

**Improving road safety for vulnerable road-users  
in developing countries**

**F.C.M. Wegman**

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*Contribution to the World Bank Seminar on Road Safety, Washington, 14-15 December, 1992*

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## IMPROVING ROAD SAFETY FOR VULNERABLE ROAD-USERS IN DEVELOPING COUNTRIES

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### 1. Vulnerable road-users

The road safety policies of various countries state that priority should be given to improving the safety of vulnerable road-users. However, they seldom indicate precisely which groups of road-users are regarded as vulnerable and why. Clearly, this is a complex issue in which various aspects come into play, e.g.

- the concept of the 'weaker' party in an accident, in which factors such as difference in mass, speed and degree of protection are relevant.
- literal vulnerability, in the sense of an increased risk of (serious) injury or fatality, as with elderly road-users due to their lower degree of physical resistance (high letality rate).
- the ability of road-users to 'hold their own' in traffic situations e.g. knowledge of traffic regulations, degree of experience in traffic, speed of response (in which elderly people and children are often at a disadvantage).
- groups of people who cannot strictly be regarded as road-users, such as children at play and shoppers, but who could nevertheless become the victims of a road accident.

There are clearly other aspects involved which enter into the overall concept of vulnerability, such as being the innocent party in an accident (e.g. can an accident ever be blamed on a four-year-old child?) or being a member of an (economically) disadvantaged group and therefore not being able to afford to buy or use a form of transport which may offer more protection.

Obviously, it is impossible to establish an objective definition for such a complicated concept. However, it is possible to select one or two criteria of vulnerability which can in principle be measured, and to use these as a yardstick. These might include factors such as:

- a high risk per travelled kilometre of being involved in an accident.
- identifying which party is generally the casualty in a certain type of accident (e.g. private car versus bicycle), and designating the party which usually emerges as the casualty as 'vulnerable'.

A high risk of accident appears to be linked to the form of transport used, age and experience (OECD, 1986). Motorised two-wheelers, bicycles and pedestrians are high-risk categories compared with passengers in cars, trucks and buses (Figure 1). Children and elderly road-users stand a higher risk of being involved in an accident than those between the ages of 25 and 50 (Figure 2). Inexperienced drivers are more at risk than more experienced ones.

Almost all of the victims in accidents between different types of road-user are either pedestrians, cyclists, moped riders or motorcyclists, as

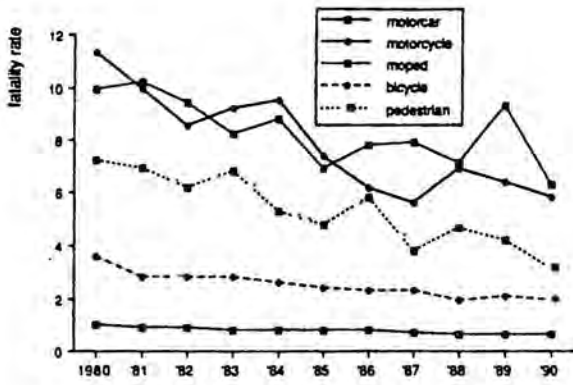


Figure 1. Development of fatality rates by transport mode in the Netherlands.

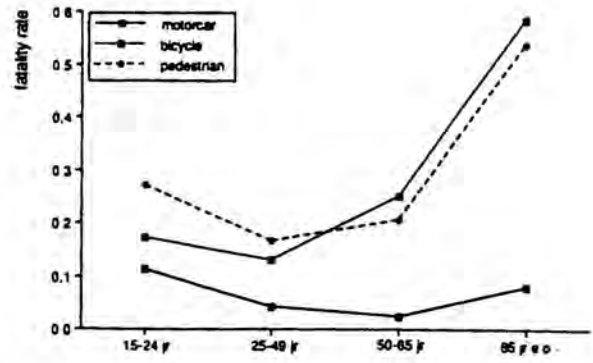


Figure 2. Fatality rate by transport mode and age in the Netherlands.

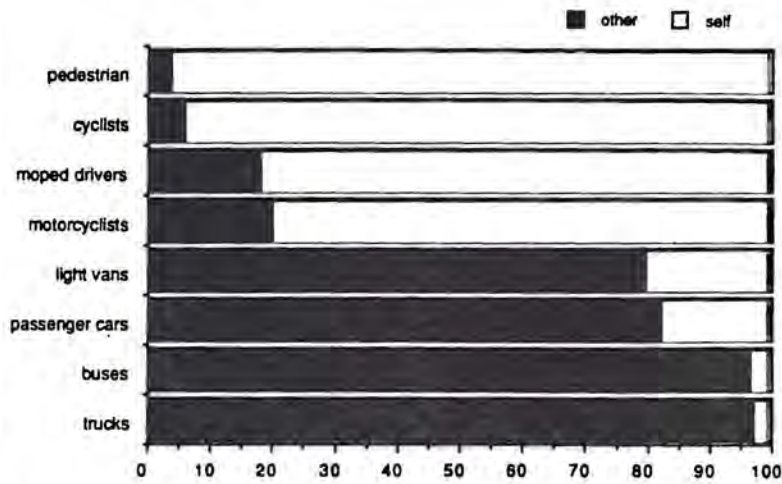


Figure 3. Distribution of casualties (deaths+in-patients) in accidents with two parties involved (the Netherlands, 1991).

