrence of an accident;

- the social cost of incurring the risk of being involved in an accident.

The nature of each of the above components costs and the difficulties and technical complexities involved were thoroughly discussed in chapter six.

7-2-2. TRRL Figures for the United Kingdom

Table 7-1, which is mentioned in Ref.(37) is quoted from Sabey (TRRL.S.R.581, 1980), as follows:

Table 7-1 Costs of Road Accidents in Great Britain in 1977

Resources Costs	Total £ Million	£ Per accident		
		Fatal	Serious injury	Slight injury
Lost output	282	37450	770	20
Police Administration	75	150	120	90
Medical & Ambulance	44	300	510	30
Damage to Property	545	820	690	480
Sub-Total	946	38720	2090	620
Pain, grief, and suffering	347	25880	2650	50
Total	1293	64600	4740	670

7-2-3. Roy Jorgenseen Formula

Roy Jorgenseen and Associates in its comprehensive research in 1966[64], using the following calculable costs provided by the National Safety Council of the United States[52] as:

		$1988 assuming ann. inf. 3.5%
Death	$ 34400	73300
Non-fatal injury	$ 1800	3800
Property damage accident	$ 310	660

calculated the average cost per fatality-injury, Q, as follows:

$$Q = \frac{(34400) + (I/F)(1800)}{I + (I/F)}$$

Where: the I/F is the ratio between non-fatal injuries and fatalities.

The injury-to-fatality ratios for urban and rural highways in the United States in 1966 was 67 and 22 respectively. The combined ratio was 36. The corresponding values of Q, were $2280, $3220 and $2690.

7-2-4. National Safety Council of the United States' Analysis

The total motor-vehicle accident costs in the United States based on the National Safety Council evaluation[52] was $47.6 billion in 1984. That evaluation is based on the following analysis of the accidents' cost components:

1- Wage loss ($15.2 billion)

Since theoretically, a worker's contribution to the wealth of the nation is measured in terms of wages, then the total of wages lost due to accidents provides a measure of this lost productivity. For non-fatal injuries, actual wage losses are used.

For fatalities and permanent disabilities, the figure used is the present value of all future earnings lost. Procedures for estimating wage loss was revised in 1984.

2- Medical expense ($4.7 billion)

Doctor fees, hospital charges, the cost of medicines, and all other medical expenses incurred as the result of accident injuries are included.

3- Insurance administration cost ($ 8.9 billion)

This is the difference between premiums paid to insurance companies and claims paid out by them; it is their cost of doing business and is a part of the accident cost total. Claims paid by insurance companies are not identified separately, as every claim is compensation for losses such as wages, medical expenses, property damage, etc., which are included in other categories above and below.

4- Property damage in motor-vehicle accidents ($ 18.8 billion)

Includes the value of property damage to vehicles from moving motor-vehicle accidents. The damage is valued at the cost to repair the vehicle or the market value of the vehicle when damage exceeds its market value. The cost of minor damage (such as scratches or dents incurred while parking) is considered part of the normal wear and tear to vehicles and is not included.

The total cost (urban and rural) as was mentioned, is valued at $ 47.6 billion in 1984.

7-2-5. Discounting Procedure Adopted by Hire

To evaluate costs and benefits in the future, a discounting procedure is adopted by Hire(27), which values the present and immediate future more highly than the intermediate and distant future. A number of different decision criteria (such as net present value or internal rate of return) can be applied to the sums of discounted costs and benefits which will indicate the best investment programme taking into account factors such as mutually exclusive options, budget constraints, possibility of failure and optimal timing.

7-2-6. Other Different Estimates and Evaluations

World Health Organization estimate(83) for the cost of road accidents in the Gulf States* by the mid-1970s was close to US$ one billion per year. One of the important epidemiological parameter used in relation to disease motrality is the potential years of life lost (PYLL) as an indicator of premature mortality for health planning. The rate of PYLL in Kuwait in 1978 was found to be 13 years per 1000 population.**

The definition used in the analysis carried out by the Unit,

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* Hejaz (Saudi Arabia). Qatar, Dubai, Oman, Kuwait and Bahrain .
** This is equivalent to 5 days per head per year, i.e. one year per lifetime.

takes a developing country as one with a gross national product(GNP) per capital of less than $1,400 per annum* (1978 prices). A preliminary study of accident costs [Fouracre and Jacobs 1976] indicated in those developing countries for which data were available, the total cost of road accidents was almost one per cent of these gross national product- a sum that these countries can ill afford to lose. If the above definition is taken of a developing country, the 1% of the total GNP's of all countries below $1,400 GNP/capita per annum combined is approximately $14,000 million - a very crude estimate of the total annual cost of accidents in these countries (41). Most of the countries for which data were available in the above study used a "gross output"** approach in costing road accidents with no additional sum added to reflect "pain, grief and suffering". This additional sum represented over 30% of the assumed cost of a fatal accident in Great Britain(41), but it is increased even to 50% recently (UK department of transport, 1979, Ref. 86). Further alternative ways of costing** road accidents, are likely to produce accident cost estimates considerably greater. Thus the cost of accidents to developing countries could possibly be higher than that stated above. In addition, the population involved in developing countries are not a representative cross-section, because many of the fatalities may occur to vehicle users who generally come from a small minority of highly educated

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* For different definitions of a developing country see Ref.(38).
** See sub-section 6-5-1 for explanation.

people whose loss to the country is particularly serious.

The court award as was discussed in chapter six, sometimes gives some indications for the value of lives and the cost of road-accidents. As an example[31], the high court in Ontario (Torento-Canada) instructed the Canadian Royal Insurance company to pay $3,100,000 in 1984 to a family of 6 persons and their relatives of seven persons. On 15th March 1981, a drunk driver had collided with this family's parked car, killing the driver and injuring other 7 members of the family. The verdicts of the Islamic courts in Iran for compensation amounts will be discussed in this chapter.

7-3. How a Fatal Accident Affects the Pattern of Savings, Earnings, and Consumption of the Victim and His Dependents.

Fig. 7-1. which is given in Ref.(24), helps to clarify how a fatal accident affects the pattern of savings, earnings, and consumption of the victim and his dependents. The victim's consumption, earnings, and savings are shown extending over his entire life, as are the consumption patterns of his dependents and other members of society who might be affected by his life cycle, when he is killed:

(a) He loses his consumption C'.

(b) His savings S' are lost and reduce the consumption patterns, D' and R', of his dependants and the rest of society.

(c) The portion of his past saving, S, which he would have consumed in retirement, is transferred to his dependants, D', and other members of society, R'.

The net cost of a fatal accident, ignoring any transfers to or from the rest of society, can thus be summarized:

(a) The victim loses C', part of which is financed from his past savings S.

(b) His dependants lose $(1-p)(S'+E')$, where p is the portion of his present output, and the income from his present and past savings, which he consumes.

(c) His dependants gain $m.pS$, where m represents the proportional difference in marginal utility associated with the transfer of his past savings to his dependants.

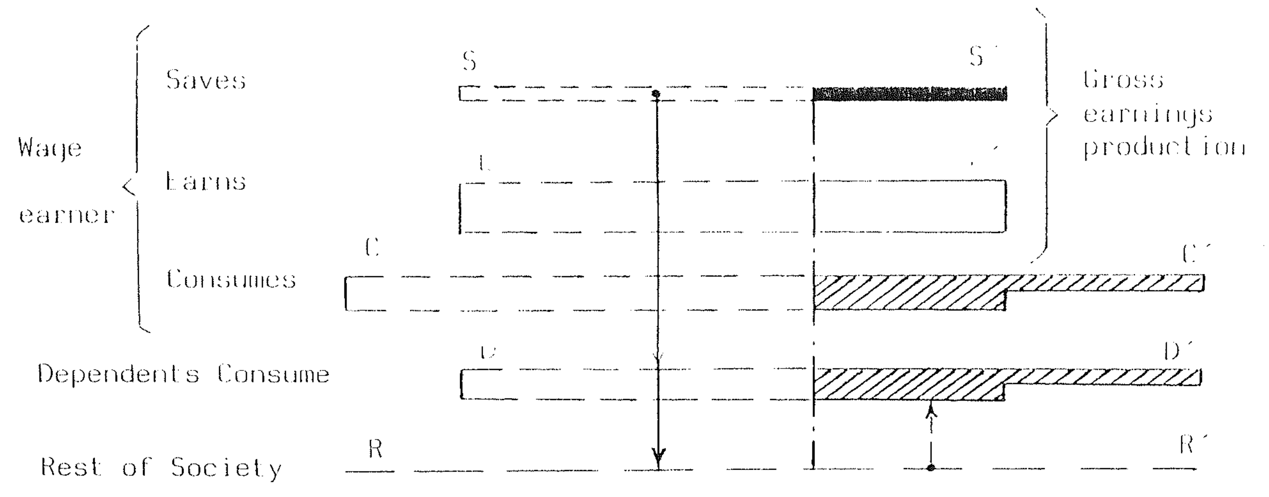

Fig 7-1. How a fatal accident affects the pattern of savings, earnings, and consumption of the victim and his dependants.

The net cost to society is thus equal to:

$$[C' + (1-p)(S'+E')-m.pS]$$

The item $(S'+ E')$ clearly represents the loss of his future production. The above expression can never be negative; and will only be equal to zero if the victim is retired and if m is one.

Although the above model introduces some consistency into the evaluation of accident costs, it is still far from perfect. It ignores, for example, the value of leisure.

7-4. The Insurance Approach

In chapter six, some reasons were explained that insurance approach is neither quite relevant to the purposes of computing road-accident costs in Iran (a mixture of national output, macro-economic and social-welfare purposes)*; nor is suitable for the conditions of developing countries. Nonetheless in this section the information obtained from Bimeh Iran (the largest insurance company in the country, which is state owned and covers about 70% of insurance policies in Iran) through an official letter to M.R.T (8) are presented in Table 7-2. This information gives at least some indication of the magnitudes of compensations paid in Iran and the percentages of each range in which those magnitudes are existed.

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* See sub-section 6-5-3 for explanation.

Table 7-2

Compensation amounts paid by "Bimeh-Iran" Insurance Company and the Number of Policy-holders Being Compensated

	1982	1983
Compensations paid "Third party policies"	1705559 (1000 Rials)	3173948 (1000 Rials)
Compensations paid "Completely insured policies"	495173 (1000 Rials)	705753 (1000 Rials)
Total compensations paid	2200732 (1000 Rials)	3879701 (1000 Rials)
Number of fatality cases being compensated	290 (0.64%)	271 (0.44%)
Number of injury cases being compensated	476 (1.05%)	552 (0.90%)
Number of damage only cases being compensated	44353 (98.31%)	60447 (98.66%)
Number of total cases being compensated	45119 (100%)	61270 (100%)

Source: Ref. (8).

7-5. Fatal Traffic-Accidents and the Punishment of the Culpable Driver in Iran Based on the Islamic Rules

In this section most of the important aspects of a fatal traffic-accident will be discussed, through a real case which will be explained as an example. In this example which is discussed in Ref.(88), the case will be examined from the first moment of the accident to the later stages of investigation process and court decision. Different aspects of the subject like: "opinion of the official investigator", "opinion of the government medical centre", "interrogation from the culpable driver", "general aspects of the crime", "payment of dieh*", "the rights of the killed person's inheritors" and "the effect of killed person's inheritors forgiveness" will be seen in this real example.

The Real Example Case

At the 9 o'clock of 7th october 1983, there was a telephone-call from "Dr Shareeti Hospital, Teheran" to the district police-station; informing a traffic-accident injured person is brought to the hospital; he is a pedestrian and has been hit by a car, which its 24 years of age young driver is present in the hospital. Following the telephone call a police officer is sent to the hospital, to see the injured person, preparing a preliminary report, and to

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* In accordance with the Islamic Fegh,h (see footnote in sub-section 6-5-1 on page 314 for explanation); the compensation amount payable to the victim's relatives after a homicide case, or other crime is called "dieh".

taken the driver to a police-station.

At the preliminary interrogation from the driver in the district police-station, he confesses to be involved in an accident with the injured person and says:

" I was driving in Gazvin street from west to east, that suddenly collided with a pedestrian passing across the street. The pedestrian came out of a mini-bus and suddenly jumped in front of my car. It was raining and the street surface was wet."

At this moment the police-station was informed that the injured person died in the hospital.

After the interrogation from the accused driver and completion of the police-report, the file with the accused person are sent to the public prosecutor's office and are referred for cross-examination. Examining magistrate, after the investigation of the file send it back to the same police-station for:

1- Obtaining the government medical organization's views and opinions.

2- Obtaining the traffic-accident specialist views and opinions.

3- More investigation about the dead person and his possible inheritors.

Examining magistrate, also instructs the police, that the accused driver should remain in custody until introduction of a qualified guarantor. Therefore, the driver remains in custody for 19 days until one of his relatives, guarantees his appearance.

From 26 october 1983 in which he is let free to 20 February 1984 in which the court final verdict was issued, he has been actively engaged in trying to obtain the killed person relatives' forgiveness. For some of them he could and for some he could not. Therefore, because he was found guilty, he had to pay the shares of those whom their forgiveness were not obtained. These shares were payable from one complete "dieh" and an additional third of a complete "dieh". The additional third, was because the accident happened in one of the holy Islamic months*.

A complete "dieh" can be chosen as one of the following six items by the culpable person:

1- One hundred camels, which should be intact and without any deficiency and not too slim.

2- Two hundred cows, which should be intact and without any deficiency and not too slim.

3- One thousand sheep, which should be intact and without any deficiency and not too slim.

4- Two hundred sets of high quality clothes.

5- One thousand "dinar"** of intact gold coin.

6- Ten thousand "derham"*** of intact silver coin.

Of course, with mutual agreement a combination of the above six items can be paid. the driver in this case chose item "4".

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* In those cases that the "homicide" - or any other kind of crime for that matter- is occurred in Mecca (inside "Haram") or in one of the four holy Islamic months (Rajab, Zeeghaadeh, Zeehajjeh and Moharram), one third is added to "dieh".

** Each "dinar" is equavalent to one "mesghal", which is $\frac{75}{16} \sim 4.7$ gram.

*** Each "derham" is equavalent to $\frac{12 \cdot 6}{18}$ "mesghal", which is about 3.28 gram.

7-6. Different Price Systems in Iran Based on Unofficial Market of Foreign Exchange: Primitive and Ubiquitous

Three different price systems of "governmental, preferential and free" were mentioned in chapter six. As the rate of inflation and real prices in the country, which are directly effective in road-accident cost computation, are affected by all three above mentioned systems; they will be briefly discussed in this section. The discussions here are quoted from Ref. (32) written by Dr. Ebrahim Baiza'i:

"Coexistence is not always easy at least when it comes to diverging economic interests.The multiple rates of foreign exchange one almost frozen as it was inherited from the prerevolutionary days and still used for government purchases and expenses, a prefrential one for the private sector's export revenues and a third one according to which prices are determined in the bazaar- have made the Iranian ecomony yet more complicated despite its lack of modern-day sophistication and efficiency.

This market, however, is functioning by its ways and means that could be analysed though with a little more effort. Keeping itself informed of the changes in the unofficial foreign exchange rates, the Islamic Republic News Agency regularly publishes them in its Economic Bulletin. A chart drawn on these figures shows that Iran's currency has been steadily losing its value in the period under study (March 1986-February 1987). Although the official market of foreign exchage, that reckons upon the SDR rates, registers a decline of 9.6% in the value of the dollar from the Rls. 81.211 of Feb. 20, 1986 to Rls. 73.427 on Feb. 21, 1987, the corresponding trend in the unofficial exchange market during the same period had a rise of about 34.3% from Rls. 655 for a dollar to Rls. 880.

Table 7-4

The US Dollar Against £ and DM in the International Markets and Iran's Unofficial Market

Month	London closing rates		Iran's unofficial market		Iran/Intl.	
	DM	£	DM	£	DM	£
March '86	2.25	0.68	2.30	0.70	+0.05	+0.01
April	2.31	0.67	2.29	0.69	-0.018	+0.016
May	2.19	0.65	2.23	0.67	+0.035	+0.024
June	2.25	0.66	2.28	0.73	+0.033	+0.072
July	2.18	0.65	2.21	0.69	+0.028	+0.034
Aug.	2.08	0.67	2.12	0.68	+0.04	+0.01
Sept.	2.04	0.67	2.08	0.69	+0.038	+0.024
Oct.	2.003	0.69	2.02	0.88	+0.023	-0.016
Nov.	2.033	0.70	2.03	0.70	+0.0047	-0.006
Dec.	2.0001	0.699	2.004	0.708	+0.004	+0.008
Jan. '87	1.903	0.673	1.93	0.710	+0.028	+0.037
Feb. '87	1.818	0.655	1.84	0.69	+0.022	+0.035

Source: Ref.(32).

7-7. Gross Output Approach

The major components which comprise road accident costs were discussed in section 6-3. Also the "gross output approach" was explained in No. 1 of sub-section 6-5-1. It was seen that in this approach, the cost of a traffic-accident is the sum of real resource costs (such as vehicle damage, medical and police cost) and the discounted present value of the victim's future output. Based on the experiences gained in developed countries, a sum will be added to the output loss and resource costs to reflect the "pain, grief and suffering of the accident victim and those who care for him or her."

In the meantime, it is suggested(24) that the following rather arbitrary, average values should be used for the subjective cost of casualties (1972):

fatality	£ 5000
Serious casualty	£ 200
Slight casualty	0

... [and] a qualitative case could clearly be made for varying these costs according to the age of the victims....

In Dawson's later work [1976] these figures have been changed to £ 5000, £ 500 and £ 10 respectively.*

7-7-1. Real Resource Costs

The major components which are categorised as real resource costs are:

1- The costs of destroyed or damaged objects with a market value.

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* These figures will be changed to $1983,see section 7-7-3.

2- The medical cost of physical injuries, excluding permanent disabilities but including working hours lost.

3- The cost of time wasted in road accidents.

4- The cost of administrative expenses.

There is no classified data available in Iran for none of the above items' cost. But the author should be most grateful for the help of miscellaneous organizations both in government and private sectors for providing at least the minimum information necessary to start a primitive computation. It is hoped that the important issue of the cost of road accidents in Iran will be computed more precisely in the future research works.

The hospitals, garages, police-offices, vehicle-dealers and different governmental offices which have helped in providing those information and necessary data, have been named in "acknowledgement".

As was discussed in chapter six and in section 7-6, different price systems is a reality in Iran. The real prices which are a combination of those price systems, are very complicated - if not impossible- to be precisely determined. In fact, the effective ratio of each price system in real prices is variable and depends on the type of commodity and time. Here, based on the recent calculation of the Central Bank of Iran(14) real prices will be a combination of "government prices" (45%) and "free prices" (55%), for the year 1983. Since 1983, the effect of "free prices" has been continuously increasing. The author believes the effect of "free prices" in 1987 must be at least 70%.

7-7-1-1. The Cost of Destroyed or Damaged Objects with a Market Value.

a) The Cost of Destroyed or Damaged Vehicles

The approximate cost of different vehicles being destroyed, severely damaged and slightly damaged in 1983 in Iran are listed in Table 7-5. There are no official figures for these data available in Iran, and these are some approximations based on the author individual investigations and experiences. The official evaluation of costs to vehicles in Iran for courts' juridical needs are made by some "chartered legal experts". Thus, for evaluations brought in Table 7-5, the author has consulted with Mr. Haddad who is one of such experts.

Although the total number of each type of vehicles involved in road-accidents are given in Table 3-21 and Fig 3-19, but it is not known what percentage of each number belongs to each category of the accident severity. Therefore, using the percentages given in Table 7-2 for insurance claims, the approximate number of each vehicle type involved in each category of accident severity is calculated in Table 7-6.

It is obvious that in reality some of the vehicle types might be involved in more severe and some in less severe accidents. But because such data is not available for Iran, here the average insurance figure is used for all of them. This must be more precisely be determined in future research works.

Table 7-5

The Approximate Unit-Cost of Different Vehicles

in Road-Accidents (1983) in 1000 Rials*

Type of damage / Type of vehicles	Slightly to partly damaged	Severly damaged	Destroyed
P. car	36	1825	2740
Bus	98	2960	12850
Minibus	84	2520	8400
Van	26	1300	2080
Truck	170	3500	12500
Trailer & other types of long vehicles	320	5350	19250
Others (including motor-cycles)	10	600	1000

* 45% government prices and 55% free prices (see section 7-6 and sub-section 7-7-1).

Table 7-6

The Number of Each Type of Vehicles Involved

in Each Category of Road-accidents (1983)

Vehicle type / Accident type	Slightly damaged	Sverely damaged	Destroyed	Total
	Per cent 98.66	0.90	0.44	100
P. Car	21413	195	96	21704
Bus	3269	30	14	3313
Mini-bus	4848	44	22	4914
Van	9073	83	40	9196
Truck	10710	98	48	10856
Trailer (including other types of long-vehicles)	2964	27	13	3004
Others (including motor-cycles)	8103	74	36	8213

Source: Tables 3-21 and 7-2, and Fig. 3-19.

Table 7-7

The Total Cost of Destroyed or Damaged Vehicles

in 1000000 (1983) Rials*

	Slightly to partly damaged	Severly damaged	Destroyed	Total
P. Car	771	356	263	1390
Bus	320	89	180	589
Mini-Bus	407	111	185	703
Van	236	108	83	427
Truck	1821	343	600	2764
Trailer & (other types of long-vehicles)	948	144	250	1342
Others (including motor-cycles)	81	44	36	161
Total	4584	1195	1597	7376

* Real prices, see section 7-6.

Source: Tables 7-5 and 7-6.

Using the results of Table 7-5, together with the information of Table 7-6, the cost of destroyed or damaged vehicles for 1983 in Iran is computed in Table 7-7.

b) The Cost of Other Destroyed or Damaged Objects

Sometimes in the course of road-accidents some damages are incurred to the road itself, traffic-barriers, properties beside the road, etc. There is no record of even the approximate amount of such damages and their costs. Nontheless, such costs are existed and cannot be totally ignored. Therefore, only as an approximation a 10% of the total costs of destroyed or damaged vehicles of part (a) is considered for this item:

$$10\%\ (7376) = 737.6 \text{ million Rials}$$

7-7-1-2. The Cost of Physical Injuries, Excluding Permanent Disabilities But Including Working Hours Lost

a) The Medical Costs

To collect the information relevant to this sub-section, the author had several visits to different sections of the Ministry of Health and its dependant hospitals and organizations. He also had several meetings with their authorities and made different interviews with road-accident patients either confined to bed in the hospitals or simply consulting for receiving treatment.

Even in the headquarter of the Ministry of Health general-office in Khorasan (the biggest province in Iran) there was no record of the medical costs even totally, and the author was told that each hospital keeps its own records. The only piece of information available in that headquarter was the total number of beds in each hospital, which was of no use for this research-work. The author, therefore, had several visits to hospitals; but unfortunately however, the records for medical costs were kept totally and not separately for different groups of patients. Therefore, the figures presented in Table 7-8, are the results of the author individual conclusions, which are based on many meetings, interviews and investigations.

The costs in Table 7-8 for severe injuries also include some partial or provisional disabilities.

Table 7-8

The unit medical costs and working hours lost in road-accident injuries in Iran

	average medical costs in 1000 Rials (1983)	average working-hours lost
One slight to medium injury	35	20 days x 8= 160 hours
One severe injury	3500	14 months x 180 =2520 hours

For the definition of severe and non-severe injuries,see page 218. The prices given in Table 7-8,are "real" prices,which are composed of 45% "state-prices" and 55% "free-prices" for 1983. For more explanation see section 7-6.

Table 3-5, gives the total number of people injured on roads in Iran in 1983 equal to 27569 persons. There is no record of the percentages of different types of injuries. But again, based on the experience and visits to hospitals, and considering the fact that many of too slight injuries are not referred to hospitals in Iran and noting the ratio of killed to injured people (10%), the author believes that 80-90% of the total police-recorded number of injuries are slight to medium injuries and 10-20% severe injuries.

From this 10-20% whom are severely injured about one third become permanently disabled, which are excluded in this part. But from the remaining two third also, some of them becom "to some extent" disabled, which are included in this part.*

Thus, for the evaluation of the cost for this part, 85% of the persons injured are taken to be slightly to partly injured and the remaining 15% are assumed to be severely injured. These are summarized in Table 7-9 as follows:

Table 7-9. The Number of Injured in Each Group of Severity

The number of people whom are slightly to partly injured in road-accidents in Iran in 1983	85%(27569) = 23434
The number of people whom are severly injured and partialy disabled in road-accidents in Iran in 1983 (included in this part)	$\frac{2}{3}$ x 15%(27569) = 2757
The number of people whom are severely injured and totally and permanently disabled in road-accidents in Iran in 1983(excluded in this part)	$\frac{1}{3}$ x 15%(27569) = 1378

* This assumption is in good compatibility with a recent investigation in U.K.(90),which concludes:"For severe injuries,nearly one third of casualties sustain some degree of long term disability (at one year) and nearly one quarter do not return to work after this time".

b) The price of working-hours lost

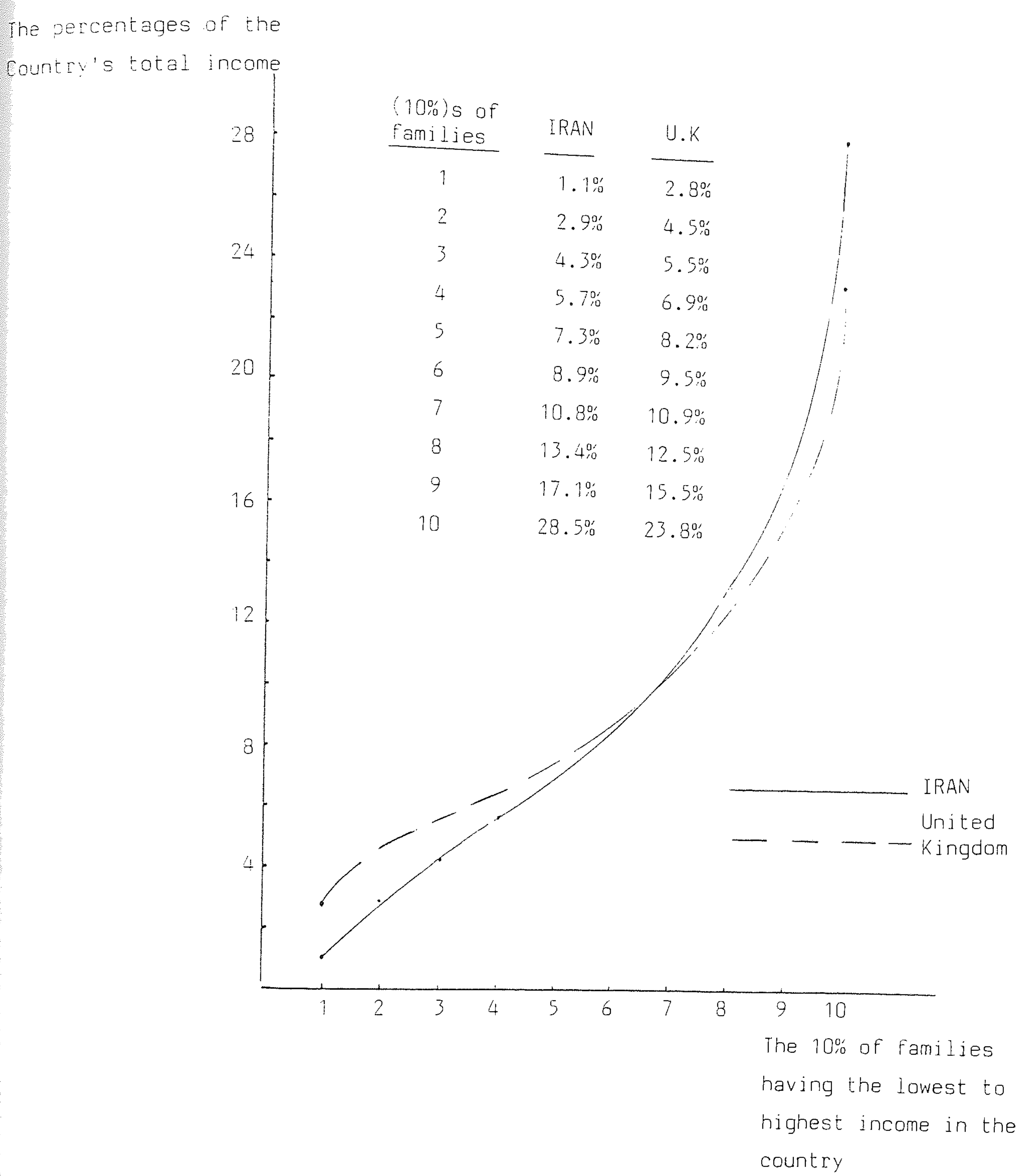
As far as the price of working hours lost are concerned, as was explained in No. 6 of sub-section 6-3-3-2, because of the appreciable disparities between the level of incomes in Iran (see Fig. 7-2 . it is more logical to allow for an average figure between the salaried incomes and non-salaried remuneration rather than the average salary or the income index per person. This is calculated in Table 7-10 and its following discussion:

Table 7-10 Average Monthly Income of an Iranian Family

Groups	Per cent in the Country	Monthly incom in Rials(1983)	Average monthly income of an Iranian family = 52500 Rials(1983)
Very low paid* farmers and labours	25%	10000	
Other farmers	25%	35000	
Other labours	15%	40000	
Employees	15%	52000	
Low income self-employed	15%	80000	
High income self-employed	5%	300000	

* Usually in remote provinces and deprived regions of the country.

