Road Asset Management Systems

Session 4: Data Analysis and Planning

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November 2022

Agenda

Day 1	Day 2
Session 1 **Introduction to RAMS**	Session 5 **RAMS Action Plan**
Coffee break	Coffee break
Session 2 **RAMS Data Collection**	Session 6 **RAMS Action Plan**
Lunch	Lunch
Session 3 **RAMS Data Management**	Session 7 **RAMS Institutionalization**
Coffee break	Coffee break
Session 4 **RAMS Data Analysis and Planning**	Session 8 **Conclusions and next steps**

Analysis and Planning

- Determine current treatment needs
  - Based on road conditions – roughness, surface defects
- Predict future road conditions and treatment needs
  - Based on road deterioration modelling
- Prioritize budget allocations to different roads/treatments
  - Based on prioritization criteria – optimize results
  - Based on available budget

Prioritization Criteria

- Different criteria used

- Economic benefits most commonly used
  - Benefit/cost ratio
  - NPV of the net benefits divided by NPV of the treatment costs
  - Strongly influenced by traffic volumes (road user costs)

- Sometimes complemented by other criteria
  - Connectivity – connecting administrative centres, airports/ports, border crossings
  - Economic productivity – connecting industrial, agricultural, tourism areas
  - Population – connecting densely populated areas, large populations
  - Social inclusion – connecting poor areas, remote areas

Economic benefits

- 3 main concepts

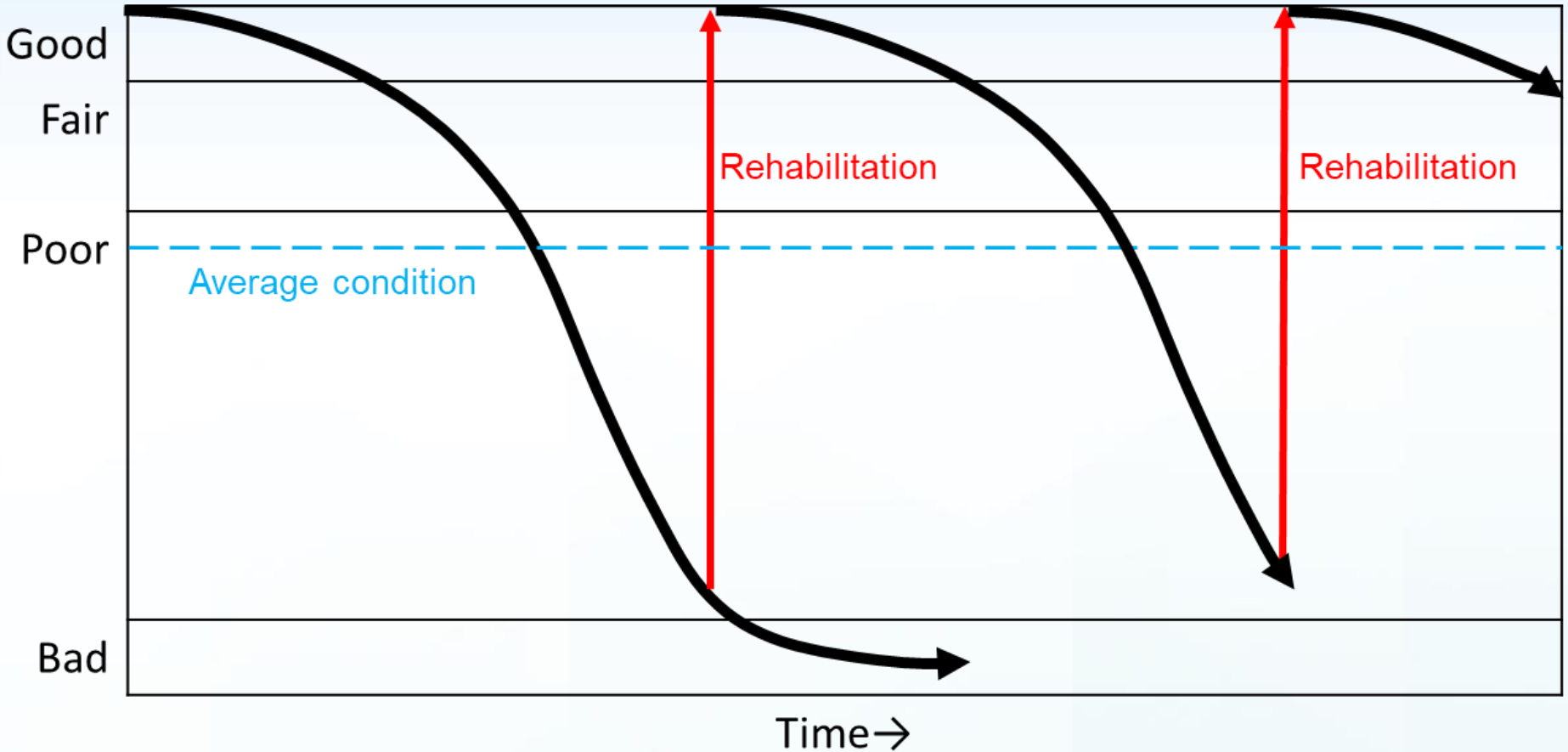
- Deterioration and maintenance
  - Roads gradually deteriorate depending on traffic, climate, topography, design, etc.
  - Different maintenance and repair types have different effects on road conditions

- Minimize total transport costs
  - Agency costs of carrying out maintenance and rehabilitation
  - Road user costs as a result of road conditions

- Influence of traffic
  - More traffic causes quicker deterioration
  - More traffic results in higher influence of road user costs on total transport costs

