Work trips and safety of bicyclists:
The international experience

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Summary

In 1999 the ministers and representatives of the European Member States of WHO and members of the European Commission released a *Draft Charter On Transport, Environment and Health*. The ministers recognise "that forms of transport that entail physical activity, like cycling and walking, separately or in conjunction with public transport, offer significant positive health gains; however, these transport modes have often been overlooked in planning and decision-making." They also commit future policies toward "shifting transport to environmentally sound and health-promoting modes." It would be difficult to move toward such goals unless we have a much better understanding of the factors that are critical in selection of travel mode choice, especially for work trips.

Data from low income countries like China and India indicates that use of bicycles for work trips is reducing with an increase in per capita incomes. In both these countries cyclists are involved in a disproportionate proportion of fatal crashes. For example, in Delhi (India) cyclists constitute 5% of the trips but 14% of the fatalities. Daily cycling trips among adults in six European countries with more detailed information, range from about 1 in Holland to as low as 0.1 in the UK.
Short trips (trips under 5km) in these countries are still done by car 30 to 65% of the time, and these are the countries with most cycling and walking in Europe. In spite of low bicycle usage in Europe, bicyclists account for 5-6% of deaths and 7-8% of injuries. Cyclists account for more fatal accidents than pedestrians in some countries, such as the Netherlands, where cycling is common. In Copenhagen (Denmark) bicyclists had a fatality rate of 21 per million trips compared to 6 for car and 0.5 for bus occupants. This may account for the declining rate of school trips by bicycle in many countries of Europe. This paper will present a detailed analysis of the role of accident risk in deterring bicycle use in different nations around the world and the possibilities of correcting the situation in the future. The paper will focus on learning from the experience of bicycle use in different socio-economic settings.

Introduction

Recently the ministers and representatives of the European Member States of WHO and members of the European Commission released a *Draft Charter On Transport, Environment and Health*.[1] The ministers recognise "that forms of transport that entail physical activity, like cycling and walking, separately or in conjunction with public transport, offer significant positive health gains; however, these transport modes have often been overlooked in planning and decision-making." They also commit future policies toward "shifting transport to environmentally sound and health-promoting modes." However, It

Figure 1. Proportion of trips and fatalities for road users in Delhi, India

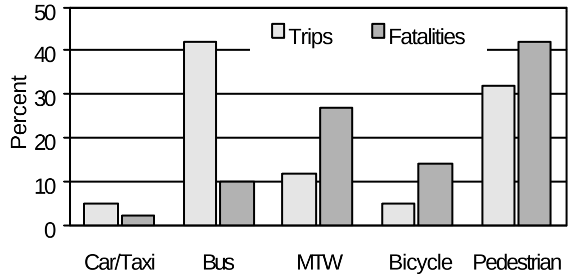
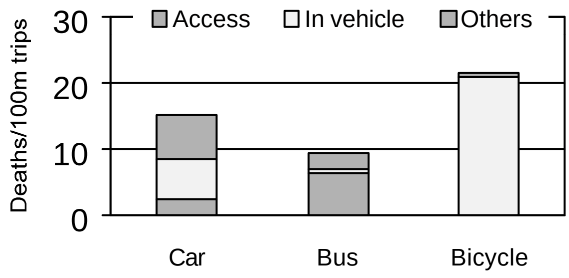


Figure 2. Trip types and ftality rates in central Copenhagen, Denmark



would be difficult to move toward such goals unless we have a much better understanding of the factors that are critical in selection of travel mode choice, especially for work trips.

In this paper we present an analysis of the role of accident risk in deterring bicycle use in different nations around the world and the possibilities of correcting the situation in the future.

Bicycle trips and safety

The rates of deaths and injury have been reducing over the past two decades in the highly motorized countries (HMCs) but not in the less motorised countries (LMCs). The composition of traffic and accident patterns in modern LMCs are not only different from those prevailing today in the HMCs, but they are also substantially different from those prevailing in the HMCs in the past. The HMCs have never experienced road traffic that comprises such a high proportion of motorised two-wheelers (MTWs), buses and trucks sharing the same road space with pedestrians and bicyclists. The traffic mix and problems faced by LMCs constitute a new phenomenon not experienced by the HMCs in their process of development. Therefore, it is necessary to examine the issues at a more fundamental level to come up with viable policies that might help improve the situation in the future both in HMCs and LMCs. Simple transfer of knowledge and technologies from HMCs to LMCs may not be entirely feasible or that effective. The experience and knowledge generated in the HMCs would, however, be very useful if the scientific basis of the same is used to develop appropriate solutions for the LMCs.

