The role of the road user in a safe system: Challenges and opportunities for the future

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Overview

• The challenges involved in modifying road user behaviour
• The need for a systems-based approach to better manage road user behaviour
• Opportunities to reduce the contribution of road user behaviour to crashes
• Fundamental issues to address:
  ➢ What role should road users play in a safe system?
  ➢ How can we cater for the safety needs of all road users?
Australia:
Population = 24.65 million
Land area = 7.7 million km²
Reg.vehicles = 18.4 million
Driver’s licences = 17.2 million

Queensland:
Population = 4.8 million
Land area = 1.7 million km²
Reg.vehicles = 4.3 million
Driver’s licences = 3.8 million
The need for a systems-based approach to manage road users

- The role of human factors in road crashes
- The demands associated with being a road user
- The inherent challenges involved in modifying road user behaviour
- The limited success of existing behavioural countermeasures
- The need for a shift away from:
  - Blaming road users for crashes
  - Over-relying on road user countermeasures
Crash causes

- Rarely a single cause of a crash, but a ‘causal chain’ of events involving:
  - road user behaviours (90%)
  - road conditions (30%)
  - vehicular defects or failures (10%)

Source: Shinar, 1978
Scope of road user behaviours contributing to crashes

- A range of behavioural mechanisms are involved:
  - *Errors/slips* – Actions not carried out as planned
  - *Lapses* – Missed actions or omissions
  - *Mistakes* – Wrong actions due to faulty plan
  - *Violations* – Deliberate illegal actions (OECD, 2016)

- Need to distinguish between intentional and non-intentional actions

- Different information processing and motivational factors contribute to these behaviours
Extreme behaviours vs system failures

Summary of the role of system failures and extreme behaviour in fatal and non-fatal crashes in South Australia

<table>
<thead>
<tr>
<th>Data source</th>
<th>Extreme behaviour (%)</th>
<th>Illegal system failure (%)</th>
<th>System failure (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal crashes 2008</td>
<td>43.4</td>
<td>22.9</td>
<td>33.7</td>
</tr>
<tr>
<td>Non-fatal metropolitan injury crashes 2002-2005</td>
<td>3.3</td>
<td>9.9</td>
<td>86.8</td>
</tr>
<tr>
<td>Non-fatal rural crashes 1998-2000</td>
<td>9.4</td>
<td>16.6</td>
<td>74.0</td>
</tr>
</tbody>
</table>

*Extreme behaviours* = high levels of alcohol and speeding, drug driving or reckless driving contributing to the crash

*Illegal system failure* = lower level illegal behaviours contributing to the crash

*System failure* = errors made by compliant road users contributing to the crash

The demands associated with being a road user (1)

“At the turn of the century, when the passenger car emerged upon the scene, Carl Benz is supposed to have considered that the market for his automobile was limited because `there were going to be no more than one million people capable of being trained as chauffeurs’“

(Henderson, 1991, p.7)
The demands associated with being a road user (2)

The need to undertake multiple tasks
Casualty Crash Involvement in Queensland by Licence Type

Source: Queensland Government, 2005
The demands associated with being a road user (3)

Dealing with inappropriate visual cues

Source: Queensland Main Roads
The demands associated with being a road user (4)

Dealing with complex situations

Source: Queensland Main Roads
Challenges involved in modifying road user behaviour (1)

• A very wide range of factors impact on the behaviour of road users including:
  ➢ Psychological and physiological conditions
  ➢ Social background
  ➢ Past experiences including habits
  ➢ Situational factors including the behaviour of other road users
  ➢ Current state and immediate goals
Factors influencing road user behaviour

