Vehicle Design for Road Safety: What are the Gaps in Evidence?

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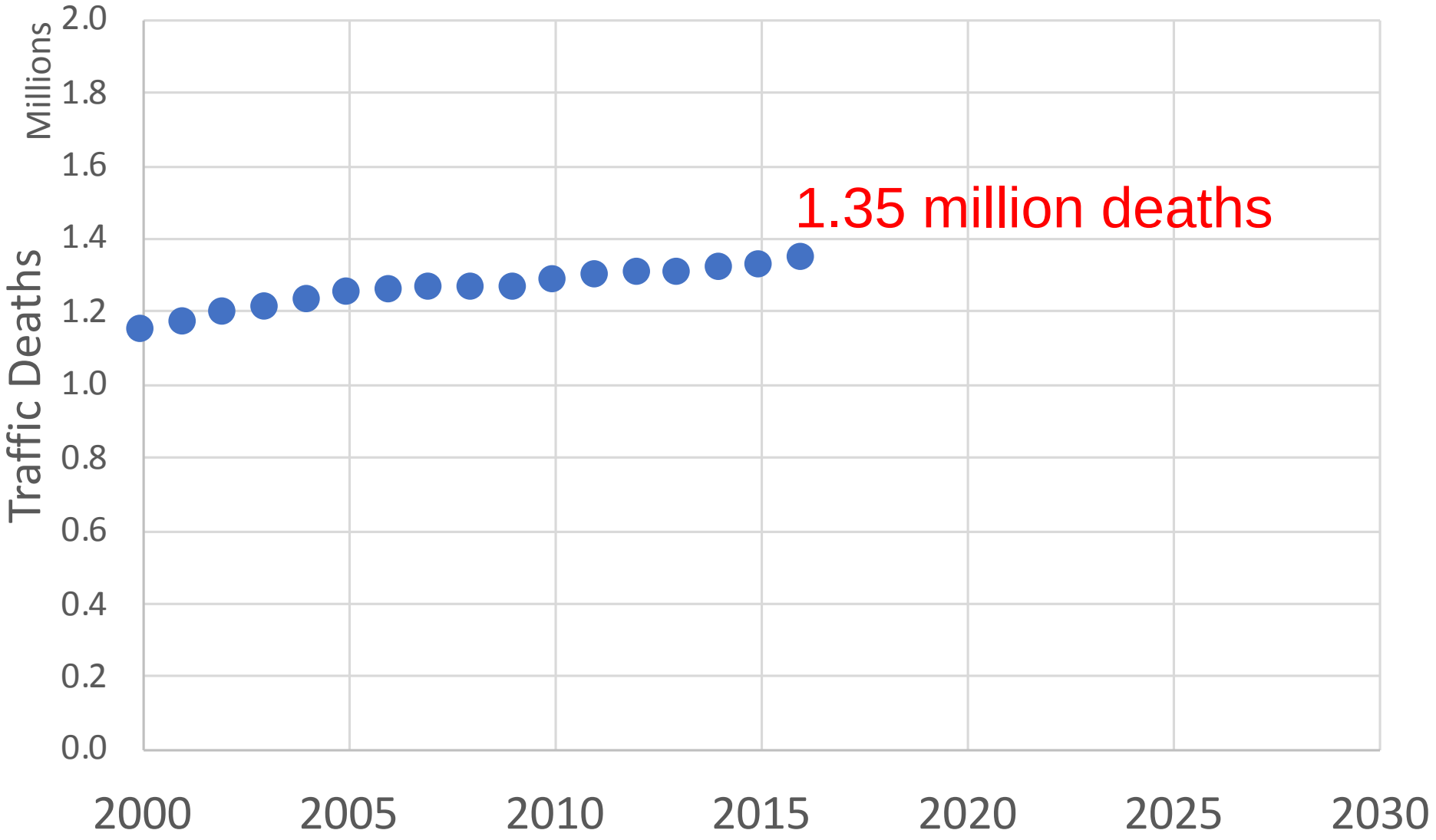
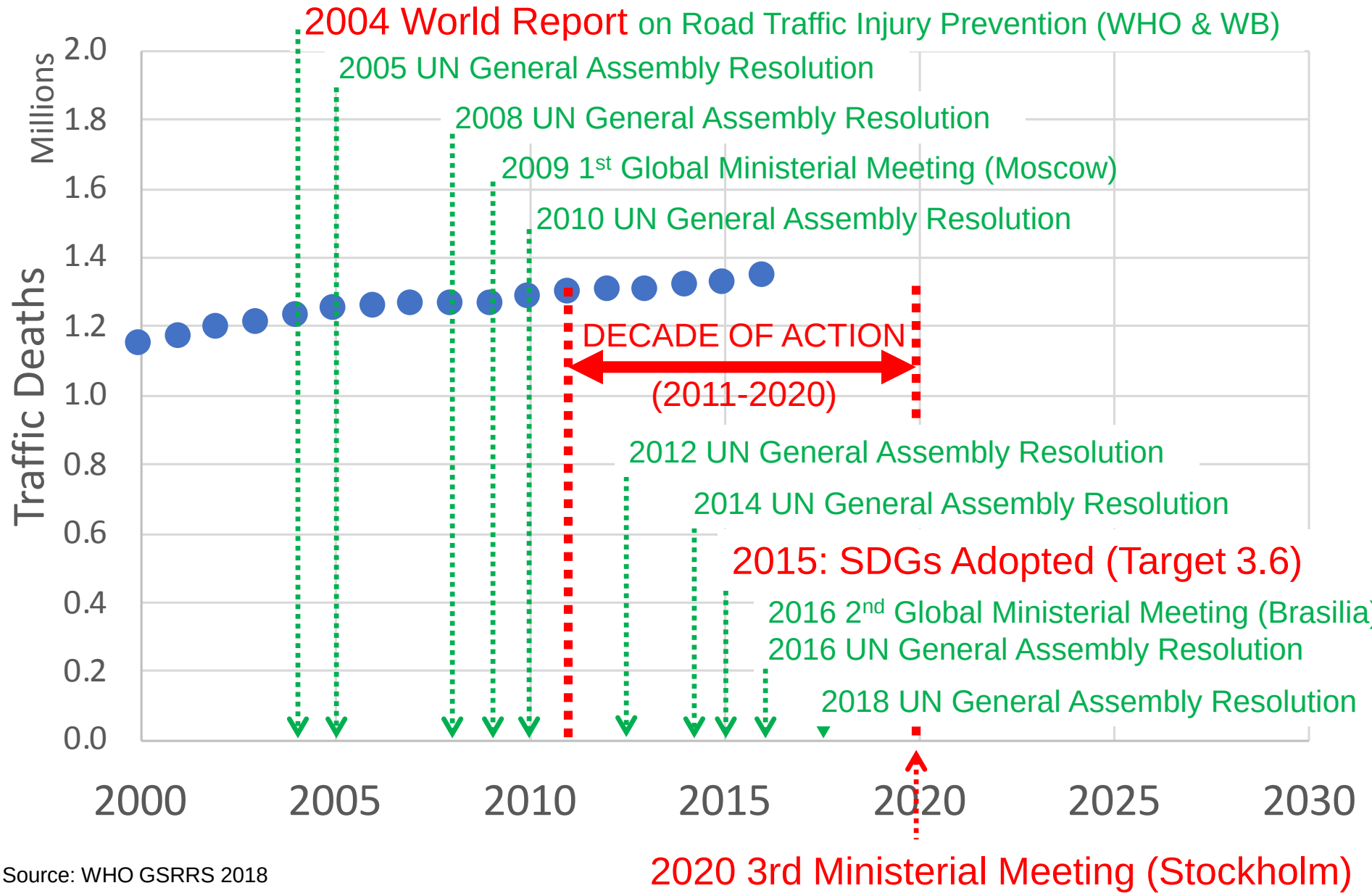
Globalizing Vision Zero: Generating Scientific Evidence for the Road Ahead, Pre-event , 3rd Global Ministerial Conference on Road Safety, Stockholm 2020