Some studies show that non-motorised traffic takes up a significant share of trips on both urban and rural roads in most LMCs. Pedestrians, bicyclists and motorcycle riders (VRUs) constitute the majority and the most important segment of road users in these countries.[2] The main difference in HMCs and LMCs is that the exposure of vulnerable road users in the former is lower than that in the latter both on urban and rural roads. Traffic cannot be separated at all locations and so road designs of the future will have to give much more importance to these issues.

The issues can be summarised as under:

- Composition of traffic and crashes very different when bicycles are a large proportion of the traffic stream
- In urban areas a majority of road crash victims can be vulnerable road users
- Buses and trucks also involved in crashes
- Exposure of vulnerable road users not likely to reduce substantially

Table 1. Pedestrian and Bicycle fatalities in LMCs and HMCs

Country	*Percent pedestrian fatalities*	*Percent bicycle fatalities*
Delhi, India (1994)	42	14
Thailand (1987)	47	6
Bandung, Indonesia (1990)	33	7
Colombo, Sri Lanka (1991)	38	8
China (1994)	27	23
Australia (1990)	18	4
U.S.A. (1995)	13	2

- Expressway use likely to be limited in LMCs
- High proportion of motorcycles in many LMCs
- No precedence in highly motorised countries
- Traffic in LMCs more complex than that in HMCs

Data from low income countries like China and India indicate that use of bicycles for work trips in cities is reducing with an increase in per capita incomes. In some urban areas of Europe there has been an increase in bicycle use in the past two decades among adults. However, in all these countries cyclists are involved in a disproportionate proportion of fatal crashes (Figures 1 and 2). For example, in Delhi (India) cyclists constitute 5% of the trips but 14% of the fatalities.[3] . In Copenhagen (Denmark) bicyclists had a fatality rate of 21 per million trips compared to 6 for car and 0.5 for bus occupants.[4] This may account for the declining rate of school trips by bicycle in many countries of Europe. Daily cycling trips among adults in six European countries with more detailed information, range from about 1 in Holland to as low as 0.1 in the UK. Short trips (trips under 5km) in these countries are still done by car 30 to 65% of the time, and these are the countries with most cycling and walking in
Europe. In spite of low bicycle usage in Europe, bicyclists account for 5-6% of deaths and 7-8% of injuries.[5] Cyclists account for more fatal accidents than pedestrians in some countries, such as the Netherlands where cycling is common

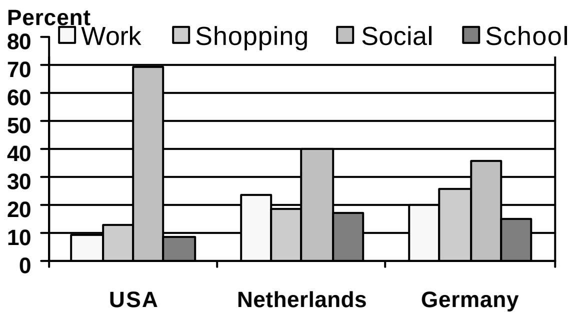
The percentage of pedestrian and bicycle fatalities as a proportion of all road traffic crash fatalities in some HMCs and LMCs is given in Table 1. These data show that the percentage of fatalities is usually higher in LMCs than that in HMCs. These differences exist largely because of the higher exposure rates of pedestrians and bicyclists in LMCs. Mixed land use is very common in LMCs and so these trips can constitute a high proportion of the total trips. Buses and trucks constitute a higher proportion of all vehicles on the road in LMCs than in HMCs. This increases the probability of conflict with these heavy vehicles. The injuries sustained in impacts with heavy vehicles are also likely to be more severe than those in crashes with cars. In most of the LMCs, the VRUs constitute 60-80 percent of all casualties. This flows logically from the fact that this class of road users forms the majority of those using the road. In a city like Delhi (India) a very large proportion of the bicycle trips are for commuting to work, where as in HICs this constitutes a much smaller proportion (Figure 3).

Because VRUs are not protected by metallic or energy absorbing materials, they sustain relatively serious injuries even at low velocity crashes. A study shows that in LMCs buses and trucks are involved in a greater proportion of crashes than they are in HMCs (Figure 4).[6] This pattern is very different from that obtained in the highly motorised nations where buses and trucks are not involved in such a high proportion of fatalities. Since most of those killed in impacts with buses and trucks are VRUs, we must give that much more attention to designing safer front structures for these vehicles. However, in the past four decades a disproportionately high share of research funds, time and energy have been spent on making the car occupant safer and more comfortable.

