Proactive Traffic Safety Evaluation : Advanced Methods and Tools

Presentation by

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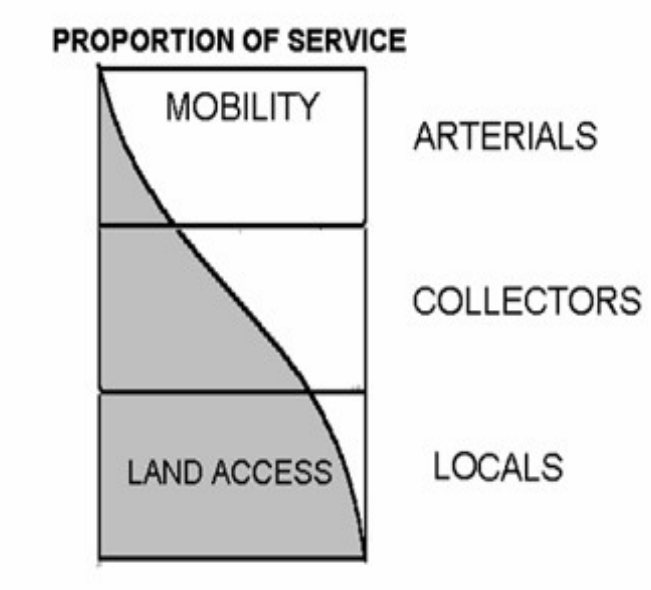
Lecture Outline

- Objectives of Road Transport Infrastructure
- Road User Behaviour and Risk Factors
- Proactive Traffic Safety Evaluation
- Surrogate Safety Measures : Challenges
- Safety Evaluation by using advanced tools
- Research to Practice

Objectives of Road Transport Infrastructure

- Safety is the primary objective
- Speed (Higher speed means shorter travel time)
- Comfort – Involves the physical characteristics of vehicles and roadways
- Convenience – The ease of making trips and the ability of transport systems to accommodate all travel needs (accessibility)
- Economy – Try to provide the best possible systems for the money
- Environmental compatibility – Provide sustainable transport systems



HADDON MATRIX : ROAD CRASH

	Proactive	Reactive	
Elements	**Before Crash**	**During a crash**	**After a crash**
Human	Training; education; behavior (e.g. not drinking or speeding); attitudes; pedestrians and Cyclists behavior	Wearing in-vehicle restraints	Prompt emergency medical service response
Vehicle	Primary safety (e.g. good brakes, roadworthiness, visibility, age)	Secondary safety (e.g. occupant protection)	Devices to attract attention (e.g. mobile phone, horn)
Road	Delineation; good road geometry; good surface condition; visibility; safe speed environment	Roadside safety adequate crash barriers	Emergency median breaks and shoulders provided on freeways

RSA /SSM

(Haddon, 1980)

Road user diversity behaviour

The traffic engineer has to design and operate the traffic facilities which will be used by pedestrians, cyclist and motorists.

A knowledge of how this behaviour is influenced by various external conditions will be useful in designing the facility.

Diversity (Behaviors) : Driver and other roads have widely varying characteristics.

Traffic controls could be easily designed if all drivers reacted to them in exactly the same way.

When you hear the phrase **“Risk Factors”** – What comes to your mind?

First reaction?

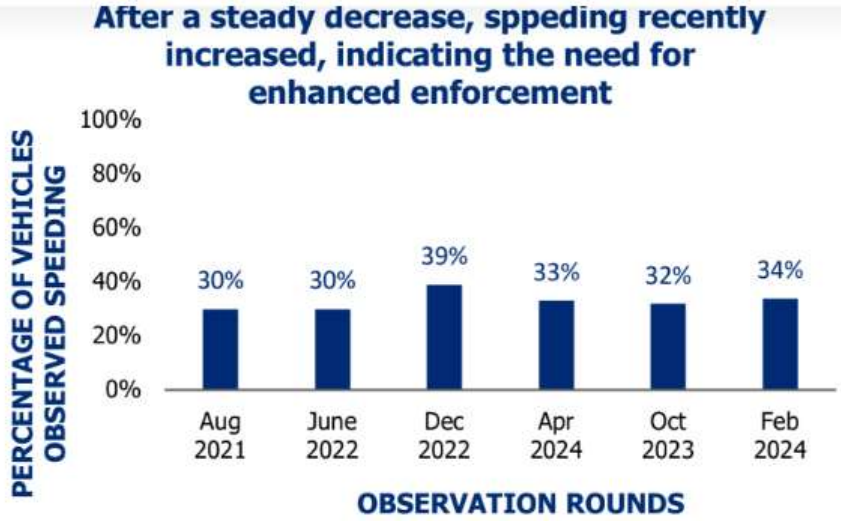
What Are The Risk Factors?

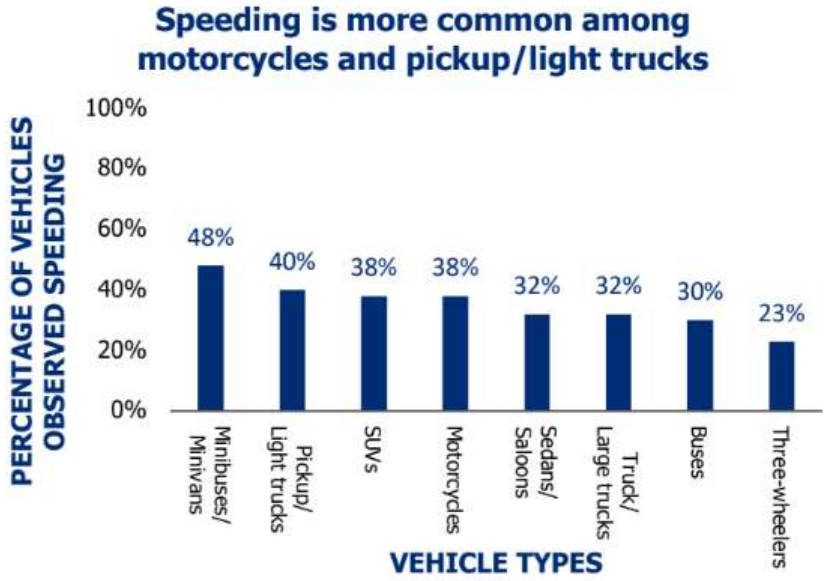
Understanding Risk Factors Key To Prevention

Risk factors for Road Traffic Injury

- Speeding
- Lack of restraint system
  - Seat – belt
  - Car seats for children
- Lack of helmet use
- Drunk and driving
- Use of mobile phone while driving
- Roadside objects

Mumbai – Speeding behavior





RECOMMENDATIONS

- Enhance enforcement efforts, focusing on:
  - Local and collector roads.
  - Minibuses/minivans and pickup/light trucks.
  - Government and private vehicles.
- Implement targeted control measures, such as increased surveillance and speed limit signage.
- Implement mass media-campaigns in coordination with enhanced enforcement efforts, emphasizing the dangers of speeding.

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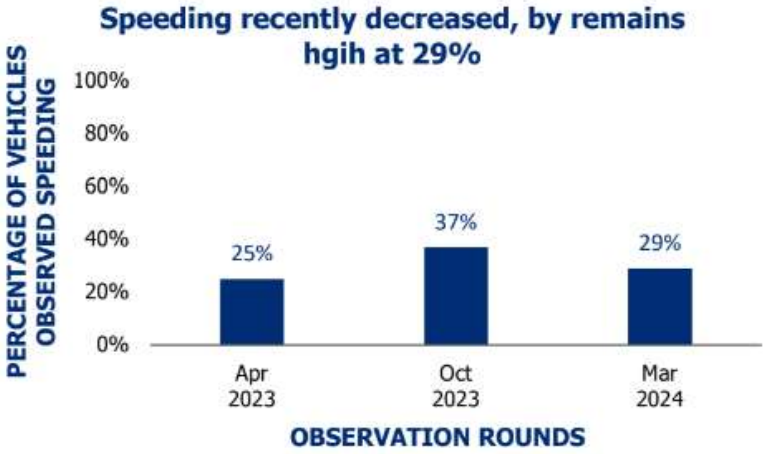
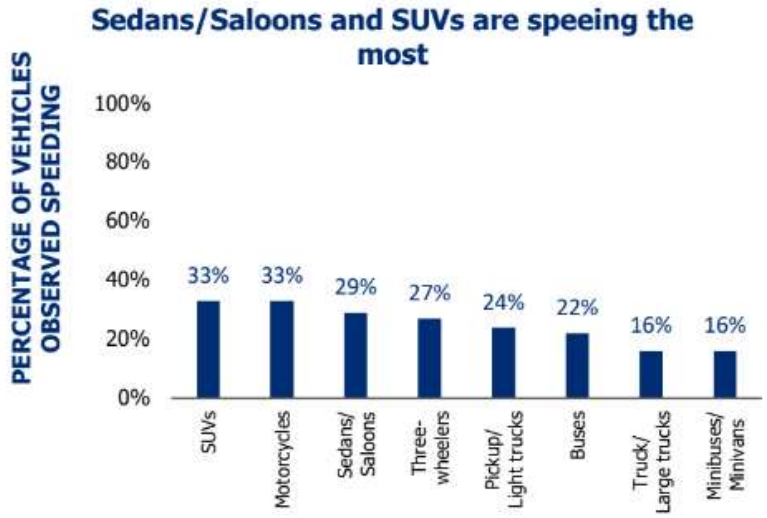
Pune – Speeding behavior





RECOMMENDATIONS

- Enhance enforcement of speed limits throughout the week, focusing on:
  - SUVs and motorcycles.
  - Government and private vehicles.
  - Arterial roads
- Advocate for enforcement of penalties and fines for all vehicles exceeding the speed limit according to the Motor Vehicle (Amendment) Act 2019 (MVAA 2019)
- Make enforcement operations regular, visible, and widespread
- Implement speed-calming measures, such as bumps, rumble strips, safe speed signage, and designation of low-speed areas to protect vulnerable road users (pedestrians, bicyclists, and motorcyclists).
- Implement mass-media campaigns in coordination with enhanced enforcement efforts, emphasizing the dangers of driving at unsafe speeds

