CALGARY 2022 CANADA

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Bridge and Tunnel Strikes by Oversized Vehicles

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VIRTUAL | VIRTUEL

XVI WORLD WINTER SERVICE AND ROAD RESILIENCE CONGRESS

XVI^{e} CONGRÈS MONDIAL DE LA VIABILITÉ HIVERNALE ET DE LA RÉSILIENCE ROUTIÈRE

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PIARC Calgary Canada

Key discussion Points

1. ROD Introduction
2. Project Motivation
3. Project Scope
4. Methodology
5. Conclusions and Recommendations

1. Roughan & O'Donovan

- Civil, structural and environmental engineering consultancy
- Markets include Bridges, Transportation, Water, Environmental, Buildings & Research
- Plan, design and manage major infrastructure projects
- Multidisciplinary team of 220 people
- Founded in 1974
- Irish Owned
- Offices in Dublin (Ireland - 2 no.) and Leeds (UK)






2. Project Motivation

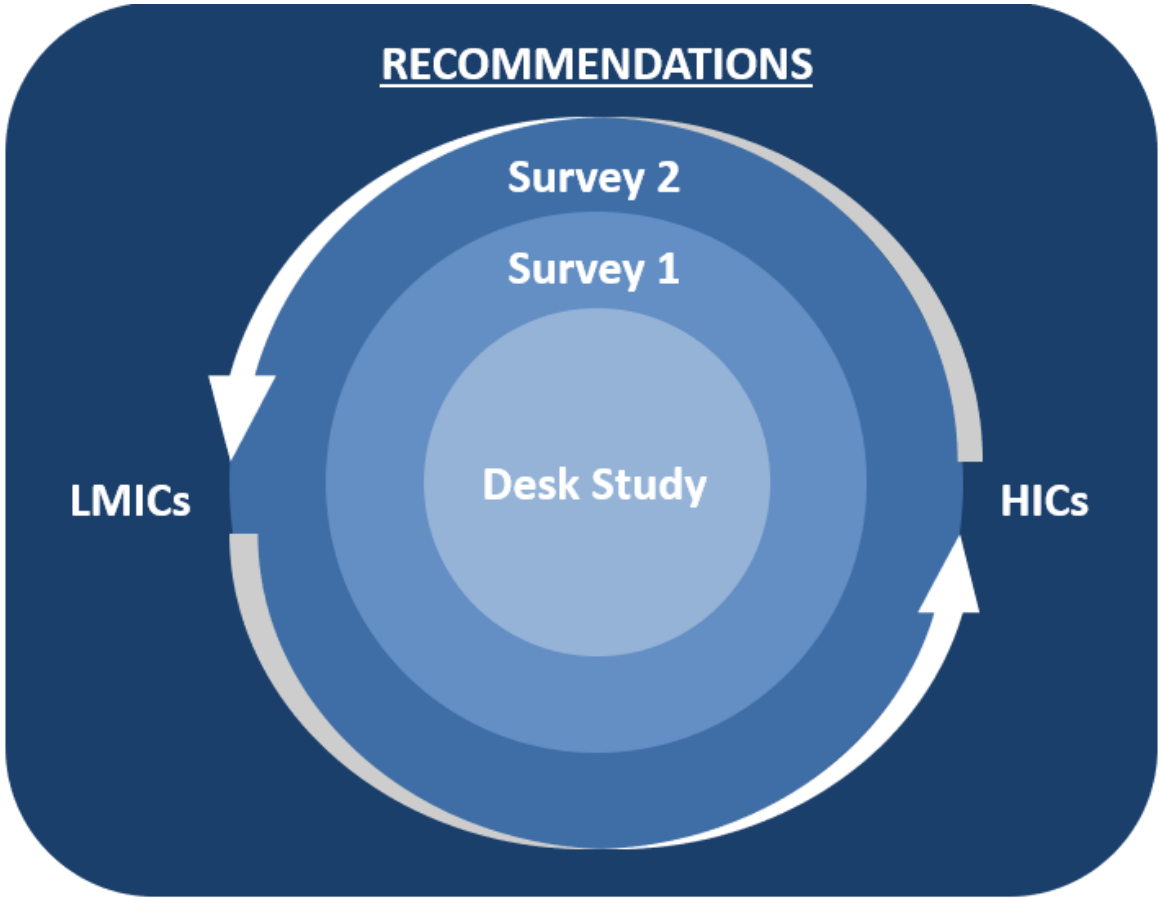
Strikes are known to be one of the most common causes of bridge failure. Network Rail report a bridge strike on average every 4.5 hours!