Source: Ref. 36).



(10%)s of families	IRAN	U.K
1	1.1%	2.8%
2	2.9%	4.5%
3	4.3%	5.5%
4	5.7%	6.9%
5	7.3%	8.2%
6	8.9%	9.5%
7	10.8%	10.9%
8	13.4%	12.5%
9	17.1%	15.5%
10	28.5%	23.8%

Fig. 7-2. The disparities between the level of incomes in Iran and in the United Kingdom (1982).
Source: Ref. (34).

Now a typical family of six persons (father "30-50 years of age", mother, one child 12-19 and two children less than 12 and one grandfather (or grandmother) more than 50) is considered. The family is assumed to have a monthly income of 1.4 times "average monthly income in Table 7-9" (one for father and 0.4 for other members of the family "especially mother"); therefore, the average monthly income of the family is:

$$1.4 \times 52500 = 72870 \text{ Rials}$$

If all members of the family were in the same risk of being injured in a road-accident, then the average value of one working hour of the family could be:

$$\frac{\text{The family average monthly income}}{\text{Number of people} \times 180 \text{ (working hours in one month)}}$$

But from Table 3-13, can be seen that the people in different age groups are exposed to different percentages of risk. Thus, by taking the risk to father (30-50 : 51.4%, see Table 3-13) who produces one unit of average monthly income, as one; the risks for other members of the family are:

The eldest child (12-19): 1.9% : 51.4% = 0.036

The younger children (less than 12)

0.3% : 51.4% ~ 0.006

Grandmother (or grandfather)(more than 50)

8.7% : 51.4% = 0.169

The risk to mother of the family must be considered in a different way. Because the women, although in the same group of age, are exposed to lesser proportions of risk in Iran (mostly because of lesser mobility). There is no data to compare the risks for each sex, therefore, the risk to mother is taken approximately as half of the father. Thus, the total risk of the family lossing its income:

1(father) + 0.5(mother) + 0.03 (eldest child) + 0.169 (grandfather or grandmother) + 0.006 x 2(small children) = 1.717

And the value of one average working-hour exposed to the risk of being lost in a road-accident:

$$\frac{1.4 \times 52500}{1.717 \times 180} = 238 \text{ Rials/hour}$$

Thus, the medical cost of injuries plus the price of working-hours lost are summarized in Table 7-11.

Table 7-11. The Cost of Medical Expenses and Working-hours Lost in Road-accident Injuries in Iran (in 1000"1983"Rials)

	medical cost	The cost of working-hours lost
Slight to medium injuries	35x23434=820190	23434x160x238:1000= =892367
Severe injuries	3500x2757=9649500	2757x2520x238:1000= =1653538
		Total = 13015595

Source: Tables 7-8, 7-9 and the calculation of one working-hour price in this section.

7-7-1-3. The Cost of Time Wasted in Road-Accidents

Considering the explanations and theoretical calculations presented in sub-section 6-3-3, the World Bank estimation quoted in Table 6-1, will be adopted here (Iran will be adopted as between developed and developing countries).

Assuming 55% of road travelling as work to work, 35% home to work and 10% leisure, the rate of real valuable time:

$$55\% \times 75\% + 35\% \times 375\% + 10\% \times 0.125 = 0.556$$

There is no record of the amount of time being wasted in road-accidents in Iran. But based on many cases actually being observed by the author, 5 hours is the minimum average time wasted in each accident in Iran. Also, it is assumed that an average of 6 people being involved in each accidents (all these assumptions must be re-examined and verified in further research-works).

Thus, the cost of time wasted in road-accidents in Iran in 1983 would be as follows:

33351 (the number of road-accidents, Table 3-4)

x 6 (the average number of people involved in each accident)

x 5 (the average hours wasted in each accident)

x 0.556 (World Bank ratio, Table 6-1)

x 238 Rials (the price of one working-hour, sub-section7-7-1-2)

= 132398 thousand Rials.

7-7-1-4. The Cost of Administrative Expenses

These are the expences of deciding liability and evaluating damages (see sub-section 6-3-6).

(a) The Cost of Police Administration

This figure is considered confidential in Iran and is not given out. Therefore the reduced similar cost in United Kingdom (considering the ratios of population, roads and police presence) (Table 7-1) is adopted:

£75000000 x $\frac{1}{2}$(reduce factor)[0.55x400(free exchange price,83) + 0.45x130 (state exchange price*)] = 10443700 thousand Rials.

(b) The Cost of Insurance

These are the costs of running the insurance industry for road-accident cases (including the companies profit) and not the compensation amunts paid to victims, because those are included in other items. In fact this is the difference between premiums paid to insurance companies and claims paid out by them. The second figure is given for Bimeh-Iran in Table 7-2, but the first figure is not available. Thus we write:

T (total insurance receit) = C (compensation amounts) + E (expenses) + P (profit)

Assuming C=0.70T, and E=P=0.15T (which seems reasonable in Iran):

* For the exchange rate in 1983, see section 7-6 and sub-section7-7-1.

the cost of road-accidents' insurance:

$$E+P = \frac{1}{0.70 \text{ (the ratio of Bimeh-Iran to total insurance, see sub-section 7-4)}}$$

$$[\frac{0.30}{0.70} \times 3879701 \text{ (see Table 7-2)}] = 1662729 \text{ thousand Rials}$$

(c) The Cost of Legal System Whatever It May Be

There is no hint available for the magnitude of such a cost in Iran. Thus, it is taken here approximately equal to the police-cost of part (a).

7-7-2. The Victims' Lost Future Output

Based on different research works which have been carried out for developing regions, it was established in previous chapters that such a cost(gross output) is relatively higher in developing regions. On the other hand, there is no data available for Iran and to the extent of the author knowledge, nothing has been done before in this regard. Thus, the figures for lost output in Great Britain (Table 7-1) are taken as the minimum amounts and the results are summarized in Table 7-12. To bring the cost in 1977 to 1983, an average yearly inflation of 8% (U.K. £) is considered:

$$\begin{cases} (1.08)^{1983-1977} = 1.587 \\ \times\ 37450 = 59428 \\ \times\ 770 = 1222 \\ \times\ 20 = 32 \end{cases}$$

Table 7-12

The Victims' Lost Future Output

	£	1000 Rials*	No.	Total 1000 Rials
Fatal	59428	16550	2831	46855000
Serious injury	1222	340	4135	1407252
Slight injury	32	8.91	23434	208844
Total				**48,471,096**

* 1983 £ = 278.5 Rials=[0.55x400+0.45x130]
  see section 7-6 and sub-section 7-7-1.

Source: Tables 3-5, 7-1, and 7-9.

7-7-3. The Subjective Costs

Taking the rather arbitrary average values of Ref. (24) for subjective costs, these costs for the year 1983 will be:

a) 2831(the number of deaths, Table 3-5) x £14300 (the subjective cost for a death) x [0.55x400(free exchange rate)+0.45x130 (state exchange rate)=278.5 Rials](s.7-6 & s.s 7-7-1)

= 11274500 thousand Rials.

b) (2757+1378)(total number of severe injuries, Table 7-9)

x 278.5 Rials (average rate of exchange, see above)

x £570(the subjective cost for a severe injury)

= 656410 thousand Rials

c) Total = 11274500 + 656410 = 11,930,910

The above arbitrary average values yield to a figure for subjective costs equal to about 11.5%(gross output) and 9.8%(court award) of the total road accident costs in Iran in 1983(see Table 7-13 and section 7-8). The subjective costs in U.K. represented over 30% of the assumed cost of a fatal accident(41) but then was increased to 50%(UK department of transport,1979).

7-7-4. The Total Cost in Gross Out Approach

The results of different components in this approach, are summarized in Table 7-13 as follows:

Table 7-13 The Cost of Road Accidents in Iran in 1983 (Gross Output Approach), in 1000 1983 Rials

Real resource costs	Destroyed or damaged vehicles	7376000
	Other destroyed or damaged objects	737600
	Medical expenses including the working hours lost	13015595
	Time wasted in road-accidents	132398
	Administration expenses	2x10443700+1662729 = 22550129
	Gross lost output	48471096
	Subjective costs	11930910
	Total	104214 million Rials

7-8. The Court Award Approach

This approach is discussed in item "4" of sub-section 6-5-1 in chapter six. The only difference with "gross output approach" is in the evaluation of the lost victims' output. The sums awarded by the courts to the surviving dependents of those killed, or permanently disabled, as a result of either crime or of negligence, are treated as indicative of the cost that society associated with the accident or the value that it would have placed on its prevention (including subjective costs).

In this part, the value of one complete Islamic Dieh (see section 7-5) for a death and the value of half complete Dieh for a permanent disabled will be considered:

One complete Dieh = 1000 sheep x 40Kg x 500 Rials/Kg

= 20000 thousand Rials

The cost of deaths= 2831 (Table 3-5) x 20000

= 56620000 thousand Rials

The cost of permanent disabilities:

= 1378 (Table 7-9) x $\frac{1}{2}$ x 20000

= 13780000 thousand Rials

As was discussed in section 7-5, if the accident (crime or negligence) is happened in one of the four (4) special holy months (which are called "Haram months"),then one third should be added to "Dieh". Thus, averagely an increasing factor of

$$1 + [\frac{1}{3} \times \frac{4}{12}] = 1\frac{1}{9}$$

will be applied. Thus, the equivalent price will be:

$(56620000+13780000)\times 1\frac{1}{9}$ = 78222 million Rials

and the total cost of road-accidents in accordance with this approach is (see Table 7-13):

104213-(48471+19311)+78222 = 122034 million Rials, 1983 prices

This shows a 27% increase in comparison with gross output approach, which is a good indication of the compatibility and reasonability of the assumptions made in the process of those evaluations (for the extent of the existed disparity between the results of different research-works see Table 6-6).

7-9. The Comparison of the Cost of Road-Accidents in Iran with the Country's Gross National Product (G.N.P)

Ref.(87) gives the country's total gross national product equal to 68314.4 billion Rials (1982). The similar figure for 1983 is not available, therefore, assuming the same figure for the year 1983,the percentage of the road-accident costs to the country's G.N.P would be as follows:

1) Gross output approach:

$104.213 : 6831.44 \times 100 = 1.52\%$

2) Court award approach:

$122.034/6831.44 \times 100 = 1.78\%$

The percentages above, are exactly inside the limits indicated by TRRL for developing countries(38) for the cost of road-accidents as 1-2% of their G.N.P. Although, this is a good indication of the relative reliability of the assumptions and approximations made in the process of the evaluations in this chapter, nontheless, a continuous effort is mostly needed to develop the data needed and to modify the results in further research-works. However, considering the fact that this has been the first ever made attempt to evaluate the cost of road-accidents in Iran, the obtained results seems to be promising and inspiring.

Chapter Eight

Discussions, Conclusions and Recommendations

8-1. Introduction

The results of the research work presented in this thesis, comprise of six essential topics:

1- General introduction of the road-accident phenomenon inside and outside Iran.

2- The quantity and quality of road-accidents' data in Iran, its comparison with other nations, finding out the short-comings and deficiencies, and suggesting remedial measures for its improvement.

3- The analysis of road accidents' data of Iran.

4- The comparison of road accidents' data of Iran with other nations.

5- The analysis of road accidents' data of Iran provinces and their comparison.

6- The cost of road accidents in Iran.

In all six above-mentioned essential topics, first, the most of previous works -directly or even sometimes indirectly related- carried out inside or outside Iran, has been tried to be found out, and be presented in this thesis.

Second, in each essential topic a new step toward identifying the nature of the problem in Iran and finding practical solutions has been tried to be taken and an original contribution be made.

Third, at least partially distinguished the dimensions of the problem, necessary "start-points" and "hints" has been provided for future research-works to be carried out in relation to this important and crucial subject.

In this chapter, in relation to each of the mentioned essential topics, both the previous works and the original research carried out by the author, are discussed and then duea recommendations are provided.

8-2. General Introduction of the Road-Accident Phenomenon Inside and Outside Iran

8-2-1. The Results of the Previous Research Works

Reviewing the history of important research-works and international conferences and seminars on road-safety, it was shown in this thesis, that:

1- Revolutionised road transport system benefits are obtained at the cost of an annually increasing number of persons killed and injured on the roads.

2- It is rarely ever possible to attribute the occurrence of a road-accident to a single factor.

3- How the most important road-safety related components affect.

4- In despite of recent satisfactory record of traffic-safety in developed countries, still the massive restoration and rehabiliation actions including "highway design for safety, roadside safety hardware, traffic control, special highway users' programs, accident data uses, traffic control and management, motorist information systems, as well as planning for future works in highway saftey as a "long range initiatives" are undertaken.

5- A list of research activities undertaken by developed countries in developing regions were provided.

6- A brief description of road-engineering, vehicle safety standard, traffic law enforcement, education and training in Iran was presented.

7- M.R.T. of Iran activities for roads' rehabiliation, maintenance and safety were discussed.

8- The reasons for the necessity of this research-work were demonstrated.

8-2-2. The Original Works Relating to This Section

1- Because of the author responsibilities in Iran road sector, especially acting for two and half years as the planning and parliamentary deputy-minister of road and transport, he possessed a unique chance to travel and personally examine Iran road-network throughout the country. Nontheless, for the sake of more specific original investigation, the northern road between Teheran and Mashad is investigated as a case-study.

2- Although it is well-established that obtaining information and necessary data for research work is very difficult and time-consuming in developed countries, those difficulties in addition to general developing world short-comings, have its own reasons which are discussed in this thesis.

8-2-3. The Proposed Future Research-Works Relating to This Section For Iran

1- Finding the most practical and cost-effective ways of improving road layout and standards.

2- Finding the most practical and cost-effective ways of improving vehicle performance.

3- Finding the most practical, cost-effective and realistic ways for enforcement of engineering and legislative measures.

4- Finding the most effective possible ways of casualties' treatment.

5- How to organize a responsible organization for road-safety.

8-3- The Situation of Road-Accident Data Inside and Outside Iran

8-3-1. The Results of the Previous Research Works

1- In developed countries accident reports are analysed nationally by reference to a great variety of characteristics and attendant circumstances and results are used extensively for research works and for guidance in the improvement of road safety in relation to roads, road users, vehicles, and traffic movement.

2- The inherent weaknesses in traffic accident data, including collection practices, reporting methods, data bias and the nature of accidents have been investigated.

3- The consistency of reporting from location to location or from year to year has been examined in some developed countries.

4- The information supplied in road accident statistics in developed countries has been discussed and the basical five levels of accident investigation have been explained.

5- Reviewing the related literature, it has been found out that the existing reporting systems in developing countries are relatively poor.

8-3-2. The Original Work Relating to This Section

1- The procedures for road accident data collection in Iran has been fully investigated and compared with developed countries. Also, the abilities of Iran road-police based on its administrative system and its relation with other governmental organizations especially M.R.T, have been shown. In this relation, to fully understand the mechanism of police reporting system, a real fatal case has been examined from the collision moment, and the police-report has been interpreted. Also, different views and criticisms in relation to that report have been found and discussed.

2- The new reporting form used in Iran has been examined and suggestions are made.

8-3-3. The Proposed Future Research Works in Relation to this Section

1- The investigation of the law enforcement academy curricula in the area of accident investigation and reporting.

2- Training programs for police-officers.

3- National road-accident statistics report form.

4- Developing a mechanism to identify Iran road accidents' data year-to-year variance and investigate the reasons for inconsistencies and large changes in the number of reported accidents.

8-4. The Analysis of Iran Road-Accidents' Data

The road accidents data from Iran road-police central statistics office and M.R.T are supplied only based on the police districts' areas. No calculation of the rates, no discussion, no comparison and no extensive analysis are provided.

All literature reviews, discussions, analysis, and computation of the rates are developed by the author.

8-5. The Comparison of the Road-Accidents in Iran with Other Nations

Neither in the studies in Iran road-police statistics centre and Iran M.R.T., nor in any of the previous studies and research-works in this relation, a detailed comparison could be found. Therefore, in this research-work by exploiting the findings of developed nations, a comprehensive comparison which is based on different bases is made and the results are discussed.

This is the comparison based on population, vehicle ownership, roads, vehicle-miles, etc. Also a relationship between"fatality per vehicle" and "vehicle per population" is derived for Iran and then is compared with actual data, which seems to be satisfactorily compatible.

8-6. The Analysis and Comparison of the Quality and Quantity of Road-Accidents in Different Provinces of Iran

Iran is a big country and each of its provinces has its own climatic factors and natural geography with the people of their own culture, education, economy and behaviour. Therefore, the analysis of road-accidents in such a country without paying enough attention to those differences, might not be perfect and the concluded remedial measures could not be quite effective.

Again no comparison between provinces could be found in this regard. Thus, in this research-work, first the provinces are tried to be introduced and all those technical, geographical, economical and social parametres which are effective-direct or indirect- on the quantity and quality of road-accidents and on the effectiveness of remedial measures to be considered.

For example, the total road network existed in each province

(Table 5-3), is considered and the rates per population, per area and per area x population are compared. Also, the traffic on the roads (light and heavy) and the rate per kilometre of existed road-network is calculated and compared.

As far as the number of road-accidents and casualties are concerned, they are analysed for each province, and the deaths per population, per "average daily traffic" and per "comparative average daily traffic" are calculated and compared.

8-7. The Cost of Road Accidents

8-7-1. The Results of Other Research-Works and Investigations Used in This Relation

The reasons for assigning explicit values to road-accidents and their avoidance have been discussed. It has been shown that the definition of costs or values depends upon the use to which they are to be put. This selection of a definition must take place with reference to the goals and sub-goals of overall economic and social policy of any particular community.

The two important approaches for defining and valuing the road-accidents cost, which are "general deterrence" and "specific deterrence" have been explained and their aims have been compared.

Although different research-works have identified different components for road-accidents cost (see for example Ref. 29), having examined different views, it has been concluded that essentially there are six major components. Those components have been divided into two distinguishable groups:

1. The cost of destroyed or damaged objects with a market value.

2. The cost of elements, for which there is no ready market value. These are nonmonetizable items, whose costs are very difficult to be assessed. Different approaches have been proposed, which all of them have been discussed in this thesis. These are:

1. The gross output approach
2. The net output approach
3. The life insurance approach
4. The court award approach
5. The "implicit" public sector valuation approach
6. The willingness to pay approach.

Discussing the relations between different valuation methods and different planner's objectives which are:

1. National output objective
2. Other macroeconomic objectives
3. Social welfare objective
4. Mixed objectives.

Each of the methods (approaches) has one of the following relations to each of the objectives:

1. Definitely relevant
2. Possibly relevant
3. Relevance uncertain
4. Probably irrelevant
5. Definitely irrelevant.

Possible procedures for taking account of the safety effects cost and road accidents' cost which have been examined, are as follows:

1. To ignore the estimates and valuations.

2. To rely on informal weighting of effects.

3. To base the decision upon legally or conventionally imposed safety-standards.

4. To use some form of cost-effectiveness analysis.

5. To evolve criterion for assigning explicit costs to accidents and explicit values to their avoidance (cost-benefit analysis).

The result of explaining, examining and comparing the abovementioned procedures is:

"If the primary concern in transport project appraisal is to ensure an economically efficient use of scarce resources, then only the fifth approach deserves serious consideration. All other approaches are likely to lead to inconsistency and inefficiency.

TRRL figures for the cost of road-accidents in the United Kingdom, Roy Jorgenseen formula for calculation the average cost per fatality-injury, National Safety Council of the United States analysis of road-accidents' cost and discounting procedure adopted by Hire. have been all explained and discussed.

World Health Organization, Unit, Jacobs, and others has each its own estimate, which most of them are quoted and discussed.

Also, it is shown how a fatal accident affects the pattern of savings, earnings, and consumption of the victim and his dependents.

8-7-2. The Original Work Presented in This Relation

As Jabbari[37] mentioned in his research-work, no attempt has so far been made to evaluate the cost of road-accidents in Iran. He suggested that "the cost of road-accidents in Iran is extremely high." But this suggestion was only based on general views concerning the scarcity of educated people and specialists in the country and the expensiveness of the vehicles and spare parts. No actual evaluation is observed neither in his work, nor in any other work .

The fatal traffic-accidents and the punishment of the culpable driver in Iran which are based on the Islamic rules are examined in detail in this research-work. This is essential for assessing the cost in Iran.

Another factor which is directly effective in cost, is the unofficial market of foreign exchange and resulted different price systems in Iran. This is complicated in nature and is considered by Central Bank of Iran for evaluation of "real prices" and the rate of inflation[87]. Therefore, in a sub-section this problem has been discussed and the evaluation of costs has been based on "real prices" which is a complicated combination of "state price", "preferential price", and "free price".

The author could not find any theoretical calculation for evaluation the cost of "times" wasted in road-accidents, except one from Noureddin[54] which was presented to the 17th World Road Congress in Sydney in 1983. Based on this theoretical calculation and actual experimental results presented in this research-work, the cost of time wasted in road-accidents in Iran, is also evaluated and included in the total cost.

The total cost of road-accidents in Iran which is very difficult to be approached, based on all available theoretical and experimental investigations and results both inside and outside Iran, is for the first time computed and compared with the country's G.N.P.

Naturally however, the first attempt in such an important and complicated issue certainly contains shortcomings, which should be improved in future research-works. Although, even this first attempt -thanks to the results of many investigations exploited in this work and the author long experience in road sector- fortunately seems very reasonable and inside the bracket given by TRRL for developing countries[38].

8-7-3. The Proposed Further Research-Works in Relation to This Section.

The necessary data and information that were not available and therefore some assumptions were necessirily made, should be found out and be developed for more precise evaluations in future research-works. These include:

1. The amounts of costs incurred by each type of motor-vehicle in different categories of road-accidents.

2. The number of each category of accidents. (The tables given out at present time by Iran road-police statistics central office, is tabulated by "fatal", "injury" or "only-damaged", but it is not known "how severe" the "injury" or "only damaged" cases

are?)

3. The quantity and quality of property damages, other than vehicles and the cost.

4. How many beds and what percentages of the medical facilities in hospitals are specifically used for traffic-accident casualties? How many of them gain their complete health and how many become permanently or provisionally disabled (completely or partially)?

5. How much is the value of one average working-hour lost?

6. Which of the different developed approaches is the most appropriate for valuation of the cost of road-accidents in Iran and how the lost future output of the victim should be computed?

7. What is the best approximation for the value of subjective-costs in Iran?

8. Investigation of the existed models and/or developing new models for use in Iran for the evaluation of proposals for the design, construction and maintenance of road schemes.

9. How to establish the road data bank and how to use as a basis of all planning maintenance management and safety programs?

8-8. Recommendations Resulted from This Research-Work

The recommendations for improving the quantity and quality of road-accidents' data and information were discussed in section 2-5, and are not repeated here. The rest are as follows:

8-8-1. Definitions and Standards

Standard definitions for accident type, casual factors, type of collision, extent of injury, and description of accident location should be established and adopted nationally.

Road agencies should make policy provision for continuous review of all highway safety improvements to determine success or failure in achieving accident reduction.

8-8-2. Road Engineering

1. Minimum geometrical characteristics in highway and road construction must be more precisely determined. Of course, other important factors such as the physical characteristics of the country and economic constraints should also be simultaneously considered.

2. Dangerous sections and hazardous locations (black spots) through road reconnaissance and on-site observation guided by an analysis of accident patterns must be identified and treated accordingly.

3. Fixed roadside obstacles and crash barriers should receive more attention.

4. Maintenance is increasingly important to all countries. Especially in developing regions efforts should be made to:

a- Apply modelling procedures for the evaluation of proposals for maintenance needs in relation to road condition and traffic.

b- Apply suitable methods to define the conditions of unpaved roads and quantify visual rating systems.

c- Apply procedures for more effective control of maintenance works.

5. The segration of foot, cyclists and vehicular traffic is most likely to reduce road-accidents. This issue worth to be fully investigated.

6. Safety benefits of the speed limit has been proved to be considerable[20]. What are the best limits for Iran and how the limits should be enforced?

7. The analysis and discussions presented in chapter three, showed that the roads in Iran are not well equipped in adverse weather conditions like, heavy rains, snow, fog, etc; and the drivers are not well trained. Therefore, a special attention is needed to be paid to this problem.

8-8-3. Organization of Traffic Safety and Traffic Safety Research

This might be the most important recommendation and most effective one in Iran. Because essentially the lack of such organization to possess the necessary authorizations and be responsible for safety is clearly observed. Its function will be to produce, to implement, and to develop a comprehensive policy for the reduction of accidents in road traffic. The stages of the work which the organization will need to undertake must be determined in further research-works.

8-8-4. Developing Required Legislations and the Implementation of Their Complete Enforcement

Legislations should fulfil four minimum requirements to be effective[83]:

1. Awareness or basic knowledge.
2. Legitimacy or fairness.
3. Satisfaction of basic needs.
4. Early detection and immediate correction.

There should be close cooperation between different authorities in drawing up legislation and continuous educational efforts must be made to develope appreciation of the necessity of the legislation and enforcement activities. Also, in relation to traffic law enforcement, the police should have special training, using simple, efficient and non-expensive, but appropriate, technology. Penalties are effective when the probability of detection of offence is high, prosecution is inevitable and penalization is prompt.

8-8-5. **Cost Evaluation**

1. The real cost of road-accidents is important to be explicitly valued, and both data and method of evaluation be continuously revised for the best approximation possible.

2. In selecting the improvement type at a single location, the improvement with the highest average annual net benefit should be chosen.

3. In determining the order for improvement, as between locations, the improvement project with the highest benefit-cost ratio should be given priority.

4. In performing cost-effectiveness evaluations, it is necessary for provision to be made in the accident records system readily to obtain data on improvement costs, service lives, maintenance cost, and accident costs.

5. Low cost highway safety improvements can yield a large return in reducing highway accidents as measured by benefit-cost ratios.

Appendix 3 gives an impressive example of the trend of costs and benefits that can be attributed to investments in road safety measures.
The future research in the area needs to be focussed on what kind of information system would:

- to find the places where such benefits can be obtained as in the example,
- and what are the costs and benefits of such as road signing, white lining, etc.

Chapter Nine

List of Main conclusions

9-1. Iran with 8% annual increase in the total of injury accidents between 1979 and 1983, when compared with other nations of the world, is in the middle range - see Fig. 4-4.

9-2. Rural fatality rate per vehicle in Iran is closer to developed rather than developing countries - see Fig. 4-5.

9-3. The following relationship is derived in this work, between fatality rate and vehicle-ownership for Iran (1977-83):

$$F/V = 0.000236\ (V/P)^{-0.562}$$

9-4. In 1983 in 89% of Iran road-accidents, the human factor is the only -or part of the- cause(s) of the accidents (see Table 3-16). In the present data collection system in Iran the human factor causes are grouped in two main groups:

1- impairment, 7% of human caused or 6.2% of total, and

2- general driving manner, perceptual errors and the lack of skills, 93% of human caused or 82.8% of total.

As far as the impairment is concerned, almost all of its 7% share, is due to fatigue and drowsy driving. The shares of drinking and drugs are negligible.

9-5. As far as the road factor is concerned, during last decade Iran has had one of the largest percentages of increase in rural and access road construction and one of the lowest figures for major and standard road construction. It has also had one of the lowest amount of maintenance.

9-6. Between 1977 and 1985, the road death rate per 10,000 motor-vehicle decreased from 12.97 to 10.57, but the rate per 100,000 population was almost constant at 6.37.