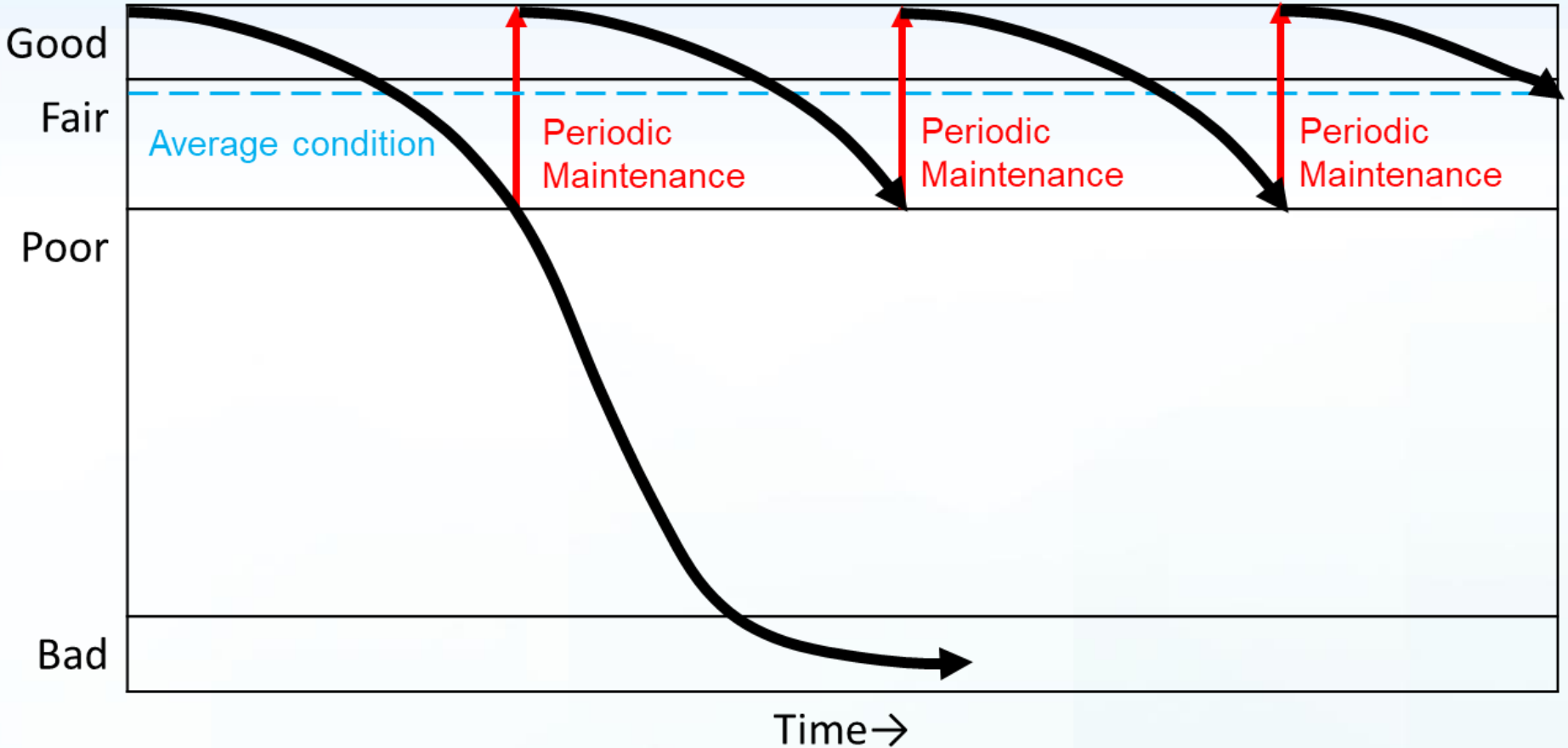
Deterioration and Maintenance

- Deterioration left unaddressed – reduced lifespan
- Costly rehabilitation needed
- Average road condition poor



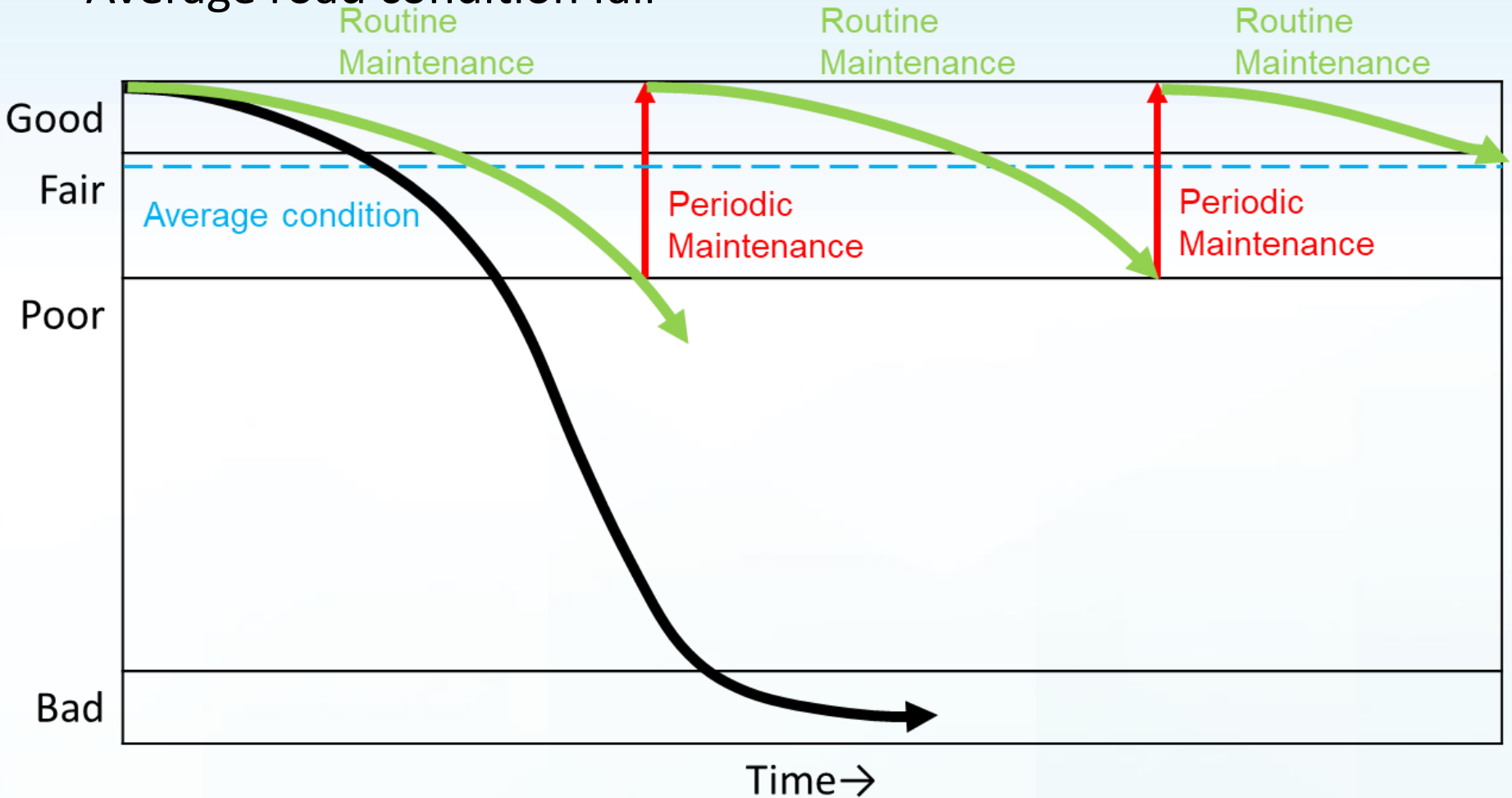
Deterioration and Maintenance

- Condition improved before it becomes poor
- Periodic maintenance less costly (but more frequent)
- Average road condition fair

