



## Cost Effective Strategies to Raise Awareness to Vulnerable Users and Increase Highway Safety in Hispanic Countries

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# Good Morning!



# Introduction



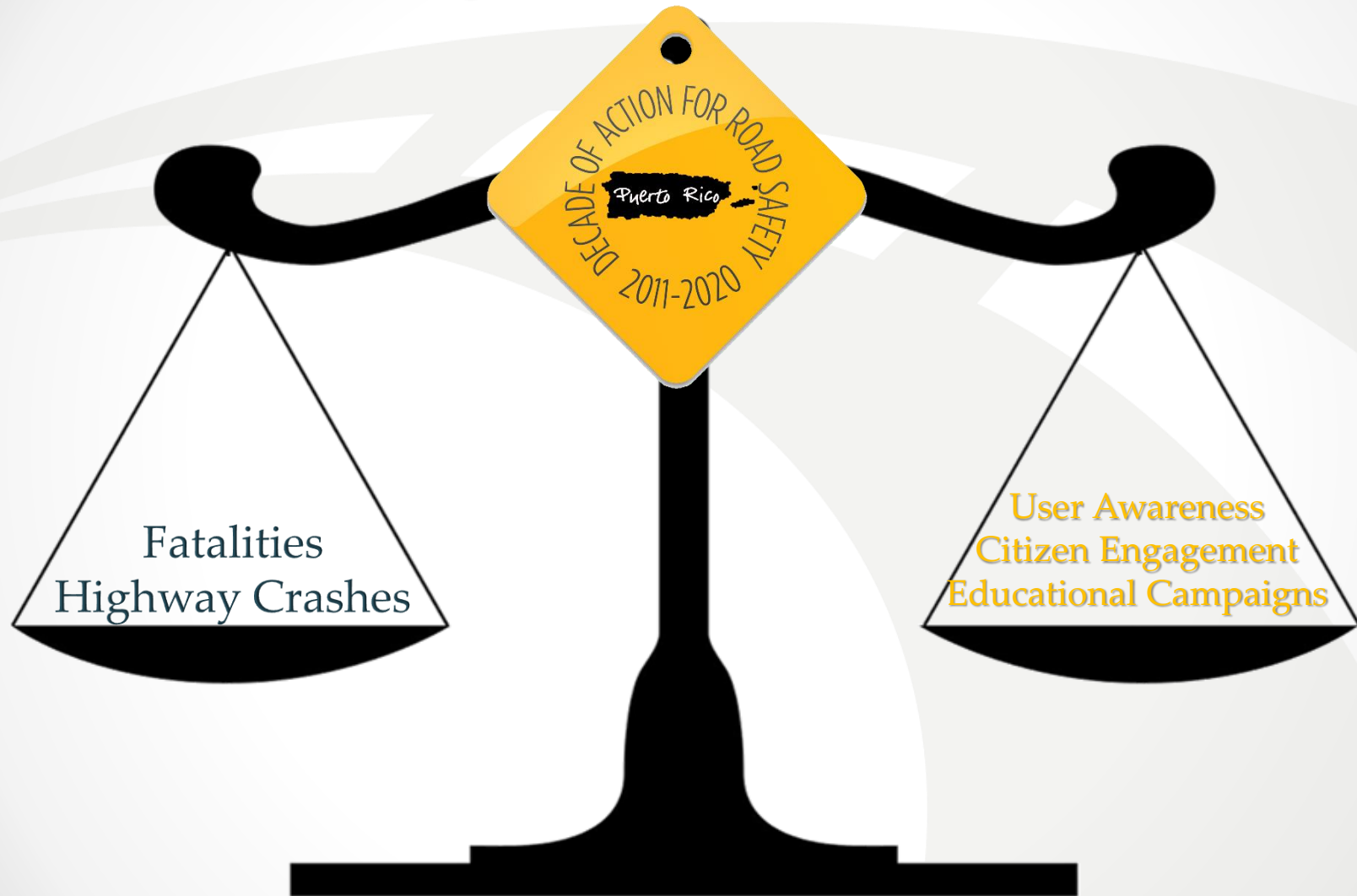
## Commonwealth of Puerto Rico

- Island: 3,500 mi<sup>2</sup> (100 mi x 35 mi)
- Population: 3.8 millions (2010 US Census)
- Unincorporated territory USA
- Tourism nearly 7% of the islands' GNP

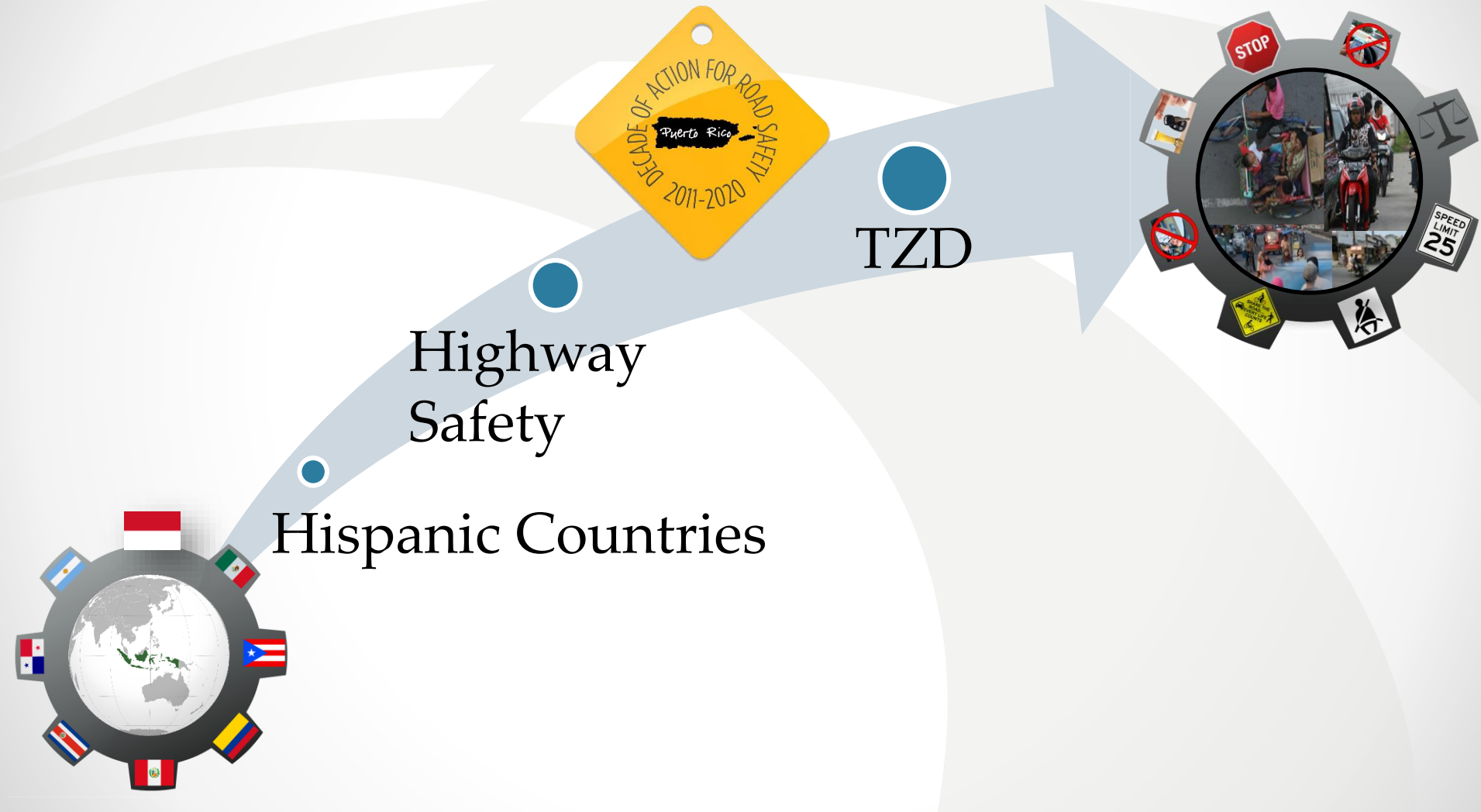
## Road Network

- 26,866 centerline kms
- Accessibility and mobility to 95% of road users and freight
- Absence of rail network contributes to premature deterioration of the network

