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THE UNIVERSITY OF NEW SOUTH WALES

RCITI
Research Centre for Integrated Transport Innovation
THE UNIVERSITY OF NEW SOUTH WALES

Insurance for Autonomous Vehicles

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Motivation

DRIVING BEHAVIOUR

AVs can mitigate the crash rates concurrently reducing insurance premiums .

PERCEIVEDPROBABILITY

Insurance decision depends on Perceived probability of risk

Risk Management in Automobile Insurance Industry

Insurance providers determine premium rates on the basis of the traditional underwriting factors. These factors include, their claims experience related to driver demographic characteristics and the safety record of the make and model of vehicle being driven, driver age, gender, occupation, prior record, as well as vehicle crashworthiness, safety features (e.g. airbags, anti-lock brakes), popularity with thieves, cost to repair, and age.

These factors are imperfectly correlated with the likelihood of having an accident. (Desyllas et al. , 2013)

Characteristics of Liability System involving Connected Autonomous Vehicles

4 Approaches to Liability System

Amar Kumar Moolayil, 2018

- Individual liability
- Technology Developer
- Analytic posterior
- Fiduciary agent approach

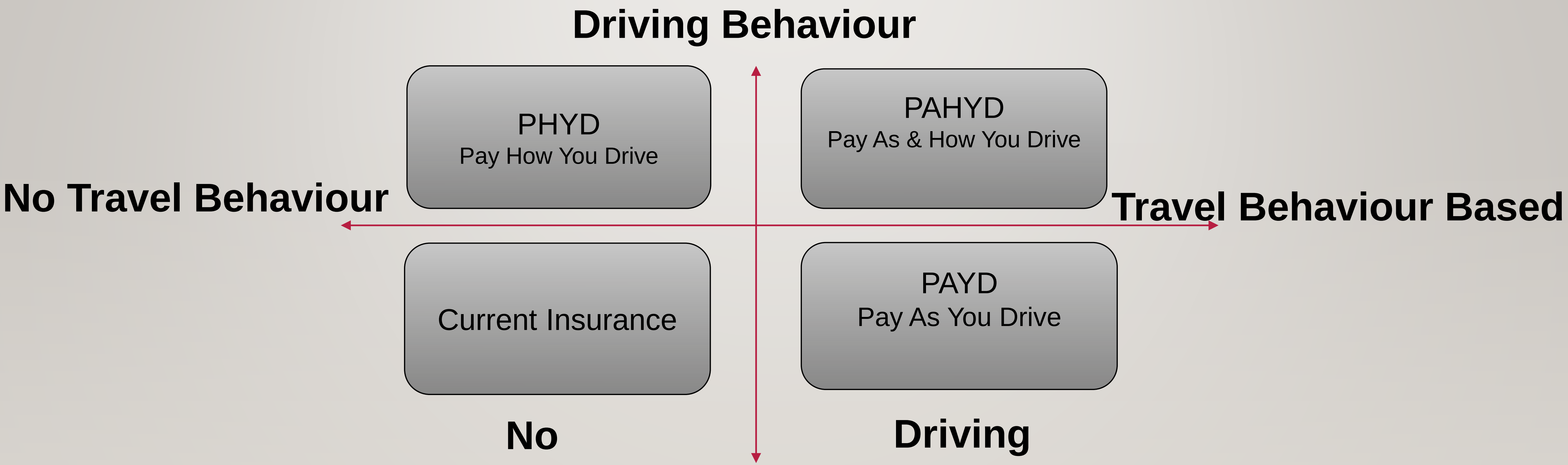
National insurance fund

Schroll, 2014

- The federally Run National Car Insurance Fund
- Alternatives to a Federally Run Fund

Our study focusses on liability system where there is personal ownership of AVs

Innovative Motor Insurance Schemes



Driving performance is safer with lower rather than higher levels of automation failures (Strand, Nilsson, Karlsson, & Nilsson, 2014).

The insurance premiums would go down as the automation will replace human drivers (Sheehan, Murphy, Ryan, Mullins, & Liu, 2017)

Tselentis, D. I., Yannis, G., & Vlahogianni, E. I. (2017)

Risk Perception in Insurance

People tend to buy insurance for high probabilities and small loss accidents rather than low probability, high loss accidents. (Slovic, Fischhoff, Lichtenstein, Corrigan, & Combs, 1977)

Response is bimodal for very low probability events. A similar study was conducted (Gandertan et al., 2000) (Mcclelland et al., 1993).

Risk-averse people are willing to pay a premium higher than or equal to the expected value of losses from a set of uncertain events, against which they will be covered.(Kunreuther and Pauly, 2006)

Perception of Autonomous Vehicles

More than 90% of the accidents happen because of human errors. Accidents reduction and costly cars will create accident event as low probability, high loss risk in contrast to high probability low loss risk.