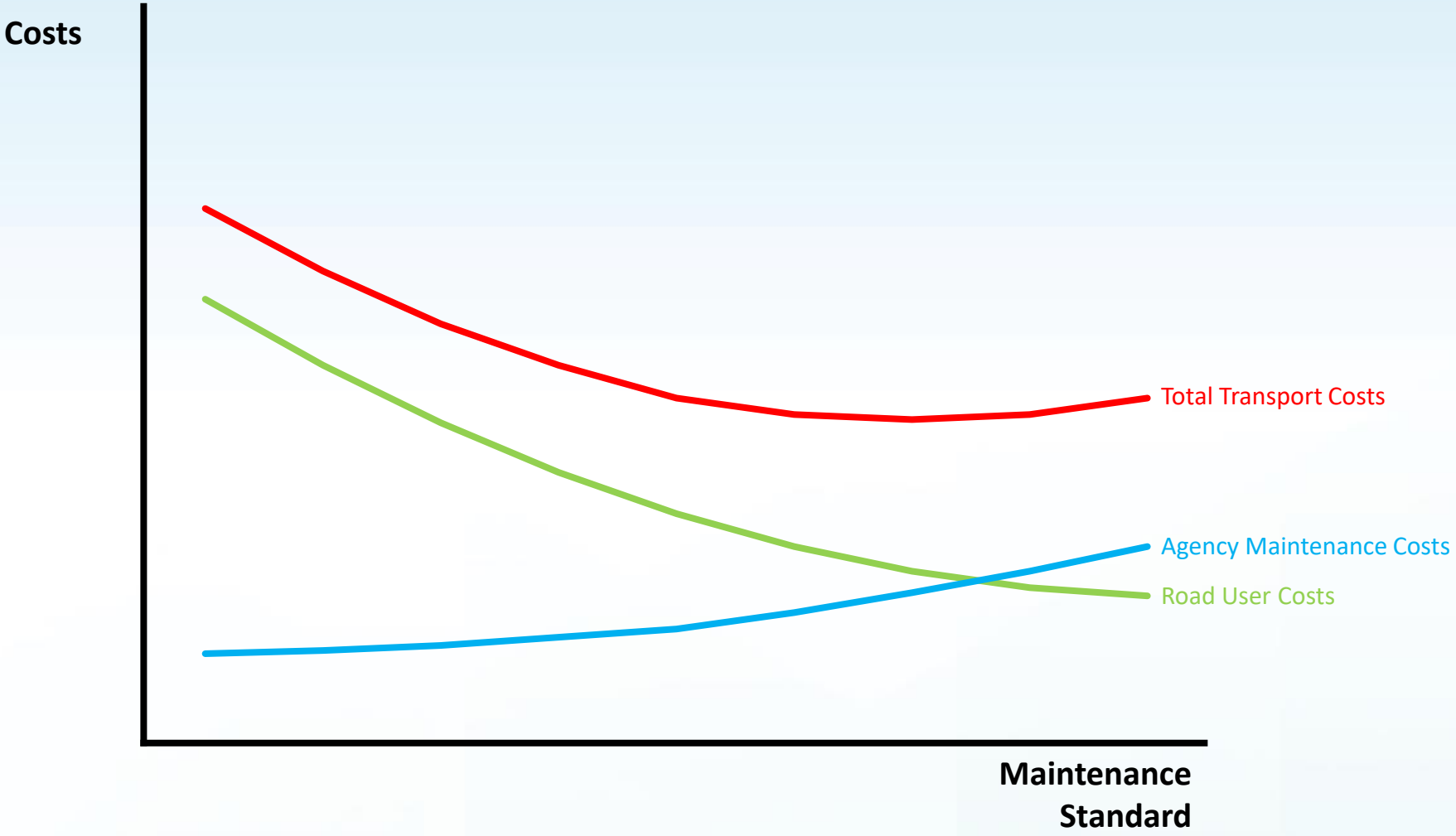


Deterioration and Maintenance

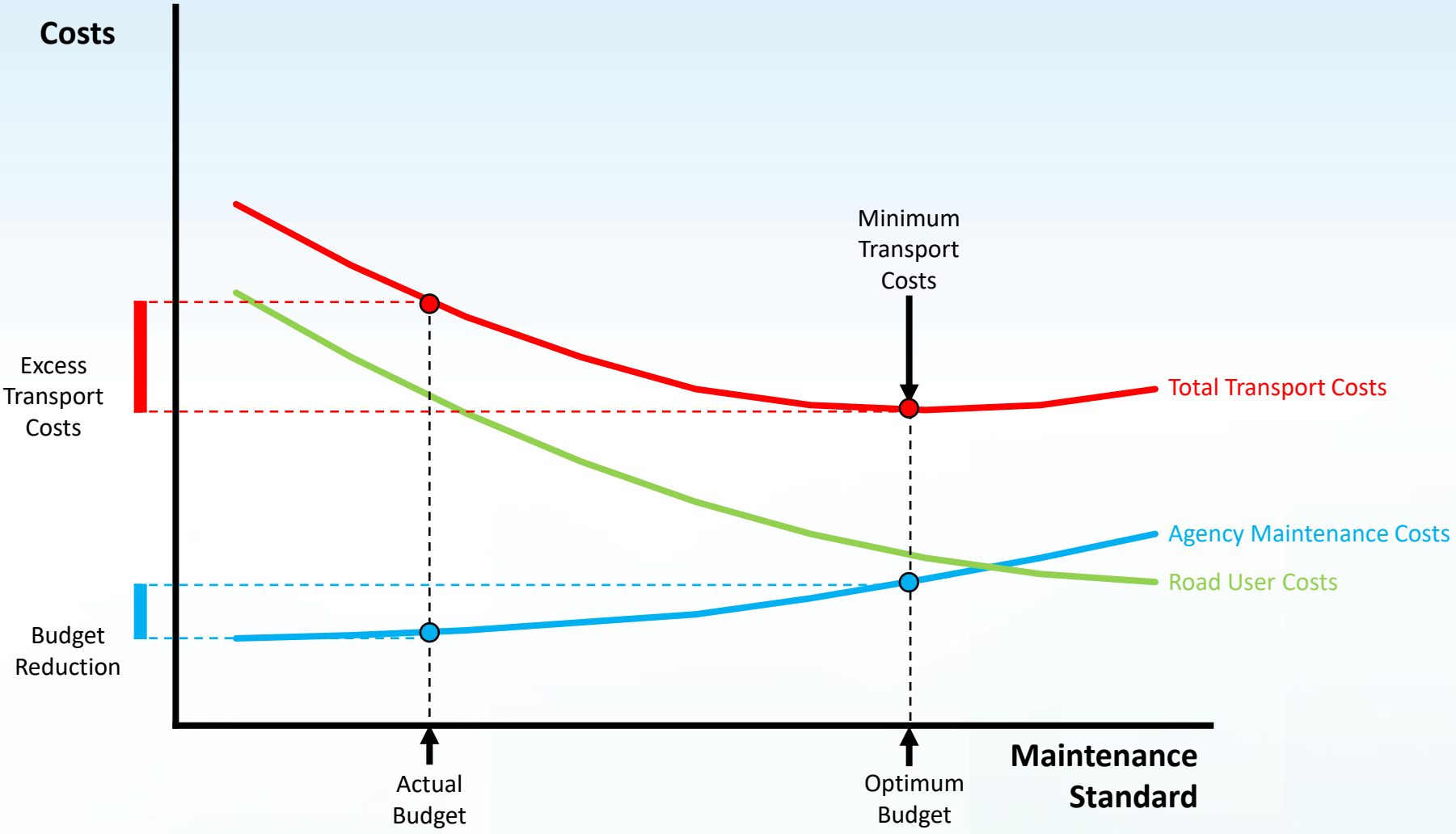
- Deterioration slowed down through annual routine maintenance
- Low additional cost, but high cost savings
- Average road condition fair