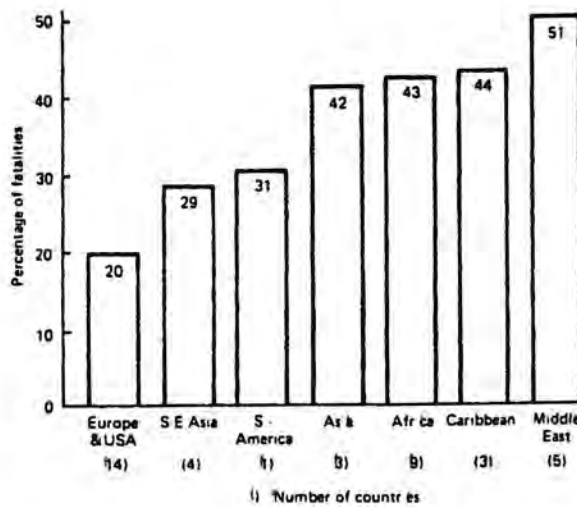


Figure 4. Pedestrian fatalities as a percentage of all road accident fatalities (Downing et al., 1991).

shown in Figure 3. On the basis of this evidence, it can be concluded that pedestrians, cyclists and motorized two-wheelers are particularly vulnerable, and that within this group, young and elderly people are the most vulnerable.

In order to be able to effectively improve road safety, in addition to considering the concept of vulnerability, it would be advisable also to consider the proportion of certain groups within the overall group of road-users. The rationale behind this is that a measure directed at a large group will have greater results than if the same measure were to be applied only to a small group, and this will maximise the rate of return of specific investments.

If we examine the nature of the road safety problem in developing countries, we find that many countries report a high proportion of pedestrians, as shown in Figure 4 (Downing, 1991). Children under the age of 16 in particular are frequent casualties of road accidents involving pedestrians. This high percentage is linked to the age distribution in developing countries (for example, 50% of the population of Africa is aged 16 or below) and to the forms of transport used (over 50% of all journeys are made on foot). In Asia, and in south-east Asia in particular, a high proportion of journeys are made by bicycle or motorized two-wheelers. In the countries concerned, this has led to a high proportion of casualties among people using these forms of transport.

There are no risk (casualties per kilometre travelled) estimates available for developing countries. Although due care should be taken when translating information available in developed countries to developing countries, it is nevertheless reasonable to expect that the same differences in risk exist in developing countries. If this premise is accepted, it would mean that road safety policy in all developing countries should give particular attention to pedestrians, especially those in the younger age category. Similarly, in countries with a high proportion of cyclists and motorized two-wheelers, a relatively high proportion of whom are also victims of road accidents, road safety policy should be giving extra attention to this group (especially young and inexperienced road-users).

## 2. Anticipated trends in road safety in developing countries

The world population is expected to grow by an annual 1.7% over the next decade. This growth rate is expected to be even higher in developing countries, with a rate of as much as 3.3% a year forecast for Sub-Saharan Africa. The rate of urbanisation throughout the world has also increased, from 34% in 1965 to an estimated 45% in 1990. This development is expected to continue. For some developing countries, macro-economic forecasts for the 1990s are frankly alarming (predicting an economic growth which is lower than the growth in the population, as in Sub-Saharan Africa). The Asiatic countries, on the other hand, are expected to do reasonably well, and some improvement is also forecast for Latin America (Ministry for Development Cooperation, 1990). However, the anticipated economic growth will not benefit everyone in developing countries; a relatively small top layer of the population (albeit a significant number in real terms) will benefit, but not the vast majority.

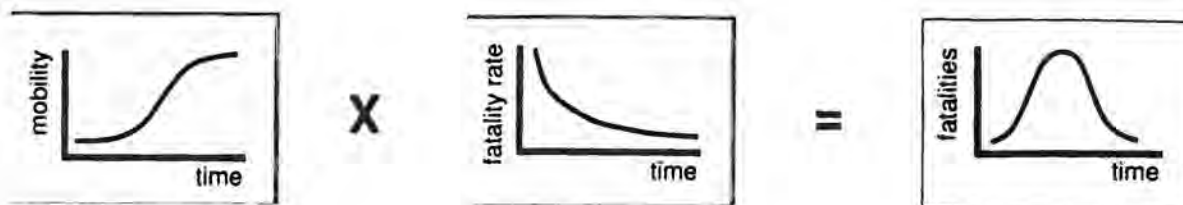


Figure 5. Trend in fatalities as result of trends in mobility and fatality rates.

