UNIVERSITY OF BIRMINGHAM | COLLEGE OF ENGINEERING AND PHYSICAL SCIENCES

Maintenance Programmes to Manage High-Risk Roads

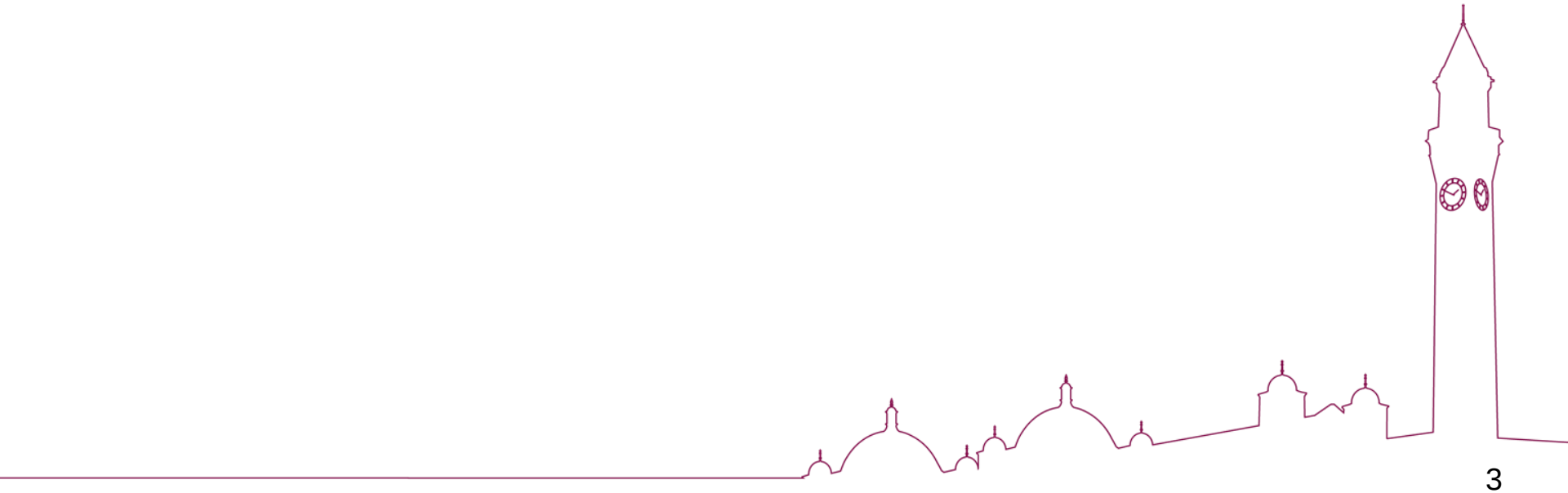
By
Azwan Ezzany Azmi

Supported by:

Outline of Presentation

- Introduction
- Objective of study
- Methodology
- Case Study
- Result & Discussion
- Conclusion

Introduction



Road Maintenance

- Purpose of road maintenance
  - Reducing deterioration
  - Lowering vehicle operating cost (VOC)
  - Keeping the road open
  - Safety
  - Environment issues
- Road maintenance programmes are normally based on **pavement condition** (roughness, cracking, skid resistance etc.)

Why we need to measure safety…

- How many accident may occur on this road?
- Any fatality? Any serious injury?

Road Safety Assessment

- International Road Assessment Programme (iRAP)
  - Assessment of accident risks based on road attributes
  - Provide economic analysis of Safer Road Investment Plan
  - Track road safety performance

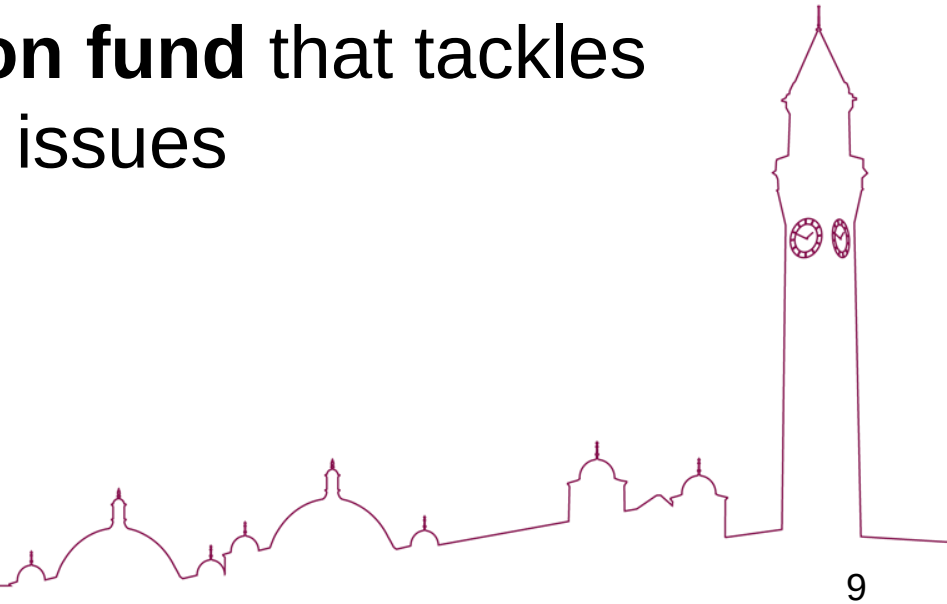
Objectives of Study

Objectives of this study

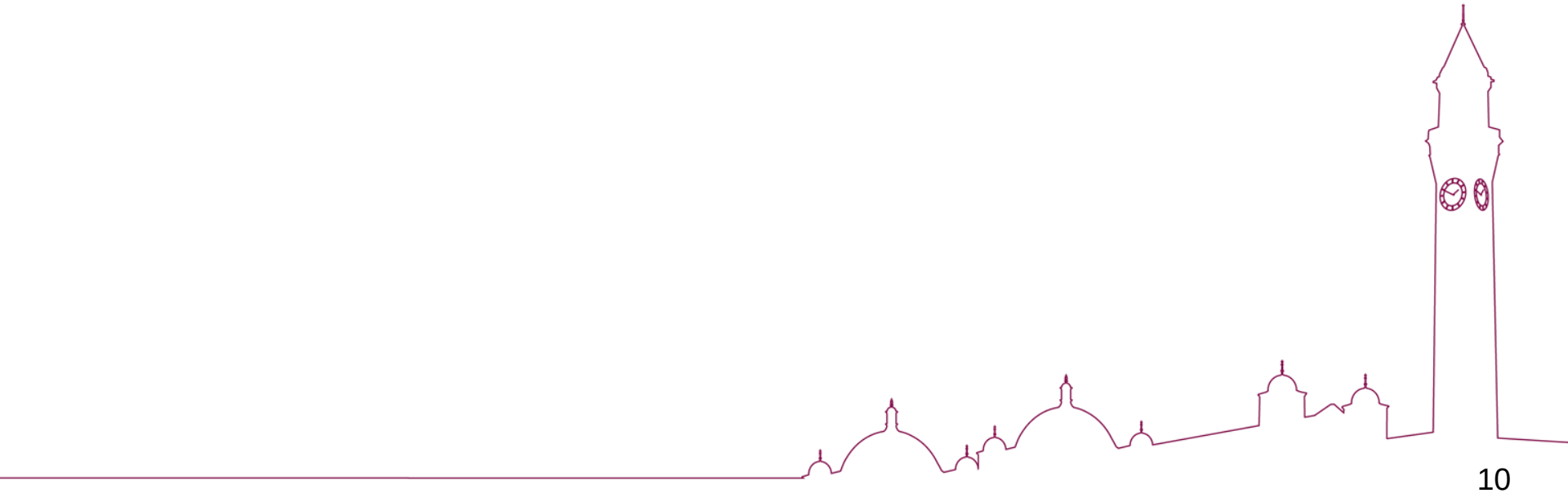
- to propose a **road maintenance planning framework** based on **road safety scores**
- to demonstrate the possibility of **integrating road maintenance and road safety programme** in order to tackle both maintenance and road safety issues with optimum budget