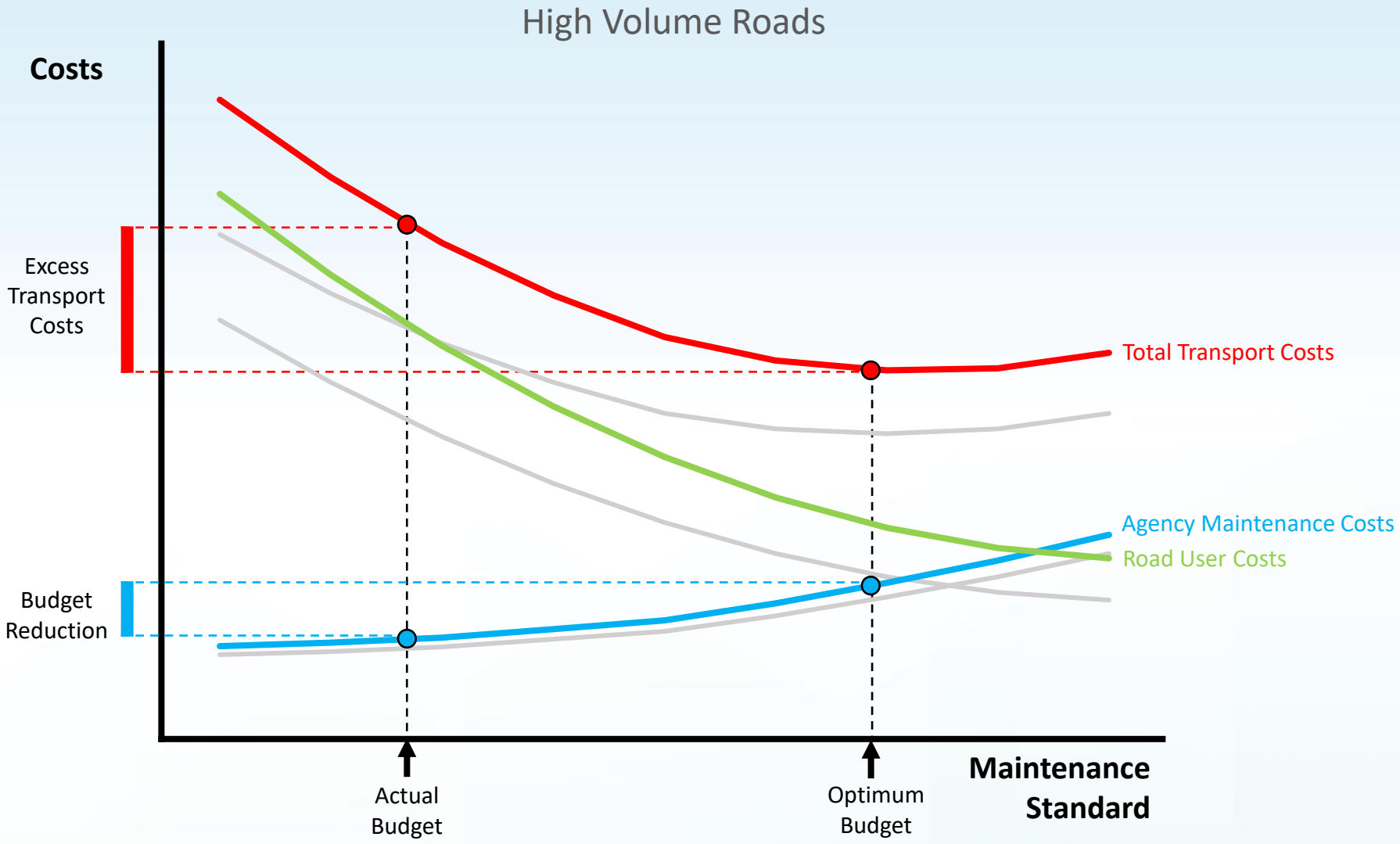
Total Transport Costs



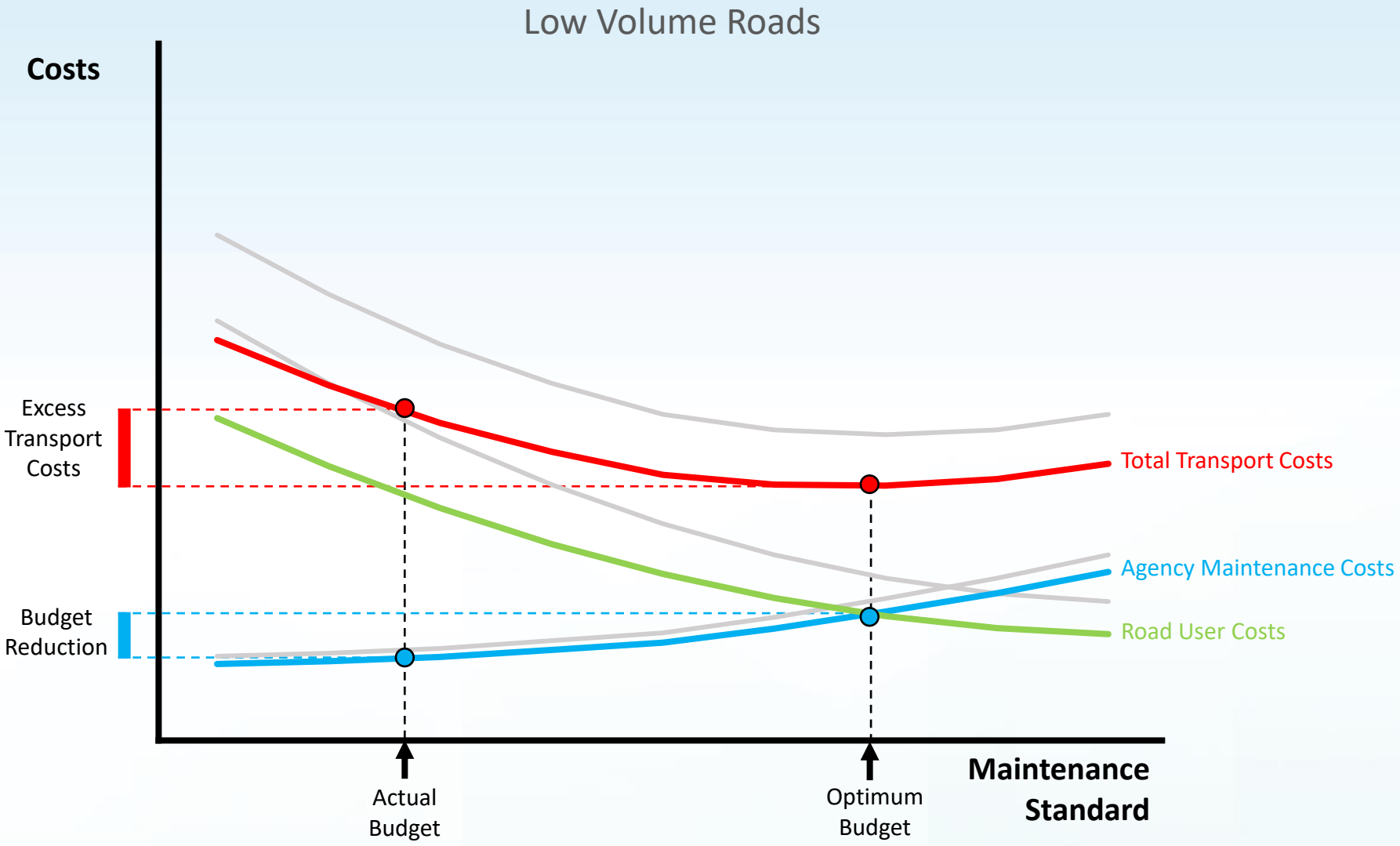
Total Transport Costs



Influence of Traffic



Influence of Traffic



Economic benefits

- We can model the condition of different roads over time
  - Depending on characteristics (design, traffic, climate, topography, etc.)
  - Depending on the maintenance treatments and their timing

- We can calculate the total transport costs
  - Costs of planned treatments and their timing
  - Road user costs
    - Depending on resulting road conditions
    - Depending on traffic volumes

- We can compare costs to benefits
  - Net present value of costs of treatments during planning period
  - Net present value of savings to total transport costs during planning period
  - NPV savings/costs compared to base scenario (do nothing)
  - Road/treatment combination with highest NPV/investment gets highest priority