Global Road Traffic Deaths



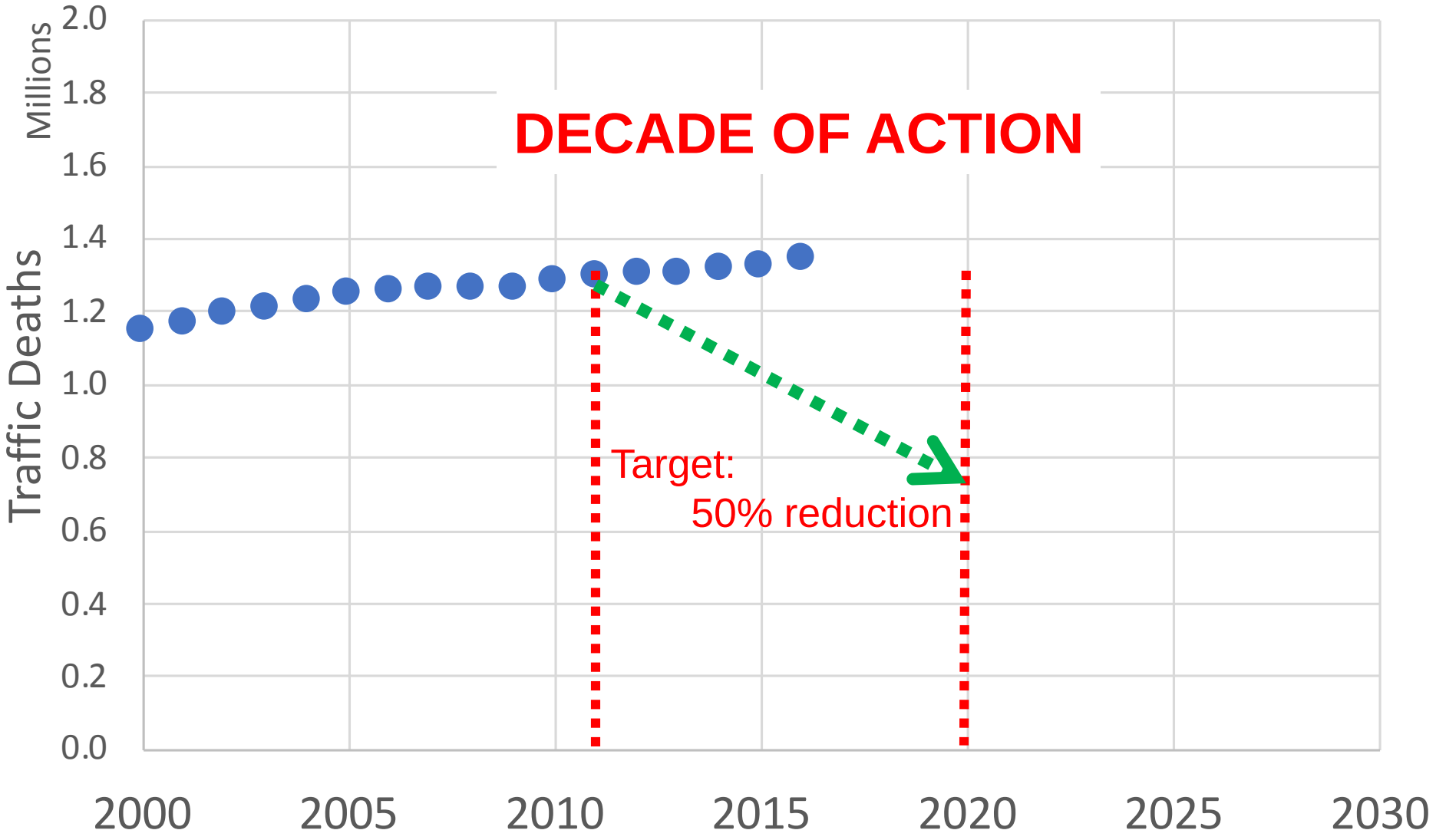
Source: WHO Global Status Report on Road Safety 2018

