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Why are Pedestrian Crashes so Different in Developing Countries? A Review of Relevant Factors in Relation to their Impact in Ethiopia

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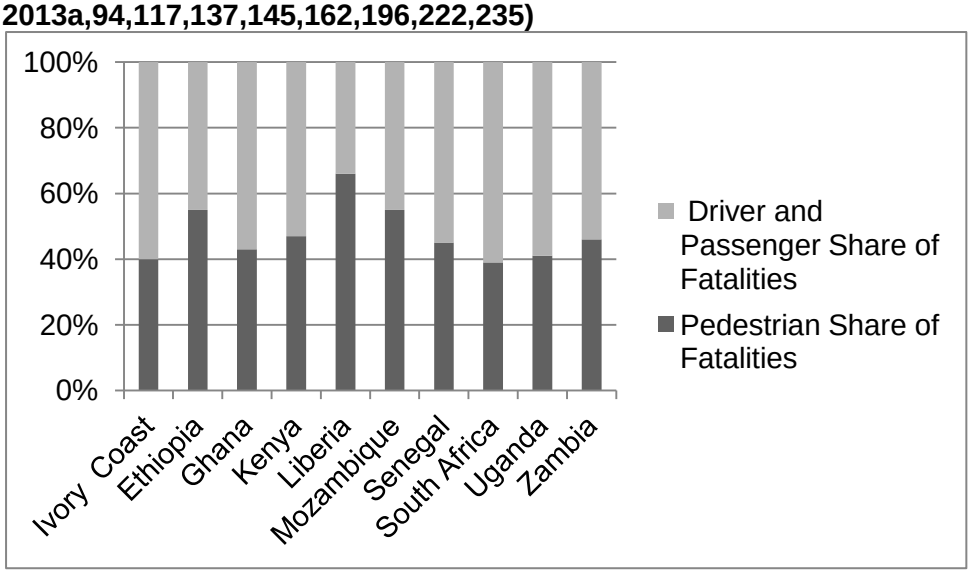
Abstract
Much is known about pedestrian behaviour and crash risk in developed countries. In contrast, the literature on pedestrian crash risk in developing countries reveals wide gaps in knowledge and understanding, and a comprehensive assessment is lacking. In particular, pedestrian behaviour in developing countries is fundamentally different in comparison to developed countries, and is influenced by a variety of less well understood contributing factors, leading to difficulty in modelling and predicting pedestrian crash risk and in turn identifying effective safety countermeasures. This paper provides a comprehensive synthesis of the factors known to influence pedestrian crash risk in developing countries, then focuses on Ethiopia as a specific example. The paper identifies where critical gaps in knowledge exist regarding pedestrian crash risk and associated behaviour in developing countries--a set of knowledge gaps which collectively are significant. The paper concludes by articulating a critical research path moving forward, with the aim to achieve an improved understanding of developing country pedestrian crash risk, and an ultimate goal of identifying effective pedestrian safety countermeasures suited to the unique challenges faced by transport system managers in developing countries.

Key words: motor vehicle crashes; pedestrian crash risk; developing countries; Ethiopia; pedestrians; safety management

1. Introduction
There are valuable insights into road safety in developed countries, as a considerable amount of research has been undertaken since the 1970s. Currently, road traffic crashes in developed countries show a declining trend due to ongoing investment in safety programs and countermeasures. However, the literature on pedestrian crash risk in developing countries (DCs) is at an early stage as the implementation of road safety interventions has only begun recently and rapid motorisation is taking place. Moreover, the focus of road safety interventions has generally been restricted to improving the safety of motorists rather than pedestrians. A considerable effort is required to understand the unique features of pedestrian crash risk in DCs. For instance, pedestrian fatalities globally were estimated to total more than 400,000 per year, out of which 55.3% and 39.2% occur in low- and middle-income countries respectively per year (Naci, Chisholm, & Baker 2009, p58). Although pedestrian crash risk is a major concern in DCs' road traffic crashes, the problem has not been sufficiently investigated. This neglect has stimulated a call by the World Health Organization (WHO) for a global focus on pedestrians, particularly in DCs. Recently, WHO's Global Status Report confirmed that 88 countries with a total population of 1.6 billion people have shown a decline in road traffic deaths, whereas 87 countries with a total population of 5.2 billion have experienced higher fatality rates (WHO 2013a, p4). Most of the increases in traffic deaths have occurred in low and middle income countries, especially in Africa. As shown in Figure 1, pedestrian fatalities in African countries account for more than 38% of total road traffic deaths (WHO, 2013b). In the case of Ethiopia, pedestrians account for 55% of fatal crashes per annum (Tulu et al. 2013, p2, WHO 2009, p99), although the comparative

levels of exposure to risk are not known with certainty. In spite of these high numbers, policy makers in DCs have failed to remediate the growing scale of pedestrian crash risk, which is exacerbated by the rapid motorisation in DCs. Given these trends it is worthwhile to scrutinise the problem of pedestrian crash risk in DCs by providing a comprehensive synthesis of the factors which expose pedestrians to crash risk.