Example

- High volume road in poor condition
  - Costs: Rehabilitation – NPV is $5.0 million
  - Benefits: Reduced total transport costs – NPV is $8.0 million
  - Benefits/Costs (NPV/CAP): 1.6
- Low volume road in poor condition
  - Costs: Rehabilitation – NPV is $5.0 million
  - Benefits: Reduced total transport costs – NPV is $6.0 million
  - Benefits/Costs (NPV/CAP): 1.2
- High volume road in fair condition
  - Costs: Periodic maintenance – NPV is $0.5 million
  - Benefits: Reduced total transport costs – NPV is $1.0 million
  - Benefits/Costs (NPV/CAP): 2.0
- Low volume road in fair condition
  - Costs: Periodic maintenance – NPV is $0.5 million
  - Benefits: Reduced total transport costs – NPV is $0.8 million
  - Benefits/Costs (NPV/CAP): 1.6

Example: HDM4

HDM-4
HIGHWAY DEVELOPMENT & MANAGEMENT

Work Programme Unconstrained by Year

Study Name: **Myanmar Strategy ALL 26OCT2015**
Run Date: **05-11-2015**
Currency: **US Dollar**

Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financial Costs	Cum. Costs
2016	T6;R3;C3;P1;	C3	2.0	3330	Bituminous	OL 40@6IRI	40.258	0.220	0.220
	T6;R3;C2;P6;	C2	162.0	3330	Bituminous	OL 40@6IRI	39.597	17.822	18.042
	T6;R2;C2;P6;	C2	315.0	3330	Bituminous	OL 40@4IRI	39.190	34.653	52.695
	T6;R2;C3;P1;	C3	6.0	3330	Bituminous	OL 40@4IRI	38.326	0.660	53.355
	T6;R3;C2;P1;	C2	99.0	3330	Bituminous	OL 40@6IRI	37.605	11.682	65.037
	T6;R2;C2;P1;	C2	145.0	3330	Bituminous	OL 40@4IRI	33.828	18.035	83.072
	T5;R3;C3;P1;	C3	24.0	1942	Bituminous	OL 40@6IRI	22.017	2.640	85.713
	T5;R3;C2;P1;	C2	145.0	1942	Bituminous	OL 40@6IRI	21.956	15.952	101.664
	T5;R3;C3;P6;	C3	54.0	1942	Bituminous	OL 40@6IRI	21.749	5.941	107.605
	T5;R3;C4;P1;	C4	14.0	1942	Bituminous	OL 40@6IRI	21.410	1.540	109.145
	T5;R2;C3;P1;	C3	26.0	1942	Bituminous	OL 40@4IRI	20.568	2.860	112.005
	T5;R2;C2;P1;	C2	371.0	1942	Bituminous	OL 40@4IRI	20.337	40.814	152.819
	T5;R2;C3;P6;	C3	86.0	1942	Bituminous	OL 40@4IRI	20.185	9.461	162.280
	T5;R2;C4;P1;	C4	39.0	1942	Bituminous	OL 40@4IRI	19.644	4.290	166.571
	T4;R3;C3;P1;	C3	43.0	832	Bituminous	OL 40@6IRI	14.937	2.844	169.415
	T6;R5;C3;P1;	C3	29.0	3330	Bituminous	MYA Upgrade Mac to .	14.674	11.165	180.580
	T6;R5;C2;P1;	C2	100.0	3330	Bituminous	MYA Upgrade Mac to .	14.587	38.500	219.080
	T5;R4;C4;P1;	C4	4.0	1942	Bituminous	Reh PenMac@8	13.904	0.660	219.740
	T5;R4;C2;P1;	C2	51.0	1942	Bituminous	Reh PenMac@8	13.727	8.418	228.158
	T5;R4;C3;P1;	C3	15.0	1942	Bituminous	Reh PenMac@8	13.669	2.476	230.634
	T6;R4;C3;P1;	C3	2.0	3330	Bituminous	MYA Upgrade Mac to .	13.255	0.770	231.404
	T6;R4;C2;P1;	C2	41.0	3330	Bituminous	MYA Upgrade Mac to .	13.226	15.785	247.189
	T4;R2;C3;P1;	C3	120.0	832	Bituminous	OL 40@4IRI	13.114	7.882	255.070
	T4;R5;C2;P1;	C2	26.0	832	Bituminous	Reh PenMac@10	11.450	2.593	257.663

