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Application of QRA and Bowtie Methodologies to transportation activities

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Background

- Projects with extensive activities in remote areas
- Widespread use of heavy and light vehicles
- Anecdotally, road transportation risk was considered to significant
- Desire to understand the road transportation risk profile
  - What are the major contributors?
  - How effective are the controls?
  - Which controls are most effective?
  - What options are available to reduce the risk exposure?

Task Objective

- Develop a model that aids the understanding of the road transportation risk profile
  - Major contributors
  - Factors influenced by each control
  - Effectiveness of controls
  - Opportunities for risk reduction

- Consideration of elements specific to on-road activities:
  - Workers involved
  - Vehicle types used
  - Distances travelled
  - Routes taken
  - Risk management controls

Agenda

- Background
- Objective
- Approach
- Risk Model
- Risk Profile
- General Findings

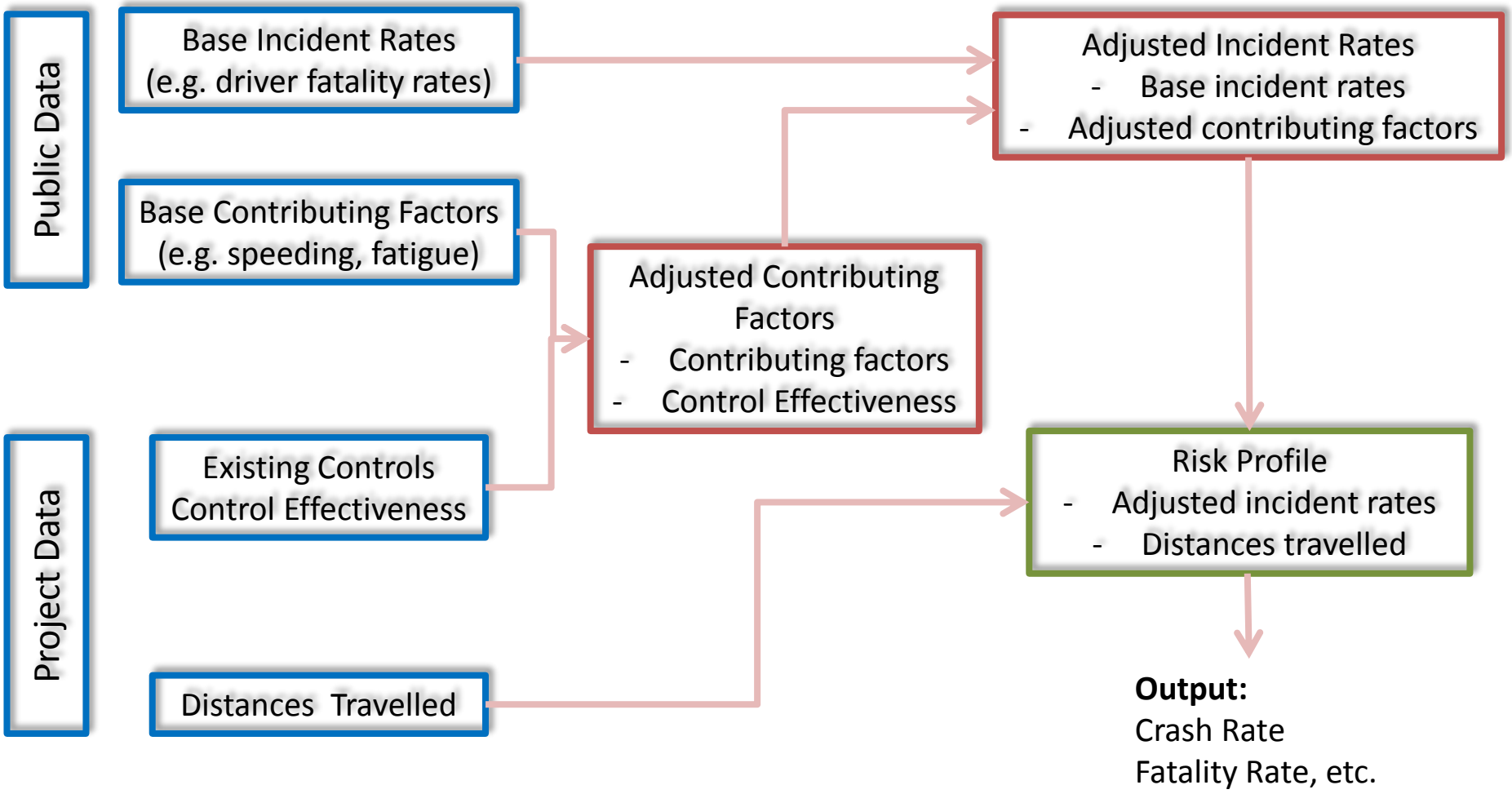
Approach

- Define the road transportation activities
- Identify hazards and applicable controls (workshop)
- Develop a quantitative risk model (input from various sources)
  - Operational data
  - Road accident data
  - Workshop information
- Generate risk profile considering the different activities
  - Comparison of road safety performance

Hazards and Controls

- Identification of the worker groups involved in road transportation:
  - Light Vehicles, Heavy Vehicles
  - Employees, Contractors, etc.
- Specification of the types of activities undertaken and associated potential incidents
- Identification of existing controls
  - Evaluate what the controls can truly influence
  - Input from human factors specialists
- Controls identified include:
  - Driver competence and training
  - In-vehicle monitoring system (IVMS); Fatigue Management
  - Vehicle Inspections / Maintenance

Risk Model Overview



Base Incident Rates

- Rates at which motor vehicles are involved in crashes
- Base incident rate for heavy and light vehicles

Vehicle Type	Rate of Involvement in Crash (per 100 million km travelled)	Driver Serious Injury Rate (per 100 million km travelled)	
		Hospitalised Casualty	Fatality
Light Vehicles	80.1	10.6	0.3
Heavy Vehicles	42.8	2.6	0.3
- Rigid	43.4	1.8	0.2
- Articulated	42.1	3.7	0.5
Bus	63.7	12.7	0.6

  - For light vehicles, the incident rates were adjusted to account for the activities being undertaken in rural areas.
  - Exclusion of “young drivers” (17-20 year olds)