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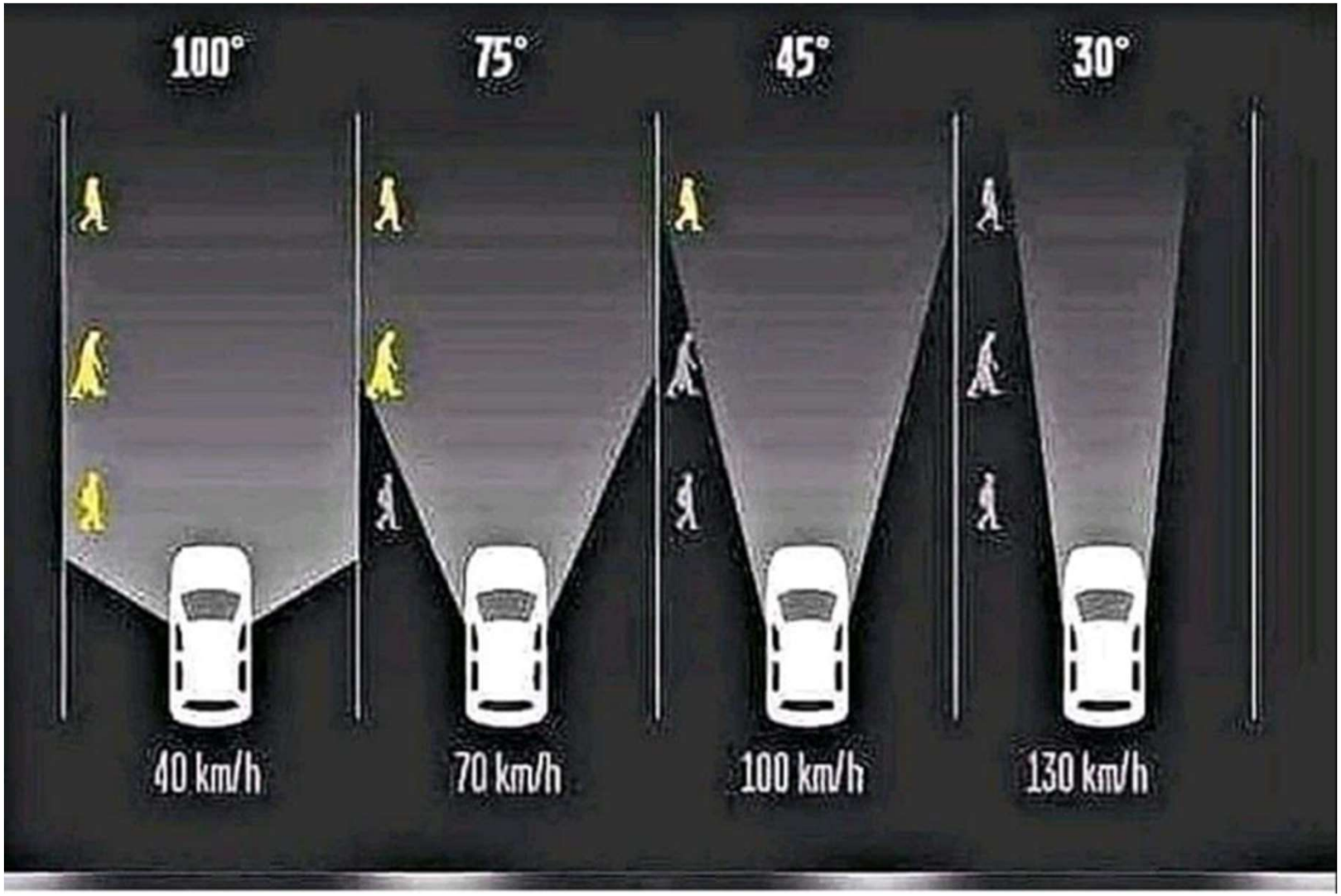
International Injury Research Unit

Speed – Driver Vision



Event

EFFECT OF ALCOHOL ON DRIVING

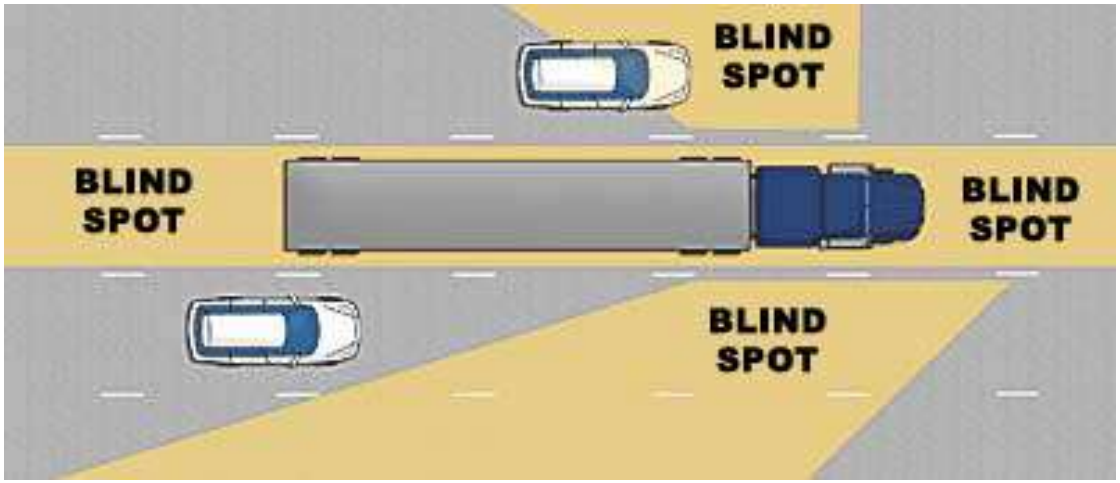
1. The interpretation and judgment power of the brain is affected. In case of some emergency, you have to take 4 to 5 decisions or actions simultaneously. While after alcohol one is able to deal only one thing at a time.

2. The brain-eye co-ordination that ensures an immediate and appropriate response during unusual situations on road is delayed by 20-30%.

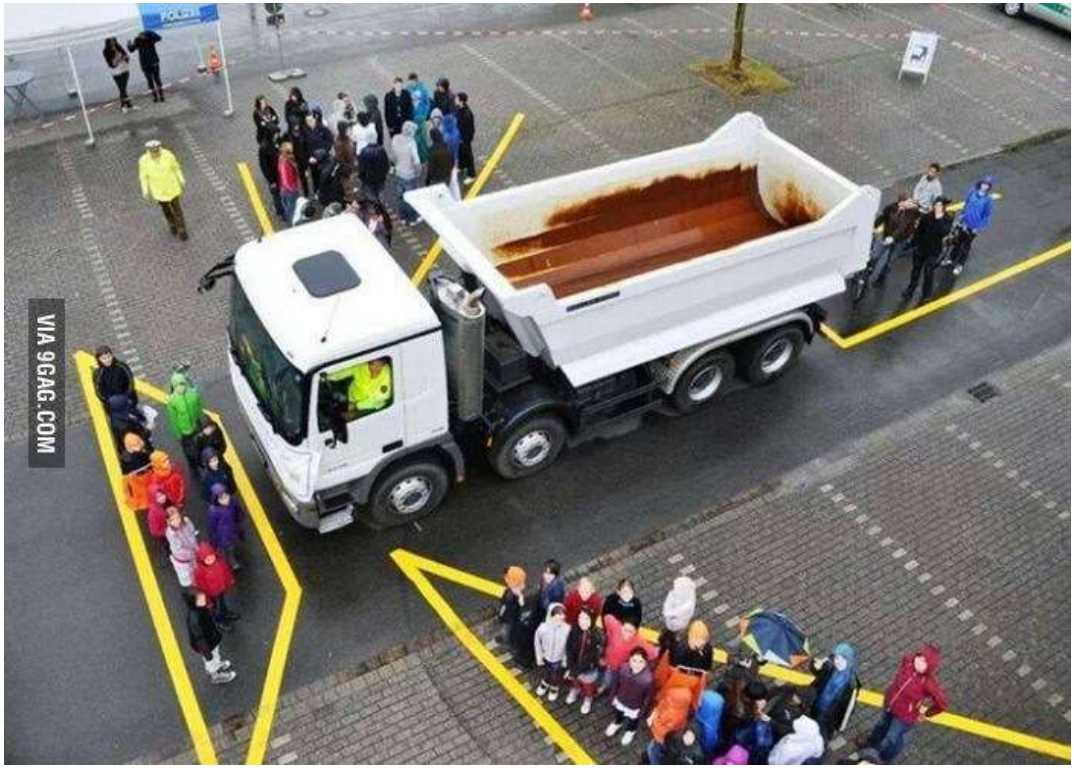
3. The risk taking tendency increases under influence of alcohol like for over speeding or overtaking .

4. It causes blurred vision or reduces vision up to 25%.

Blind Spot



To all who don't drive trucks , if you were sat in the drivers seat of this truck you would not see any of the people in the yellow stripes . So next time you think



Need for Proactive Approach

Traditionally, safety of any transportation facility has been evaluated using crash data.

Crash Data Limitations:

- Crash data may not be available, there may be under reporting
- Crashes are low in number: therefore statistically unreliable.
- Crash data is generally based on multiple resources
- Lack of details for analysis: pre crash process
- Unethical to let accidents occur

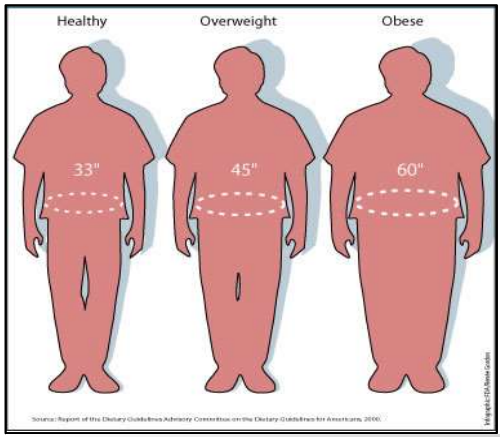
There is a need to identify other methods that can be used to evaluate safety in more effective and proactive manner.