41% of Texans are not yet ready to use SAVs even at a nominal cost of $1 per mile (Bansal, Kockelman, & Singh, 2016)

Households not apprehensive of new technology, cast no demand in contrast with the households that showed a WTP above ***$10,000*** (Daziano, Sarrias, & Leard, 2017).

40% consumers in Chinese market believe that insurance rates will go down due to AVs. In contrast ***69.24%*** are willing to pay more for insuring AVs (Xu and Fan, 2018)

Identified Research Gap

Ongoing Research

- Usage Based Insurance Factors
- Traditional Underwriting Factors

Research Gap

- Fleet Composition
- Risk Perception Distribution around CAVs

Aim of the research

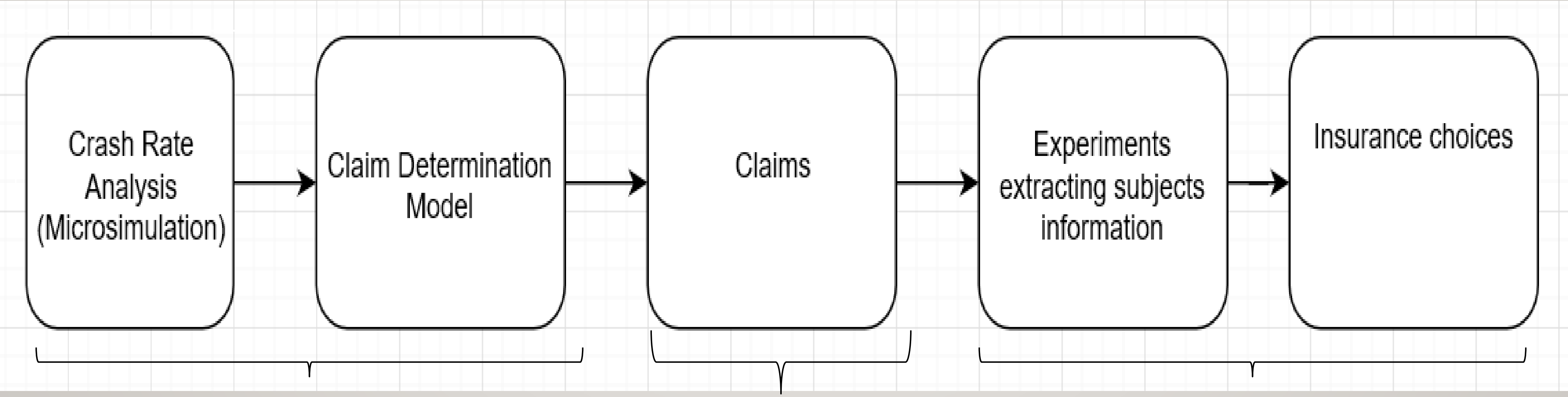
Investigate

- Actuarial Risk and Trade-off due to encompassing AVs in the fleet.

Examine

- Insurance Decision and Willingness to Pay.

Methodology



Study the effect of CAV penetration on insurance claims

Finding claim so that it is impossible to reallocate without trade-off of any one of the metrics

