

Safe System for sustainable pedestrian safety in Bangladesh

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Abstract

This paper deals with achieving sustainable pedestrian safety in Bangladesh within the concept of safe system approach. The fact is that despite the rapid motorization level in Bangladesh, pedestrians form the largest single user group and accounted for more than half (52%) of the reported road traffic fatalities in Bangladesh. Detailed analysis of crash statistics revealed that around 80 percent of pedestrian accidents occurred in urban areas and rest in rural areas. Nearly 50 percent of the pedestrian fatalities occurred on road sides and 22 percent occurred while crossing the road. Children are particularly vulnerable as pedestrians. One third of the pedestrian deaths are under the age of 16 years. Heavy vehicles such as buses and heavy trucks are over involved in pedestrian injuries accompanied by the incidence of high speeding. Hazards and deficiencies associated with road infrastructure and roadside environment are major contributors to pedestrian fatalities. The iRAP infrastructure risk assessment revealed that the major highways are mostly (97%) 2-star or less (out of possible 5-star) for pedestrians, indicative of serious deficiencies of pedestrian facilities. Road infrastructure safety is clearly a priority and it is time for Bangladesh to quickly tighten this area for improving pedestrian safety. The relevance and the scope of introducing the new paradigm of safe system approach are briefly outlined in this paper. Some of the effective road infrastructure and speed management related countermeasures which demand priority consideration in delivering sustainable pedestrian safety are also discussed in the paper.

Introduction

Bangladesh is facing considerable road safety challenge. As many as 55 people are killed in traffic crashes daily. Pedestrians are the worst sufferers being by far the largest group of the mishap. Hazards and deficiencies associated with road infrastructure and roadside environment are major contributors to pedestrian fatalities. This paper details the prevalence of such pedestrian hazards and explores the prospects of sustainable pedestrian safety in Bangladesh within the framework of the Safe System approach. In particular, it details some key road safety facts, pedestrian accident characteristics and the Safe System principles and measures which will promote sustainable pedestrian safety.

Some Key Safety Facts in Bangladesh

The Problem Characteristics

Road traffic injuries are one of the major reasons of mortality and disability in Bangladesh. This country has one of the highest fatality rates in the world of over 100 deaths per 10,000 motor vehicles. World health Organization (WHO) estimates that about 20,000 deaths occur annually in Bangladesh from road traffic crashes, while around 4000 deaths are officially reported. Analysis of reported crash data shows that nearly 70 percent of road traffic fatalities are attributed to pedestrians, cyclists or users of motorized two-wheelers collectively known as vulnerable road users (VRUs) and amongst them

pedestrians are the worst sufferers whose share in total fatalities varies around 50 percent. Further analysis revealed that about 70 percent of these crash fatalities occurred in the rural areas and 50 percent occurred on national and regional highways. Accidents are highly clustered, nearly 50 percent of the crashes occurred on less than 5 percent of the highway network. The predominant accident types are “Hit-pedestrian” (45%), “Rear-end” (16.5%), “Head-on” (13.2%) and “Overturning” (9.3%). The trend is shown in Figure 1.