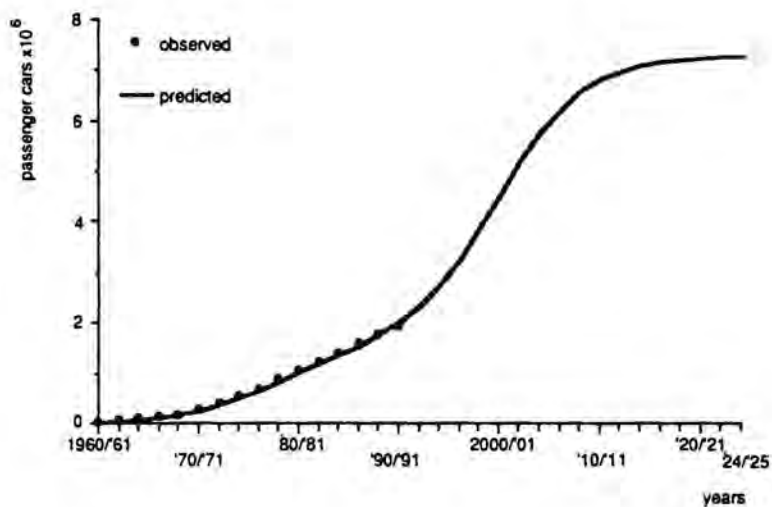


Figure 6a. Forecast analysis of motorization in Hungary (Koornstra, 1992).

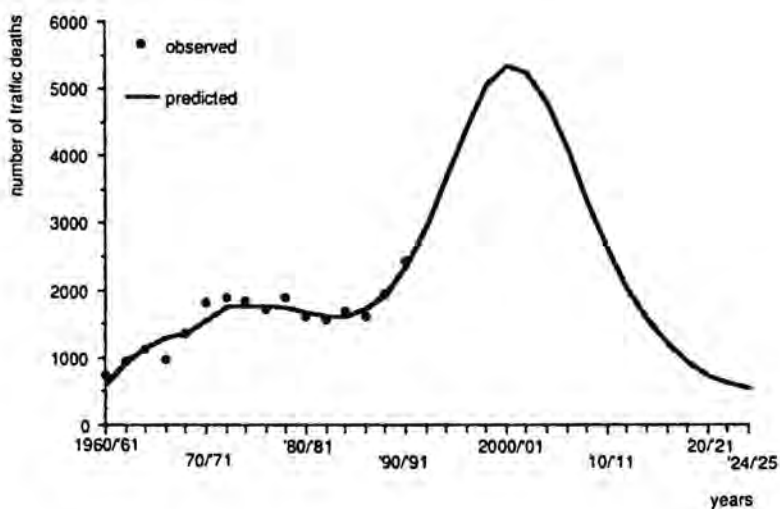


Figure 6b. Forecast analysis of fatalities in Hungary (Koornstra, 1992).

These developments will result in a sharp increase in private motorised traffic, particularly in towns and cities. Without a compensatory adjustment in policy, this will restrict the mobility of the majority of the population, who do not have, and are not likely to get, access to motorised transport. Moreover, it will also reduce the efficiency of the transport system and have a negative influence on road safety, certainly if the supply of transport facilities fails to meet demand. If for reasons of environmental concern and of urban and social development it is felt that non-motorised transport should be given a more prominent role, then it is necessary to enact a policy which will ensure that these forms of transport are made as safe as possible.

The combination of population growth and economic growth will lead to a growth in (motorised) mobility. The long term development of this growth can be described by means of a logistical curve (Figure 5). To this monotonous S-curve should be added a long wave, which may be linked to economic fluctuations. In developed countries, growth in mobility is accompanied by a regular decrease in fatality rate (i.e. number of fatalities per kilometre travelled). This development can be described by means of a negative exponential curve. The rate of the decrease in risk appears to differ according to country (Oppe, 1991). One explanation for this decrease is due to the fact that society learns to adapt to a growth in mobility and that such growth is often accompanied by improvements in infrastructure and in vehicles, and an increase in levels of cumulative experience among the road-user population: in other words, an increase of casualties leads to more safety measures.

An analysis of data from many industrialised nations indicates that it is the increase in the growth of mobility rather than the growth itself which corresponds with the decrease in fatality rate. The degree of mobility growth coupled with the ability to reduce risk can be expected to bring about a change in the number of road casualties. Obviously, in order for the number of casualties to decrease, the decrease in risk must be greater than the growth in mobility. As far as is known, prognoses have already been compiled in various highly-motorised countries (Oppe, 1991). Forecasts have also been made for a number of Central and Eastern European countries (Koornstra, 1992). The results obtained for these countries are alarming, indicating an annual growth in the number of casualties (Figure 6A and B).

If, on this basis, we can assume that the relationship established between mobility and road casualties can also be applied to developing countries (and there is no reason why it should not), then it is to be expected that in these countries too, a growth in mobility will lead to an increase in the lack of road safety. Since we have this insight, it is recommended that it be brought to the attention of the political authorities responsible, in the hope and expectation that such knowledge may form the basis for a policy response leading to further measures to promote road safety and hence also to investments to improve the quality of the transport infrastructure. This kind of response has been shown to increase the level of road safety, even in the face of a further increase in mobility. In view of the nature of the developments in mobility which have been outlined, a significant increase in the number of casualties among vulnerable road-users seem to be feared.