Figure 1: Proportion of Pedestrian Fatalities in African Countries (WHO 2009,p99,191; 2013a,94,117,137,145,162,196,222,235)



The aim of this paper is to synthesise the causes and contributing factors that typify influences on pedestrian crash risk in DCs, drawing on data from Ethiopia where they are available. The presence of critical gaps in current knowledge in pedestrian risk and behaviours in DCs are also assessed. Finally, the paper articulates a clear understanding of the gaps and the way forward for further research. Moreover, from the findings of this study, possible countermeasures suited to the particular situation are recommended. Road safety experts from Australia and other high income countries are increasingly becoming involved in work in DCs, including Ethiopia, and this research will assist in highlighting the differences in DCs that need to be taken into account. This is particularly relevant in the UN Decade of Action on Road Safety.

2. Synthesis of Pedestrian Crash Risk in Developing Countries

The factors that influence pedestrian crash risk range from specific characteristics of pedestrians and drivers through to broad issues that affect all sectors in a country. This synthesis begins by considering more specific influential factors for rising pedestrian crash risk in DCs and moves through to consider broader influences. The available literature in this area has been scanned and incorporated where appropriate in this section. However, published research works are limited and some of them describe country specific scenarios. A few papers focus on the issue of pedestrian crashes in DCs, but they are limited in their depth of scrutiny. For instance, Transport Research Laboratory (TRL) has produced many works which focus on DCs road safety starting from the early 1980s and 1990s (for example Downing et al., 2000; Downing, 1991; Jacobs, Aeron-Thomas, & Astrop, 2000; Jacobs & sayer, 1984; Sayer & Palmer, 1997; Sayer, Palmer, Murray, & Guy, 1997); however, recently, their contribution has gradually declined and has to some extent lost its relevance due to the current dynamism of the transportation system. Consequently this paper is based on more recent literature, and aims to develop an understanding of each relevant factor and identify gaps in the current state of knowledge.

Walking at Night

Pedestrian crash risk at night is higher than in the daytime due to the lower conspicuity of pedestrians (Schneider, Grembek, & Braughton 2012, p16; Wood et al. 2012, P11), this is exacerbated by the tendency for pedestrians to judge themselves as being more visible than they actually are at night (Tyrrell, Wood, & Carberry 2004; p483). One study shows that drivers' ability in recognising pedestrians at night is degraded (Wood, et al. 2012, p11) such that pedestrian fatalities may rise seven times higher at night than daytime (Sullivan & Flannagan 2007, p646). Most pedestrians in developed countries can afford to buy retro-reflective clothing which is both available and has been demonstrated to enhance visibility at night (Tyrrell, Wood, et al. 2004;p483 Wood, et al. 2012, p14), but such clothing is neither commonly available nor affordable in DCs. In addition, most locations in developed countries with high pedestrian traffic have sufficient street lighting to facilitate the visibility of pedestrians at night and thereby reduce road crashes (Beyer & Ker 2010, p12), whereas the same does not apply as widely in DCs. Researchers in Ghana, for example, have found that the night-time pedestrian crash rate is higher than the daytime rate since many built-up areas have not been provided with sufficient street lighting (Damsere-Derry, Ebel, Mock, Afukaar, & Donkor 2010, p1086). The installation of street lighting involves significant initial and operational costs, and there are other priorities for the use of electricity, so that the lack of provision of street lighting in DCs is not surprising and likely to continue. In DCs, with high levels of pedestrian movements in general, and with a great volume of pedestrians walking during night-time in shared road environments, the effects of pedestrian conspicuity on their exposure to crash risk are much higher compared with industrialised countries. Another issue is inadequate or absent headlight illumination from vehicles and headlight glare due to poor compliance with road rules and vehicle lighting standards (Balk & Tyrrell 2011; p510; Oluwadiya et al. 2009, p297). In addition to conspicuity issues, the prevalence of alcohol impaired driving and walking is likely to be higher at night, and with regard to the safety issue it poses is discussed in 'Alcohol and Drug Impaired Walking' section.

Fatigue

Most people in DCs use walking as a principal mode of transportation for short and long distance travel. Long distance walking (Ipingbemi & Aiworo 2013, p82) may cause physical fatigue in pedestrians, who, as a consequence, may lack proper judgement in the traffic system and expose to crash risks. Pedestrian fatigue may also result when pedestrians are walking when exhausted from other activities (such as extended physical work), and walking after taking heavy medication, fasting (Al-Khateeb, Obaidat, & Khedaywi 2008, p4), or under the influence of alcohol or other drugs (addressed below). However, there appear to be few studies addressing pedestrian fatigue in pedestrian crashes. In Ethiopia, police records of crashes do not provide details about the causes of pedestrian crashes, such as fatigue or other pedestrian faults, and the same is true in Ghana (Damsere-Derry, et al. 2010, p1081). For DCs, this is a gap that needs in-depth assessment through well-designed studies. On the other hand, driver fatigue and its countermeasures are well investigated in a number of research elsewhere (e.g., Fletcher, McCulloch, Baulk, & Dawson 2005, p471-474; WHO 2004, p84).