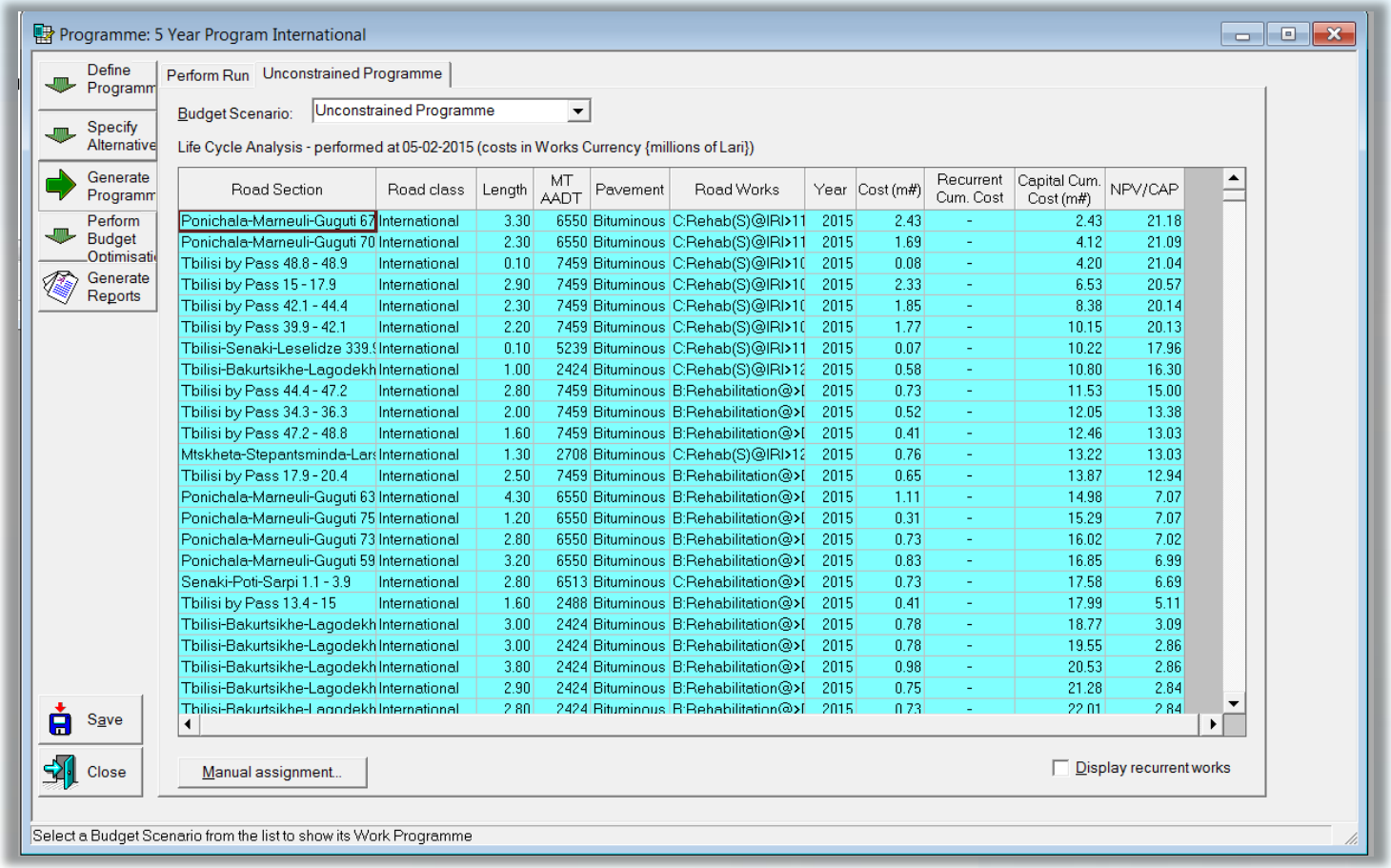
Example: HDM4

HDM-4 Work Programme Unconstrained by Year

2016	T4;R2;C4;P1;	C4	140.0	832	Bituminous	OL 40@4IRI	10.311	11.465	272.171
	T6;R5;C2;P6;	C2	55.0	3330	Bituminous	Rehab (AC) @8	9.966	21.175	293.346
	T4;R3;C4;P1;	C4	186.0	832	Bituminous	OL 40@6IRI	9.458	18.170	311.515
	T4;R2;C2;P1;	C2	192.0	832	Bituminous	OL 40@4IRI	9.180	16.886	328.402
	T4;R5;C4;P1;	C4	66.0	832	Bituminous	Reh PenMac@10	8.653	8.325	336.727
	T4;R4;C3;P1;	C3	13.0	832	Bituminous	Reh PenMac@8	8.589	1.440	338.167
	T6;R4;C2;P6;	C2	29.0	3330	Bituminous	Rehab (AC) @8	8.584	11.165	349.332
	T5;R5;C3;P1;	C3	71.0	1942	Bituminous	MYA Upgrade Mac to	8.018	27.335	376.667
	T5;R5;C4;P1;	C4	42.0	1942	Bituminous	MYA Upgrade Mac to	8.018	16.170	392.837
	T5;R5;C2;P1;	C2	40.0	1942	Bituminous	MYA Upgrade Mac to	7.792	15.400	408.237
	T4;R5;C3;P1;	C3	99.0	832	Bituminous	Reh PenMac@10	7.550	14.163	422.401
	T4;R4;C2;P1;	C2	7.0	832	Bituminous	Reh PenMac@8	7.365	0.879	423.280
	T3;R3;C2;P1;	C2	137.0	388	Bituminous	OL 40@6IRI	6.504	8.350	431.629
	T5;R5;C3;P6;	C3	148.0	1942	Bituminous	Rehab (AC) @8	6.438	56.980	488.609
	T4;R4;C4;P1;	C4	70.0	832	Bituminous	Reh PenMac@8	6.291	9.986	498.596
	T3;R3;C4;P1;	C4	159.0	388	Bituminous	OL 40@6IRI	5.760	10.804	509.400
	T3;R3;C3;P1;	C3	21.0	388	Bituminous	OL 40@6IRI	5.741	1.412	510.812
	T5;R4;C3;P6;	C3	34.0	1942	Bituminous	Rehab (AC) @8	5.420	13.090	523.902
	T6;R4;C1;P2;	C1	2.0	3330	Concrete	Overlay80mm	5.058	2.769	526.671
	T6;R3;C1;P2;	C1	5.0	3330	Concrete	Overlay60mm	5.006	5.190	531.861
	T3;R5;C4;P1;	C4	247.0	388	Bituminous	Reh PenMac@10	4.973	24.276	556.137
	T3;R3;C4;P6;	C4	112.0	388	Bituminous	OL 40@6IRI	4.847	9.283	565.420
	T3;R2;C2;P1;	C2	448.0	388	Bituminous	OL 40@4IRI	4.638	28.967	594.387
	T3;R5;C2;P1;	C2	96.0	388	Bituminous	Reh PenMac@10	4.343	10.492	604.878
	T3;R2;C4;P1;	C4	411.0	388	Bituminous	OL 40@4IRI	4.242	28.317	633.195
	T3;R4;C2;P1;	C2	42.0	388	Bituminous	Reh PenMac@8	4.058	4.077	637.272
	T3;R4;C4;P1;	C4	138.0	388	Bituminous	Reh PenMac@8	4.027	13.419	650.691
	T3;R4;C3;P1;	C3	6.0	388	Bituminous	Reh PenMac@8	3.941	0.597	651.288
	T3;R5;C3;P1;	C3	11.0	388	Bituminous	Reh PenMac@10	3.801	1.337	652.625
	T3;R2;C3;P1;	C3	113.0	388	Bituminous	OL 40@4IRI	3.581	8.833	661.458
	T2;R2;C3;P4;	C3	75.0	138	Unsealed	Gravel Resurface at 3(	2.681	2.200	663.658
	T2;R2;C4;P4;	C4	108.0	138	Unsealed	Gravel Resurface at 3(	2.584	3.255	666.913
	T2;R3;C3;P4;	C3	32.0	138	Unsealed	Gravel Resurface at 3(	2.547	1.015	667.928
	T2;R2;C3;P5;	C3	35.0	138	Unsealed	Gravel Resurface at 3(	2.505	1.154	669.082

Programme Analysis

- Prioritization of individual road segments and related treatments
  - High data requirement (IQL 2 – IQL 3)
  - Preparation of (Multi-)Annual Works Programme