Why integrate Road Safety and Road Maintenance…

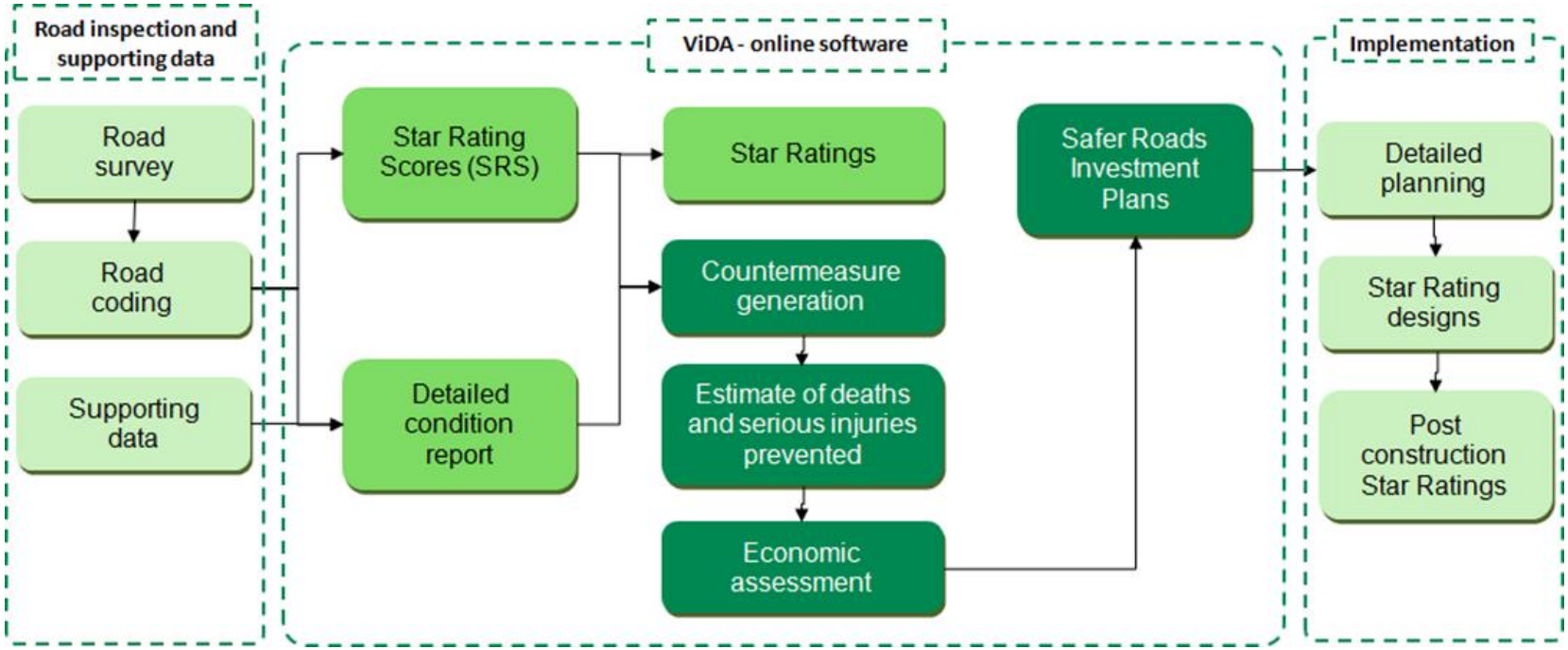
- Need to **measure safety impact** of road maintenance programme
- Need to **measure effectiveness** of road maintenance activities
- **Optimise road operation fund** that tackles maintenance and safety issues