Walking along Roads

The International Road Assessment Programme (iRAP) pointed out that 84% of roads with pedestrians in DCs had no sidewalks (WHO 2013a, p33). Pedestrians often tend to walk along roads due to the absence of footpaths or shoulders, as shown in Figure 2--a example from rural Ethiopia. The lack of separation between vulnerable road users and motorised traffic leads to a considerably larger set of potential crash risk opportunities for pedestrians compared to separated facilities encountered in developed countries.

Figure 2: Pedestrian Road Use on Main Road through Small Town South of Addis Ababa City (Photo: M. King)

Due to financial constraints, most DCs' road networks in built-up areas are constructed without the provision of sidewalks. Even when sidewalks are present, they may be occupied by roadside vendors/hawkers and bars (Damsere-Derry, et al. 2010, p1087), or pedestrian facilities may be constructed without adequately accommodating the volume of pedestrians. In particular, pedestrian volumes are extremely high in poor residential neighbourhoods, areas with high unemployment, and near markets (Figure 3). As a result, pedestrians are forced to walk along roadways (McMahon et al. 2001, p11-13). Moreover, the poor quality and unevenness of the surface of walkways may discourage pedestrian use. An in-depth study in a developed country shows that the non-provision of sidewalks and the presence of a high volume of motorised traffic, higher speeds, and unsealed shoulders can increase the probability of pedestrian crashes when walking along roads (McMahon, et al. 2001, p13). Moreover, lack of sidewalks can increase the risk of crashes twofold compared to roads that have footpaths.

Figure 3: Pedestrian Road Use in Market Area of Addis Ababa City (Photo: M. King)

In DCs, the volumes of pedestrians are high because of low levels of motorisation, so most people use walking as a primary mode of transportation. In some places, where unemployment rates are high, people may spend most of their time near the road environment, including standing on roads to seek a temporary job, or just spending their time by walking along the roads (Damsere-Derry, et al. 2010, p1087). These factors escalate the exposure to pedestrian crashes in DCs. However, with shortage of evidence, the magnitude of pedestrian crashes is not known in DCs.

Illegal Crossing Behaviour

Pedestrians are expected to follow traffic rules and cross on pedestrian designated facilities particularly in built up areas, and it is worth noting that there are fewer rules for pedestrians than for drivers (King, Soole, & Ghafourian 2009, p485). However, comprehensive road traffic legislation is in place for only 7% of the world's population (WHO 2013a, p12). Illegal crossing behaviour and absence of discipline in the road environment are relatively well investigated in some DCs which give an emphasis to these issues within other major topics to explain the high rates of pedestrian crashes (Cherry, Donlon, Yan, Moore & Xiong 2011; p320; Damsere-Derry, et al. 2010;vp1086; Ibrahim, Day, Hirshon, & El-Setouhy 2011;p65-71; Wang, Guo, Gao, & Bubb 2011;p7). A study in China found that 65.7% of pedestrians did not check the oncoming and departing vehicles when they crossed unmarked roadways (Zhuang & Wu 2011, p1936) due to poor perception priority rules. A recent study in Chile has revealed that pedestrians have a positive attitude towards illegal midblock crossing (Díaz 2002, p172). In cities of DCs, illegal crossing can be governed by psychological attributes and complexity of road environment (Wickramasinghe, Priyankara, & Dissanayake, 2012).

Crossing behaviour of pedestrians in Addis Ababa City, Ethiopia is rarely in compliance with the pedestrian regulations, though drivers contribute to this as they do not yield at pedestrian crossings. There are also infrastructure factors that contribute to illegal crossing behaviour: there are relatively few legal crossing points, and centre medians are sometimes difficult or impossible for pedestrians to negotiate, and in recent years the traffic lights in Addis Ababa (which should halt traffic to allow a pedestrian phase) have been turned off because their unlinked fixed-phase operation contributes to greater congestion. At other locations there are interactions between behavioural and infrastructure factors. For example, the Addis Ababa City ring road traverses through mostly densely populated areas, and has a central New Jersey barrier which makes it impossible for pedestrians to cross. As a consequence there is fencing to prevent pedestrians using the road and overpasses are provided, however pedestrians are often reluctant to use pedestrian overpasses (Ribbens 1996, p16). Instead, they jump over the fences and median barriers to cross the roadways (Figure 4). As a result, many pedestrians have been seriously injured or killed by fast moving vehicles. It is worth noting that, according to the Ethiopian traffic rules, drivers are not liable for such pedestrian injuries or fatalities because it is a fully access-controlled road.