3. Project Scope

- “Examine proven countermeasures, practices, and technologies used to reduce the incidence of oversize vehicles striking bridges and tunnels along with effective processes for accurately reporting and tracking bridge strike occurrences”
- Examine impacts, challenges and opportunities
- Cost Benefit Analysis (CBA)
- Key focus: consideration of LMICs
- Conclusions and Recommendations

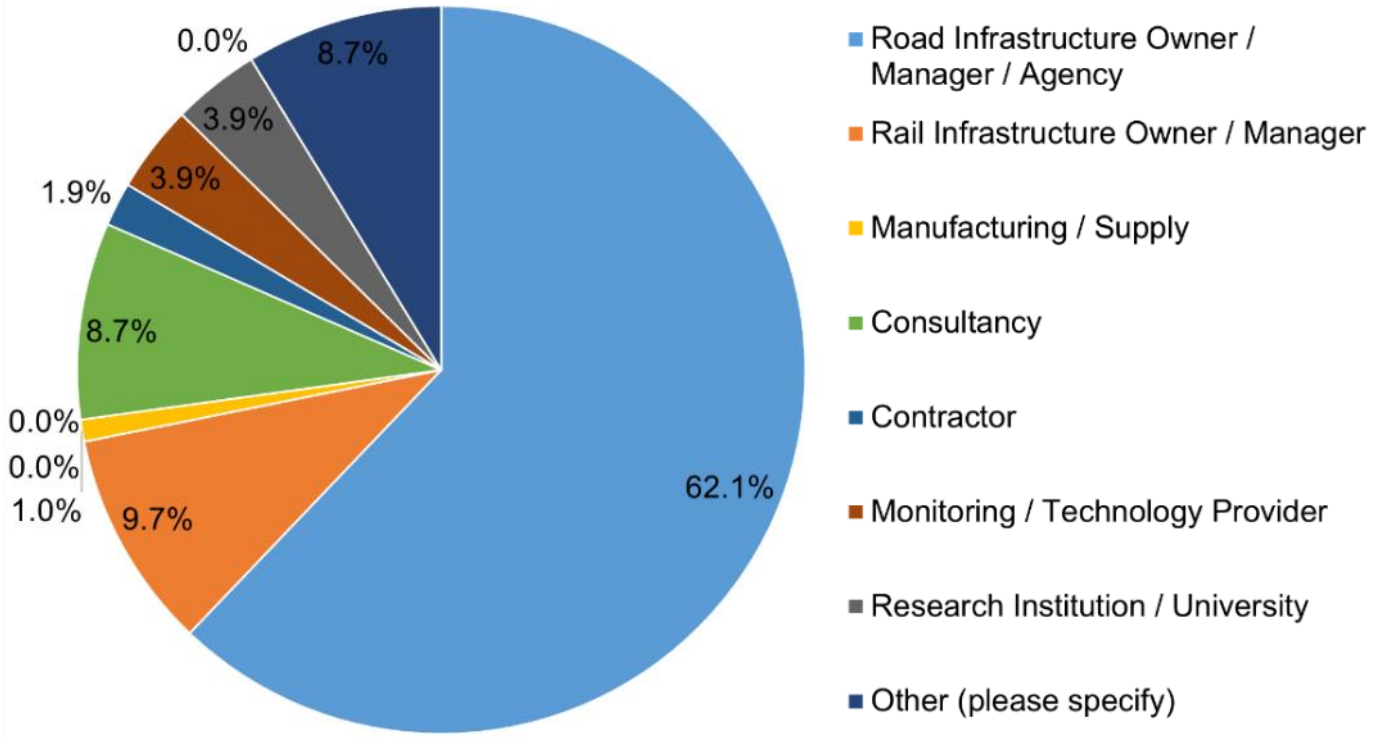
4. Methodology

- Data Acquisition Phase
  - Information acquisition through literature, regulation and surveys
  - Analysis of data and gap analysis
  - Grouping, clustering and interviews
- Mitigation Measures Overview
- Cost Benefit Analysis
- Conclusions & Recommendations