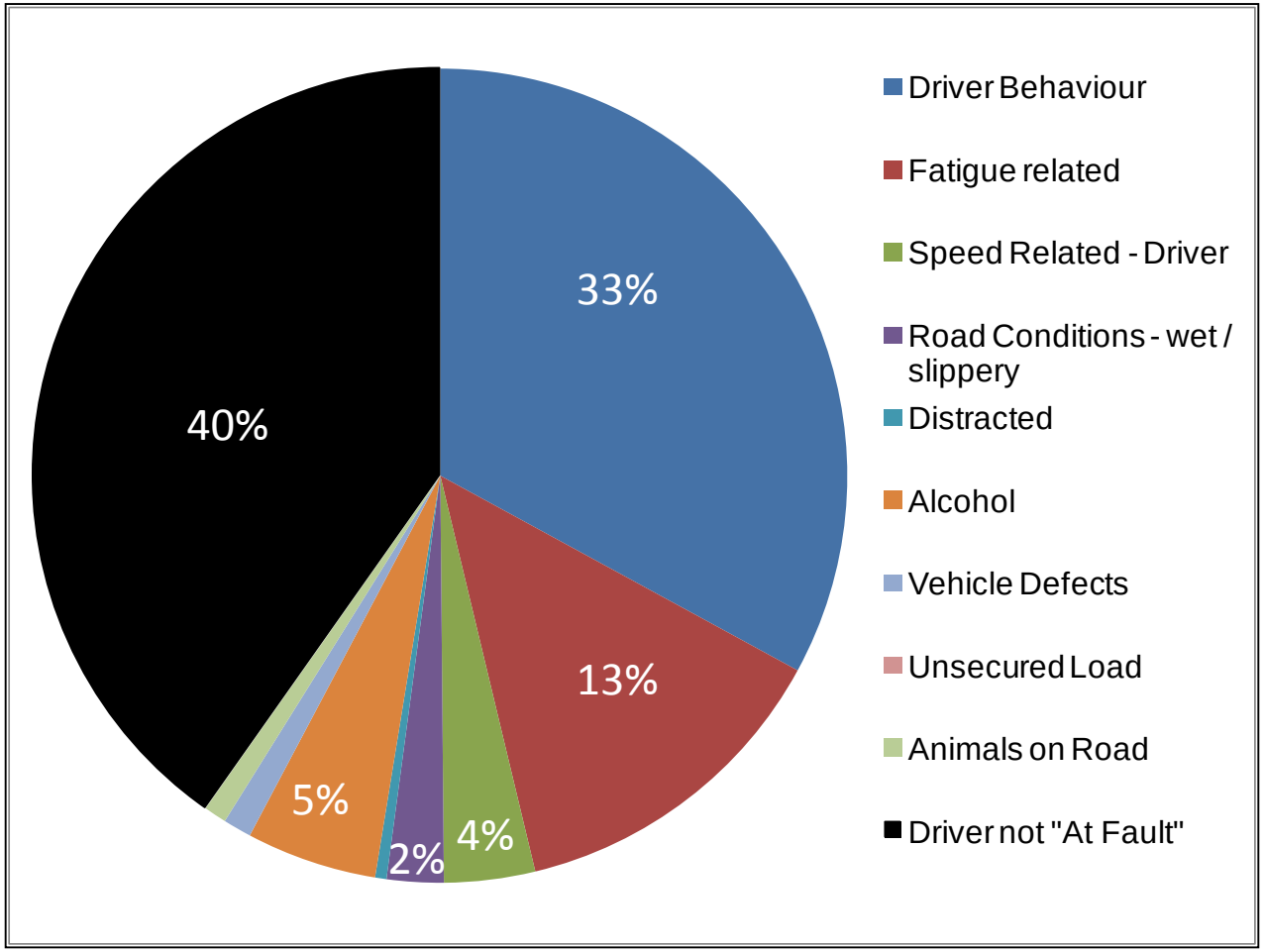
Base Contributing Factors

- Factors contributing to the cause / severity of crash
  - Obtain a ***complete set*** of accident data, specific to the study area

- Factors contributing to serious injury / fatal crashes:
  - *Driver Behaviour (illegal manoeuvre, dangerous driving)*
  - *Speed-related, Fatigue-related*
  - *Alcohol / Drink-driving*

- "Uncontrollable" circumstances
  - Lighting
  - Atmospheric conditions
  - Medical conditions
  - Other road users