History of Global Road Safety Advocacy



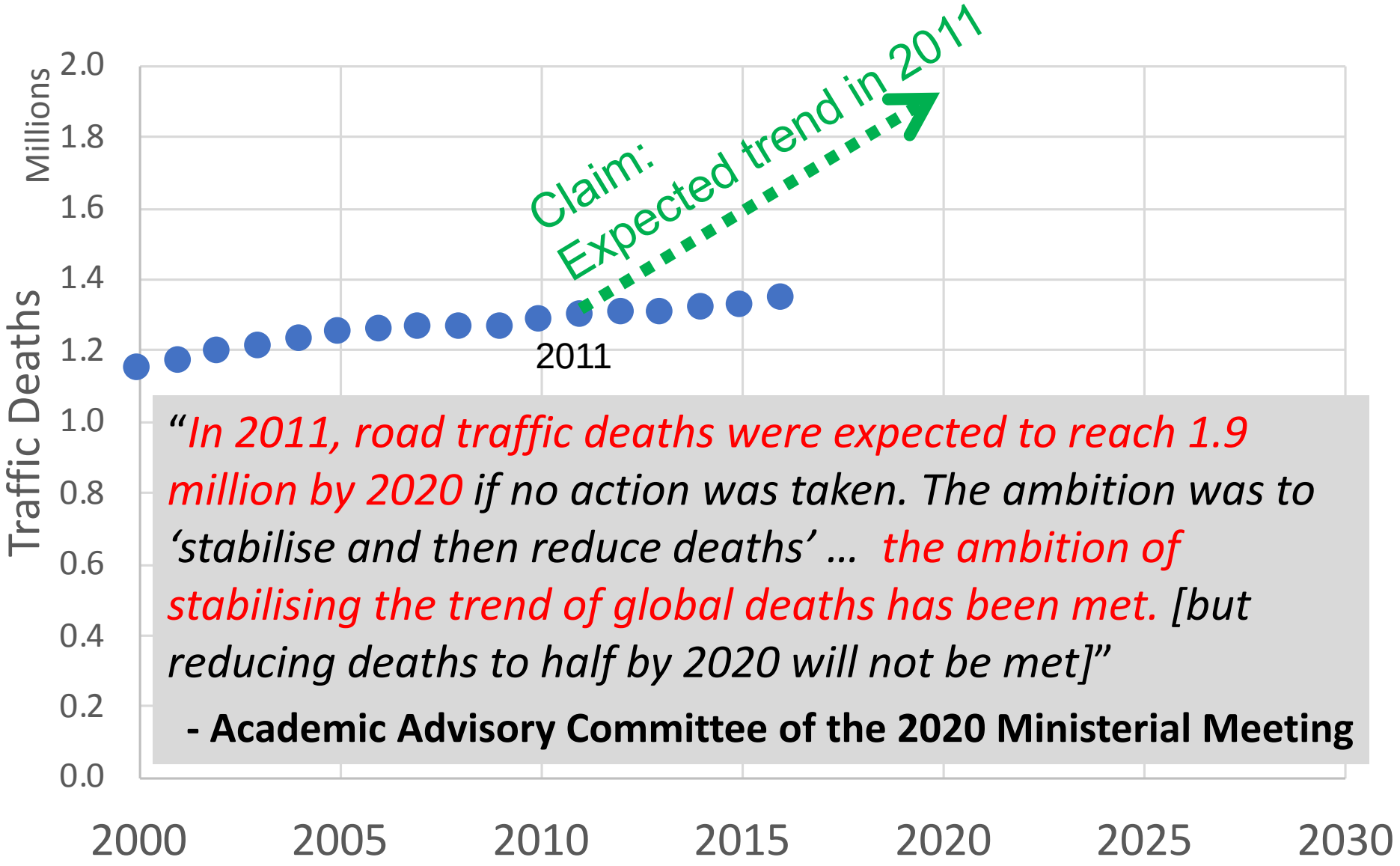
Source: WHO GSRRS 2018

Did the Decade of Action Succeed?



Source: WHO GSRRS 2018

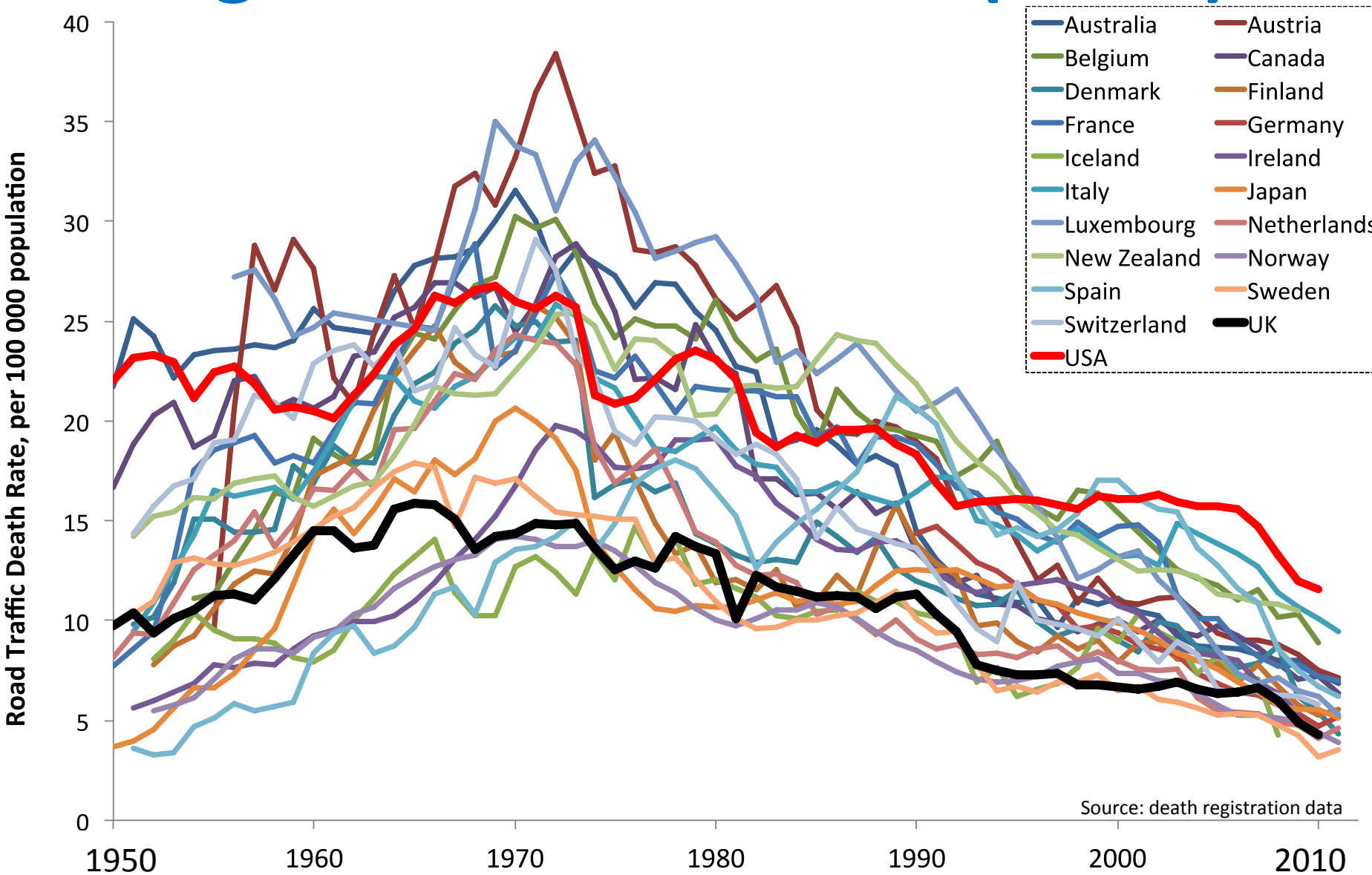
Did the Decade of Action Succeed?