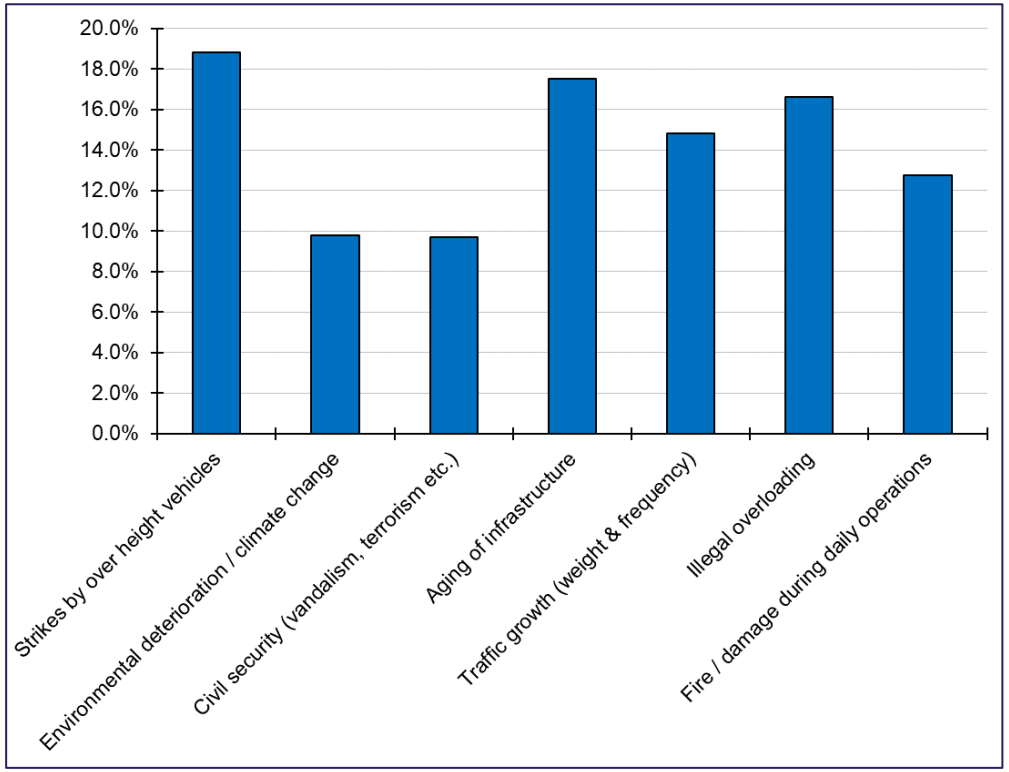


4. Methodology
Data Acquisition – Survey 1

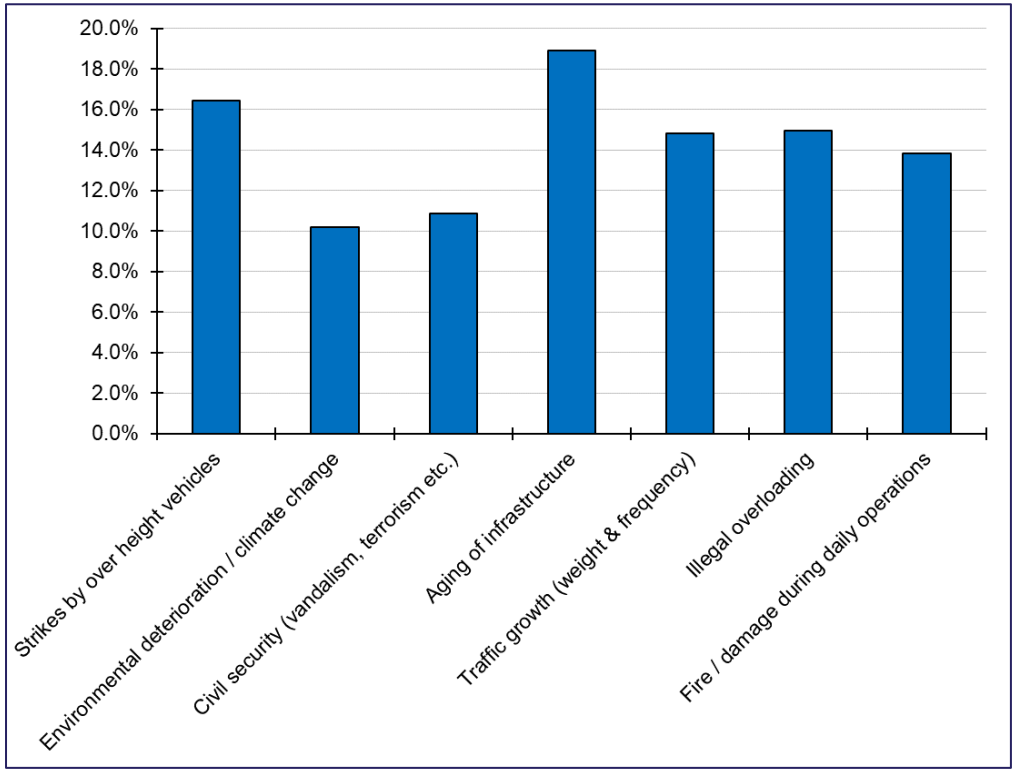
- Extensive literature review followed by surveys.
- Survey 1 – intention to obtain key stakeholder contacts and develop an initial understanding.