Figure 4: Illegal Crossing of Addis Ababa City Ring Road (Photo: M. King)

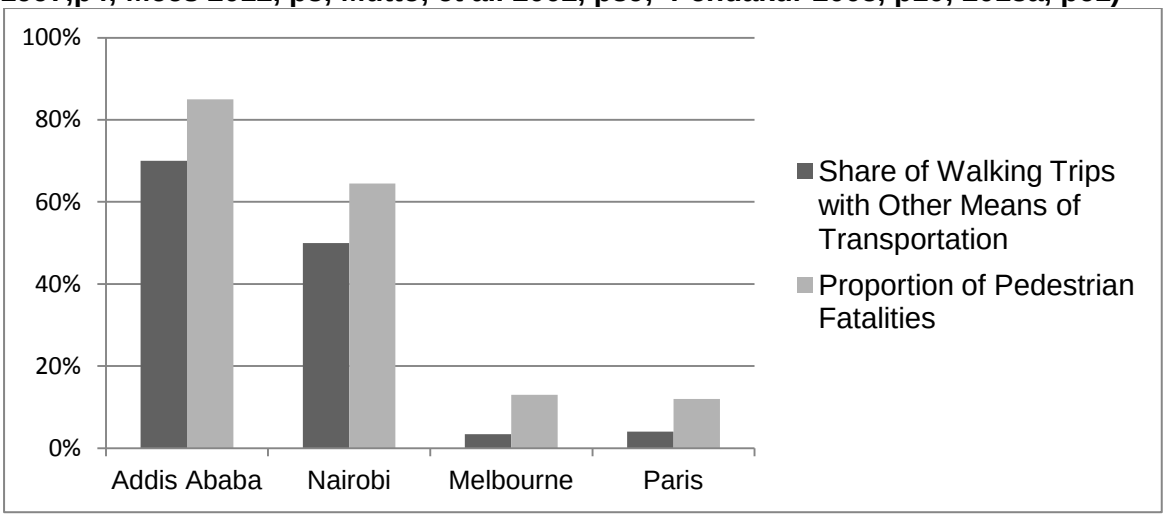
Although illegal behaviour is widespread, there is little information about the relative contribution to this behaviour of levels of knowledge about road rules, levels of enforcement of the rules, relative opportunities to cross legally (which is in turn influenced by amount of traffic, distribution of legal crossing points, and compliance of drivers with requirements to

stop or give way at crossing points). Research with pedestrians and drivers about their knowledge, attitudes and practices would provide valuable insights

Socioeconomic Factors

Unlike other means of transportation, walking as a principal mode of transportation is mostly used by people who have lower income. This can involve activities other than walking: observation in Addis Ababa City, Ethiopia reveals that young males play football on the roadways, and orphan street boys sleep on roadways or edges of roadways. By definition, low and middle income countries have a high proportion of low income people, are less motorised and therefore have more of their population exposed to risk of crashes (Mohan 2002; p529 & Nantulya & Reich 2003, p13). This corresponds with the finding in 44 countries that the higher gross national incomes, the lower the pedestrian volume in the traffic system, and the lower the pedestrian fatalities (Paulozzi, Ryan, Espitia-Hardeman, & Xi 2007, p616). Similarly, studies from the United States confirmed that African American residents, who have a lower average socioeconomic status, are overrepresented in traffic crashes as well as in pedestrian crashes (Daniels et al. 2002; p108; Poling 2012, p51).

Figure 5: Share of Walking Trips with Other Means of Transportation, and Proportion of Pedestrian Fatalities in Selected Cities (Ebrahim, Sun, Ely, & Ai, 2012; Khayesi 1997,p4; Mees 2012, p3; Mutto, et al. 2002, p89; Pendakur 2005, p10; 2013a, p61)



Studies indicate that walking as a mode of transportation accounts for 70% of all trips and 60% of modal share in Addis Ababa City, Ethiopia (Nyarirangwe 2008, p518; Pendakur 2005, p10). Individuals from low-income households usually use walking as a primary mode of transportation as they have financial constraints that prevent them from better alternative modes of transportation, and spend more time along the roadway and crossing roadways to access properties. This implies greater exposure to pedestrian crash risk, which is borne out in crash statistics, and is illustrated in the comparative data presented in Figure 5. In Addis Ababa City, Ethiopia, the 70% pedestrian share of trips translates to a much higher 85% pedestrian share of fatalities (Mutto, Kobusingye, & Lett 2002, p89). This is high even for DCs as a whole, where pedestrian deaths account for 55-70% or more of total urban area fatalities (Nantulya & Reich 2002, p1139). Ethiopia's rate is reflective of an extremely poor country, being higher than the rate in Nairobi (see Figure 5). In general, Figure 5 illustrates that the share of walking modes as a primary means of transportation (high volume) has a positive relationship pedestrian crash risk, i.e. as mode share increases, so does fatality share. It is possible that there is more to this relationship than just exposure as measured in terms of mode share; however this does not appear to have been widely explored.