Concept of 'Surrogacy'

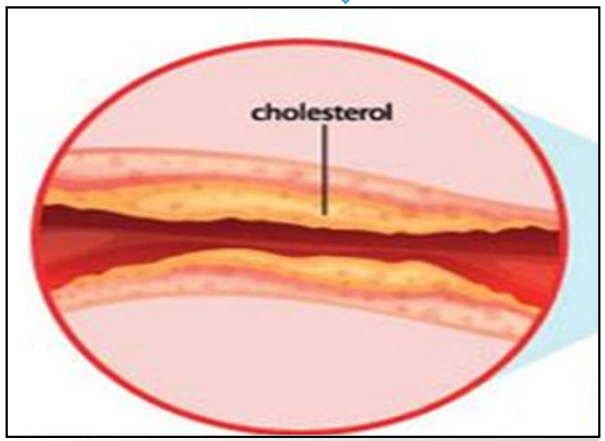
Healthy Man

Heart Disease

Surrogacy in Traffic



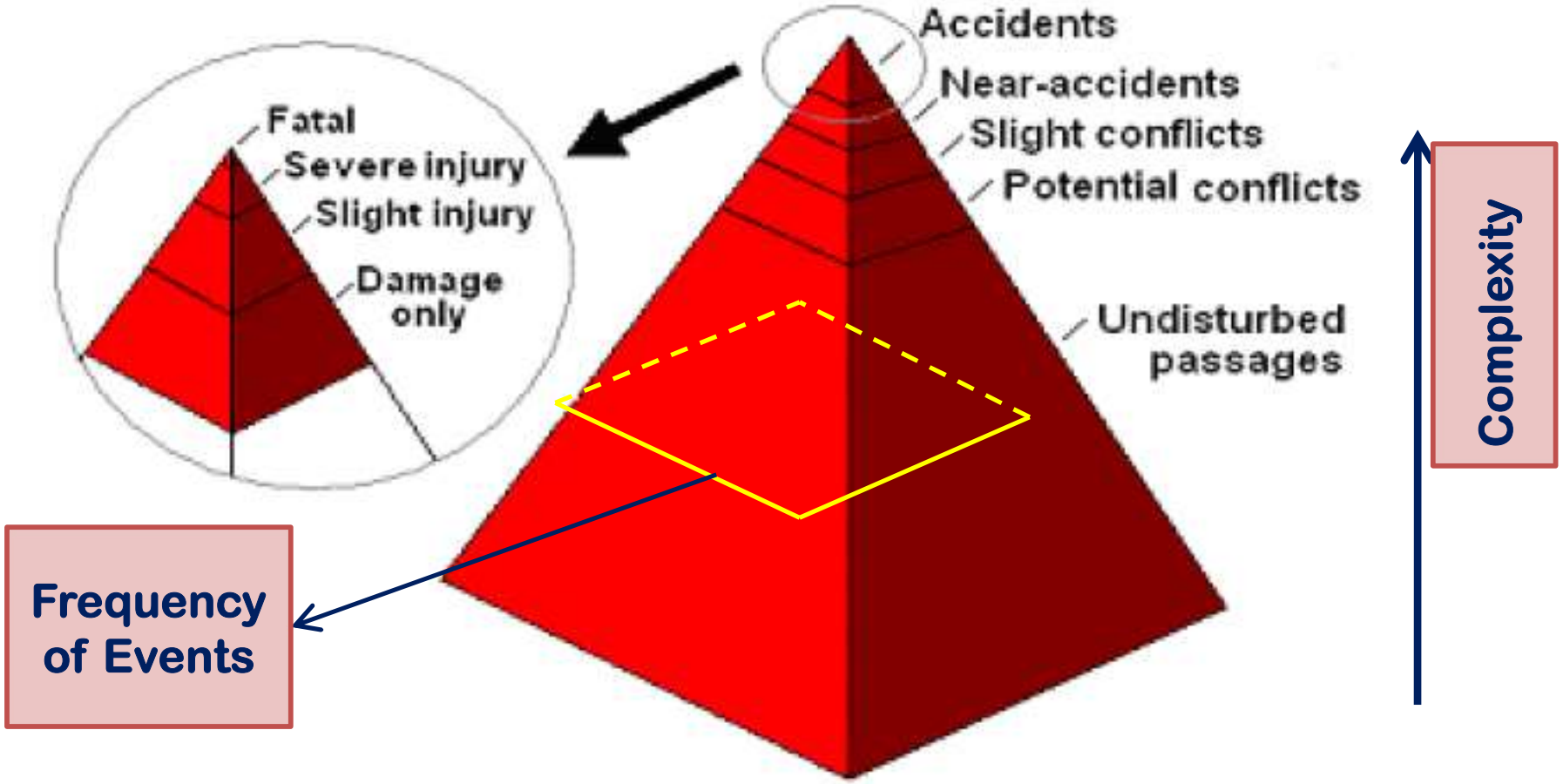
Depends on Body Mass Index



Lipoprotein Cholesterol level in blood

Indicator ?

Safety Hierarchy



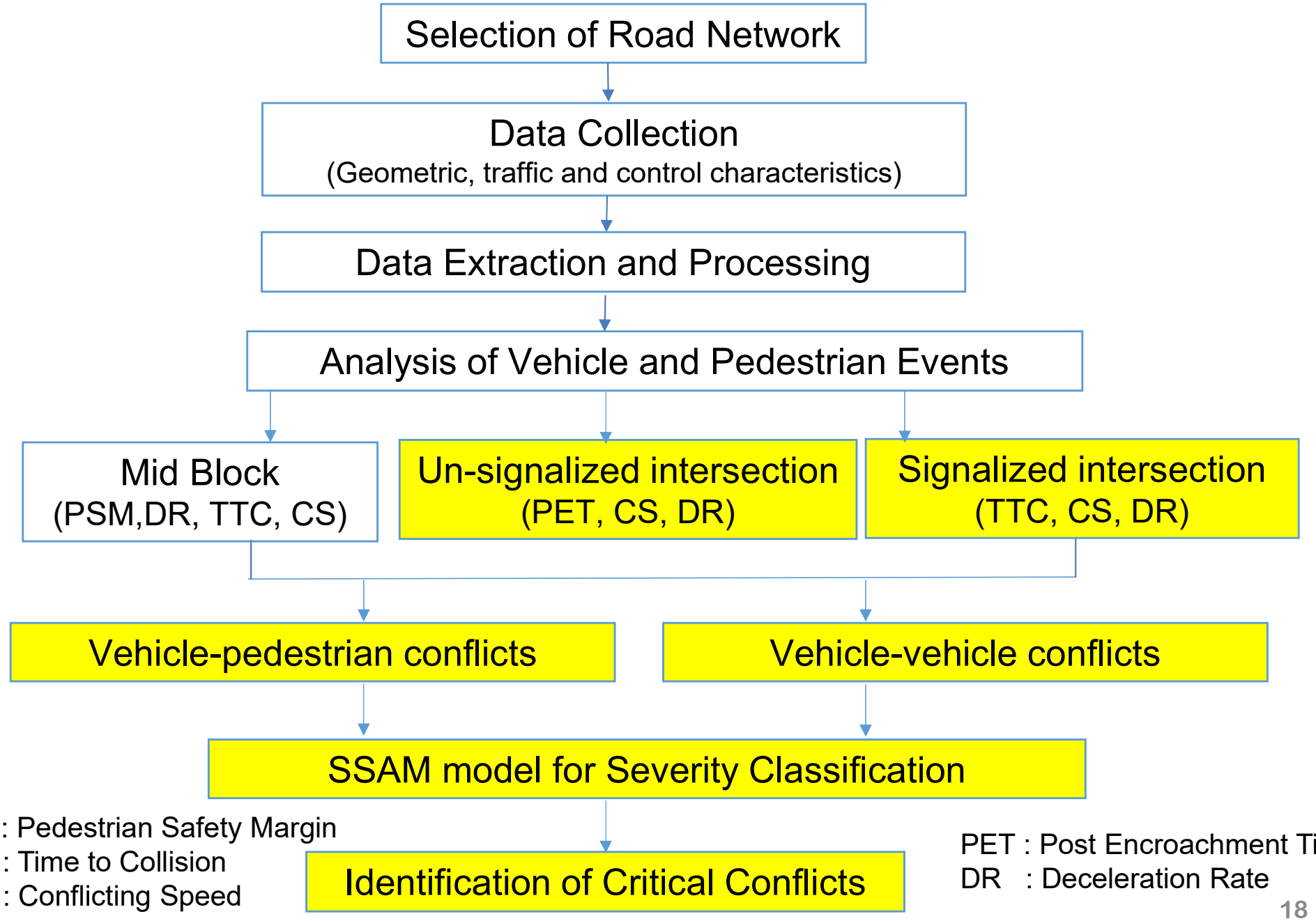
Hyden Safety Pyramid

SSM : Issues and Challenges

Goal : Proactive safety evaluation of different traffic facilities using SSM

- How to identify suitable SSM for various traffic facilities ?
- Whether to use the selected indicator individually or in aggregation ?
- How to collect and estimate accurately the selected SSMs ?
- Procedure for realistic severity levels/threshold limits for critical conflicts, suitable for Indian traffic conditions.

