MONASH University
Engineering

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Road Safety Modeling Using a Safety Analysis Chain: A Theoretical Discussion

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Contents

- Research Background
- Safety Analysis Chain (SACH)
- Quantifying Components of the SACH
- Future Research
- Conclusion

Research Background

Perspective	Method	Input Variable	Output Variable
Transportation	Statistical Analysis Micro Simulation	Road and Environmental Characteristics	Number and Severity of Conflicts and Crashes
Crash Analysis	Statistical Analysis Newtonian Mechanics Crash Simulation	Crash Characteristics	Crash severity
Medical	Statistical Analysis	Human Body Characteristics	Crash Severity
Psychological	Experiments and Studies to Understand Human Behaviour	N/A	N/A

Safety Analysis Chain (SACH)

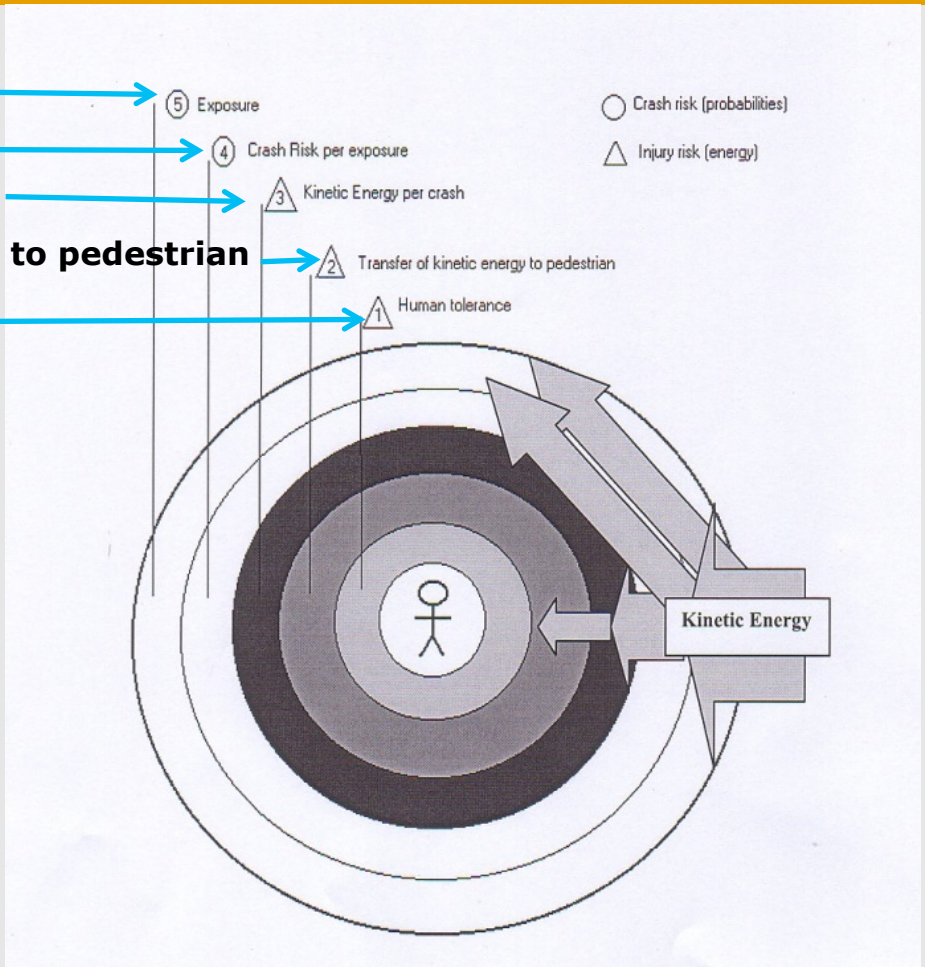
Exposure

Crash risk per exposure

Kinetic energy per crash

Transfer of kinetic energy to pedestrian

Human tolerance



KEM (Corben et al., 2004)