Alcohol and Drug Impaired Walking

Alcohol and drug intoxicated pedestrians and driving are at heightened risk for crashes, as has been widely demonstrated in developed countries (Haque et al. 2012; p378; Ostro¨m & Eriksson 2001, p173). Pedestrian crashes involving alcohol are likely to be higher at night for two main reasons. First, alcohol consumption is higher at night relative to the day. Second, reduced visibility at night coupled with poor perception and reaction of drivers and/or pedestrians due to alcohol increases the crash risk (WHO, 2013b). A study carried out by Boni et al. (2011, p1408) in southern Brazil showed that positive alcohol breath-tests were found in 9.2% of pedestrians who had been involved in crashes. Likewise, although alcohol-related pedestrian crash data have not been collected properly in Ghana, rough evidence indicates that the consumption of alcohol may be high in young adolescent and adult pedestrians (Damsere-Derry, et al. 2010, p1081). In Zimbabwe, a hospital survey also indicated that 70% of pedestrian killed in crashes had alcohol present in their blood (Downing 1991, p6). The results of these three studies have confirmed that alcohol intoxicated pedestrians are exposed to high fatality and injury risks. Unlike for drivers, laws do not restrict pedestrians' alcohol levels and drug use in either developed nations or DCs, and the issue is addressed instead through broader public health approaches aimed at reducing alcohol consumption in general. Apart from the studies mentioned above, which provide a rough indication of the magnitude of alcohol impaired pedestrian crashes, no comprehensive studies were found in respect of DCs. Moreover, data on pedestrian alcohol- and drug-related crashes are usually not registered in police crash records.

Poor Transportation and Land Use Planning

Integrated transportation and land use planning should reduce travel demand and create a safer road environment for all. The lack of provision of footpaths and crossings mentioned above already suggests some deficits in planning of infrastructure to take account of pedestrians in DCs. Land use planning agencies may not exist, and land use planning that does occur lacks integration in most DCs (Gwilliam 2003, p127; Ribbens, Everitt, & Noah 2008, p65). The problem involves not only the absence of a land use management agency but also the lack of transportation and traffic management (Suandi & Dia 2005, p1572). It is only recently that the Addis Ababa City Administration has announced intentions to establish a traffic management unit. Moreover, there is no coordination between the road authority and utility providers, which has led to examples where newly constructed footpaths have been dug up, and the base materials have been excavated but not appropriately replaced, leaving an uneven surface which results in pedestrians using the roadways.

The provision of pedestrian facilities during planning and construction of road projects is not given attention (e.g., in Ghana and South Africa (Ribbens, Everitt, & Noah 2008, p71-72)) and they are considered as ancillary works if they are incorporated in the planning stage (WHO 2013a, p30). A recent study in two DCs found that pedestrian paths and footpaths have generally been poorly maintained, with undulating surfaces and narrow width being particularly common (Shah & Silva 2010, p2). A pedestrian preference interview in thirteen Asian countries revealed that 41% of the participants indicated that the pedestrian facilities in their cities were very bad or the worst (Leather, Fabian, Gota, & Mejia 2011, pvii). Furthermore, as mentioned above, footpaths are frequently used by a number of venues, like restaurants and bars, and by events, like roadside markets.

Recently, in Ethiopia, major trunk roads (rural highways) upgrading and construction have been incorporating a by-pass in cities for road safety reasons (e.g Modjo and Shashemene cities). However, commercial activities like bars, restaurants, shops, roadside vendors and other activities have been relocated into the by-pass areas without permission from the road authority. This is because of the lack of coordination between the road authority and municipalities during the planning and operation stages of road projects. The problems extends to everyone who has settled on the by-passes without lodging an application for

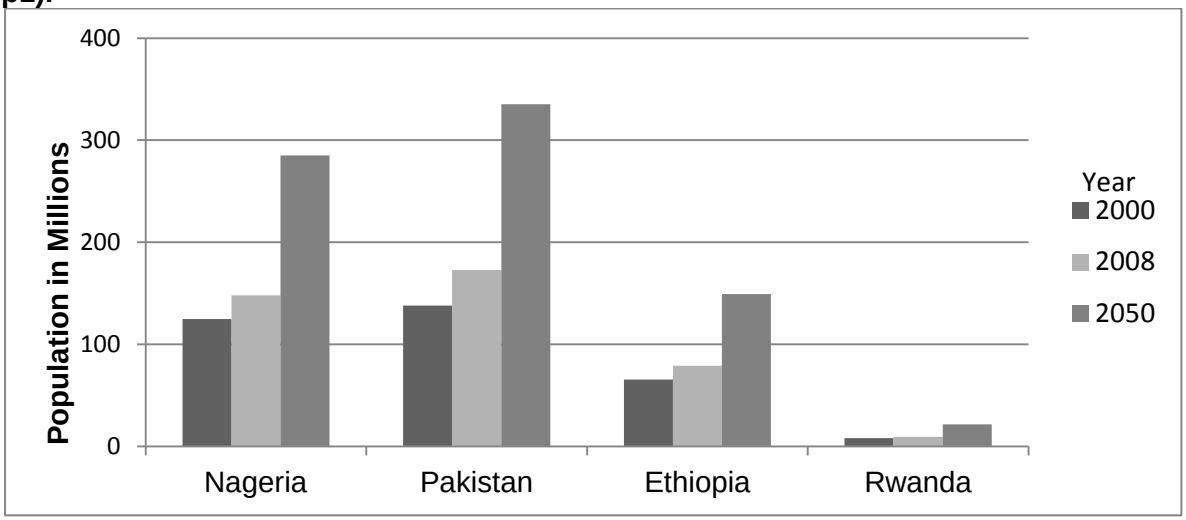
access points, since the country does not have access point standards and permission procedures.