# Road Safety: A Balance of Interest



# National Strategic Road Safety Plans, a Good Starting Point



# The 5 E's: Fundamental Principles of Roadway Safety to all Road Users

E

- Engineering

E

- Education

E

- Enforcement

E

- Emergency Medical Services

E

- Everyone

# OBJECTIVES

- To increase road user awareness and contribute to the safer road users pillar of the worldwide Decade of Action for Road Safety initiative



# World Health Organization (WHO)

- 1.23 million road traffic deaths
- 50% of the fatalities are associated with vulnerable road users
- 7% of the world's population (28 countries) have comprehensive laws on five key risk factors



Source: [http://www.who.int/gho/road\\_safety/en/](http://www.who.int/gho/road_safety/en/)

# Vulnerable Road Users (VRU)

- Term applied to those users at most risk in traffic.
- Unprotected by an outside shield, namely,
  - Pedestrians
    - Children
    - Elderly People
    - Disabled Persons
  - Two-wheelers
    - Motorized
    - Non-motorized
  - New drivers
  - Animals
- VRU from developing countries are at a higher risk
- They are at greater risk of injury in any collision against a vehicle



Source: [http://safety.fhwa.dot.gov/ped\\_bike/docs/oecd\\_safety.pdf](http://safety.fhwa.dot.gov/ped_bike/docs/oecd_safety.pdf)

# VRU Fatalities Statistics in India and Thailand

- In Delhi, India → 80% of fatalities are associated with VRU
- In Thailand → 70% of the road fatalities relates motorcycles



Source: <http://www.grsproadsafety.org/>

# Vulnerable Road Users (VRU)



1. [http://www.who.int/violence\\_injury\\_prevention/publications/road\\_traffic/make\\_walking\\_safe/en/](http://www.who.int/violence_injury_prevention/publications/road_traffic/make_walking_safe/en/); 2. <http://observer.com/2011/06/bicycle-backlash-over-says-uh-the-journal/>; 3. <http://www.thedailystar.net/rickshaws-clog-streets-10655>; 4. <http://kawikaguillermo.com/2008/08/>; 5. [http://news.bbc.co.uk/cbbcnews/hi/newsid\\_8190000/newsid\\_8191300/8191304.stm](http://news.bbc.co.uk/cbbcnews/hi/newsid_8190000/newsid_8191300/8191304.stm); 6. <http://raynaleigh.wordpress.com/sgms-courses/english-20/random-assignments/hold-hands-more/>; 7. <http://www.shutterstock.com/>; 8. <http://tribune.com.pk/story/7392/>

# We can save millions of lives





# Crash Trends in Puerto Rico



# Fatality Crash Trend in Roads in Puerto Rico: 2013

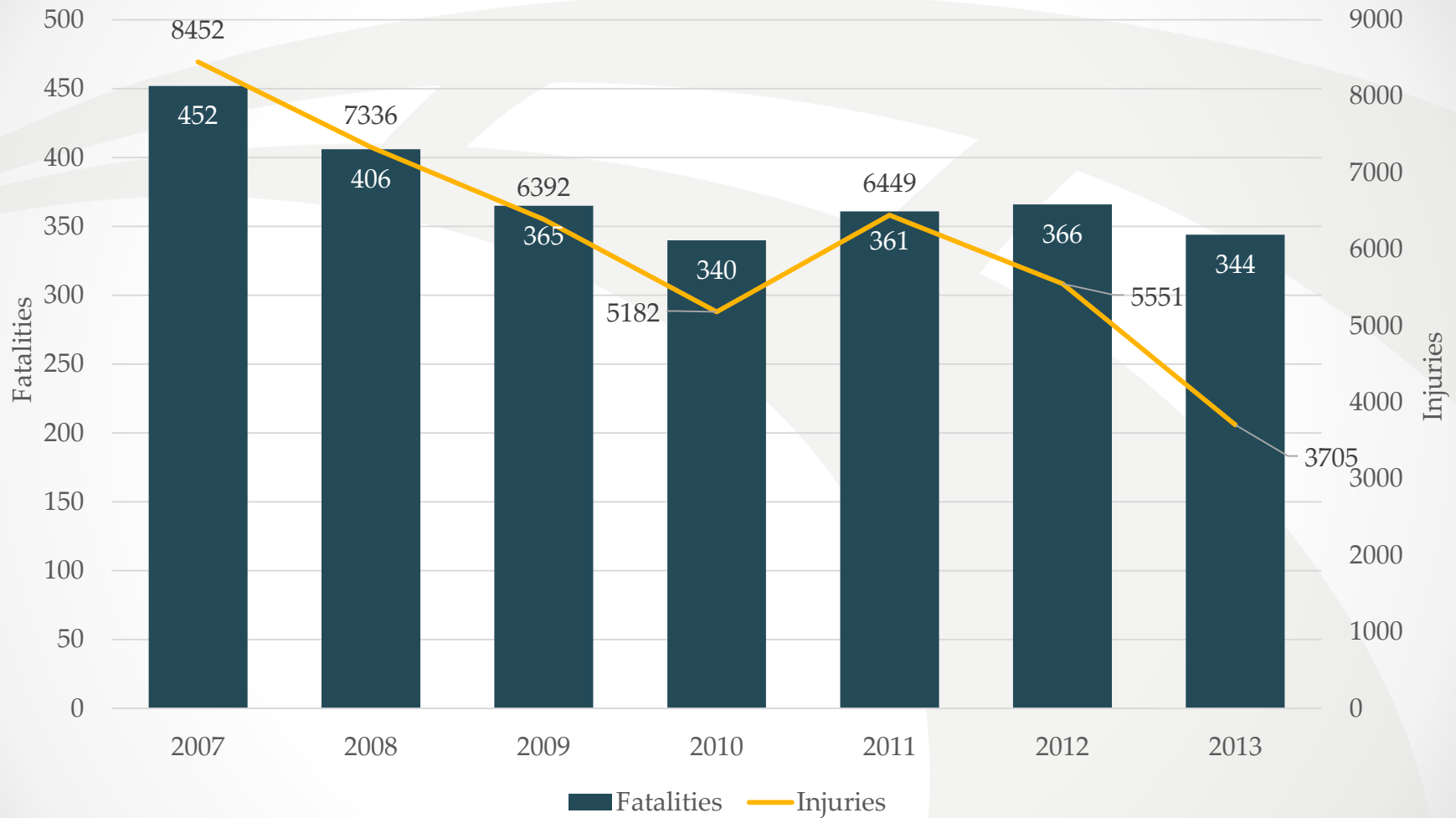
- Crashes: 236,107
- Injuries: 31,957
- Fatalities: 344
- Pedestrians: 31% of total fatalities
- Alcohol and controlled substances: 2,137 (39.1%)
- Motorcyclists: 23% of total fatalities
- Human factor (drivers and pedestrians): 90% a 93%
- Geometric and operational deficiencies: 2% a 3%