Insurance Decisions

Objective: Study the effect of CAV penetration on insurance claims

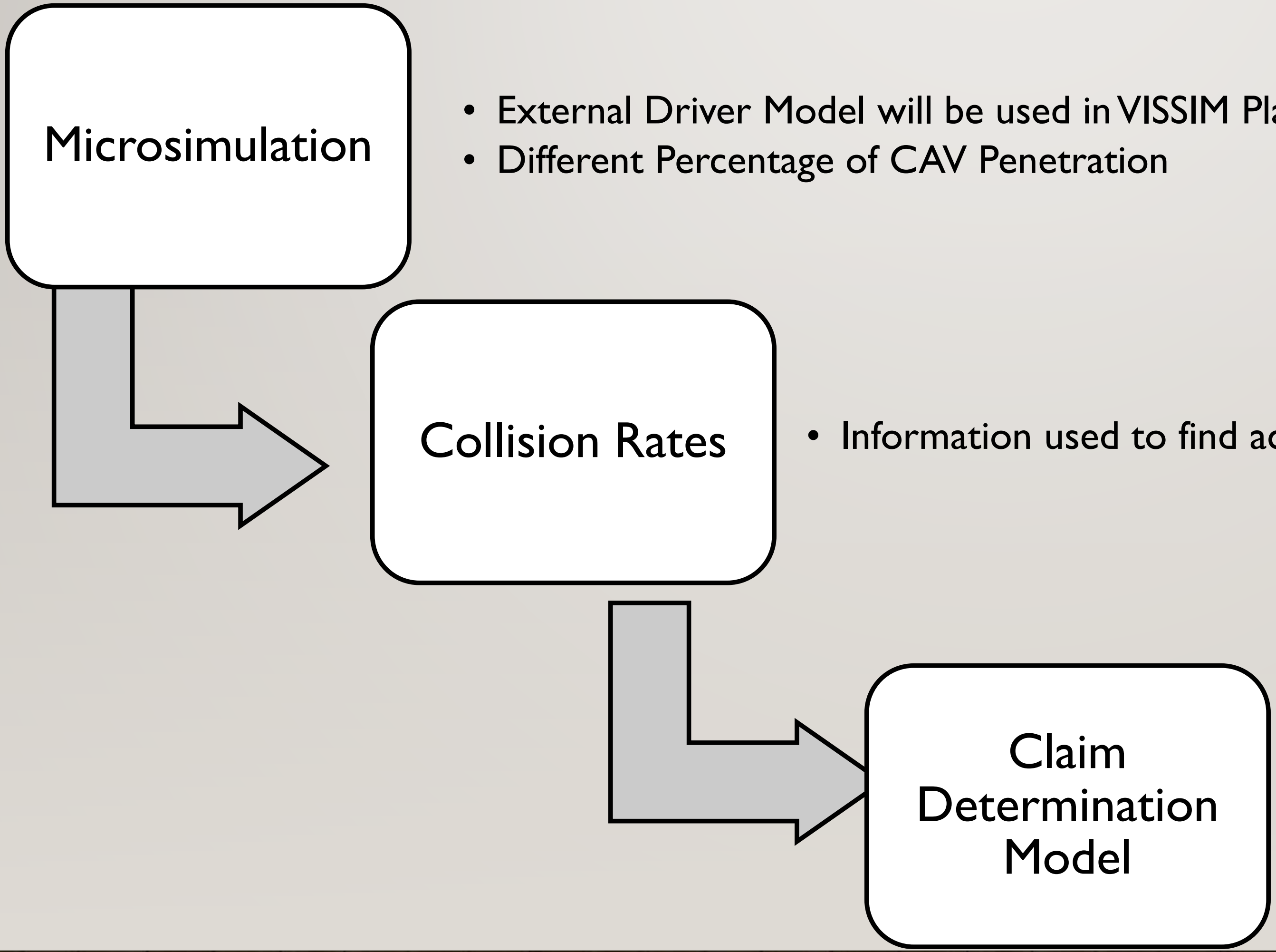
Why is it necessary to examine the whole network?

- Crash rate would be different depending on homogeneity of traffic flows.(Hiselius, 2004)
- Crash Rates depends on contextual relative speed (Average Network Speed and Maximum Allowed Speed). (Yu-Luen Ma, 2018)

Value and impact in mixed fleet containing Connected Autonomous Vehicles.

- Platooning
- Efficient Speed
- Reduced Headway

Objective: Study the effect of CAV penetration on insurance claims



- External Driver Model will be used in VISSIM Platform
- Different Percentage of CAV Penetration

- Information used to find accident severity and accident frequency

- Aggregated Claims

Objective: Finding claim so that it is impossible to reallocate without trade-off of any one of the metrics