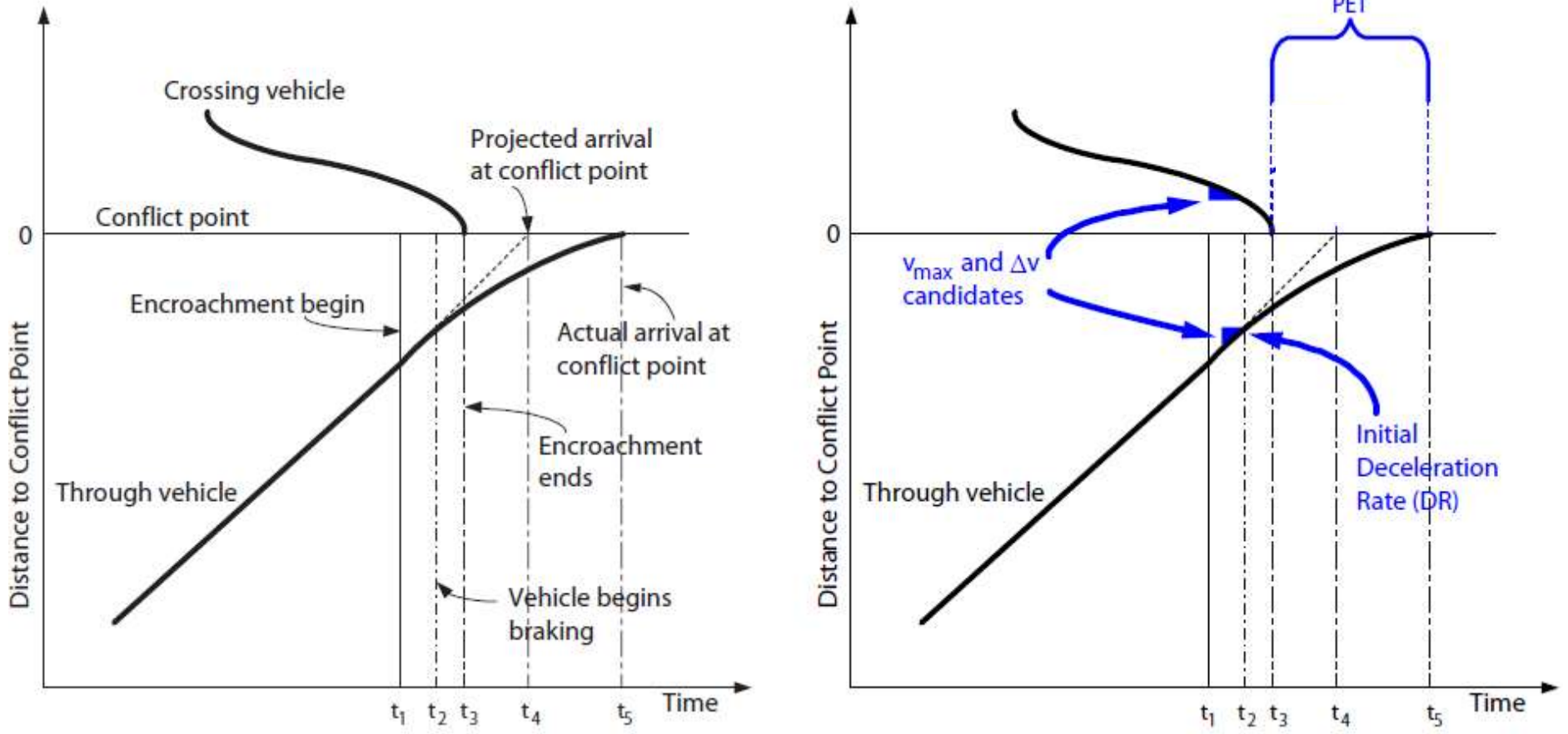
SSAM Study Framework



PSM : Pedestrian Safety Margin
TTC : Time to Collision
CS : Conflicting Speed

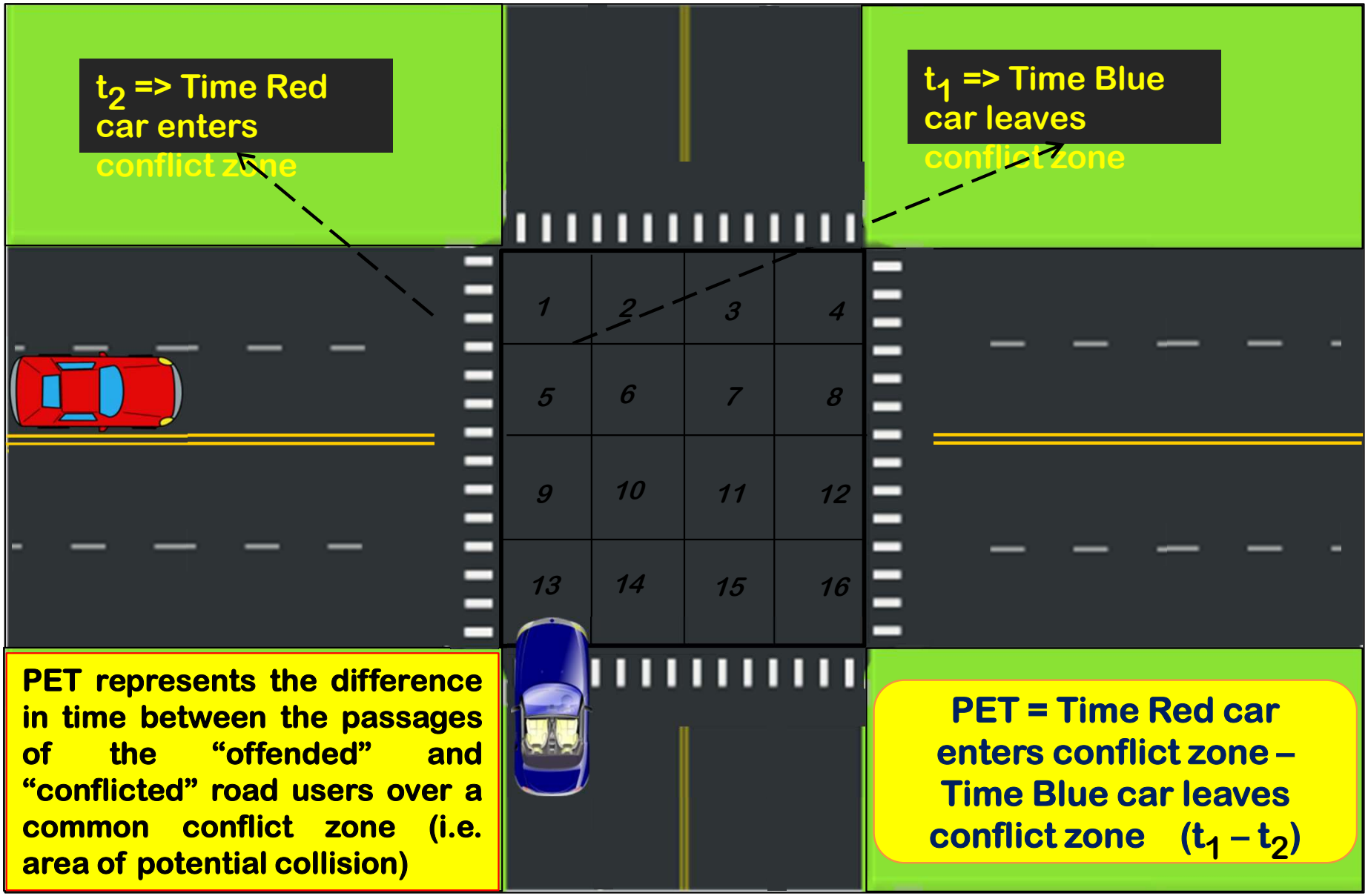
PET : Post Encroachment Time
DR : Deceleration Rate

Uncontrolled Intersection SSM Indicator



t_1: The crossing vehicle enters the encroachment area (i.e., starts to turn right).
t_2: The through vehicle realizes that a collision might occur
t_3: The corner of the rear bumper of the crossing vehicle leaves the encroachment point.
t_4: The through vehicle was projected to arrive at the conflict point if the vehicle continued at the same speed and trajectory before it started braking.
t_5: The through vehicle actually arrives at the conflict point.

Post Encroachment Time (PET)



SSM Data Collection

Midblock pedestrian crossing

Unsignalised Intersection

Roundabout Intersection

Signalised Intersection

Data Collection by Videographic Method

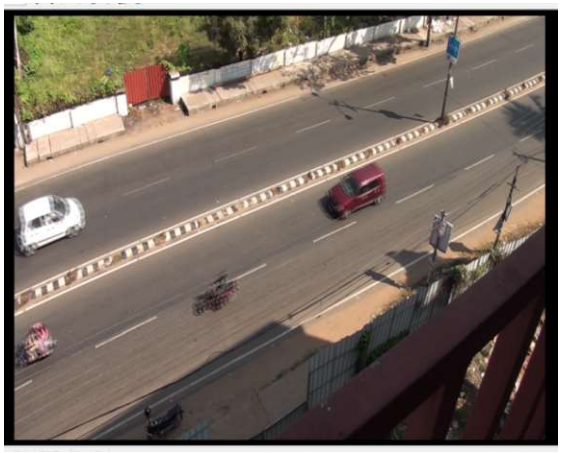
Camera view

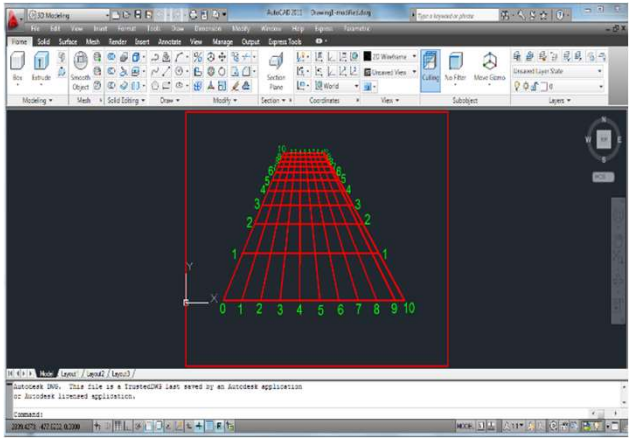
UAV (Unmanned Aerial Vehicle- Drone)

