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Review on Road Safety Aspect in Transportation

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ABSTRACT *This paper presents an analysis of the fatal crashes thatinvolved public transport buses in Bangalore, India. The study suggests that low floorbuses with mechanical doors and segregated pedestrian and bicycle lanes can have amajor impact on reducing fatal crashes of bicycles and pedestrians involving buses.And another research paper based on the aim of facilitating a comparative functional analysis of driving assistance systemsand infrastructure measures for traffic safety, this paper studies the underlying concepts of safe road design, and derives a general set of traffic safety principles. Road categorisation isstudied as an important parameter for both road design and route selection that is optimised from a traffic safety perspective and an extended road categorisation is proposed. Finally a systematic overview of infrastructure measures is provided, as a basis for a future comparative functional analysis.*

INTRODUCTION

In low and middle income countries, buses are likely to remain the primary mode of mass transit for the foreseeable future (Tiwari 1994). Biomechanics and crash investigation studies have confirmed that occupants of buses are at much lower risk of dying in the event of a crash (Bhalla et al. 2006) However, bus users face risks of road trafficinjuries on access trips and buses also are associated with road traffic crashes with other road users (Bhalla et al. 2007, Mohan et al. 2009).

The total motor vehicle population in India has increased from about 300,000 in 1951 to about 73,000,000 in 2004 (see Table 1). The basis of this figure is the number of new vehicles registered each year. The vehicles registered each year are accumulated to arrive at the total figure of vehicles on road, notwithstanding that vehicles do have a specified life. Out-of-use vehicles remain on record. Recent studies have estimated that actual number of vehicles on the road in Delhi is 60-70 percent of the official statistic (Expert Committee 2002; CRRI 2007). The figures in Table 1 reveal that motorcycles are more than five times as numerous as cars and that the total of buses, goods vehicles and other vehicles is similar in magnitude to the number of cars. These proportions of vehicle types are different from those in high-income countries and can influence fatality rate patterns. In the U.S. in 2005, for example, passenger cars constituted 66 percent of vehicles on the road, trucks and vans 30 percent, motorcycles only 3 percent, and buses 1 percent. The number of vehicles in a city with a population of about 6 million (Bengaluru) is indicated in Table 2. Statistics about road crashes in India are compiled at the national level by the Ministry of Road Transport and National Highways. This is based on the reports received from the state governments. This is attributable partly to an increase in the number of vehicles on the road, and partly to the absence of a coordinated official policy to control the problem. The fatality rate has increased from 36 fatalities per million persons in 1980 to 95 fatalities per million persons in 2006 (Mohan et al. 2009). However, a study done in Bangalore shows that while the number of traffic crash deaths recorded by the police may be reasonably reliable, the total number of injuries is grossly underestimated (Guru Raj)

Table 1. Total Number of Registered Motor Vehicles in India, 1951-2004(in thousands)

Year (as of March 31)	All Vehicles	Two-Wheelers	Cars, Jeeps and Taxis	Buses	Good Vehicles	Others*
1956	426	41	203	47	119	16
1966	1099	226	456	73	259	85
1976	2700	1057	779	115	351	398
1986	10577	6245	1780	227	863	1462
1996	33786	23729	4672	484	2343	4104
2000	48857	34118	6143	562	2715	5319
2004	72718	51922	9451	768	3749	6828

*Others include tractors, trailers, three-wheelers (passenger vehicles), and other miscellaneous vehicles that are not separately classified.

Source: Ministry of Road Transport and Highways Web site.

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Table 2.The number of vehicles in a city with a population of about 6 million (Bangalore) is indicated

Year	Two-Wheelers	Three-Wheelers	Car	Jeeps	Taxis	Buses
1991	2,79,498	31,864	36,602	3,051	1,046	9,706
2000	1,64,204	68,734	2,30,388	7,986	8,638	6,380
2005	18,76,498	92,722	3,40,168	9,171	14,250	11,708
2006	21,61,663	94,587	4,15,645	6,280	19,802	13,032
2007	2,405,727	109,405	486,657	8,775	27,723	14,739

TRAFFIC SAFETY PRINCIPLES

The twelve requirements focus on prevention and mitigation of the effects of conflictsbetween vehicle and vehicle, vehicle and other road users, and vehicle and obstacles, whilenot all possible conflicts in these categories are covered (e.g. prevention of collision with

Coincidental obstacle on the road), and especially single-vehicle situations are missing. Theseinclude single vehicle roll-over and single vehicle run-off road incidents, due to loss of lateralcontrol or wrong manoeuvring, and inappropriate speed when the vehicle approaches acurve. In addition, the principle of error forgivingness is missing. This implies that thesesafety requirements do not cover all measures based on infrastructure and driving assistancesystems. Therefore, and based on the aforementioned concepts of sustainable safety, weidentify an extended set of five basic traffic safety principles, as fundamental components oftraffic safety, with no or minimal overlap, and covering the major functional aspects of trafficsafety measures related to infrastructure design and driving assistance systems. Alternativeterms for (traffic safety) principle are (traffic safety) feature, parameter, determinant orvector (amongst other possibilities). For each traffic safety principle several more operationalsub-principles or traffic safety requirements are identified. The traffic safety principles arelisted and described below, while for each principle the related traffic safety requirementsare indicated.

