ROAD SAFETY IMPLICATIONS AND OPPORTUNITIES FOR REGIONS UNDER INCREASING MOTORIZATION

Jac Wismans
SAFER Vehicle and Traffic Safety Centre at Chalmers University
SE-419 96, Gothenburg, Sweden
Phone: +31634333355, E-mail: jac.wismans@chalmers.se

Ingrid Skogsmo[1)], Anna Nilsson-Ehle[1)], Anders Lie[2)], Marie Thynell[3)], Gunnar Lindberg[4)]
1) SAFER Vehicle and Traffic Safety Centre at Chalmers University, Gothenburg, Sweden,
2) Swedish Transport Administration and Chalmers University, Gothenburg, Sweden
3) School of Global Studies, University of Gothenburg, Sweden
4) Institute of Transport Economics (TØI), Oslo, Norway

ABSTRACT

This paper compiles, evaluates and analyses information from different data sources on accidents and health, road transport and economic performance in a comprehensive manner to assess the size and impact of road accidents and injuries in regions under increasing motorization. Strategies based on global road safety improvement experiences are presented. In addition the paper aims at discussing a way forward by indicating opportunities and countermeasures that could be implemented to achieve a new level of safety in these regions. The data used comes from e.g. World Health Organization (WHO) and World Bank. Estimations on costs due to road transport injuries are presented. The results clearly demonstrate that road safety is causing large problems and costs with an enormous impact on the well-being of people, economy and productivity. For example, according to our analysis, the loss to the economy in Latin America is more than 130 billion US$ or 2.8 % of GDP.

In many of low and middle-income countries the yearly number of fatalities and injuries is still increasing. Vulnerable road users (pedestrians, cyclists and motor cyclists) are particularly at risk. Reliable accident data are imperative to determine evidence based intervention strategies and monitor the success of these interventions and analyses. When comparing data it is clear that there are large problems in official statistics in several countries. The lack of good high quality accident data should, however, not be an excuse to postpone measures.

Future trends in road transport and lessons learned from best practices in high-income countries are reviewed. The paper also proposes measures beyond the Decade of Action Plan for Road Safety 2011-2020, with respect to vulnerable road users, infrastructure, vehicle technology and truck and bus safety and discusses the implications for road safety in the UN's new Sustainable Development Goals.

1. INTRODUCTION

Recent publications from the World Health Organization (WHO 2015) and The Institute for Health Metrics and Evaluation (IHME)-World Bank (2014) estimate that worldwide some 1.2 - 1.3 million people die yearly due to injuries in road accidents, while many more are injured often with long-term disabilities as a consequence. In particular this tragedy affects persons that are economically active, creating important losses in their families. The number of road traffic injuries is increasing in low- and middle-income countries while it is stabilizing or decreasing in many high-income countries

(IHMI/World Bank 2014). The rapid motorization in many developing countries without timely introduction of accident and injury prevention strategies is the main reason for this.

The key drivers for the growing demand for transportation are population growth, urbanisation and increase in income per person (economic growth). Figure 1 shows predictions for global population, GDP (Gross Domestic Product) and vehicle growth up to 2035, according to the BP energy outlook 2035 (BP 2015). In this period the population is expected to increase to 8.7 billion, an increase of more than 20% compared to 2015. The GDP is about to double in this period, like the number of vehicles (passenger cars and commercial), which is expected to increase from around 1.2 billion today to 2.4 billion by 2035. Most of the vehicle growth will happen in the developing world (88%). The yearly sales worldwide of motor vehicles in 2014 was around 45 million of which about 25% commercial vehicles (OICA 2015). Yearly global sales of motorcycles (including e-bicycles) is forecasted to 132 million units in 2018 (Freedonia 2014) and electric two-wheel vehicles (e-scooters, e-motorcycles, and e-bicycles) take a large share in this, in particular in The People's Republic of China.

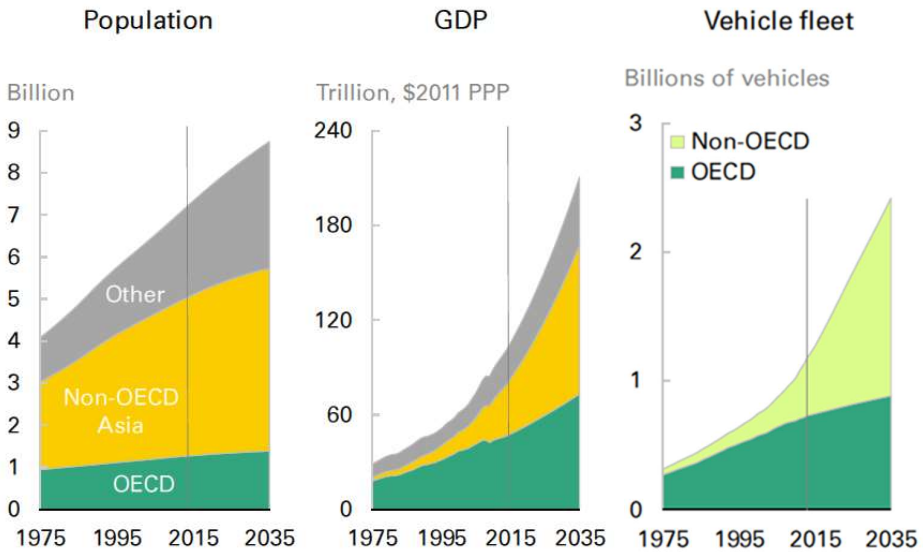

Figure 1: Predictions for global population, GDP expressed in purchasing power parity (PPP) and vehicles growth for OECD and non-OECD countries from 1975-2035 (BP 2015)