Performance Metrics

- Extracted from Simulation

Safety Metrics

- Model Developed in First part

Objective: Determining Insurance Choices

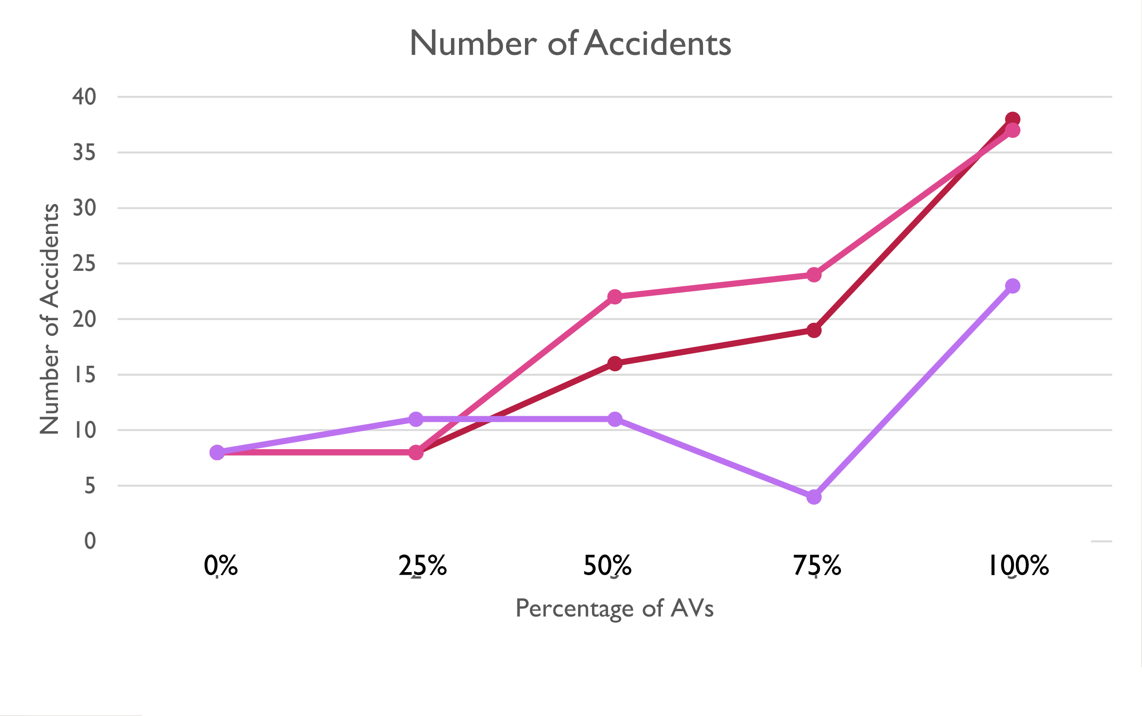
Risk Preference Task

Time Preference Task

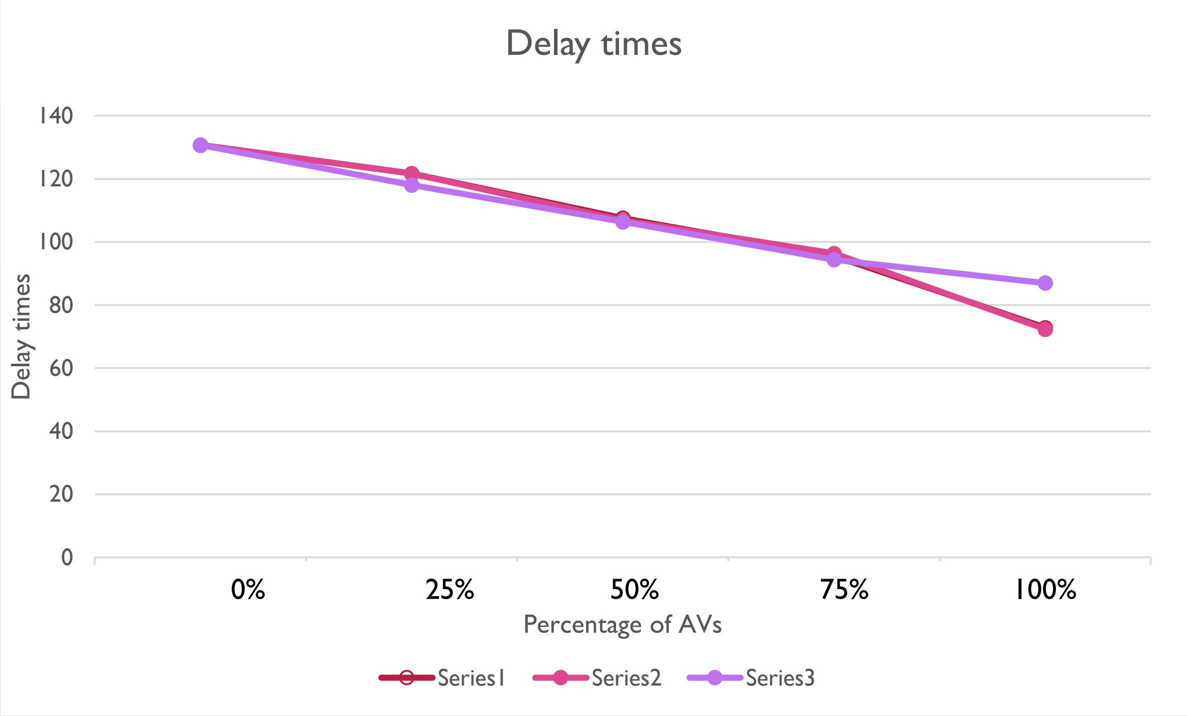
Simulated Driving Test

Insurance Purchase Task

Results



Number of Accidents
40
35
30
25
20
15
10
5
0
Number of Accidents
0%
25%
50%
75%
100%
Percentage of AVs