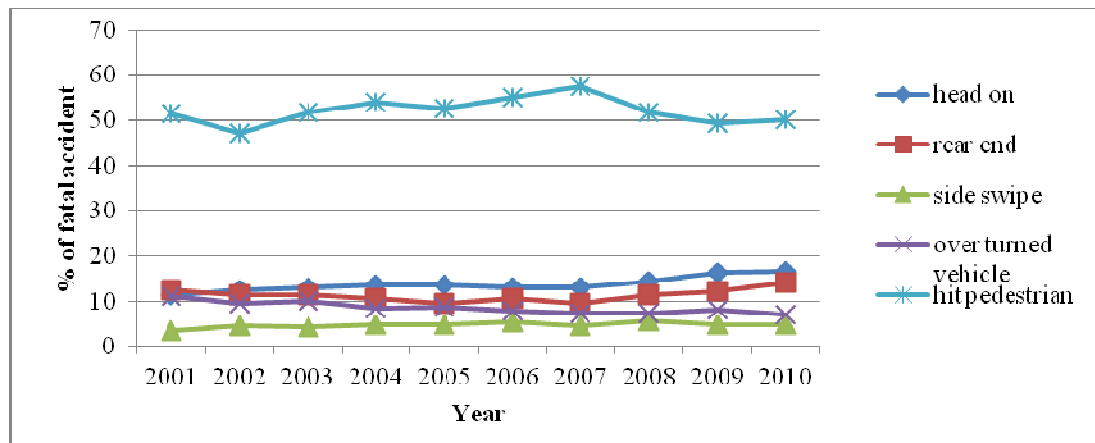


Figure 1. Trends of fatal accidents by types of collisions

Pedestrians – The Biggest Problem

Pedestrians are clearly the most vulnerable road user group largely due to their lack of protection and limited biomechanical tolerance to violent forces if hit by a vehicle. Despite the rapid level of motorization in Bangladesh, pedestrians form the largest single user group, primarily because of the lack of suitable transportation facilities and poor economic condition of the people. Walking represents a significant share of all urban trips here and nearly 60 percent of the trips in Dhaka city involved walking and it is particularly prevalent for short trips (JBIC Report, 2000).

Pedestrian fatalities are increasing up to 70 percent in urban areas. The share of pedestrian fatalities in Dhaka city is much higher, upto 80 percent. Some further pedestrian crash characteristics are:

- About one- third of total pedestrian fatalities are children under the age of 16 years.
- Of the total child fatalities in road accidents, nearly 80 percent are involved as pedestrians with the dominant age group of 5-15 years.
- Children fatalities in rural areas are three times higher than that of urban areas.
- Most of pedestrian fatalities occur at roadsides, 45 percent which is followed by on road 38 percent and at pedestrian crossing points, 12 percent.
- Most of the pedestrian fatalities occur while crossing the road (41%) and is closely followed by walking on the road (39%) and standing on road (14%).
- Heavy vehicles such as trucks and buses including minibuses are major contributors to road accidents and are particularly over involved in pedestrian accidents accounting for about 72 percent of urban pedestrian fatalities.



Figure 2. Typical scenes of pedestrians on road in Bangladesh (Source: Hoque et al. 2012)

Improving Pedestrian Safety: The Safe System Context

The Road Factor in Pedestrian Injuries

It is now abundantly clear that a range of factors and circumstances is attributable to pedestrian accidents. According to FHWA (2010), factors related to pedestrian safety and morbidity include such categories as pedestrians (e.g. pedestrian's age, behaviour), drivers (driver distraction), vehicles (large trucks), roadway environment (vehicle speeds and volumes, roadway and intersection design), as well as demographic, social and policy factors (land use and zoning practices). Of the other roadway/environment factors include intersection geometrics, midblock crossing issues, roadway lighting, weather related issues, urban planning and design issues, traffic and pedestrian signals, signs and markings, bus/transit stop design issues and maintenance issues. Evidence (Rogers 2013) suggests that the risk of pedestrian injuries is increased by a number of factors that relate to the road environment, including:

- high speed of traffic (increases severity)
- poorly maintained, obstructed footpaths
- inadequate crossing facilities
- lack of pedestrian crossing opportunities (traffic volume)
- number of lanes to cross
- complexity and unpredictability of traffic movements at intersection
- inadequate separation from traffic
- poor crossing sight distance

The principal contributing factors to accidents in Bangladesh have been widely documented in earlier studies. For example, Hoque et al. (2010 & 2011) identified the following factors contributing to accidents: adverse road and roadside environment, poor detailed design of junctions and road sections, excessive speeding, overloading, dangerous overtaking, reckless driving, carelessness of road users, failure to obey mandatory traffic regulations, conflicting use of roads and requirements, mix traffic with a variety of vehicle characteristics and speeds and defects in vehicles.