TRAFFIC SAFETY PRINCIPLE 1: ROAD NETWORK FUNCTIONALITY

The structure and layout of the road network should be functional. Functional use of theroad infrastructure should be encouraged and induced, and unintended use should beprevented. This principle addresses road network layout and use at a more global level, i.e.at the network level. It has both objective aspects, that inherently generate functionalbehaviour (as other behaviour is not possible), and subjective aspects, that should inducefunctional behaviour of the driver. This principle covers part of the idea of self-explainingroads at the global level.

TRAFFIC SAFETY PRINCIPLE 2: RECOGNISABILITY AND PREDICTABILITY

The road environment should be adapted to the limitations of the road user, and should beinformative about expected behaviour. Complex traffic situations should be avoided, andeverywhere route choice and necessary manoeuvres should be fully comprehensible forevery road user. Recognisability of the traffic situation should induce predictable behaviour, and prevent insecure and ambiguous behaviour. An important precondition is willingness ofroad users to accept and behave in accordance with the rules set by the traffic regulation.This principle addresses road layout and use at a local level, i.e. at the level of the trafficsituation that the road user encounters. This principle covers the other part of the idea of

Self-explaining roads, i.e. at the local level.

TRAFFIC SAFETY PRINCIPLE 3: HOMOGENEITY

Homogeneous use of the road network aims at preventing encounters between road users,and between road users and obstacles, at high differences in speed, direction and mass.

TRAFFIC SAFETY PRINCIPLE 4: DRIVING TASK SIMPLIFICATION

Simplifying the driving task and thereby reducing driver workload is a way to enhance thecapability of the driver. This principle at first sight resembles one aspect of the principle "recognisability and predictability", i.e. making traffic situations simple (avoidance of complexTraffic situations), but even though a simple traffic situation simplifies the driving task, it is infect different. This principle does not focus on the ad-hoc traffic situation but on thecontinuous process of driving. It aims at taking away some of the effort that is needed fordriving, and/or at reducing the needed attention for certain parts of the driving task, and/orat helping to take correct decisions in certain situations. Related traffic safety requirementare the items 13 "driver capability enhancement" and 14 "driver workload reduction".

TRAFFIC SAFETY PRINCIPLE 5: ERROR FORGIVINGNESS

Despite implementation of the foregoing four principles, drivers will continue to make errors, because of the limitations of the human being. This principle focuses on: (1) correctingdriving errors at an early stage, when they start developing, by interfering with or blockingthe development of the error; and (2) mitigating consequences of driving errors once theyhave developed too far and a conflict cannot be avoided anymore. Related traffic safetyrequirements are the items 15 "error correction", and 16 "consequence mitigation".

ROAD CATEGORISATION

For several reasons functional road categorisation (or classification) is a relevant topic forroad traffic safety: (1) different road categories involve different types and levels of trafficrisk; (2) a specific infrastructure measure often relates to a specific road category; (3) implementation of road categories with clear and recognisable characteristics improves roadnetwork functionality, and thereby helps to induce intended road user behaviour; (4) Different road categories require a distinct design of the road environment to satisfy the Requirements of self-explaining and forgiving nature; (5) road categories play a role in the Above mentioned sixteen requirements (especially in requirements 2, 4, 6 and 7); (6) road Categorisation is used for a long time in urban planning [Buchanan 1964] and by urban Traffic planners (see, for instance, the yellow urban arterials on standard paper city maps)

CONCLUSION

The analysis has provided a very useful input to policy makers who could take corrective steps and consequently reduce the number of such fatal crashes. The paper establishes that change in bus design with low floors, automatically-closing doors, safer bus fronts, and segregated infrastructure for bicycles and pedestrians would go a long way in reducing the number of fatal crashes on city roads involving public buses. The main contribution of this paper to understanding in transportation science lies in Compiling a set of general traffic safety principles. Based on a review of the underlying Concepts of road design focusing on sustainable traffic safety, we defined an extended set of Five traffic safety principles, and sixteen more operational sub-principles or traffic safety Requirements.

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