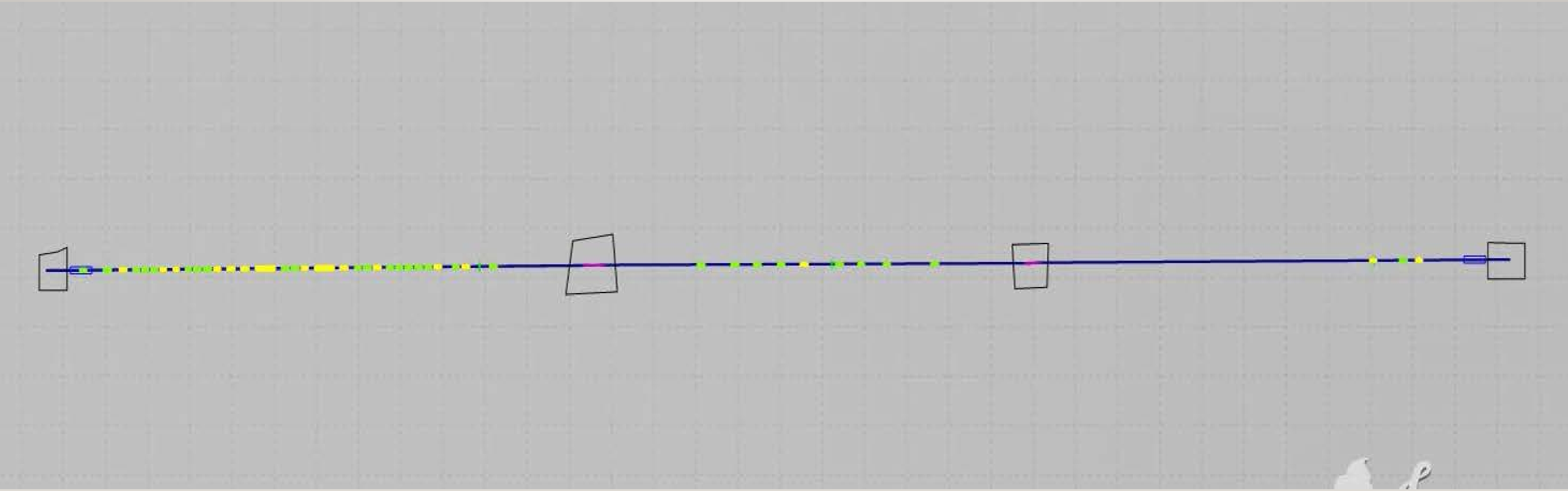


Delay times
140
120
100
80
60
40
20
0
Delay times
0%
25%
50%
75%
100%
Percentage of AVs
Series1
Series2
Series3

THANK YOU

APPENDIX

Different Connected Autonomous Vehicles behaviour for different links



https://drive.google.com/file/d/11hapTvKwpnAQJZcEbLkLt6brXcyuNTxA/view

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CLAIM DETERMINATION MODEL

Microsimulation

- External Driver Model will be used in VISSIM Platform
- Different Percentage of CAV Penetration

Collision Rates

- SSAM will be used to extract collision information.
- Information used to find accident severity and accident frequency

Claim Determination Model

- Aggregated and Individual Claims

Objective: Study the effect of CAV penetration on insurance claims

SURROGATE SAFETY ASSESSMENT MODEL (SSAM

TTC is the minimum time-to-collision value observed during the conflict. This estimate is based on the current location, speed, and future trajectory of two vehicles at a given instant. A TTC value is defined for each time step during the conflict event. A conflict event is concluded after the TTC value rises back above the critical threshold value. This value is recorded in seconds.

PET is the minimum post-encroachment time observed during the conflict. Post-encroachment time is the time between when the first vehicle last occupied a position and the time when the second vehicle subsequently arrived to the same position. A value of zero indicates a collision. A post-encroachment time is associated with each time step during a conflict. A conflict event is concluded when the final PET value is recorded at the last location where a time-to-collision value was still below the critical threshold value. This value is recorded in seconds.

MaxS is the maximum speed of either vehicle throughout the conflict (i.e., while the TTC is less than the specified threshold). This value is expressed in feet per second or meters per second, depending on the units specified in the corresponding trajectory file.

DeltaS is the difference in vehicle speeds as observed at **tMinTTC**. More precisely, this value is mathematically defined as the magnitude of the difference in vehicle velocities (or trajectories), such that if v_1 and v_2 are the velocity vectors of the first and second vehicles respectively, then **DeltaS** = $\| v_1 - v_2 \|$. For context, consider an example where both vehicles are traveling at the same speed, v. If they are traveling in the same direction, **DeltaS** = 0. If they have a perpendicular crossing path, **DeltaS** = $(\sqrt{2})v$. If they are approaching each other head on, **DeltaS** = $2v$.

DR is the initial deceleration rate of the second vehicle, recorded as the instantaneous acceleration rate. If the vehicle brakes (i.e., reacts), this is the first negative acceleration value observed during the conflict. If the vehicle does not brake, this is the lowest acceleration value observed during the conflict. This value is expressed in feet per second or meters per second, depending on the units specified in the corresponding trajectory file.

MaxD is the maximum deceleration of the second vehicle, recorded as the minimum instantaneous acceleration rate observed during the conflict. A negative value indicates deceleration (braking or release of gas pedal). A positive value indicates that the vehicle did not decelerate during the conflict. This value is expressed in feet per second or meters per second, depending on the units specified in the corresponding trajectory file.

ConflictType describes whether the conflict is the result of a rear end, lane change, or crossing movement. If link and lane information is not available for both vehicles then the event type is classified based solely on the absolute value of the **ConflictAngle** as follows. The type is classified as a rear-end conflict if ||**ConflictAngle**|| < 30 °, a crossing conflict if ||**ConflictAngle**|| > 85 °, or otherwise a lane-changing conflict. However, the simulation model that produced the vehicle trajectory data can generally provide link and lane information for both vehicles—though the coding of these values may vary significantly from one simulation vendor to the next. If link and lane information is available, that information is utilized for classification in the case that the vehicles both occupy the same lane (of the same link) at either the start or end of the conflict event. If the vehicles both occupy the same lane at the start and end of the event, then it is classified as a rear-end event. If either vehicle ends the conflict event in a different lane than it started (while having not changed links), then the event is classified as a lane-change. If either of the vehicles changes links over the course of the event, then the conflict angle determines the classification as previously described, with the following possible exception). For two vehicles that begin the conflict event in the same lane but change links over the course of the event, the classification logic considers only rear-end or lane-change types, based on the conflict angle (using the threshold value previously mentioned). Note that vehicle maneuvers such as changing lanes into an adjacent turn bay lane or entering into an intersection area may be consider changing links, depending on the underlying simulation model. In some cases, vehicles which appear to be traveling in the same lane may actually by considered by the simulation model as traveling on different links that happen to overlap.