The objectives of this paper are to:

- Review and summarize the most recent and relevant information on the global road safety problem with a particular emphasis on low and middle-income regions in Latin America, Sub-Saharan Africa and Asia,
- Present the United Nations' global goals for sustainability development and its expected consequences for these regions,
- Present accident and injury prevention strategies based on experience and effectiveness in Western Europe and the status of implementation in these regions,
- Discuss the way forward by summarizing existing and new opportunities to prevent road accident fatalities and injuries in these regions.

The methodology used for this study includes a review and analyses of data in literature, among others from the World Health Organisation (WHO) and the World Bank, review of lessons learned from best practices in high-income countries, estimation of costs due to road transport injuries and a review of future trends in road transport.

2. THE GLOBAL ROAD SAFETY PROBLEM

In 2004 the World Health Organization (WHO) and the World Bank jointly launched the World report on road traffic injury prevention (Peden et al. 2004). The report identified, among others, the need for accurate reliable accident data systems in order to allow countries to develop and monitor evidence based road safety strategies

Since the launch of the World report on road traffic injury prevention, three Global Status Reports on Road Safety have been published by the WHO (2009, 2013, 2015). In these reports data that were collected with help of different sectors and stakeholders in each country are presented. For details on the methodology for collecting the data refer to WHO (2015). The accident data included in the 2013 report concern the year 2010 and in the 2015 WHO report the year 2013.

Data presented in 2014 by the Global Road Safety Facility at the World Bank in cooperation with the Institute for Health Metrics and Evaluation (IHME/World Bank 2014) are based on the Global Burden of Diseases, Injuries, and Risk Factors Study 2010 ("GBD 2010"). The data are for the same year 2010 as the WHO (2013) status report. It produced estimates for 187 countries and 21 regions and assessments of the burden of road injuries as well as the burden that can be attributed to outdoor air pollution. For a description of the methodology used, see (IHME/World Bank 2014).

WHO (2015) estimates that the number of road fatalities in the world annually in 2013 is about 1.25 million and this figure is rather constant since 2007. The IHME/World Bank (2014) estimates are slightly higher: almost 1.33 million injury caused deaths due to motorized transport in 2010. The IHME/World Bank study (2014) also calculated the risk of indirect deaths caused by air pollution from motorized transport. If this risk is included the total number of deaths in 2010 exceeds 1.5 million annually, so more than 4000 per day. The main causes of the additional 180.000 annual deaths are ischemic heart disease, stroke, COPD (chronic obstructive pulmonary disease) and lung cancer.

Deaths due to road accidents are just the tip of the iceberg. Non-fatal injuries are much more difficult to record and measure than fatal injuries, also in high-income countries. The reasons for this include difficulties in defining the severity of injuries and availability of good hospital data linked to police data (see WHO 2013, WHO 2015, IHME/World Bank 2014 and IRTAD-OECD/ITF 2010). This is particularly true for pedestrians and cyclists injuries that in many cases are not reported.

The GBD 2010 data analysed in the IHME/World Bank (2014) study represent the first attempt to quantify data on non-fatal injury on a global level. For the year 2010 the number of injured persons worldwide due to road accidents was estimated to be 78.2 million persons needing medical care of which 9.2 million were requiring an hospital admission. These hospital admissions were defined as "injuries that would have required at least an overnight hospital stay if adequate access to medical care had been available to the victims". Considering the number of deaths in 2010 due to road accidents the resulting ratio between fatalities, hospital admissions and other injuries based on these GBD 2010 estimates would be **1 : 7 : 52**. The number of injuries are higher and more precise than injury data reported by the WHO in various reports (up to 50 million, WHO 2015).

3. FATALITIES AND INJURIES IN AFRICA, LATIN AMERICA AND ASIA

Table 1 provides an overview of the 3 regions, sub-regions and countries for which data are included in this paper. Western Europe is included as a reference. The definitions of the sub regions is according to the regions as defined in the GBD 2010 database.

Table 1: Overview of regions, sub-regions and countries within the (sub)-regions

Regions	Countries
Latin America	
Andean Latin America	Bolivia, Ecuador, Peru
Central Latin America	Colombia, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Venezuela
Southern Latin America	Argentina, Chile, Uruguay
Tropical Latin America	Brazil, Paraguay
Sub-Saharan Africa	
Central Sub-Saharan Africa	Angola, Central African Republic, Congo, Demo Rep. Of the Congo, Equatorial Guinea, Gabon
Eastern Sub-Saharan Africa	Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, Sudan, Tanzania, Uganda, Zambia
Southern Sub-Saharan Africa	Botswana, Lesotho, Namibia, South Africa, Swaziland, Zimbabwe
Western Sub-Saharan Africa	Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, São Tomé and Príncipe, Senegal, Sierra Leone, Togo
Asia	
China	China
South Asia	Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan
Southeast Asia	Cambodia, Indonesia, Laos, Malaysia, Maldives, Myanmar, Philippines, Sri Lanka, Thailand, Timor-Leste, Vietnam
Western Europe	Andorra, Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom

Table 2 provides an overview key data for these regions including population, number of vehicles (defined as all registered motorized vehicles, so including cars, motorized 2- and 3 wheelers, buses, trucks etc.) and the contribution (%) in this total of motorized 2- and 3- wheelers, further referred to as PTW and the contribution (%) of Cars and 4-wheeled light vehicles, further referred to as Cars. The number of PTW and Cars per 1000 capita is included as well. All data concern the year 2010 and are based on WHO 2013, except if no data were provided in WHO 2013, then data from WHO 2015 for the year 2013 were used, or estimates were made based on other countries within the same region. Note that the registration of vehicles is not always reliable in a country or that registration for certain categories of vehicles is not always carried out in a country. For instance in the Netherlands the number of PTW only concerns motorcycles and not mopeds and e-bikes. Income per capita is also included in Table 2, based on both GDP per capita from the World Bank (in US$) dollars. If no data are included in the Table the available data were considered not sufficiently reliable or not available.

Table 3 contains data concerning the impact from road accidents in the various regions. Data are compiled from IHME /World Bank (2014) on traffic related fatalities, injuries requiring hospital admission and total number of nonfatal injuries in 2010. The information on the number of fatalities comprises both official numbers and estimates adjusted for underreporting by IHME/World Bank (2014). The number of fatalities per car is also added in the Table. In WHO 2013 fatality estimates are also included and they are in most cases in the same order of magnitude as the IHME/World Bank estimates and therefore not included in the Table 3. There was one exception and that were the estimates

for South Africa, that we found to be unrealistically low in the IHME/World Bank estimates, and therefore the data from WHO 2013 have been used instead.

Table 2 Key data per region.

Region	Population	Vehicles WHO 2013	% Cars	% PTW	Cars/ 1000 pop.	PTW/ 1000 pop.	GDP per capita (US$)
Andean Latin America	53,471,100	5,105,311	60.0%	30.3%	57.29	28.90	4,377
Central Latin America	230,844,067	47,984,963	63.5%	12.4%	132.09	25.67	7,973
Southern Latin America	60,894,850	18,825,660	74.5%	21.7%	230.26	67.13	11,705
Tropical Latin America	201,401,036	65,737,221	67.1%	25.5%	219.08	83.15	10,871
Latin America	**546,611,053**	**137,653,155**	**66.6%**	**20.6%**	**167.76**	**51.78**	**9,105**
Central Sub-Saharan Africa	95,697,522	795,953			6.20	1.91	1,378
Eastern Sub-Saharan Africa	300,538,822	5,108,388	49.2%	34.3%	8.36	5.82	720
Southern Sub-Saharan Africa	70,351,882	11,227,904	81.0%	3.6%	129.24	5.81	5,815
Western Sub-Saharan Africa	315,015,034	18,117,683	58.8%	37.7%	33.83	21.66	1,561
Sub-Saharan Africa	**781,603,260**	**35,249,928**	**64.8%**	**26.0%**	**29.24**	**11.73**	**1,578**
China	1,348,932,032	207,061,286	54.8%	38.0%	84.12	58.33	4,515
South Asia	1,608,996,830	126,397,841	14.5%	70.3%	11.40	55.23	1,262
Southeast Asia	609,105,801	170,169,595	18.6%	75.6%	52.08	211.17	2,822
Asia	**3,567,034,663**	**503,628,722**	**32.5%**	**58.8%**	**45.84**	**83.03**	**2,759**
Western Europe	**418,669,637**	**271,645,257**	**82.8%**	**10.5%**	**537.09**	**68.31**	**40,156**

Table 3 Impact from road traffic accidents in 2010

Region	Death 2010 Off. Stat	Death 2010 GBD	Death 2010 (GBD)/ 100000 pop.	Hospital Admissions 2010	Nonfatal injuries 2010	Fatalities (GBD)/ 10000 Cars	Tot Costs (mill. US$)	Prop of GDP
Andean Latin America	7,417	9,460	17.69	59,941	514,907	30.9	7,297	3.1 %
Central Latin America	35,573	40,962	17.74	156,004	1,457,122	13.4	44,692	2.4 %
Southern Latin America	7,721	8,699	14.29	59,416	510,982	6.2	18,928	2.7 %
Tropical Latin America	37,705	45,232	22.46	172,375	1,594,049	10.3	66,276	3.0 %
Latin America	**88,416**	**104,353**	**19.09**	**447,736**	**4,077,060**	**11.4**	**137,194**	**2.8 %**
Central Sub-Saharan Africa	5,168	22,759	23.78	109,601	964,848	383.8	6,640	5.0 %
Eastern Sub-Saharan Africa	21,865	83,615	27.82	355,719	3,267,240	333.0	8,020	3.5 %
Southern Sub-Saharan Africa	17,836	20,477	29.11	69,126	584,499	22.5	9,799	2.4 %
Western Sub-Saharan Africa	18,117	115,678	36.72	349,370	3,369,311	108.6	23,591	4.5 %
Sub-Saharan Africa	**62,986**	**242,529**	**31.03**	**883,816**	**8,185,898**	**106.1**	**48,051**	**3.7 %**
China	70,134	282,576	20.95	1,903,239	16,300,000	24.9	235,388	3.9 %
South Asia	141,370	310,114	19.27	2,922,725	24,274,761	169.1	91,265	4.5 %
Southeast Asia	77,704	129,583	21.27	945,674	8,055,168	40.9	69,863	4.1 %
Asia	**289,208**	**722,273**	**20.25**	**5,771,638**	**48,629,929**	**44.2**	**396,516**	**4.0 %**
Western Europe	**22,690**	**35,186**	**8.40**	**281,080**	**2,381,099**	**1.6**	**290,703**	**1.7 %**