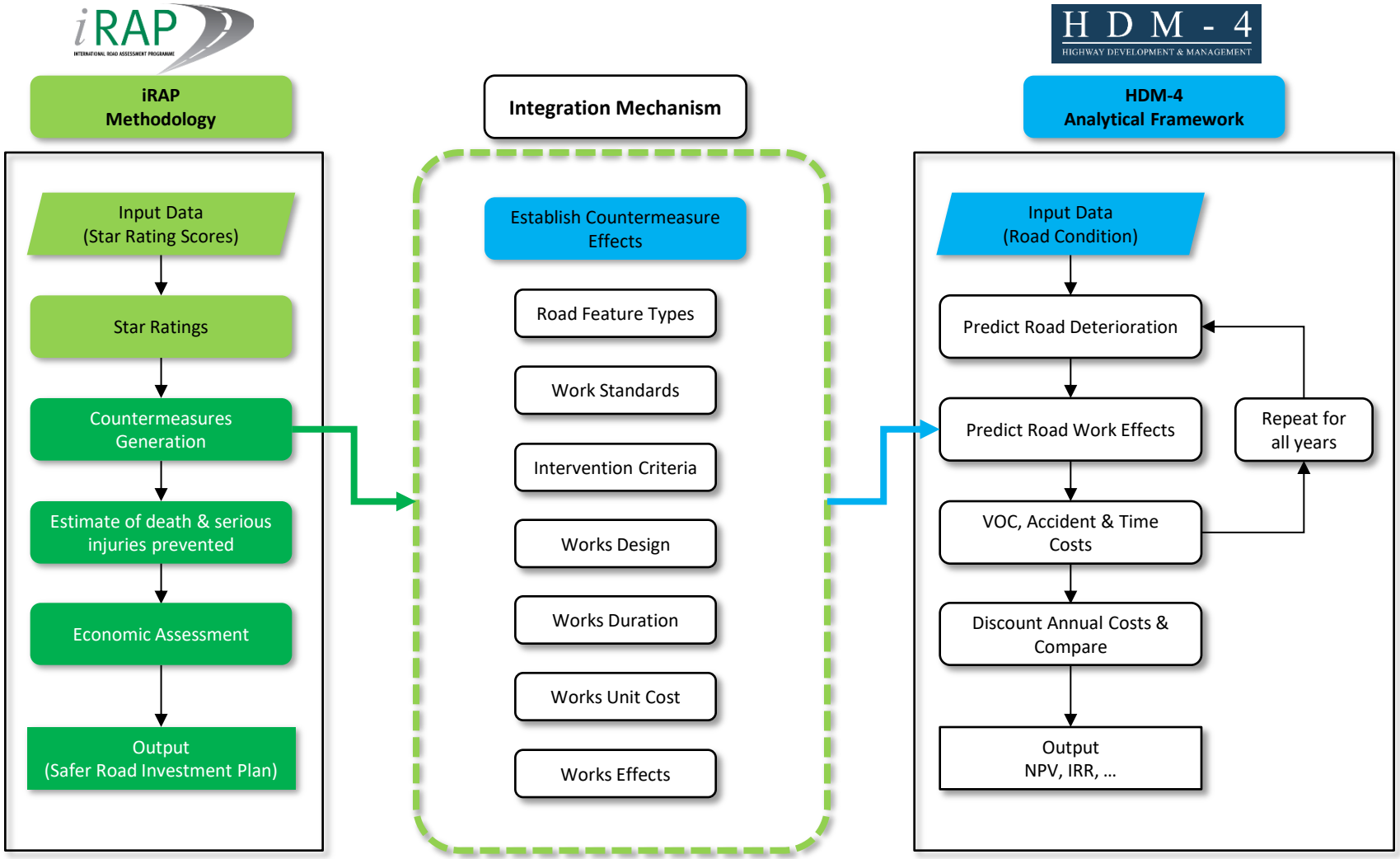
Methodology



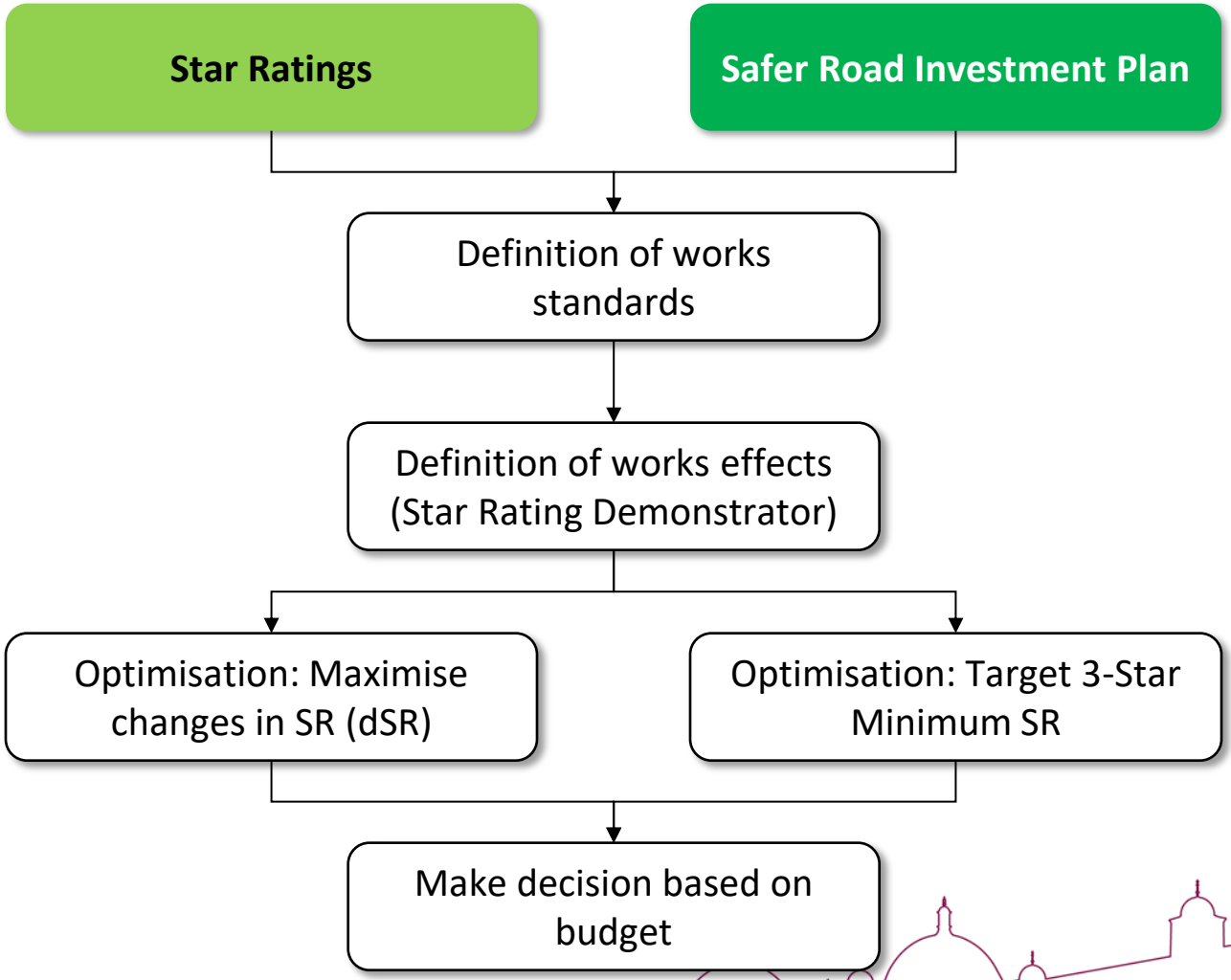
iRAP Methodology



Proposed Integration Mechanism



Research Methodology

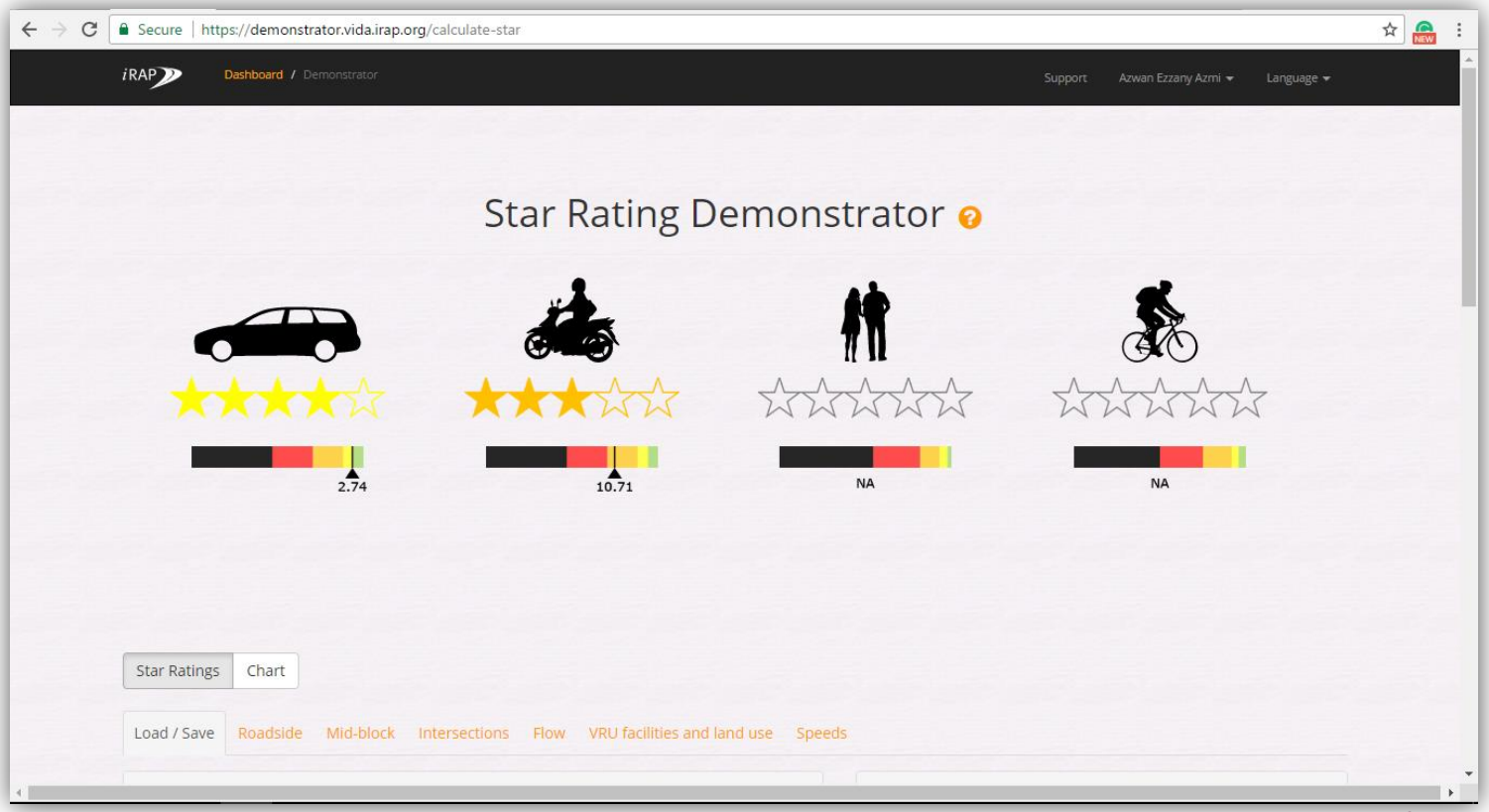


Work Standards

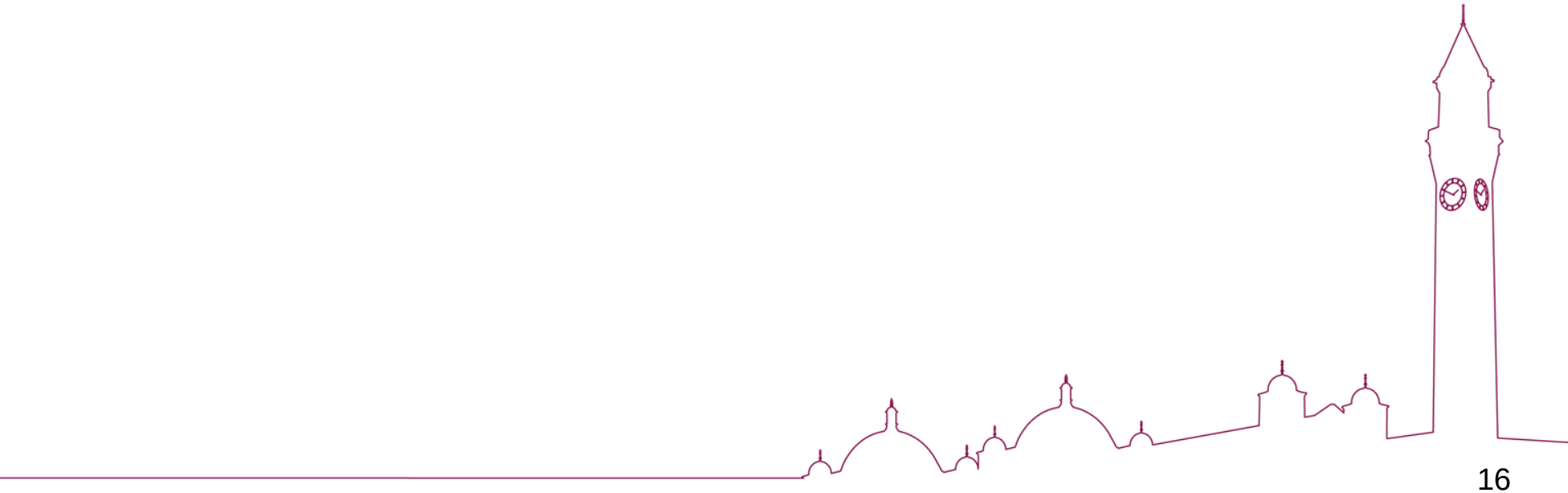
Star Rating	Work Effects (Countermeasure Effects)										
★★★★★											
★★★★											
★★★											
★★											
★											
Work Standard	D1	U1	U2	P1	P2	P3	R1	R2	R3	R4	R5
Work Category	Development	Upgrading 1	Upgrading 2	Periodic 1	Periodic 2	Periodic 3	Routine 1	Routine 2	Routine 3	Routine 4	Routine 5

Work Effects

https://demonstrator.vida.irap.org/calculate-star



Case Study



Case Study: Malaysia

2016 statistics

- Population : 31,660,000
- Reg. veh. : 27,613,120
- Accidents : 521,466
- Death : 7,152
- Index per 10,000 Vehicles : 2.59
- Index per 100,000 Population : 22.6

Budapest, Hungary

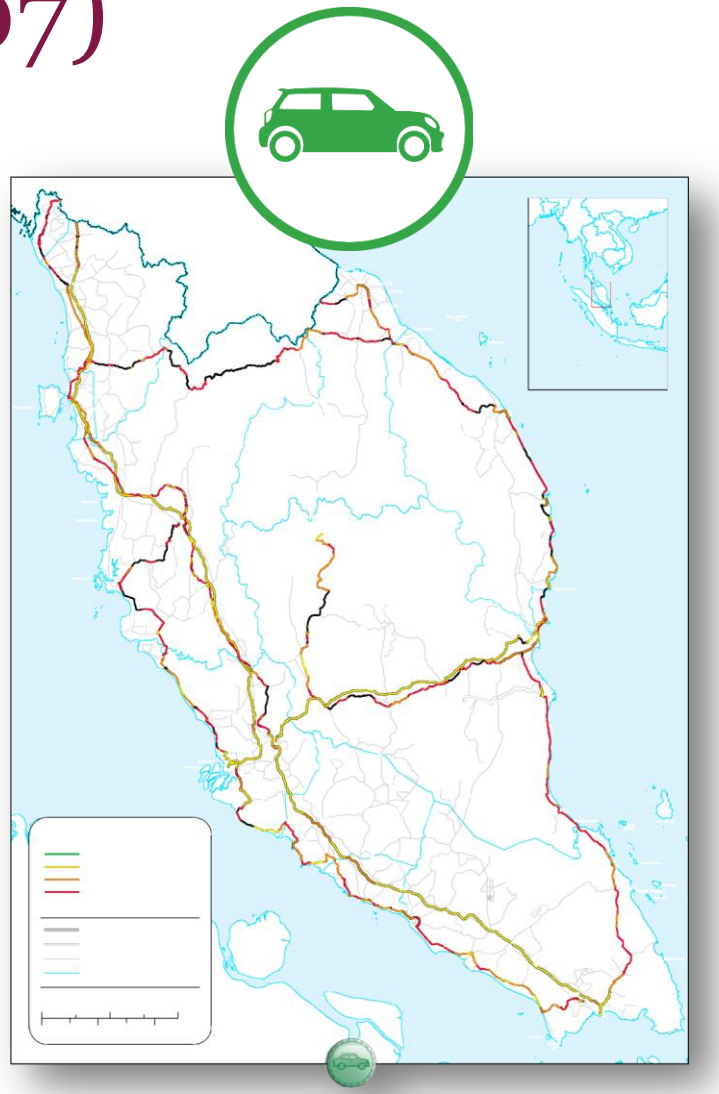
• *9,912 km*

Kuala Lumpur, Malaysia

UNIVERSITY OF BIRMINGHAM | COLLEGE OF ENGINEERING AND PHYSICAL SCIENCES

iRAP Pilot Project (2007)

Star Rating	Length (km)	Percentage
★★★★★	1	0.03%
★★★★	1163	31.53%
★★★	953	25.84%
★★	1127	30.56%