Current road user behaviour

- Traffic Congestion
- Psychopathology
- Education
- Publicity/News
- Boredom
- Thrill Seeking
- Informal Social Norms
- Observed Models
- Peer Pressure
- Family Pressure
- Value of Future Time
- Risk Acceptance
- Frustration/Aggression
- Knowledge
- Stimulus Needs
- Habits
- Experience
- Training
- Driving Culture
- Media/Pop Culture
- Motor Sport Fun/Adventure
- Broad Societal Concerns
- Commercial Advertising
- Conservation
- Mobility/Growth
- Economic Cycle
- Trip Purpose
- Value of Present Time
- Time Pressure
- Vehicle Handling
- Skills
- Information Processing
- Other Drivers
- Feedback
- Near Misses/Conflicts
- Impairment
- Fatigue
- Distractions
- Alertness
- Task Conflicts
- Legislation
- Enforcement
- Deterrent Threat
- Source: Lonero & Clinton (1998)
Challenges involved in modifying road user behaviour (2)

• *Psychological factors*
  - Individual differences:
    ➢ Age, gender, ability
  - Personality characteristics:
    ➢ Sensation seeking, general aggression etc.
  - Perceptual biases:
    ➢ Optimism bias, fundamental attribution error,
      third-person effect
  - Current state
    ➢ Stress, emotional state, mood
Challenges involved in modifying road user behaviour (2)

• *Subjective vs objective* risk

• Distinction between *performance* (what people are capable of) and *behaviour* (what they actually do)
  - Greater skill (proficiency) does not necessarily equate to better behaviour
  - US study found that racing car drivers had more offences and crashes than general drivers (Williams & O’Neil, 1974)

• Some road users are highly resistant to change
  - Recidivist offenders are over-represented in traffic offences and crashes
Recidivist offenders

• International studies show that:
  ➢ approximately 20% of drink driving offenders have had a prior conviction within the last 5 years
  ➢ there is a strong relationship between repeat offending and high-range blood alcohol concentrations (BACs)

• A Queensland study of speeding offenders found that:
  ➢ Over 45% reoffended within two years
  ➢ High range offenders (those with at least two prior offences 30 km/h above the limit) were more likely to be male, younger, hold a provisional licence, ride a motorcycle and have committed other traffic offences

Source: Watson et al, 2015a,b
People drive as they live

• Tillman & Hobbs (1949) found that taxi drivers involved in crashes (compared to those who weren’t) were more likely to have a history of over-involvement with:
  ➢ criminal courts, social service, public health agencies and credit bureaus

• They coined the phrase: “a man drives as he lives”

• Many other studies have confirmed the strong association between on-road and general behaviour

• Risky on-road behaviours often cluster together

Sources: Evans, 1994; Shinar, 1978
Self-reported criminal convictions among unlicensed drivers in Brisbane (n = 309)

<table>
<thead>
<tr>
<th>Category</th>
<th>% Yes</th>
<th>% No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disqualified</td>
<td>65.4</td>
<td>34.6</td>
</tr>
<tr>
<td>Suspended</td>
<td>69.7</td>
<td>30.3</td>
</tr>
<tr>
<td>Expired</td>
<td>71.4</td>
<td>28.6</td>
</tr>
<tr>
<td>Not currently licensed</td>
<td>57.1</td>
<td>42.9</td>
</tr>
<tr>
<td>Never licensed</td>
<td>65.4</td>
<td>34.6</td>
</tr>
<tr>
<td>Total</td>
<td>61.2</td>
<td>38.8</td>
</tr>
</tbody>
</table>

\[ \chi^2 (5,309) = 34.19, \ p < .001 \]

Source: Watson, 2004
Serious casualty crashes by involvement of alcohol & drugs: Queensland 2003-08

<table>
<thead>
<tr>
<th></th>
<th>Licensed</th>
<th>Unlicensed</th>
</tr>
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<tbody>
<tr>
<td>Present</td>
<td>7.8</td>
<td>35.9</td>
</tr>
<tr>
<td>Not present</td>
<td>92.2</td>
<td>64.1</td>
</tr>
</tbody>
</table>

\[ \chi^2 (df1) = 2309.1, \ p < .001 \]