Table 2 Percent of Person Trips By Various Travel Modes<sup>30</sup>

City	Year	Walk	Bicycle & cycle rickshaw	Bus & rail	Motorcycle & scooter	Automobile	Other <sup>a</sup>
<b>NMV Dependent Cities</b>							
<b>China</b>							
Shanghai	1936	38	33	26		3	
Shenyang	1934	10	65	25	0	0	0
Tianjin	1937	50	41	9	0	0	0
<b>India</b>							
Kanpur	1977	72	24	0	3	1	0
Ahmedabad	1981	43	20	29	6	1	1
Bangalore	1984	44	12	36	6	2	0
Visakhapatnam	1981	43	12	35	5	1	4
<b>Indonesia</b>							
Sandung	1976	40	16			46	
Yogyakarta	1976	50			50		
<b>Nepal</b>							
Kathmandu	1987	56	8	16		14	6
<b>Mixed Traffic Cities</b>							
<b>Indonesia</b>							
Jakarta	1984	23	17	25	13	8	14
Surabaya	1984	20	25	13	26	9	7
<b>India</b>							
Delhi	1981	29	18	40		13	
Madras	1989	21	20	53	4	1	1
Bombay	1981	15	11	58	1	8	7
<b>Japan</b>							
Saitama pref.	1978		30	34		36	..
<b>Motor Vehicle Dependent Cities</b>							
<b>Malaysia</b>							
Kuala Lumpur	1984	10	2	34	12	34	8
<b>Phillipines</b>							
Manila	1984	8	0	14	0	23	55
<b>Thailand</b>							
Bangkok	1984	16	0	58	5	19	2
<b>Japan</b>							
Tokyo pref.	1978		21	64		15	..

**Notes:**

a. Other includes motorized paratransit and taxi modes.

Figure 7. Percent of person trips by various travel modes (Replogle, 1992)

### 3. Nature of accidents involving vulnerable road users in developing countries

The problem of pedestrian vulnerability is addressed in a great many studies on road accidents in developing countries. A World Bank report (Kranton, 1991) states that in African cities 'walking is the predominant mode of transport'. In many towns, over 50% of all journeys are said to be made on foot, a percentage which is believed to be even higher for lower income groups (in Addis Ababa, for example, 79% of all daily journeys made by the lowest income group are made on foot, compared with 17% among the highest income group). The non-availability of motorised vehicles and the cost and irregular timetable of public transport appear to be the main reasons.

Figure 7 (Replogle, 1992) provides an overview of the modal split for a number of Asiatic towns and cities. In addition to walking, the proportion of bicycle transport in some cities (China, India) is extremely high. In Indonesia, the use of motorised two-wheelers is a major mode of transport. There are considerable differences between the various cities in the use of non-motorised vehicles (NMVs), differences which, according to Replogle, can be attributed to topography, income, metropolitan structure, level of motorisation, climate and transport policies.

The biggest problems of road safety, and therefore particularly for vulnerable road-users, currently exist on traffic arteries in built-up areas. Traffic arteries usually combine various different functions, there is often no separation of traffic modes, and vehicles are often moving at high speed, so that road-users are constantly having to take account of traffic which is either turning off, crossing or overtaking on the carriageway. Basically, such situations are (too) complicated, and involve a relatively high degree of risk (SVOV, 1992).

There is another reason why the problems for pedestrians and NMVs are likely to increase. The current road capacity is limited, and will become more so as a result of the growth in motorised mobility, since the growth in mobility will overtake the expansion of road space. Motorised vehicles will therefore make increasing demands of the public highway, to the detriment of road safety for pedestrians and NMVs. Even if pavements have been provided, pedestrians are often 'pushed off' them by commercial activity. The lack of parking facilities means that cars will tend to park on areas which have been reserved for pedestrians and NMVs. The lack of facilities for these groups has already been identified in reports and surveys as a problem which results in road accidents.

Overpass and underpass facilities are rarely an option; if they are available, they are not much used due to relaxed enforcement of the rules by the police and due to the mediocre design of the facilities themselves. Ground-level crossings tend not to be respected by motorised traffic, and pedestrians (therefore) very frequently cross the carriageway outside designated crossings (Downing et al., 1991). This constitutes a very real road safety hazard in developing countries. Sayer et al. (1991) have established that in Karachi (Pakistan), 54% of road deaths in 1987 involved pedestrians, of whom 73% were crossing a road when they were killed. 85% of these deaths occurred while the victims were crossing a road outside the designated crossings. Ghana

presents a similar picture: 50% of fatalities were pedestrians, 66% of whom were killed outside official crossings and 62% while they were crossing the carriageway.