★	444	12.04%
Total	**3688**	**100%**



iRAP Pilot Project (2007)

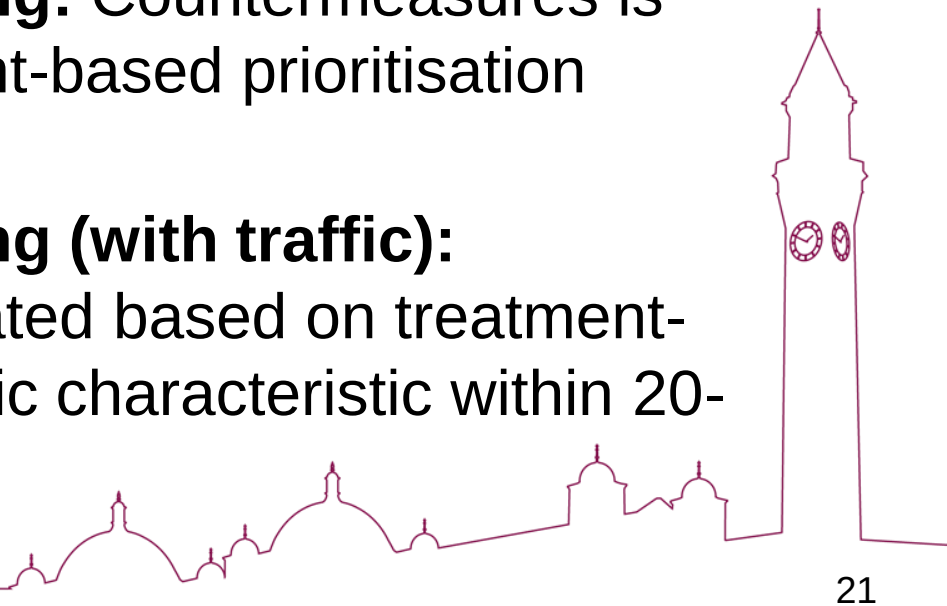
Route Number / Road Name	Traffic	Approximate Length (km)	%	Star Rating (km)				
				★	★★	★★★	★★★★	★★★★★
E1 Kuala Lumpur – Bukit Kayu Hitam	40000	495	13.42			80	415	
E2 Johor Bahru – Kuala Lumpur	35000	335	9.08			62	273	
E8 Karak - Kuantan	30000	236	6.40	5		5	225	1
Total Traffic T1	**105000**	**1066**	**28.90**	**5**	**0**	**147**	**913**	**1**
F1 Alor Setar – Kuala Lumpur	15000	459	12.45	30	270	110	49	
F3 Rantau Panjang – Johor Bahru	15000	725	19.66	59	324	292	50	
F2 Gebeng - Karak	10000	208	5.64	60	70	60	18	
F5 Johor Bahru - Ipoh	10000	680	18.44	70	270	240	100	
F7 Padang Besar – Alor Setar	10000	78	2.11	15	58	5		
Total Traffic T2	**60000**	**2150**	**58.30**	**234**	**992**	**707**	**217**	**0**
F4 Gerik – Kota Bahru	7000	200	5.42	100	70	30		
F8 Bentong – Sungai Temau	7000	163	4.42	50	20	60	33	
F67 Sungai Petani - Baling	3000	55	1.49	30	20	5		
F76 Baling - Gerik	3000	54	1.46	25	25	4		
Total Traffic T3	**20000**	**472**	**12.80**	**205**	**135**	**99**	**33**	**0**
TOTAL		**3688**	**100.00**	**444**	**1127**	**953**	**1163**	**1**