- Risk perception & Mitigation effectiveness
- 104 responses (English, French & Spanish)



4. Methodology
Data Acquisition – Survey 1



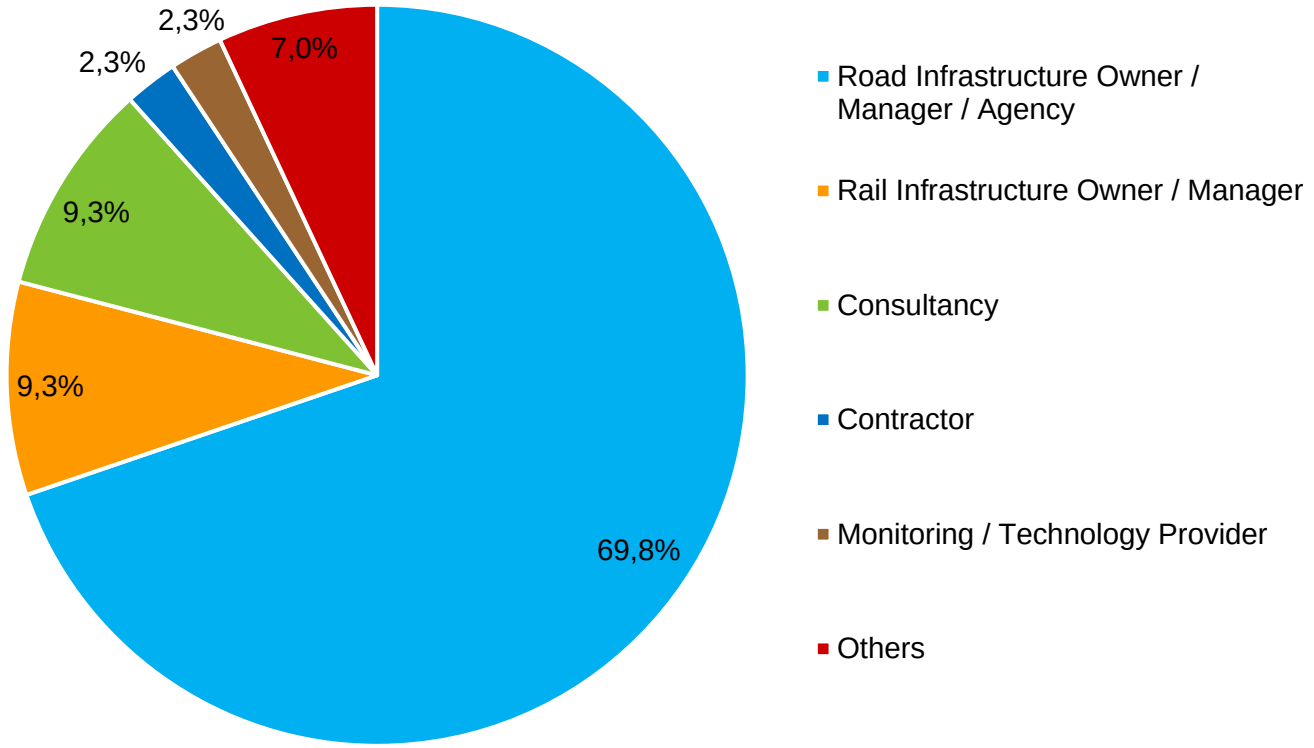
Q) Rank the following bridge / tunnel hazards by their impact on **safety**.