Several road environmental factors that are particularly prevalent in rural roads are major roadway defects in design and layout, shoulders, roadsides, bridge and its approaches, delineation devices, inadequacy of traffic segregation and lack of access control. Unregulated private/ business access to inter-urban highways led to endless linear settlement resulting in high risk for pedestrians and other vulnerable road users. Most of these factors are responsible for the alarmingly high number of pedestrian crashes on the roads of Bangladesh.

Road Infrastructure Safety: A Crucial Element

The International Road Assessment Program (iRAP) - Bangladesh Pilot Project (iRAP 2010) which provided the first comprehensive infrastructure risk assessment of the N2 and N3 highways showed that hazards and deficiencies associated with road infrastructure and roadside environment are major contributors to pedestrian fatalities. The safety ratings of these two major highways are mostly (98%) 2-star or less (out of possible 5-star) for pedestrians - indicative of serious road infrastructure and environmental deficiencies. Further assessment of around 1400 kilometres of highways revealed that 97 percent of highway sections are 2-star or less for pedestrians. Some of the facts driving the relatively poor star ratings are (more details can be seen in Hoque et al. 2010 & 2013):

- **Absence/Poor Provision of Footpaths and Crossings:** The high risk of serious pedestrian crashes is attributable to high pedestrian flows along and across the roads by the absence or poor provision of footpaths. More than 90 percent of the highways investigated do not have footpaths in place. Footpaths where available are often blocked by parked vehicles or shops, meaning that pedestrians need to walk on the road pavement. There are only a few pedestrian crossings located on the highway including zebra crossing and foot over bridges although most of the highways passed through locations where a significant amount of pedestrians crossed the road, in particular close to schools. The safety problems especially for pedestrians are greatly compounded by its serious incompatibility with the existing roadway conditions (Figure 3).
- **Non-compliance of Overpasses and Crossings:** Pedestrian overpasses are often not used by pedestrians (Figure 4). This is a common challenge around the world, and requires careful planning and design to ensure that facilities match pedestrian desire lines and channel pedestrians towards the safe crossing point.
- **Linear Settlements:** Roadside developments are located on either side of the highway which mainly consist of shops, commercial or residential areas and in most cases highway passes through villages and market places with high pedestrian activities. Unregulated private/ business access to inter-urban highways leads to endless linear settlement resulting in high risk for pedestrians (Figure 5).



Fig 3. Pedestrians on High Speed Road



Fig 4. Pedestrians at risk for crossing the road



Figure 5. Typical linear settlement

These findings indicate that pedestrians, who constitute the greatest volume of road users, are facing very alarming threats and risks. The fact is that pedestrians, being the largest travel mode, have little choice but to travel along roads in close proximity to fast vehicles. As a consequence, they find themselves in a high risk situation which inevitably leads to a large number of crashes and casualties. Due to absence of proper regulation and dedicated facilities for this vast group of road users they consequently become the worst sufferer of road crashes in this country. Clearly pedestrian deaths and injuries could not be saved until safety treatments are built for correcting such hazards on the roads.

The Safe System Approach

One of the most recent advances in tackling road safety is the introduction of the concept of the Safe System approach. It aims to reduce the likelihood that crashes occur, and minimize the severity of those that do happen (World Bank, 2009). This approach puts particular emphasis on safe roads along with the mutual importance of safe road users, safe vehicles and safe speeds. The Safe System approach is very effective in preventing road deaths and serious injuries on large scale and its potential in less motorized countries like Bangladesh is enormous. Given the road environmental situation and hazards associated with pedestrians, as discussed in the preceding sections, the systematic implementation of safe system approach can enhance the safety of the pedestrians significantly. Recognizing the importance of adopting Safe System approach for the safety of the pedestrians, some of the safety measures related to road infrastructural improvements are briefly discussed. Indeed safer roads have the capacity to address key crash types and play an important role in addressing behavioral issues and makes travel safer for all road users (World Bank, 2009). Evidence (TRL 1991) suggested that excessive speed and driver inattention are a common occurrence at accident blackspots. This characteristic is fairly prevalent in Bangladesh as well. Therefore, countermeasures designed to alert drivers to the conditions and to encourage or force them to reduce speed is of paramount importance for the pedestrians.