MaxDeltaV is the maximum **DeltaV** value of either vehicle in the conflict (see **FirstDeltaV** or **SecondDeltaV** for more information).

FirstDeltaV (**SecondDeltaV**) is the change between conflict velocity (given by speed **FirstVMinTTC** and heading **FirstHeading**) and the postcollision velocity (given by speed **PostCrashV** and heading **PostCrashHeading**). This is a surrogate for the severity of the conflict, calculated assuming a hypothetical collision of the two vehicles in the conflict.

The validation effort for SSAM consists of a theoretical validation, field validation, and sensitivity analysis.

Driving performance is safer with lower rather than higher levels of automation failures (Strand, Nilsson, Karlsson, & Nilsson, 2014).

- Highly Automated (ACC)
- Semi Automated (TJA)

- Moderate Deceleration Failure (MDF)
- Severe Deceleration Failure (SDF)
- Complete Deceleration Failure (CDF)

Driving Performance Parameter

- Point of No Return (PoNR)
- Minimum Time to Collision (MTTC)
- Minimum Time Head Way (MTHW)
- Response Time (RT)

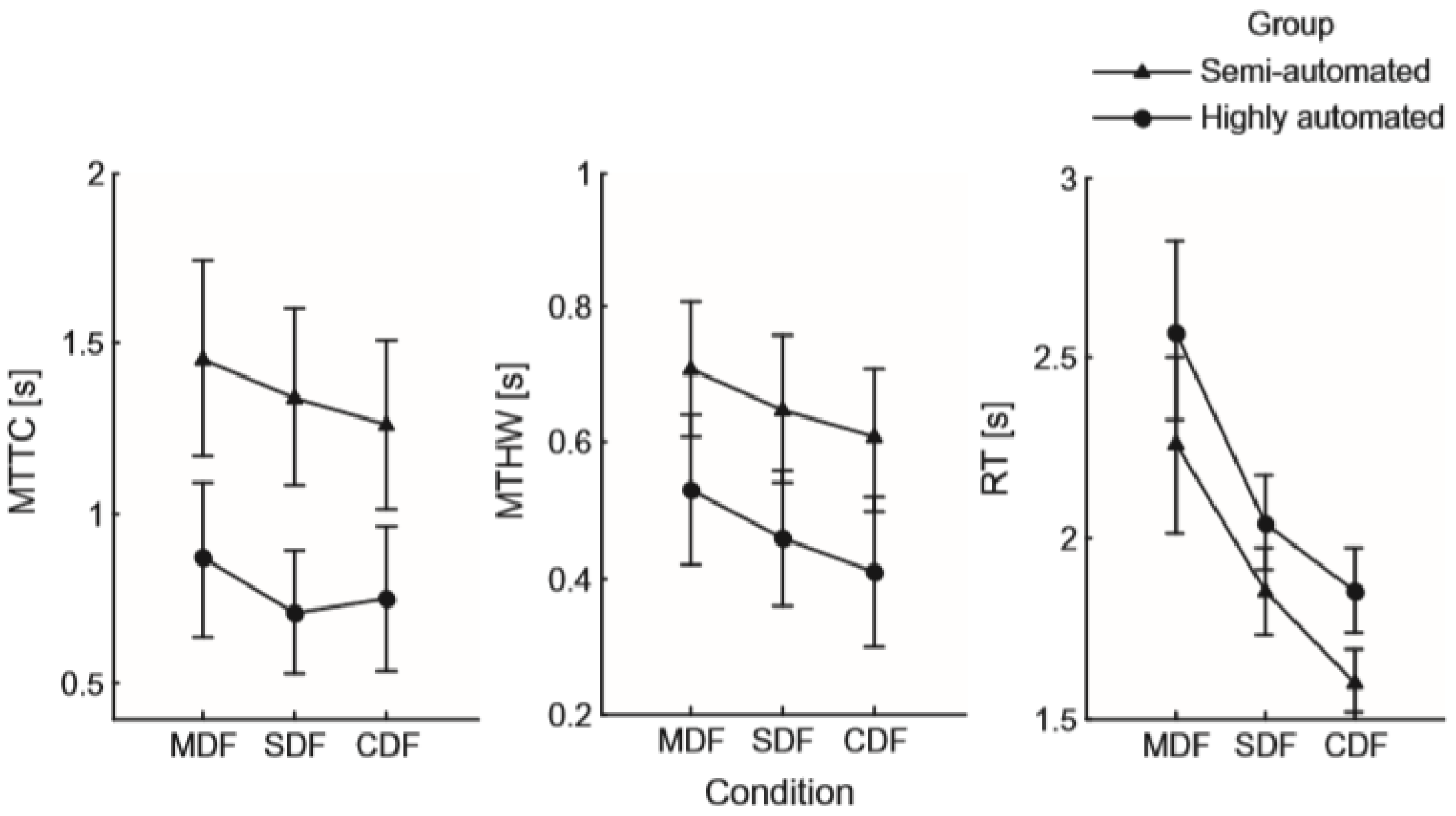
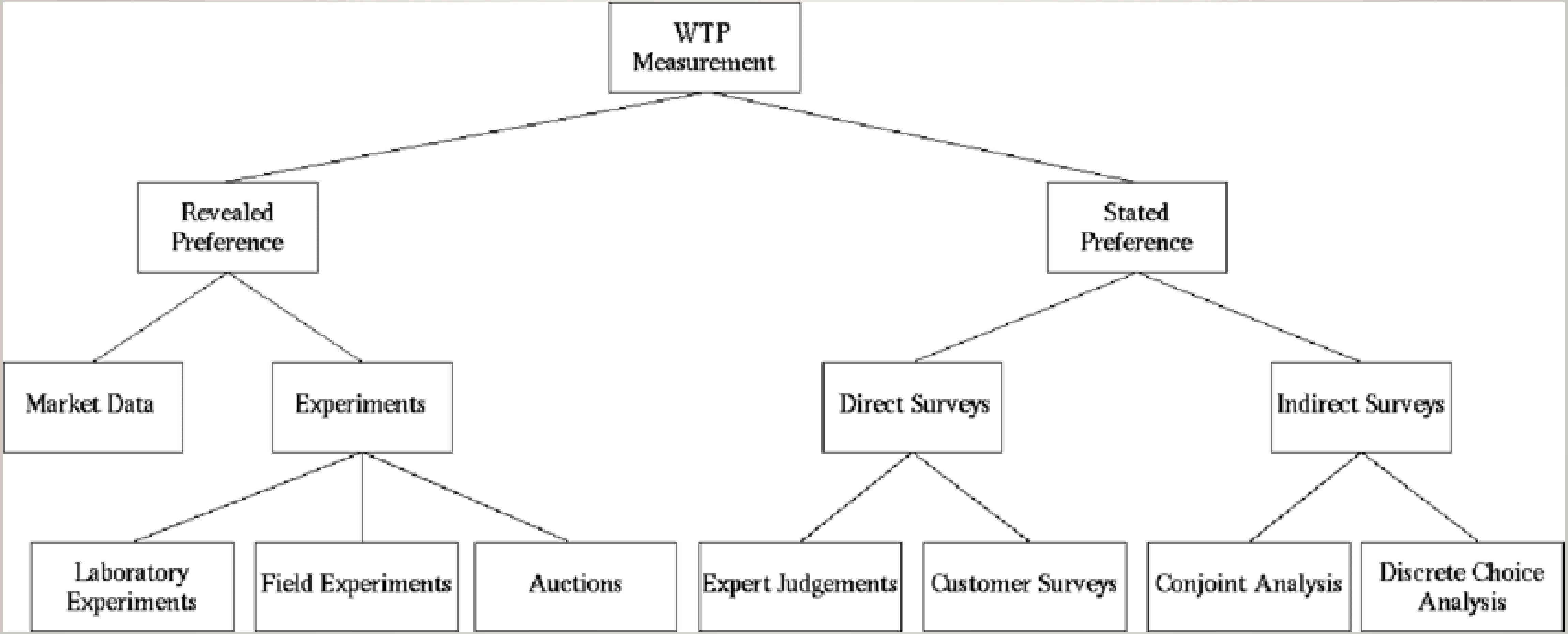