Another problem which has been regularly reported is the problem of pedestrians who are killed or injured while walking in the roadway outside built-up areas. In most of these cases, there are no facilities available to enable pedestrians to walk anywhere other than in the roadway.

#### 4. Improving road safety for vulnerable road-users

The growth in motorised mobility will almost certainly lead to a significant increase in casualties in road accidents, particularly for slow-moving road-users, unless measures are taken to prevent such a development. What, then, can be done?

The simplest approach would seem to be to discourage people from walking or using NMVs. An attempt could be made, for example, to replace walking and cycling by the use of public transport. Apart from its practical non-feasibility, it is doubtful whether such an approach would be desirable. In countries which are still in the early stages of mass motorisation and which are already experiencing enormous problems of congestion and related environmental problems, it would seem preferable to coordinate urban development and the development of public transport and NMVs so that private motorised transport becomes less attractive and public transport and NMVs become a more viable option. Environmental considerations, coupled with the need to use space efficiently and to provide a transport facility which is accessible to the majority of people would seem to argue for greater encouragement to be given to NMVs rather than less. However, if walking and cycling are to be encouraged, then it is vital to take measures to ensure that they can be done safely.

If it is decided that it is either not feasible or desirable to discourage NMVs, then it will be necessary to find a solution as to how to provide for the safety of NMV users. In the interests of road safety, the policy line can be presented briefly and forcefully as follows: Separation of slow and fast traffic and traffic with a large mass differences, and where this is not possible, moderate the speed of motorised traffic and ensure that the conjunction of fast and slow-moving traffic is managed safely. As such, consequential, physical separation of traffic are to be preferred to non-consequential, non-physical separations.

The first priority of urban planning should be to ensure that slow-moving traffic is given the shortest possible routes, and that these routes are safe. The precise nature of such solutions depends on the circumstances in which they are introduced. For example, in large agglomerations, where bicycle journeys are often too long and therefore unattractive, bicycle traffic could be used as a supplement to, and a conveyance to and from, public transport facilities (Gupta, 1992). In smaller cities (500,000 to a million inhabitants), a possible solution might take the form of a network for cyclists and pedestrians outside the main arterial routes. Examples are provided in studies of cities in developing countries in which these networks have been successfully introduced, e.g. Chandigarh (India), Shanghai and Tianjin (China) (Replogle, 1992).

The principles of urban development which promote the use of NMVs, which are attractive to pedestrians and which also encourage road safety are well enough known. It is relatively easy to apply them in new urban developments. But even in existing urban structures, there are numerous possibilities, e.g. the development of 'extensive alley systems', a solution which can be found for example in some Japanese cities and in Shanghai (at the instigation of the World Bank).

The next step can be introduced at the level of traffic management. In the interests of both road safety and capacity requirements, the guiding principle here should be to separate the different modes of transport.

The third step is that of the carefully-planned design. Preference should be given to designs which are both self-enforcing and linked to low investment costs. A safe-conscious and careful design should actively promote required behaviour and prevent undesirable behaviour. Predictable traffic behaviour encouraged by appropriate road design helps to promote road safety. Efforts should be made wherever possible to prevent motorised vehicles from turning off and crossing the carriageway in places where NMVs and pedestrians are also present.

Apart from adequate design, the enforcement of regulations is also vital in promoting the aims of road planning. One example of this is to prevent cars from parking in places reserved for NMVs and pedestrians, and to stop these areas from being used by retailers and traders. Naturally, given the economic importance of commercial activities, it will be necessary to make alternative provisions, such as creating access to shops through back-streets. Obviously, if there is so much retail activity that the traffic flow is disrupted, then it may be necessary to consider building a shopping precinct.

Finally, facilities for NMVs and pedestrians should be properly maintained. Badly-maintained facilities will not be used by the groups for which they are intended.

Considerable expertise in providing facilities for NMVs and pedestrians has been gained in some developed countries. It is perhaps unnecessary to emphasise that this knowledge cannot simply be transferred directly to developing countries, but that it should be made to correspond with the economic realities and prevailing traffic conditions in those countries.

Irrespective of the evolution of the traffic system, people can be taught about traffic safety, preceding their usage of the road. A second phase of education has to take place in traffic. Education programmes has to be adjusted to the evolution stage or the traffic system. The more the traffic system has been evolved, the more people have to learn about differences of behaviour with regard to different roads and different regulations. But also in a completely unstructured traffic system, some education programmes can be composed. New regulations and infrastructural measures must fit with behavioural determinants in order to receive acceptance. When people are accustomed to behaviour, in general a kind of external pressure is needed to change it. Information programmes are most effective when they are joined to measures putting pressure.