Safe System Countermeasures for Pedestrian Safety

Fundamentally Safe System countermeasures aim either to prevent a crash from occurring or to reduce the severity of that crash, while minimizing the possible role of human error in precipitating the crash. According to Turner & Cairney (2010), the countermeasures or treatments can be broadly classified under two heads: Primary and Supportive Treatments. Within this context and principles some of the effective road infrastructure and speed related countermeasures which demand priority consideration in promoting pedestrian safety in Bangladesh are discussed below.

Safe roads and roadsides through physical separation: The principle of physical separation includes provision of grade separation for pedestrians (overpass/underpass), as well as separate facilities (e.g. sidewalks, pedestrian fencing, pedestrian crossings and malls). Other geometric countermeasures like raised medians, refuge islands, paved shoulder etc. provides physical separation to the pedestrians from the speeding vehicles.

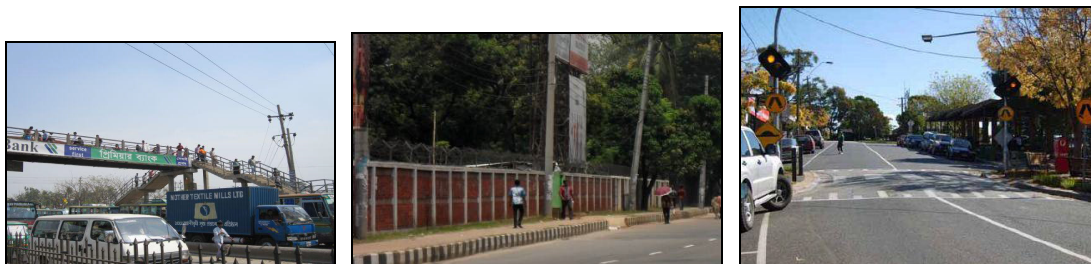


Figure 6. Grade Separated Crossing (Overpass) (left), Urban Footpath (middle), Raised or Crossing (right)

Pedestrian Footpaths and Crossings: Given that ‘hit-pedestrian’ is the most dominant type of accident in Bangladesh, providing pedestrian footpaths and sidewalks and adequate pedestrian crossings including grade separated pedestrian crossing facilities are two very effective measures to reduce pedestrian deaths and deserve urgent attention. Most striking feature as observed during the

field studies is that 80% of roads where pedestrians are present do not have formal footpaths. It is therefore clear that footpaths and sidewalks construction and improvement should be core element in any road development both in urban and rural areas of Bangladesh. Indeed footpath showed very high first year rates of return up to 1000% as revealed from the published results.

Pedestrian Fencing: Although installing pedestrian safety barriers can play a vital role to channel the pedestrians away from the main traffic stream, pedestrian fencing on national highways is a rare practice in Bangladesh. Safety barriers and fences should be installed and maintained wherever warranted to prevent the pedestrians to cross the carriageways randomly and indiscriminately.

Shoulders and Medians: Most of the sections of national highways in Bangladesh do not have adequate provision for shoulders and medians. In the absence of adequate shoulders pedestrians are forced to share the carriageway with fast moving motorized traffic. Providing suitable shoulder will not only minimize side friction for the fast moving vehicle but also will provide greater recovery and maneuvering space. Median barriers can be very effective on the high speed roads of this country and will have safety implications on both motorists and pedestrians. Installation of central refuges and islands where appropriate will be highly beneficial. Refuges are indeed considered to be the simplest and cheapest method of protecting pedestrians.

