CONFLICT BETWEEN TRANSPORTATION SAFETY AND ENVIRONMENTAL CONCERN

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Abstract

In this paper we discuss some of the issues relating to transportation, safety and the environment. We explain that unless the needs of non-motorized modes of traffic are met it will be almost impossible to design any sustainable transportation system for urban district. We show that pedestrians, bicyclists and other non-motorized Vehicles are the most critical elements in mixed traffic. If the infrastructure design does not meet the supply of these elements all modes of transport operate in sub-optimal conditions. However, it is possible to redesign the existing roads to provide a safer and more convenient environment for non-motorized modes. This also results in improved efficiency of public transport vehicles and enhanced capacity of the corridor when measured in number of passengers transported per hour per lane.

A great majority in Iran today accepts environmental protection as one of the most important goals. The answer to the growing conflict between environment and transport is the model of "sustainable mobility" which follows from the concept of "sustainable development", the keynote of the UN-Conference for Environment and Development in Rio de Janeiro 1992. In fact the tight Iran regulations to avoid or at least to minimize interferences in nature and landscape have a very high rank in the planning of new roads, bypasses or alterations to old roads. In these cases the legal instrument of "Highway Design Guidelines" will guarantee road safety its important place.

Introduction

A sustainable transport system must provide mobility and accessibility to all urban residents in a safe and environment friendly mode of transport. This is a complex and difficult task when the needs and demands of people belonging to different income groups are not only different but also often conflicting. For example, if a large proportion of the population can not afford to use motorized transport - private vehicles or public buses - then they have to either walk or ride bicycles to work. Provision of safe infrastructure for bicyclists and pedestrians may need segregation of road space for bicyclists and pedestrians from motorized traffic or reduction in speeds of vehicles. Both measures could result in restricting mobility of car users.
The Iranian Safety Commission stated that 81 fatalities occur each day on Iranian's roads. Based on the most recent figures the Safety Commission predicts that about 1 in 80 of citizens will die, on average 20 years too soon, because of a traffic accident and 1 in 3 will require hospital treatment as a result of a road accident (most of the nation’s road fatalities occur in travel outside big Cities, specially Tehran) [1].

According to human rights it is the national duty of each society to tackle this bloodshed through all means of education, enforcement and engineering of vehicles and roads. The design of roads has a very high influence on road safety but in addition to finance road and transport engineers need the assistance of legal instruments to promote safety measures against competitive private and other public interests.

The Environmental Concern

Similarly, measures to reduce pollution may at times conflict with those needed for reduction in road impact. For instance, increases in average vehicle speeds may reduce emissions but they can result in a raise in accident rates. But most public session and government policy documents dealing with transportation and health focus only on air pollution as the main concern. This is because air pollution is generally visible and its deleterious effects are obvious. It is easy for most people to connect the associations between quality of motor vehicles, exhaust gas and increased morbidity due to pollution. But most individuals are not able to understand the complex contact of factors associated with road accidents. Health problems due to pollution are seen as worthy of public action whereas those due to injury and death in accidents as due to individual mistakes. Therefore, policy documents dealing with sustainable development for cities always include options for pollution reduction but rarely for accident control.

The above discussion demonstrates that [2]:

- Non-motorized modes of transport constitute a significant proportion of all trips made in Iran and are likely to do so in the future.
- Increase in use of public transport also results in an increase in walking/bicycling trips
- At present pedestrians and bicyclists are more likely to have injuries and fatalities that car occupants in accidents in which cars and pedestrians/bicycles collide.
- It is not possible to have efficient bus transport systems with selected lanes for buses unless segregated lanes are provided for non-motorized transport.

Sustainable transportation options rely heavily on promotion of public transport and non-motorized modes. However, the actual policies promoted do not recognize the conflicts inherent in some of the measures suggested [3]. Subsequently an Environmental Pollution Control Authority was set up for the city. Some of the measures suggested for reducing vehicular pollution are given below:

- Construction of expressways and grade separated intersections.
- Introduction of one way streets and introduction of corresponding signals and area traffic control systems.
- Construction of a metro rail transport system.
- Phasing out of older buses and increase in number of buses.
The Road Safety System

The level of road safety in countries is the result of technical and legal regulations in the interacting system consisting of:

People: instruments are education and enforcement,
Vehicles: instruments are active and passive safety,
Roads: instruments are road equipment, maintenance and road design, Environment (surrounding) of roads: with external influences and finally, Rescue services [3].