# Vulnerable Road Users (VRU) Can Suddenly Appear Anytime of the Day

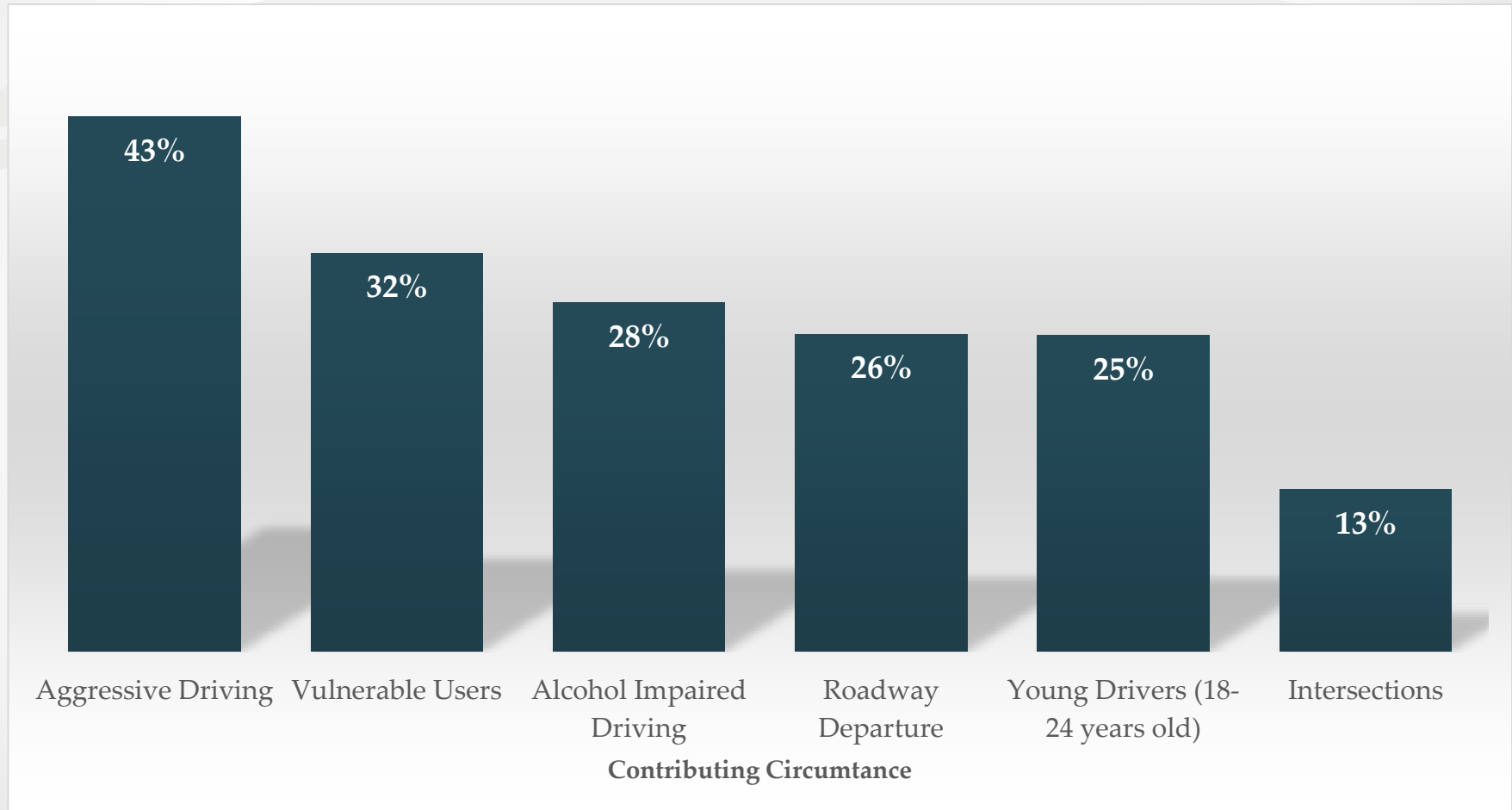


# Fatality and Injury Crash Trends: Puerto Rico Highway Network



**Source:** SHSP-PR 2014-2018, ACAA 2007-2013 and FARS 2007-2013

# Contributing Circumstances to Fatal Crashes Commonwealth of Puerto Rico: 2007-2009, 2012



**Source:** *Critical Analysis Reporting Environment (CARE)*

# Characteristics of fatal crashes in Puerto Rico: 2008-2013

Parameters	2008	2009	2010	2011	2012	2013
Registered Vehicles	3,129,561	3,026,815	3,020,455	3,084,543	4,500,941	2,842,420
Licensed Drivers <sup>1</sup>	2,017,055	2,628,207	3,102,941	3,619,499	2,991,904	2,100,076
Roadway Miles <sup>2</sup>	16,576	16,680	16,693	16,694	17,387	Not Available
VMT (Million) <sup>3</sup>	194.3	190.1	185.7	183.9	18,108	Not Available
Total Crashes <sup>4</sup>	287,798	210,721	202,335	190,170	232,012	236,107
Total Injuries <sup>5</sup>	39,100	38,748	37,396	35,592	35,219	31,957
Fatal Crashes	386	343	330	343	354	314
Total Fatalities	406	365	340	361	366	344

<sup>1</sup> PRDTPW-Drivers Services Directory; <sup>2</sup>PRHTA-Highway Systems Office; <sup>3</sup>PRDTPW-Accident Analysis Office; <sup>4</sup>ACAA; <sup>5</sup>Puerto Rico Police.

**Source:** Puerto Rico Strategic Highway Safety Plan 2014-2018

## Comparison of Fatal Crashes between Puerto Rico and United States of America

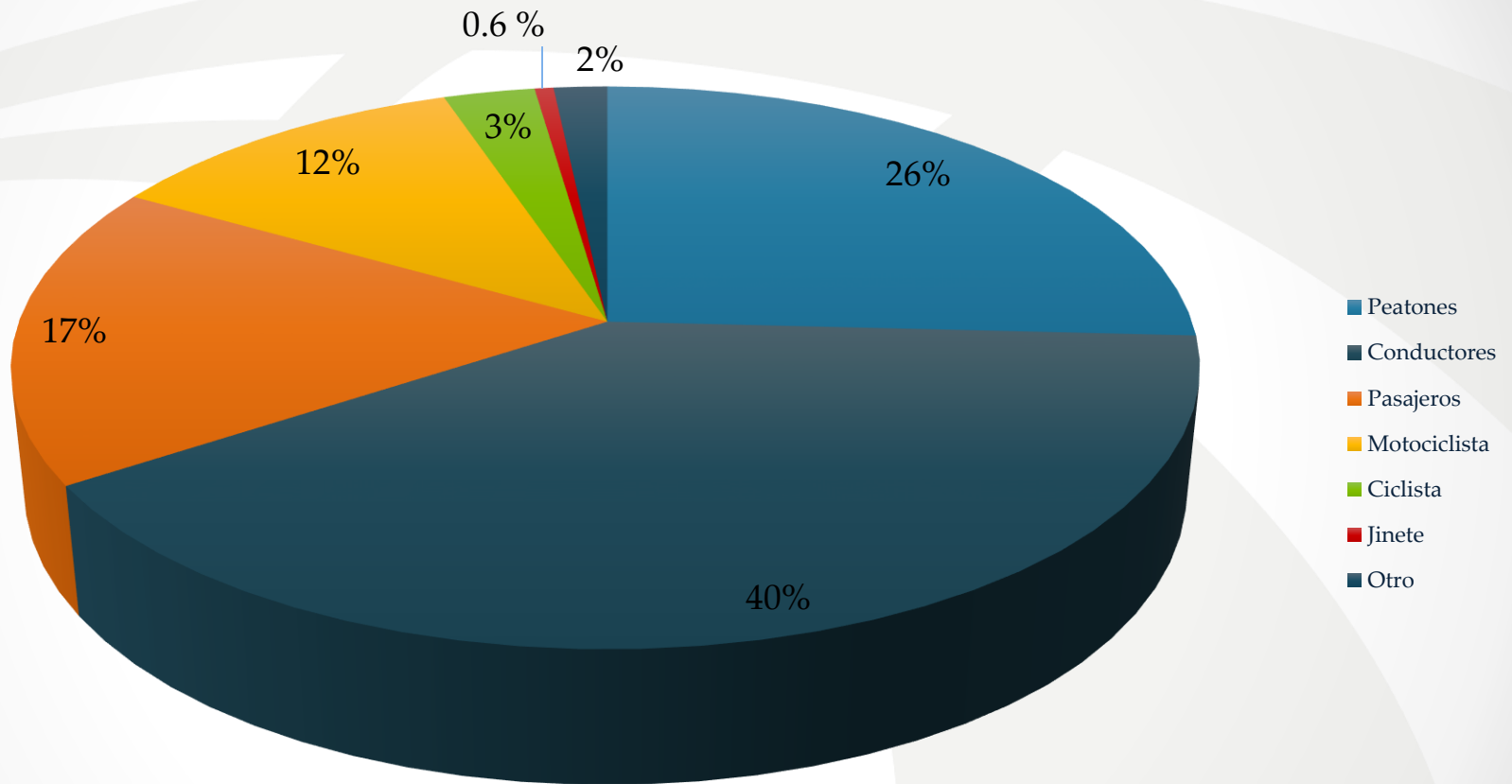
Parameters	United States of America	North Carolina, EE UU	Wisconsin, EE UU	Puerto Rico
Total Fatalities	33,808	894	561	365
Ratio (HMMVT)	1.14	1.82	1.18	1.92
Off-Road	18,087 (53%)	543 (61%)	319 (57%)	101 (28%)
Intersection	7,043 (21%)	146 (16%)	125 (22%)	42 (12%)
Pedestrians	4,092 (12%)	89 (10%)	38 (7%)	109 (30%)
Velocity	10,591 (31%)	337 (38%)	203 (36%)	156 (43%)
Alcohol	10,848 (32%)	377 (42%)	213 (38%)	109 (30%)
Rural Reason (HMMVT)	1.98	3.62	1.38	15.08
Urban Reason (HMMVT)	0.72	0.06	0.59	0.94