9-7. 85% of the road-accidents in Iran in 1983, occurred in the vicinity of 50 kilometres from cities and towns.

9-8. The age-group of 30-39 in Iran contains the maximum rate of the number of guilty drivers per its population.

9-9. In Iran, road-accidents' data and information are quantitively insufficient and under-reported and qualitively not accurate enough.

9-10. The more developed provinces of Tehran, Mazandaran, Gillan Esfahan and East-Azarbayegan have the highest "average daily traffic" per Km. of their road-network. ie, they have heavier road-traffic. In these provinces "following too closely" possesses the highest percentages between different types of improper driving. On the contrary, "inexperienced and loss of control" has the lowest rate in these provinces.

9-11. In remote provinces of Systan&Baloochestan, Lorestan and Kerman, the percentages of fatal accidents are the highest.

9-12 In remote provinces like Kordestan, the road-accident death rate per unit of population is low (mostly because of less mobility of the people), but the rate per average daily traffic is high (mostly because of low level of traffic on roads and low level of safety standards).

9-13. Because Iran is a big country and each province has its own natural, geographical, social and economical characteristics , therefore each region must receive its own appropriate priority of remedial solutions. Nontheless however, as it is demonstrated, there are great potential cost-effective low-cost solutions everywhere in the country.

9-14. The "gross output + subjective costs" method of costing road-accidents brings the cost of road-accidents in Iran to 1.4 per cent of the country's G.N.P. The "court award" method yields 1.8 per cent. Both these figures are well inside the bracket given by TRRL for developing countries, i.e 1-2% of G.N.P.

9-15. In Iran, buses and vans proportionally possess the worst record of road accidents.

9-16. The provinces of Tehran, Esfahan, E. Azarbayegan and Mazandaran in relation to their combined area and population have proportionally the lowest figures of road net-work.

Chapter Ten

List of Main Recommendations

10-1. To improve the data situation in Iran:

10-1-1. Standard definitions for using in road-accident report-forms be established and adopted nationally.

10-1-2. Road-police act under a joint-committee.

10-1-3. The law enforcement academy curricula be reviewed.

10-1-4. Training programs be instituted to improve the knowledge of police-officers and police-chiefs.

10-1-5. A national road-accident statistics report-form be developed and a committee be set up to monitor, check and revise the form continuously.

10-1-6. A program be developed to evaluate the quantity and quality of the annual accident data and idetify year-to-year variance.

10-2. To identify and treat Black-spots.

10-3. To set up the organization of traffic-safety and traffic-safety research-centre.

10-4. To develope the required legislations and ensure their complete enforcement.

10-5. To increase the number of types and grades of driving-license.

10-6. To give priority to the projects of road construction, maintenance, black-spots' treatment, etc, in the vicinity of towns and populated centres.

10-7. To revise continuously the cost of road-accidents in Iran for the best approximation.

10-8 To implement the research- works listed in chapter eleven.

Chapter Eleven

List of Suggestions for future work

11-1. Finding the most practical and cost-effective ways of improving roads' layout and standard, vehicle performance, enforcement of engineering and legislative measures, and also casualties' treatment.

11-2. Further investigations about law enforcement academy curricula , training programs for police-officers, and report-forms.

11-3. Black-spots' investigation throughout the country's (or each province's) road net-work.

11-4. Evaluation of the amounts of costs incurred by each type of motor-vehicle in different categories of road-accidents.

11-5. Developing better data and information about the medical cost of road-accident casualties in Iran.

11-6. Evaluation of the cost of road-accident prevention methods in Iran.

11-7. Cost-benifit analysis of different road-accident prevention methods in Iran.

Appendix 1

Iran Provinces' Main Traffic Axes

(see enclosed map of Iran)

1- Teheran

1-1. Teheran-Karaj (Highway)

1-2. Karaj-Ghazvin "

1-3. Teheran-Ghom "

1-4. Jajrood

1-5. Karaj-Ghazvin (Hesarak)

1-6. Gharchak-Varamin

1-7. Robat Karim

2- Central (Markazi)

2-1. Ghom-Teheran (Highway)

2-2. Ghom-Teheran (Second axis)

2-3. Sapafchekan (Ghom-Rahgard-Saveh)

2-4. Arak-Khomein

2-5. Deligan (Neyzar-Esfahan-Khomein)

2-6. Kashan (Ardestan-Ghom-Ghamsar)

2-7. Arak-Tooreh

3- Gillan

3-1. Rasht-Gazvin

3-2. Rasht-Lahijan

3-3. Rasht-Anzali

3-4. Anzali-Astara

3-5. Chaboksar (Tankabon-Roodsar-Katalom)

4- Mazandaran

4-1. Chaloos-Tankabon

4-2. Chaloos-Karaj

4-3. Mahmood Abad (Alamdeh-Mahmood Abad-Babolsar-Babol-Amol-Chamestan)

4-4. Amol (Haraz-Babol-Amol)

4-5. Kazanak (Amol-Lar Dam)

4-6. Sari (Ghaem,Shahr-Babol-Sari-Kiasar-Power station)

4-7. Firooz,Kooh (Ghaem,Shahr-Firrooz,Kooh-Doab-Alasht)

4-8. Nowkandeh (Behshahr-Gorgan-Azadshahr-Ramian)

5- East, Azarbayejan

5-1. Tabriz-Mianeh

5-2. Tabriz-Azarshahr

5-3. Tabriz-Marand

5-4. Mianeh-Zanjan

5-5. Marand-Tabriz

5-6. Jolfa (Marand-Jolfa-Seah,Rood)

5-7. Ardabil-Sarab

6-West, Azarbayejan

6-1. Oroomieh-Khoy

6-2. Miandoab (Maragheh-Ajabshir-Mehabad-Ghandvar-Tihrash)

6-3. Khoy-Salmas

6-4. Makoo (Khoy-Bazargan-Shoot)

6-5. Oroomieh-Miandoab

7- Bakhtaran

7-1. Bakhtaran-Khosravi

7-2. Bakhtaran-Hamadan

8- Khoozestan

8-1. Ahwaz-Andimeshk

8-2. Ahwaz-Sarbandar

8-3. Andimeshk-Khoram.abad

8-4. Sarbandar-Ahwaz

8-5. Khoramshahr (Ahwaz-Abadan-Sarbandar)

9- Fars

9-1. Shiraz-Kazeroon

9-2. Shiraz-Gahrom

9-3. Kazeroon-Shiraz

9-4. Abadeh (Esfahan-Shiraz-Eglid)

10- Kerman

10-1. Kerman-Sirjan

10-2. Kerman-Bam

10-3. Sirjan (Kerman-Bandar Abbas

11- Khorasan

11-1. Bojnord (Minoodasht-Shirvan-Ash,Khaneh)

11-2. Mashad (old Neyshaboor- Sento Ring Road-Fariman-new Mashad-Torbat-Sarakhs-Torghabeh-Vakilabad-Cement,Factory-Kalat Naderi)

11-3. Ghoochan-Mashad

11-4. Fariman (mashad-Torbat)

11-5. Shirvan (Ghoochan-Bojnord)

11-6. Torbat,Jam (Tayebad-Fariman)

11-7. Sabzevar (Shahrood-Neyshaboor-Esfarayen)

11-8. Chenaran

11-9. Emam Taghi (Mashad-Kashmar)

12- Esfahan

12-1. Esfahan-Teheran

12-2. Esfahan-Shiraz

12-3. Esfahan-Naeen

12-4. Esfahan-Najaf,abad

12-5. Esfahan-Shahre Kord

12-6. Naeen-Yazd

13- Systan & Baloochestan

13-1. Zahedan (Kerman-Khash-Mirjaveh-Zahedan)

13-2. Zabol (Birjand-Zabol)

13-3. Iranshahr (Khash-Chahbahar-Bampoor-Saravan-Zabol)

14- Hamadan

14-1. Hamadan-Gazvin

14-2. Hamadan-Bakhtaran

15- Lorestan

15-1. Malavi (Khorramabad-Andimeshk-Eslamabad-Darehshahr)

15-2. Boroojerd (Arak-Malayer-Nahavand)

16- Zanjan

16-1. Gazvin-Rasht

16-2. Gazvin-Teheran

16-3. Zanjan-Mianeh

16-4. Gazvin-Hamadan

16-5. Gazvin-Karaj

Appendix 2

Bar-Chart diagrams showing road accident analysis in the provinces of:

1- Teheran

2- Gillan

3- West-Azarbayejan

4- Esfahan

5- Khorasan

6- Systan & Baloochestan

For the reasons of selection of these six provinces among twenty-four provinces of Iran see introduction to chapter five.

The Province of Teheran

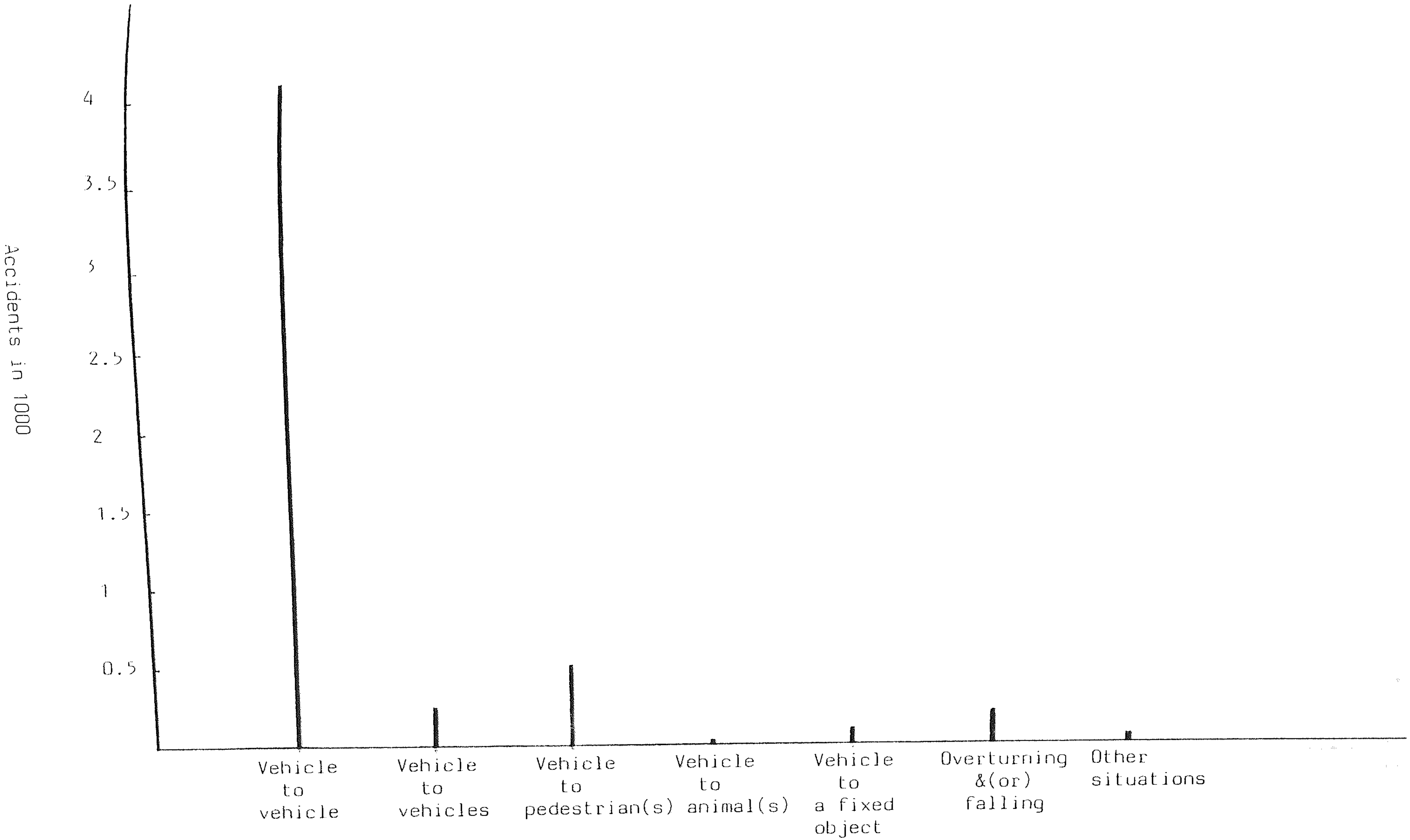


Fig. (A2-T-1). The parties involved in road accidents in the province of Teheran.

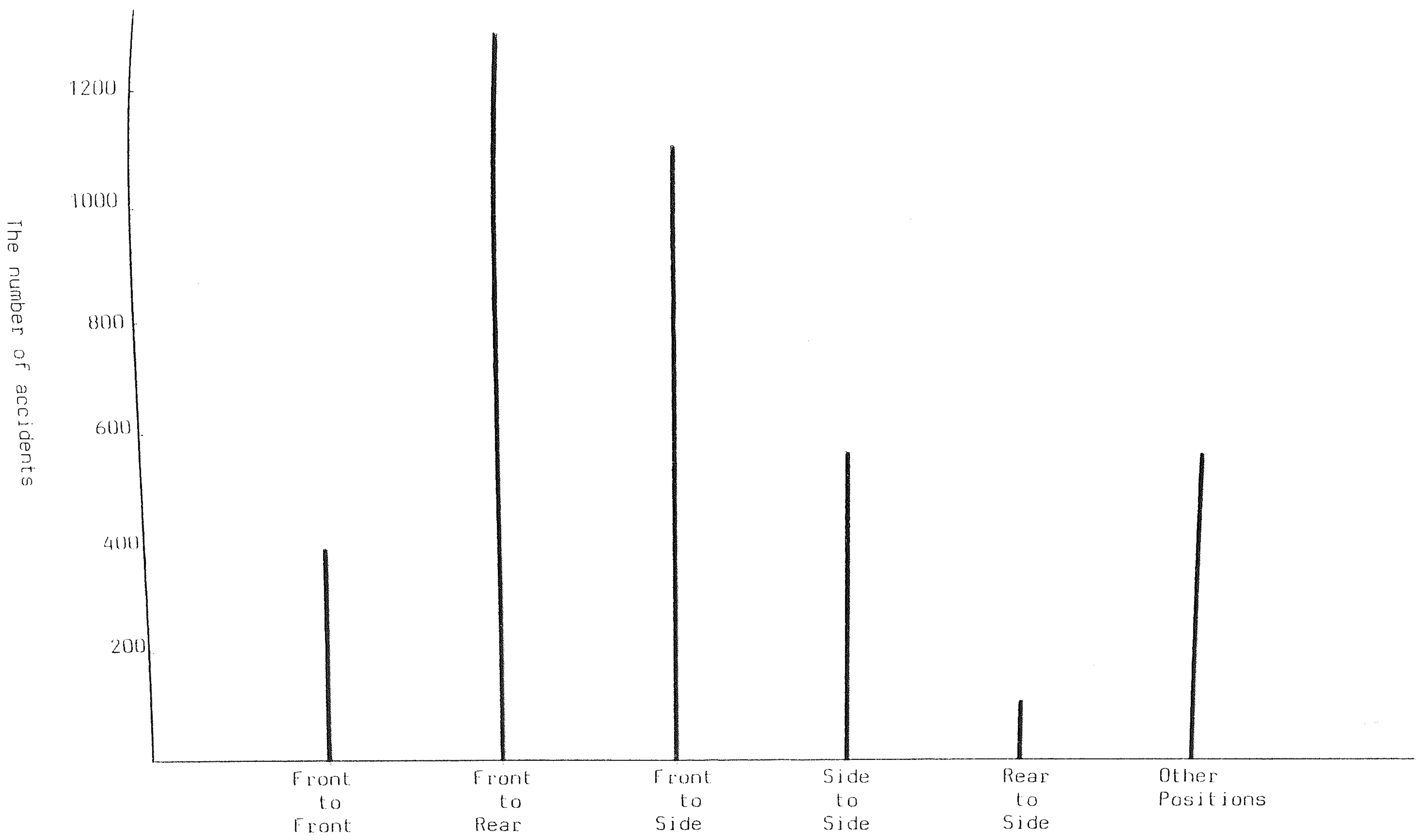


Fig. (A2-1-2). The contact points of vehicles involved in road accidents in the province of Teheran.

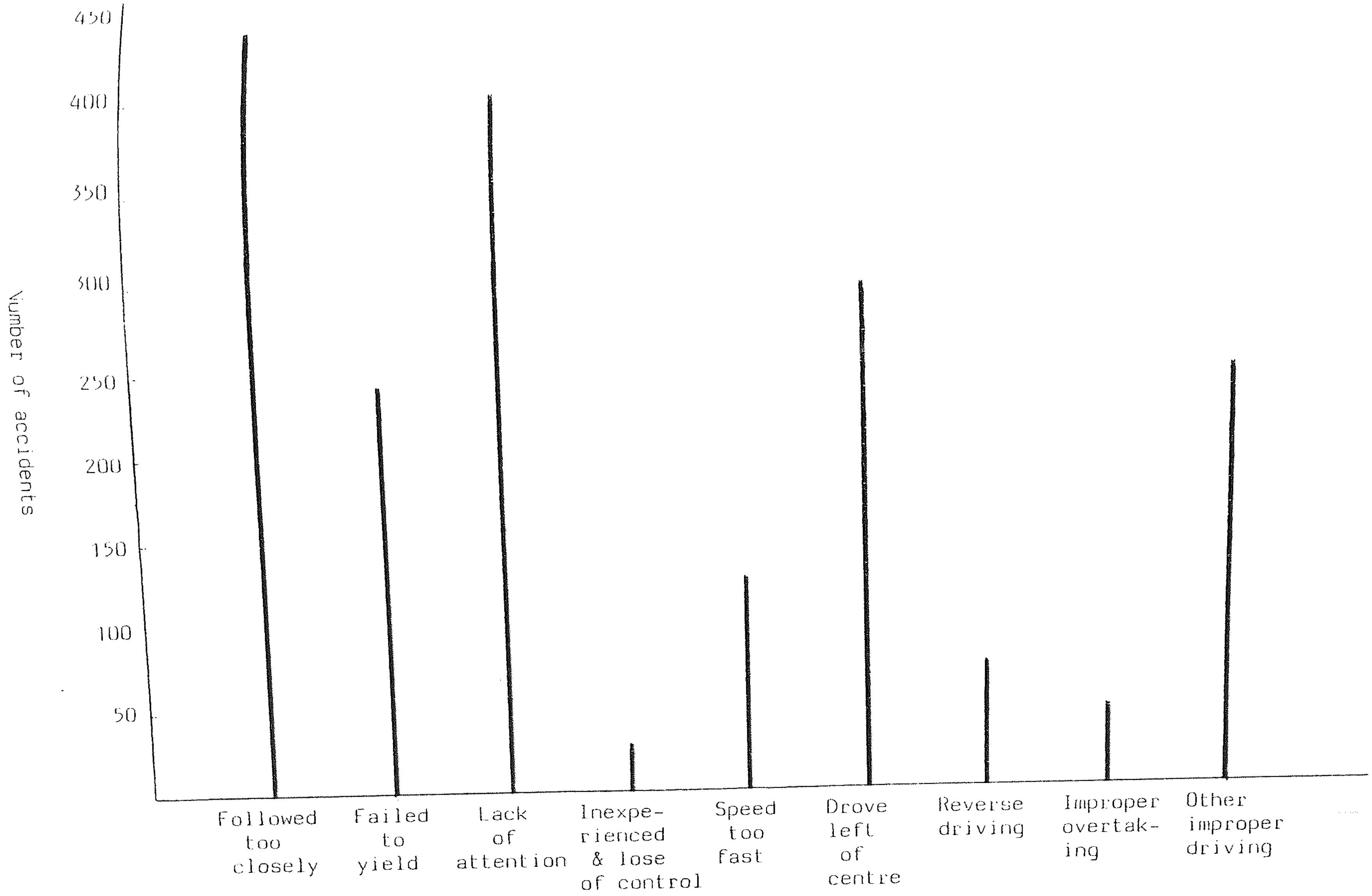


Fig.(A2-I-3). The road accidents caused by improper driving in the province of Teheran.

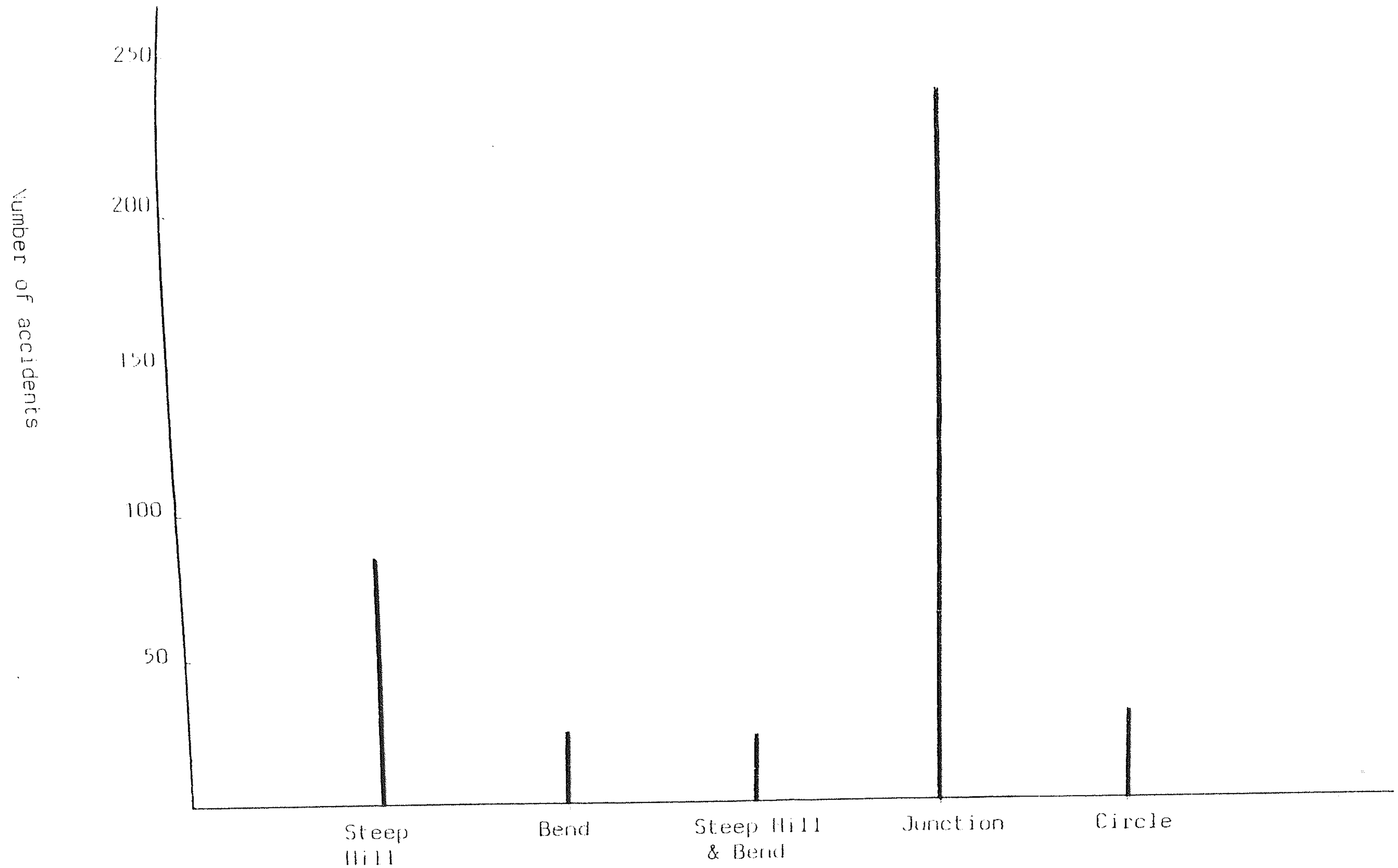


Fig.(A2-I-4). The road accidents for different road situations in the province of Teheran.

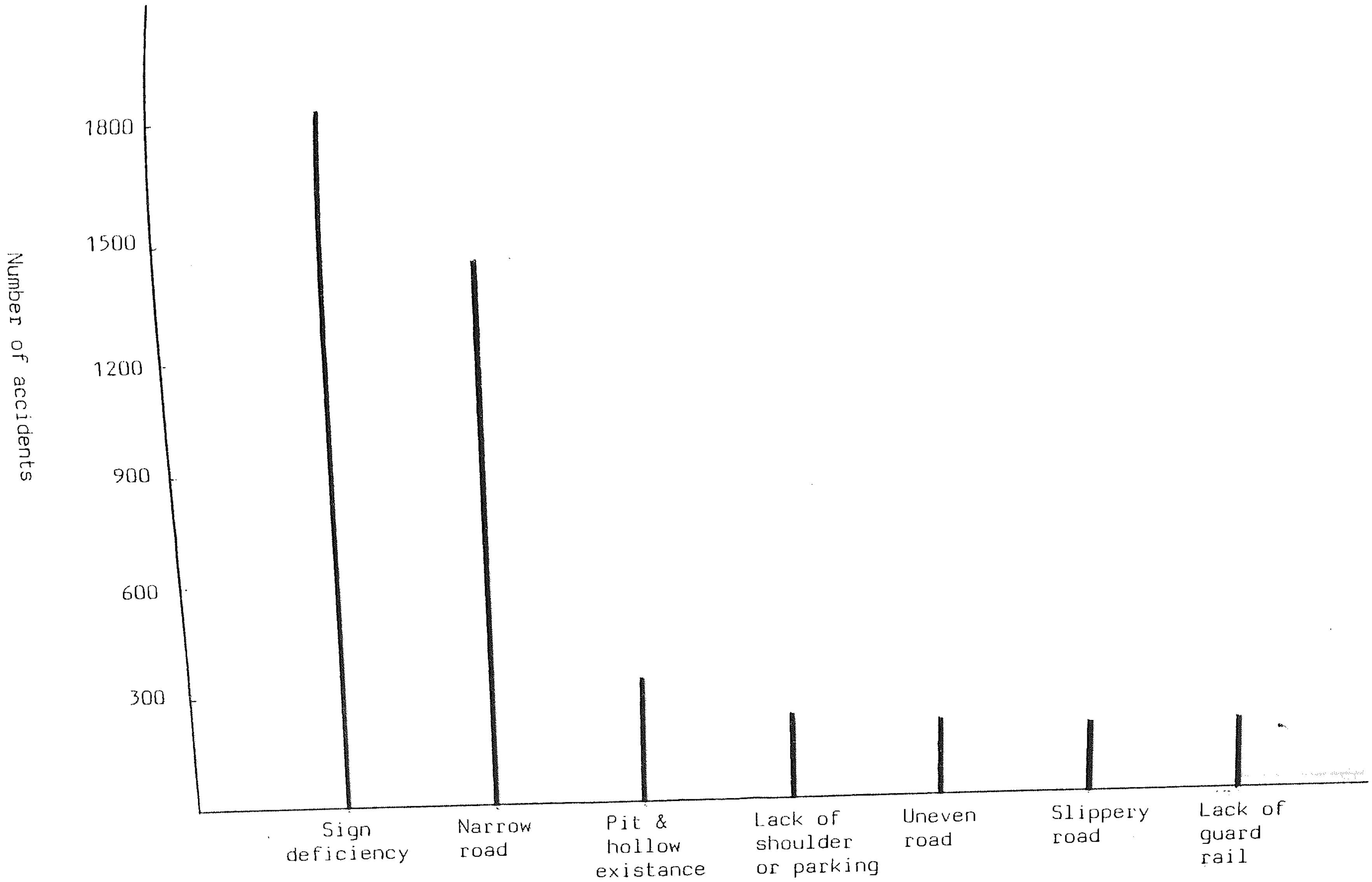


Fig.(A2-T-5). The road accidents caused by road imperfections in the province of Teheran.