Base Contributing Factors

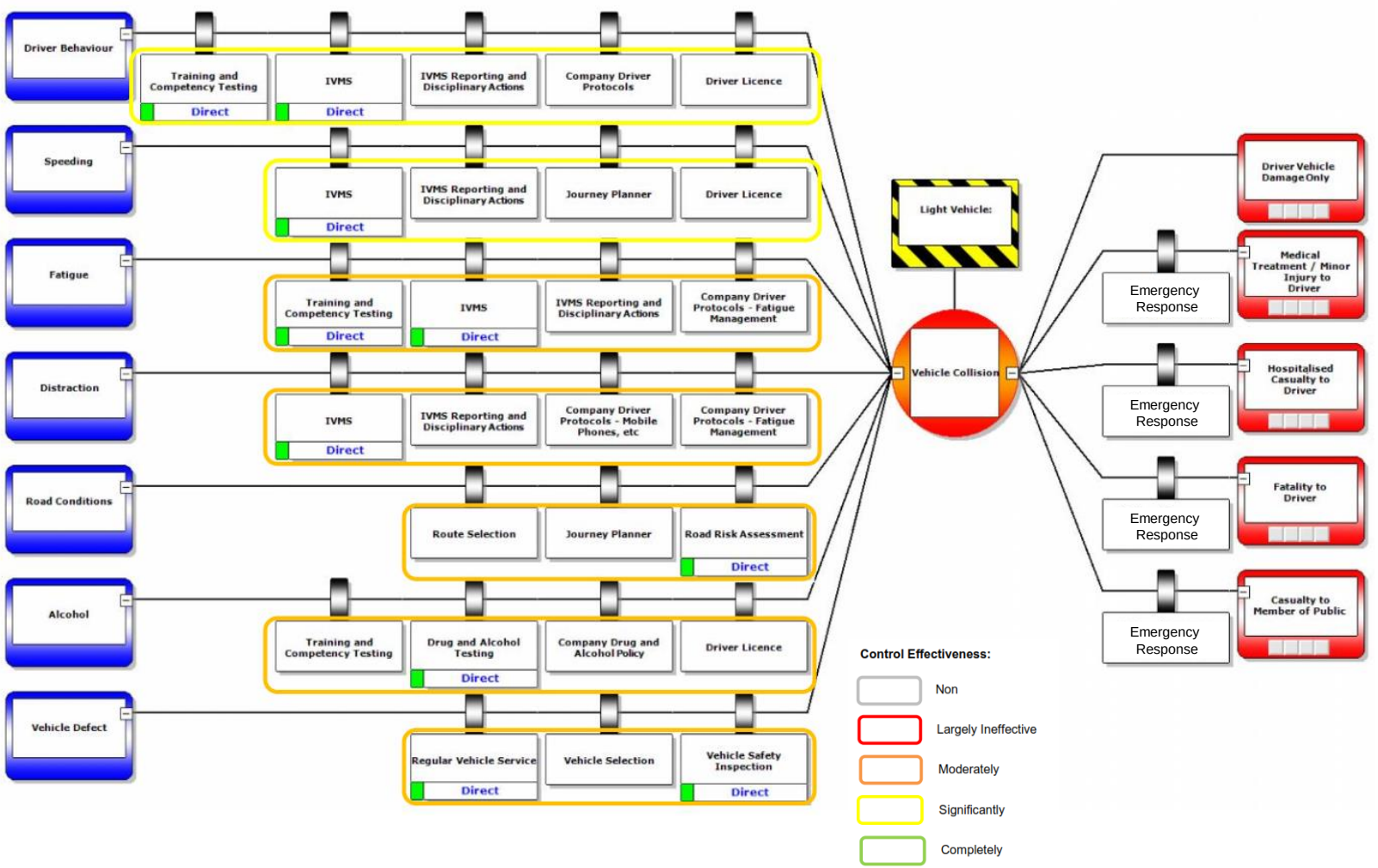


Bowtie Development

- Bowties developed for the various sub-groups involved in road transportation
  - Light Vehicles, Heavy Vehicles
  - Employees, Contractors, Sub-contractors

- Potential Outcomes considered
  - Driver injury and fatality
  - Impacts on other road users
  - Passenger injury and fatality

Bowtie Example



Control Effectiveness

- The effectiveness of controls was assessed for the various activities
- Identification of "*Direct*" Controls
  - Improve accident performance, relative to the public (e.g. IVMS)
- Effectiveness of each "*Direct*" control was estimated
  - Reduction in risk, relative to the general public
- Controls that were not considered to improve accident performance relative to the general population were not assigned a risk reduction
  - e.g. Driver's licence