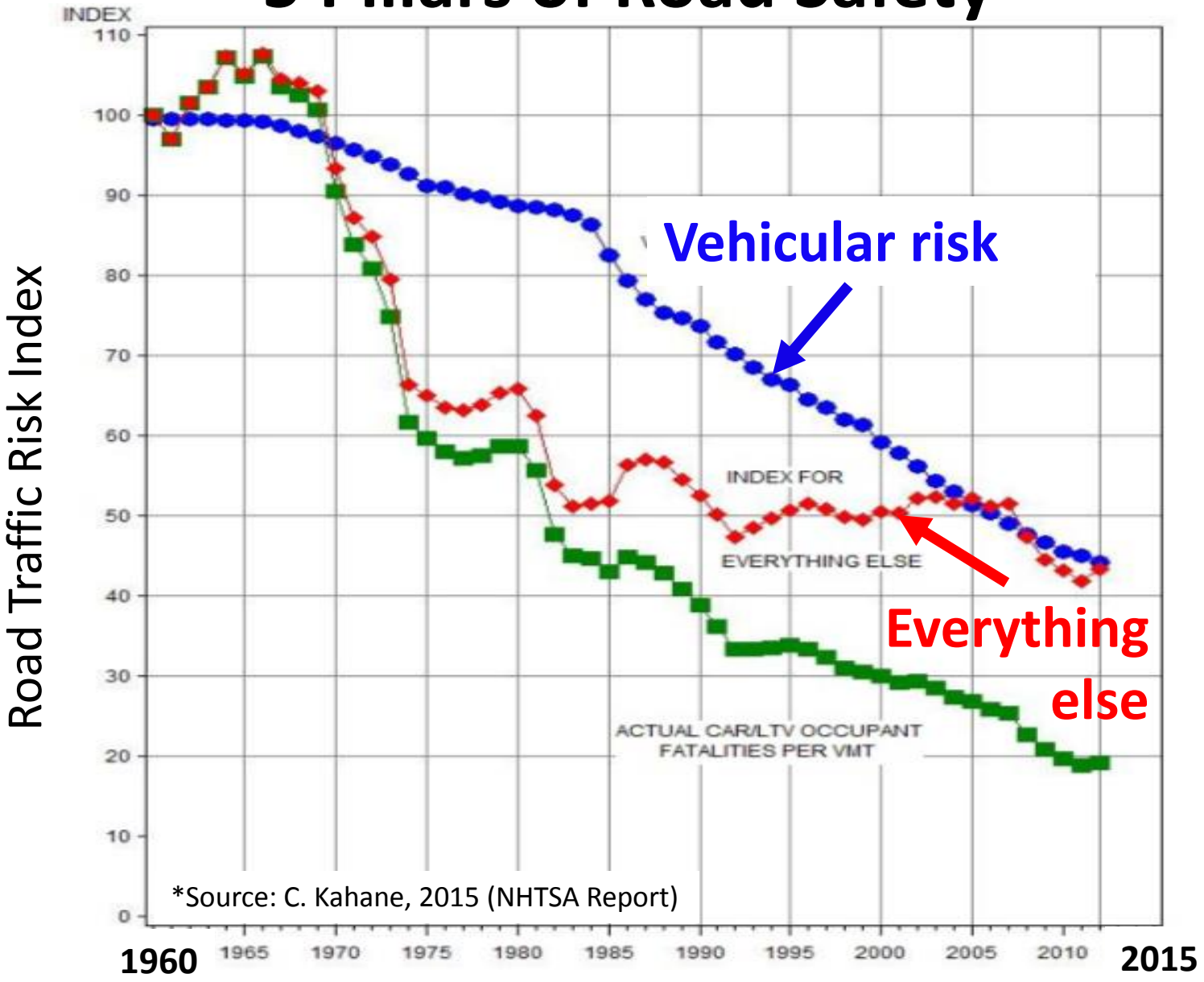
"*In 2011, road traffic deaths were expected to reach 1.9 million by 2020 if no action was taken. The ambition was to 'stabilise and then reduce deaths' … the ambition of stabilising the trend of global deaths has been met. [but reducing deaths to half by 2020 will not be met]*"

- Academic Advisory Committee of the 2020 Ministerial Meeting

Per Capita Traffic Death Rates: High Income Countries (OECD)



Vehicle Design: The Most Important of the 5 Pillars of Road Safety



*Source: C. Kahane, 2015 (NHTSA Report)

Tried & Tested Technologies

Including …

- Seat belts
- Belt pretensioners & load limiters
- Child safety seats
- Air bags: Front, side
- Rollover curtains
- Roof crush mitigation
- Collapsible steering columns
- Improved door locks
- Side-structure & padding
- Adhesive windshield bonding
- Side door beams
- Fuel System Integrity
- Conspicuity tape for trailers
- Lane Departure Warning*
- Brakes: Dual master & disc
- ABS (& motorcycle ABS)
- Automatic Braking*
- Electronic Stability Control
- Vehicle Front-end design*

** Emerging Technologies*

- Proven effectiveness in real-world crashes (Extensive literature & many high-quality systematic reviews!)
- Most are required in HICs
- UN WP29 priority regulations aim to encourage their availability in LMICs

How much would it matter if LMICs had these technologies?

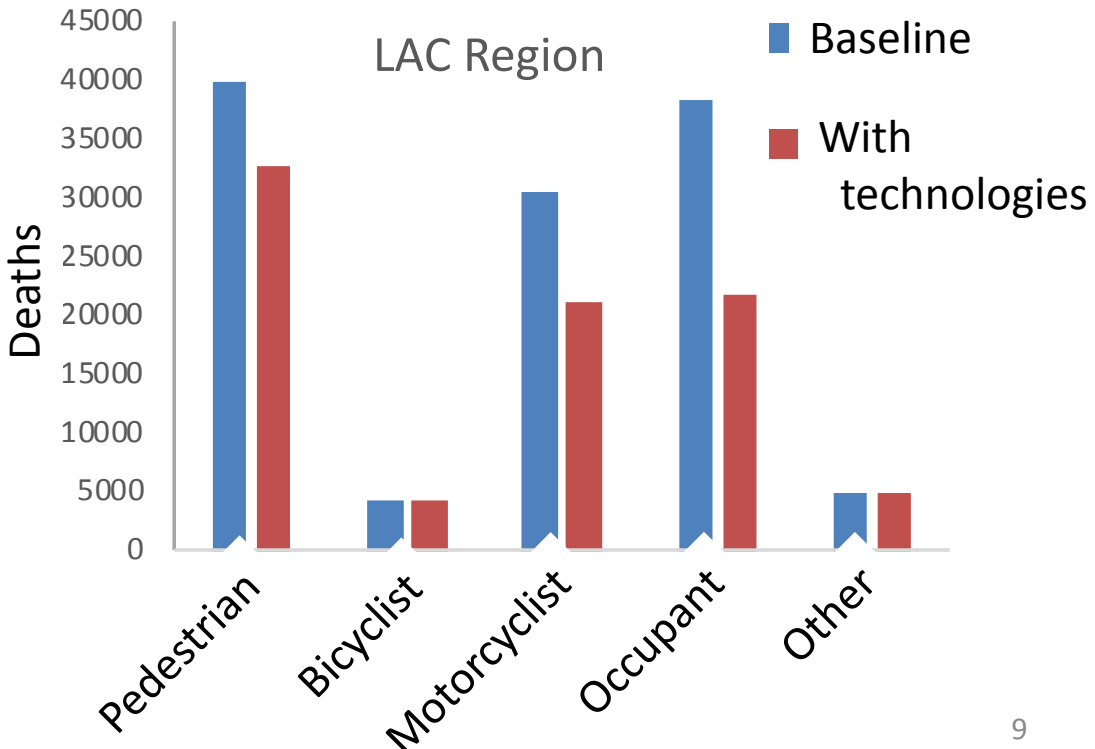
Tried & Tested Technologies

Including …

- Seat belts
- Belt pretensioners & load limiters
- Child safety seats
- Air bags: Front, side
- Rollover curtains
- Roof crush mitigation
- Collapsible steering columns
- Improved door locks
- Side-structure & padding
- Adhesive windshield bonding
- Side door beams
- Fuel System Integrity
- Conspicuity tape for trailers
- Lane Departure Warning*
- Brakes: Dual master & disc
- Antilock brakes
- Automatic Emergency Braking*
- Electronic Stability Control
- Vehicle Front-end design*

How much would it matter if cars in LMICs had these technologies?