Population Growth Rate

The population growth rate in extremely poor countries is more than 3% per annum. Some selected countries' populations and their growth trends for 2000, 2008 and 2050 are indicated in Figure 6. The population growth affects the capacity of pedestrian facilities. For instance, the Ethiopian population growth rate is nearly 3.0% per annum, and, currently, the total population is more than 91 million (Central Intelligence Agency 2011). In 2050, the population will be expected to reach about 150 million (Population Institute 2010, p1). A direct implication is that a large proportion of the population is aged 15 or less, the opposite of developed countries. These high numbers of children are exposed to risk of a pedestrian crash when travelling to and from school, often when playing, and even when accompanying their parents. As they are smaller they are more difficult for drivers to see, and are physically more vulnerable in the event of a crash.

A high population growth rate leads to increased population density and demands additional facilities (Lasmoni & Indriastuti 2010, p8). In turn, huge financial resources will be required to provide safe, convenient, and economical infrastructure. However, financial constraints are the barrier in developing infrastructure. For example, in Asian cities, provision of pedestrian facilities has been unsuccessful when faced with a lack of financial resources to support the demand (Leather, et al. 2011, p37). The consequence of the financial resource constraints has been deterioration in the safety of pedestrians. This in turn has resulted in rising pedestrian crashes. Moreover, as the number and density of the population increase, pedestrian volumes rise in the road environment. Research shows that the exposure to pedestrian risks rises when the volume of pedestrians increases rather than traffic volume (Gårder 2004, p536).

Figure 6: Estimated Population Trends for Selected DCs (Population Institute 2010, p1).



Lack of Road Safety Education

In most DCs, pedestrians are not properly aware of pedestrian rules and regulations due to the inadequacy of formal and informal education (Sayer & Palmer 1997, p3). The level of formal education is poor in the majority of citizens. For instance, the average expectancy of school life from primary to tertiary is 8 years in Ethiopia (Central Intelligence Agency, 2011). Moreover, road traffic education has only been introduced into formal education in the last 7-8 years. However, a lack of knowledge in those who teach road safety and low quality teaching materials are significant problems for road safety education in low income countries (Sayer & Palmer, 1997; Sayer, et al. 1997, p1). A survey that was conducted in 1,200

schools in three DCs found that little formal road traffic safety education was carried out (Sayer & Palmer 1997, p10). Therefore, the evidence suggests that road safety education is in its infancy in many DCs. In contrast, in western countries, road safety education has been present for a long time and brought an attitude of change within society (King, 1999, p2). It is arguable that western countries have ample experience in this area, and that it is advisable to adapt the available knowledge, experience, and technology to the social and cultural context in DCs (King, 1999, p1). In addition to school-based education, public education about road safety can take place via the media. While there is mixed evidence about the effectiveness of public education in achieving behaviour change, there is stronger evidence that public education campaigns tend to be most effective when they complement enforcement programs (King 1999, p8).

Poor Enforcement of Traffic Regulation

Adequate traffic rules and regulations exist in DCs traffic systems. However, as the high proportion of illegal behaviour mentioned above suggests, the problem is that enforcement is poor. There are many reasons for this. There is much corruption involved in regulatory bodies (Nantulya & Reich 2002, 1140). This corruption extends to ownership of vehicles, annual inspections of vehicles, and driver licensing. Also, enforcement bodies lack resources, and sufficient training to regulate traffic rule violations (The World Bank Group 2002, p1). Moreover, DCs usually have a lower proportion of police per population than developed countries, there is often a lack of funds to support enforcement outside of working hours, and enforcement aimed at traffic often involves controlling traffic movements rather than focusing on observance of safety laws (King 2005, p204).

Poor enforcement of traffic regulations is one of many factors contributing to high rates of fatalities and injuries in DCs (McIlvenny 2006, p4). Moreover, the practice of enforcement in DCs is different from and more challenging than in western countries due to the lack of political will, training, linkage with engineering and driver training, coordination among enforcing bodies, segregation of traffic, and defined responsibilities of enforcing bodies (Baluja 2004, p64,66).