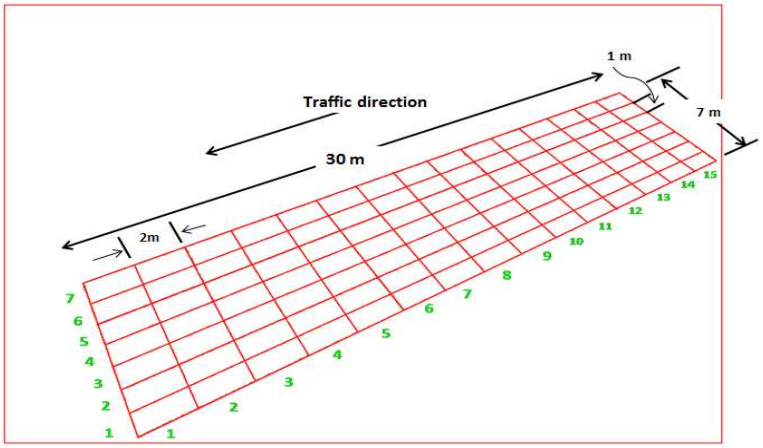
Sample video at Mannanthala Roundabout Intersection, Kerala

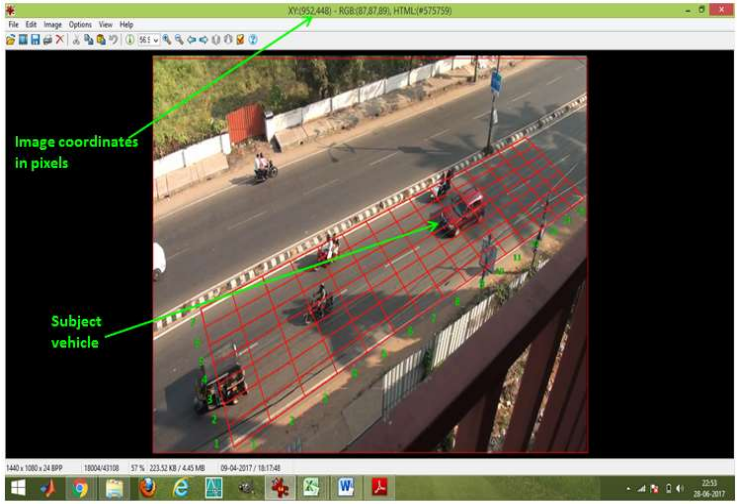
Drone based Snapshot of Roundabout Junction

SSM Data Extraction



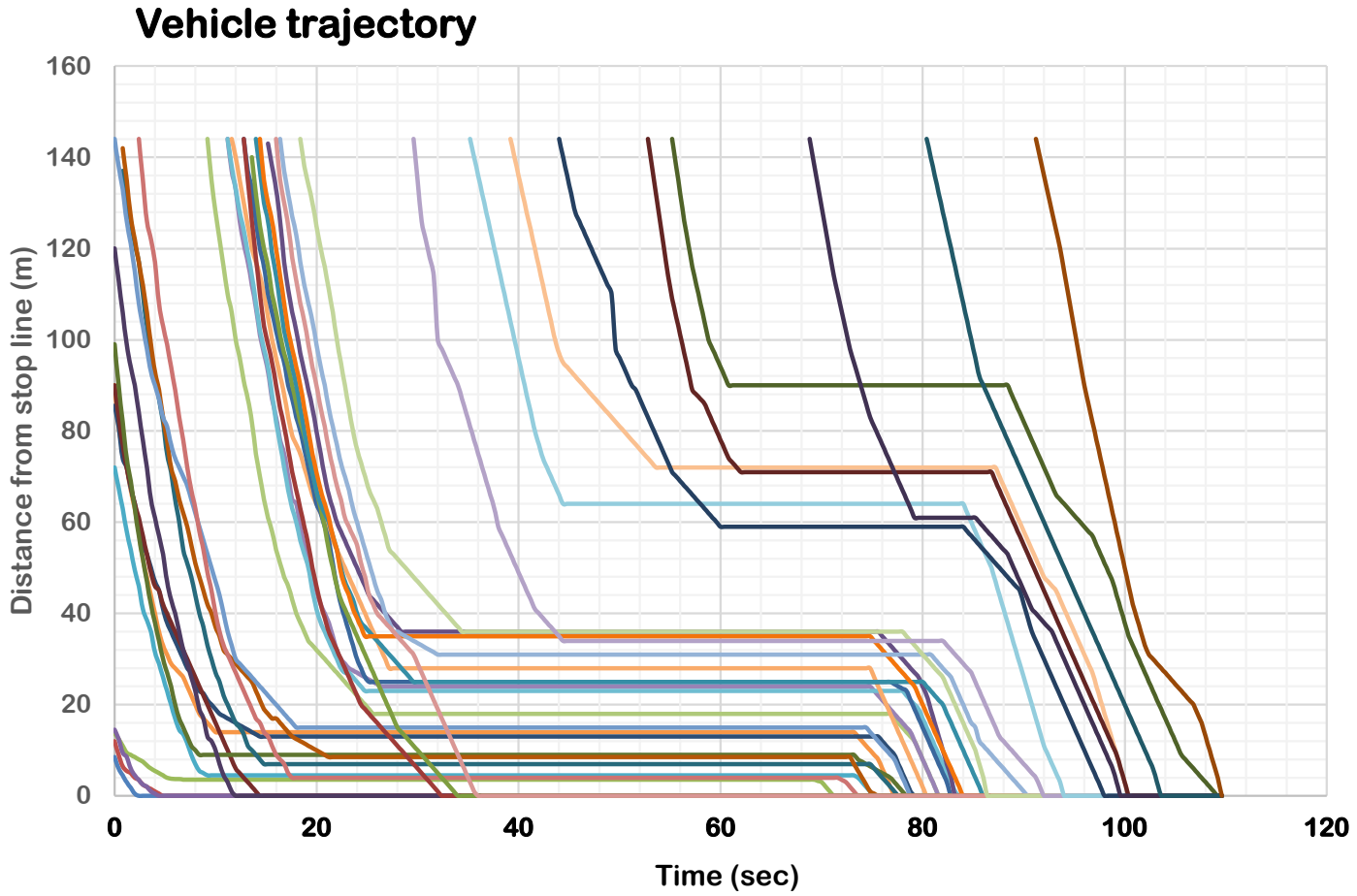






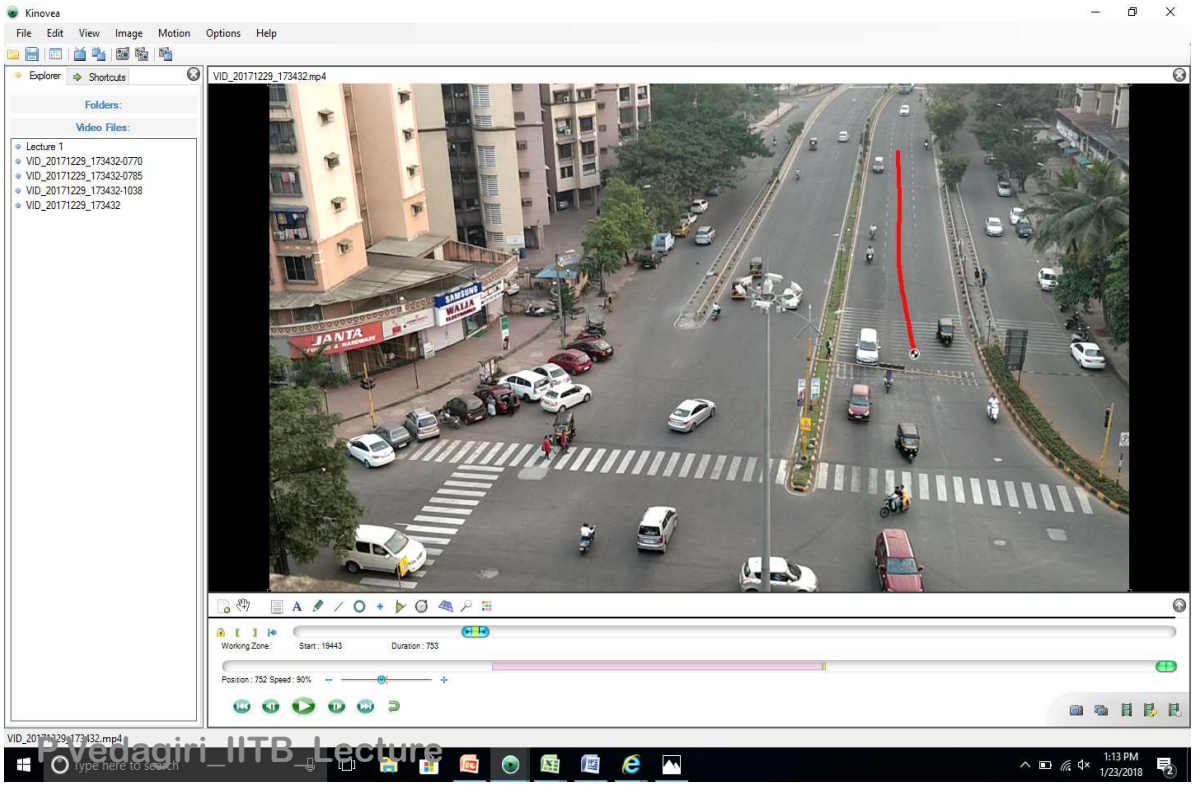
Vehicle Trajectory

A **trajectory** is the path that a moving object follows through space as a function of time. The object might be a vehicle or a pedestrian.