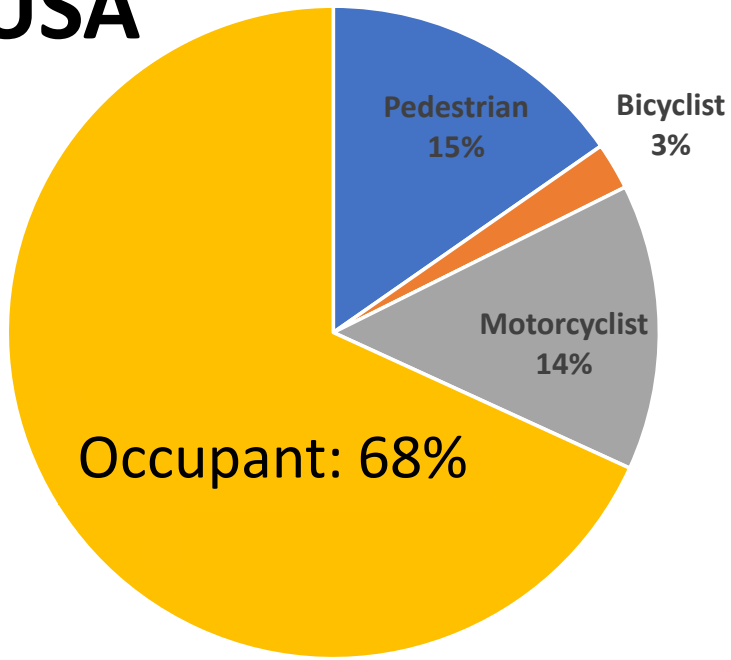
- We estimate 28% fewer death in Latin America
- But gains in US were much larger (~50%)



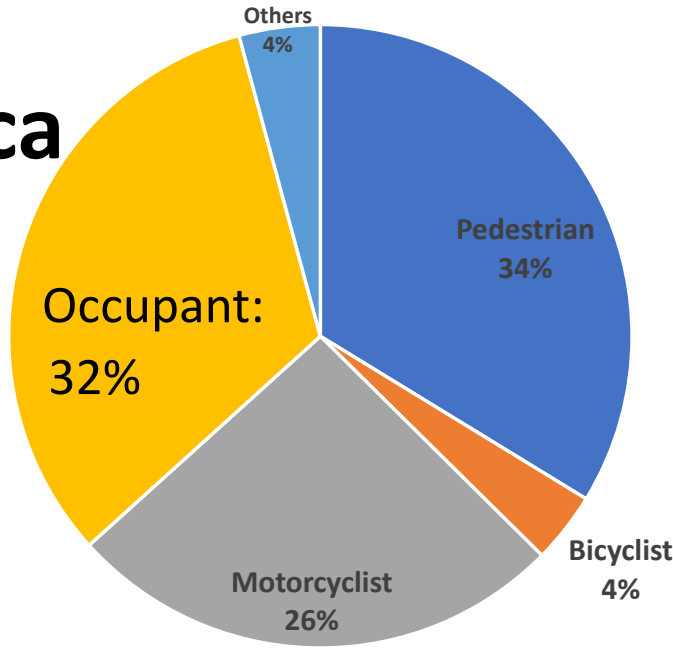
Source: Bhalla et al. 2018, IADB Report

Traffic Deaths

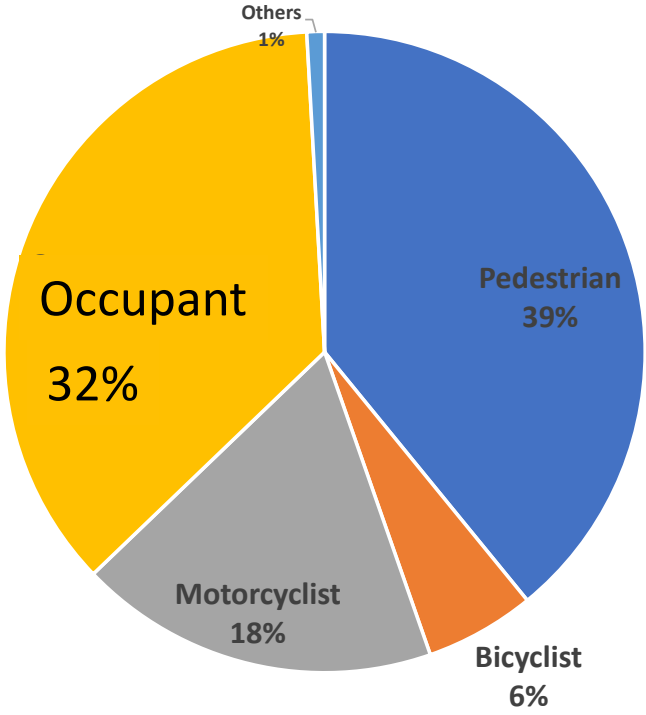
USA



Latin America



Global



Tried & Tested Technologies

- More effective for occupants
- Most victims in LMICs (and globally) are outside cars

Evidence Gap Map (EGM)

There are high-quality reviews of evidence on technologies that protect vehicle occupants.

Therefore,

EGM focused *ONLY* on technologies that protect people outside cars.

Here is what we found ….

Evidence from Rich vs Poor Countries

of Publications Identified in EGM

	Fatal Crashes	Non Fatal Crashes	Helmet Use	Speeding	Drink Driving
Bicycle	0 / 5	0 / 9	1 / 3	0 / 0	0 / 0
Motorcycle	1 / 11	1 / 12	1 / 3	0 / 0	0 / 0
Bus	0 / 3	0 / 3	0 / 0	0 / 1	0 / 0
Truck	0 / 5	0 / 5	0 / 0	0 / 1	0 / 0
Others	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Car (for non-occupants)	0 / 10	0 / 9	0 / 0	0 / 6	0 / 0

Poor Countries (Low- and Middle-Income)

Rich Countries (High Income)

Evidence from Rich vs Poor Countries

of Publications Identified in EGM

No studies from poor countries except 1 paper on helmet use in Cambodia

***Conclusion**: There is no research on evaluation of vehicle designs happening in LMICs*

Poor Countries (Low- and Middle-Income)

Rich Countries (High Income)