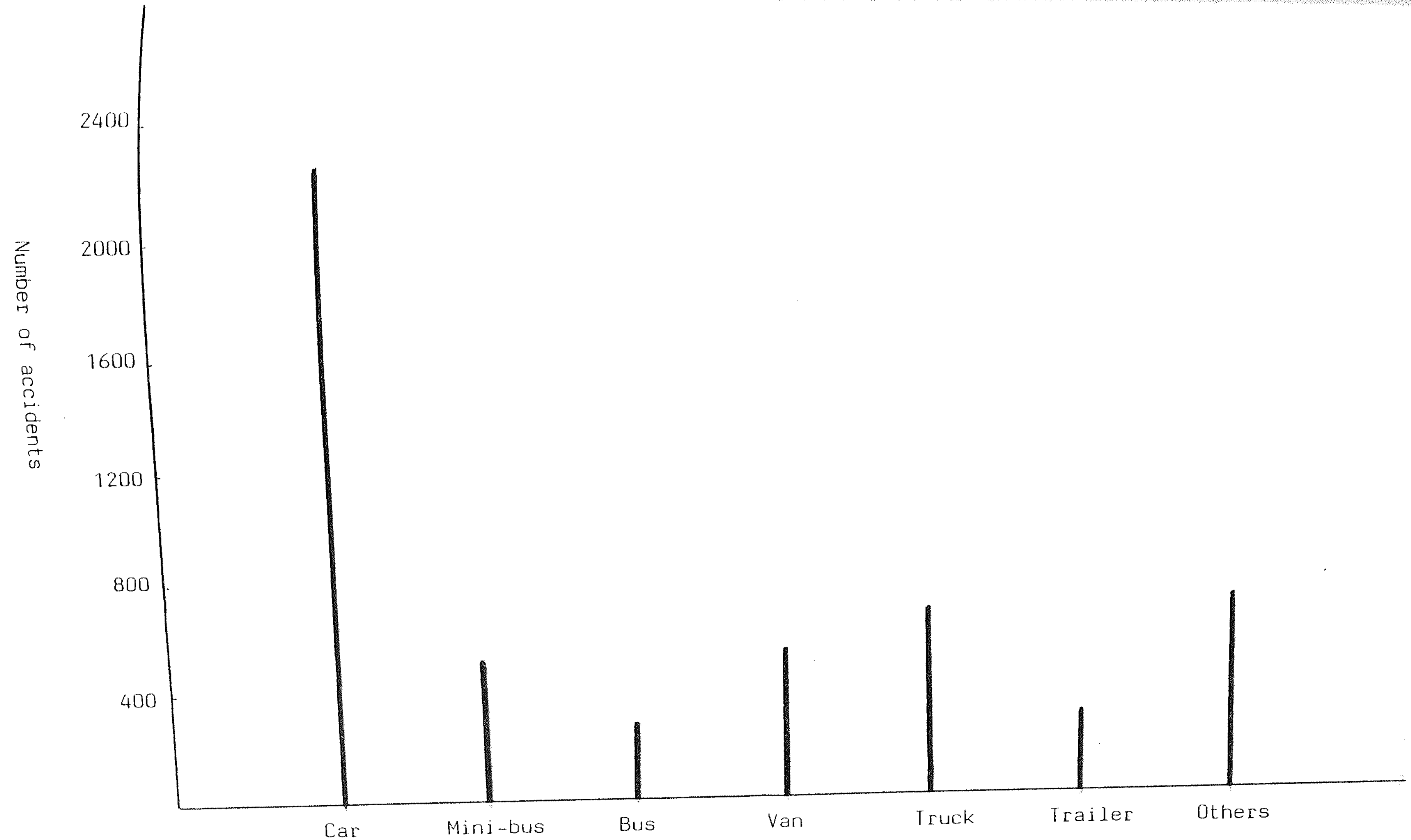


Fig.(A2-T-6). The number of different type of vehicles involved in road accidents in the province of Teheran.

The Province of Gillan

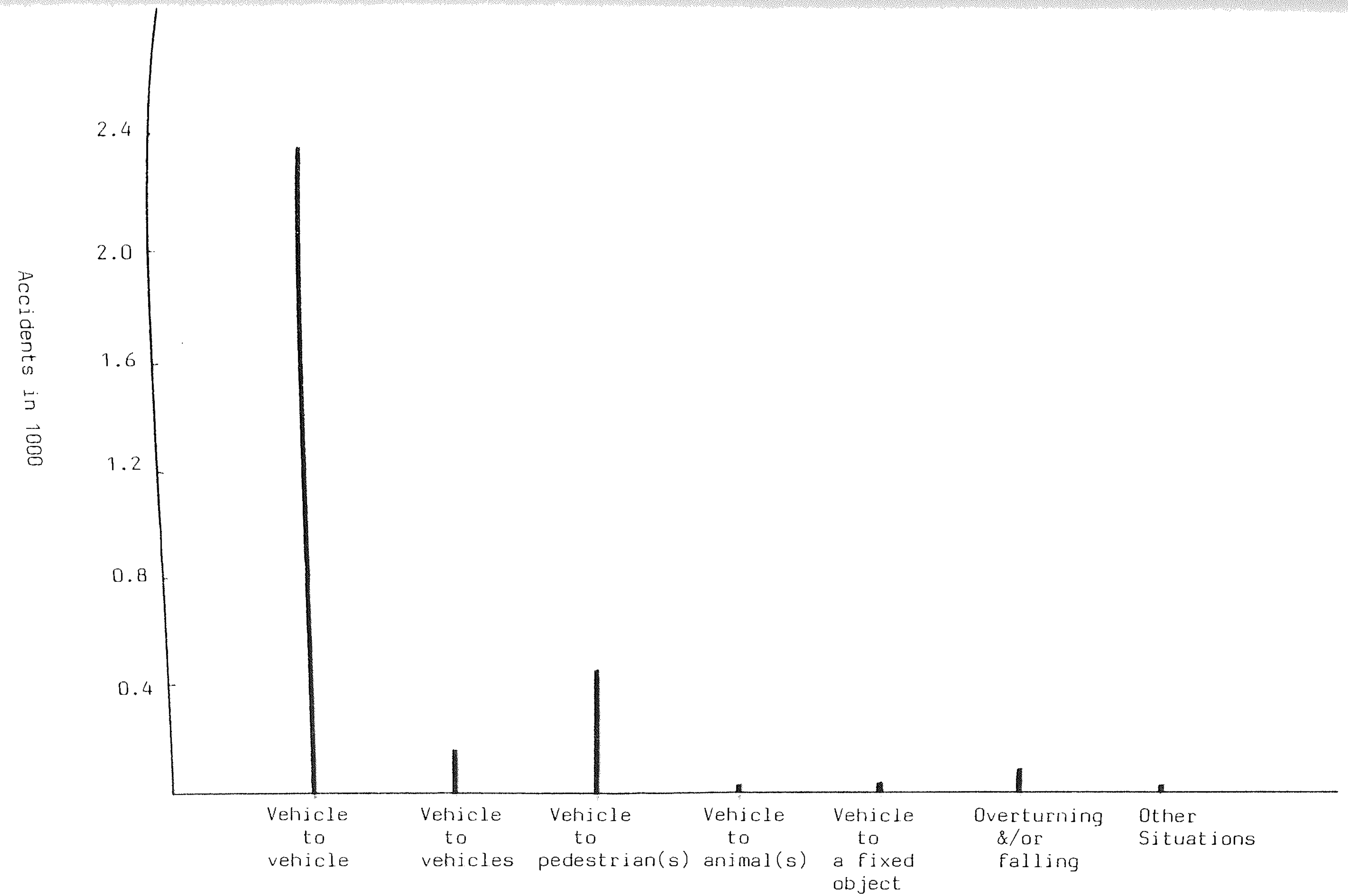


Fig.(A2-G-1). The parties involved in road accidents in the province of Gillan.

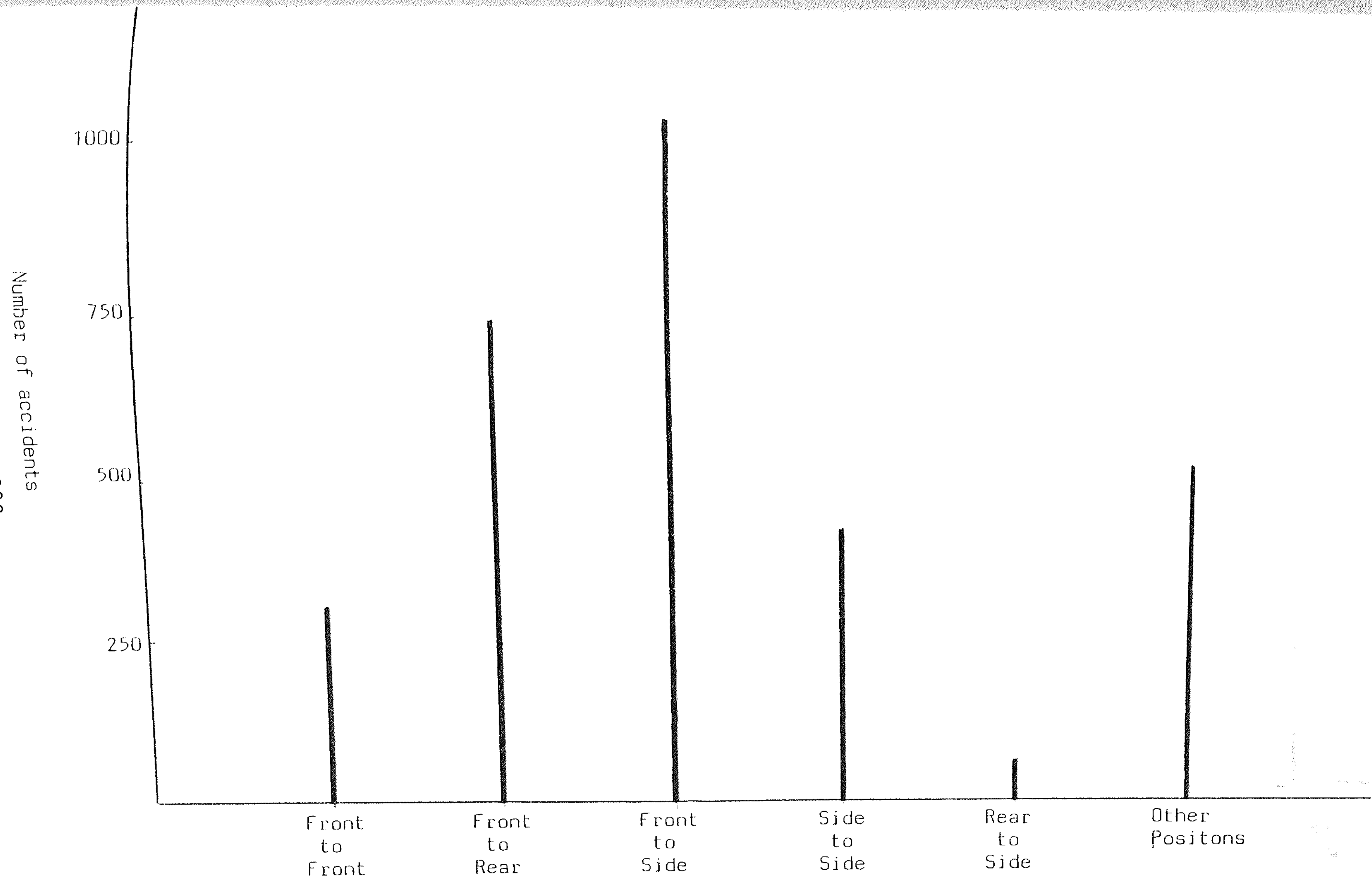


Fig. (A2-G-2). The contact points of vehicles in road-accidents in the province of Gillan.

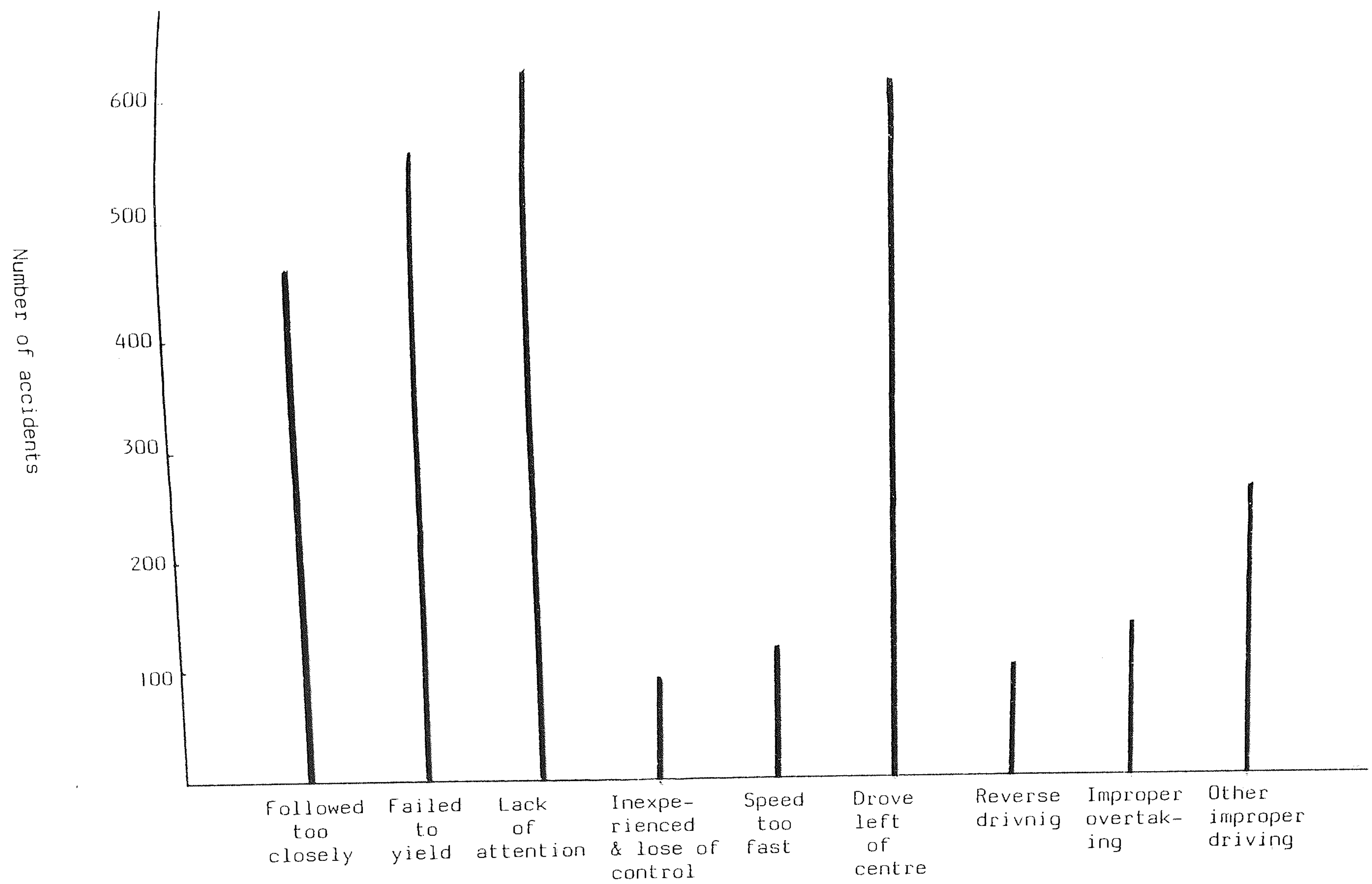


Fig.(A2-G-3). Gillan road accidents per different improper drivings.

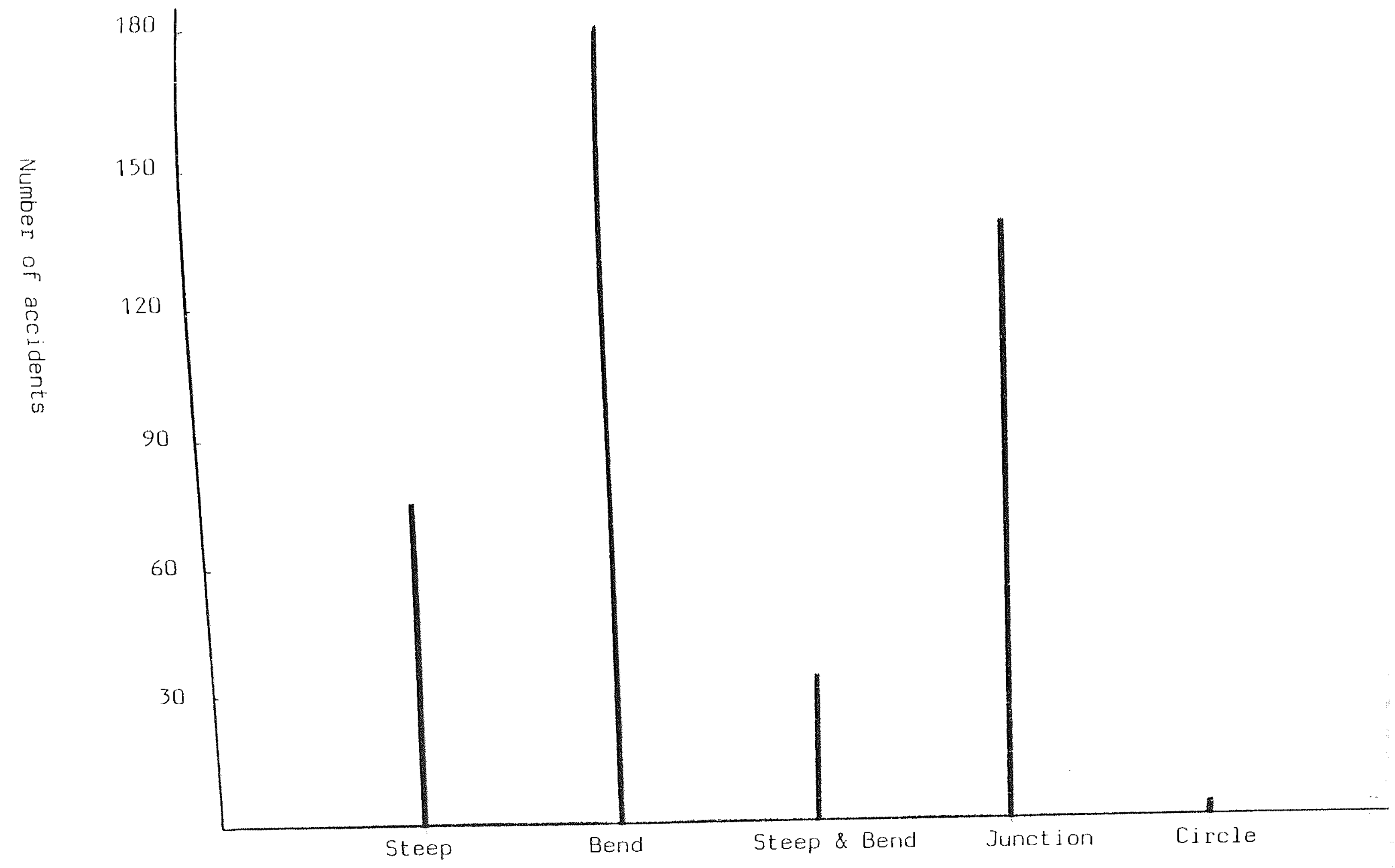


Fig.(A2-G-4). Gillan road accidents per place of collision.

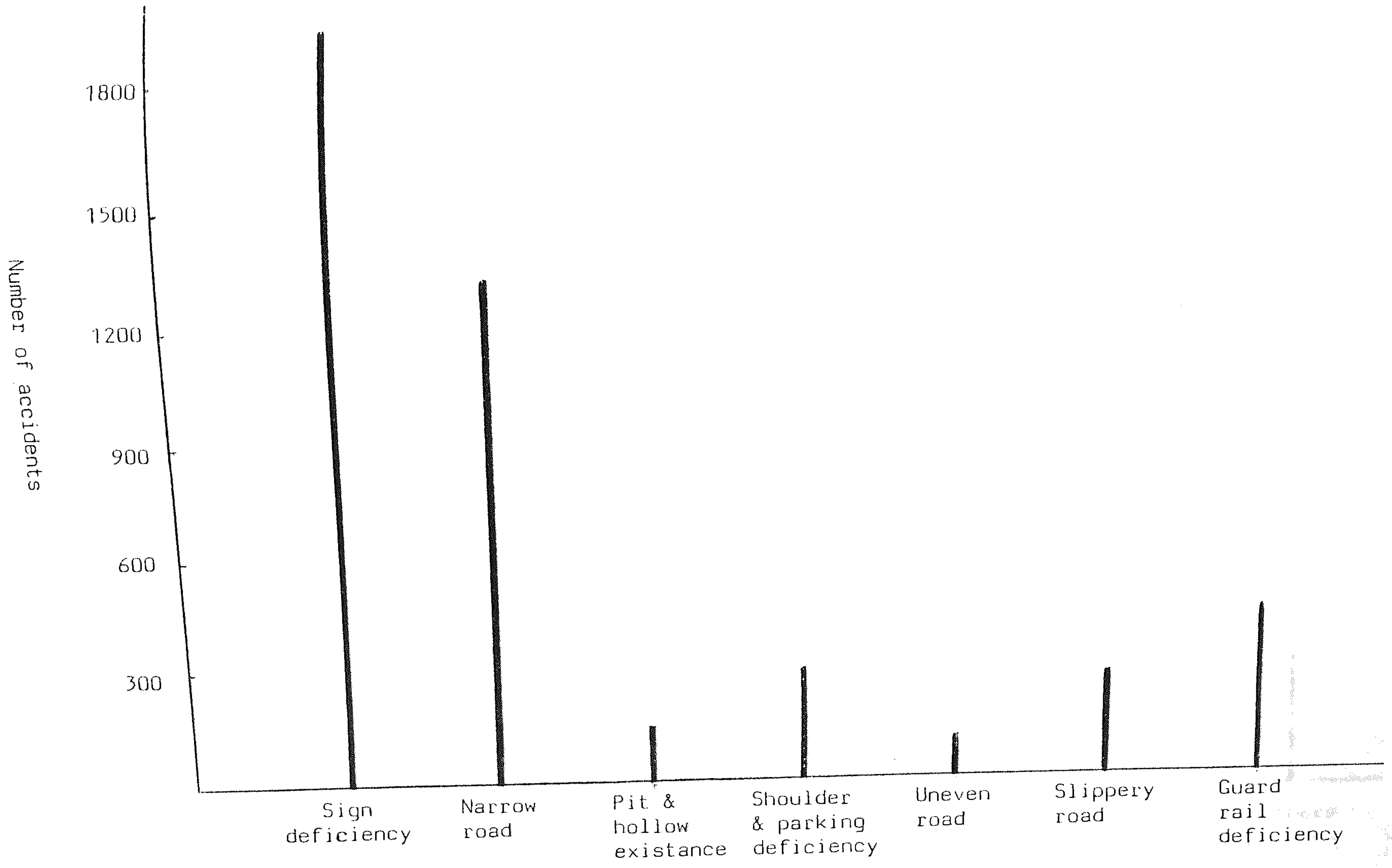


Fig.(A2-G-5). Gillan road accidents per road imperfections.

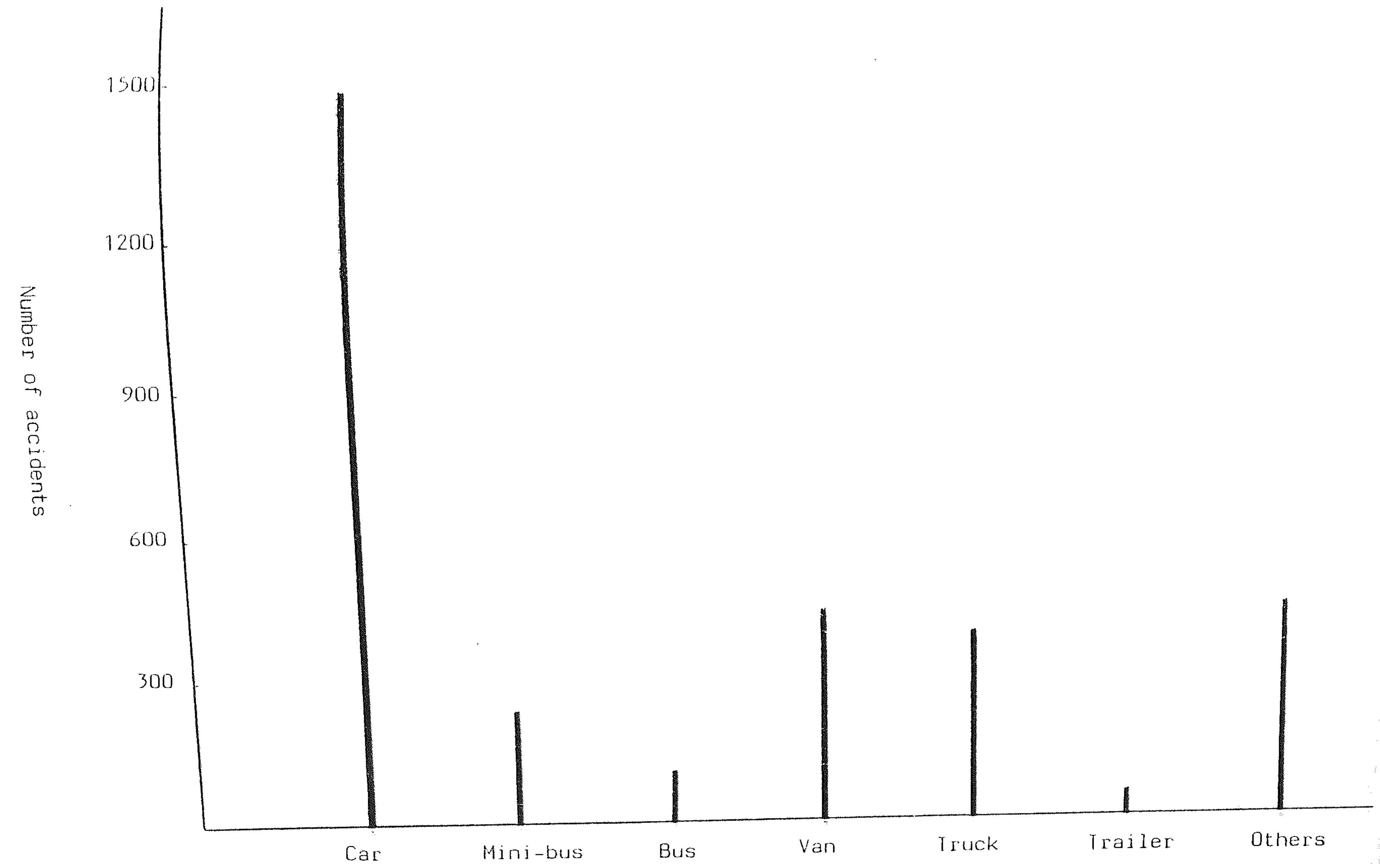


Fig.(A2-G-6). Gillan road accidents per type of motor-vehicles.

The Province of West-Azarbayejan

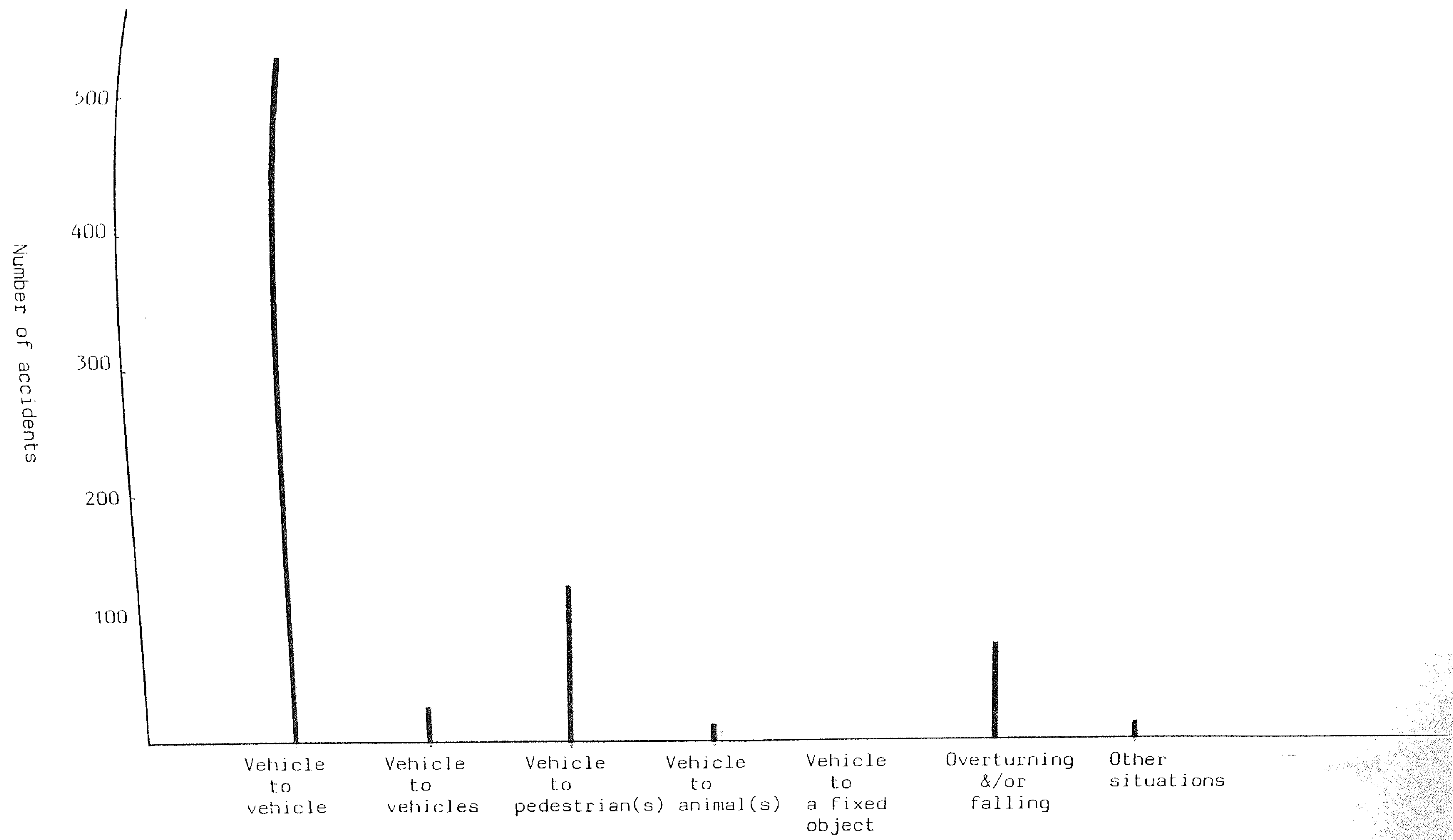


Fig.(A2-WA-1). The parties involved in road-accidents in the province of West-Azarbayejan.