Of course driver's behavior is most important. We need to promote training for riding bicycles and motorcycles or for driving cars and we are responsible both for maintaining vehicles in good repair and for ensuring safe driving taking into consideration road condition.

The legal instruments for this part of the safety system include traffic regulations, the regulations for vehicles and the checking of their technical conditions, enforcement as carried out by the traffic police and finally the exacting rules.

These instruments directly correct the behavior of the drivers. But education and enforcement have to be repeated continually to maintain an appropriate standard of road safety.

Effect of Rural Road and Highway Geometry Design on Safety

It is more efficient to influence drivers, behavior indirectly by the technical parts of the system: vehicles and roads. The importance of active and reactive safety in vehicles is evident. But worldwide research on road safety shows that the proper design of roads is crucial to prevent human errors in traffic. The safe design of roads is more than road equipment such as traffic signs and signals, guidelines, barriers etc. It includes the proper geometry of roads that will reduce the probability of mistakes and minimize their bad effects. Of particular importance is the geometric design of roads horizontal and vertical alignment [2]:

- The horizontal alignment of roads as the sequence of curves, transition curves and straight lines and especially the harmonization of radii prevent large differences in direction and speed. The superelevation of carriageways avoids aquaplaning and supports drivers in curves (Fig.1).

Figure1. The horizontal alignment as a sequence of curves and transition curves [2]
- The radii of vertical curves (hills and depressions) should be as large as possible to facilitate the prediction of the roads course and the actions of other road users (Fig.2).

- The proper choice of the different types of cross-sections with one or two lane carriageways, emergency-lanes, bicycle and pedestrian paths etc. depending on road functions, road hierarchy and density of traffic, has a high influence on road safety.

- The correct form of junctions and crossings may reduce the number of collision-points and make them predictable for the drivers etc.

However, the improvement of these design parameters according to the guidelines for road design in most cases requires the extension to private properties, the restriction of their use, the felling of trees and so on. That is why engineering for safer roads very often is in conflict with the environment as it may affect people's rights, planning policies and impinge on sensitive locations such as monument sites, or other sites of special interest.

Finally the surrounding of roads itself may have a negative influence on road safety by unacceptable use of the roads or of properties near the roads. These influences have to be prevented and again road safety can be in conflict with private rights, planning policies etc. It is important to have a clear legislation to regulate these conflicts [2].

Figure 2. Types of cross-sections for rural roads & highway-meter [2]
(Refer to source2 for more details: capacity of the roads, their typical, bicycle pathways and roads for buses)
Effect of Urban Roadway Geometry Design on Safety

Construction of expressways through or around cities and grade separated junctions may hearten higher speeds, greater use of private vehicles and longer trip lengths. Higher speeds always result in an increase in the incidence and severity of accidents unless very special countermeasures are put in place for control of injuries. Figure (Fig.3) shows the relationship between impact speed and probability of death for a pedestrian (pedestrians' impact by cars). These data show that an S-shaped curve describes the relationship between car impact speed and probability of death for a pedestrian. This probability of death starts increasing dramatically at speeds greater than 30 km/h and flattens out at levels above 95% at 60 km/h. A similar relationship would be true for bicyclists and motorcyclists [4].

Researchers report that in impacts with heavy vehicles severe injuries can be sustained even at velocities lower than 30 km/h. Thus very small increases in speeds can result in large increases in deaths and injuries. This increase in risk has the maximum effect on pedestrians and bicyclists resulting in lower use rates of public transport services [5].

Wide roads and expressways (especially elevated sections) and grade separated junctions also divide the urban landscape into disconnect zones. It becomes very difficult for people to cross these arteries on foot or using other non-motorized modes. As explained above, this has the effect of discouraging public transport use, as all commuters using buses have to cross the road at least two times for every round trip at the origin or the destination.

Elevated roads also reduce the attractiveness of business and entertainment activity in their vicinity [5].

Figure 3. Possibility of walker fatality by crash Velocity (pedestrians– cars accident) [4]

Grade separated junctions have a similar effect. The area occupied by grade separated intersections is much greater than usual intersections. The location of bus stops at grade separated intersections is such that commuters have to walk greater distances for changing bus routes. This can dispirit those who own private means of motorized transport from using public transportation modes. In addition, because of the increase in
walking distance and road widths, pedestrians and commuters would be exposed to higher accident risks. This would further discourage use of public transportation by children, disabled persons and other vulnerable road users [5].