High Annual Growth of Motorisation

Growth of motorised traffic leads to a rise in fatalities and injuries from valuable road users due to the increment in exposure (Zegeer and Bushell 2012, p3). China and India are good examples of rapidly rising population growth, urbanisation, per capita income, and ownership of motor vehicles (Pucher, Peng, Mittal, Zhu, & Korattyswaroopam 2007, p379). For instance, the total vehicle population increased from 0.2 million in 1960 to 207 million in 2010 in China, and India's vehicle population grew from 0.4 million in 1960 to 114.952 million in 2009 (Dargay, Gately, & Sommer 2007, p5; WHO 2013a, p88,126). In 2009, 72% of India's registered vehicles were 2- and 3-wheelers which may not have had crashworthiness features, particularly for pedestrians. In 2010, China reported pedestrian fatalities of 16,307, and in the same year, India suffered 12,055 pedestrian fatalities (WHO 2013a, p88,126). Moreover, motorised vehicles in poor countries accounted for 1% of the world vehicle population; however, they contributed 12% of road traffic deaths including pedestrians (WHO 2013a, p5). The increments of vehicle population within four years (from 2007 to 2010) in some selected DCs are given in Table 1.

Regarding used cars, DCs depend to different degrees on the importation of used cars from higher income countries. Used cars supplied to DCs typically do not undergo safety inspections and do not meet national safety standards of the exporting country (Akloweg, Hayshi, & Kato 2011, p67). The technical efficiency of old cars is undoubtedly at a very low standard. In Ethiopia, second-hand cars account for 77% and 48.2% of the imported cars older than 5 and 10 years old, respectively (Akloweg, Hayshi, & Kato 2011, p66). Moreover, these obsolete and technically deficient vehicles are in use for long periods without receiving proper service and maintenance. This practice is bolstered by the many Ethiopians who are

financially incapable of procuring a new vehicle at the standard price charged in other countries, and by government taxes on the importation of new vehicles (Akloweg, et al. 2011, p66). Overall, the skyrocketing growth in motorisation and lack of crashworthiness standards has contributed to high levels of pedestrian crashes in DCs.

Table 1: Motorisation Growth in Number from 2007 to 2010 in selected low and middle income countries (WHO, 2009, p45-226, 2013a, p55-236).

Description	Registered Vehicles 2007 (thousands)	Registered Vehicles 2010 (thousands)	% Motorised 2- and 3-wheelers	% Growth in four years	% Growth per annum (average)
Africa					
Botswana	294	395	N/A	34	9
Burkina Faso	515	885	78	72	18
Ethiopia	244	378	12	55	14
Ghana	932	1,123	20	21	5
Kenya	1,004	1,390	N/A	38	10
Mozambique	259	380	13	47	12
Tanzania	578	977	46	69	17
Uganda	1,245	1,489	1	20	5
Zambia	364	636	N/A	75	19
Asia					
China	145,229	207,061	N/A	43	11
India	72,718*	114,952	72	58	15
Pakistan	52,872	7,853	57	49	12
Bangladesh	1,054	1,625	60	54	14
Nepal	617	1,179	76	91	23
Latin America and Caribbean					
Brazil	49,644	64,818	25	31	8
Paraguay	576	919	26	60	15
Colombia	4,951	7,229	49	46	12
Chile	2,825	3,376	3	20	5

NB: *2004,! 2006 and N/A= Not Available

Institutional Capacity

Institutional capacity in road safety is a major problem in DCs (The World Bank 2007, p7). Road safety needs a responsible institution at a national level as well as at different levels of state governance units (WHO 2004, p13). In the case of DCs, there may be responsible institutions at a national level, but resources for road safety research and other countermeasures are limited. Although there are a few funding schemes for road safety in Ethiopia, the funds are not utilised effectively in part due to the lack of understanding of how to spend the available money to improve road safety most effectively. A contributing aspect is inadequate information in the database as a result of underreporting of crashes (Samuel et.al. 2012, p1). For instance, fatal crashes in Ethiopia were estimated by WHO to be 14,606 in 2010, whereas police reports indicated 2,581 in the same year (WHO 2013a, p109, 246). The discrepancies between the two figures are approximately six fold, too great to be solely due to flaws in WHO's estimation process, which highlights the problem of underreporting due to the lack of institutional capacity. As a result of the limitations of pedestrian crash data, there may be some important, unidentified factors which could affect the impact of intervention measures. Moreover, professionals who are responsible for carrying out analysis and interpretation of results are not found in DCs, which is why the United Nations (UN) has called for collaboration between developed countries and DCs (WHO 2011, p8). In general, poor institutional capacity is a multifaceted problem which incorporates absence of a professional skills, and lack of institutional strength for multi disciplinary action.

3.0 Discussion and Recommendations

The factors identified previously reveal a range of differences between developing and DCs in both the prevalence of risk factors and the contexts in which they operate, as well as a wide variation in the application of countermeasures (Mohan 2002, p527). A standard way of approaching road safety problems is through the "three Es": engineering, education, and enforcement (King, 2009, p7) so these subheadings have been employed.

Engineering

There are clearly many inadequacies in the provision of road infrastructure for pedestrians. This can be seen in the high exposure of pedestrians walking along roads where there are no sidewalks, having to cross where there are no facilities, and being at risk at night due to a lack of adequate lighting.