## 5. Possible solutions for pedestrians and non motorized vehicles

Japan is one of the countries which have achieved remarkable results in road safety. During the 1970s, Japan was able to reduce its number of fatalities with 50% a rate of improvement which has not been achieved in any other country. Japanese road safety policy is set out in a 'Five-Year Fundamental Programme of Safety Measures'. Each year, an evaluation report is submitted as part of the White Paper on Transportation Safety. Although no formal evaluation is available of the contribution made by the various measures taken, Koshi (in Evans & Schwing, 1985) concludes that the expansion of measures to improve infrastructure in particular 'are regarded to have been highly effective in the prevention of accidents'. Over a period of 10 years, the number of pedestrian crossings grew by a factor of 4.3, the number of road markings increased by a factor of 6.8, and the number of road signs by a factor of 11. The overall length of the number of footpaths and bicycle paths increased by a factor of 3.7. Almost 90% of the available national budget was spent on improving the physical infrastructure. The Japanese approach was based on a straightforward decision to make as many elementary improvements in road safety as possible at the lowest possible cost. Measures were applied to 400,000 accident black spots, a massive programme was undertaken to improve road safety in the vicinity of schools, and 70,000 km of footpaths and bicycle paths were laid. Japan's success can be explained as 'Wakon Yosai' (a mixture of Japanese thinking and Western technology). In subsequent years, however, the Japanese were confronted with a stagnation in the falling numbers of road casualties, and it was therefore decided to adopt a different approach.

The Japanese solution is one which could also be applied in developing countries, where there is a shortage of 'road safety facilities'. In such countries, safety provisions could simply be incorporated into (other major) investments in infrastructure. Accident preventive countermeasures should be based on an analysis of accidents. Different manuals or guidelines are available to analyse accidents, to find the causes of accidents and to propose possible countermeasures (e.g. UN ECA, 1989 and TRRL, 1991). An example is given in Figure 8.

In some developing countries, cycling occupies a very minor role in urban traffic. There is therefore no need to make large-scale investments in provisions for cyclists. However, in such situations, there is all the more reason to protect the 'single isolated cyclist' from motorised traffic. One possible solution might be to allow bicycles to use footpaths and pedestrian crossings. Obviously, this only be possible in the absence of large numbers of pedestrians.

There are also developing countries in which NMVs play a highly prominent role in urban traffic, particularly in some south-east Asian countries.

Large numbers of NMVs mean that both in urban and transport planning (e.g. in relation to public transport) and in the design and construction of roads, this is a major factor to be taken into account. Large numbers of NMVs, combined with a growth in motorised traffic and no adequate provisions for NMVs led to a trebling of road deaths in Guangzhou (China) over a period of 20 years, most of them cyclists hit by motorised vehicles (Thomas et al, 1992).



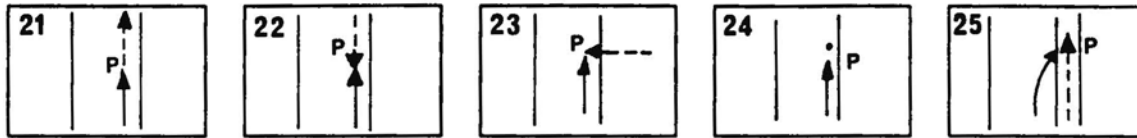
## (2) Pedestrian accidents

### Subtypes

21-22 Pedestrians walking along the road in direction /  
towards the traffic

23 Pedestrians crossing the road

24-25 Pedestrian(s) standing on/by the road



### Causes

- negligent crossing/walking
- undefined crossing sites
- narrow road
- poor visibility
- high speeds
- rushing into the roadway
- lack of footpaths

### Countermeasures

- Improvement of pedestrians'/cyclists' facilities
  - \* widening/construction of shoulders
  - \* construction of separate footways
  - \* painting of edgelines in order to separate shoulders
- Speed limiting measures
  - \* speed limit signs
  - \* constructive speed limiting measures
  - \* active police enforcement
- Improvement of visibility
  - \* parking prohibition
  - \* removal of sight limiting obstacles, plants etc.
  - \* construction of pedestrian bay within street parking
  - \* lighting (especially of crossing sites)
  - \* use of pedestrian reflectors
- Limiting pedestrian movements by fences or guardrails
- Improvement of crossing sites
  - \* (re)paint of a zebra crossing and provide of signs
  - \* provide rumble strips on both sides of a zebra crossing
  - \* erect warning signs for a pedestrian crossing (outside City Centre)
  - \* construct pedestrian refuge with road signs
  - \* provide a line of reflective studs on both sides of a zebra crossing
  - \* construct raised zebra crossing (with warning signs)
  - \* construct level-separated crossing

Figure 8. Pedestrian accidents (UN ECA guidelines, 1989).

Some developed countries (the Netherlands, Germany, Denmark) already have experience in the planning of cycle-friendly towns and villages and in the construction of safe and cycle-friendly facilities. This experience has shown that measures to protect cyclists must be carefully planned if they and other road-users are to be encouraged to use them properly. Moreover, it has been revealed that the simple expedient of separating different forms of transport does not necessarily lead to greater road safety. The expertise which has been gained in this area in developed countries should therefore be collected together and an attempt should be made to determine how to apply it to the situation in developing countries.