Safe speeds for pedestrians: Speed management is of core importance in delivering Safe System outcomes. Pedestrian fatality risk is a function of the impact speed of a car as shown in Figure 7. Here pedestrians have been shown to have a 90% chance of survival when struck by a car travelling at 30 km/hr or below, but less than 50% chance of surviving an impact at 45 km/hr. Pedestrians have almost no chance of surviving an impact at 80 km/hr. Therefore, implementation of speed control measures appears to be of utmost importance and promising ways to reduce pedestrian deaths and injuries in Bangladesh.

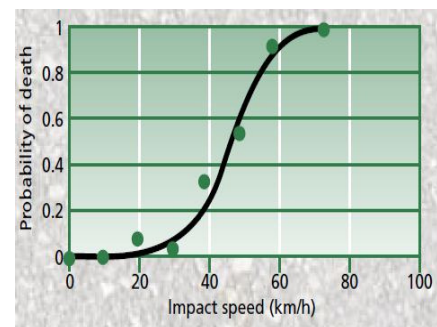


Figure 7. Pedestrian fatality risk vs. the impact speed of a car (Source: Pasanen E, 1991)

Speed Limits: Setting lower speed limit holds great promise for pedestrians. According to Oxley (2010), moderation of vehicle speeds to not exceeding 30 km/hr can be achieved through adoption of low urban speed limits (maximum 50 km/hr) with lower speeds (30km/hr) in residential and shopping areas and in school zones. Additional measures to increase speed limit compliance and adoption of appropriate travel speeds include out-of-vehicle Intelligent Transport System (ITS) applications (e.g., dynamic messaging in the form of active speed warning signs and variable message signs) and introduction of traffic calming measures. There is no established speed limit for different types of roads in Bangladesh. In case of some bazaar areas, posted speed limits are without proper warning signs and are not usually obeyed by the drivers. Increasing attention to these aspects is needed for addressing pedestrian safety in Bangladesh.

Traffic Calming: Indeed vehicular speeds can be controlled by adopting innovative and appropriate traffic calming measures. Implementation of innovative traffic calming measures as a part of urban safety management is urgently needed to improving pedestrian safety substantially. Indeed traffic calming is meant to benefit a wider group by reducing speeds and volumes and can also provide self enforcing speed reductions. Traffic calming can be achieved through measures such as pavement narrowing, refuge islands, alterations to the road surface with rumble strips, raised platforms at

pedestrian crossing locations and at intersections, speed humps, speed cushions, roundabouts and gateway treatments.

General Traffic Engineering Improvements

The potential for conflicts between pedestrians and motorized vehicles is the greatest at junctions. Therefore, a significant portion of pedestrian crashes occur at junctions which very often become accident blackspots. Almost three quarters of intersections (70%) are unsignalized with no protected turning lanes and no channelization. At present lack of channelization and proper signal controlling are causing many confusion and conflicts at the critical junctions. Presently, there is no practice of pedestrian only signal phase in this country and sometimes there is no pedestrian facility like overpass or underpass at many intersections. At times, buses stopping at or near the junction for boarding and alighting of passengers are aggravating the situation. Improving junctions by proper channelization, installing refuge islands for pedestrians, providing bus lay by away from the junctions and enforcing proper safety practices can effectively improve the overall road safety. Other measures like adding exclusive pedestrian phasing, improving signal timing, pedestrian countdown signal heads, modifying signal phasing, safety cameras etc. will help delivering safer junctions and intersections. Intersection lighting, improved pavement friction (skid treatment with overlay), increased enforcement, parking restrictions etc. also have substantial safety implications and deserve increased attention in promoting pedestrian safety.

Effectiveness and Benefits of Different Countermeasures

The Road Safety Toolkit which is the result of the collaboration of iRAP, the Global Transport Knowledge Partnership (gTKP) and the World Bank Global Road Safety Facility provides the effectiveness of some of the aforementioned countermeasures in reducing the number and severity of pedestrian crashes. These are listed in Table 1 below.