Safer Road Investment Plan (iRAP)

*Star Rating Investment Plan (SRIP) (Countermeasure Types)	*Length or number of sites	*Estimated Cost to Build and Maintain (20 years) MYR 'mil	*Benefit-Cost Ratio	Work Standards	Work Effects
Roadside safety - hazard removal	1650 km	24	121	Routine	R1/R2/R3/R4/R5
Realignment – horizontal	3 km	1	117	Upgrading	U1
Intersection – roundabout	20 sites	0.3	39	Periodic	P1
Central hatching	10 km	0.4	36	Periodic	P1
Intersection - right turn provision (signalised site)	60 sites	4	16	Periodic	P3
Additional lane	380 km	179	14	Development	D1
Intersection - right turn provision (unsignalised site)	120 sites	14	14	Periodic	P1
Intersection – signalise	190 sites	25	13	Upgrading	U1
Shoulder widening	270 km	34	12	Periodic	P1
Median barrier	40 km	20	12	Upgrading	U1
Improve delineation	130 km	11	12	Periodic	P1
Road surface upgrade	10 km	0.8	11	Periodic	P3
Duplication (additional lanes)	120 km	220	10	Development	D1
Roadside safety – barriers	30 km	9	10	Periodic	P1
Lane widening	30 km	6	9	Periodic	P1
Rumble strip / flexi-post	10 km	0.5	7	Periodic	P2
Regulate roadside commercial activity	0.2 km	0.03	7	Periodic	P2
Parking improvements	0.1 km	0.02	7	Periodic	P2
TOTAL		549.05 **(581.08)	16		

4 Budget Strategies

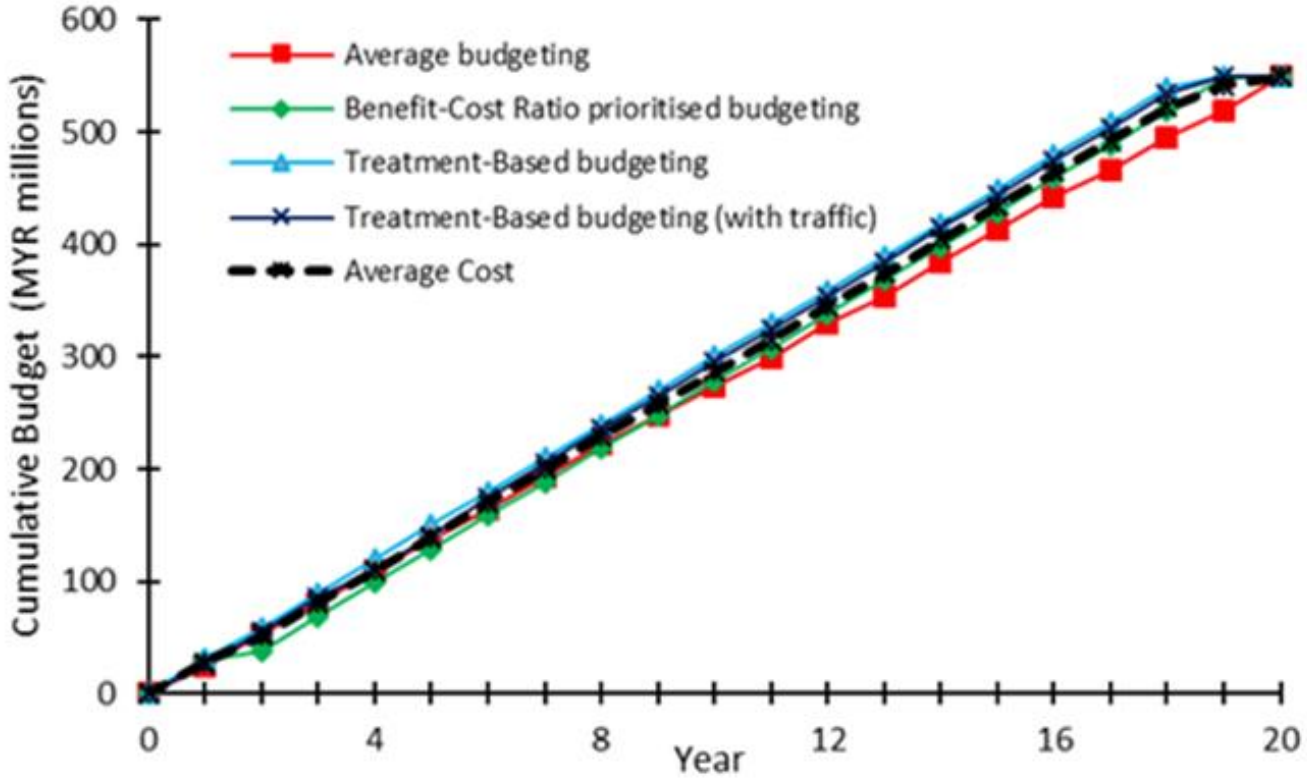
- **Average budgeting:** countermeasures are spread out within 20-years
- **Benefit-Cost Ratio prioritised budgeting:** Countermeasures are allocated based on benefit-cost ratio prioritisation within 20-years
- **Treatment-Based budgeting:** Countermeasures is allocated based on treatment-based prioritisation within 20-years
- **Treatment-Based budgeting (with traffic):** Countermeasures are allocated based on treatment-based prioritisation and traffic characteristic within 20-years