Example: Myanmar

- 5-year works programme

Road code	Road name	RDB Sections	Start (miles/furlongs)	End	Length of works (km) Overlay	Rehab	Upgrade PM	Upgrade AC	Total	Cost of works (MK billion) Overlay	Rehab	Upgrade PM	Upgrade AC	Total
	Ayeyarwady				**357.6**	**34.2**	**27.2**	**-**	**419.0**	**18.9**	**2.7**	**10.5**	**-**	**32.0**
DT162	Pa Thein-Ngwe Saung Road	10-30	0/0	29/1	48.4				48.4	2.6				2.6
DT165	Kyain Pin Sae-Set Kawt- Dana Phyu -Zalun Road	10-40	0/0	27/4	31.0		27.2		58.2	1.6		10.5		12.1
DT204	Hin Tha Da-Do Yar - Daunt Gyi- Da Na Phyu Road	10	0/0	0/5	16.1				16.1	0.8				0.8
DT205	Da Nu Phyu- Thaung Gyi Road	10-30	0/0	24/2		34.2			34.2		2.7			2.7
SR59	Ma Euu Pin-Twan Tay Road	10-20	0/0	23/2	36.8				36.8	1.9				1.9
UR20B	Yangon -Pa Thein Road	10-70	17/4	80/0	104.2				104.2	5.5				5.5
UR8A	Pa Thein - Mon Ywar Road	10-90	0/0	74/5	121.2				121.2	6.4				6.4
	Bago				**636.5**	**136.1**	**-**	**-**	**772.6**	**58.8**	**15.2**	**-**	**-**	**74.0**
DT53	Nyaung lay Pin - Pa Zun Myaung - Shwe Kyinn	10	0/0	12/4		28.1			28.1		3.5			3.5
DT57	Pyay-Pout Kaung-Taung Gu	40	40/0	80/1		64.0			64.0		8.0			8.0
IC25A	Yangon - Maw La Myin - Dewe - Myeik	10	60/5	86/6	42.9				42.9	3.9				3.9
IC25F	Sit Taung Bridge Approach	10	0/0	6/3	9.8				9.8	0.8				0.8
IC41	Yangon - Taungoo - Mandalay Highway Old Road	10-80	0/0	200/1	296.3				296.3	30.8				30.8
NC7E	Shwe Bon Thoor - Sin Del - Padaung - Ohn Ship	40-50	20/1	46/7		44.0			44.0		3.7			3.7
UR8B	Pa Thein - Mon	10-30	135/5	179/1	66.4				66.4	5.0				5.0
UR9B	Yangon - Pyay - Mandalay	10-150	70/6	193/7	199.8				199.8	16.6				16.6
UR9E	Pyay City Out Bound Road	10	0/0	13/2	21.4				21.4	1.8				1.8
	Kayin				**63.2**	**73.2**	**-**	**86.8**	**223.2**	**4.9**	**17.1**	**-**	**33.4**	**55.5**
IC10B	Tha Htone-Ba Ahn-Kokkareit-Myawaddy Road	10-20	8/1	23/6	30.5				30.5	2.7				2.7
IC10F	Tha Htone-Ba Ahn-Kokkareit-Myawaddy Road	10-20	0/0	41/0		36.5		33.7	70.2		14.1		13.0	27.0
IC10G	Tha Htone-Ba Ahn-Kokkareit-Myawaddy Road	10-20	0/2	9/0	12.1			8.3	20.4	0.7			3.2	3.9
IC10H	Tha Htone-Ba Ahn-Kokkareit-Myawaddy Road	10-70	59/0	103/1	20.6			44.8	65.4	1.5			17.3	18.7
NC3C	Hte Lone - Ta Tar Kyae Road	10	0/0	9/4		15.5			15.5		1.3			1.3
TV70	Hteepoekalone – Myinegyinguu – Maethayor road	10	0/0	13/0		21.2			21.2		1.8			1.8
	Magway				**252.0**	**319.6**	**-**	**-**	**571.6**	**17.2**	**38.8**	**-**	**-**	**56.0**
DT59	Min Bu - Sa Linn - Ta Nyaun - Sate Phyu Road	10-50	0/0	45/0		41.6			41.6		4.8			4.8
DT61A	Gway Cho - Chauk - Sate Phyu Road	10	389/5	399/5		17.0			17.0		2.1			2.1
DT71	Sin Paung Wal - Taw Nyaung Pin Road	10	0/0	16/5	28.6				28.6	1.6				1.6
IC23B	Monywa - Pale - Gangaw Road	10-50	67/0	120/0		87.3			87.3		8.3			8.3
IC24A	Kalay - Gangaw Road	10	0/0	8/7		14.7			14.7		1.8			1.8
IC32	Chaung Oo - Pa Koak Khu Road	10	6/4	10/6	7.1				7.1	0.8				0.8
SR19	Pa Koak Khu - Mon Ywa Road	10-30	2/5	24/7	40.3				40.3	3.6				3.6

Strategy Analysis

- Simplification of road network into road cases
  - Reduced data requirements (IQL 3 – IQL 4)
  - Each case represents total length of road segments with those characteristics

1,340 road links 75 road cases			P1 Asphalt Concrete			P2 Surface Treatment			P3 Gravel			P4 Earth			Subtotal	Total
			R1 IRI<=4	R2 4<IRI<=9	R3 IRI>9	R1 IRI<=4	R2 4<IRI<=9	R3 IRI>9	R1 SDI<=2.5	R2 2.5<SDI<=3.5	R3 SDI>3.5	R1 SDI<=2.5	R2 2.5<SDI<=3.5	R3 SDI>3.5		
T6 ADT>5000	C1	Trunk	62	-	-	-	-	-	-	-	-	-	-	-	62	71
	C2	Main	9	-	-	-	-	-	-	-	-	-	-	-	9	
	C3	District	-	-	-	-	-	-	-	-	-	-	-	-	-	
	C4	Feeder	-	-	-	-	-	-	-	-	-	-	-	-	-	
T5 ADT>1000 ADT<=5000	C1	Trunk	515	3	-	52	80	-	-	-	-	-	-	-	651	771
	C2	Main	37	20	-	42	-	-	-	-	-	-	-	-	99	
	C3	District	-	-	-	-	-	-	-	-	-	-	-	21	21	
	C4	Feeder	-	-	-	-	-	-	-	-	-	-	-	-	-	
T4 ADT>500 ADT<=1000	C1	Trunk	852	1	-	1,005	97	-	-	72	-	-	-	21	2,048	3,268
	C2	Main	40	5	-	645	26	-	-	-	169	-	-	-	886	
	C3	District	17	-	-	129	-	-	-	142	46	-	-	-	334	
	C4	Feeder	-	-	-	-	-	-	-	-	-	-	-	-	-	
T3 ADT>100 ADT<=500	C1	Trunk	-	-	-	356	-	-	-	-	-	-	-	-	356	3,728
	C2	Main	386	17	-	904	83	-	-	192	-	-	-	-	1,584	
	C3	District	175	11	-	454	9	3	103	224	735	-	42	33	1,788	
	C4	Feeder	-	-	-	-	-	-	-	-	-	-	-	-	-	
T2 ADT>50 ADT<=100	C1	Trunk	-	-	-	-	-	-	-	-	-	-	-	-	-	3,232
	C2	Main	5	-	-	337	-	-	-	-	168	-	18	25	553	
	C3	District	59	-	-	385	3	-	236	617	736	-	91	553	2,679	
	C4	Feeder	-	-	-	-	-	-	-	-	-	-	-	-	-	
T1 ADT<=50	C1	Trunk	-	-	-	-	-	-	-	-	-	-	-	-	-	8,357
	C2	Main	162	-	-	438	-	-	-	-	-	-	-	-	600	
	C3	District	119	35	-	663	88	17	189	2,357	1,587	8	1,187	1,506	7,757	
	C4	Feeder	6	-	-	39	-	2	634	3,089	1,784	-	4,669	5,429	15,653	
		Subtotal	2,446	93	-	5,448	387	21	1,162	6,693	5,226	8	6,007	7,588	35,080	
		Total	2,539			5,857			13,080			13,604				

Strategy Analysis

- For each case the proposed treatment and threshold are indicated
- Optimize treatment strategies for different budget scenarios
  - Predict resulting road network conditions for each budget scenario