Drink driving offence history of speeding offenders

Low-range vs. high-range: $\chi^2 (1) = 376.9$, $p < .001$, $\phi_c = .22$
Mid-range vs. high-range: $\chi^2 (1) = 346.3$, $p < .001$, $\phi_c = .07$

Source: Watson et al, 2015b
Driver distraction

• Distraction has been found to be a contributing factor in 22% of car crashes and 71% of truck crashes in naturalistic driving studies
• Using a mobile phone whilst driving is highly distracting and is estimated to increase the risk of crashing four-fold
• A Queensland survey found that:
  ➢ 25% of respondents reported using their hand-held mobile phone on a daily basis to answer or make calls, as well as read text messages
• A Canadian study found that:
  ➢ 37% of respondents (and 55% of those 16-34) reported using their cell phone while driving in the previous 7 days

Sources: CARRS-Q, 2017; Vanlaar et al, 2006
The limited effectiveness of behavioural countermeasures

“While the predominance of ‘human errors’ as causes of accidents should serve as a humbling experience, it does not imply that the practical way to eliminate most accidents is to ‘fix’ the driver. On the contrary, it appears that of the three major highway traffic components - the driver, the vehicle, and the roadway environment - the driver is the most difficult to change or improve.”

(Shinar, 1978, p.126)
Behavioural countermeasures: Success stories

- Wearing a seat-belt reduces the risk of a fatal injury by:
  - Up to 50% for front seat occupants
  - Up to 75% for rear seat occupants

- Enforcing drink-driving laws can reduce road deaths by 20%.

- The correct use of a motorcycle helmet can result in a 40% reduction to the risk of death, and 70% reduction to the risk of severe injury.

- A 5% cut in average speed can result in a 30% reduction in the number of fatal crashes.

Source: WHO Global Status Report on Road Safety, 2013
Percentage of drivers and riders killed with BAC of .05 or more in Australia: 1980-2015
(where BAC is known*)

Sources: ATSB and BITRE

* See explanation on Notes view
Number and percent of deaths involving a drinking driver in Canada: 1996-2013

Source: CCMTA, 2013
Failure to wear appropriate restraints

• In Australia:
  ➢ Surveys indicate that over 95% of occupants in front seats and around 90% in rear seats wear seat belts
  ➢ However, approximately 20% of drivers and passengers killed (where seat belt use is known) are not wearing seat belts (CARRS-Q, 2016)

• In Canada:
  ➢ A 2010 survey found that 95.3% of all occupants in light vehicles wore seat belts (Government of Alberta, 2012)
  ➢ However, in 2015 28.7% of vehicle fatalities were not wearing seat belts (Transport Canada, 2015)
Some common misconceptions about changing road user behaviour

• Specialised skills-based driver training is effective in reducing novice driver crashes
• Harsh penalties are more effective than less severe ones
• Fear-based public education is effective
• Covert traffic law enforcement is more effective than visible operations
• Rewards are more effective than traffic law enforcement
The need for systems-based perspective

“For the first 50 years of motorization in the United States, Australia, and Europe, the almost exclusive emphasis was on trying to prevent crashes by changing the behaviour of individual drivers. This delayed for decades the recognition and application of possible prevention measures in other components of the causal chain leading to injury.” (Williams, 2000, p.1)
## The Haddon Matrix

<table>
<thead>
<tr>
<th></th>
<th>Pre-Crash stage</th>
<th>Crash Stage</th>
<th>Post-Crash stage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Road User</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vehicle</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Road Environment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The need to be realistic about human capabilities and responsibility

• From the 1990s, there was a growing awareness in many countries that:
  ➢ Humans inevitably make mistakes
  ➢ The historical tendency to blame road users for crashes had hampered prevention efforts
  ➢ Road system operators needed to take more responsibility for the safety of the system
  ➢ A more holistic, systems-based approach was required to achieve major reductions in road crash fatalities and injuries
Evolution of the Safe System Approach