# Total Fatal Crashes and Pedestrian Fatalities: Puerto Rico vs. United States of America

Year	Puerto Rico			United States of America		
	Total Fatalities	Pedestrians		Total Fatalities	Pedestrians	
		Fatalities	Percentage (%)		Fatalities	Percentage (%)
2002	519	177	34	43,005	4,851	11
2003	495	150	30	42,884	4,774	11
2004	495	162	33	42,836	4,675	11
2005	457	134	29	43,510	4,892	11
2006	508	140	28	42,708	4,795	11
2007	452	145	32	41,259	4,699	11
2008	406	130	32	37,423	4,414	12
2009	365	109	30	33,883	4,092	12
2010	340	101	30	32,885	4,280	13
2011	361	111	31	-	-	-
<b>Total</b>	<b>4,398</b>	<b>1,359</b>	<b>31%*</b>	<b>360,393</b>	<b>41,472</b>	<b>11%*</b>

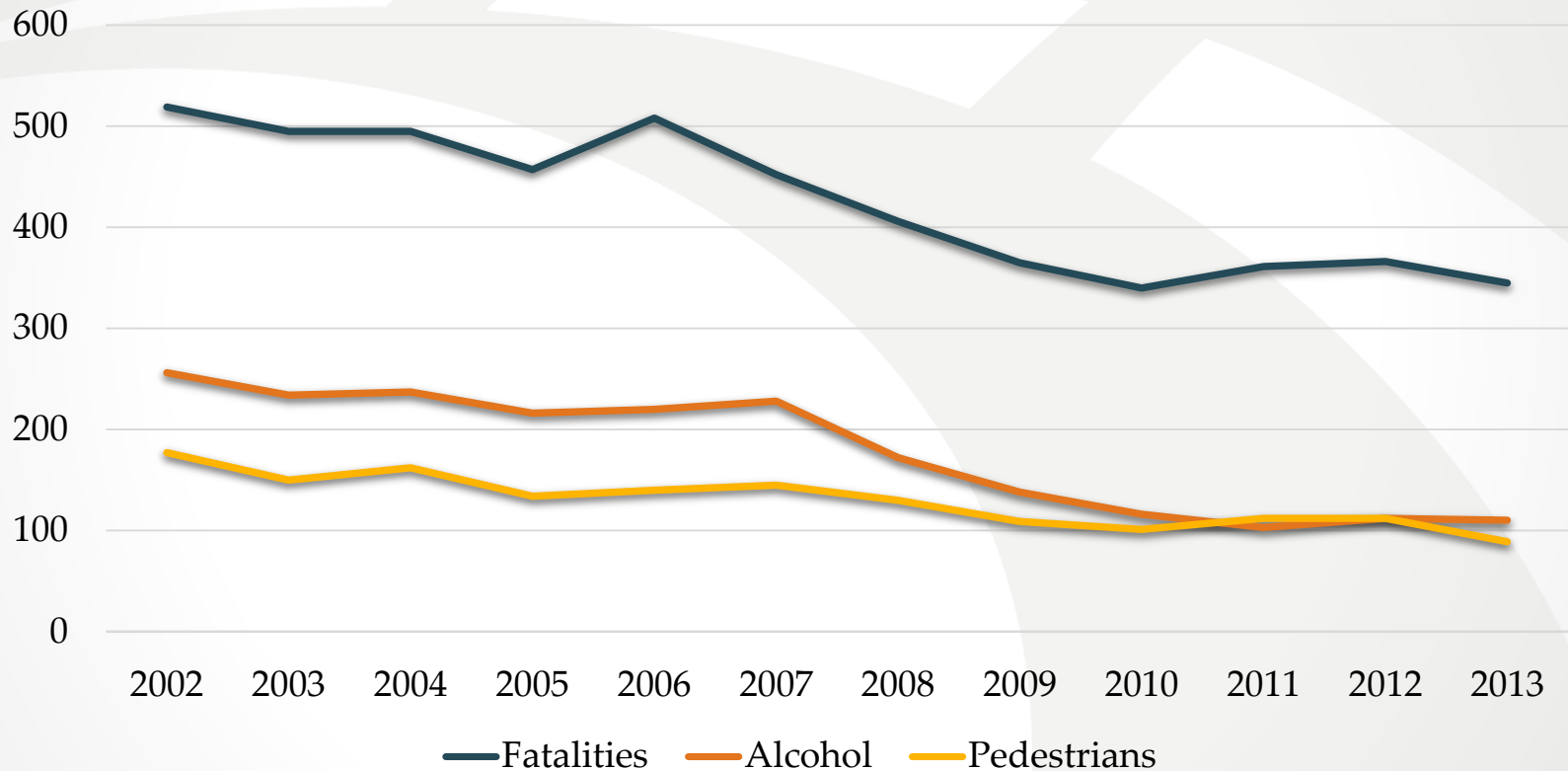
\*The average fatalities associated with pedestrians in Puerto Rico within the last 10 years represents 31% of the total fatal crashes vs. 11% in the United States of America (USA)