Treatment-Based budgeting

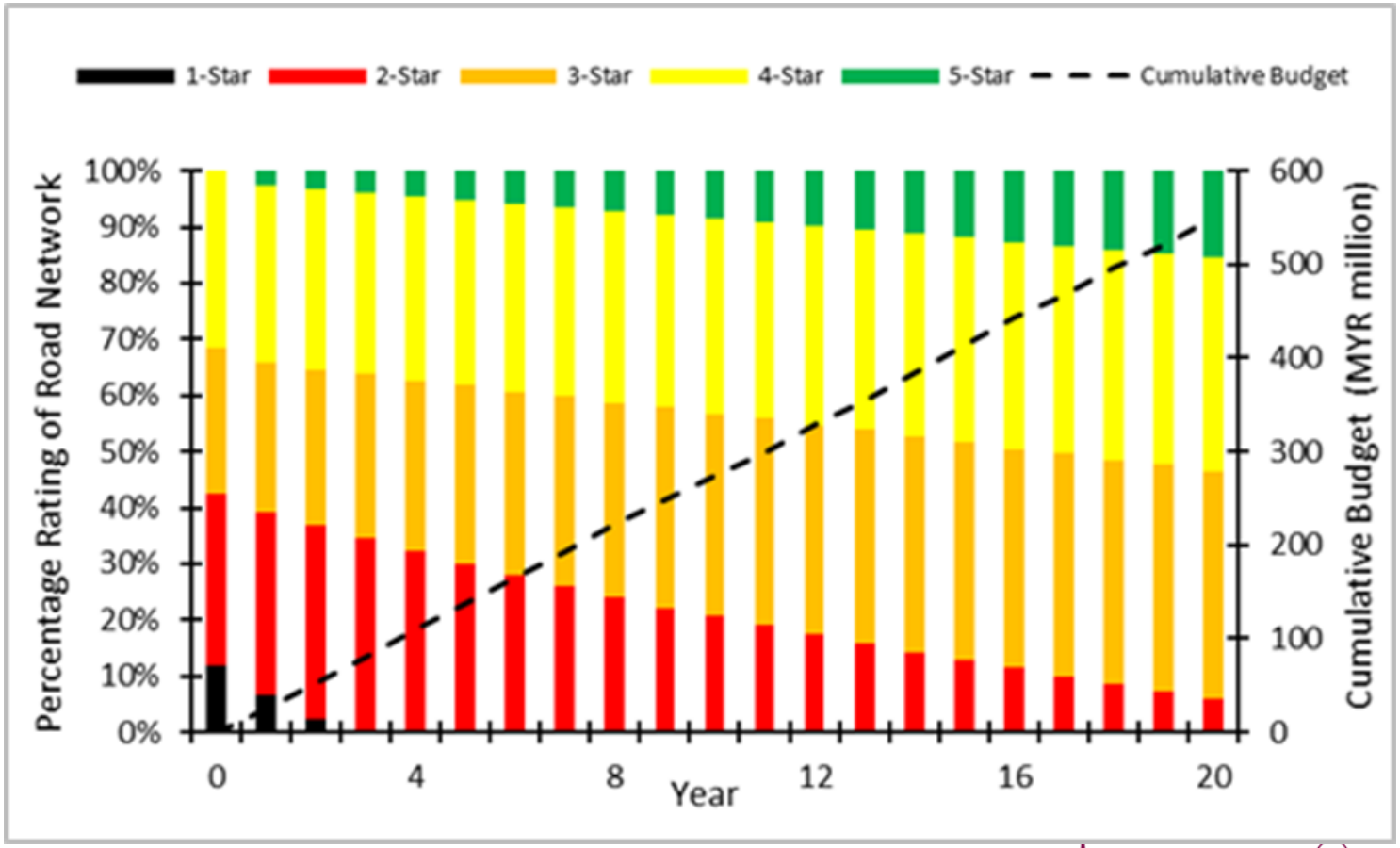
Hierarchy of Maintenance Works	Work Effects (Star Rating)					Works Category	Traffic Hierarchy		
	1	2	3	4	5		T1	T2	T3
P1						Periodic	1	2	3
R2						Routine / Cyclic	4	5	6
R1						Routine / Cyclic	7	8	9
P2						Periodic	10	11	12
U1						Upgrading	13	14	15
U2						Upgrading	16	17	18
D1						Development	19	20	21
R3						Routine / Cyclic	22	26	30
P3						Periodic	23	27	31
R4						Routine / Cyclic	24	28	32
R5						Routine / Cyclic	25	29	33