From Table 2 and 3 the following observations can be made:

- The number of cars varies greatly per region and is very low in Sub-Saharan Africa and Asia compared to Western Europe. An exception is Southern Sub-Saharan Africa (that includes South Africa) where the order of magnitude is the same as in Latin America (about 3-4 times smaller as Western Europe).
- The proportion of PTW is the largest in Asia, namely about 2-3 times larger than in Latin America and Sub-Saharan Africa. In South and South East Asia the number of PTW is much larger than the number of passenger cars.
- The number of death in Latin America is more than 100,000 per year, in Sub-Saharan Africa almost 250,000 and in Asia more than 700,000.
- In Sub-Saharan Africa the number of death per 100,000 capita is 3-4 times larger than in Western Europe and for Asia and Latin America this is about a factor 2-2.5 larger.
- Both WHO (2013) and IHME/World Bank (2014) estimates for the number of fatalities are exceeding the official country statistics indicating underreporting in many countries. In particular in sub-Saharan Africa and in Asia the difference between the two sources appears to be large, for instance a factor 4 in China and more than a factor 6 in Western Sub-Saharan Africa.
- The number of fatalities per 10.000 vehicles shows large variations between and also within the various regions with the lowest in Europe (1.6) and the highest in Eastern and Central Sub-Saharan Africa showing more than 200 times the European level.

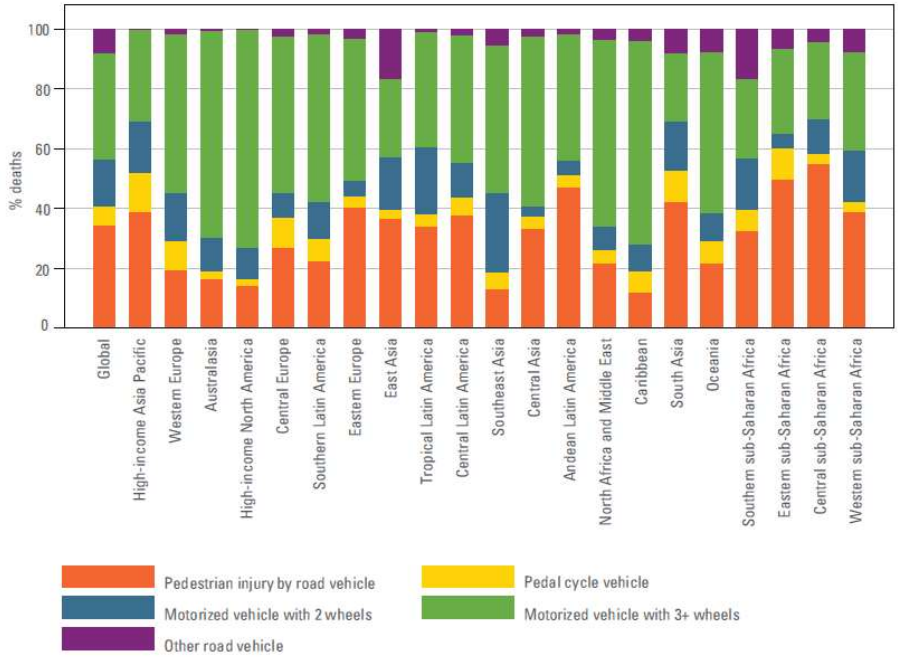

Figure 2: Distribution by region and type of road user of death in road crashes in 2010 according to IHME/World Bank 2014

Fig. 2 shows the distribution by region and type of road user of death in road crashes in 2010 according to IHME/World Bank 2014. Note that more regions are shown than the ones included in this paper in Table 2 and 3. China is part of East Asia. The proportion of vulnerable road users (pedestrians, pedal cyclists and motor cyclists) shows large variations between regions. Where it is about 45% in Western Europe it can be up to 70% in some regions in Sub-Saharan Africa and Asia.

4. ROAD SAFETY AND ECONOMIC IMPACT

In addition to the invaluable human tragedy, traffic accidents are a huge loss for the economy. These costs can be divided into *direct economic* cost, *indirect economic cost a*nd *value of life* per se (Elvik 2000). The *direct economic* costs are more or less visible, as medical costs, legal and emergency service costs and property damage costs. The medical treatment of an accident one year will for some patients continue over many years ahead, in the worst cases over their whole lifetime and it is necessary to estimate the present value of future medical treatments. The *indirect economic* cost of accidents consists of the value to society of goods and services that could have been produced by the person, if the accident had not occurred. The value of a person's production is assumed to be equal to the gross labour cost, wage and additional labour cost, paid by employer. The losses of one year's accident will continue over time up to the retirement and will grow with a growing economy. However, the weight of the later years will be smaller as a discount rate will be used in the calculations. To account for the lost lifespan due to premature mortality the number of years of life lost (YLL) are measured as the difference between the expected lifetime and actual age at accident. YLL will thus measure the number of lost productive years if it is adjusted for local retirement age.