Defining Origin – Perspective Grids

User Interface



Pedestrian Vehicle Trajectory

Video V-Box

Set up

Results

- It combines a 20 Hz VBOX GPS data logger with a 4 camera video system.
- Logs directly to SD Card

Research to Practice by using Advanced Tools

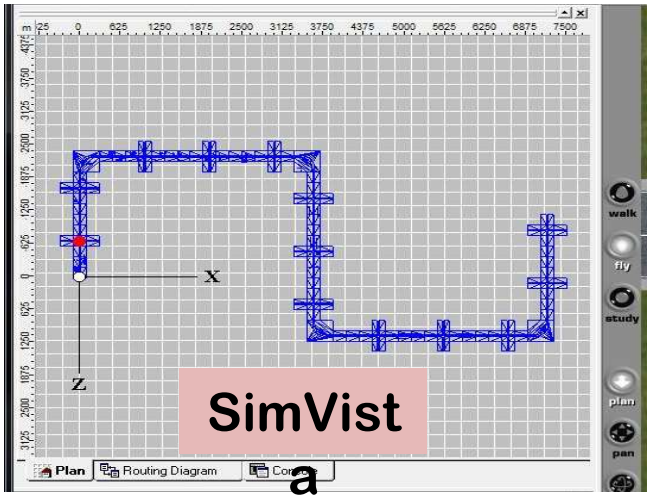
Driving Simulator

- Sometimes it is difficult to collect adequate number of observations from the field setting in certain context
- Driving simulator offers controllability over the things that are difficult to handle in real field environment

- Fixed base simulator
- 6 channels image generation, 3 forward views and 3 rear-view mirrors
- 150 degrees field of vision
- ABC pedals, Manual gear transmission

TSE lab, IIT Bombay

Scenario design and development

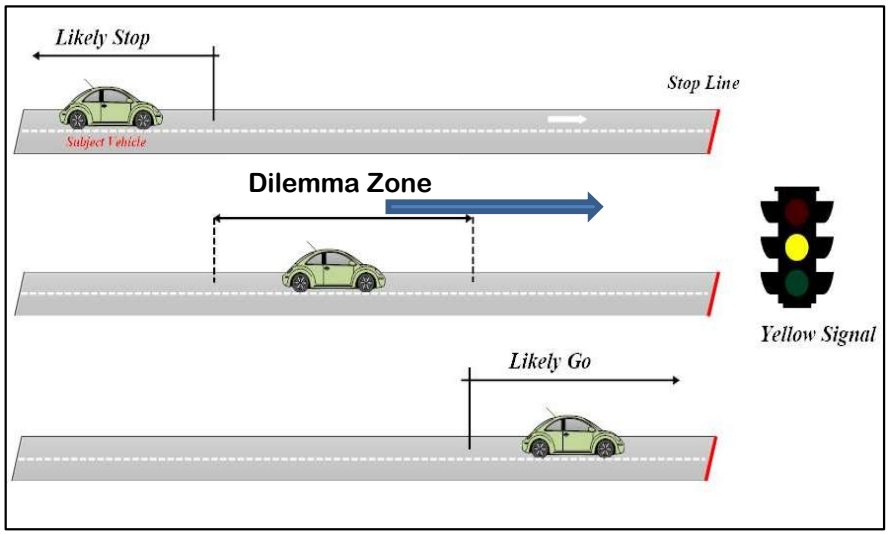


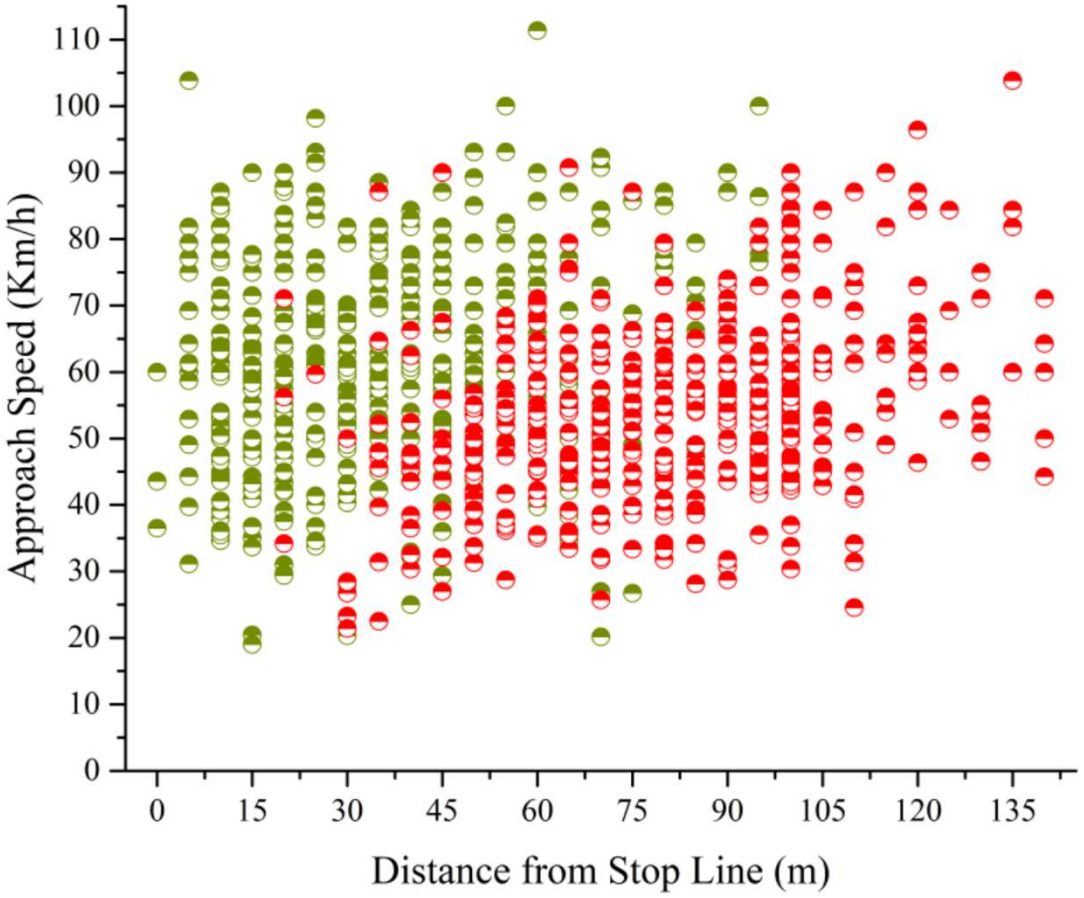
SimVista

SimCreator

Driving Simulator

Dilemma Zone at Signalized Intersections





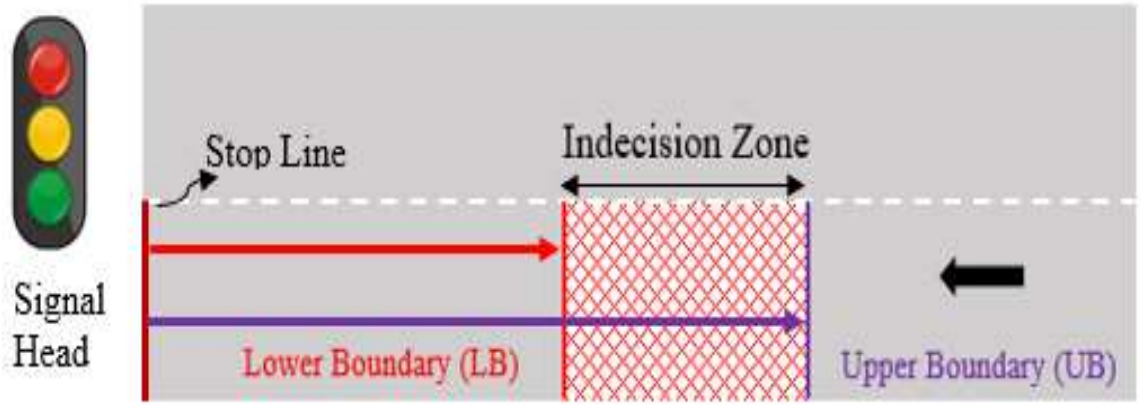
Cross

Stop

Proposed Dilemma Zone Countermeasures

(i) Dilemma zone road marking

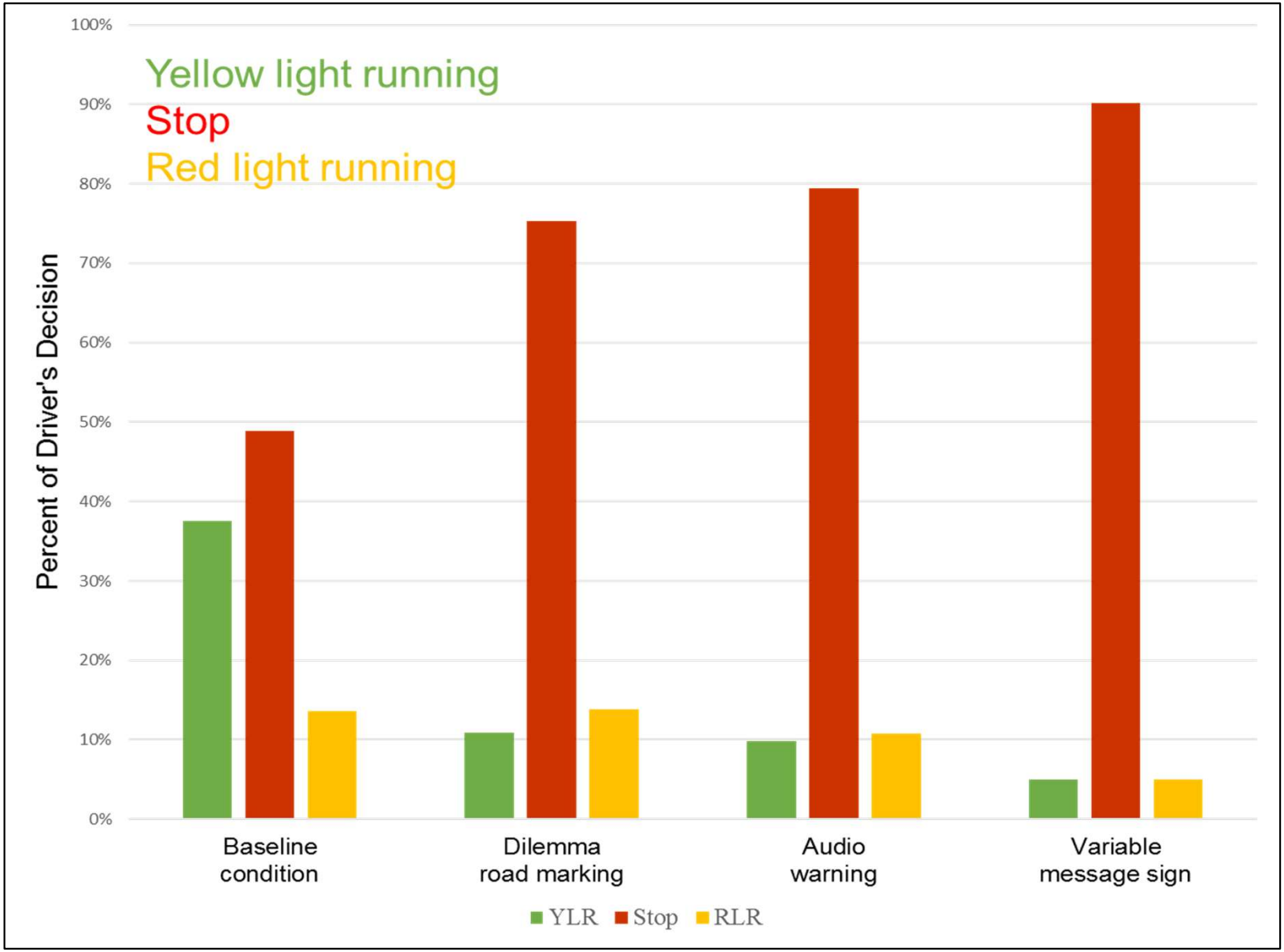
Perception towards speed deduction & Warning