Vehicle design

Most of the studies done on pedestrian and bicycle impacts in the last twenty years have concentrated on impacts with cars . These studies are aimed at developing car fronts that are less aggressive. In such impacts the front of the car generally impacts the lower limbs and the torso and head impacts the bonnet (hood), cowl area, and the windshield of the car. These kinematics are very different from that which would be experienced in bus and truck impacts with pedestrians as these vehicles present a vertical structure for the whole body, whether adult or child. A study of pedestrian impacts with light vehicles and heavy vehicles, reports that "pedestrians struck by the fronts of buses or heavy goods vehicles sustained fewer serious pelvic and leg injuries and more serious chest, arm and head injuries than pedestrians struck by the fronts of cars." [7] Therefore it is very important that fronts of buses and trucks be designed which are much more forgiving in impacts with pedestrians. The data and techniques developed over the years by would be very useful for designing safer fronts for other vehicles. Some work in this area has been started as reported by Kajzer, Yang and Mohan[1] and Chawla et al.[8]

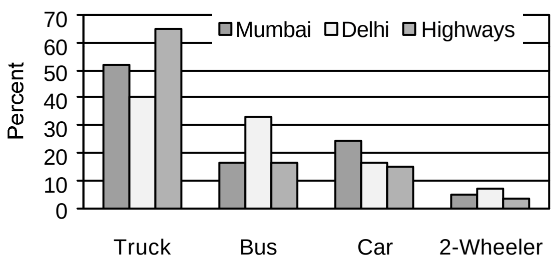
Figure 3. Purpose of bicycle trips in The Netherlands, Germany and USA (Ref. 4)



Speed control

The safety of road users is influenced both by the absolute speed of vehicles and by the variation in speeds among vehicles on the road.[9] There is enough evidence to show that lowering of speed limits on expressways and urban roads result in fewer fatalities and injuries.[10] The data presented show that the increase in speed limits from 55 mph to 65 mph on interstate highways in the USA resulted in 2-4 mph increase in mean speeds and 19%-34% increase in fatalities. Reduction of speed limits by 10-20 km/h on motorways and rural roads in Switzerland and Sweden resulted in 6%-21% fewer fatalities. A study on effects of speed limits on casualties in 21 countries concluded that reducing speed limits from 60 to 50 km/h would result in a reduction of 25% in fatalities and casualties.[11] A reduction in the speed limit from 60 to 50 km/h in Zurich has been reported to have resulted in 24% fewer pedestrian fatalities. For car occupants in crashes at 80 km/h the likelihood of death is 20 times more than at 32 km/h.[12] The estimates for probability of pedestrian deaths at different impact velocities are: 5%-8% at 30 km/h, 25% at 40 km/h, 45%-80% at 50 km/h, and more

Figure 4. Proportion of vehicles involved in crashes in different locations in India



than 85% at 60 km/h.

Speed limits are difficult to enforce if the design speed of a road is much higher than the speed limit and the road has low density of traffic. Enforcement on rural roads is also very difficult. Fleet owners can be forced to have trip times so regulated that the drivers do not have to exceed speed limits on iter-city trips. In many countries buses and trucks are fitted with speed limiting devices and speed recording systems. This can be implemented right away on all buses and trucks in Asian countries. Urban buses in particular could have speed limiters fixed at 50 km/h. Trucks and buses using inter-city highways could have speed limiters fixed at 90 km/h. A similar measure could eventually be introduced on cars, motorcycles and taxis also. In urban areas the most effective way of speed regulation is by *traffic calming measures* which are described briefly below.

Road design

The most important aspect of road design is that slow traffic on arterial roads and highways be segregated from fast moving traffic. Experiences from China, Netherlands and reports from India[13] show that such schemes are possible to implement and effective. It is important that rural roads be designed in such a manner that the design speed is kept below 100 km/h. Use of roundabouts at intersections and visual cues that do not give the driver a feeling of great expanses helps in controlling speeds. These include advisory speed limit signs, reflecting surfaces on the side of the road (painted trees, reflectors mounted on posts, etc.). When rural roads pass through built up areas, physical measures are necessary to slow down the vehicles. These include constructing very conspicuous "gates" at the entrance of the village/town, use of speed breakers and even putting barriers to make the road less negotiable at high speeds.

In urban areas speeds are controlled by the presence of intersections and high density of traffic on the roads. Roundabouts are very effective in controlling speeds on arterial roads in urban areas and some modern deigns are also very effective in channelising traffic. One great advantage of roundabouts over traffic lights is that they are very effective in the absence of police officers and at night time.

In residential and shopping areas maximum speeds of vehicles have to kept below 30 km/h and this can only be done through traffic calming methods. These involve: narrowing of streets, giving priority to pedestrians and bicyclists, link closure, partial street closure, use of speed breakers (road humps), raised pedestrian crossings, roundabouts, channelization, rumble devices, chicanes ('build outs' or 'kerb extensions'), pinch points, etc. With well designed traffic calming measures road fatalities can be brought almost to zero levels in residential areas.[14]

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