Value of statistical life (VSL) reflects that people value their safety for more subtle reasons than their lost production capacity. In most countries this value is the dominant element in the valuation of accidents. With a focus on the welfare of the individual, VSL is estimated as the individual's willingness-to-pay for a small risk reduction, which is summed up to one "statistical life". VSL can be based on labour market observations (Viscusi et al. 2003) or responses to questionnaires (Jones-Lee 1976). A huge literature on methodology and meta studies exists today (Viscusi et al. 2003, de Blaeij et al. 2003), concluding that although the methodology is not flawless it is more appropriate than the alternatives.

For this paper costs have been calculated based on a VSL of 70*GDP/capita (iRAP 2008) as described in detail in: Wismans et al. (2014). The cost of serious injuries is based on a value of serious injury of 17*GDP/capita [iRAP 2008]. The resulting cost estimates per region are included in Table 3 as well as the proportion of the GDP. The GDP proportion of the road fatalities and injuries is 1.7% in Europe, about 3% in Latin-America and about 4% in Asia and Sub-Saharan Africa (with large variations within regions).

5. GLOBAL SUSTAINABLE DEVELOPMENT GOALS (SDG'S) AND BRASILIA DECLARATION ON ROAD SAFETY

The year 2015 was an important year for global road safety. On 25 September United Nations (UN) adopted a new agenda for Global Sustainable Development Goals (UN 2015). They build on the achievements of the Millennium Development Goals (MDGs) that will expire in 2015. There are 17 goals and 169 targets, which focus on various global issues such as poverty and environmental issues and they are to be implemented from 2016 over the next fifteen years until 2030. In contrast to the MDGs, that didn't cover traffic safety specifically, the SDG's contain several important aspect of traffic safety.

Road safety is specifically included in two goals:

- Goal 3: *ensure healthy lives and promote well-being for all at all ages,* contains the target 3.6: *By 2020, halve the number of global deaths and injuries from road traffic accidents*.
- Goal 11: *make cities and human settlements inclusive, safe, resilient and sustainable,* contains the target 11.2: *By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention*

to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

These goals are a strong mandate for action to promote road safety. The ambitious targets for 50% reductions of both road crash fatalities and injuries is a significant challenge to all governments and other stakeholders. To fulfil this goal the number of fatalities need to be reduced with 600,000 to 700,000 lives annually worldwide and the number of injuries have to be reduced by 40 million annually.

In November 2015 the 2nd Global high-level conference on road safety was held in Brasilia with more than 2,200 participants from 136 countries. Among its objectives was to evaluate the progress of initiatives to reduce road traffic deaths and injuries worldwide. At the end of the conference the Brasilia Declaration on Road Safety was adopted recommending actions (WHO 2015b) to:

- strengthening road safety management and improving legislation and enforcement
- promote safer roads and the use of sustainable modes of transportation
- protect vulnerable road users
- develop and promote the use of safer vehicles
- increase awareness and build capacity of road users
- improve post-crash response and rehabilitation services
- strengthen cooperation and coordination towards global road safety

The new SDG's and the Brasilia Declaration on Road Safety are shaping an important and new platform where road safety sits firm as an element of sustainability. The two documents also include good advice about best practice in the field.

What does the 50% goal of reduction for each continent (or larger region) mean? For Latin America for example, this means a saving of 50,000 lives annually, 225,000 hospital admissions and 2 million injuries per year. The average number of fatalities per 100 000 population in Latin America was 5 five years ago 19.1 (year 2010). A reduction of 50% equals a target of 9.5 fatalities per 100,000 inhabitants by 2020. Is this achievable? It would mean that the Latin America countries should have to achieve in 5 years a safety level, which is close to the status of Western Europe. The same also holds for Asia. Such targets are extremely ambitious, but on the other hand examples for some individual countries in Europe have shown that significant improvements are possible in a short period of time, in particular by adapting best practices from other, better performing countries (European Commission 2010). As was shown in Table 3, the total yearly costs of traffic accident fatalities and injuries in Latin America is about 137 billion US$. To reach the SDG's would reduce the burden on the economy with 70 billion US$ per year or equivalent to a growth in GDP of almost 2%. In the next Chapter a number of strategies that can help achieving such a reduction will be discussed.

6. ROAD INJURY PREVENTION STRATEGIES

High-income countries have shown a continuous decline in death rates in the past two decades. In Europe the number of road fatalities in 1990, which was around 75,000, dropped more than half to 35,000 in 2009 (European Commission 2010), but this required almost 20 years. In the 2011 White Paper – "Roadmap to a Single European Transport Area" (European Commission 2011) the EU aims at a further reduction of 50% of road fatalities from 2011 until 2020 and for 2050 to move close to zero fatalities. This "zero vision" goal should be achieved by new intelligent safety technologies, applying improved safety testing, education and promotion of use of safety equipment and in particular also attention to vulnerable road users (pedestrians, cyclists and motorcyclists) through safer infrastructure and new vehicle technologies (European Commission 2011).