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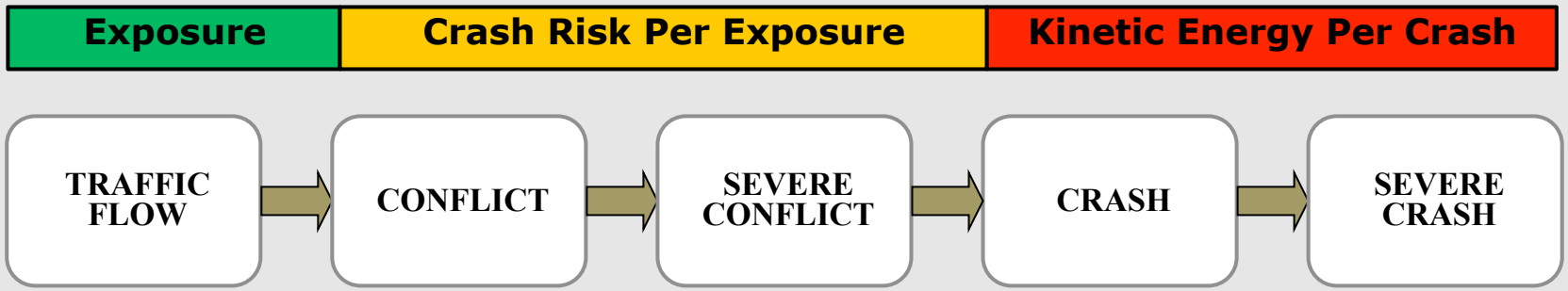
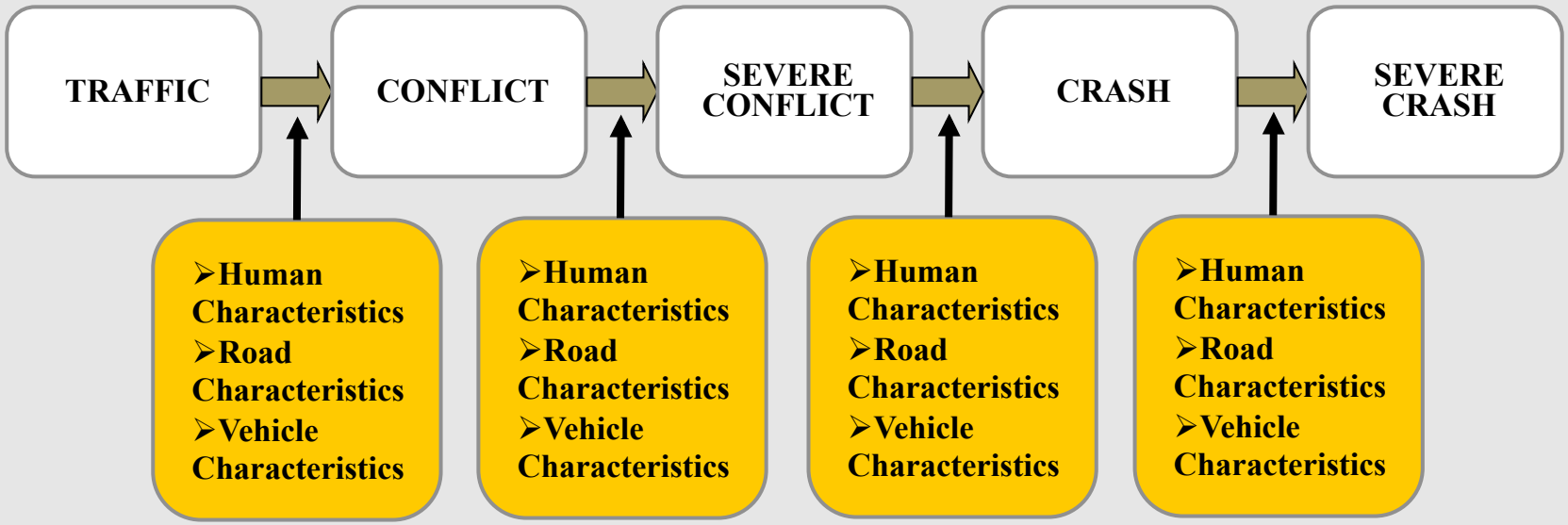
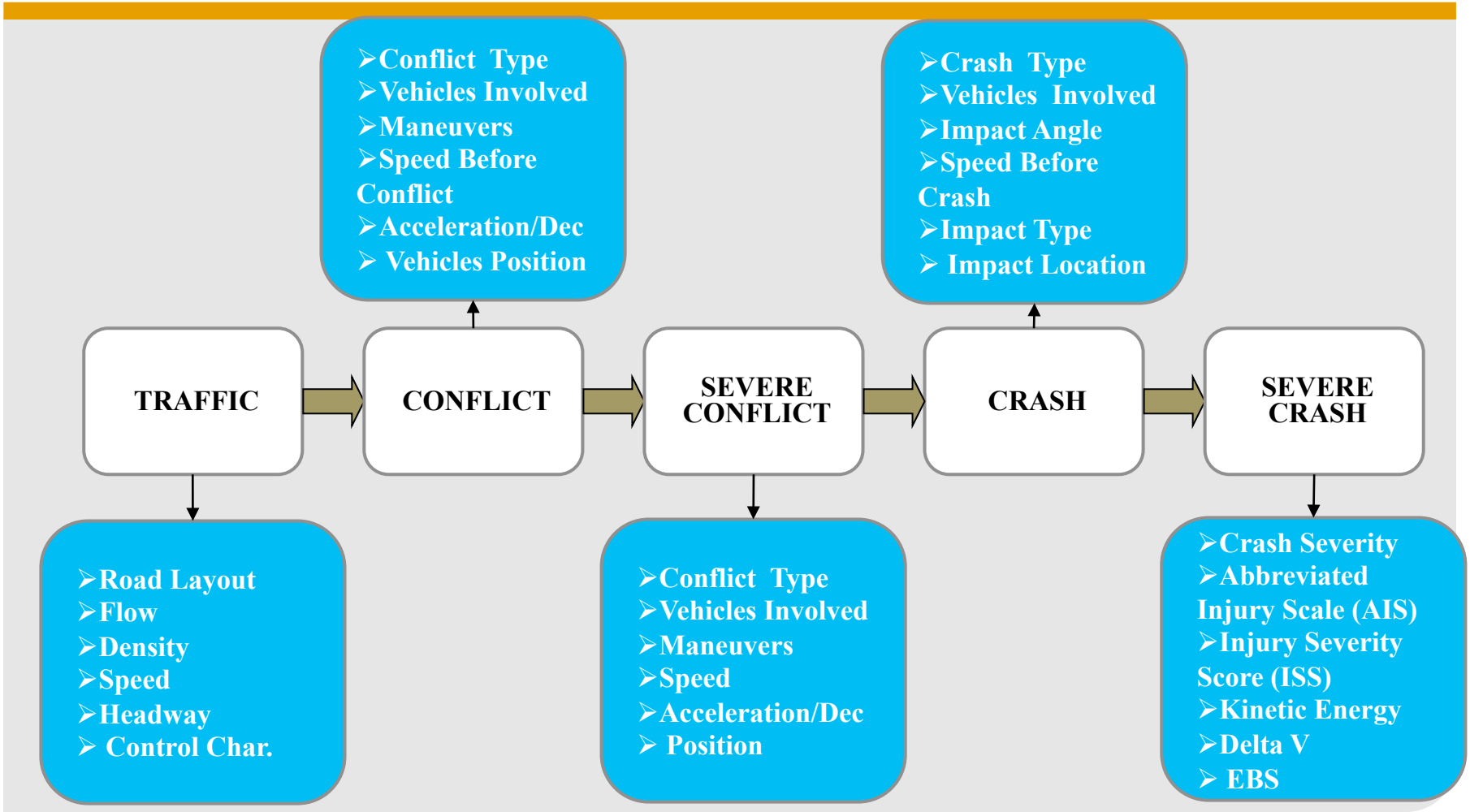
Safety Analysis Chain (SACH)



SACH(Link of Events)



SACH(Variables)



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Quantifying Components of the SACH (Step 1)

Step 1: Modelling The Link Between "Traffic" and "Conflict" and "Severe Conflict"

- Researchers have developed several conflict techniques to find out the number and severity of conflicts using micro-simulation model (Hyden 1987; Hyden 1996; Archer 2005).