Impact Evaluations & Systematic Reviews

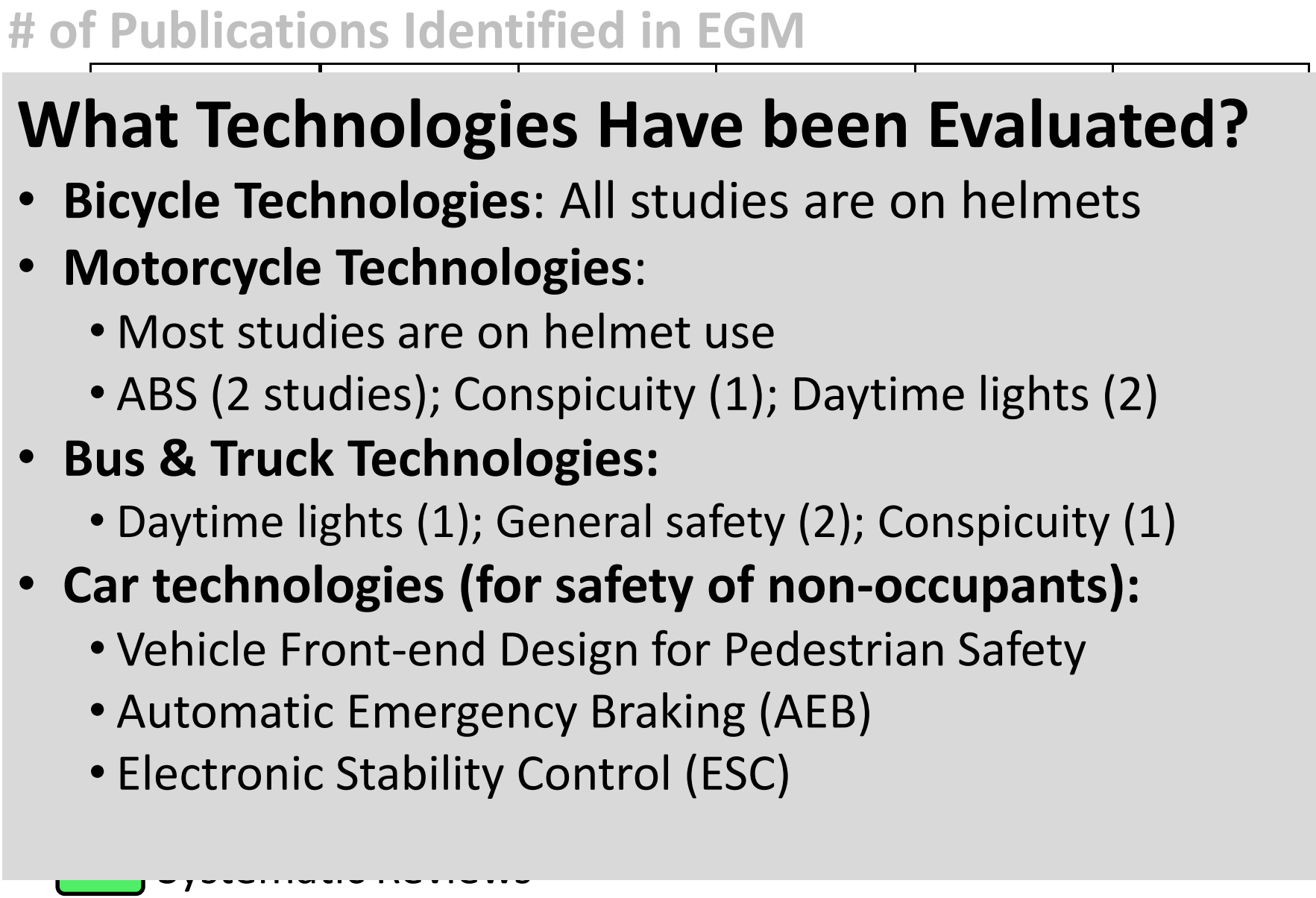
of Publications Identified in EGM

	Fatal Crashes	Non Fatal Crashes	Helmet Use	Speeding	Drink Driving
Bicycle	5 / 4	5 / 7	2 / 3	0 / 0	0 / 0
Motorcycle	12 / 3	13 / 3	4 / 0	0 / 0	0 / 0
Bus	3 / 0	3 / 0	0 / 0	1 / 0	0 / 0
Truck	5 / 0	5 / 0	0 / 0	1 / 0	0 / 0
Others	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Car (for non-occupants)	10 / 2	9 / 2	0 / 0	6 / 0	0 / 0

Impact Evaluation Studies

Systematic Reviews

Impact Evaluations & Systematic Reviews



What Technologies Have been Evaluated?

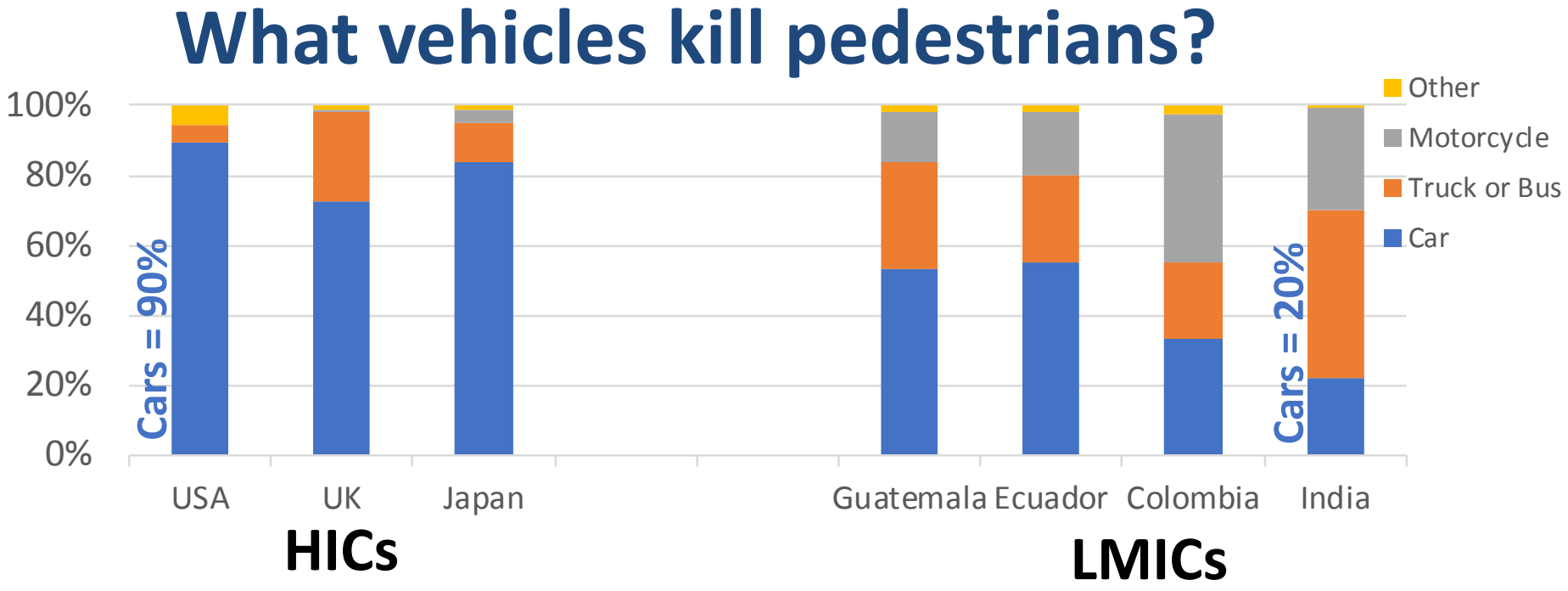
- **Bicycle Technologies**: All studies are on helmets
- **Motorcycle Technologies**:
  - Most studies are on helmet use
  - ABS (2 studies); Conspicuity (1); Daytime lights (2)
- **Bus & Truck Technologies:**
  - Daytime lights (1); General safety (2); Conspicuity (1)
- **Car technologies (for safety of non-occupants):**
  - Vehicle Front-end Design for Pedestrian Safety
  - Automatic Emergency Braking (AEB)
  - Electronic Stability Control (ESC)