The road safety improvement in Europe and in many other high-income countries have in particular also been achieved by implementation of requirements for vehicle safety, including the regulations developed by the UNECE (United Nations Economic Commission for Europe) World Forum for Harmonization of Vehicle Regulations and the introduction of consumer information test based rating programs (New Car Assessment Programs, NCAP). The UN regulations should be seen as a set of minimal performance requirements. Fig 3 shows an overview of the status of application of a number of the most important UN vehicle safety standards (including frontal and side crashworthiness testing) in various countries in the world. They are used in many high-income countries but implementation in other countries is still limited in particular in Africa, parts of Latin America and South-East Asia. The fact that North America has hardly applied UN Regulations so far, is partially due to the fact that they have their own demanding vehicle safety requirements already for a long time.

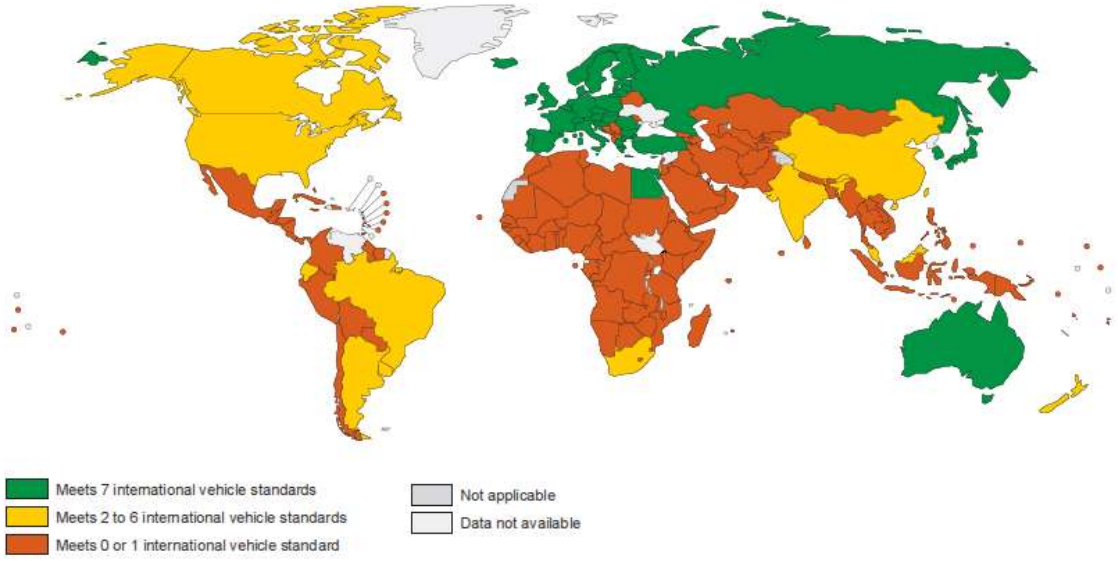

Figure 3: Countries applying the most important 7 UN vehicle safety standards (WHO 2015)

The prime objective of NCAPs is to stimulate consumers to buy the safest vehicles and safety equipment and to encourage industry to develop safer designs (Global NCAP 2014). In an NCAP the protection offered by a vehicle or a component is rated by means of a star rating system and compared with the performance of other vehicles or safety systems. Test severity and/or requirements are often more demanding than for UN regulations. NCAP programs have been applied in many parts of the world (including recently in Latin America) but not in Africa.

In May 2010 the UN General Assembly proclaimed the period 2011–2020 as the Decade of Action for Road Safety (UN resolution A/RES/64/255). The Global Plan for the Decade of Action is built on five pillars: Road safety management, Safer roads and mobility, Safe vehicles, Safe road users and Post-crash response. Furthermore five key risk factors have been identified for which global introduction and enforcing of legislation would be important: *speed*, *drunk–driving*, not wearing *motorcycle helmets*, not wearing *seat-belts* and not using *child restraints* in cars (WHO 2011). For an overview of the status of implementation of measures concerning these 5 risk factors in different parts of the world see WHO (2015). A systematic overview of the efficiency of measures concerning these five risk factors, based on an analysis of 117 studies from the international literature, can be found in TØI (2012).

7. FUTURE TRENDS

Due to urbanisation, modernisation and growth of different kinds, transportation of people and goods is undergoing important changes. Due to climate change, environmental concerns, population increases, shortage of natural resources, strong application of Intelligent Transportation Systems (ITS) solutions and changing views on private car ownership, a transition towards low-carbon policies in parts of the world and changes in use of transport modes and mobility needs are likely to take place in the next 2 to 3 decades.

Several countries and cities are slowly shifting focus from modern mainstream motorisation towards planning for the post-car society based on a multitude of modes of transport and formal/informal operators. A huge part of travels in certain areas is made on public transport and by non-motorised means of mobility. Making non-motorised and/or informal means of mobility safe will be a genuine part of the next generation of transport policies. In order to meet the safety requirements and to be more secure, these modes will have to be further developed, modernised, designed, regulated, managed and controlled by authorities.

Heavy vehicles are an important cause of unsafe conditions, not least since growing cities increase the demand for public transport and goods distribution. Research shows that introducing new logistic planning, resulting in more efficient and less intrusive transport operations, increases safety significantly and, at the same time, decreases congestion and emissions.