A grade separated intersection inside the city speeds up traffic at that junction and the arrival rate of vehicles at the next light controlled junction increases. This causes greater delays at junctions on both sides, especially during rush hours. Therefore, it is not clear whether such junctions serve a useful function over a network in terms of travel time or reduction in pollution. At grade separated junctions noise and exhaust is produced at a greater height and spreads over a wider area. This makes this area unsuitable for living and other community functions [2].

This is very well illustrated by the environmental impact assessment done for the construction of the inner ring road in Tehran. This inner ring road is a "modern high-speed road running around the centre of the city" with a total length of 26 km. Elevated sections account for 75% of the length with design speed of 60km/h. A detailed environmental protection and monitoring plan has been worked out for this project. Some of the important guidelines are outlined below [2]:

- Increase distances between residential houses, sensitive areas and the ring road.
- Minimum distance between road and buildings 17 m.
- First row of buildings not suitable for schools, hospitals etc. These should not be within 150 m of the road.
- Buildings sensitive to vibrations not to be within 100 m of the road.
- Strict controls of heavy vehicle use at night to prevent noise pollution.
- Strict control of speeding by all vehicles to limit noise.
- Elevated roads should be reduced as far as possible and double-layer or Milt-layer roads should not be adopted.

This shows that any high capacity road inside a city influences land use around it and makes it less people friendly. Owners of residential houses also tend to shift away from such locations. The experience of large cities in Iran shows that construction of such high capacity roads has not even improved traffic congestion levels.

**Present Study, Tehran Urban Transportation**

Tehran has an orbital expressway and inner ring road and a large number of interchanges. The total number of vehicles is 2.2 million. The average speed on north-south and east-west main roads for 12 hrs in daytime is 18-21 km/h. The road area in Tehran has been increased by 42% and 400 roads have been designated as one-way streets. And the total number of vehicles in Tehran has been increased more than 100% between 1990 and 2004. The average vehicular speeds inside the inner ring road during rush hours are 26 km/h [6].

Tehran is well provided with a basic transport infrastructure that can, given the right stimuli, respond to the challenge of sustainable transport planning and meet the needs of its residents for clean air, safe streets, reliable public transport and highly attractive walking and cycling journeys.
The assets are as follows:

- A reasonably compact city, heavily populated with many journeys that have to be made being well within the capabilities of walking, cycling and public transport.

- A metro line that caters very well indeed for north-south movements and connects densely populated areas in the north and the south with the CBD and important areas for employment.

Bus Transport in Tehran is perhaps the most significant mode of transport in terms of people carried. The Tehran bus system is, however, of unrelieved poor quality exposing its passengers to conditions of discomfort and danger that would not be tolerated elsewhere. Buses are also a significant source of pollution and it is unusual to see a bus that is not belching out huge clouds of black smoke.

Taxis are an important part of any urban transport system. They provide a valuable function and enable people either not to own a car or to use their car less in cities. If cars are banned from certain parts of congested city areas taxis can be given access as long as they meet all registration and emission regulations. Taxis in Tehran are in poor condition. They contribute significant amounts of air pollution and are frequently in poor mechanical condition.

Experiences in Tehran suggests that construction of more high capacity roads can have the unintended effect of reductions in public transport and bicycle use without increasing vehicle speeds or reducing congestion on city roads. Reductions in bus and bicycle use would result in higher pollution levels and possible increase in traffic congestion.

No detailed studies have been done to understand the effect of these changes on road user behavior in cities of low-income countries. It is possible that in these countries the construction of high capacity roads at the expense of facilities for public transport and non-motorized traffic may make things worse for everyone. These effects could include higher incidence of congestion for motorized traffic, higher accident risk for non-motorized traffic and reductions in public transport and non-motorized traffic.

The experience from Tehran supports the conclusions that building metro systems does not necessarily reduce congestion and decrease private transport use (because Private Cars are increasing at this time). The metro system in Tehran takes only 15% of the public passenger transport volume. The number of public transit vehicle equivalents increased by 75% between 1990 and 2004 but the total number of passengers carried decreased by 50% in the same period. The city has increased availability of public transport standard vehicle equivalents by 60% and total number of passengers carried has increased by 90% [6]. It seems that buses are preferred to rail metro systems because metro system is new and unknown in Iranian society.