Vehicle Front-End Design:

EGM found no evaluation of bus/truck front design

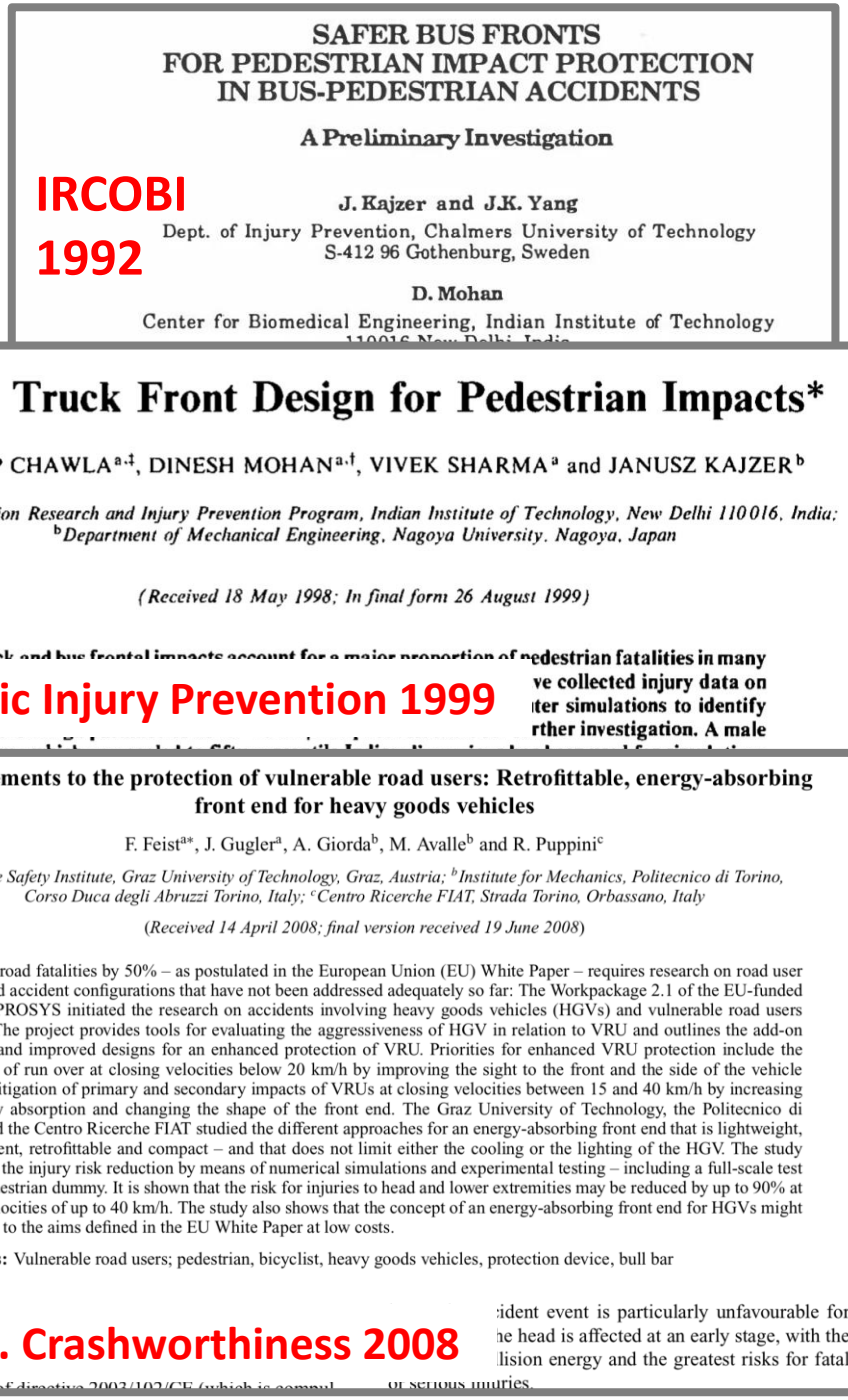
– Proposed UN Regulations *only* target cars

– But, in LMICs, most pedestrians are not killed by cars



Safer Bus/Truck Fronts

- Researchers have been showing feasibility for 30 years!
- Have still not been field tested
- Are receiving no attention in current policy & regulatory discussion



SAFER BUS FRONTS
FOR PEDESTRIAN IMPACT PROTECTION
IN BUS-PEDESTRIAN ACCIDENTS

A Preliminary Investigation

IRCOBI 1992

J. Kajzer and J.K. Yang
Dept. of Injury Prevention, Chalmers University of Technology
S-412 96 Gothenburg, Sweden

D. Mohan
Center for Biomedical Engineering, Indian Institute of Technology

Safer Truck Front Design for Pedestrian Impacts*

ANOOP CHAWLA[a,‡], DINESH MOHAN[a,†], VIVEK SHARMA[a] and JANUSZ KAJZER[b]

[a]Transportation Research and Injury Prevention Program, Indian Institute of Technology, New Delhi 110016, India; [b]Department of Mechanical Engineering, Nagoya University, Nagoya, Japan

(Received 18 May 1998; In final form 26 August 1999)

Traffic Injury Prevention 1999

Improvements to the protection of vulnerable road users: Retrofittable, energy-absorbing front end for heavy goods vehicles

F. Feist[a*], J. Gugler[a], A. Giorda[b], M. Avalle[b] and R. Puppini[c]

[a]Vehicle Safety Institute, Graz University of Technology, Graz, Austria; [b]Institute for Mechanics, Politecnico di Torino, Corso Duca degli Abruzzi Torino, Italy; [c]Centro Ricerche FIAT, Strada Torino, Orbassano, Italy

(Received 14 April 2008; final version received 19 June 2008)

Reducing road fatalities by 50% – as postulated in the European Union (EU) White Paper – requires research on road user groups and accident configurations that have not been addressed adequately so far: The Workpackage 2.1 of the EU-funded project APROSYS initiated the research on accidents involving heavy goods vehicles (HGVs) and vulnerable road users (VRUs). The project provides tools for evaluating the aggressiveness of HGV in relation to VRU and outlines the add-on solutions and improved designs for an enhanced protection of VRU. Priorities for enhanced VRU protection include the avoidance of run over at closing velocities below 20 km/h by improving the sight to the front and the side of the vehicle and the mitigation of primary and secondary impacts of VRUs at closing velocities between 15 and 40 km/h by increasing the energy absorption and changing the shape of the front end. The Graz University of Technology, the Politecnico di Torino and the Centro Ricerche FIAT studied the different approaches for an energy-absorbing front end that is lightweight, cost-efficient, retrofittable and compact – and that does not limit either the cooling or the lighting of the HGV. The study highlights the injury risk reduction by means of numerical simulations and experimental testing – including a full-scale test with a pedestrian dummy. It is shown that the risk for injuries to head and lower extremities may be reduced by up to 90% at impact velocities of up to 40 km/h. The study also shows that the concept of an energy-absorbing front end for HGVs might contribute to the aims defined in the EU White Paper at low costs.