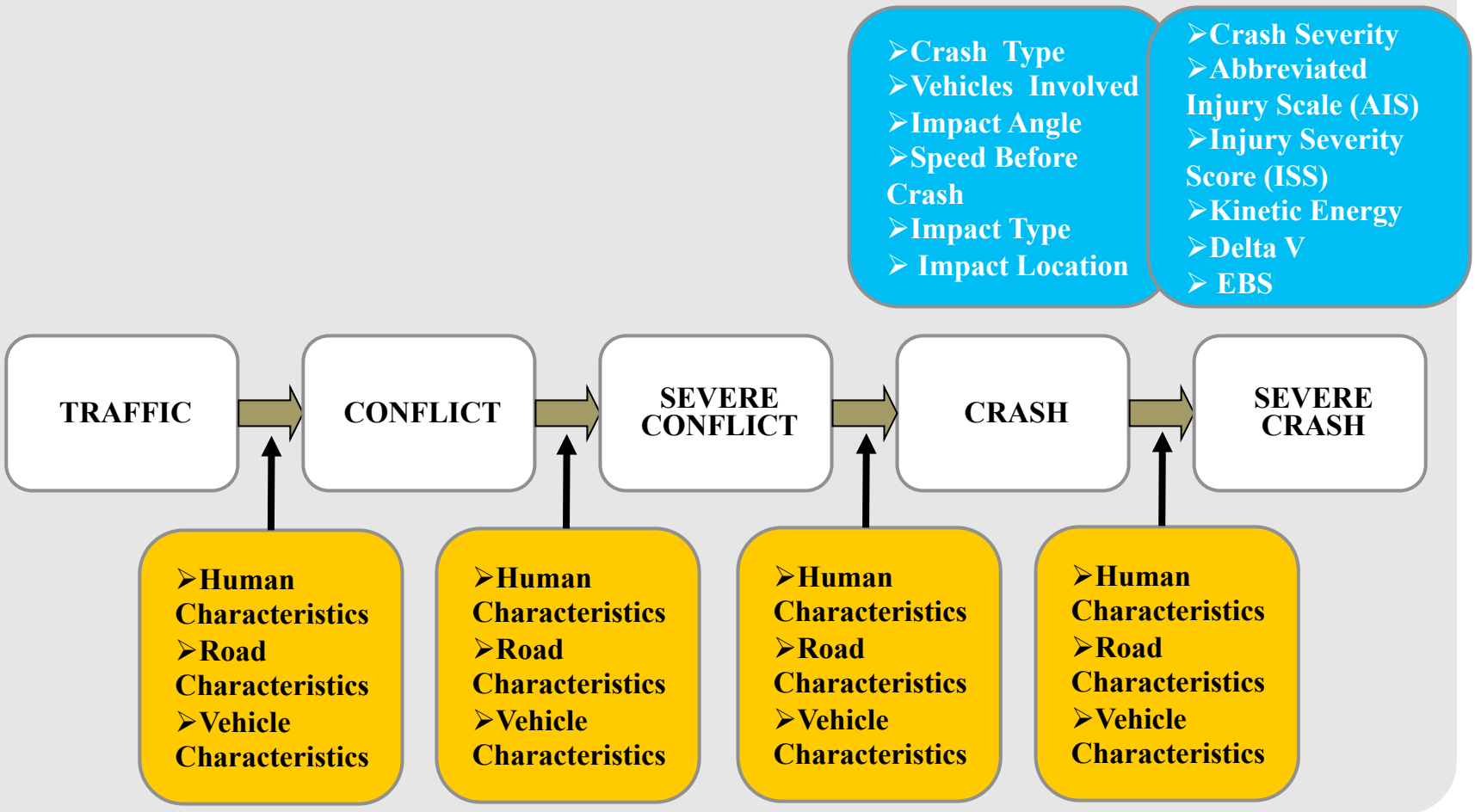
- After generating individual vehicle movement, the conflicts could be determined using probabilistic human behaviour models such as lane changing, car following, gap acceptance and stop-or-go decision at the onset of amber (Archer 2005; Cunto and Saccomanno 2008; Archer and Young 2009).

Quantifying Components of the SACH (Step 2)

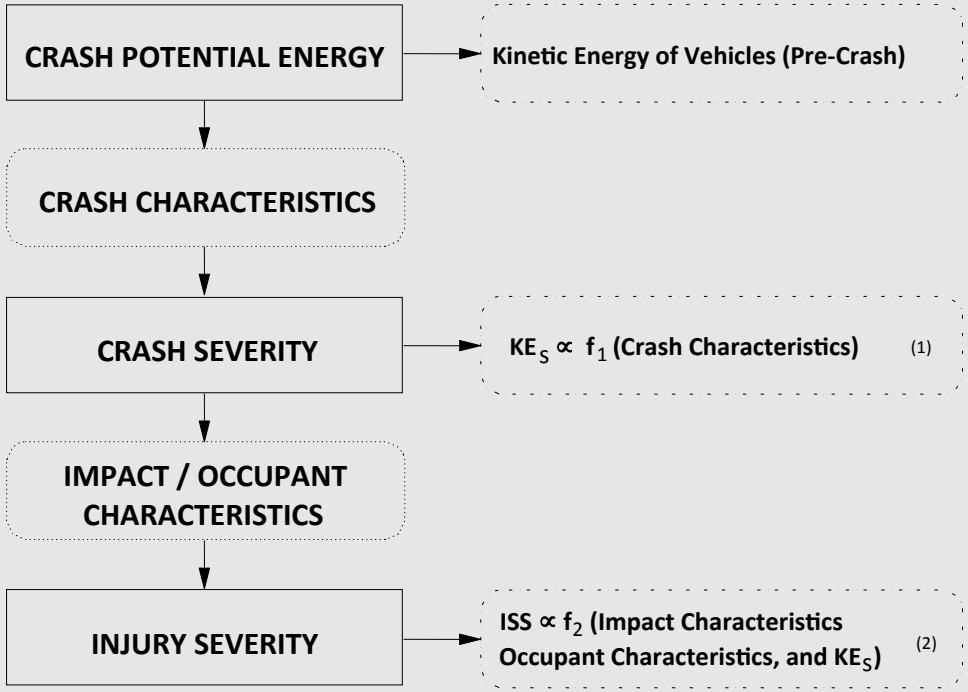
Step 1: Modelling The Link Between "Traffic" and "Conflict" and "Severe Conflict"