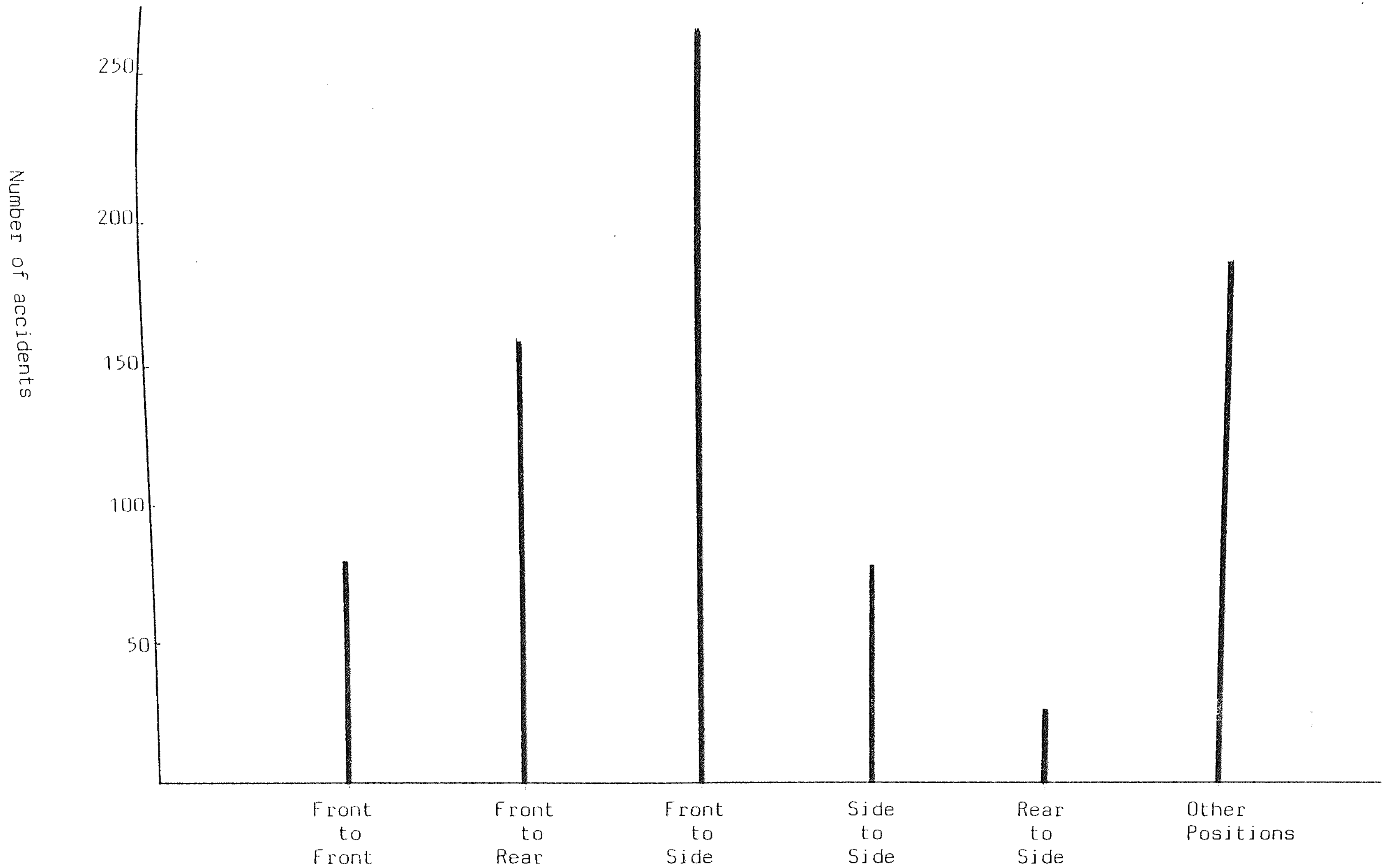


Fig-(A2-WA-2). The contact points of vehicles involved in road-accidents in the province of West-Azarbayejan.

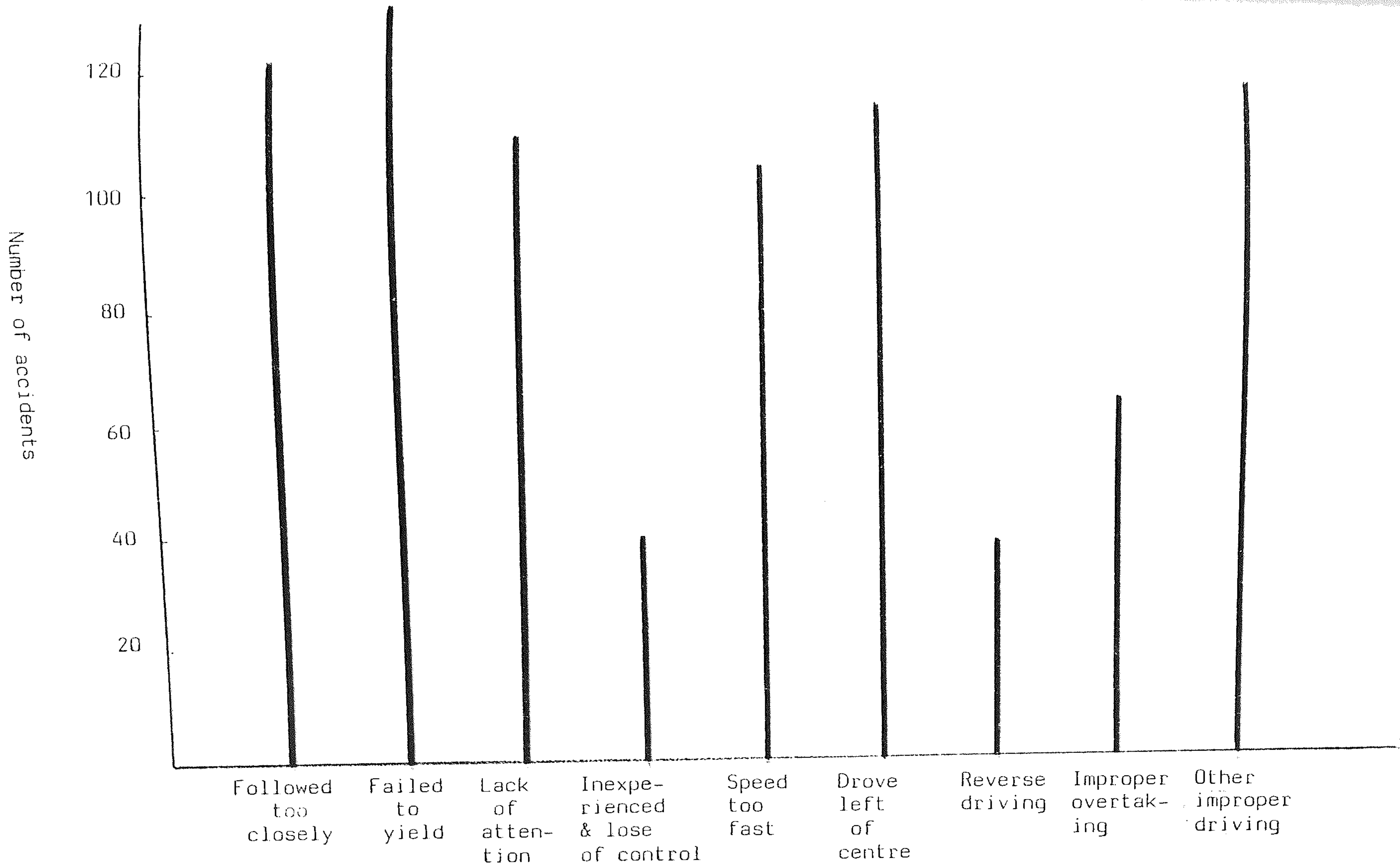


Fig.(A2-WA-3). The road-accidents caused by improper driving in the province of West-Azarbayejan.

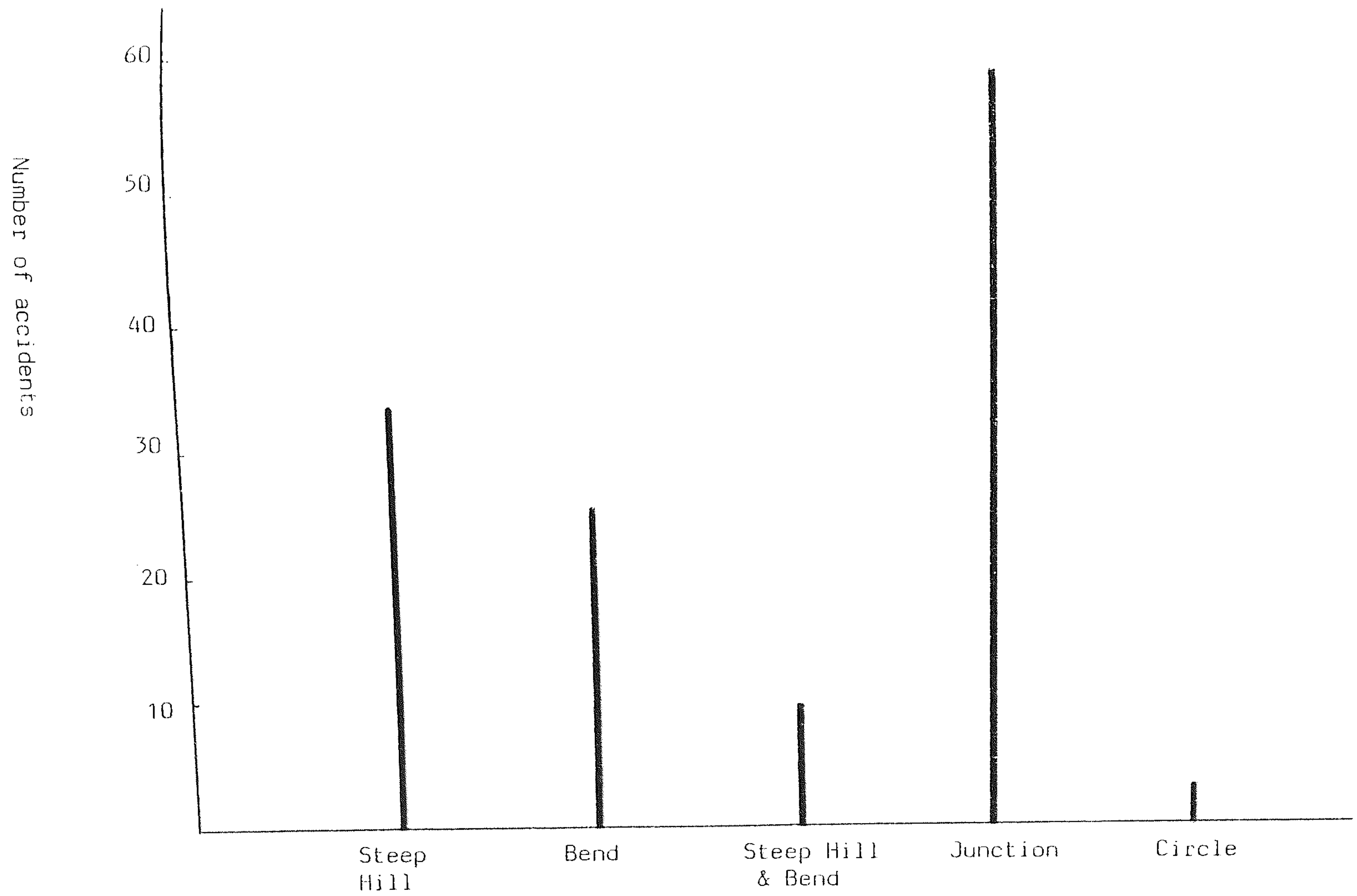


Fig.(A2-WA-4). The road-accidents for different road situations in the province of West-Azarbayejan.

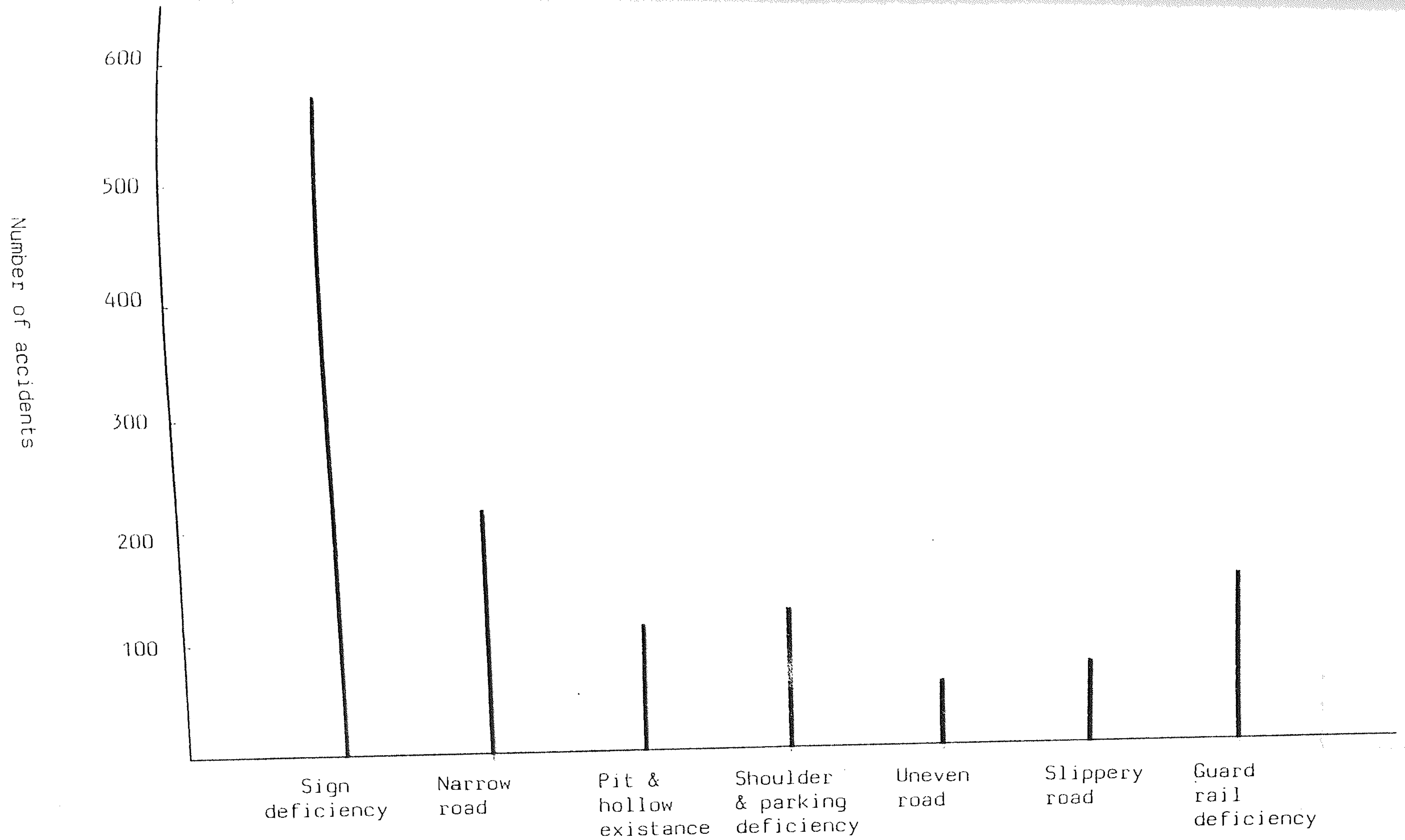


Fig.(A2-WA-5). The road-accidents caused by road imperfections in the province of West-Azarbayejan.

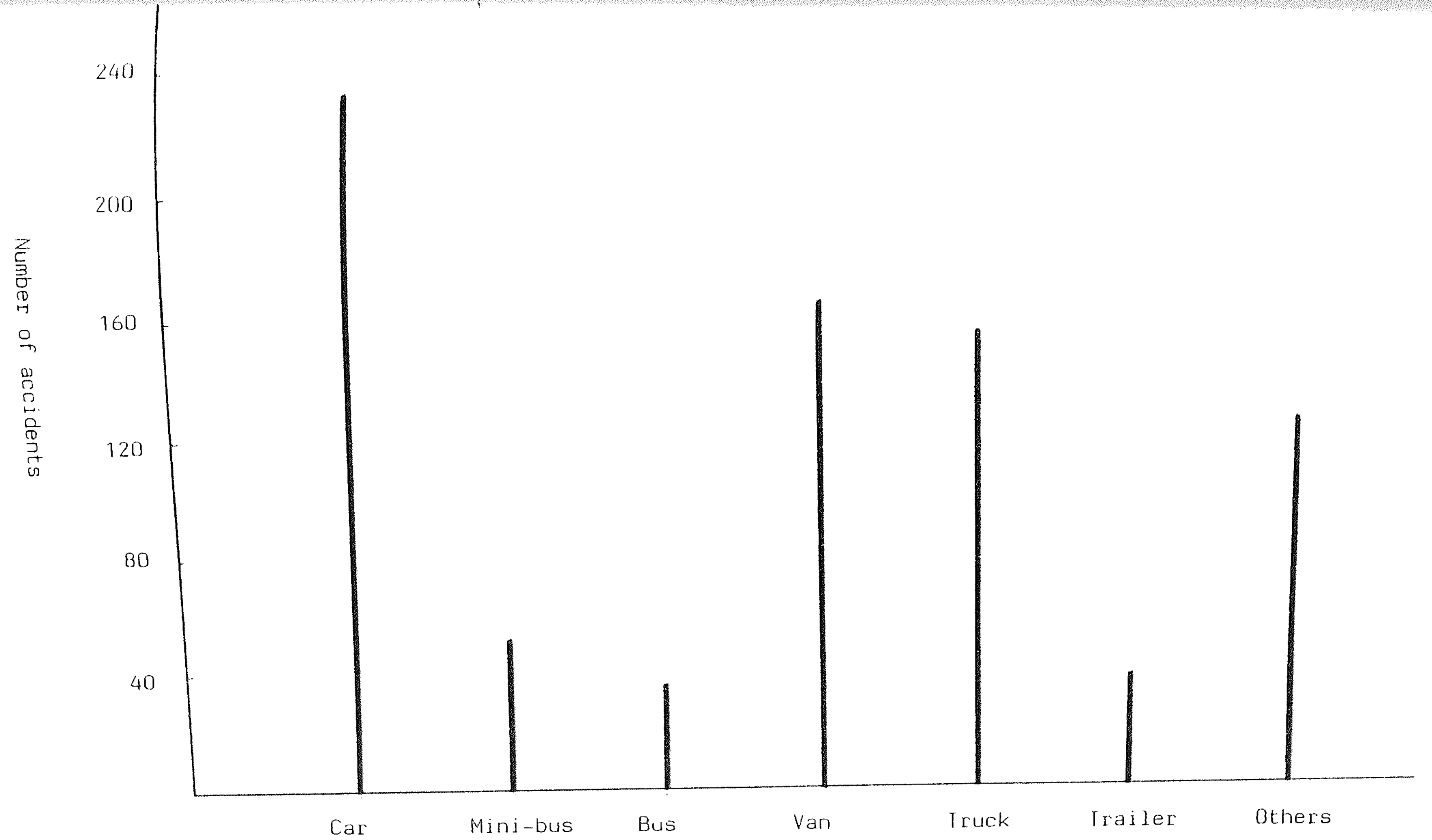


Fig.(A2-WA-6). The number of different type of vehicles involved in road-accidents in the province of West-Azarbayejan.

The Province of Esfahan

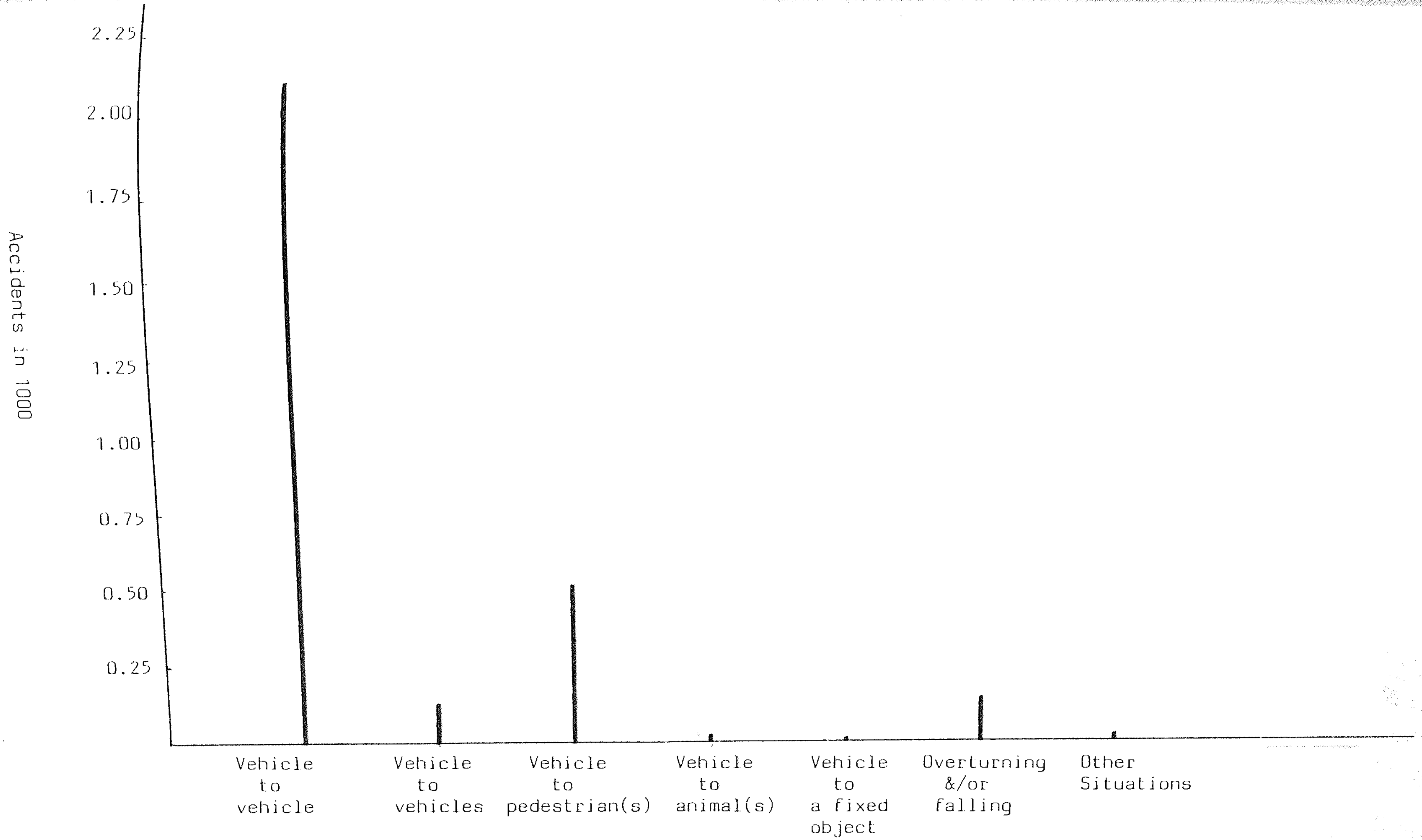


Fig. (A2-E-1). The parties involved in road-accidents in the province of Esfahan.

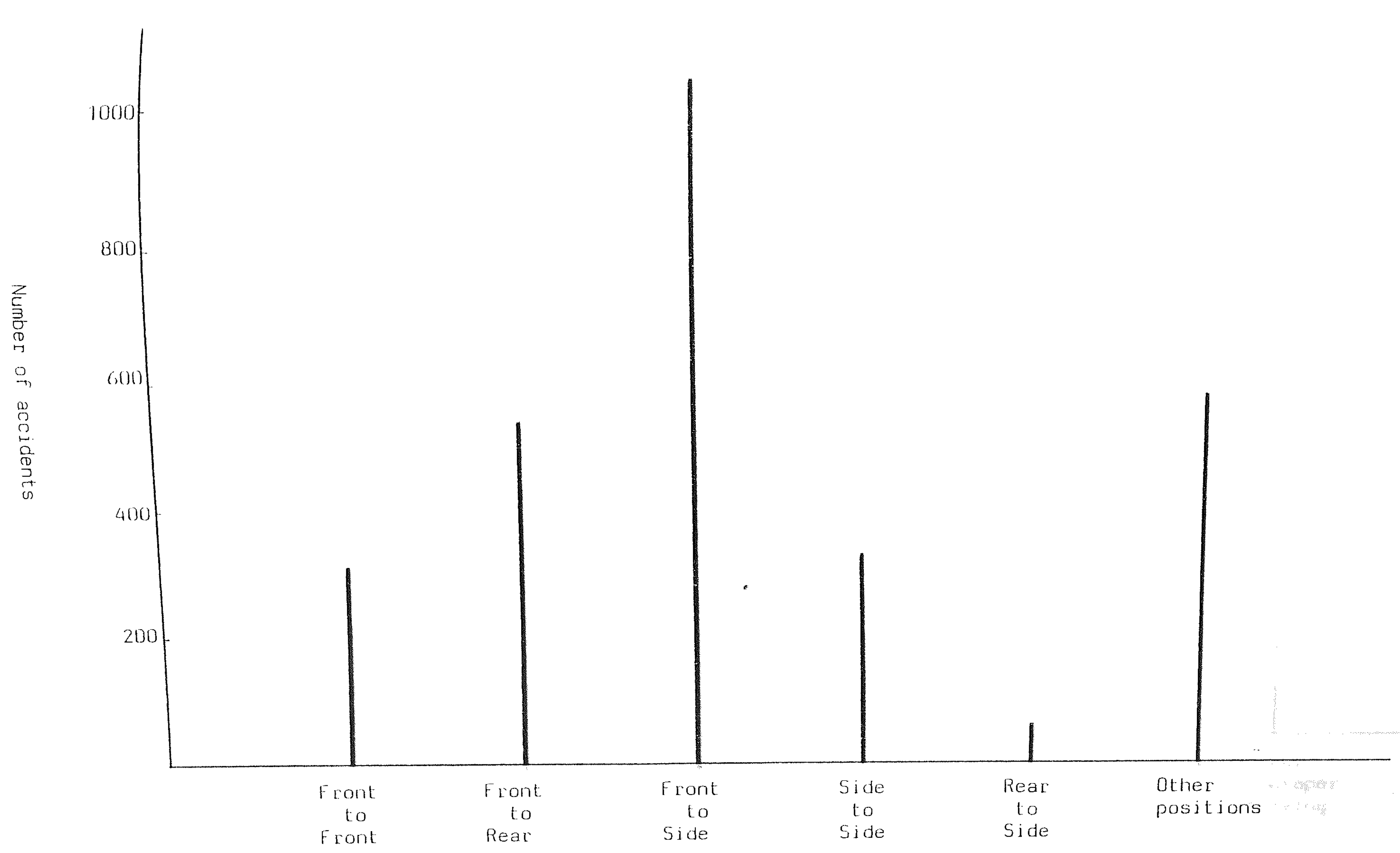


Fig.(A2-E-2). The contact points of vehicles involved in road-accidents in the province of Esfahan.