## 6. Traffic calming

The more the volume of traffic continues to grow in urban areas, and the more the expansion of the road network is unable to keep pace with this growth -- a situation which is becoming increasingly prevalent in both developed and developing countries -- the greater will be the dominance of motorised traffic. This will not only be a problem on arterial roads, but it will also affect roads without a through-traffic function: namely those in residential areas. As congestion on the major through-roads continues to grow, traffic will increasingly look for (and find) by-pass options, unless preventive measures are taken. This in turn will have a negative effect on road safety.

In developed countries, around 30% of all victims of road accidents in built-up areas are injured or killed in residential streets. Pedestrians in particular (especially young and elderly people) tend to be the victims of large numbers of fast-moving traffic on residential streets and distributor roads in residential areas. These groups, whose radius of activity is relatively restricted, are the most intensive users of such roads (the younger the child, the smaller his radius of activity) (OECD, 1979).

It has been clear for some time that improving road safety and the quality of life in residential areas will not be achieved simply by removing one or two accident black spots. Lack of safety is inherent in the whole structure, not just in a single location. What is required, therefore, is an approach targeted to the area as a whole.

The area-targeted approach should begin with a hierarchical breakdown of the urban road network, ascribing dominant functions to a particular road and then ensuring that it is built in accordance with that function. Coordinating the function and design of the road will allow for more predictable traffic situations to develop and thus reduce the number of accidents (see e.g. OECD, 1978, Wegman, 1979, TRRL, 1991, SWOV, 1992). The combination of various functions (channelling through-traffic, destination for local traffic, residential role) leads to an increase in accidents and should therefore be discouraged (Brindle, 1978). See also Figure 9.

In order to improve road safety in residential areas, attempts will have to be made wherever possible to divert motorised through-traffic (i.e. traffic seeking alternative secondary routes) away from residential areas and to regulate the speed of local traffic to under 30 km/hour. Several countries, such as Denmark, Germany, the Netherlands and the United Kingdom, have already used this approach, and it has produced

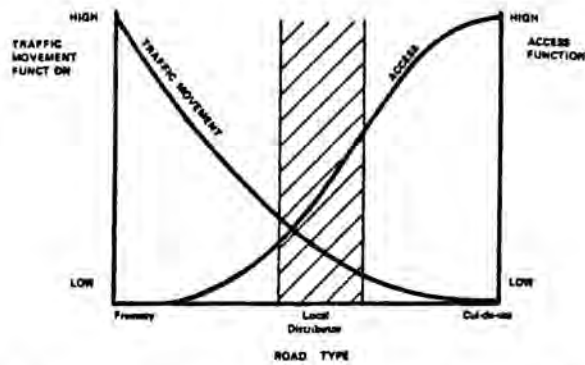


Figure 9a. The traditional concept of the graded road hierarchy (Brindle, 1978).

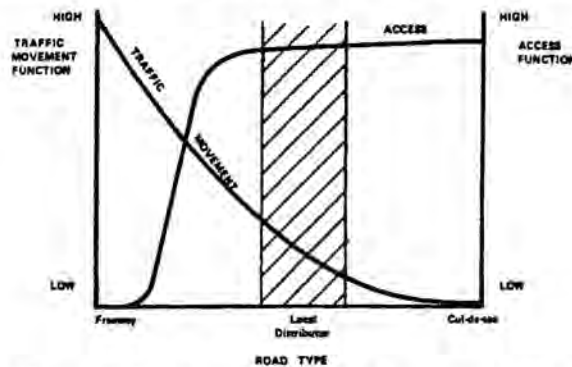


Figure 9b. What really happens in a hierarchy (Brindle, 1978).

positive results in each case. Some projects have led to a reduction in road casualties of as much as 40-50% reduction, while elsewhere, a 10-30% reduction has been reported. These studies have led to two conclusions:

- the greater the reduction in the volume and speed of traffic, the more positive the effect, or in other words: give priority to those areas which are suffering from the highest volumes and highest speeds of through-traffic.
- the more the measures applied lead to the required behaviour, the greater the overall effects.

It is recommended in the general interests of cost-effectiveness to use low-cost measures wherever possible to bring about large-scale overall results; so it would be advisable to use low-cost measures to try to improve road safety in residential areas, particularly in the interests of the most intensive users of these areas, namely children, and especially if there is an opportunity to tie them in with urban rehabilitation projects. Efforts should be made to ascertain the economic rate of return which can be achieved using such measures (Srinivasan, 1986).

## 7. Conclusions and recommendations

1. Pedestrians, and, in some countries, non-motorised vehicles (NMVs), form a large proportion of the traffic in the developing world. Despite the increase in motorisation in these countries, this proportion is unlikely to change in the foreseeable future. The importance of these forms of transport should therefore be given some form of recognition in terms of policy.



2. The high risk of road accidents among pedestrians, their high level of vulnerability, their large presence (sometimes over 50%) in the total road-user population, and the fact that this presence is likely to grow, have led to the conclusion that they should be given high priority in measures to improve road safety in developing countries. Within this group, young pedestrians (e.g. those below the age of than 16) should be given particular attention. In some developing countries (Asia), NMVs also present a considerable road safety problem.