**Safety Rule and Environmental Protection**

A great majority in Iran today accepts environmental protection as one of the most important goals. The answer to the growing conflict between environment and transport is the model of "sustainable mobility" which follows from the concept of "sustainable development", the keynote of the UN-Conference for Environment and Development in Rio de Janeiro 1992. In fact the tight Iranian and national regulations to avoid or at least to minimize interferences in nature and landscape have a very high rank in the planning of
new roads, bypasses or alterations to old roads. In these cases the legal instrument of "Highway Design Standard" will guarantee road safety its essential place [2, 7].

Environmental laws and pressures, however, make the struggle for similar implementations of road safety by smaller measures on old roads in practice more and more difficult. The widening of a cross-section, a curve or a junction is often in conflict with a rare biotope of wild orchids, bats or the red belly toad, which know exactly where to jump out of the red list of endangered species.

Some years ago the objective assessment of a dangerous situation by a traffic administration was sufficient to cut down a tree near to the pavement. Today administrations for the protection of nature try to get the legal authority to endorse such a decision, which they often would not give as long as the tree is still alive.

Even the maintenance of roads gets under pressure. The cleaning of shoulders and drainage ditches from wild growing bushes and trees is tackled by environmental protectors as well as the use of salt in small dosage to thaw the most dangerous snow and ice on the roads in winter[8].

Fatalities and injuries are less and less persuasive arguments for environmental protectors. The politicians as legislators and the administrations as the executive have to ensure that human rights are not compromised by a biometric or ideological environmental protection.

In the end the paper is mostly about buses whereas it is most important in public transportation in Tehran and other cities of low-income countries.

Buses and non-motorized modes of transport will remain the backbone of mobility in mega-cities. Bus use has to be increased without increasing pollution or the rate of road accidents. This would be possible only if the following conditions are met for Public transport:

1. The cost effectiveness of metro rail systems is evaluated very carefully. Current evidence suggests that metro rail systems, especially the construction of two or three lines at great cost, do not help in reduction of private vehicle use, congestion or pollution.

2. Design and development of modern and sophisticated high capacity bus systems be given priority in mega-cities of Iran.

3. Introduction of bus engine and transmission technologies that ensure clean burning and efficient combustion at the passenger loads and driving cycles experienced in Iranian mega-cities.

4. Safe entry and exit procedures for bus passengers. This would include all buses to be equipped with closing doors, low floors, and appropriately designed bus stands.

5. Operation of buses at safe speeds. This will require setting of realistic trip times and installation of speed limiting devices in buses.

6. Bus stop locations that ensure route changes are convenient and safe for commuters.

7. Development of safer bus front designs and standards.
Since a significant proportion of road user fatalities involve buses in low income countries, it would be very important to develop such designs. Particularly in view of the fact that increases in bus numbers can mean an increase in conflict between them and other road users. Recent studies suggest that such designs are technically feasible:

a. Segregated lanes for non-motorized transport and safer pedestrian facilities.
b. Urban and road design characteristics that ensure the safety of pedestrians and bicyclists.
c. Provision of segregated bicycle lanes on all arterial roads.
d. Wider use of traffic calming techniques, keeping peak vehicle speed below 50 km/h on arterial roads and 30 km/h on inhabited streets and shopping areas.
e. Convenient street crossing facilities for pedestrians.

The above recommendations have to be considered in an overall context where safety and environmental research efforts are not conducted in complete isolation. We have to move toward adoption and implementation of schemes that remain at a human scale and improve all aspects of human health [8].

**Conclusion**

Worldwide there are each year more than 500,000 victims and 50 million severe injuries caused by road traffic accidents. According to human rights the implementation of road safety is a duty of each culture. A proper road design is critical to prevent errors of drivers. In addition to the classical field of road safety work-people, vehicles and roads-the surroundings of roads are an important factor. Very often road authorities have to overcome external resistances against safer road design and undesirable impacts on road safety from frontage properties. We need legislation to equilibrium private and other public interests with the requirements of safer roads.

In Iran the Law for Highways, and the road laws for regional and communal roads, contain regulations for the safer design use of roads and frontage properties [9].

The authors for integration of strategies for safety and environment suggest the following guidelines for policy makers (This process shows in Figure 4):

- Ask leading questions about safety and environmental goals at the conceptual stage of the project and look beyond the immediate boundaries of the scheme.
- The safety and environmental consequences of changes in transport and land use should be made more explicit in technical and public assessments.
- There should be concurrent consideration of safety and environmental issues by involving all concerned agencies.
Figure 4. Process for eliminate and reduction conflict between transportation safety and environmental concern [9]

Reference


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