Distribution of Budget Within 20-years analysis period

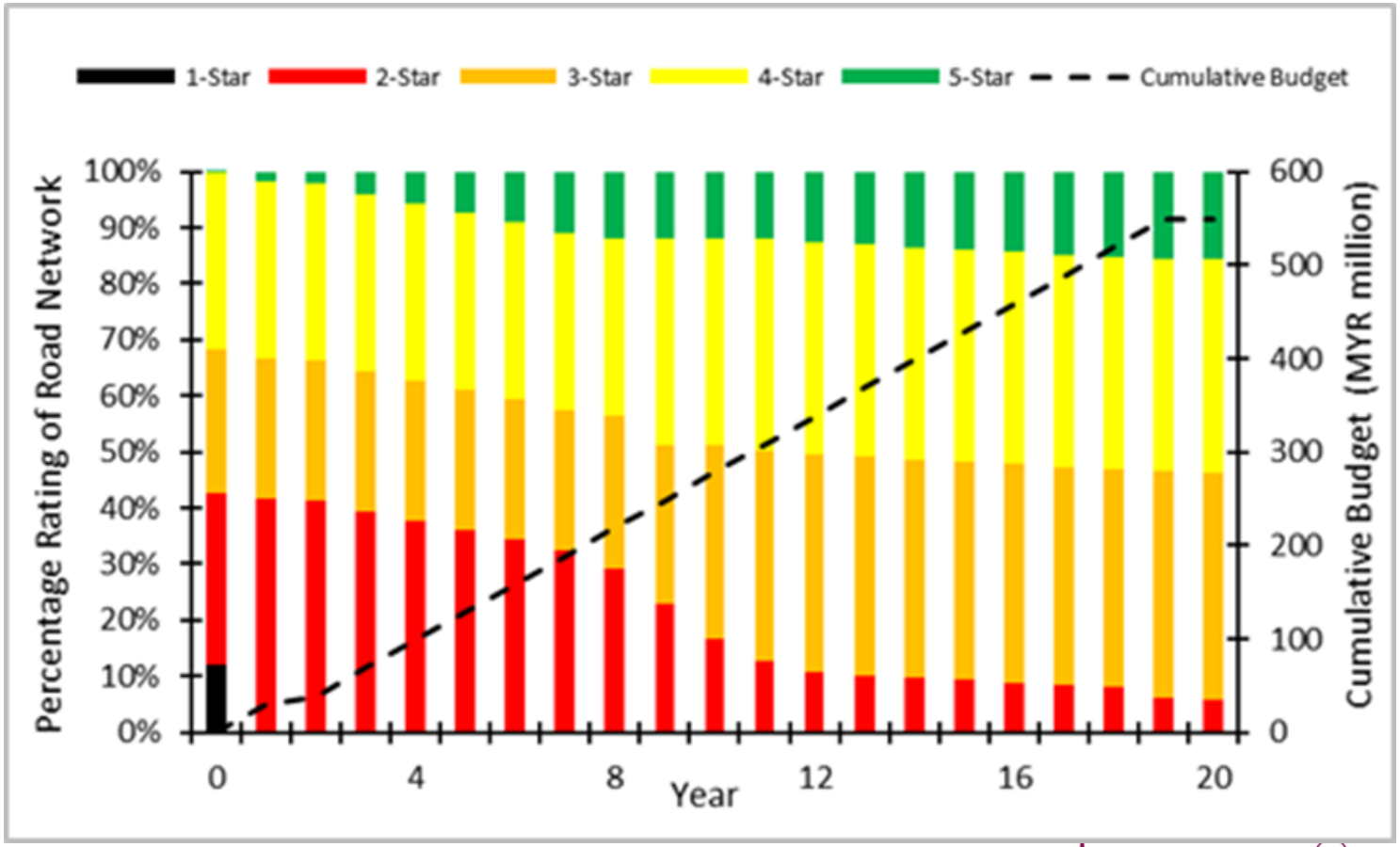


Result & Discussion

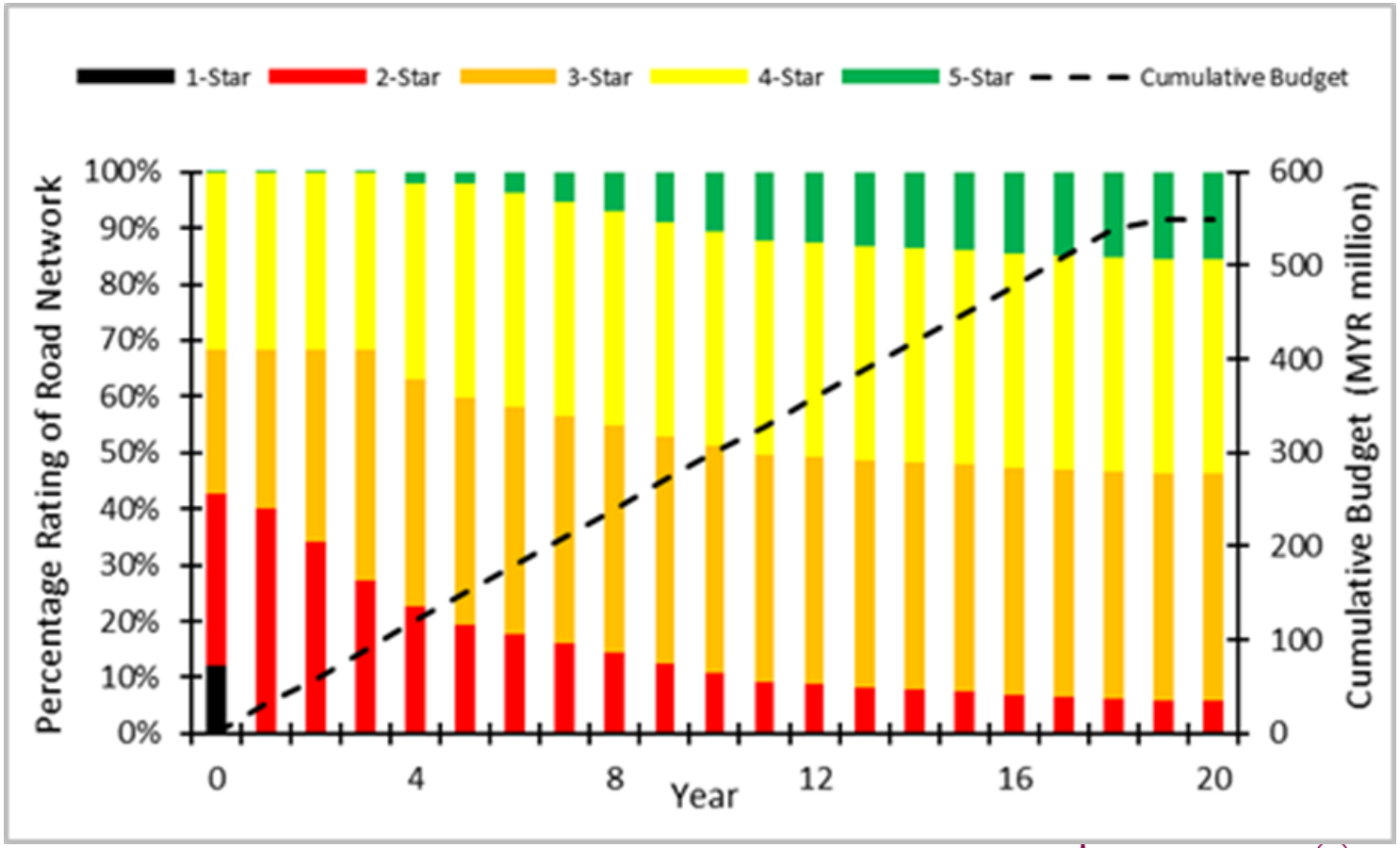
Average budgeting



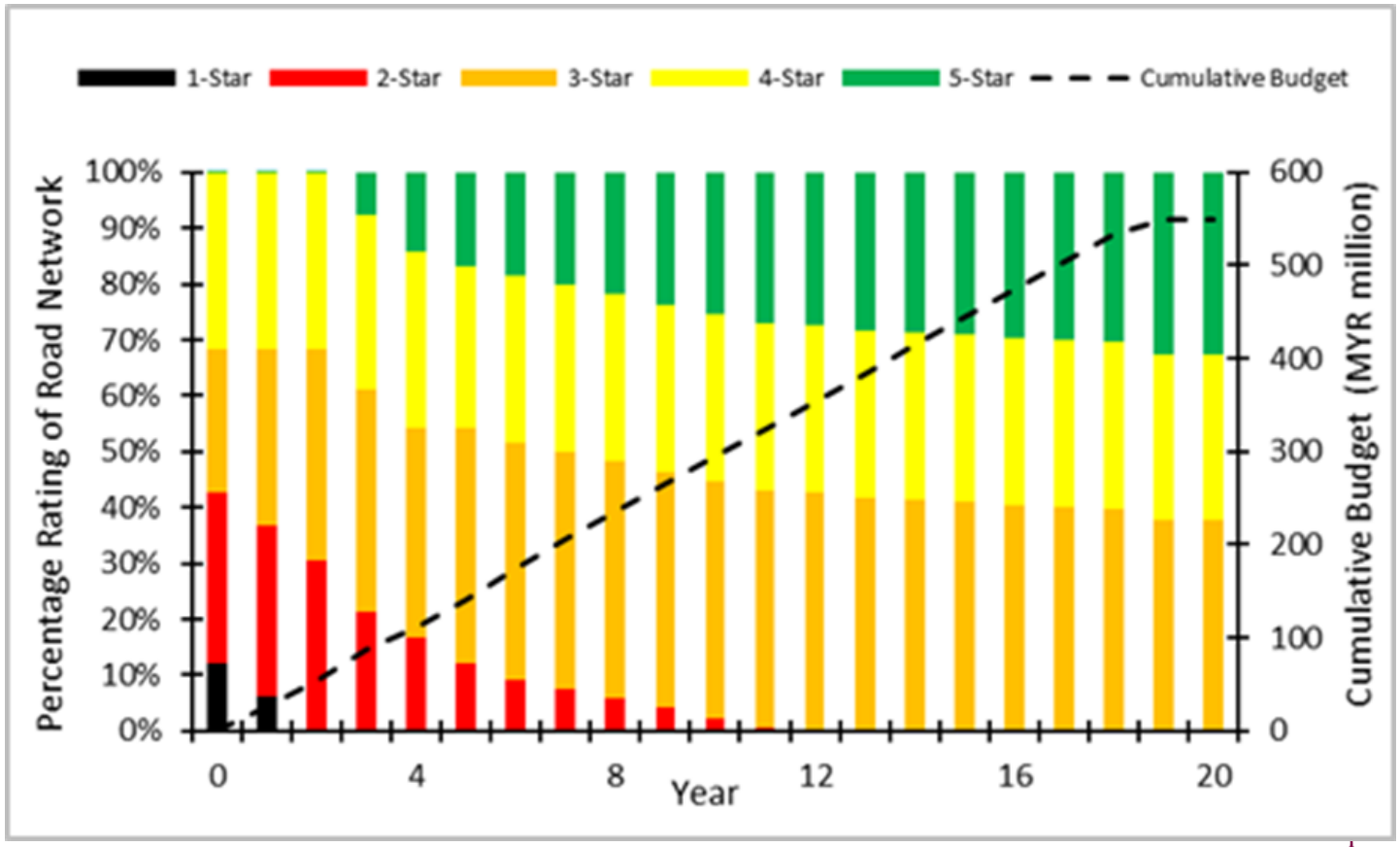
Benefit-Cost Ratio prioritised budgeting