## Highway crashes fatalities in Puerto Rico classified by Vulnerable Road Users (VRU)



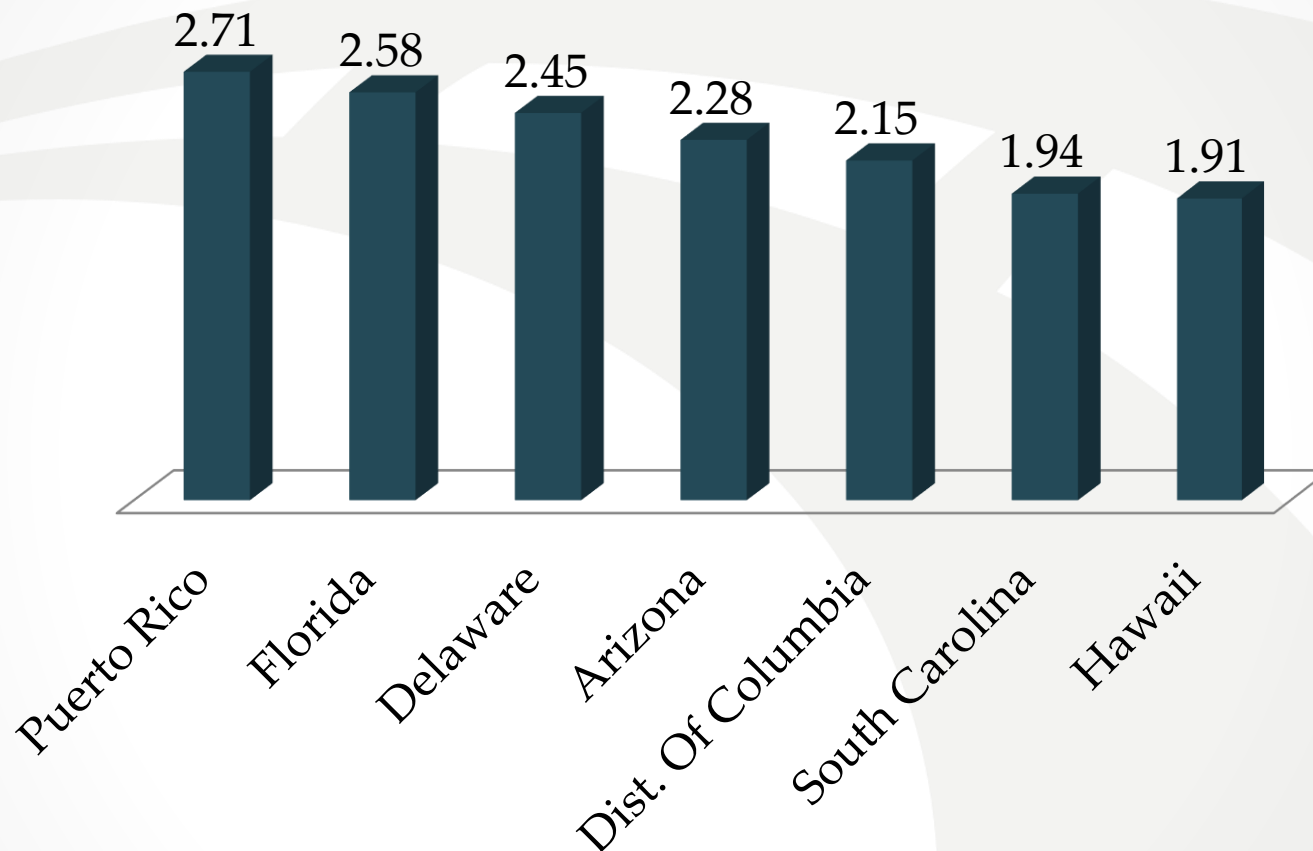
**Source:** Traffic Safety Facts Research Note, NHTSA, 2013

# Comparison of Fatalities, Alcohol and Pedestrians (VRU) Commonwealth of Puerto Rico



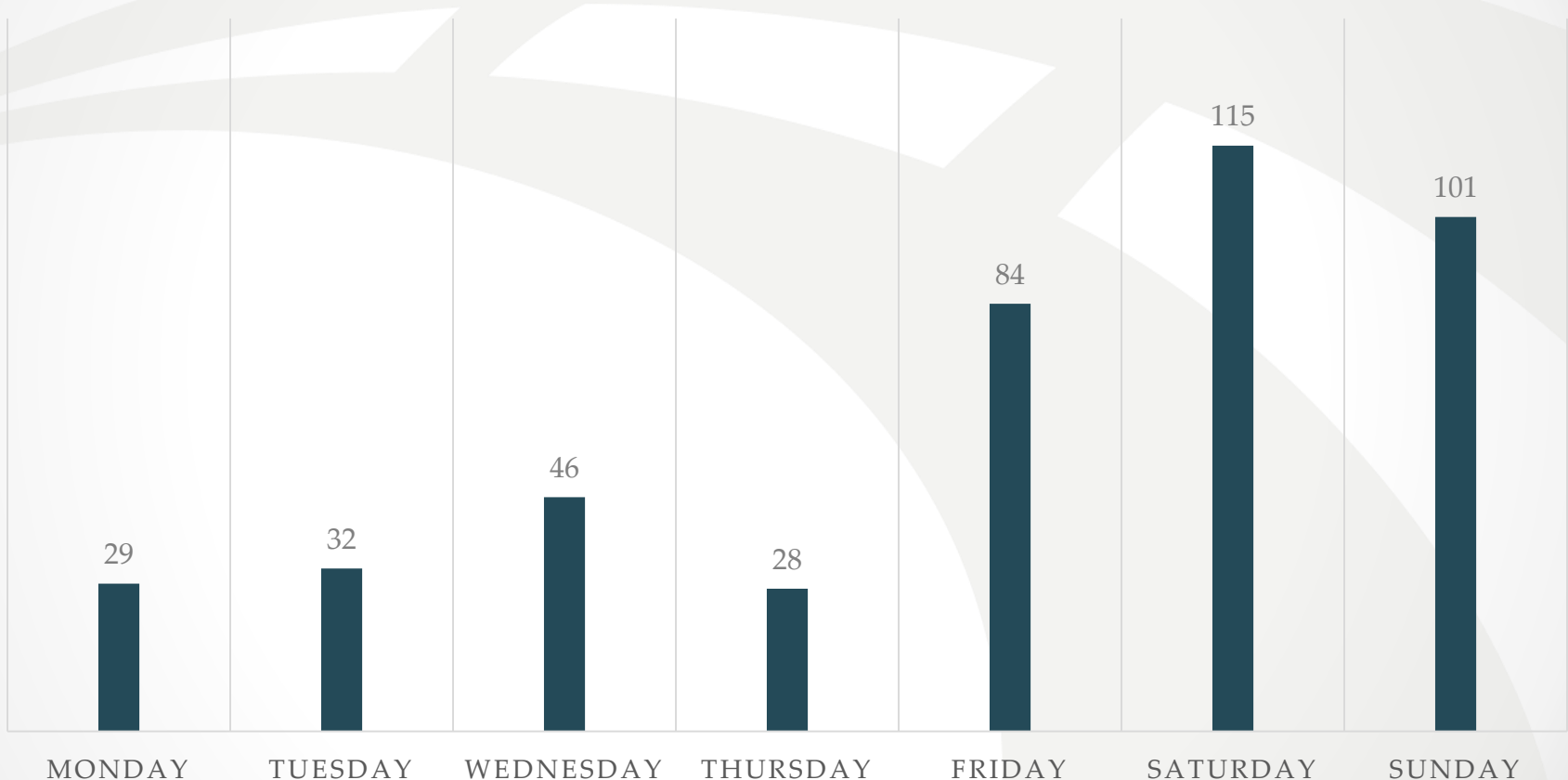
**Source:** Traffic Safety Commission, 2013