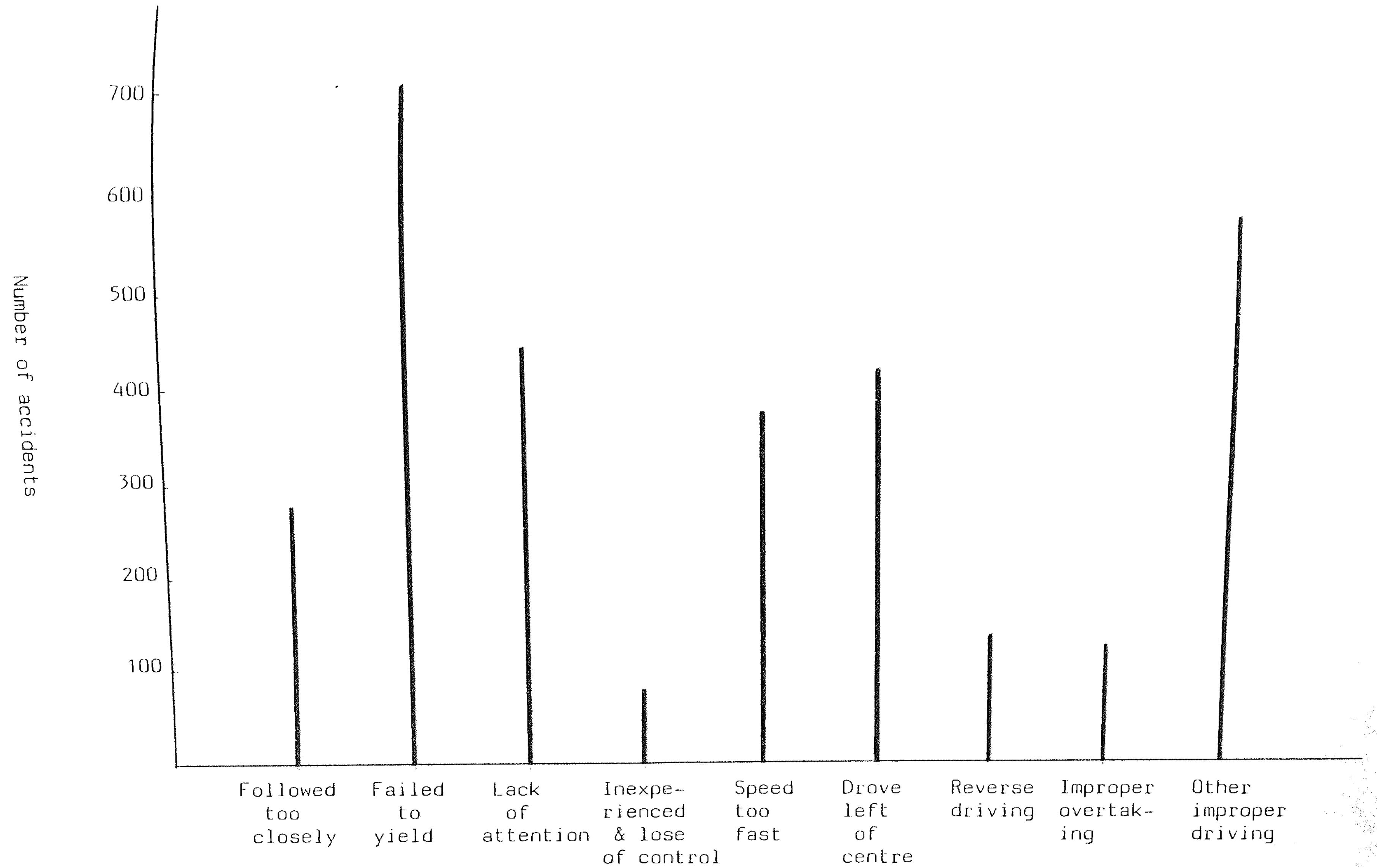


Fig.(A2-E-3). The road-accidents caused by improper driving in the province of Esfahan.

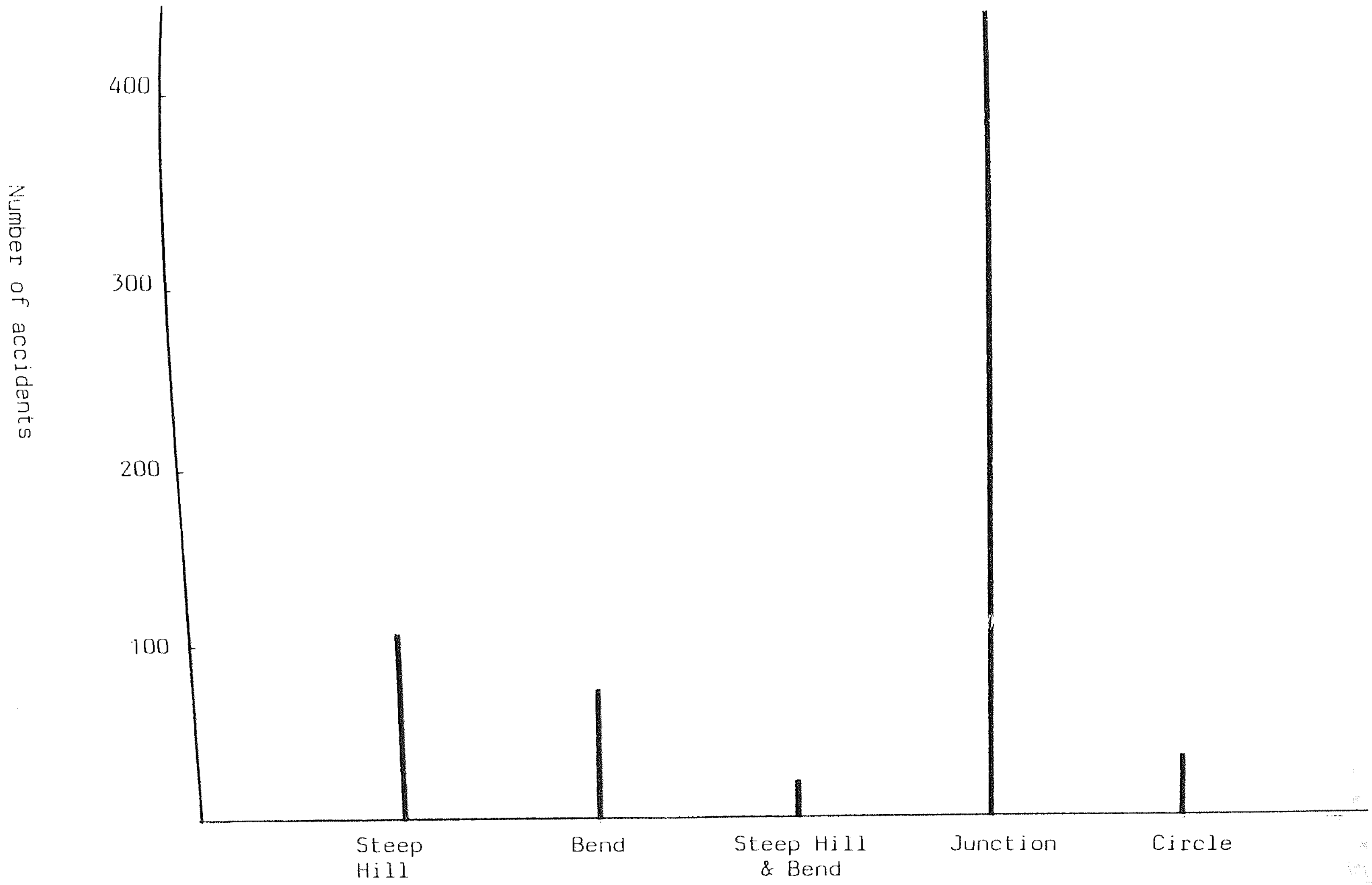


Fig.(A2-E-4). The road-accidents for different road situations in the province of Esfahan.

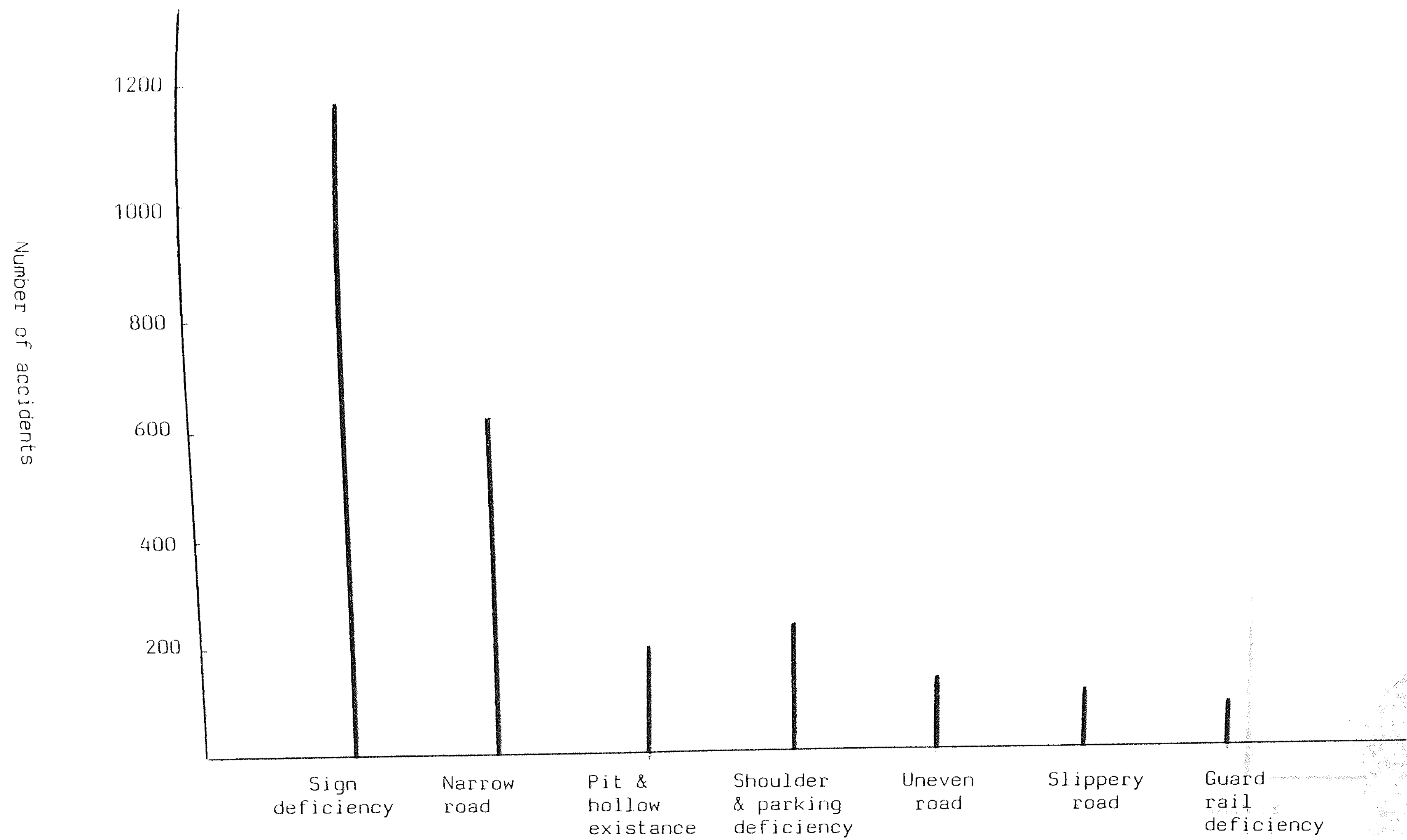


Fig.(A2-E-5). The road-accidents caused by road imperfections in the province of Esfahan.

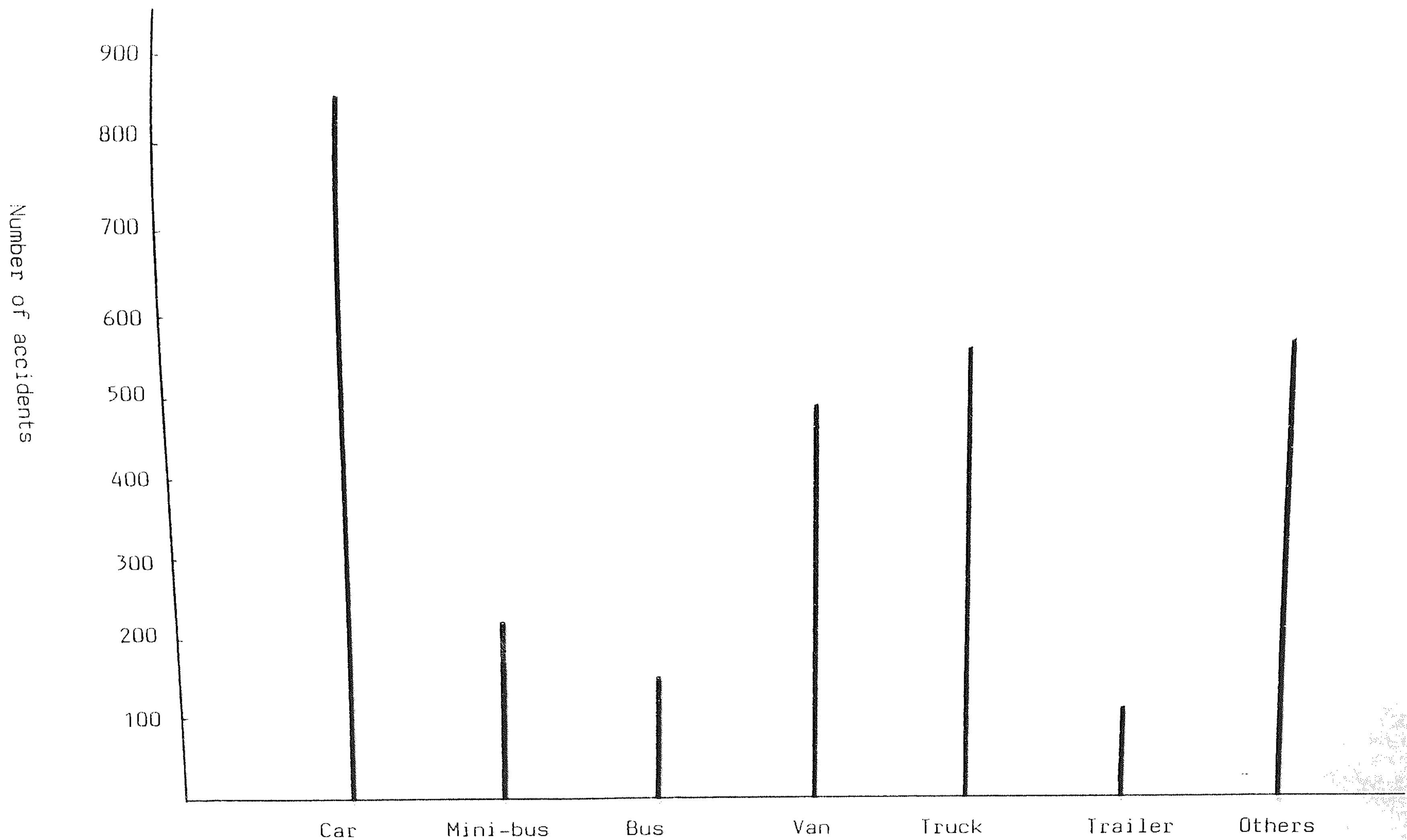


Fig.(A2-E-6). The number of different type of vehicles involved in road-accidents in the province of Esfahan.

The Province of Khorasan

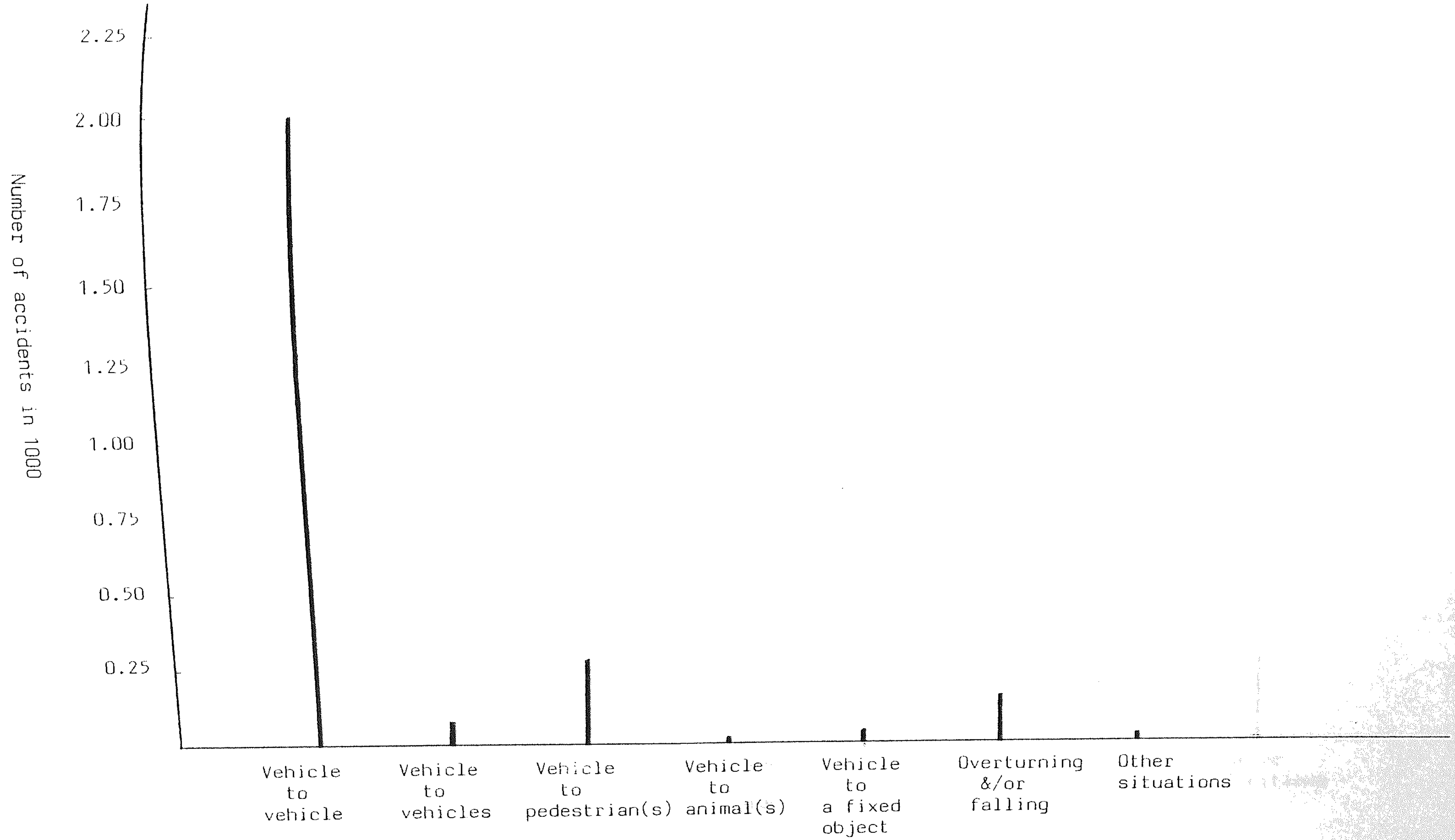


Fig.(A2-Kh-1). The parties involved in road-accidents in the province of Khorasan.

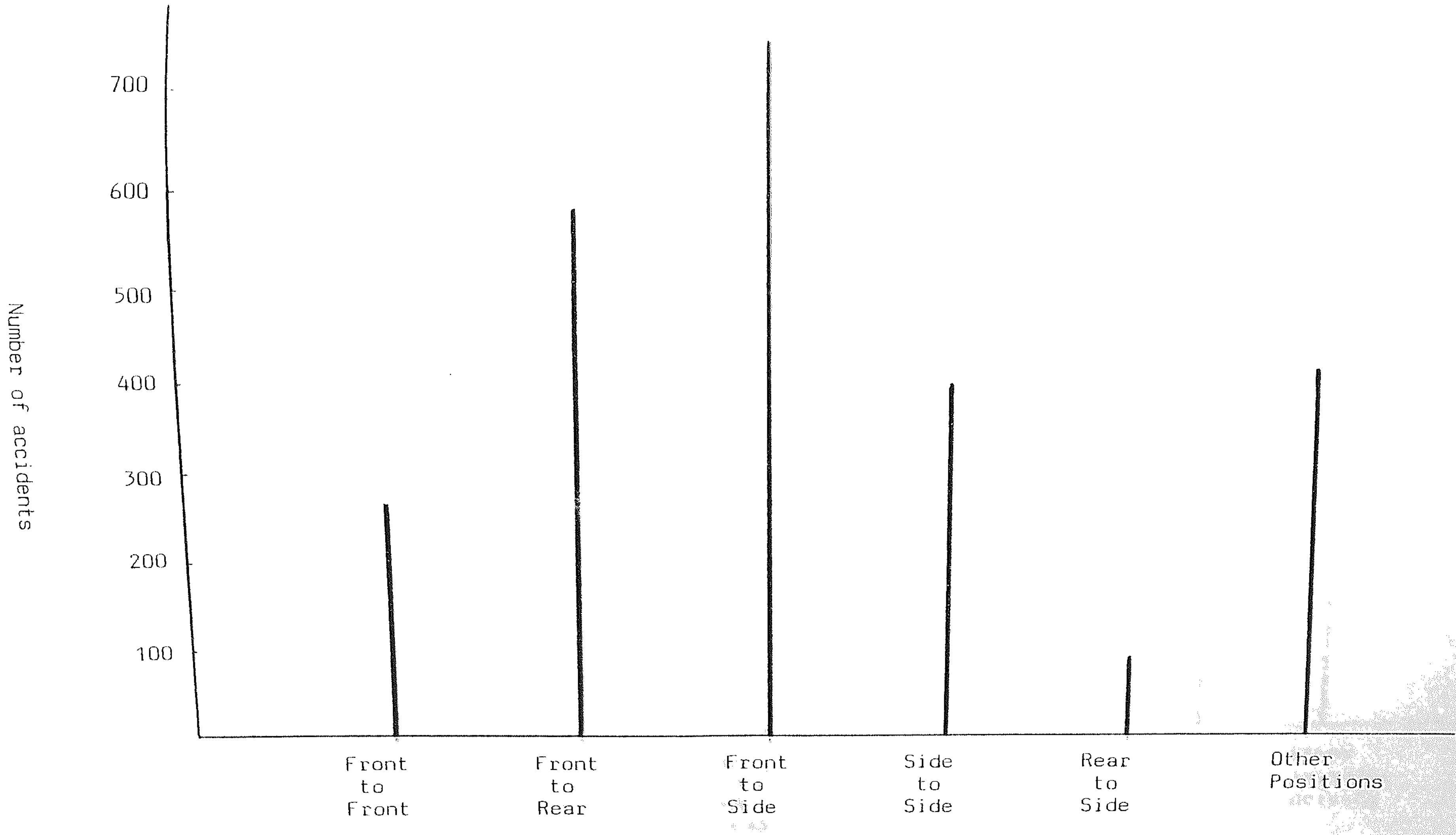


Fig.(A2-Kh-2). The contact points of vehicles involved in road-accidents in the province of Khorasan.

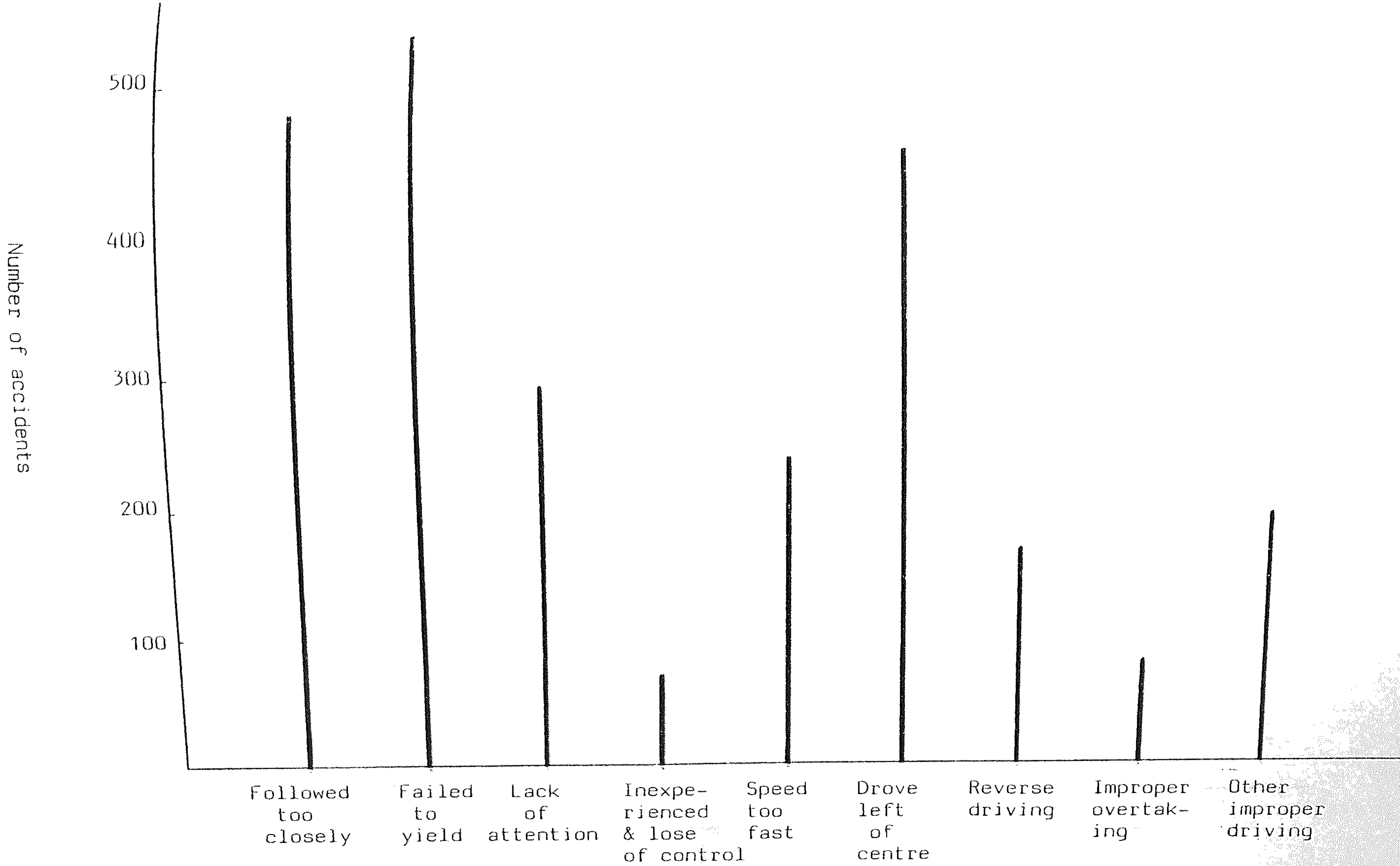


Fig.(A2-Kh-3). The road-accidents caused by improper driving in the province of Khorasan.