- Origins lay in Sweden’s *Vision Zero* and the Netherlands’ *Sustainable Safety* concepts
- Refined and adopted by:
  - Global road safety community in the 2011 *Decade of Action Global Plan*
  - Many national, state and city level jurisdictions
- Further refined in ITF/OECD’s 2016 report *Zero Road Deaths and Serious Injuries* report
Principles of the Safe System Approach

- Humans inevitably make mistakes that can result in road crashes
- The human body has physical limits, in terms of the forces it can tolerate
- The responsibility for the safety of the system needs to be shared by all those involved in the design, building and management of the system, as well as road users
- A holistic approach is required to managing the system to build in redundancy and thereby optimise the safety of road users

Source: ITF/OECD, 2016
The ITF/OECD’s vision of the Safe System
Another vision of a Safe System
Putting the Safe System Approach into practice

- Challenges remain in operationalizing the Safe System Approach, particularly in low and middle income countries:
  - Many traditionalists fail to accept the philosophy underpinning the approach
  - Most examples of good safe system practices come from high income countries
  - There is an assumption that additional funding is required to implement a safe systems approach
  - The underlying concepts are sometimes misunderstood
An alternative view of a Safe System

SAFE INTERACTIONS
- Exposure control
- Separation of users
- Safe Speeds

SAFE ROADS

SAFE VEHICLES

SAFE ROAD USERS

Source: Watson, 2015
The need for new approaches to reduce the contribution of road users to crashes

• To date, even successful behavioural countermeasures have had limited effectiveness
• Distraction/inattention caused by smart phones and other technology is a growing problem
• Vulnerable road users have been historically overlooked in many jurisdictions
• In many low and middle income countries:
  − the take-up of evidence-based laws and regulations remains slow
  − enforcement efforts are not sufficiently intense or sustained
Opportunities to reduce the contribution of road users to crashes (1)

• In many countries, particularly LMICs, there is considerable potential to introduce evidence-based laws and regulations relating to key risk factors like:
  - Drink driving
  - Speeding
  - Helmet use
  - Seat belts and child restraints
  - Driver distraction

Sources: WHO, 2013, 2015, 2017
Implementing good practice

Global Plan
for the Decade of Action
for Road Safety 2011-2020

DECADE OF ACTION FOR ROAD SAFETY 2011-2020

Save Lives
A road safety technical package

www.carrsq.qut.edu.au
Save LIVES Package

• Focal areas:
  – Speed management
  – Leadership
  – Infrastructure
  – Vehicles
  – Enforcement of laws
  – Survival

• Contents:
  – 22 specific interventions identified
  – Based on evidence of cost effectiveness
  – Follows principles of DoA and 5 pillars to build on existing momentum and action by countries

Source: WHO, 2017
Opportunities to reduce the contribution of road users to crashes (2)

• In high-income countries there is less scope to optimize the benefits of existing behavioural countermeasures

• Ongoing innovation is required to:
  ➢ Further control the exposure of high risk users
  ➢ Better manage the interactions between motor vehicles and vulnerable road users
  ➢ Use technology to provide more assistance to road users and intervene to prevent crashes
  ➢ Use technology to prevent risky behaviours like drink driving, speeding, cell phone use, unlicensed driving
Opportunities to reduce the role of alcohol in road crashes

• Expand the use of alcohol ignition interlocks and other vehicle sanctions to all drink driving offenders
• Further lower alcohol limits for general and high-risk drivers, to reflect international good practice
• Introduce random breath testing or intensive sobriety checkpoints (where RBT not possible)
• Require the fitting of unobtrusive alcohol interlocks to all vehicles e.g. DADSS system
Driver Alcohol Detection System for Safety (DADSS)

Technologies We're Exploring

The goal of the DADSS research program is to advance the state of alcohol detection technology by developing a system that is fast, accurate, reliable and affordable – all without affecting normal driving behavior. The program is exploring two different technologies for vehicle integration: a breath-based system and a touch-based system.

**BREATH-BASED SYSTEM**
This system measures the alcohol level in a driver’s naturally exhaled breath unobtrusively. It will be designed to take instantaneous readings as the driver breathes normally and to accurately and reliably distinguish between the driver’s breath and that of any passengers.