Step 2: Modelling The Link Between "Crash" and "Severe Crash"

Quantifying Components of the SACH (Step 2)



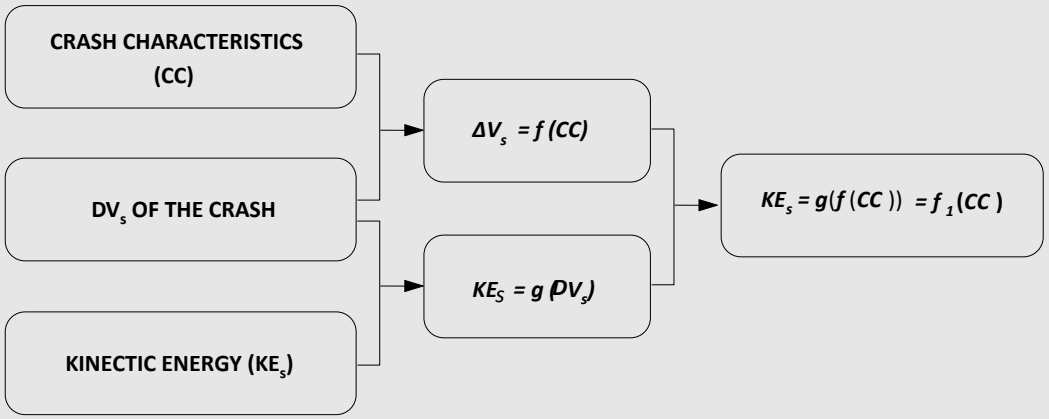
Quantifying Components of the SACH (Step 2)

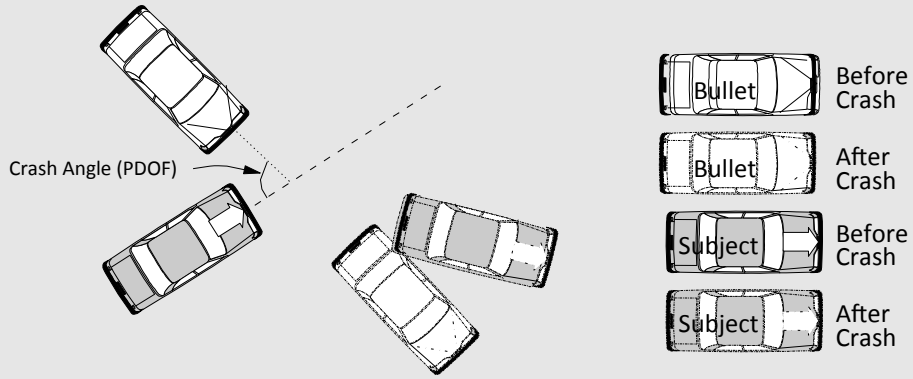


(1) f_1 is the mathematical model presenting the kinectic energy transferred to the subject vehicle in crash according to crash characteristics

(2) f_2 is the mathematical model presenting the ISS of the crash according to impact characteristics, kinectic energy transferred to the subject vehicle and occupant characteristics.

Quantifying Components of the SACH (Step 2)





$$\Delta V_s = v_s^b - v_s^a = \frac{m_b}{m_s}[v_b^a(\cos\alpha_b^a + \frac{\sin\alpha_b^a}{\sin\alpha_s^a} - \frac{\sin\alpha_b^a}{\tan\alpha_s^a}) - v_b^b(\frac{\sin(PDOF)}{\sin\alpha_s^a} + \cos(PDOF) - \frac{\sin(PDOF)}{\tan\alpha_s^a})]$$

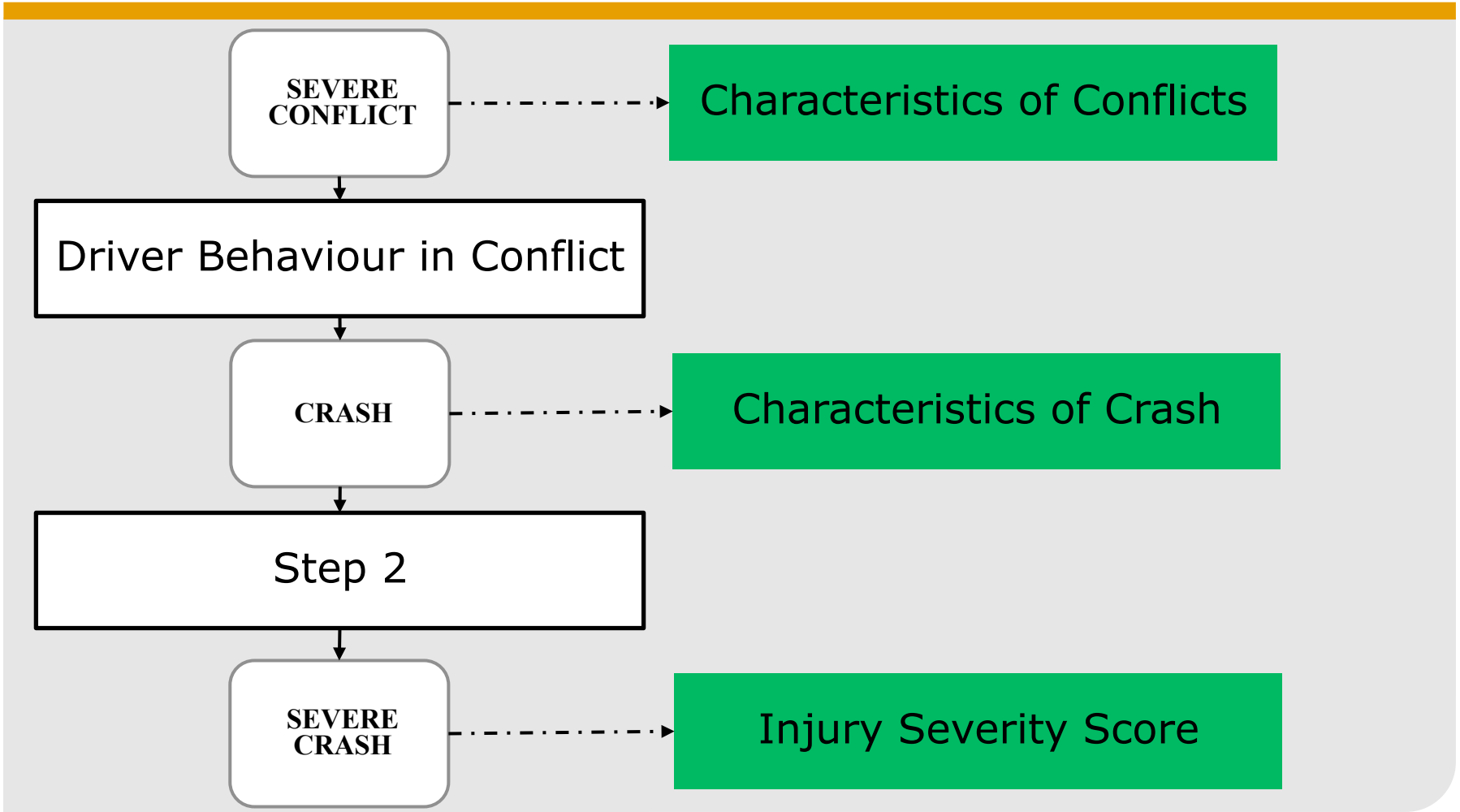
Quantifying Components of the SACH (Step 3)