New propulsion system (like electric vehicles) in conjunction with weight and size reduction will lead to new vehicle architectures which pose new challenges concerning vehicle safety, such as protection of occupants in crashes with significantly heavier vehicles. The electrification trend is also influencing pedal cycle design. Bicycles are increasingly becoming partially electrified and this is likely leading to elevated speeds for this vulnerable road user category and consequently higher injury risk. The light weight trend will also result in increased popularity of ultra-light vehicles. There are many countries which have not yet implemented safety requirements for these types of vehicles

The automotive community has achieved significant progress in the development of automated vehicles in conjunction with fast developments in the field of ITS (Intelligent Transport Systems) technology. In addition to many technical issues there are several other questions to sort out, such as how to secure a net safety benefit from automated traffic and whether developing countries can benefit from these developments? Currently several systems are already commercially available, such as Adaptive Cruise Control (ACC), Lane Keeping Assist (LKA) and Autonomous Emergency Braking (AEB). Some of the systems would already now offer significant benefit in developing countries due to their safety performance. This is particularly true for emergency braking in case of a potential crash with a vulnerable road user. Tests with automated vehicles are conducted world-wide, but the question remains when automation will be widely available in consumer vehicles. To have automated vehicles drive safely and efficiently on public roads, numerous challenges have to be resolved including behavioural, legal, social and technological aspects. Automated driving is expected to have significant safety benefits, but there will certainly be some crashes and injuries remaining. In order to make an impact also in emerging markets the automation discussion needs to expand beyond its current focus on more urban aspects.

8. DISCUSSION AND CONCLUSION – THE WAY FORWARD

This paper compiles, evaluates and analyses information from different data sources on accidents and health, road transport and economic performance in a comprehensive manner to give both a region and a global picture of the traffic safety situation. The combination of information on health, economics and transport on a global level gives a better understanding of the regional uniqueness in the traffic safety

situation and the need for regional policy measures. It is shown that road safety is causing large problems and costs in many parts of the world and in particular also in Latin America, Sub-Saharan Africa and Asia, with an enormous impact on the well-being of people, economy and productivity. In several low and middle-income countries the yearly number of fatalities and injuries is still increasing while in many high-income countries worldwide these numbers are decreasing. Vulnerable road users (pedestrians, cyclists and motorcyclists combined) are particularly at risk.

The above figures and the material throughout the paper and in particular also the Sustainable Development Goals dealing with road safety, definitely justify that road safety should be given rightful attention, including taking powerful, effective actions. It stresses the need for reliable accident data which are imperative to determine evidence based intervention strategies and monitor the success of these interventions and analyses. Still, lack of good high quality accident data should not be an excuse to postpone interventions. There are many opportunities and some are shown in this paper.

The progress in the area of road safety in high-income countries was made possible because of important efforts in capacity building, research and the development of knowledge in the area of traffic safety. Studies of local conditions and the reason why accidents take place made it possible to develop ways to reduce them. But without a long-term commitment to improve conditions on road, political will, policy and planning it would have been impossible to achieve safer roads. There needs to be institutions and human resources together with a budget that pays for the work otherwise such development does not take place. The information provided in this paper concerning the economic impact of road accidents can help defining the business case for such investments. The challenges to improve road safety in developing countries are large. This is due, among others, to the absence of adequate infrastructure, unplanned urbanization taking place, lack of a legal regulatory framework and a strong increase in motorisation. But, on the other, hand the knowledge how to achieve improved road safety is largely there, which was not the case in in Europe and the USA when motorisation started.

Although a number of countries in Latin America, Sub-Saharan Africa and Asia have made progress, the potential for improved traffic safety is high and should get priority in view also of the UN SDG's. If all countries were to give high priority to implementing the most relevant and effective activities in the Global Plan for the Decade of Action for Road Safety, substantial further improvements already can be made. This in particular holds for addressing the five risk factors included in the Global plan: speed, drunk–driving, not wearing motorcycle helmets, not wearing seat-belts and not using child restraints in cars. In addition to the recommendations form the Global Plan some specific recommendations will be given here:

Vulnerable road users

The ambition should be that pedestrians can move safely inside as well as outside urban areas. Separate roads or lanes have been proven to be successful in many countries in particular also for pedal cyclists. The view of pedestrians as well as the pedestrian's perceived safety may vary significantly in different parts of the world. Nevertheless a person walking in traffic should not have to worry about being injured, run over or assaulted or falling. Poor, or even totally absent, lighting on roads used by pedestrians and pedal cyclists is another concern. Improvement to visibility through proper road lighting is an important aspect. Furthermore in many countries a strong increase in the usage of e-bikes (electrically supported bikes) can be observed allowing higher speeds than regular bikes. Helmet wearing for e-bike riders should be considered compulsory in order to change the trend of increasing fatalities and injuries seen among pedal bicyclists. The successful introduction of helmet wearing in many countries has shown that the helmet not only protects in accidents with other vehicles but also in single 2-wheeler accidents. The increased speed of e-bikes at one side and the increased affordability and capacity of batteries make e-bikes (and other electric 2-wheelers) a very promising sustainable alternative for 2-wheelers with a

combustion engine. Concerning motorcycle safety specifically, the focus in the Global Plan is on helmets only. But much more can be done e.g. promotion of protective clothing, requirements for advanced braking systems on motorcycles, measures that improve the visibility of motorcycles like day-time running lights (Wu Yuan 2000) and well-designed guard rails that help mitigating the effect of an impact rather than making it more severe.

Elderly Persons

Keeping a high degree of mobility also at higher age is essential for the individual's continued quality of life, and movements in traffic should be absent from worries for assault, harm or injury. Generally members of this growing and heterogeneous group are more fragile and spend more time in traffic as pedestrians and bicyclists than other age groups. This needs to be taken into account in e.g. public transportation and its associated stops, access routes and vehicles.