3. In view of the growth in population and in mobility, and the fact that the growth in infrastructure is unlikely to be able to keep pace with these developments, number of road accident casualties in developing countries is expected to increase, particularly among the more vulnerable road-users (i.e. (young) pedestrians and, in some countries, NMVs), unless significant improvements are made. Increased congestion in urban areas in developing countries will not only compromise the efficiency of the transport system, but also (and in particular) the safety of more vulnerable road-users, who will quite literally 'lose out'.

4. The high proportion of vulnerable road-users in traffic, the lack of separate facilities for pedestrians and NMVs and the insufficient use of existing facilities, all contribute to the high degree of risk for vulnerable road-users, in addition to the other factors leading to a lack of road safety in developing countries (i.e. road and traffic environment of widely varying standards, poor road maintenance, poor quality of vehicles, lack of knowledge among road-users and lack of discipline).

5. If the importance of pedestrians and NMVs is acknowledged in developing countries, and if a policy decision is made to provide these groups with better transport facilities and greater road safety, the best option would be to try to ensure the physical separation of different forms of transport, and, where this is not possible, to moderate the speed of motorised traffic and to ensure that the conjunction of fast and slow traffic is managed safely. Produce 'road safety facilities' on a massive scale.

6. These principles should be observed in all decisions relating to urban planning, traffic management, and the proper design and maintenance of infrastructure. Examples are available of how to realise such an approach. The approach should be translated into concrete projects corresponding to the conditions prevailing in developing countries, and the projects should be monitored by research. A 'Good Practice Manual' should also be compiled.

#### Literature

Brindle, R.E. (1978). Residential area planning for pedestrian safety. Paper presented at the joint ARRB/DOT Pedestrian Conference, Sydney, 1978.

Downing, A.J.; Baguley, C.J. & Hills, B.L. (1991). Road safety in developing countries: An overview. Proceedings of PTRC 19th Summer Annual Meeting, Seminar C. PTRC Education and Research Services Ltd.

- Gupta, J.D. (1992). Non-motorized urban transportation for emerging cities in India. Paper presented at the 71st Annual Meeting of the Transportation Research Board. T.R.B., Washington, D.C.
- Koornstra, M.J. (1992). Long-term requirements for road safety: Lessons to be learnt. Paper presented at the OECD-Seminar on 'Road technology transfer and diffusion for Central and East European Countries', Budapest, 1992.
- Koshi, M. (1985). Road safety measures in Japan. In: Evans, L. & Schwing, R.C. (1985). Human behaviour and traffic safety. Plenum Press, New York.
- Kranton, R.E. (1991). Transport and the mobility needs of the urban poor; An exploratory study. Report INU 86. The World Bank, Washington.
- Ministry for Development Cooperation (1990). Een wereld van verschil (A world of difference). A new framework for development cooperation in the nineties. SDU-uitgeverij, 's-Gravenhage.
- OECD (1978). Traffic safety in residential areas. OECD, Paris.
- Oppe, S. (1991). Development of traffic and traffic safety in six developed countries. *Accid. Anal. & Prev.* 23: 401-412.
- Replogle, M.A. (1992). Bicycles and cycle rickshaws in Asian cities: Issues and strategies. Paper presented at the 71st Annual Meeting of the Transportation Research Board. T.R.B., Washington, D.C.
- Sayer, I.A.; Baguley, C.J. & Downing, A.J. (1991). Low cost engineering measures in Egypt, Ghana and Pakistan. Proceedings of PTRC 19th Summer Annual Meeting, Seminar C. PTRC Education and Research Services Ltd.
- Srinivasan, N.S. (1986). Low cost traffic schemes (LCTS) for medium sized cities in India. In: Second World Congress of the International Road Safety Organisation PRI, Luxembourg, 1986.
- SWOV (1992). Naar een duurzaam veilig wegverkeer (Towards a sustainable safe road traffic). Nationale Verkeersveiligheidsverkenning 1990/2010. SWOV, Leidschendam.
- Thomas, C.; Ferguson, E.; Feng, D. & De Priest (1992). Policy implications of increasing motorization on non-motorized transport in developing countries: The case of Guangzhou, Peoples Republic of China. Paper presented at the 71st Annual Meeting of the Transportation Research Board. T.R.B., Washington, D.C.
- TRRL (1991). Towards safer roads in developing countries. A guide for planners and engineers. TRRL, Crowthorne.
- United Nations Economic Commission for Africa (1989). Road safety manual on low-cost engineering countermeasures; Practical guidelines to improve road safety in Africa Addis Abada, 1989.
- Wegman, F.C.M. (1979). Urban planning, traffic planning and traffic safety of pedestrians and cyclists. Paper presented at the OECD Symposium on Safety of Pedestrians and Cyclists, Paris, 1979. R-79-9. SWOV, Leidschendam.