Step 1: Modelling The Link Between "Traffic" and "Conflict" and "Severe Conflict"

Step 2: Modelling The Link Between "Crash" and "Severe Crash"

Step 3: Modelling The Link Between "Severe Conflict" and "Crash"

Quantifying Components of the SACH (Step 3)



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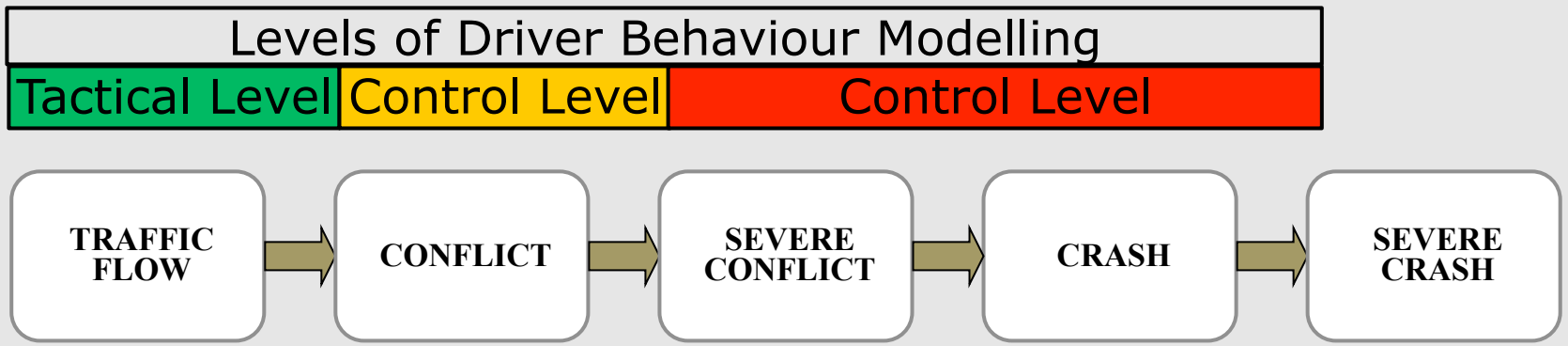


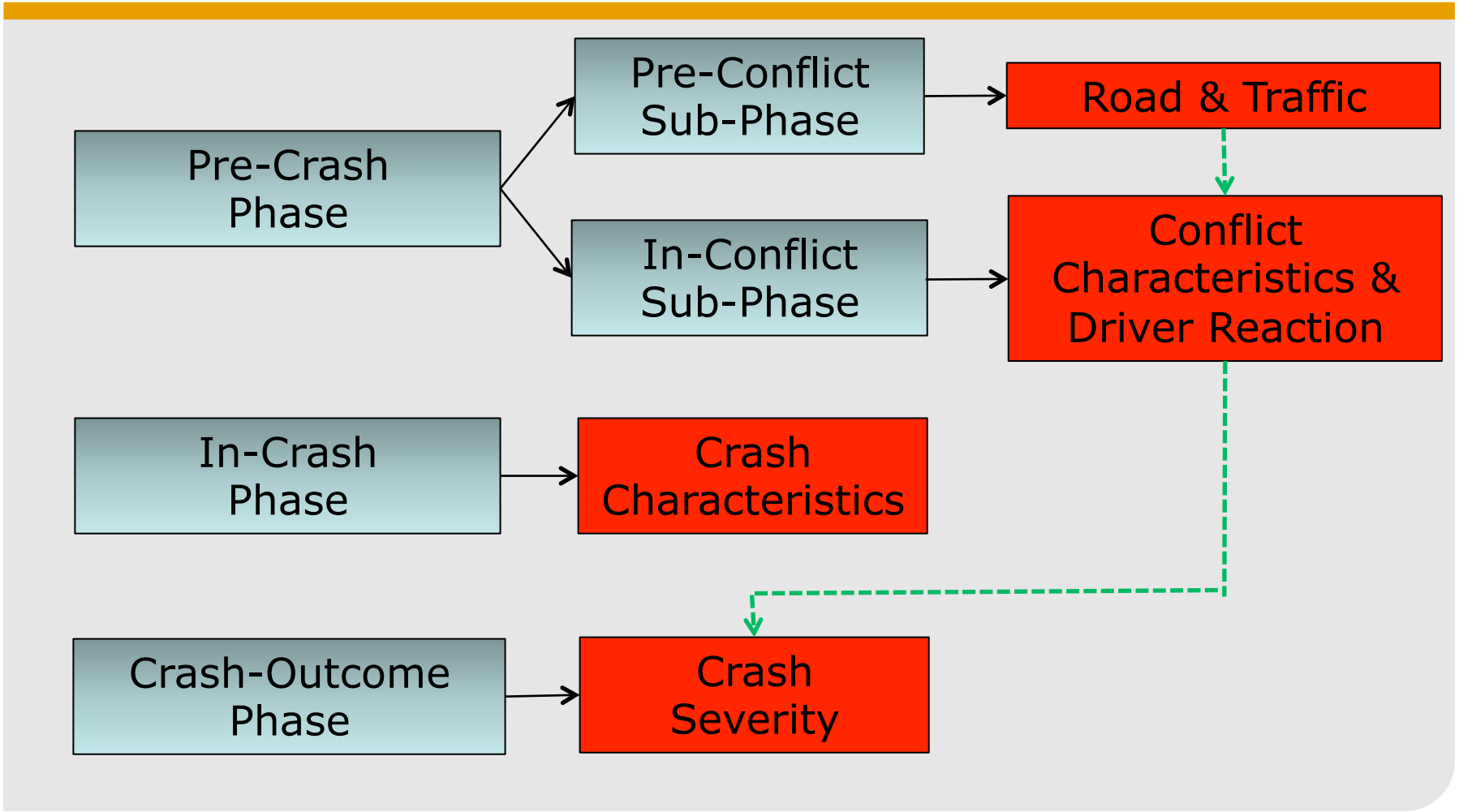
Quantifying Components of the SACH (Step 3)