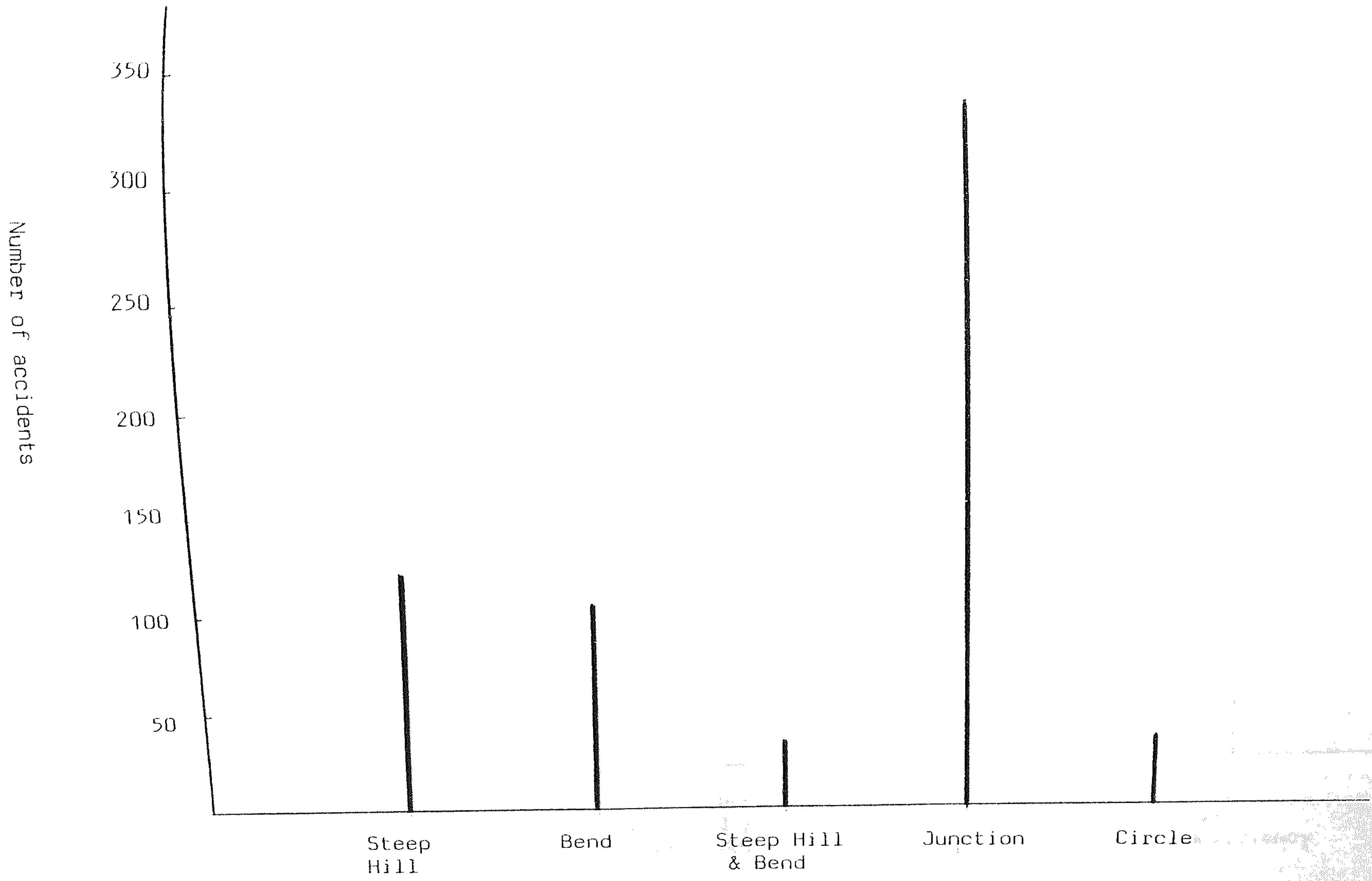


Fig.(A2-Kh-4). The road-accidents per different road situations in the province of Khorasan.

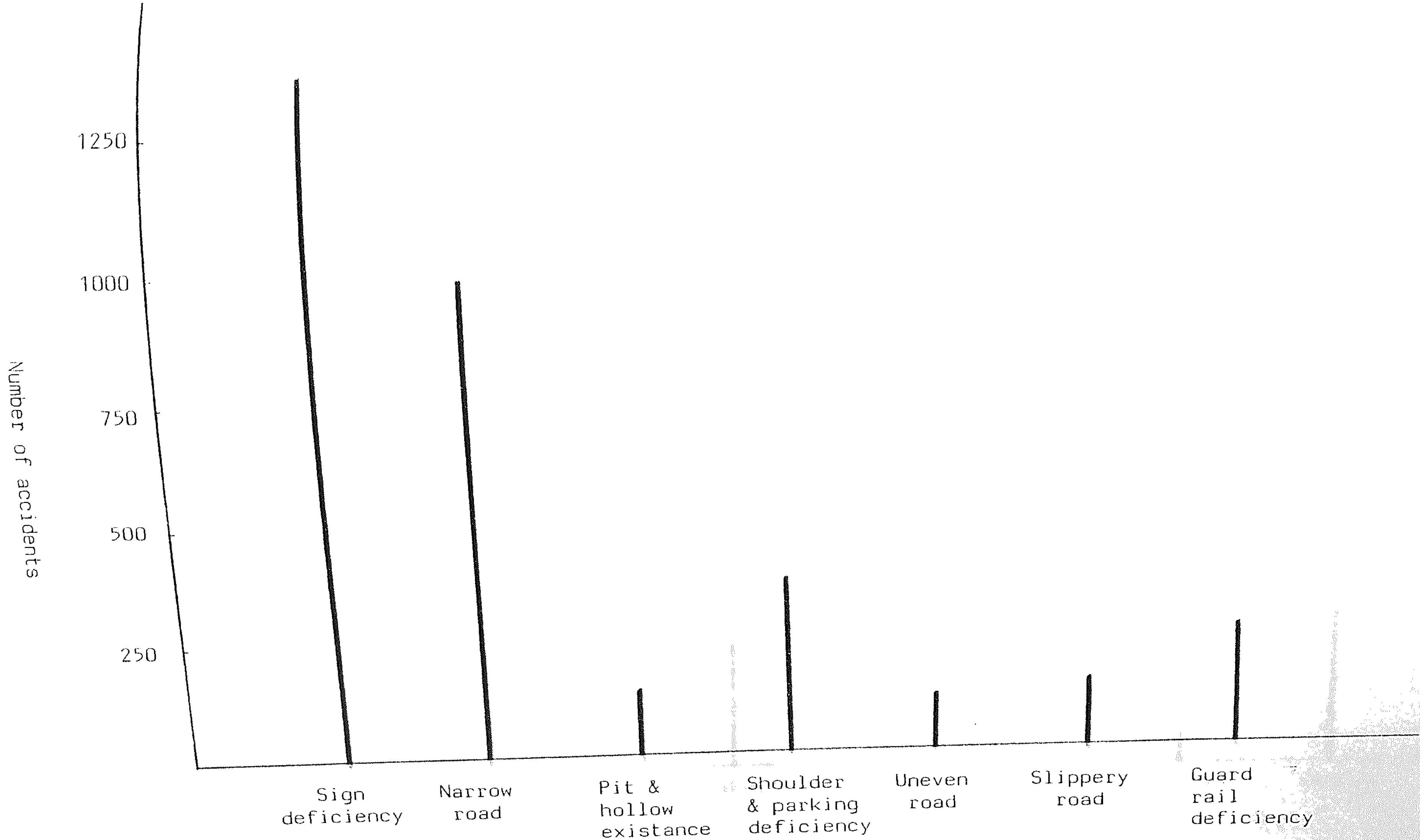


Fig.(A2-Kh-5). The road-accidents caused by road imperfections in the province of Khorasan.

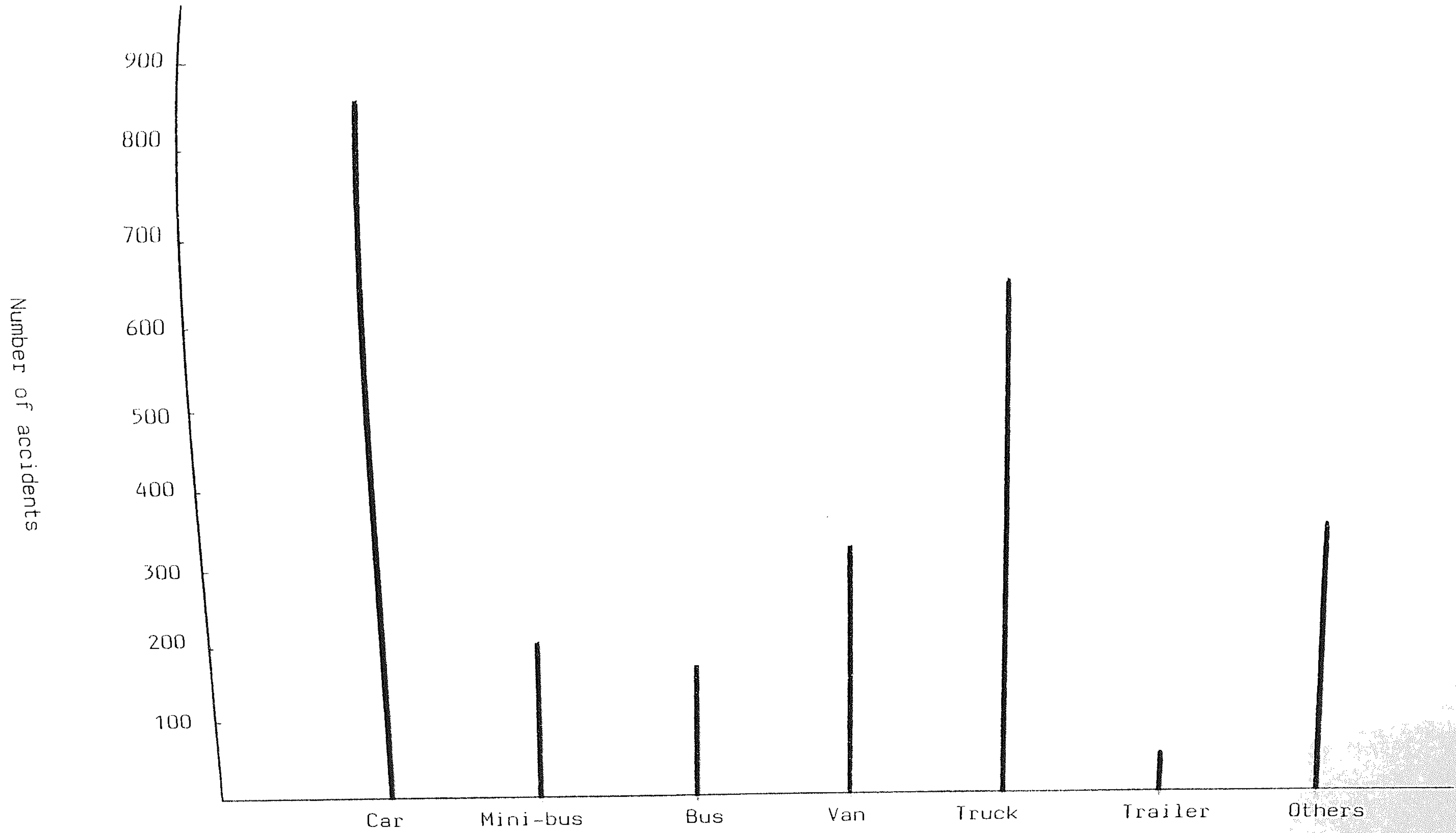


Fig.(A2-Kh-6). The number of different type of vehicles involed in road-accidents in the province of Khorasan.

The Province of Systan & Baloochestan

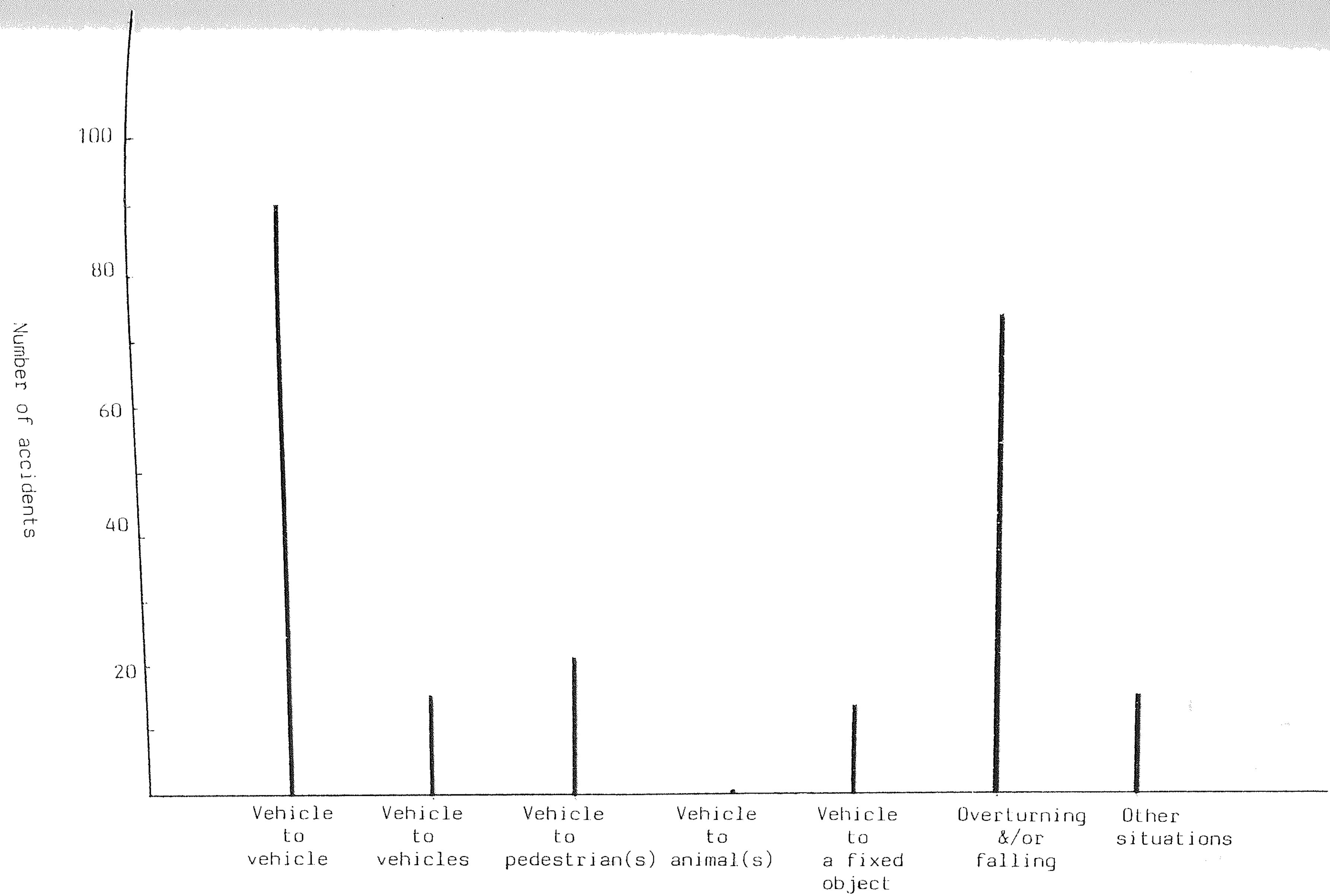


Fig.(A2-S&B-1). The parties involved in road-accidents in the province of Systan &Baloochestan.

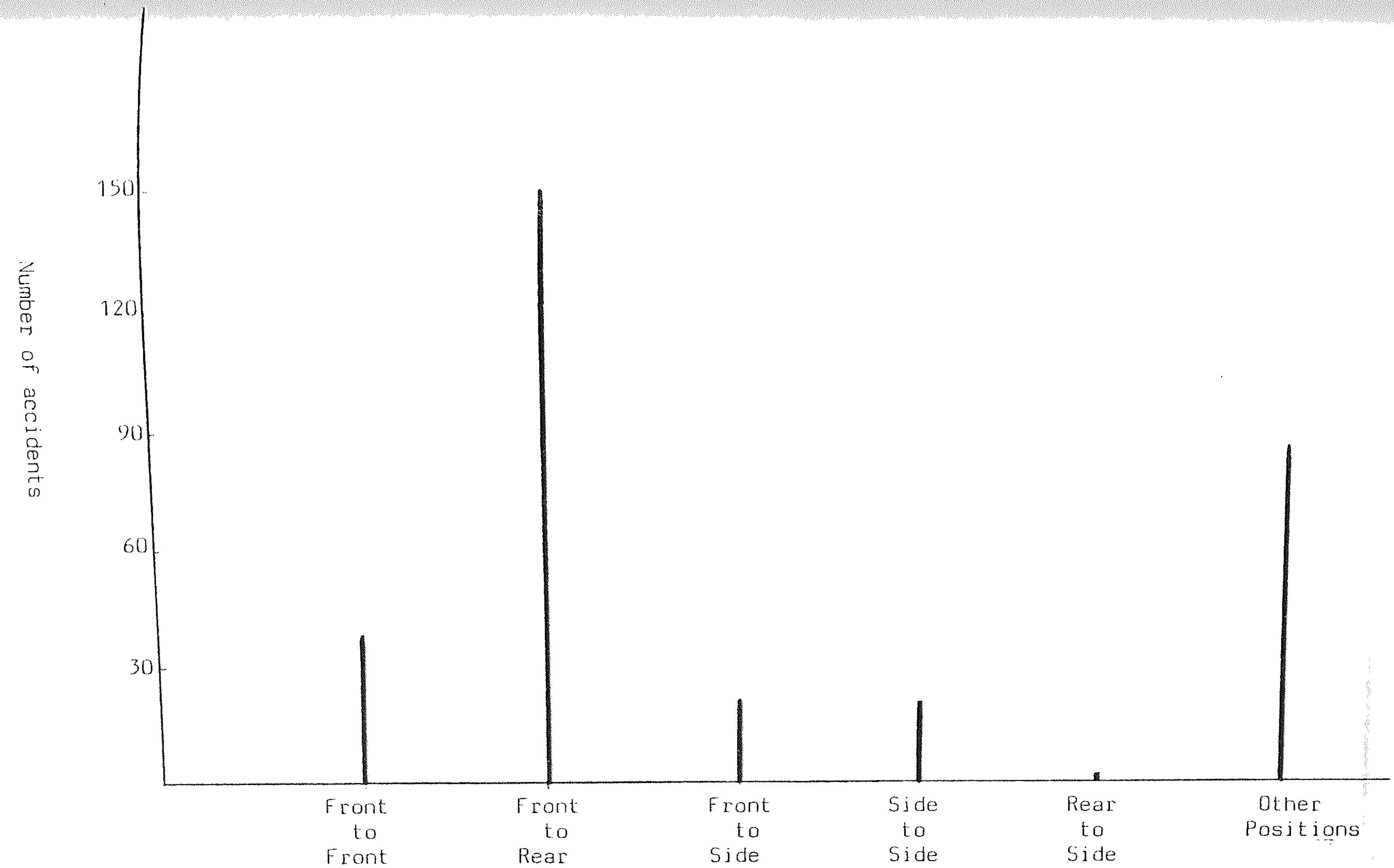


Fig.(A2-S&B-2). The contact points of vehicles involved in road-accidents in the province of Systan & Baloochestan.

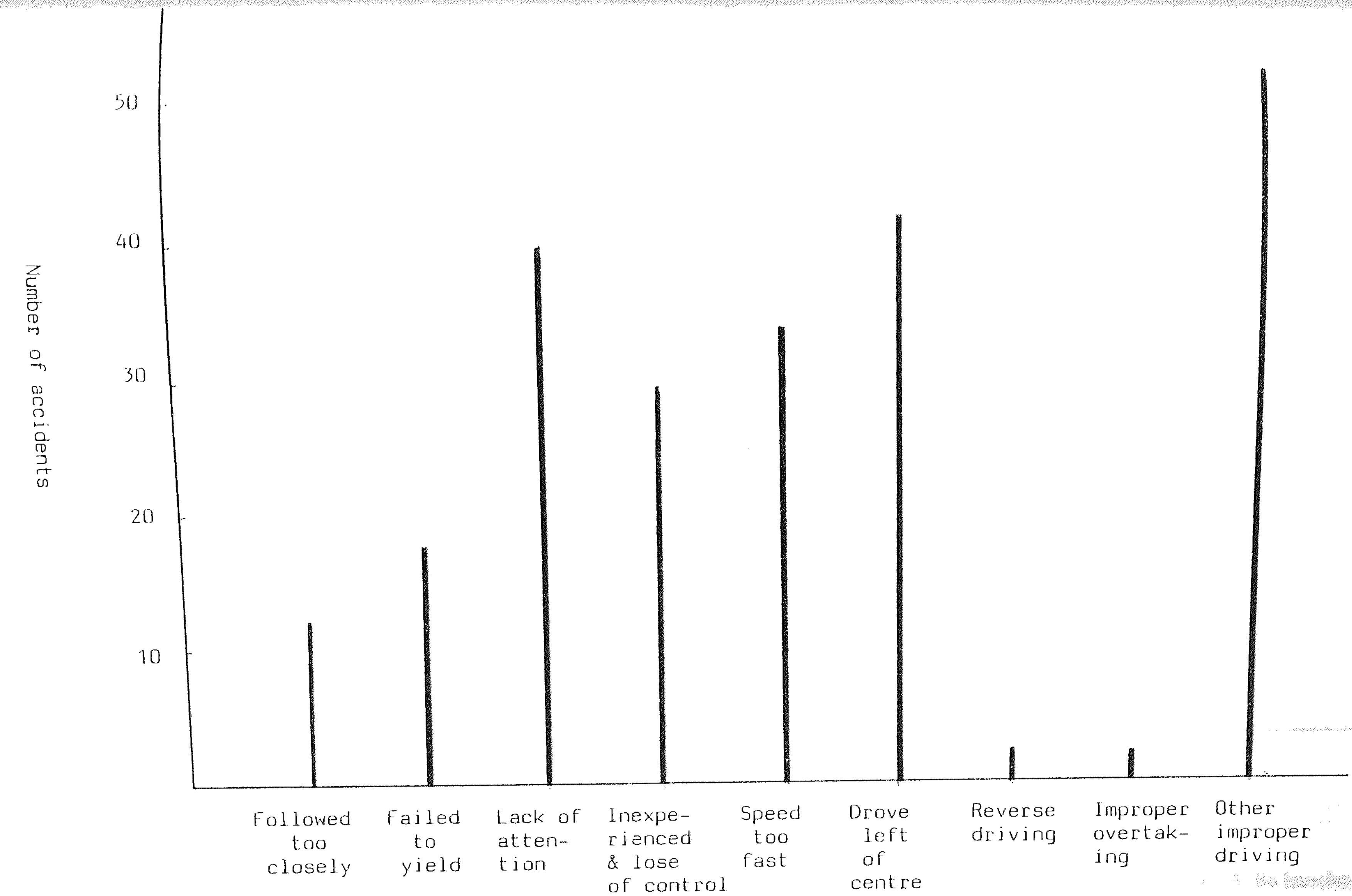


Fig.(A2-S&B-3). The road-accidents caused by improper driving in the province of Systan & Baloochestan.

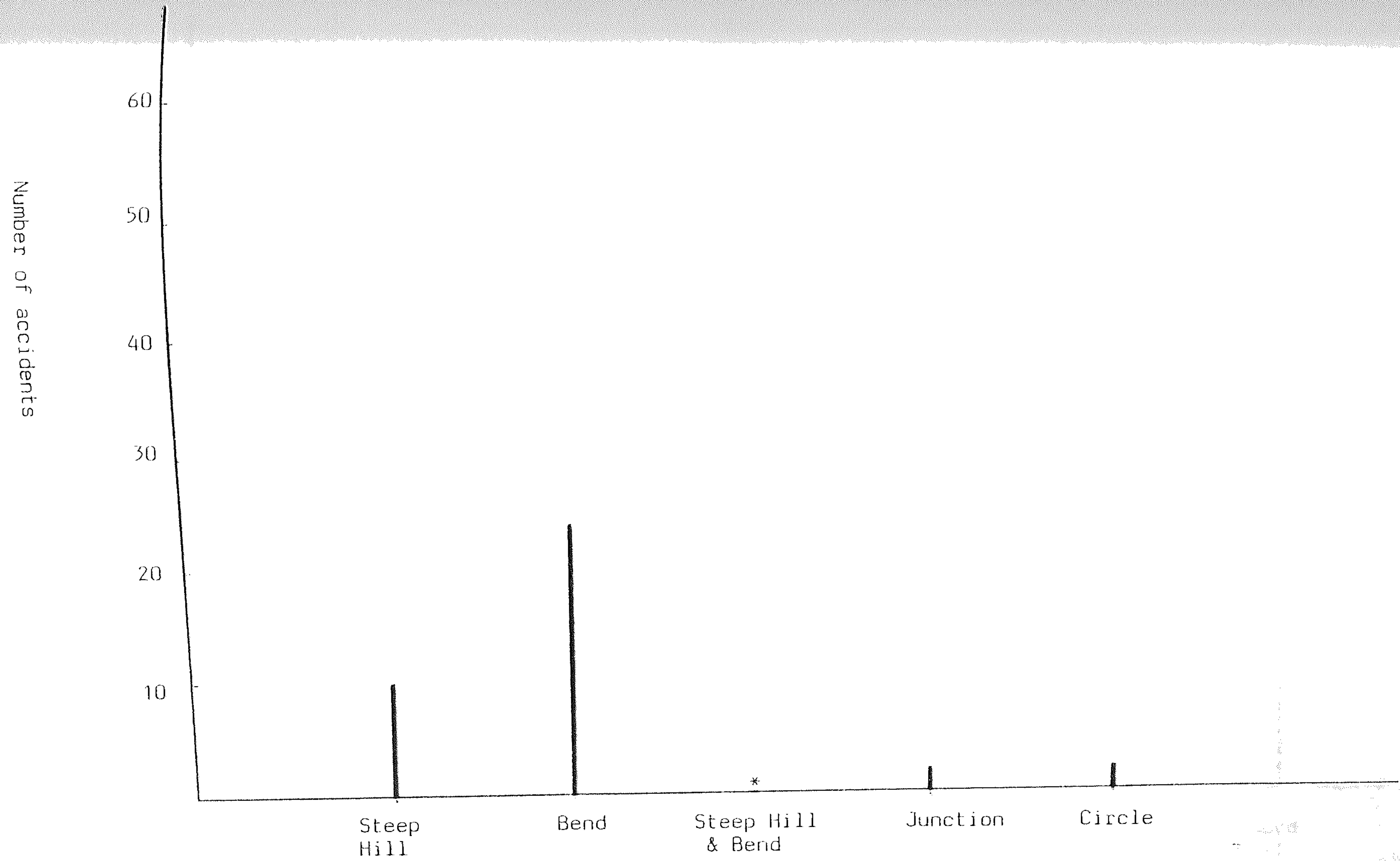


Fig.(A2-S&B-4). The road-accidents for different road situations in the province of Systan & Baloochestan.

*) No case has been reported.

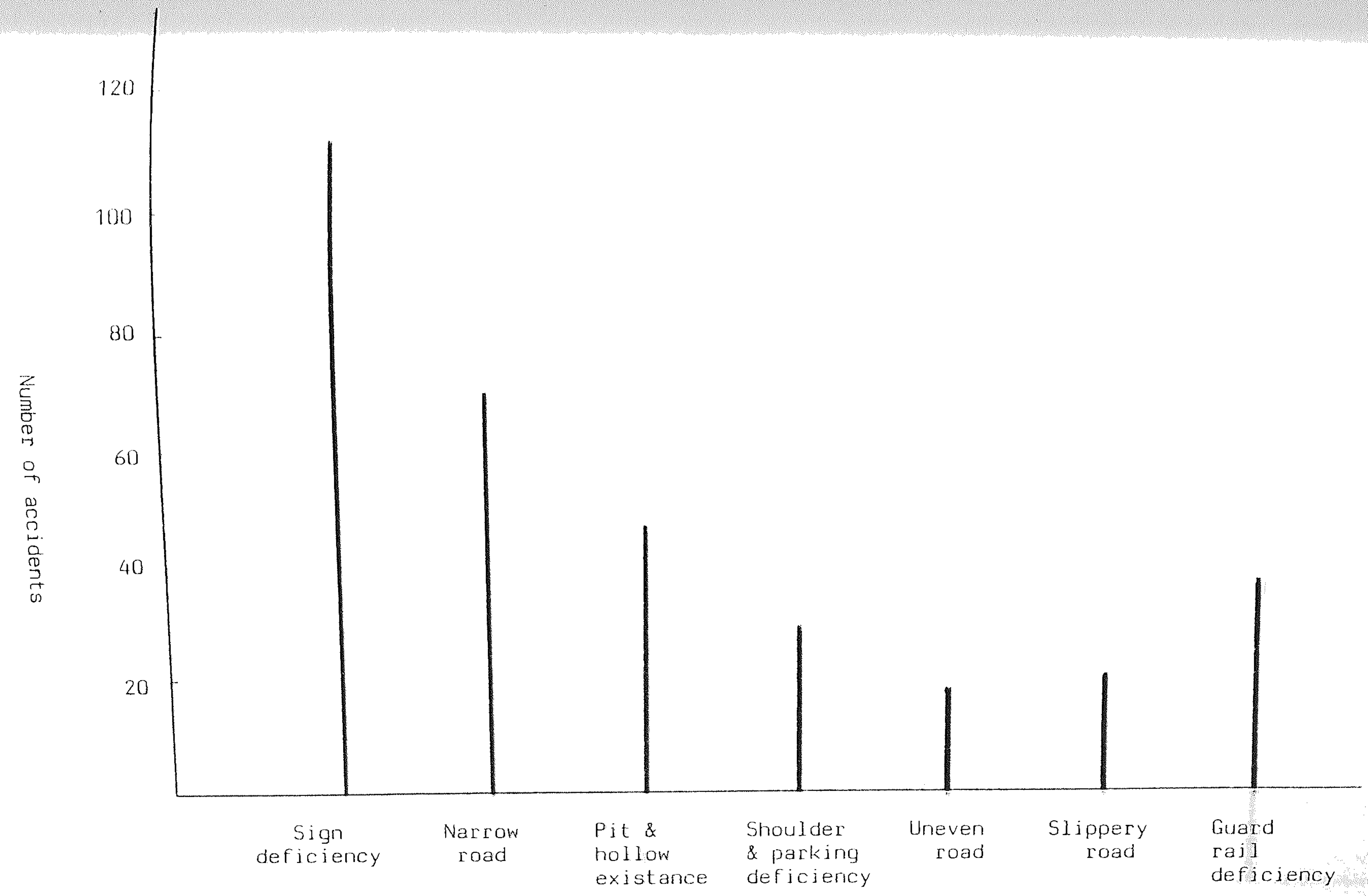


Fig.(A2-S&B-5). The road-accidents caused by road imperfections in the province of Systan&Baloochestan.