Collision avoidance technologies

In addition to the technologies recommended in the Global Plan (primarily ABS and ESC) emerging technologies should be considered in particular automatic emergency braking (AEB) and alcohol locks, which offer also very interesting opportunities in developing countries. This holds for passenger cars but also for trucks, buses and motorcycles. It should be realized however that implementation of such accident avoidance and other future safety technologies very much depend on the regional situation in each country. In other words the local situation should be carefully analysed before introduction of such new technologies.

Truck and bus safety

The Global Plan recommendations concerning trucks focus on safe operation of trucks only. Much more can and has to be done on the vehicles themselves concerning partner protection, including: visibility and detectability of other road users, introduction of blind spot detection technology, under-run protection at the front, rear and side, energy absorbing fronts for collisions with other road users (compatibility) and in particular for VRU collisions. The same also holds for bus safety, where in addition to partner protection also bus passenger safety in crashes need full attention as well as safe design and locations of bus stops.

Enforcement

Improved road safety can only be reached when introduced measures and actions are applied, respected or observed. The need for persistent promotion of measures already at hand is obvious, even when data clearly points out effects of different measures, there are other studies showing that a high percentage of accidents and injuries are associated with the non-use or lack of enforcement of the measures.

ACKNOWLEDGEMENT

This study was funded by Chalmers University in Gothenburg, Sweden.

REFERENCES

BP Energy Outlook 2035, February 2015, available at: http://www.bp.com/content/dam/bp/pdf/Energy-economics/energy-outlook-2015/Energy_Outlook_2035_booklet.pdf

de Blaeij, Arianne, Raymond J.G.M. Florax, Piet Rietveld, Erik Verhoef, The Value of Statistical Life: a Meta-Analysis, Accident Analysis and Prevention, 2003, 35(6), 973-986.

European Commission, Towards a European road safety area: policy orientations on road safety 2011-2020, COM(2010) 389 final European Commission, Brussels, 2010

European Commission, White Paper - Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, European Commission, COM(2011) 144 final, Brussels, 2011

Elvik Rune, How much do road accidents cost the national economy?, Accident Analysis & Prevention, Volume 32, Issue 6, November 2000, Pages 849-851.

Freedonia, 2015, available at: http://www.freedoniagroup.com/DocumentDetails.aspx?ReferrerId=FG-01&studyid=3198

Global NCAP, Global NCAP fleet safety guide and safer car purchasing policy 2014-2015, 2014. Available at: http://www.globalncap.org/wp-content/uploads/2013/07/gncap_brochure_lr.pdf

IHME/World Bank, Transport for Health: The Global Burden of Disease from Motorized Road Transport, The Institute for Health Metrics and Evaluation (IHME), Seattle, WA Washington, DC and Global Road Safety Facility, The World Bank, 2014.

iRAP, The true cost of road crashes - Valuing life and the cost of a serious injury, International Road Assessment Programme (iRAP), 2008. Available at: http://www.irap.net/en/about-irap-3/research-and-technical-papers

IRTAD-OECD/ITF, Reporting on Serious Road Traffic Casualties - Combining and using different data sources to improve understanding of non-fatal road traffic crashes, International Traffic Safety Data and Analysis Group (IRTAD), 2010.

OICA, see: http://www.oica.net/category/sales-statistics, 2015

Peden Margie, Richard Scurfield, David Sleet, Dinesh Mohan, Adnan A. Hyder, Eva Jarawan and Colin Mathers, World report on road traffic injury prevention, World Health Organization, Geneva, 2004

TØI (2012), Handbook of Road safety measures, Oslo. (In Norwegian)

UN, United Nations Resolution A/RES/70/1 - Transforming our world: the 2030 Agenda for Sustainable Development, 2015

Viscusi, W. Kip, and Joseph A. Aldy, The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World, The Journal of Risk and Uncertainty, 2003, 27(1), 5-76.

Wismans Jac, Ingrid Skogsmo, Anna Nilsson-Ehle, Anders Lie, Marie Thynell and Gunnar Lindberg. Implications of Road Safety in National Productivity and Human Development in Asia. Background paper for the Eighth Regional EST Forum in Asia, 19 to 21 November 2014, Colombo, Sri Lanka, 2014. Available at: http://www.uncrd.or.jp/content/documents/22698EST-P4_Wismans.pdf.

WHO 2009, Global status report on road safety: time for action. Geneva, World Health Organization, 2009

WHO 2011, Global Plan for the Decade of Action for Road Safety, 2011–2020. Geneva, World Health Organization, 2011. Available at: (www.who.int/roadsafety/decade_of_action/plan/plan_english.pdf).

WHO 2013, Global Status Report on Road Safety 2013, supporting a decade of action, ISBN 978 92 4 156456 4, World Health Organisation, 2013.

WHO 2015, World Health Organization, Global status report on road safety 2015. WHO Geneva, ISBN 978 92 4 156506 6.

WHO 2015b, see: http://www.who.int/violence_injury_prevention/road_traffic/Final_Brasilia_declaration_EN.pdf

Wu Yuan, The effectiveness of the 'ride-bright' legislation for motorcycles in Singapore, Accident Analysis and Prevention 32, 559–563, 2000.