Table 1. Effectiveness of different countermeasures (Compiled from: <http://toolkit.irap.org/>)

Countermeasure	Cost	Treatment Life	Effectiveness	Benefits
Pedestrian Footpaths	Low to medium	10-20 years	40-60%	<ul style="list-style-type: none"> •Reduced risk to pedestrians •Increased use of walking which leads to reduction in congestion, and provides health benefits
Pedestrian Crossings	Low to high	5-15 years	10-40%	<ul style="list-style-type: none"> •Reduces pedestrian crashes •Disruption to traffic flow is reduced or removed
Central Hatching	Low	1-5 years	10-25%	<ul style="list-style-type: none"> •Staged crossing length •Possible protection for pedestrians •Provides width for formal pedestrian refuge islands
Pedestrian Fencing	Low	10-20 years	25-40%	<ul style="list-style-type: none"> •Helps to guide pedestrians to formal crossing points. •Can help to prevent unwanted pedestrian crossing movements. •Physically prevents pedestrian access to the carriageway. •Provides useful guidance for visually impaired pedestrians.
Traffic Calming	Medium to high	10-20 years	10-25%	<ul style="list-style-type: none"> •Reduces crashes •Reduces traffic volume •Improved environment for pedestrians, cyclists and community
Grade Separated Crossing	High	20 years +	60% or more	<ul style="list-style-type: none"> •Reduces pedestrian crashes •Traffic flow improvements
Signalized Intersections	Medium	15 years	25-40%	<ul style="list-style-type: none"> •Increases intersection capacity •Reduces some crash types, especially side impacts •Improves pedestrian and cyclist safety

Sustainability of Pedestrian Safety

Mobility and safety as well as sustainability are the fundamental requirements for any transportation system which should be built into the planning, design and construction and operation stages of the system. By requirements, sustainable transport strategies are those that meet the basic mobility needs of all modally balanced and be sustained into the foreseeable future without any adverse implications. One of the main characteristics of the emerging sustainable safety is to have integrated approach which integrates man, vehicle and road into a safe system covering the whole network, all vehicles, all road users. Sustainable safety essentially invokes safe system approach and central to this approach is promoting infrastructures that maximize opportunities by ensuring safety for pedestrians and other VRUs.

To provide sustainable road safety, Bangladesh needs to address pedestrian safety as a matter of some urgency. Pedestrian being the largest road user group are exposed to the highest level of risk in

Bangladesh because the prevailing road infrastructure and its environment as demonstrated in the preceding sections deny pedestrians as a safe place to walk. The concept of Safe System Principles clearly emphasizes building safety into the road system and making it inherently safe and adaptive to human limitations. Therefore safe system improvement measures relating to road infrastructure context are expected to contribute to achieving sustainable pedestrian safety, rapidly with longer lasting effects at marginal cost.

Conclusions

Road traffic crashes place a heavy burden on the society in Bangladesh and are severely inhibiting poverty reduction efforts particularly in the rural areas. Pedestrians are the major victims and are involved in around 50 percent of all fatalities. Importantly, addressing pedestrian safety is crucial for achieving the goals and targets of the Decade of Action for road safety and the focus in this paper has been on improving pedestrian safety. Crash studies and field investigations revealed that hazards and deficiencies associated with road infrastructure are major contributors to pedestrian fatalities and injuries. The safety ratings of the major highways are mostly (97%) 2-star or less for pedestrians. Engineering safety on roads is clearly a priority issue and pedestrian deaths cannot be prevented until safety treatments are built on the road infrastructure. Safe system approach provides new paradigm for road safety which is widely recommended for low and middle income countries. Substantial opportunities and scope exist for making road infrastructure safer for pedestrians through systematic application of Safe System Principles and measures. Aspects and relevance of Safe System approach and its prospects in providing sustainable pedestrian safety are briefly discussed in the paper.

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