Step 1: Modelling The Link Between "Traffic" and "Conflict" and "Severe Conflict"

Step 2: Modelling The Link Between "Crash" and "Severe Crash"

Step 3: Using an Alternative Model

Quantifying Components of the SACH (Step 3)



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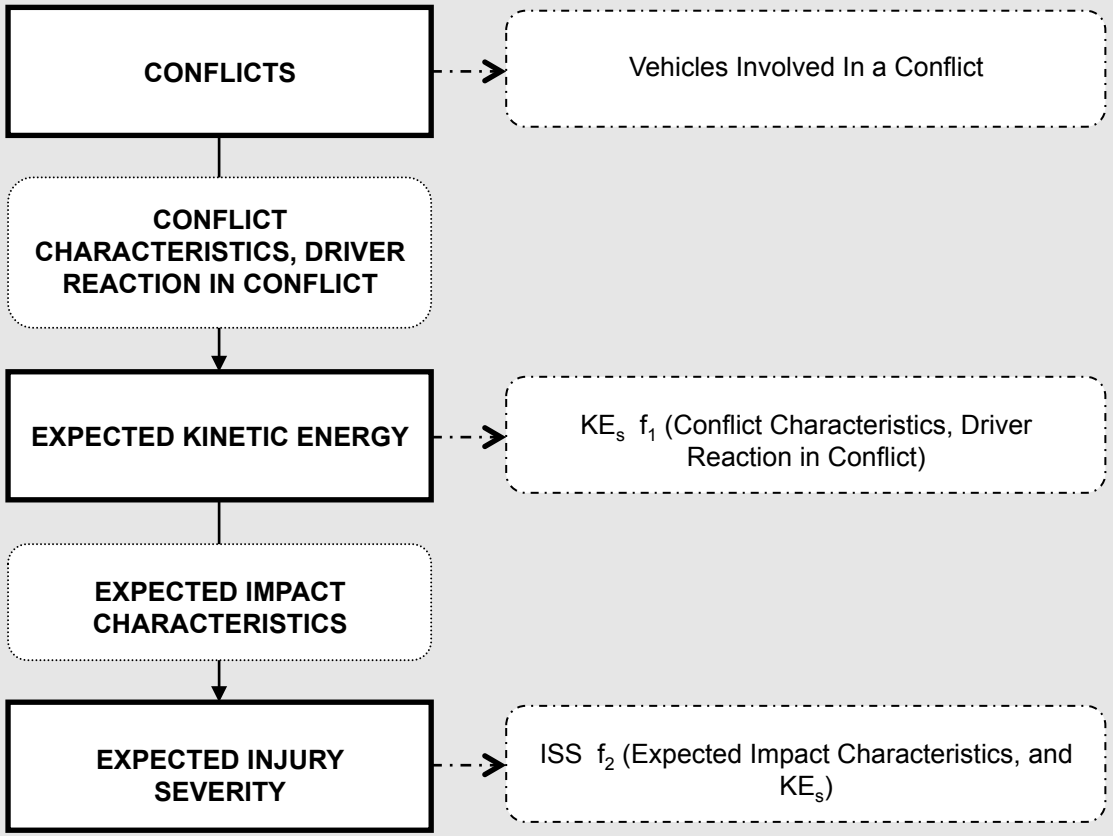

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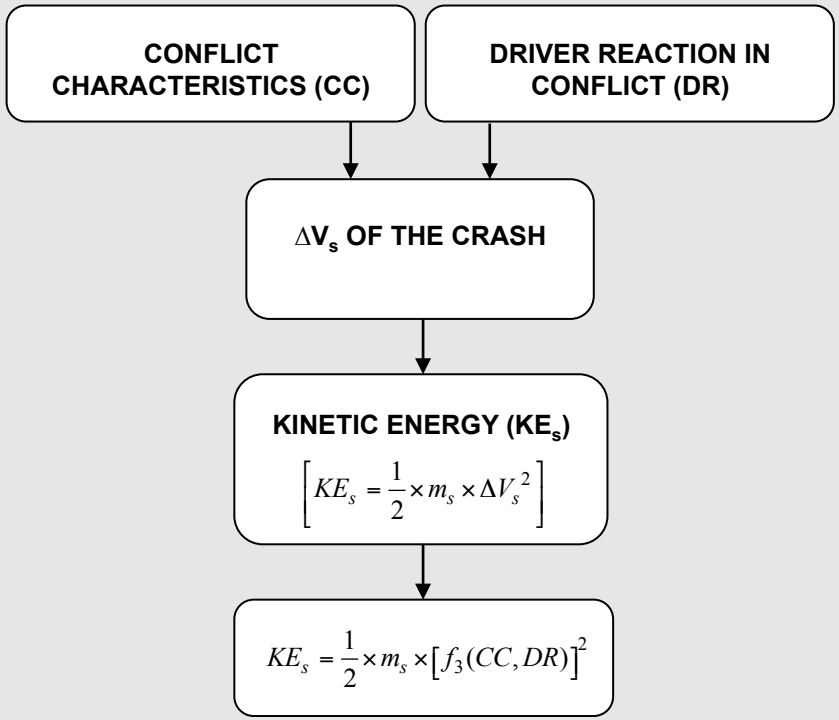