While full provision of pedestrian infrastructure is prohibitively expensive for existing roads, it is possible to incorporate sidewalks and crossing points into new roads without a large additional cost. For existing roads the focus should be placed on locations where pedestrian numbers and risk are highest. For example, pedestrian crashes have often been observed to cluster in urban areas. Studies confirmed that multi-modal transportation planning can play a vital role in minimising pedestrian involved crashes (Beukes et al., 2011, p452). Research in western countries provides growing evidence that three engineering countermeasures have brought substantial reductions in pedestrian crashes (Retting, Ferguson, & McCartt 2003, p1456), including separation of pedestrians from motorised traffic in time and/or location (vertical and horizontal), increase in visibility and pedestrian conspicuity through pavement markings and pedestrian lighting; and speed controls for motor vehicles in pedestrian zones (Brude & Larsson 2000, p21; Retting, et al. 2003, p1457). At present, engineering treatments for pedestrians are not common practice in DCs, as there is a lack of awareness of the wider economic benefit of these measures, so this area has unexplored potential.

One way of addressing this need is through the development of planning guides or manuals for pedestrian facilities in DCs. Pedestrian safety audits on existing and new roads should be conducted (Nabors et al. 2007, p3). Areas that will attract high volumes of pedestrians could be planned not to conflict with major arterial roads and freeways, which would reduce interactions between pedestrians and vehicles. Multi modal transportation planning has potential benefits as well, but requires the engagement of the private sector to deliver efficiency and effectiveness.

Vehicle standards and crashworthiness have also been identified to have influence on pedestrian safety and thus could also be addressed to improve pedestrian safety. Most DCs import vehicles from high income countries, however as noted earlier many are older vehicles that may no longer be roadworthy or have up-to-date safety features. In addition, while they have been manufactured to meet the safety standards of the originating country and its environmental conditions (Mohan 2002, p529), they may not be suitable in other geographic situations where altitude, climate, and road conditions differ. Ethiopia often imports vehicles from European and Arabian countries (Akloweg, et al. 2011, p66), however unlike these countries Ethiopia has extremes of altitude of the country (from 120m below sea level to 4,550m above sea level) which could affect the safety performance of vehicle. Western countries could address this by controlling the quality of export cars, both new and used (Akloweg, et al. 2011, p67). On the other hand, DCs could encourage the purchase of new cars by reducing the burden of taxes. Also, there is a need to ensure the ongoing operational safety of vehicles through regular inspections. Most two- and three-wheelers are produced in small scale factories which do not incorporate safety standards, and DCs could give attention to enforcing safety requirements as they constitute a significant proportion of the vehicle population (WHO 2013a, p55-236).

Education

Evidence suggests that pedestrians in DCs have little knowledge of and an indifferent attitude towards traffic rules (Jacobs & Sayer 1984, p8). Improvements to road infrastructure and vehicle crashworthiness will have a limited impact if pedestrians and drivers do not know how they should behave and interact. Road safety education for pedestrians would involve alerting them to road traffic rules and there is a similar need for drivers to understand their legal requirements, such as when pedestrians have right of way. This is only part of the answer, however, if there is insufficient infrastructure to enable pedestrians and drivers to comply with the law.

Moreover, aggressive promotional campaigns and road safety education could address the problem of noncompliance of pedestrians with crossing regulations, but absence of relevant data about illegal pedestrian crossing behaviour makes this difficult (King 2009, p485). One study suggested the appropriateness of community education from the experiences of western countries (Davis & Quimby 2003, p25). School children are at risk of involvement in a pedestrian crash because they are difficult to see and in many DCs there are very large numbers of school children; providing education at school about safe crossing should assist in reducing their risk.

Enforcement

Changes to infrastructure and education about rules and rights are of little assistance to pedestrians if they fail to comply with laws aimed at enhancing pedestrian safety. Illegal crossing is a major problem in aggravating pedestrian crashes in DCs (Ahmed 2000, p64), and includes people deliberately ignoring infrastructure provided for safety reasons. There is also a need to ensure driver compliance, not just with rules relating to pedestrians, but also observance of speed limits and traffic control signals and signs. At present enforcement tends to focus on ensuring traffic flow, often leading to police ignoring other offences.

A Combined Approach

The difficulty with an enforcement approach on its own is that there are many places (easily found in Addis Ababa) where crossing illegally is the only way to cross the road at all. This suggests that infrastructure provision and enforcement go together. It has also been suggested that a combination of education and a campaign for enforcement may bring a paradigm shift in the behaviour of pedestrians (Tay 2005, p927), and this also has implications for infrastructure, since the provision of overpass and underpass facilities should be undertaken while in the context of public acceptance through education.

Whatever approach is taken to addressing pedestrian safety in DCs such as Ethiopia, it should rely on evidence and best practice. While the discussion above has identified some measures that have potential, there is clearly a need to undertake further research into pedestrian exposure and risk in DCs. Similarly, there is also a need to understand the potential and limitations that apply to engineering, education and enforcement measures within the country of interest. It is intended that these considerations will guide research which we plan to undertake in Ethiopia in the near future.

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