(ii) Variable message sign
(Provide advisory information)

(iii) Advance In-vehicle audio warning system
(Provide advisory information)

Observed Driver Responses from Driving Simulator Experiments



Implemented safety counter measures at various stretches

Two Wheeler and Truck Simulators at IITB

Evidence Based Policy Reformation to Strengthen Motorized Two-Wheeler Users' Safety : GRSP AND IITB

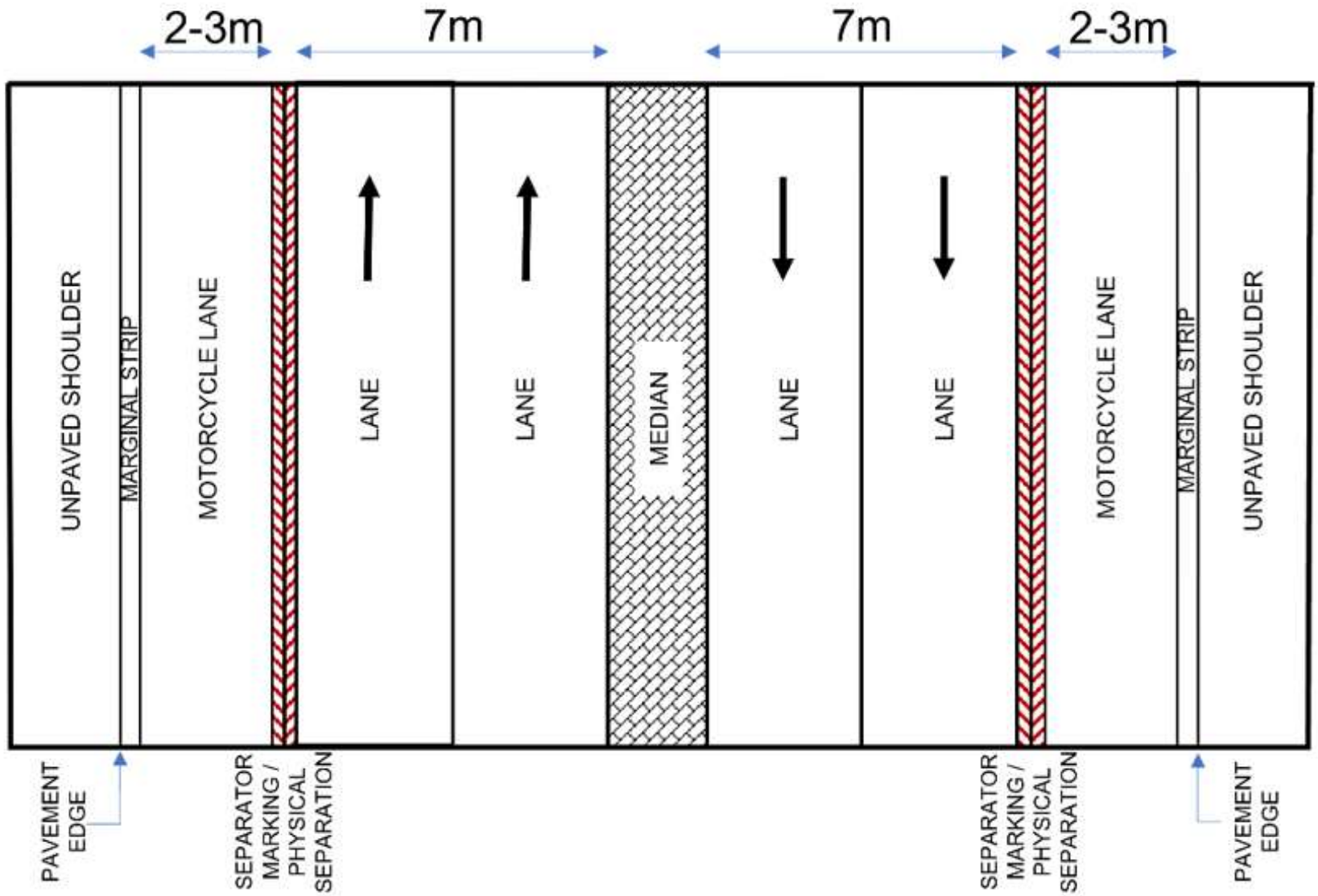
Infrastructure measures

- Mid-block sections: **Implementing Exclusive Motorcycle Lanes** may be beneficial in reducing conflict and ensuring the smooth flow of traffic, as observed in the case of several regions of Malaysia, Taiwan, and Jakarta

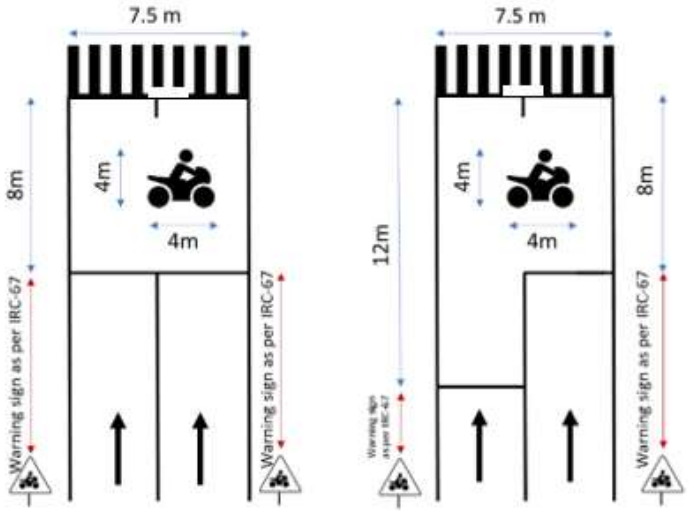
- Intersections: **Implementing Motorcycle Boxes** (P-type or box-type motorcycle box) can be provided at the intersection so that MTWs get a dedicated stopping area at intersections which helps reduce the conflict and gives them a head start as the signal turns green.