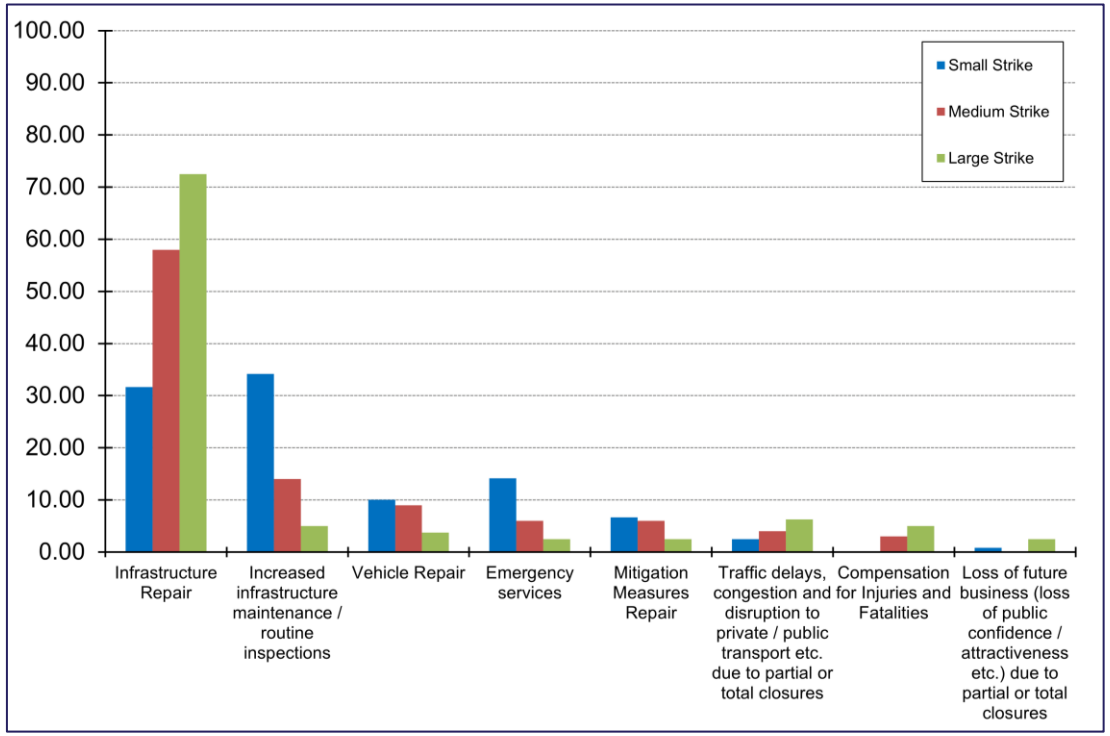
Q) Rank the following bridge / tunnel hazards by their impact on **cost**.