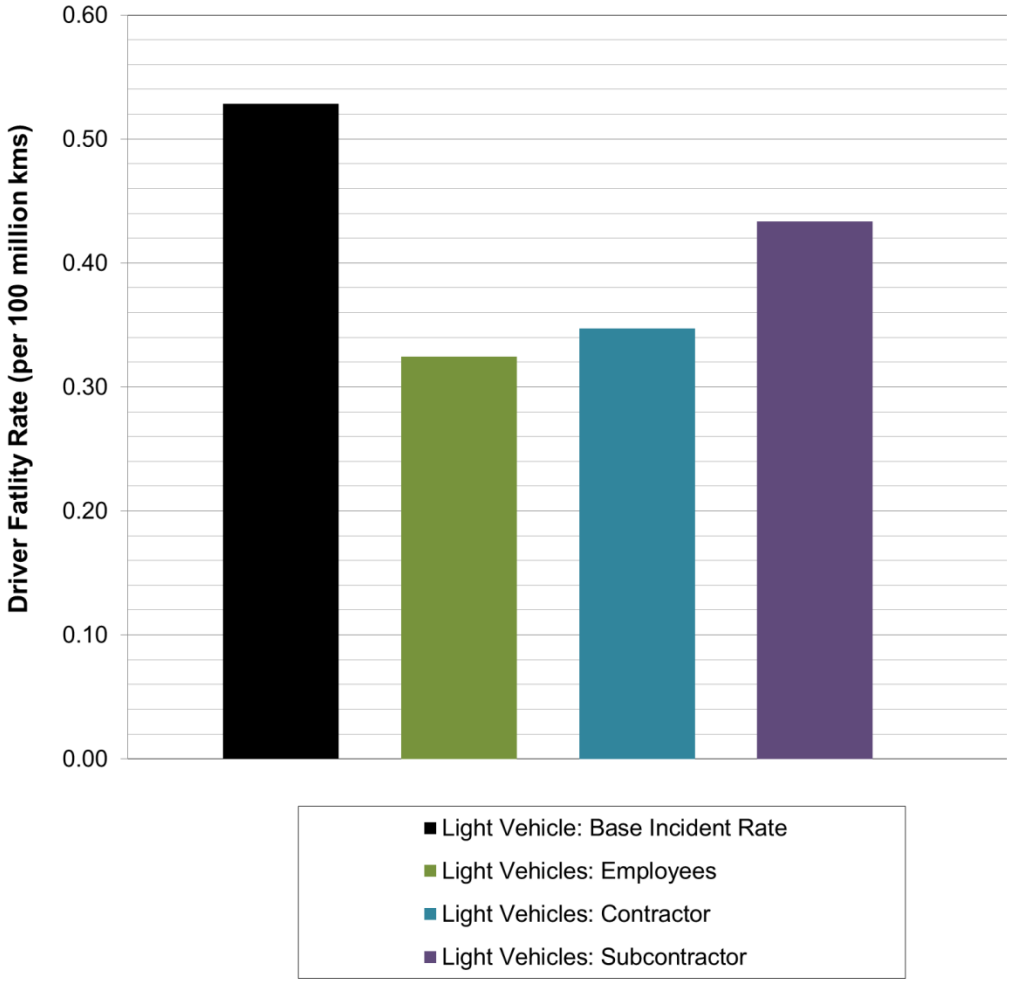
Adjusted Contributing Factors

- Incorporation of control “effectiveness” into the model
- **Controls** were linked with *contributing factors*
  - e.g. **IVMS Fatigue Management** linked to *Fatigue-related*
- The effectiveness of each control was ranked, based on its ability to influence the *contributing factors*
- *Control effectiveness* incorporated into the model by reducing the influence of the linked *contributing factors* on the incident rates (reducing the overall incident rate)

Adjusted Contributing Factors:

- Adjustment factors were based on the *Control Effectiveness*
- *Controls* were linked with *Contributing Factors*
- The control effectiveness was used to “adjust” the overall incident rate
  - Adjusted for each individual *Contributing Factor*
  - Determination of the overall “adjusted” incident rate
- Incident Rate reduction: ~10% to 40%

Adjusted Incident Rates: Driver Fatality Rate



Distances Travelled

- Input data: Projected distances travelled
- Distances for each type of vehicles
- Distances for each sub-group / activity

Risk Profile

- Risk Profile metrics:
  - Estimated Driver fatalities per year
  - Estimated Driver hospitalised casualties per year

- Values estimated for
  - Vehicle types
  - Activities / sub-groups
  - Overall

Risk Profile

			Likelihood				
			A	B	C	D	E