Quantifying Components of the SACH (Step 4)

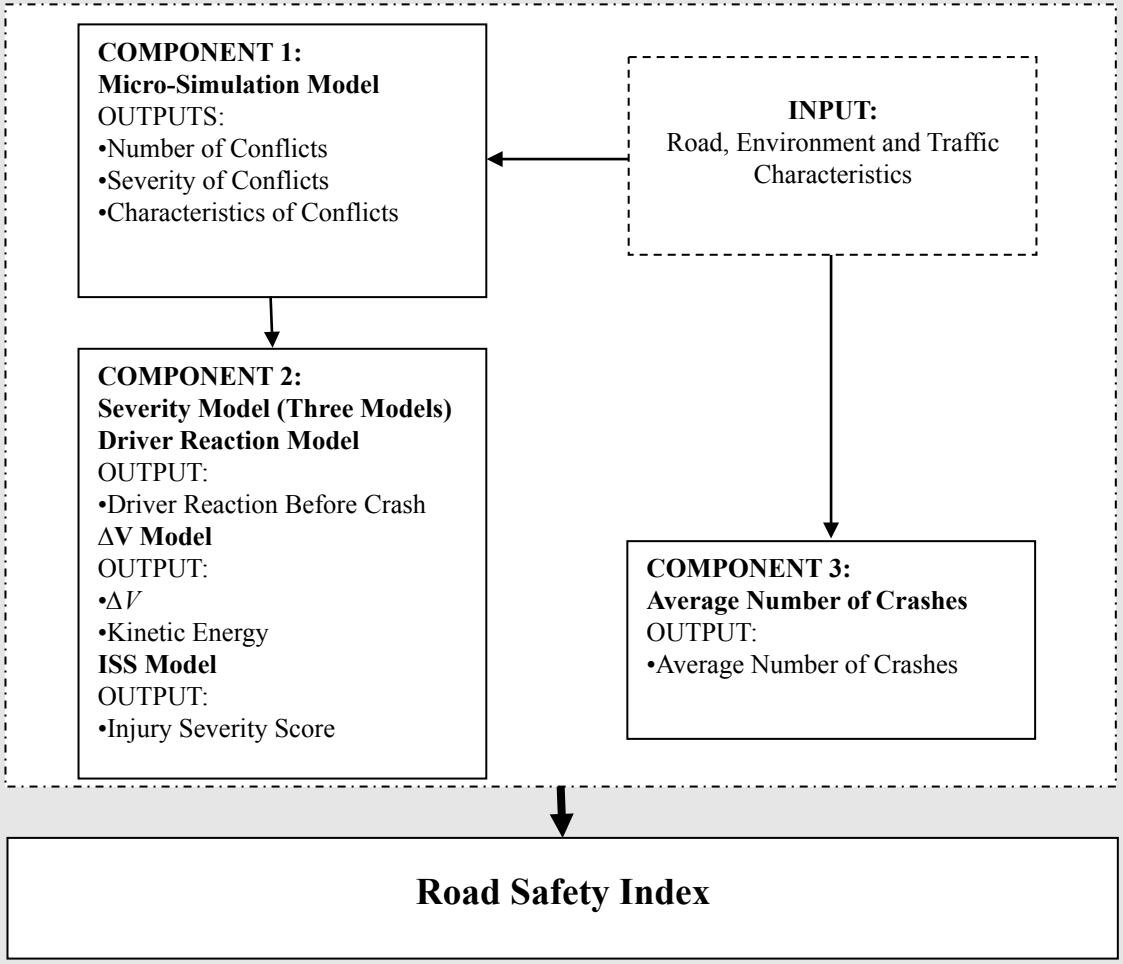
Step 1: Modelling The Link Between "Traffic" and "Conflict" and "Severe Conflict"

Step 2: Modelling The Link Between "Crash" and "Severe Crash"

Step 3: Using an Alternative Model

Step 4: Road Safety Index

Quantifying Components of the SACH (Step 4)



Road Safety Index

$$RSI = \left[\left(\sum_{i=1}^{n_{con}} ISS \right) / n_{con} \right] \times n_{cr} / \mu$$

DATA

Model	Data	
	Calibration	Validation/Verification
Micro-Simulation Model	SCATS data Recorded Video	SCATS data Recorded Video Police Data
Driver Reaction Model	ANCIS Database	ANCIS Database NASS Database
ΔV Model	ANCIS Database	ANCIS Database NASS Database
ISS Model	ANCIS Database	ANCIS Database NASS Database