4. Methodology
Data Acquisition – Survey 2

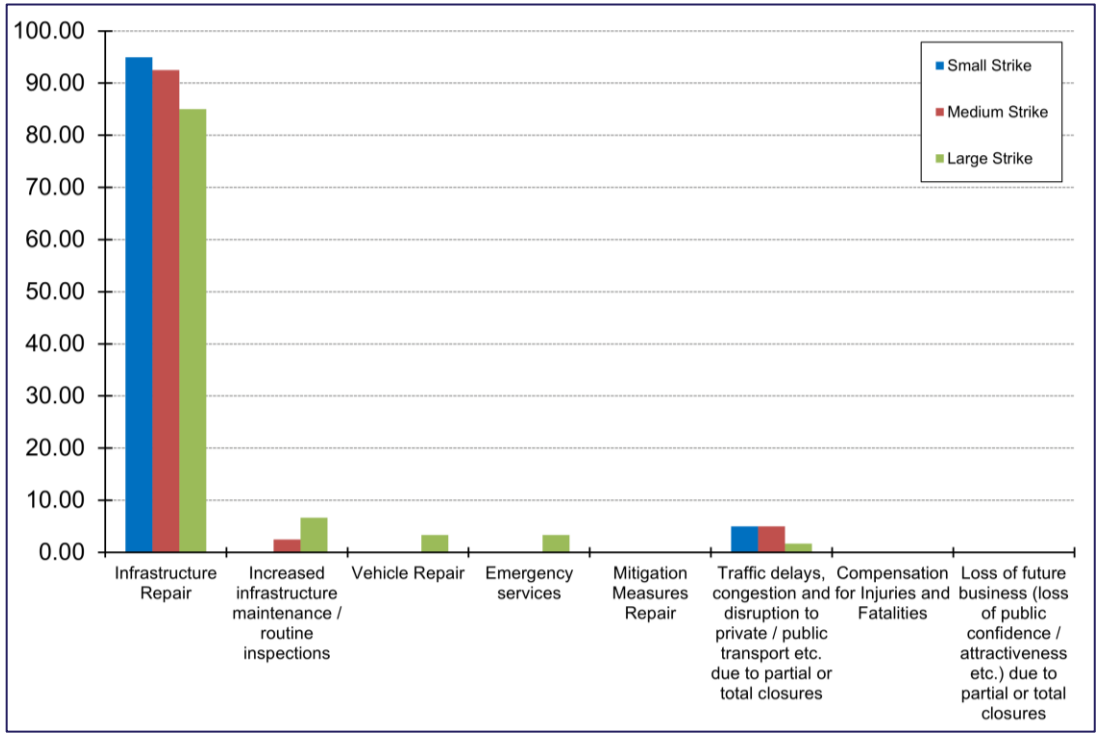
- The second survey aimed to obtain cost, consequences and mitigation effectiveness data that will be later used to perform a semi-quantitative CBA.
- Ambitious nature of questions – only issued to key stakeholders from survey 1.
- 43 responses (English, French & Spanish)



4. Methodology
Data Acquisition – Survey 2



Q) Percentage breakdown of the cost for **bridges**.



Q) Percentage breakdown of the cost for **tunnels**.