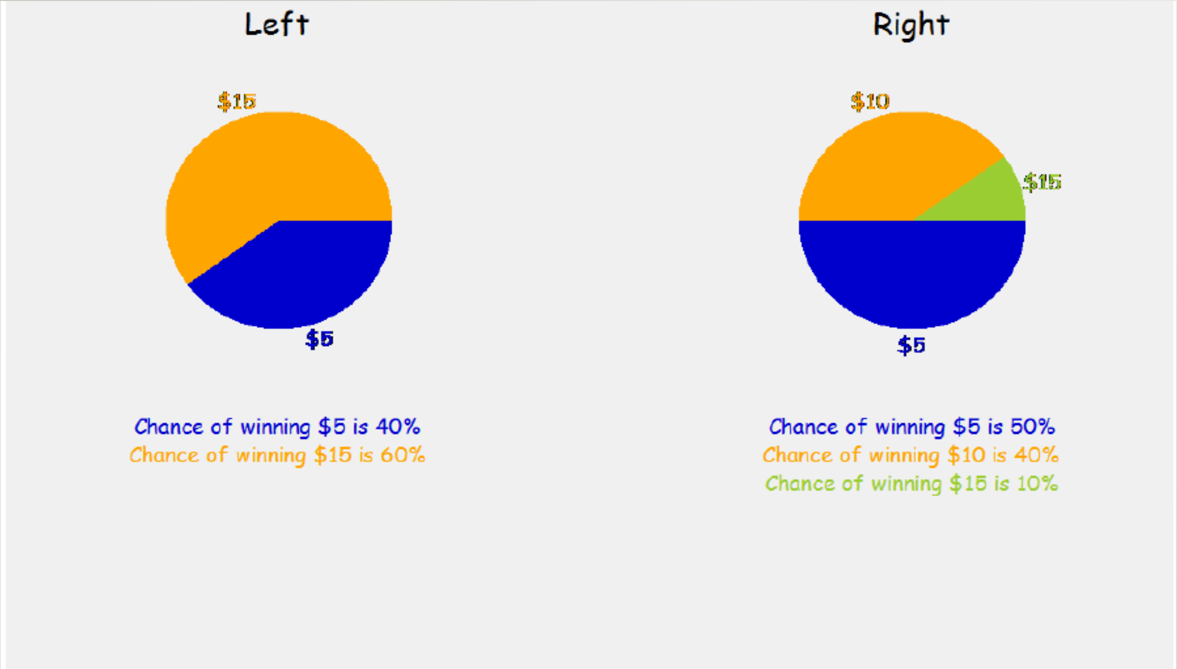
Fig. 3. Mean Minimum Time-To-Collision (MTTC), Minimum Time Head-Way (MTHW), and Response Time (RT) (±*SE*) semi-automated and highly automated driving in the deceleration failure conditions.

WTP :Willingness to Pay

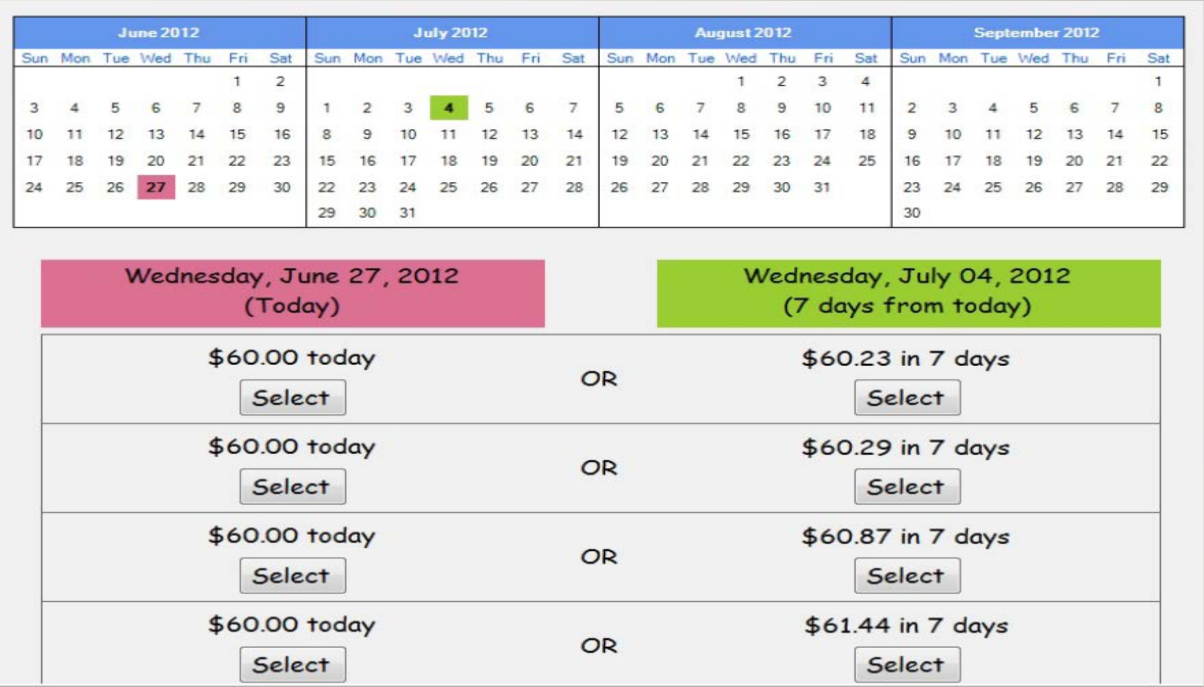


HUMAN PERCEPTION

Risk Preference Task



Time Preference Task



Dependent Variables : Risk attitude
Independent Variables : Age, Race, Gender etc.

Dependent Variables : Time Preference
Independent Variables : Age, Race, Gender etc.

Driving Task:

Task will assign driver score based on Speeding, Collision, Stop, Travel Time.

Insurance Decision Task

Discrete Choice Analysis