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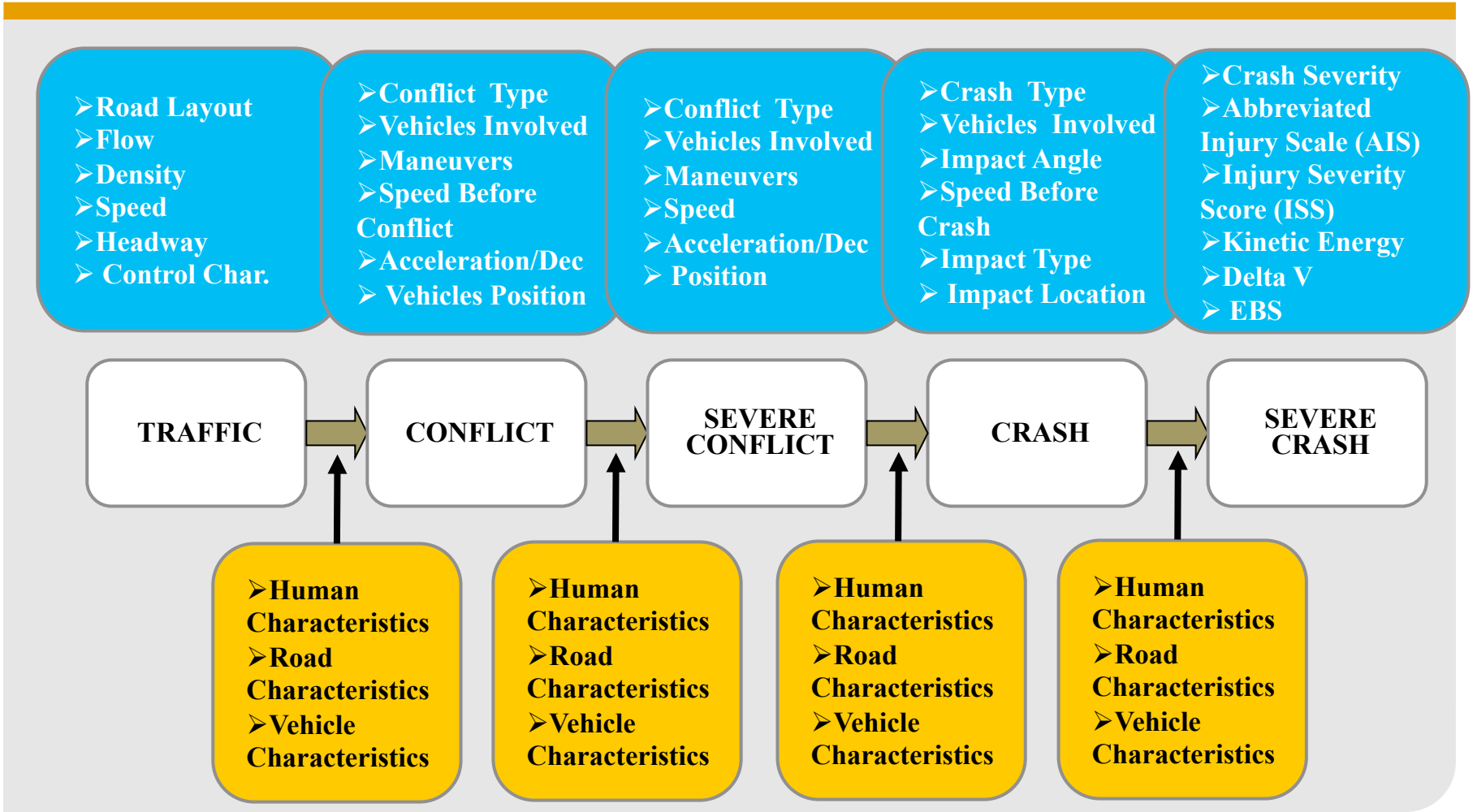
Future Research



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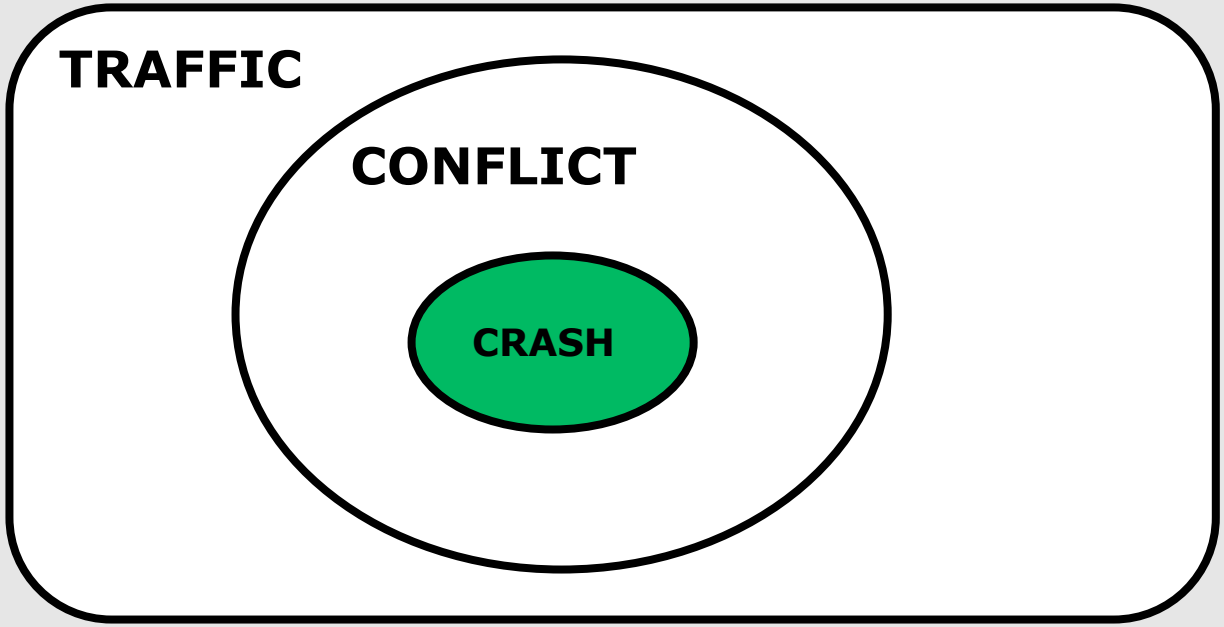
Conclusion

- **A Safety Analysis Chain (SACH) has been introduced as a basis for assessing safety performance of roads.**
- **A method has been outlined to quantify the components of the SACH through integrating the preceding safety modelling perspectives.**
- **The proposed theoretical framework proposed takes an important step towards the evaluation of the safety performance of roads.**
- **The SACH framework is a key for future research in road safety modelling since it provides a general overview of the main components of road safety modelling.**

Questions

Quantifying Components of the SACH (Step 3)