GLOBAL ROAD SAFETY PARTNERSHIP

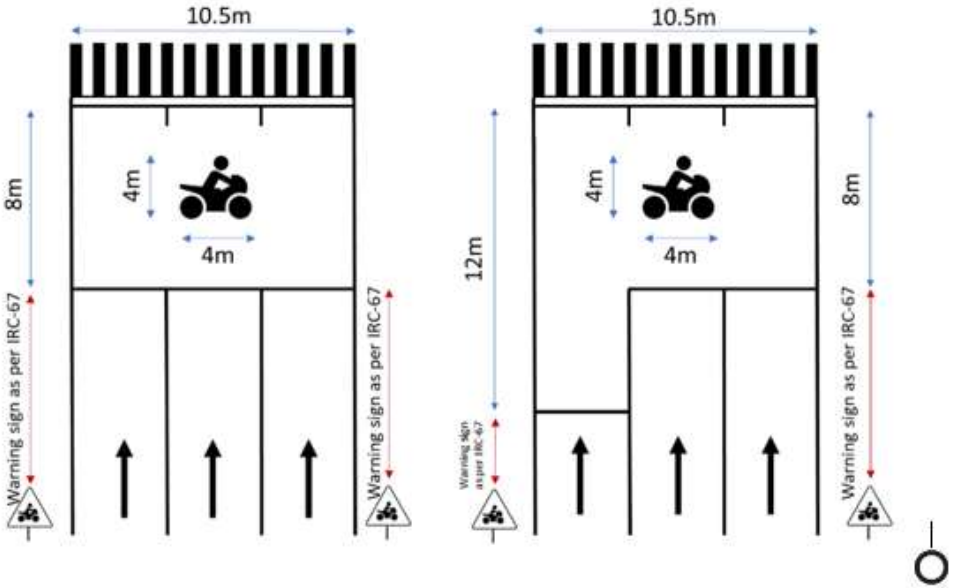
Implementing Exclusive Motorcycle Lanes



Implementing Motorcycle Boxes

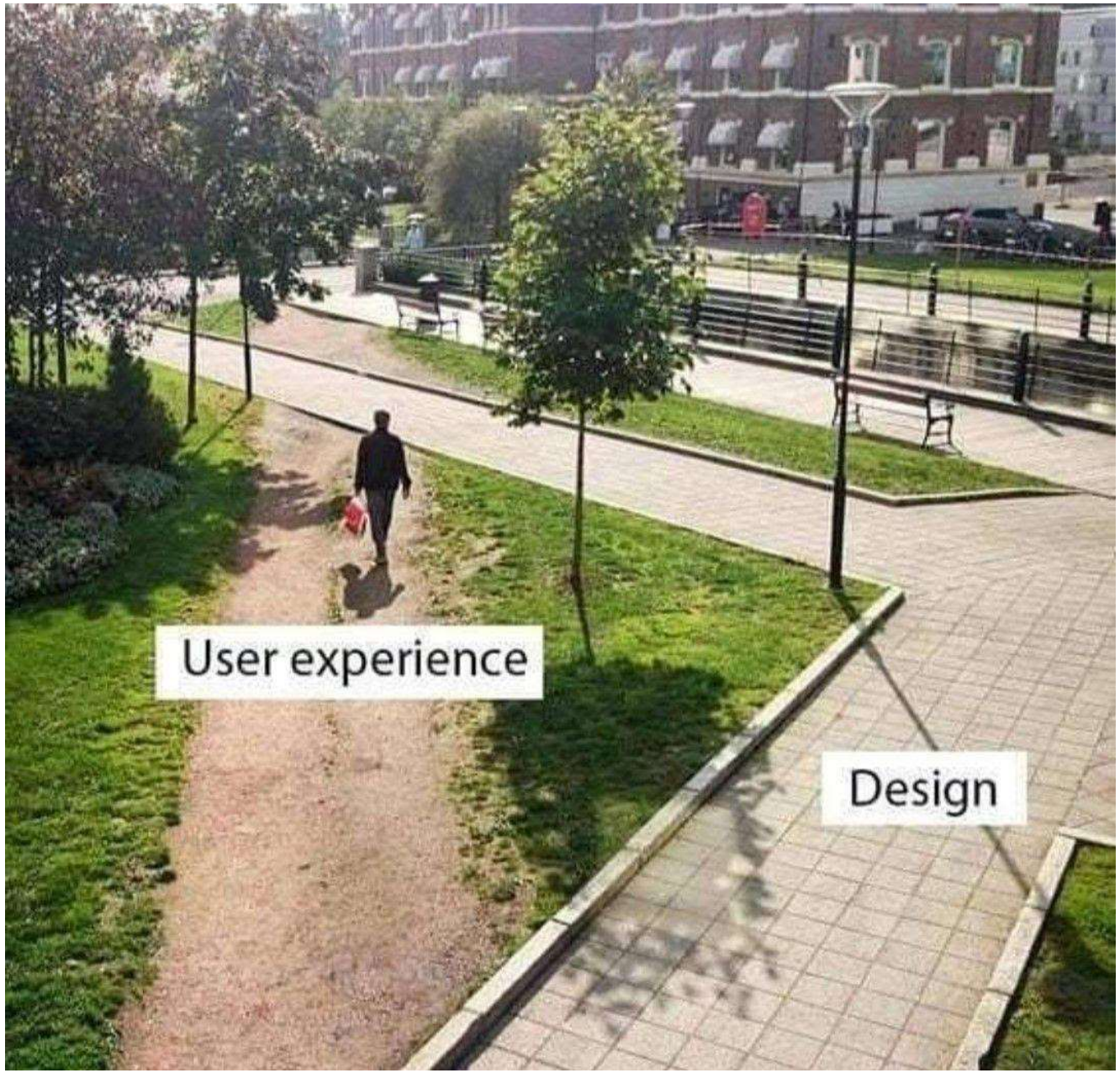


(a) Four-lane divided carriageway (Box and P-type)

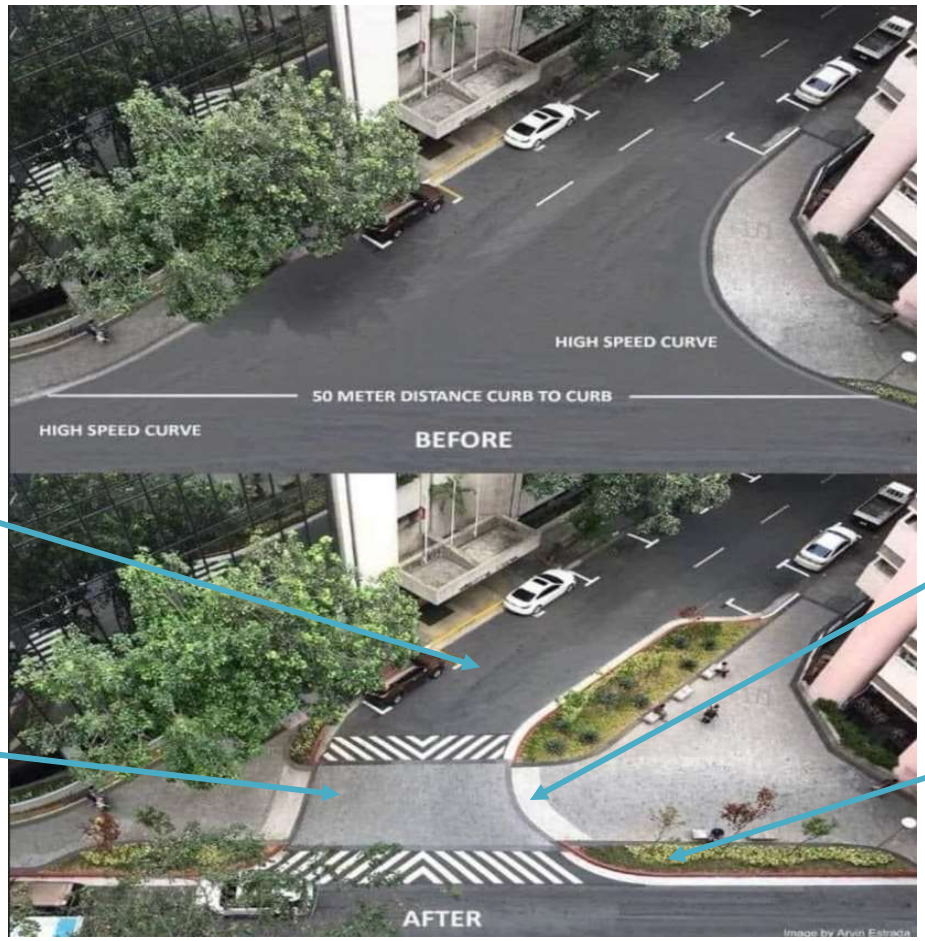


(b) Six-lane divided carriageway (Box and P-type, Source: Mulyadi & Amelia, (2013))

User Perceptions



Human Centric Street Design



Narrow Streets

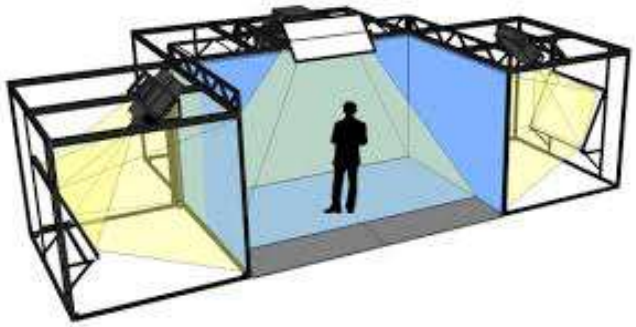
Raised Crosswalks

Curb Extension

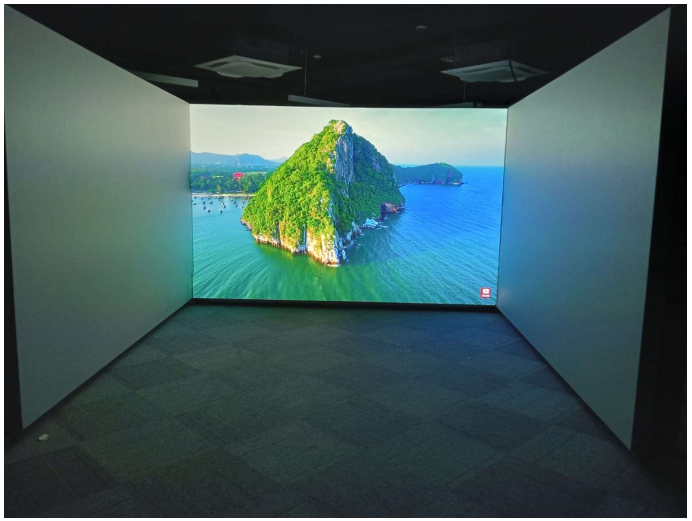
Infusion of Nature

Immersive Virtual Reality Systems (IVRS)

- IVRS is a computer-based platform facilitating high-end visualization and offers a safe three-dimensional representation of real environments.



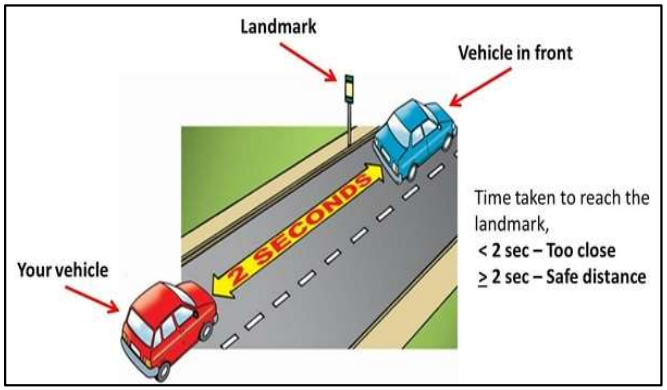
- The perception of the real world is created by surrounding users with images, sounds and other stimuli, which deliver the experience of the engrossing total environment.



Principles for Safer Road Design

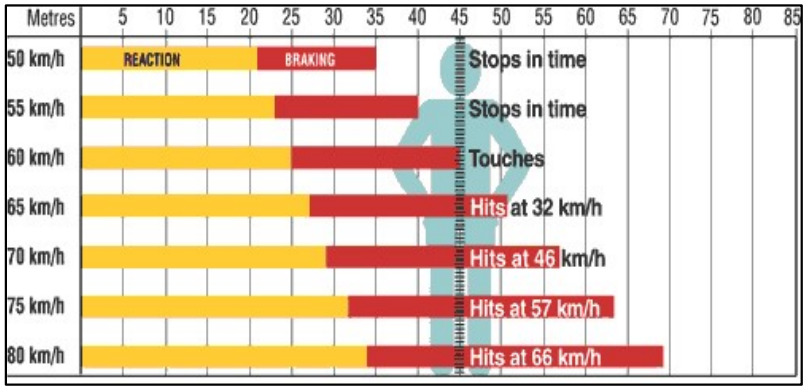
- A safe road environment should
  - WARN for unusual features
  - INFORM of conditions to be encountered
  - GUIDE through unusual sections
  - CONTROL through conflict points
  - FORGIVE for errant behaviors
- A safe road environment is one which provides
  - No surprises
  - Controlled release of relevant information
  - Repeated pertinent information

Traffic Safety Tips



2 Seconds Rule

Blind Spot



Speed Vs Severity

Thank you

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