Keywords: Vulnerable road users; pedestrian, bicyclist, heavy goods vehicles, protection device, bull bar

Intl. J. Crashworthiness 2008

No Studies on Indigenous Vehicles

Autorickshaws

eRickshaws

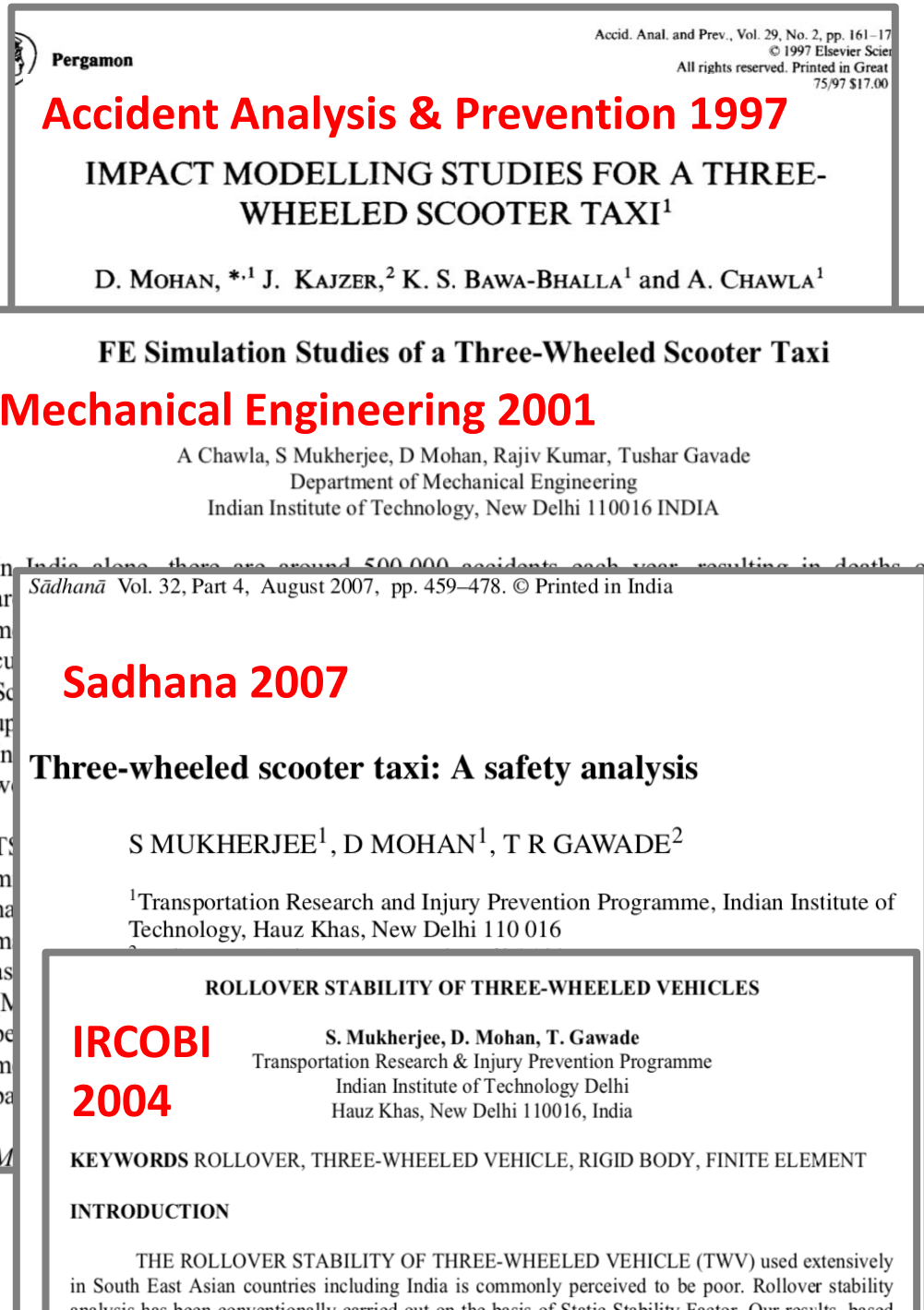
Tuk-Tuks

Tempos

Jeepneys

Safety of Indigenous Vehicles

- Researchers have been showing feasibility for over 20 years!
- Technologies have still not been field tested
- Are receiving no attention in current policy & regulatory discussion



Pergamon

Accid. Anal. and Prev., Vol. 29, No. 2, pp. 161–17
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75/97 $17.00

Accident Analysis & Prevention 1997

IMPACT MODELLING STUDIES FOR A THREE-WHEELED SCOOTER TAXI[1]

D. MOHAN, *,[1] J. KAJZER,[2] K. S. BAWA-BHALLA[1] and A. CHAWLA[1]

FE Simulation Studies of a Three-Wheeled Scooter Taxi

Mechanical Engineering 2001

A Chawla, S Mukherjee, D Mohan, Rajiv Kumar, Tushar Gavade
Department of Mechanical Engineering
Indian Institute of Technology, New Delhi 110016 INDIA

Sādhanā Vol. 32, Part 4, August 2007, pp. 459–478. © Printed in India

Sadhana 2007

Three-wheeled scooter taxi: A safety analysis

S MUKHERJEE[1], D MOHAN[1], T R GAWADE[2]

[1]Transportation Research and Injury Prevention Programme, Indian Institute of Technology, Hauz Khas, New Delhi 110 016

ROLLOVER STABILITY OF THREE-WHEELED VEHICLES

IRCOBI 2004

S. Mukherjee, D. Mohan, T. Gawade
Transportation Research & Injury Prevention Programme
Indian Institute of Technology Delhi
Hauz Khas, New Delhi 110016, India

KEYWORDS ROLLOVER, THREE-WHEELED VEHICLE, RIGID BODY, FINITE ELEMENT

INTRODUCTION

THE ROLLOVER STABILITY OF THREE-WHEELED VEHICLE (TWV) used extensively in South East Asian countries including India is commonly perceived to be poor. Rollover stability

- **Wide spectrum of poorly understood issues**
  - Examples
    - Pedestrian safety in crashes with motorcycles
    - Transport of people on agricultural tractor trailers
    - Flowing garments (e.g. saris) on motorcycles
    - Kids on motorcycles
- **Need for Research in LMICs**
  - Epidemiological investigations to identify key risks
  - Engineering research to develop countermeasures
  - Evaluation of field performance
  - Scale up through regulation, consumer information, & other means

Conclusions

- Vehicle design is the most important pillar of road safety
- Tried & Tested Technologies:
  - Need to be promulgated (UN regulations & NCAP)
  - Do not cover important LMIC issues
- Need for research in LMICs to address the many LMIC-specific concerns

Thank You!

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