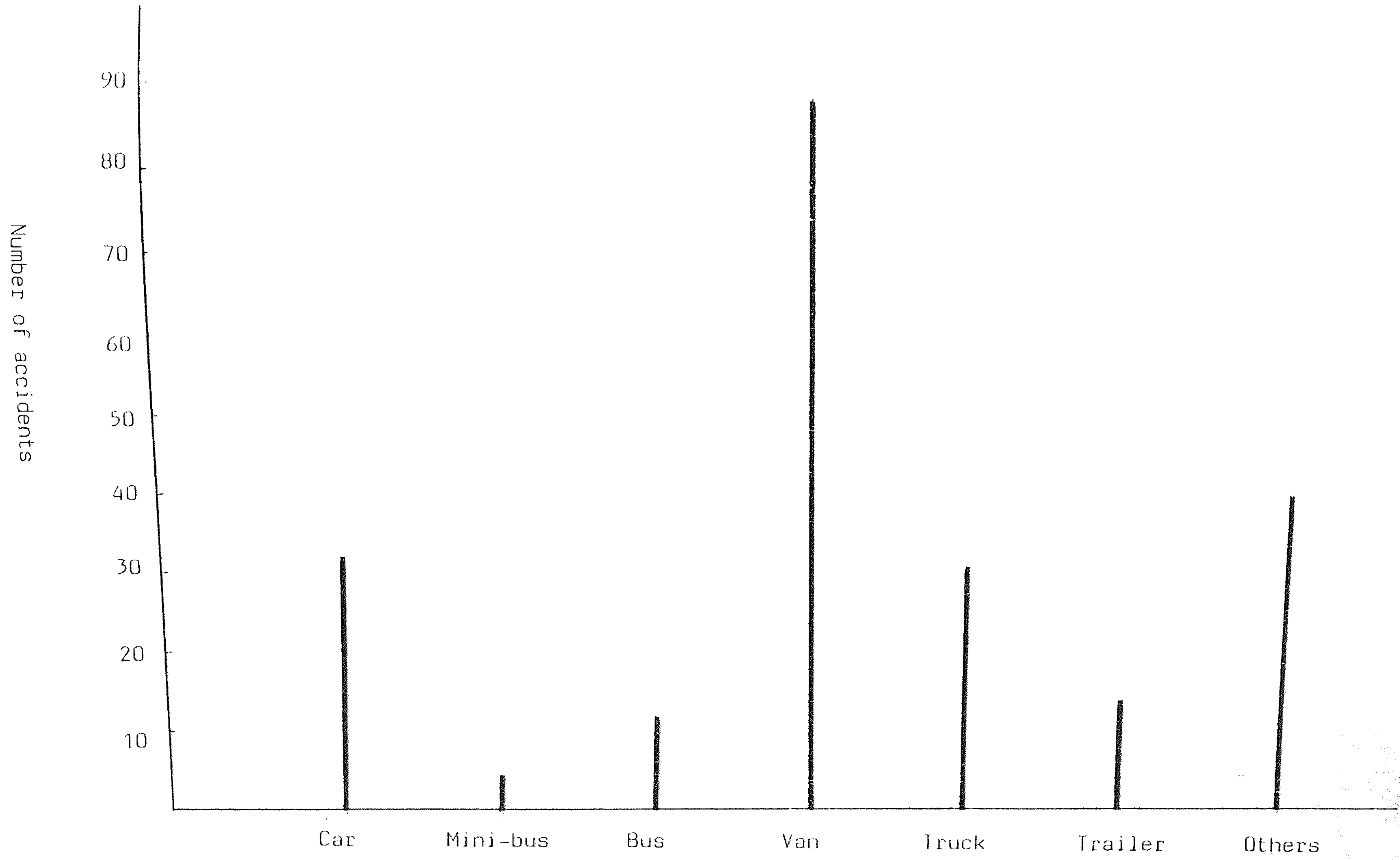


Fig.(A2-S&B-6). The number of different type of vehicles involved in road-accidents in the province of Systan&Baloochestan.

Appendix 3

An Approximate Cost-Benefit Analysis of Road Safety Measures in Iran

A3-1. Introduction

As it was explained in sub-section 6-3-6, in this research-work only "the cost of road-accidents" and not "the cost of road-accidents' prevention methods" has been considered and evaluated.

Also, in introduction to chapter seven, it was mentioned that in this research-work the cost of road-accidents generally, and for Iran specifically is investigated. But further research-works will be needed to evaluate the cost and possible range of benefits in terms of accident reduction of different prevention methods. After that,the combination of them can be exploited for appraisal of the related safety projects in Iran. Nontheless however, it is intended in this Appendix to expand a little more on the costs of some of the measures proposed for Iran.

These unit-costs will be only ranges and an approximate cost-effectiveness/benefit analysis of certain engineering counter-measures already implemented in Iran, will be introduced.

A3-2. Road-Safety Measures in Iran

a) Road alignment is usually implemented only on hot asphalt concrete pavements. It is either hot painting or cold painting, each of them with or without reflecting components.

b) Sign posts are widely different and depends to the road class and nature of the land.

c) Guard-rails' useage are mostly restricted to mountainy ragions and precipice places.

d) Reflectors are installed along the centre-lines and sometimes along the road-edges mostly in hot regions, because in the places where there is a need for snow-wiping, usually they are taken away by the snow-wiping equipments' blades.

e) Traffic-light signals:

Their usage frequency depends on the frequency of junctions along the road and the number of villages and population centres on its two sides. Also it depends on the possibility of providing electricity power in the place.

A3-3. Road-Safety Unit-Prices in Iran

The road-safety equipments and materials are mostly built in Iran by the "company of making road-safety devices of Iran", Registration number :3107. This is an affiliated company of M.R.T and can import its required raw-materials from abroad by "state-foreign currencies" for the Ministry of Road and Transport in 1987. These prices are 90% state-prices*.

Therefore, the prices quoted below, are the official prices supplied by that company.

Table A3-1

Safety-equipments' Unit Prices in Iran (1987)

No.	Description	Unit	Unit Prices Rials	Additional explanations
1	Large informing signs	m^2	13260	For Motor-ways
2	Circle signs (radius=75cm)	1	5850	"
3	Triangle signs (each face=95 cm)	1	3250	"
4	Circle signs (radius=60 cm)	1	5070	For Mjor roads
5	Triangle signs (each face=60 cm)	1	2600	"
6	75x50 cm informing signs	1	4420	"
7	50x50 cm "	1	2925	"

*) See section 7-6, for explanation.

No.	Description	Unit	Unit Prices Rials	Additional explanations
8	60x40 cm informing signs	1	2860	For Major roads
9	70x50 cm "	1	4160	"
10	80x40 cm Arrow sign	1	3900	
11	60x45 cm "	1	3380	
12	30x45 cm "	1	1690	
13	Octagonal Stop sign (radius= 75 cm)	1	6500	
14	Stop sign (radius= 60 cm)	1	5850	
15	Sign-post* (Aluminum)	Kg	130	
16	Two-side reflector (86 eyes)	1	390	
17	one-side reflector (43 eyes)	1	300	
18	Sticking-plaster for instaling reflectors**	Kg	845	
19	Aluminum stud (pedestrian crossing)	1	250	
20	Guard-rail+	Kg	169	

No.	Discription	Unit	Unit Prices Rials	Additional explanations
21	Blinking traffic-light (3 lights)	1	60000	
22	Cold alignment paint without reflectors	Kg++	515	

*) 1.50^{m} ~ 4 Kg
2.00^{m} ~ 15 Kg
3.00^{m} ~ 22.5 Kg

**) 100 grams for installing each reflector.

+) One metre ~ 15 Kg

++) 110 grams for one metre solid alignment.

A3-4. Introducing One Example of High Cost-Effective Safety Project Recently Implemented in Iran

A3-4-1. Delbaran Junction Improvement in "Emam Taghi"

(See scketch A3-1)

This is a place where the two major roads of Mashad-Neyshaboor and Torbat-Mashad and the minor road of Fariman intersect. Before the junction improvement, this was a cross-junction(+) with a high toll of very severe accidents. The approximate estimation of Khorasan M.R.T is that there were at least one severe accident with 7-8 fatalities each month. In the junction improvement, a quadrangle with a total length of one kilometre and the cost of 100 million Rials was built in the place and brought the spot-accidents to almost zero.

The approximate cost of a severe accident with 7-8 fatalities and 20-25 severly injured, using the results of this research-work, is:

a) The average cost of vehicle (Table 7-5)
2.58 million Rials

b) The average medical costs of severely injured (Table 7-8) 22.5x3,500,000=78.75 million Rials

c) The average working hours lost of severely injured (Tables 7-8 and 7-11)
22.5x2520x238=13.50 million Rials

d) The average cost of administrative expenses (sub-section 7-7-1-4)
(2x10,443,700+1,662,729)x1000:33351=0.67 million Rials

e) The average lost future output of the victims (Table 7-12)

7.5x16,550,000=124.12 million Rials

f) The average subjective costs (sub-section 7-7-3):

fatalities: 7.5x14300x278.5 = 29.87 million Rials

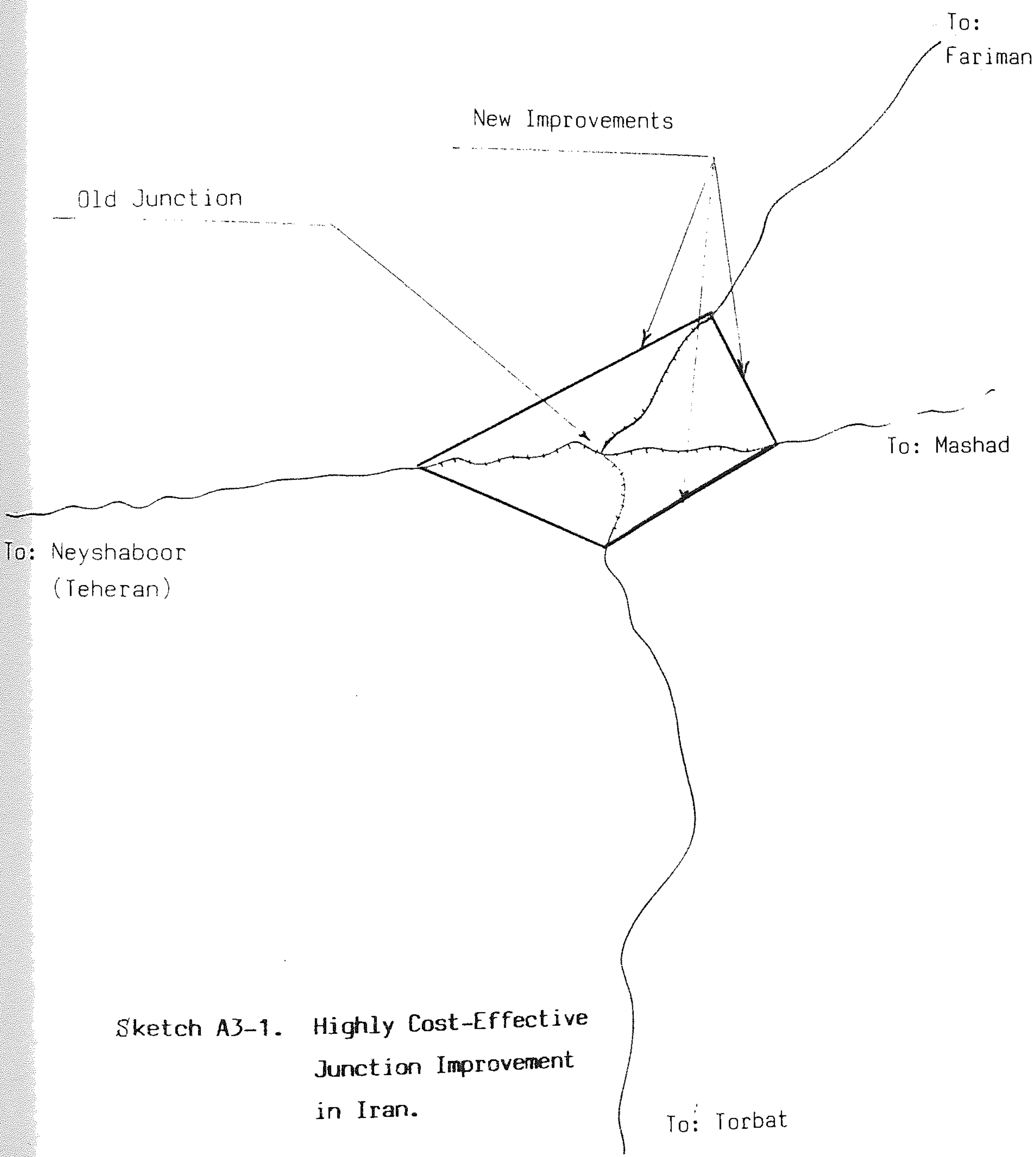
injuries : 22.5x570x278.5 = 3.57 " "

Total = 253 million Rials

As it was mentioned before, the total cost of this junction improvement has been only about 100million Rials, whereas the cost of each of the severe accidents occured at least once a month in this junction, has been 2.5 times of the total cost of improvement. Therefore, this was one of those very cost-effective remedial measures.

The commonly quoted method of investment appraisal used by such funding organisations as, the World Bank is, to calculate the internal rate of return of a project. The internal rate of return may be thought of as the discount rate which reduces the net present value of a stream of net benefits from a project to zero.

In the example quoted here, the immediate benefits are so high that there is no sensible internal rate of return which can be applied. On average the investment is returned many fold each year. Clearly this is an extreme example, but it does show the potential for investment in road-safety measures.



Sketch A3-1. Highly Cost-Effective Junction Improvement in Iran.

List of References

1. Adduci, V.J. (President and chief executive officer of the Motor Vehicle Manufacturers Association of the United States), "Accident data-key link in highway safety chain", 10th IRF World Meeting, Rio (Brazil), 1984.

2. Alder, H.A., "Economic appraisal of transport projects", Indiana University Press, Bloomington, Indiana, 1971.

3. Anani, B. "Impact of geometric design on highway safety at some intersections in Jordan", 10th World Meeting, IRF, Rio, 1984.

4. Armando, G.B. "Safety and geometric design of highways in Argentina", 10th World Meeting, IRF, Rio, 1984.

5. Atkins, A. "The economic and social cost of road accidents in Australia", Rep. No. CR21, Melborne Univ., June 1981.

6. Ayati, E. "The ways for the expansion of research in the society and in the universities", a paper submitted to the first seminar of Iran universities in Mashad (Iran) for "investigation of research problems in the universities of Iran". Printed by the University of Mashad, Farsi language, 1985.

7. Bailey, S.E. "Can the influence of police activity on driver behaviour, traffic flow and accidents be quantified in cost benifit terms", P.T.R.C seminar proceedings, June 1972.

8. Bimeh Iran (the biggest insurance company in Iran), "The list of compensation amounts paid in 1982 & 1983", enclosure of the letter No. 10-A-326/9th May 1985 from Bimeh Iran to M.R.T of Iran, Farsi language, 1985.

9. Blomquist, G. and Jones - Lee, M.W. "Estimating the value of life and safety". Amsterdam, 1982.

10. Bridle, R.J. "Road safety in developing countries". Conference discussion: The impact of road networks on economic and social life in industrialized and in developing countries, P.I.A.R.C, 17th World Road Congress, Sydney (Australia), 1983.

11. Bull, G.P. and Roberts, B.J. "Road accident statistics: a comparison of police and hospital information. Accident analysis and prevention, Vol. 5, No. 1, 1973.

12. Calabresi, G. "The cost of accidents, a legal and economic analysis". Imprint: New Haven, London, Yale U.P., 1970.

13. Cengiz Yusef, N., cf IBRD study, "A survey of the theories and imperical investigations of the value of travel time savings". Paper No. 199, Feb. 1975.

14. (The) Central Bank of Iran "The concise review of the tax system in the country". Farsi language, 1985.

15. (The) Central Bank of Iran (the office of economic investigations) "The ratio of tax revenue in the total government revenue". Farsi language, 1982.

16. (The) Central Bank of Iran (the office of economic investigations) "The investigation of new tax indexes and their role in the governmental revenue increases". Farsi language, 1982.

17. Clayton, A.B. "The role of alcohol and other drugs in traffic accidents". A report presented at P.T.R.C seminar proceedings, Accident analysis, June 1973.

18. Council, F.M. and others, "Accident research manual". Highway Research Centre, Univ. of North Carolina, Chapel Hill, Rept. DOT-FH-11-9424, Feb. 1980.

19. Davies, P. and Salter, D.R. "Reliability of classified traffic count data". Transport Research Record, No. 905, 1983.

20. Deen, T.B. and Godwin, S.R. "Safety benefits of the 55 MPH speed limit". Transport Quarterly, Vol. 39, No. 3, July 1985 (P321-343).

21. Department of Transport, Scottish development department. "Instructions for the completion of road accident reports". STATS 20 (Rev. Jan. 1977).

22. Elliot, D.W. "Road-accidents". 1968.

23. Encyclopedia International, published by: Grolier Incorporated in U.S.A, Vol. 9, 1973.

24. Heggie, J.G. "The impact of transport improvements". Transport Engineering Economics, Mc. Graw Hill, 1972.

25. Henry Janet, M. "Evaluation of socio-economic effects of a major road or motor-way infrastructure". Committee report on economic and finance. P.I.A.R.C, 17th World Road Congress, Sydney (Australia), 1983.

26. Hills, P.J. and Jones-Lee, M.W. "The costs of traffic accidents and the valuation of accident prevention in less developed countries". Report to World Bank, forthcoming as World Bank Staff working paper, 1981.

27. Hire, J.L. "Road planning for rural development in developing countries: a review of the current practice". TRRL. Rep. No.1046, 1982.

28. House, E.G. and others. "How complete are driver records?" An analysis based on insurance claim crashes. Highway Safety Research Centre, Univ. of North Carolina, Chapel Hill, 1974.

29. Hugh Miller, D. "The collection and use of road and traffic information for road accident investigation and prevention". Ph.D Thesis, The Univ. of Aston in Birmingham, 1980.

30. (The) Industry of Transport, Iranian monthly engineering and economic journal, 20 Aug. 1984 (Farsi language).

31. (The) Industry of Transport, No. 26, Farsi language, Oct.1984.

32. (The) Industry of Transport, No. 55, Farsi language, May 1987.

33. International Road Federation (IRF), "Highway expenditures road and motor-vehicle statistics for 1973". Washington, 1974.

34. (The) Ministry of planning and budget affairs, The Iran Centre of Statistics. "The comparison of the income distribution between Iran and some other countries of the world". Farsi lang. 1985.

35. (The) Ministry of planning and budget affairs, the Iran Centre of Statistics. "The brief comparison of non-equity in wealth distribution indexes during the years 1968-1982, Farsi lang., 1985.

36. (The) Ministry of planning and budget affairs, the Iran Centre of Statistics. "Iran in the mirror of statistics". Farsi lang. 1984.

37. Jabbari, A. "Rural road accident investigation and prevention in Iran". Ph.D. Thesis, the Univ. of Aston in Birmingham, 1981.

38. Jacobs, G.D. and Fouracre. "Further research on road accident rates in developing countries". TRRL rep. SR270, 1977.

39. Jacobs, G.D and Hutchinson, P. "A study of accident rates in developing countries". TRRL Rep. LR546, 1973.

40. Jacobs, G.D. and Marguerite, N.B. "Road accidents as a cause of death in developing countries". TRRL supplementary report 277, 1977.

41. Jacobs, G.D. and Sayer, I. "Road accidents in developing countries". Accid. Anal & Prev. vol. 15, No. 5, PP 337-353, 1983.

42. Jones-Lee, M.W. "Human Capital, the risk-aversion and the value of life". Vol.2, Croom Helm, London, 1980.

43. Jorgensen, N.O. "Experimental research concerning the effects of police enforcement on traffic accidents". P.T.R.C seminar proceedings, Accid. Anal. June 1973.

44. Kianpoor. Colonel, "The official report No 24-205-01-528, from Iran Road Police High Command to M.R.T of Iran". Farsi lang., 25/6/1983.

45. Kianpoor. Colonel, "The official report No. 34-205-01-128, from Iran Road Police High Command to M.R.T of Iran". Farsi lang., 25/6/1984.

46. Krell, K. "Traffic and the well-being of man". Road usage and traffic safety, 10th World Meeting, IRF, Rio (Brazil), 1984.

47. Mackay, G.M. "Restraint systems, their use and effectiveness". Accident research unit, Univ. of Birmingham, published by: W.H.O, Nov. 1984.

48. Metcalf, J.B. "Accessibility: the justification for land transport infrastructure investment". A discussion note for the XVIII P.I.A.R.C Congress, 1986.

49. (The) Ministry of Road and Transport (M.R.T) of Iran, "Visual traffic statistics of Iran rural roads". Farsi lang. 1984.

50. (The) Ministry of Road and Transport of Iran, (The office of public relations), "The report of M.R.T activities during the years 1981-1984". Farsi lang. Limited internal circulation, 1985.

51. Nadi, E. and Farjad, M.H. "The buses' drivers in Iran and their problems". A social oriented research conducted by the organization of bus-terminals in Iran. Farsi lang. Oct. 1984.

52. National Safety Council of the United States of America. "Accidents Facts". 1985 edition.

53. Nayeb, E. "An experimental survey into Iran road safety situation". A report prepared inside M.R.T of Iran, Farsi lang. 1983.

54. Noureddine Alaoui, M. "The problem of time saving in highway investment cost benefit calculations in underdeveloped countries". Committee report on economic and finance, presented to the 17th World Road Congress, Sydney (Australia), 1983.

55. (The) Organization for Economic Cooperation and Development, "The role of alcohol and drugs in road accidents". Paris, 1978.

56. Peter, R. and Richard, R. "Need to set priorities for road maintenance in developing countries". Transportation Research Record, No. 898, 1986.

57. Pfundt, K. "Three difficulties in comparison of accident rates". Acci. Anal. & Prev, Vol.1, No.3, 1969.

58. Pignataro, L.J. "Traffic engineering, Theory and Practice". Published by: Prentice-Hall, Inc. Englewood Cliffs, New Jersey, U.S.A, 1973.

59. P.I.A.R.C, XVII World Road Congress, "Committee report on economic and finance". Sydney (Australia), 1983.

60. P.I.A.R.C, XVIII World Road Congress, "Roads in developing regions". Committee report, Brussels (Belgium), 1987.

61. P.I.A.R.C, XVII World Road Congress, Conference discussion, "The impact of road networks on economic and social life in industrialised countries and in developing countries". Sydney (Australia), 1983.

62. P.I.A.R.C, "Minutes of the meeting of the technical committee: roads in developing regions", Valladolid, Jan. 1986.

63. Roger, L.H. "Prosperity, efficiency and road safety". 10th IRF World Meeting Rio (Brazil), 1984.

64. Roy Jorgensen and Associates, "Evaluation of criteria for safety improvements on the highway". Westat Research Analysts, INC., 1966.

65. Sabey, B.E. and Staughton, G.G. "Interacting roles of road environment, vehicle and road user in accidents". 5th Int. Conf. of Int. Ass. for Accident and Traffic Medicine, London, Sep.1975.

66. Satherthwaite, S.P. "A survey of research into relationship between traffic accidents & traffic volume". Uni. College. London, TRRL Supp. Rep. 692.

67. Stannard Baker, J. "Traffic accident investigation manual". Published by: The Traffic Institute, Northwestern Univ, Evanston, Illinois, 1975.

68. Stenzel, W. "The promise of new technology: Implications for traffic record systems". Transportation Research Record, No.910, 1985.

69. Tabib Zadeh, M. "A research into the problems of Iranian bus-drivers". The organization of Teheran bus-terminals, Farsi lang. 1984.

70. Tomislav, S. "Traffic accidents as a function of design elements of roads, volume and structure of traffic flow". Road usage and traffic safety, 10th World Meeting, International Road Federation (IRF), Rio(Brazil), 1984.

71. Torres, J. , Martinez, H. and Ward, A.W. "A road safety investment challenge for developing countries". Road safety and traffic, 10th World Meeting, IRF, Rio, 1984.

72. Transport Quarterly, Eno Foundation for Transportation, Inc., Westport, Connecticut, U.S.A. ,1985.

73. Transport and traffic general office of road transport deputy division of M.R.T (Iran). "Iran visual roads' traffic statistics". Circulated internally in limitted numbers (300), 1981.

74. Turner, S. and Mansfield, E.R. "Variability in rural accident reporting". Transport Research Record, No. 910,1985.

75. United Nations Publication, "Annual bulletin of transport statistics for Europe". EFR. 85.11.E.7, 92-1-016171-8, Vol.XXXVI, 1984.

76. United Nations Publications. "Statistics of road traffic accidents in Europe". EFR. 85.11.E.12, 92-1-016176-9, Vol.XXXI, 1984.

77. U.S. Department of Transportation. "1983 federally coordinated program of highway research, development and technology". Federal highway administration, May 1984.

78. Weisbrod, B.A. "Income redistribution effects and benefit-cost analysis". In: Chase, S.B.(ed) Problems in public expenditure analysis, Brookings, Washington, 1968.

79. Willis, C.O., Turner and Colson. "Evaluation of accident reporting histories". Transportation Research Record, 910.1985.

80. Willoughby, C.R. "Road Safety Components in World Bank Projects". 1982.

81. Wilson, J.L.S. "Strategic thinking on accident prevention by engineering methods". P.T.R.C Seminar proceedings. Accid. Anal. June 1973.

82. World Health Organization. "Human factors in road accidents". Report on a symposium convened by the regional office for Europe of the World Health Organization in Rome in Oct. 1967, 1968.

83. World Health Organization. "Major issues in road traffic safety". IRP/ADR-204/6- 1981. (Copenhagen)

84. Zellweger Uster Limited. "Philosophy of application and benefit of the radar speed metres". Hug/af, 1983.

85. (The) Economist Intelligence Unit. "Quarterly Economic Review of Iran". Annual supplement, 1983.

86. Hills, B.L. & Jacobs, G.D. "The application of road safety measures in developing countries", TRRL, Printed in "Traffic engineering and control". 1982.

87. (The) Central Bank of Iran, the office of economic investigation, "The investigation of economic changes in Iran after revolution", 1984.

88. (The) Industry of Transport, a monthly Iranian journal published in Farsi language, edition No. 38, Nov. 1985.

89. Mackay, G.M., "Road traffic accidents and injuries", D.S.C. thesis, University of Birmingham, 1979.

90. Tunbridge, R.J. and others, "An in depth study of road accident casualties and their injury patterns", TRRL, R.R.136, 1988.