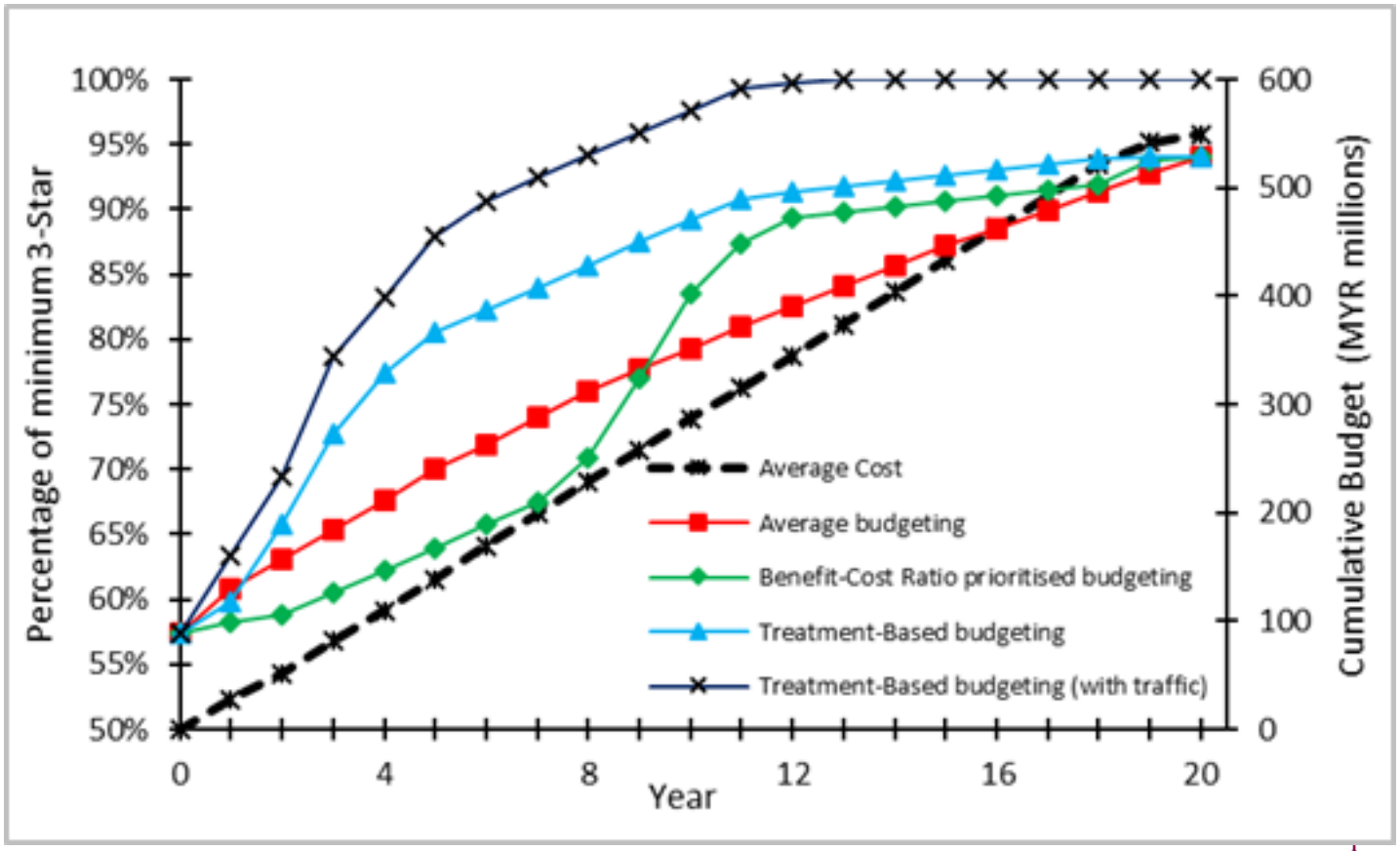
Treatment-Based budgeting



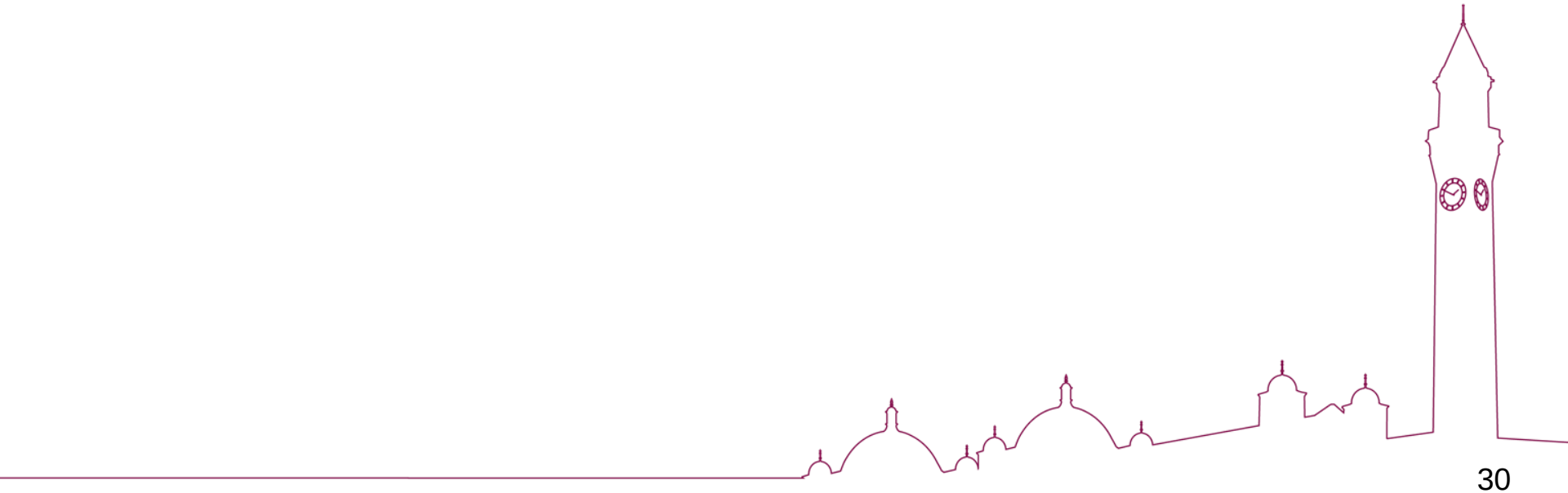
Treatment-Based budgeting (with traffic)



Changes to minimum 3-Star roads



Conclusion

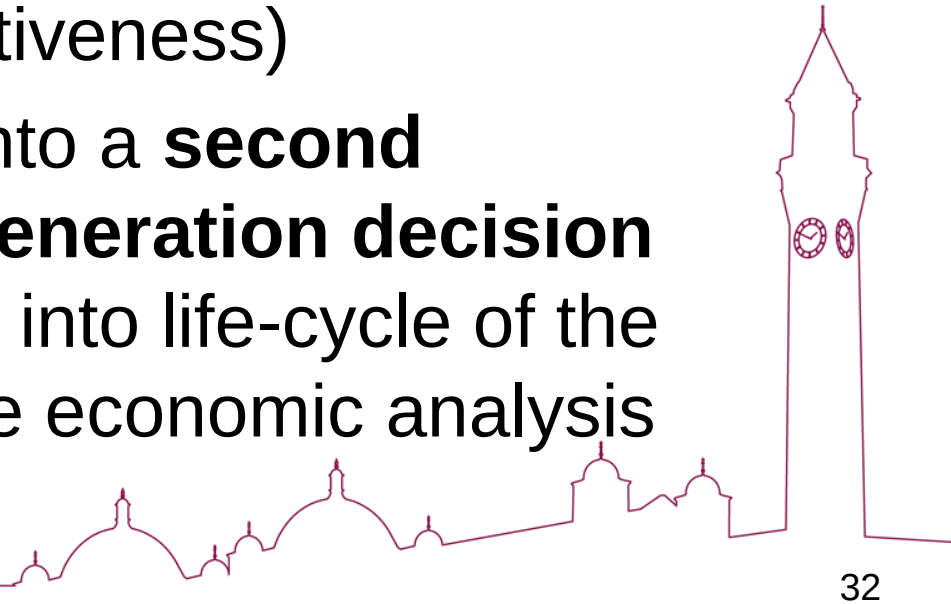


Conclusion

- This study has **successfully demonstrated the methodology** on how to identify the average road safety condition with regards to different budget strategy and budget constraint
- **Traffic hierarchy** may reflects the effects of strategies
- This study is not intended to identify the best strategy to implement road safety programme

Future Works

- To include **other occupants** (motorcycle, bicycle and pedestrian)
- To investigate the **Work Effects** or Countermeasure Effects for all 94 type of countermeasures (effectiveness)
- To develop this model into a **second generation and third generation decision support tool** by looking into life-cycle of the asset and more advance economic analysis



Thank you
Köszönöm
Terima kasih

Contact:

Azwan Ezzany Azmi

aea199@student.bham.ac.uk

azwanea.jkr@1govuc.gov.my