4. Methodology
Mitigation Measures

Passive Systems

- Static signage
- Variable Message Signs (VMS)
- Beacons
- Bridge markings

4. Methodology
Mitigation Measures

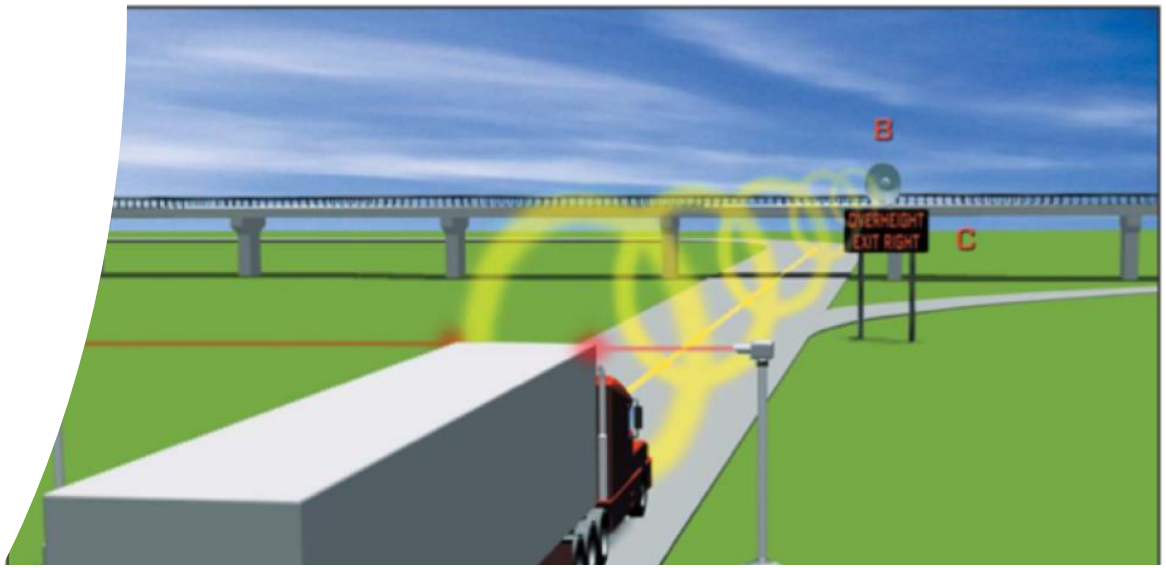
Sacrificial Systems

- Hanging chains or bells
- Crash beams
- Rumble Strips

4. Methodology
Mitigation Measures

Active Systems

- Intelligent Transportation Systems (ITS)
- Early Warning Detection Systems (EWDS)
- Computer vision systems



4. Methodology
Mitigation Measures

Detection Systems

- Used where there is a risk of unreported strikes

4. Methodology
Mitigation Measures

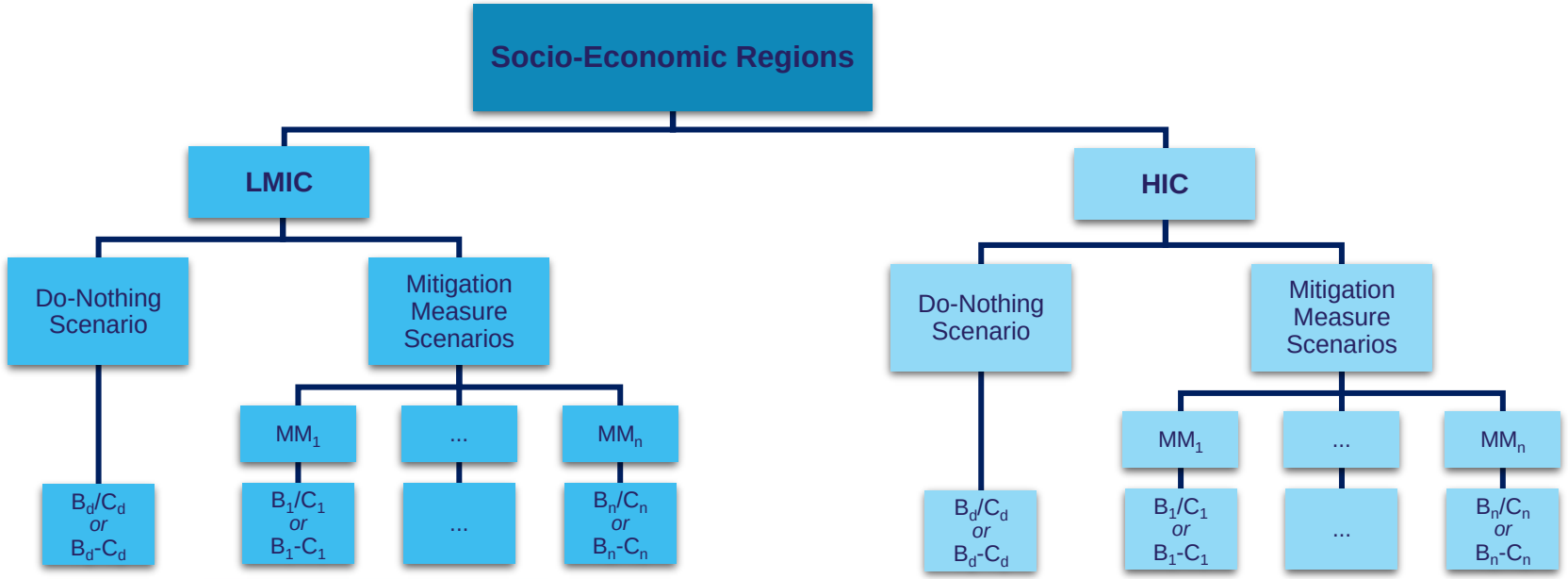
Driver-based Mitigation

- Permits
- Load restrictions
- Fines
- Driver education and awareness programs
- Good practice manuals and protocols
- Can have a positive impact with a reasonably low cost and can be easily applied in LMICs.
- Future potential in Geographical Positioning Systems (GPS)
- Vehicle based technology

4. Methodology
Cost-Benefit Analysis

Definition of CBA objective

Make recommendations on the best mitigation measures for different socio-economic regions, based on road administrators and owners' point of view.