# Pedestrian (VRU) Fatalities/100,000 habitants



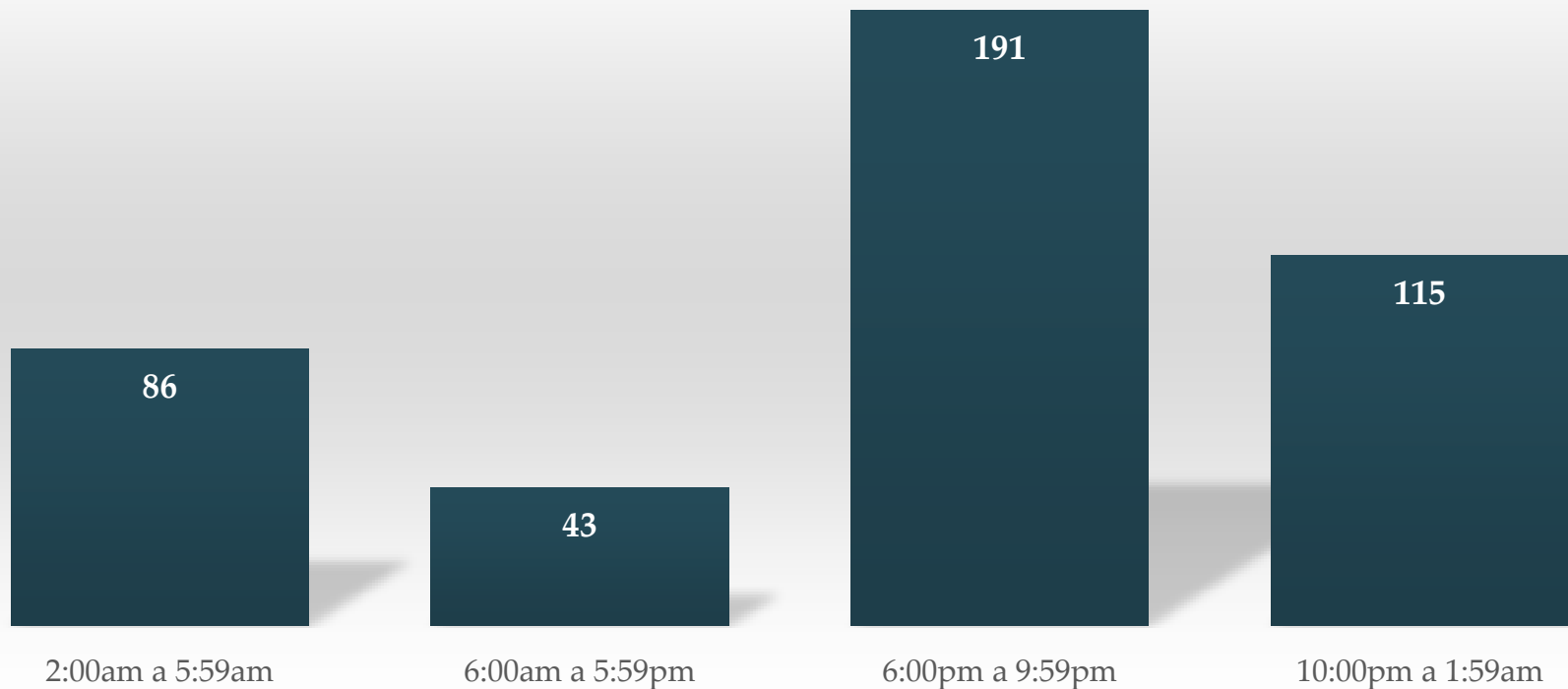
Source: NHTSA, 2010

# Pedestrian (VRU) Fatalities Associated with Alcohol Consumption per Day of the Week



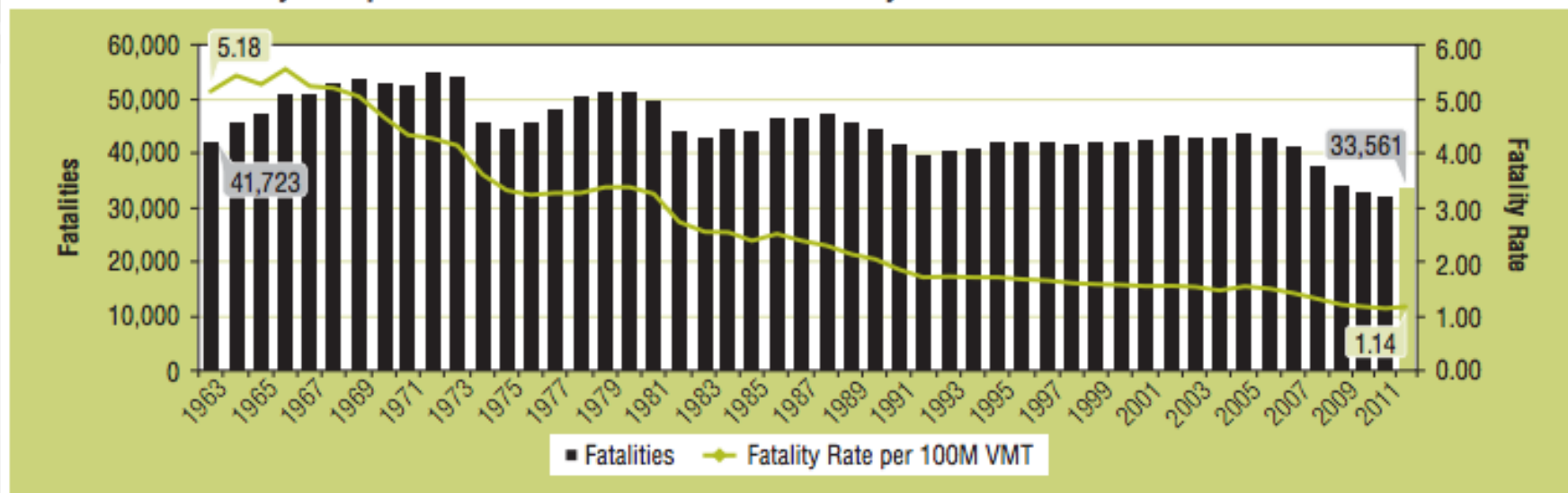
**Source:** Traffic Safety Commission, 2012

# Pedestrian (VRU) Fatalities Associated with Alcohol Consumption per day period



**Source:** Traffic Safety Commission, 2012

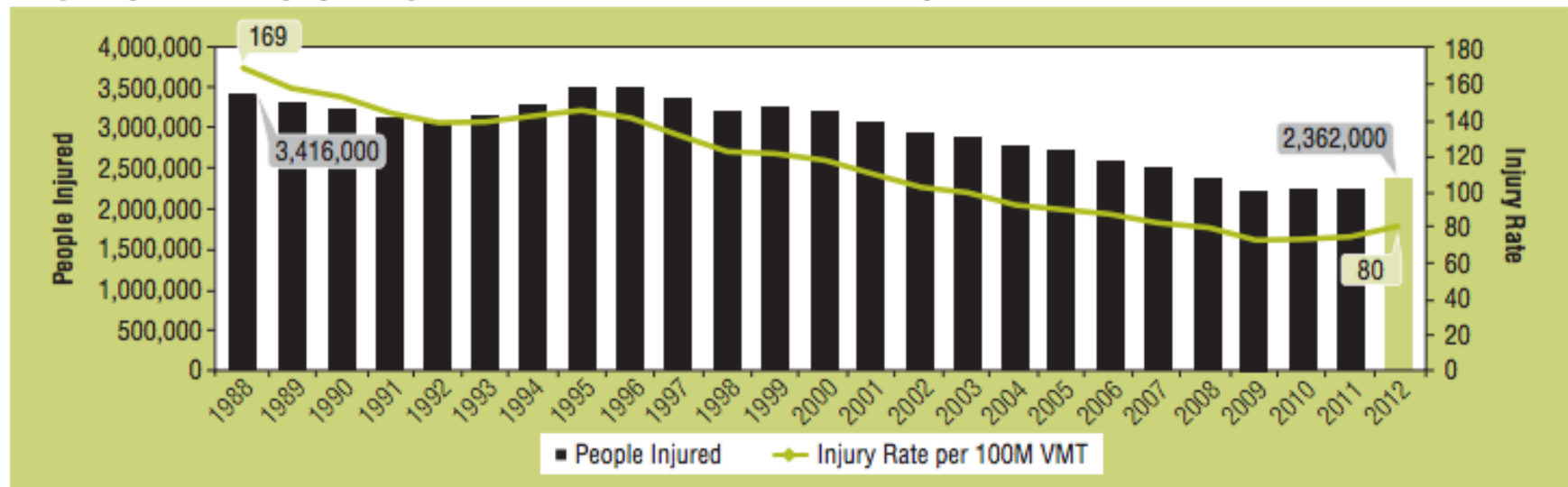
**Fatalities and Fatality Rate per 100 Million Vehicle Miles Traveled by Year**



Source: 1963–1974: National Center for Health Statistics, HEW, and State Accident Summaries (Adjusted to 30-Day Traffic Deaths by NHTSA); FARS 1975–2011 (Final), 2012 Annual Report File (ARF); Vehicle Miles Traveled (VMT): Federal Highway Administration.