			Unlikley: Less than once in 10,000 (10-4) years	Rarely/seldom: Once in 1000 to 10,000 (10-2 to 10-4) years	Possible during lifetime of plant: Once in 10 to 1000 (10-1 to 10-2) years	Probable, event has occured: Once in 1 to 10 years	Regular: more than once per year
Consequence	1	Negligible personal injurie(s) (near miss, MTC, first aid)	L	L	L	L	M
	2	Personal injurie(s) with lost work time (LTI)	L	L	L	M	H
	3	Serious injuries(s) causing disablement	L	M	M	H	H
	4	One fatality	M	M	H	H	H
	5	More than one fatality	M	H	H	H	H

Heavy Vehicle Driver Fatality

Light Vehicle Driver Fatality

General Findings

- Risk associated with road transportation activities was ranked as “High”
- Large proportion of incidents attributed to behaviour of “other driver”
  - Large risk reduction difficult to achieve
- Light vehicle movements presented a greater risk than heavy vehicle movements
  - Greater distances travelled by light vehicles
  - Similar base fatality rates
  - Lower adjusted fatality rates for heavy vehicles
- Certain Contributing Factors are more readily managed:
  - Driver behaviour
  - Fatigue
  - Speed

Potential Risk Reduction

- Improving controls only achieves a limited risk reduction
  - Large proportion of incidents are outside the control of the driver
- Distance Travelled is a key factor dictating the risk profile
- Major risk reduction only achieved by reducing exposure, i.e. reduce distances travelled
  - Efficient use of vehicle
  - Minimisation of unnecessary trips
  - Use buses to replace multiple light vehicle journeys

Thank you