4. Methodology
Cost-Benefit Analysis

Calculation of costs and benefits values

Costs: $C_{tot} = C_p + C_i + C_m + C_r$

Benefits: $B_{tot} = E_{MM} \cdot S_{MM} \cdot C_{s,tot}$

E_{MM}: mitigation measure effectiveness
S_{MM}: mitigation measure suitability

Costs for:

- Mitigation measure purchase cost, $\mathbf{C_p}$
- Mitigation measure installation cost, $\mathbf{C_i}$
- Mitigation measure maintenance cost, $\mathbf{C_m}$
- Mitigation measure repair due to strike, $\mathbf{C_r}$

Saved costs for:

- Infrastructure / vehicle repair, $\mathbf{C_{sri}}$ / $\mathbf{C_{srv}}$
- Increased infrastructure maintenance, $\mathbf{C_{sm}}$
- Emergency services ($\mathbf{C_{ses}}$), Injuries & fatalities ($\mathbf{C_{sc}}$)
- Fines applied to driver, $\mathbf{C_{sf}}$
- Loss of business, $\mathbf{C_{sb}}$
- Environmental costs, $\mathbf{C_{sen}}$

4. Methodology
Cost-Benefit Analysis

- **Applied Framework**

Low benefit-cost ratio

- variable message signs (VMS)
- increased structure vertical clearance
- laser vision
- hanging chains or bells
- water screens with STOP signs
- road narrowing techniques

Medium benefit-cost ratio

- bridge markings, rumble strips and speed bumps
- crash sacrificial beams
- cameras and computer vision techniques,
- infrared dual beam arrays LaRa-OHVD and radar systems
- accelerometers, piezometric sensors and fibre optic cables

High benefit-cost ratio

- static signage
- beacons / flashing beacons and lights
- clear heights signage and obstacles related to dimensional loads
- vehicle redirection in case of excessive dimensions

Very high benefit-cost ratio

- media campaigns
- increased fines and surveillance, and heavy vehicle goods licence test
- increased restrictions on vehicle dimensions
- better driver education, good practice manuals
- pre-routed maps

5. Recommendations

For Road Administrations - HICs

Short Term Recommendations

- Effective mitigation: Accurate overheight clearance signage, flashing beacons, laser-based overheight detection in combination with variable message signs (VMS)
- An appropriate combination of mitigation measures will be essential based on the site.
- Adopt CBA methodology
- Development of a multi-sectoral panel to address and share / disseminate knowledge on the issue. Road administrators, hauliers, government, and police collaboration.

Long Term Recommendations

- Driver education, advertising and engagement
- Enhancements to vehicle technologies (e.g. gathering of accurate low clearance bridge information and inclusion in GPS/Navigation Systems).
- Future technologies: on-board navigation systems in combination with CAV technology and vehicle-2-infrastructure communication were found to have significant promise in tackling the bridge / tunnel strike problem. More research funding required in this area.

5. Recommendations

For Road Administrations - LMICs

Short Term Recommendations

- Effective mitigation: Accurate overheight clearance signage, ensuring signage is unobstructed.
- Flashing beacons & obstacles related to dimensional loads
- Adopt CBA methodology (semi quantitative).

Long Term Recommendations

- Development of a multi-sectoral panel to address and share / disseminate knowledge on the issue. Road administrators, hauliers, government, and police collaboration.

5. Recommendations

- **For PIARC**

1. Publishing of guideline on data storage for CBA.
2. Perform a sample case study, focusing on a single network or list of structures, showing how the required data can be gathered, and how to use it in a detailed risk analysis and CBA to decide on appropriate interventions

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Thank you for your attention!

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Roughan & O'Donovan Consulting Engineers

***'Bridge and Tunnel Strike by Oversized Vehicles'* Report**

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