**Source:** Traffic Safety Facts Research Note, NHTSA, November 2013

**People Injured and Injury Rate per 100 Million Vehicle Miles Traveled by Year**



Source: NASS GES 1988–2012; Vehicle Miles Traveled (VMT): Federal Highway Administration.

**Source:** Traffic Safety Facts Research Note, NHTSA, November 2013

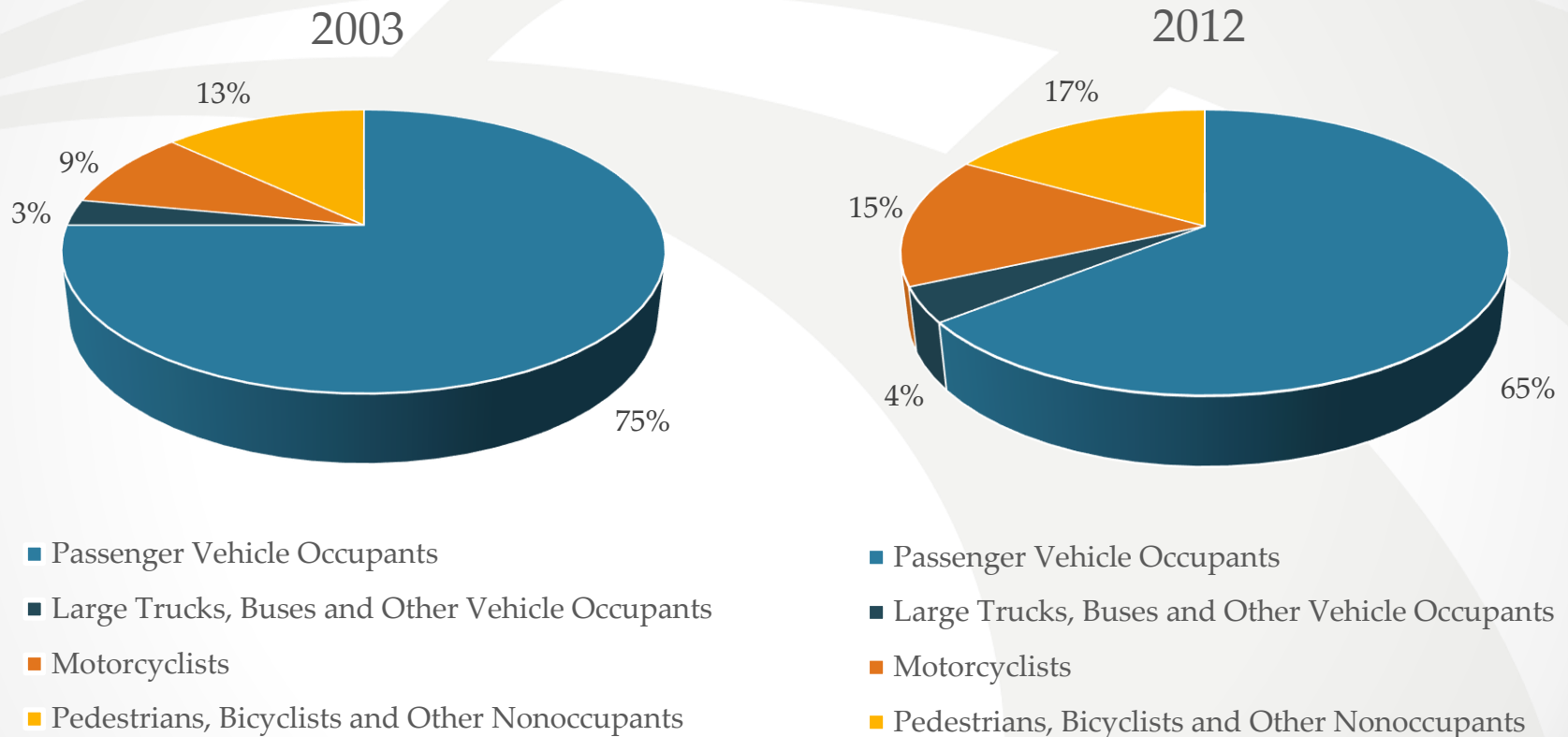
## Fatality and Injury Rates/100 Million VMT

Rate	2011	2012	Change	%Change
Fatalities	1.10	1.14	0.04	3.6%
Injuries	75	80	5	6.7%



**Source:** Traffic Safety Facts Research Note, NHTSA, November 2013

# Comparison of VRU Fatalities in the Commonwealth of Puerto Rico: 2003-2012



**Source:** Traffic Safety Facts Research Note, NHTSA, November 2013



## Representative Scenarios of Urban Intersections and Rural Highways for VRU

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# VRU Urban Intersection



# VRU Urban Signalized Intersection



## VRU under adverse weather condition rural section



# Ineffective Refuge Island for Motorcycles



# Near miss secondary crash for VRU at Urban Intersection



# Lack of Adequate Traffic Control Devices (TCD) and Enforcement at Urban Intersection, VRU at High Risk



# Pedestrian Crash Simulation Studies



# Real Motor vehicle-Pedestrian crash at a Rural Freeway on a Disabled Vehicle Center lane



# Cyclist Crash Simulation Studies



## Rear and Side View Motorcycle-Vehicle Crash Simulation Studies



# Reckless Motorcycle Driver Behavior



# Rear-ended motorcycle crash in an idle motor vehicle in the center lane in a freeway



## Skidding related crash under rainy conditions



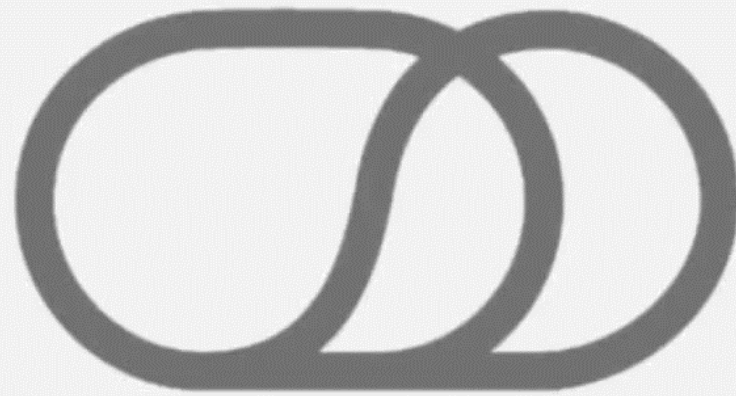
# Innovative Technologies to Improve Safety VRU