**TOUCH-BASED SYSTEM**
This technology measures blood alcohol levels under the skin’s surface by shining an infrared-light through the fingertip. It will be integrated into current vehicle controls, such as the start button or steering wheel, and take multiple, accurate readings in less than a second.

Source: http://www.dadss.org/
Opportunities to reduce the role of speeding in road crashes

- Introduce lower speed limits in areas with vulnerable road users
- Expand automatic speed enforcement programs, including wide-spread use of point-to-point (average speed) cameras
- Encourage the wide-spread adoption of intelligent speed adaption (ISA) technology
- Require repeat offenders to install speed interlocks
- Require the fitting of ISA into all vehicles
Opportunities to reduce the role of cell phones in road crashes

• Improve police detection technology, to enhance general deterrence
• Ban their complete use among novice drivers
• Encourage businesses to ban employee use
• Encourage drivers to use voice message options
• Encourage vehicle manufacturers to introduce performance-based call monitoring systems
• Require call blocking technology in all vehicles
The car of the future is here . . . . if you can afford it

Source: Mercedes Benz, Australia
Managing the risks involved in moving towards a Safe System

- What level of vehicle automation is the public ready for?
- How do we manage potential resistance to perceived loss of freedom on the road?
- How do we ensure equity across the system, so that technological improvements benefit:
  - the poor and those living in rural areas
  - vulnerable road users
  - those in low and middle income countries?
- Can we achieve a truly safe system while road users are able to make safety-critical decisions?
What level of vehicle automation is the public ready for?

- More and more jurisdictions are conducting trials of automated vehicles
- The focus is currently on technical performance
- Governments are scrambling to develop policy frameworks relating to licensing, policing, insurance etc
- Limited public consultation and education appears to have been undertaken to date
- Surveys suggest that the highest support for vehicle automation is among young people
- Awareness still appears low among some road users
In the future will you be able to drive vehicles like this on all roads or only in specified areas with strict controls?
The need for robust technological solutions

- Much of the research into intelligent transport systems and vehicle automation is occurring in high income countries and has a strong truck and car-based focus.
- Rather than be a panacea, some technological solutions may further increase the safety gap between the rich and poor in rural areas, outer urban areas and LMICs.
- Research needs to focus on technological solutions that:
  - Fit with the infrastructure available in different settings.
  - Cater for the needs of vulnerable road users.
  - Can be implemented in a widespread, equitable manner.
Conclusion (1)

- Road user behaviour continues to be a major contributing factor to road crashes
- While many existing behavioural countermeasures have proven (very) successful, their overall effectiveness remains limited
- A systems-based approach is required to better manage road users and reduce their contribution to road trauma
- This will involve the better integration of road user, vehicle and road environment countermeasures to create a more ‘human proof’ system
Conclusion (2)

- Considerable scope exists to enhance behavioural countermeasures in LMICs
- However, in high income countries more innovative approaches will be required involving:
  - Further controlling the exposure of high risk users
  - Better managing the interactions between motor vehicles and vulnerable road users
  - Applying technology to provide more assistance to road users and intervene to prevent crashes
  - Applying technology to prevent risky behaviours like drink driving, speeding, cell phone use etc
• Road safety stakeholders need to work cooperatively to:
  ➢ Undertake community education and consultation regarding the benefits and implications of moving towards a safe system
  ➢ Set a safety-oriented agenda on the issue, rather than allow broader societal and technological trends to lead the way (as happened with cell phones)
  ➢ Harmonise safety goals with other social, health and environment agendas (eg. active transport) to ensure broad government and community support
  ➢ Debate whether a truly safe system can be achieved while road users are able to make safety-critical decisions?
Achieving a safe system requires cooperative efforts
References (1)


BITRE. Bureau of Infrastructure, Transport & Regional Economics. Canberra: Department of Infrastructure & Transport.


References (2)


References (3)