# Fully-electric and fully-enclosed self-balancing motorcycle



# Fully-electric and fully-enclosed self-balancing motorcycle



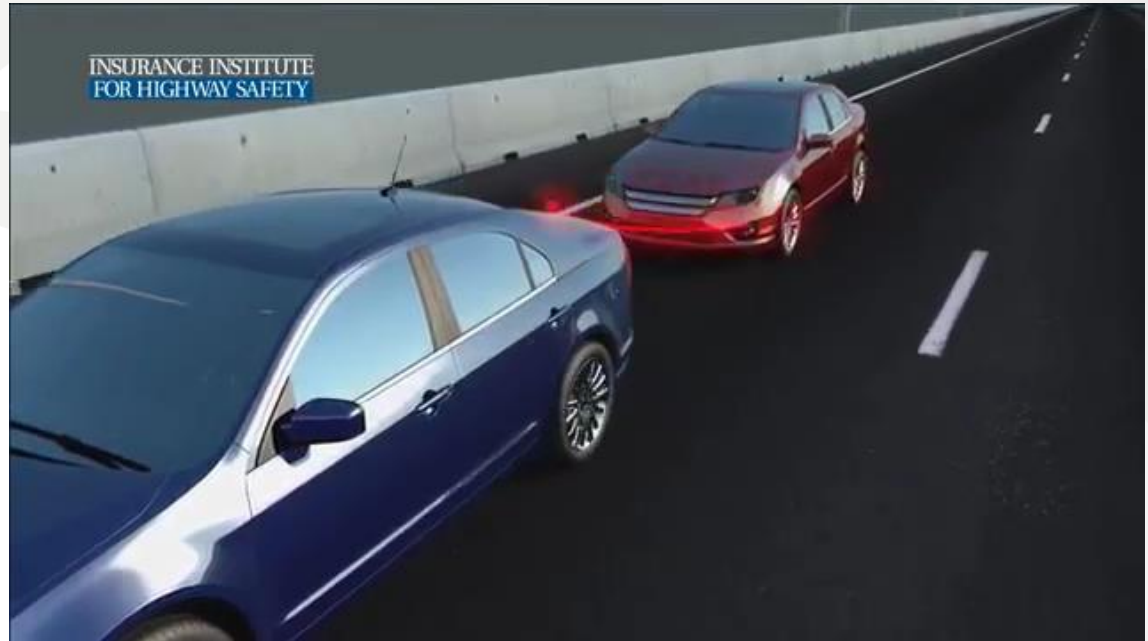
**LIT MOTORS**

# Crash Avoidance Technologies

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# Front Crash Prevention

- Uses various types of sensors, such as
  - Cameras
  - Radar or
  - **Light Detection and Ranging (LIDAR)**
- Detects when the vehicle is getting too close to one in front of it.
- Most systems issue a warning and precharge the brakes to maximize their effect if the driver responds by braking.
- Many systems brake the vehicle autonomously if the driver doesn't respond.
- In some cases, automatic braking is activated without a preliminary warning.



Source: <http://www.iihs.org/iihs/topics/t/crash-avoidance-technologies/qanda>

# Adaptive Cruise Control

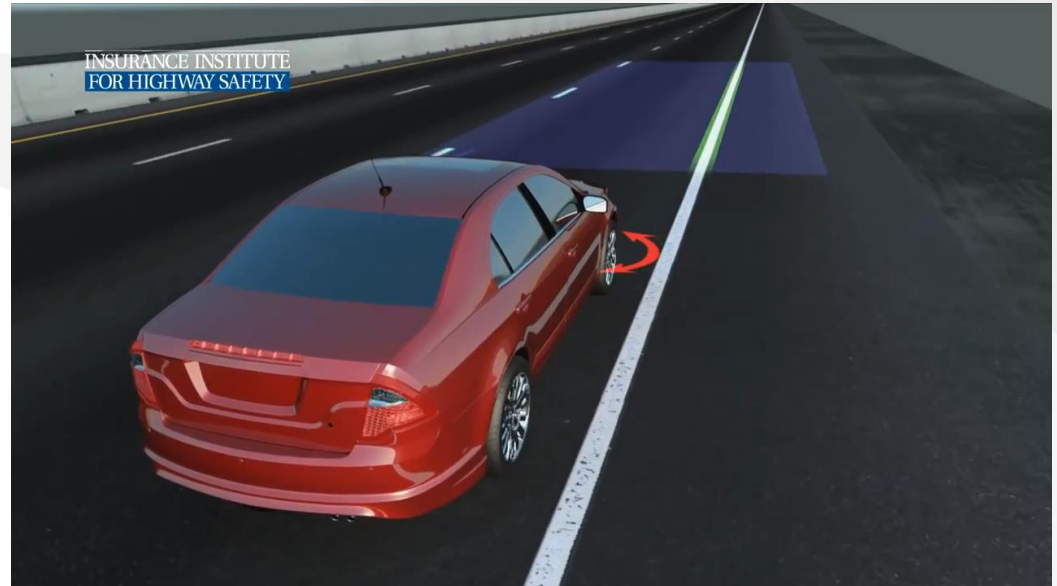
- The driver sets the desired speed.
- The forward-mounted sensors track the distance to a lead vehicle, and the engine and brakes are used to maintain a safe gap if traffic slows.
- As traffic speeds up again, the vehicle accelerates to maintain the preset cruise speed.



Source: <http://www.iihs.org/iihs/topics/t/crash-avoidance-technologies/qanda>

# Lane Departure Warning and Prevention

- Uses cameras to track the vehicle's position within the lane, alerting the driver if the vehicle is in danger of inadvertently straying across lane markings.
- Some systems use haptic warnings, such as steering wheel or seat vibration, while others use audible and/or visual warnings.
- Some systems cause the vehicle to actively resist moving out of the lane or help direct the vehicle back into the lane through light braking or minor steering adjustments.



Source: <http://www.iihs.org/iihs/topics/t/crash-avoidance-technologies/qanda>

# Blind Spot Detection

- Uses sensors to monitor the side of the vehicle for approaching vehicles approaching blind spots.
- In many systems, a visual alert appears on or near the sideview mirrors if a vehicle is detected.
- An audible alert may activate if the driver signals a turn and there is a vehicle in the blind spot.
- Some systems also may activate the brake or steering controls to keep the vehicle in its lane.



Source: <http://www.iihs.org/iihs/topics/t/crash-avoidance-technologies/qanda>

# Park Assist and Backover Prevention

- Rear object detection systems use cameras and sensors to help the driver look for objects behind the vehicle when backing up.
- Rearview cameras display what is behind the vehicle.
- Systems that use radar or ultrasonic sensors, along with some camera systems, warn the driver if there are objects in the way when the vehicle is in reverse.
- Some systems automatically apply the brakes to keep the vehicle from backing into or over an object.
- A cross-traffic alert system detects approaching vehicles that may cross the path of a backing vehicle, warns the driver, and may automatically brake to prevent a collision.



Source: <http://www.iihs.org/iihs/topics/t/crash-avoidance-technologies/qanda>

# Adaptive Headlights

- Help drivers see better on dark, curved roads.
- The headlights pivot in the direction of travel based on steering wheel movement and sometimes the vehicle's speed to illuminate the road ahead.



Source: <http://www.iihs.org/iihs/topics/t/crash-avoidance-technologies/qanda>

# Conclusion

- Innovative Technologies namely, xx, vv, tt, have the potential to reduce severity and save to vulnerable users.
- Effective Enforcement is required to establish controls at intersections in urban settings
- Educational Campaigns for the benefits of all road users in terms of sharing the road and improving efficiency in Highway Operations is essential to establish a safety culture in developing countries and world wide.
- All together we can make the difference in reducing to vulnerable road users.

# Reflection



# United we can address regional needs in reducing fatalities in our highway network



## Thank you for the opportunity