Road case	Length (km)	**Scenario 1A:** MK 100 billion restricted		**Scenario 1B:** MK 100 billion optimized		**Scenario 2:** MK 250 billion optimized		**Scenario 3:** MK 400 billion optimized	
		Standard	Cost (MK billion)	Standard	Cost (MK billion)	Standard	Cost (MK billion)	Standard	Cost (MK billion)
T3;R5;C2;P2;	23	RM only	-	RM only	-	RM only	-	RM only	-
T3;R5;C2;P3;	120	GR@10mm	4.03	GR@10mm	4.03	GR@10mm	4.03	UPGRADE PM	46.20
T3;R5;C2;P5;	85	GR@10mm	7.34	RM only	-	GR@10mm	7.34	UPGRADE PM	32.73
T3;R5;C3;P1;	11	REHAB PM@IRI10	1.34	RM only	-	REHAB PM@IRI10	1.34	REHAB PM@IRI10	1.34
T3;R5;C3;P4;	153	GR@10mm	5.01	GR@10mm	5.01	GR@10mm	5.01	UPGRADE PM	58.91
T3;R5;C3;P5;	35	GR@10mm	1.15	GR@10mm	1.15	GR@10mm	1.15	UPGRADE PM	13.48
T3;R5;C4;P1;	247	REHAB PM@IRI10	24.28	RM only	-	REHAB PM@IRI10	24.28	REHAB PM@IRI10	24.28
T3;R5;C4;P3;	48	GR@10mm	1.57	GR@10mm	1.57	GR@10mm	1.57	UPGRADE PM	18.48
T3;R5;C4;P4;	65	GR@10mm	2.13	GR@10mm	2.13	GR@10mm	2.13	UPGRADE PM	25.03
T3;R5;C4;P6;	112	RM only	-	RM only	-	RM only	-	REHAB AC@IRI10	43.12
T4;R1;C2;P1;	201	RM only	-	RM only	-	RM only	-	RM only	-
T4;R1;C3;P1;	93	RM only	-	RM only	-	RM only	-	RM only	-
T4;R1;C4;P1;	60	RM only	-	RM only	-	RM only	-	RM only	-
T4;R2;C2;P1;	192	SD25mm@IRI5	11.82	SD25mm@IRI5	11.82	SD25mm@IRI5	11.82	OL40mm@IRI4	16.89
T4;R2;C3;P1;	120	OL40mm@IRI4	7.88	SD25mm@IRI5	5.52	SD25mm@IRI5	5.52	OL40mm@IRI4	7.88
T4;R2;C4;P1;	140	SD25mm@IRI5	8.03	SD25mm@IRI5	8.03	SD25mm@IRI5	8.03	OL40mm@IRI4	11.46
T4;R3;C2;P1;	36	OL40mm@IRI6	3.04	OL40mm@IRI6	3.04	OL40mm@IRI6	3.04	OL40mm@IRI6	3.04
T4;R3;C3;P1;	43	OL40mm@IRI6	2.84	OL40mm@IRI6	2.84	OL40mm@IRI6	2.84	OL40mm@IRI6	2.84
T4;R3;C4;P1;	186	OL40mm@IRI6	18.17	OL40mm@IRI6	18.17	OL40mm@IRI6	18.17	OL40mm@IRI6	18.17
T4;R4;C2;P1;	7	REHAB PM@IRI8	0.88	REHAB PM@IRI8	0.88	REHAB PM@IRI8	0.88	REHAB PM@IRI8	0.88
T4;R4;C3;P1;	13	REHAB PM@IRI8	1.44	REHAB PM@IRI8	1.44	REHAB PM@IRI8	1.44	REHAB PM@IRI8	1.44
T4;R4;C4;P1;	70	REHAB PM@IRI8	9.99	RM only	-	REHAB PM@IRI8	9.99	REHAB PM@IRI8	9.99
T4;R5;C2;P1;	26	REHAB PM@IRI10	2.59	REHAB PM@IRI10	2.59	REHAB PM@IRI10	2.59	REHAB PM@IRI10	2.59
T4;R5;C3;P1;	99	REHAB PM@IRI10	14.16	REHAB PM@IRI10	14.16	REHAB PM@IRI10	14.16	REHAB PM@IRI10	14.16
T4;R5;C4;P1;	66	REHAB PM@IRI10	8.33	REHAB PM@IRI10	8.33	REHAB PM@IRI10	8.33	REHAB PM@IRI10	8.33
T5;R1;C2;P1;	326	RM only	-	SD25mm@IRI4	25.11	SD25mm@IRI4	25.11	OL40mm@IRI4	35.86
T5;R1;C3;P1;	9	RM only	-	SD25mm@IRI4	0.69	OL40mm@IRI4	0.99	OL40mm@IRI4	0.99
T5;R1;C3;P6;	91	RM only	-	RM only	-	RM only	-	OL40mm@IRI4	10.01
T5;R1;C4;P1;	16	SD25mm@IRI4	1.23	SD25mm@IRI4	1.23	SD25mm@IRI4	1.23	SD25mm@IRI4	1.23
T5;R2;C2;P1;	371	RM only	-	SD25mm@IRI5	28.57	SD25mm@IRI5	28.57	OL40mm@IRI4	40.81
T5;R2;C3;P1;	26	RM only	-	SD25mm@IRI5	2.00	SD25mm@IRI5	2.00	OL40mm@IRI4	2.86
T5;R2;C3;P6;	86	RM only	-	SD25mm@IRI5	6.62	SD25mm@IRI5	6.62	OL40mm@IRI4	9.46
T5;R2;C4;P1;	39	OL40mm@IRI4	4.29	SD25mm@IRI5	3.00	OL40mm@IRI4	4.29	OL40mm@IRI4	4.29
T5;R3;C2;P1;	145	RM only	-	OL40mm@IRI6	15.95	OL40mm@IRI6	15.95	OL40mm@IRI6	15.95
T5;R3;C3;P1;	24	RM only	-	OL40mm@IRI6	2.64	OL40mm@IRI6	2.64	OL40mm@IRI6	2.64

Strategy Analysis

- Can be used to prepare a decision matrix for selection of treatments
  - Based on expected budget
  - Based on optimum use of that budget
- Can be used as basis for further planning
  - Integrated into RAMS

Решения о работах в зависимости от состояния

Инт-ть дв. (СГС	Трещины	Колея / Ямы	0-1 IRI: 0-1	0-1 IRI: 2	0-1 IRI: 3-4	2 IRI: 0-1	2 IRI: 2	2 IRI: 3-4	3 IRI: 0-1	3 IRI: 2	3 IRI: 3-4
< 1000	0-1	0 - 1	СОД	СОД	МР	СОД	СОД	МР	МР	РЕК1	РЕК1
		2	ЯР	ЯР	МР	ЯР	ЯР	МР	ПИ	РЕК1	РЕК1
		3	ЯР	ЯР	МР	ЯР	МР	МР	ПИ	РЕК1	РЕК1
	2 - 3	0 - 1	ЗТ	ШПО	Ф308	ШПО	ШПО	Ф308	РЕК1	РЕК1	РЕК1
		2	ШПО	ШПО	Ф308	ШПО	Ф304	Ф308	РЕК1	РЕК1	РЕК1
		3	ШПО	ШПО	Ф308	Ф304	Ф306	Ф308	РЕК1	РЕК1	РЕК1
	4	0 - 1	ШПО	ШПО	ПИ	ШПО	Ф304	ПИ	РЕК1	РЕК1	РЕК1
		2	ШПО	Ф304	ПИ	Ф304	Ф306	ПИ	РЕК1	РЕК1	РЕК1
		3	РЕК1	РЕК1	РЕК1	РЕК1	РЕК1	РЕК1	РЕК1	РЕК1	РЕК1
1000-3000	0-1	0 - 1	СОД	СОД	МР	СОД	ШПО	АБ08	МР	РЕК2	РЕК2
		2	ЯР	ЯР	АБ08	МР	МР	АБ08	ПИ	РЕК2	РЕК2
		3	ЯР	ЯР	АБ08	МР	АБ08	АБ08	ПИ	РЕК2	РЕК2
	2 - 3	0 - 1	ЗТ	ДШПО	АБ08	ШПО	АБ04	АБ08	РЕК2	РЕК2	РЕК2
		2	ШПО	Ф304	АБ11	Ф304	АБ08	АБ11	РЕК2	РЕК2	РЕК2
		3	Ф304	АБ08	АБ11	АБ08	АБ11	АБ11	РЕК2	РЕК2	РЕК2
	4	0 - 1	ШПО	Ф304	АБ11	Ф304	АБ08	АБ11	РЕК2	РЕК2	РЕК2
		2	Ф304	АБ08	РЕК2	АБ08	АБ11	РЕК2	РЕК2	РЕК2	РЕК2
		3	РЕК2	РЕК2	РЕК2	РЕК2	РЕК2	РЕК2	РЕК2	РЕК2	РЕК2
>3000	0-1	0 - 1	СОД	СОД	МР	СОД	ШПО	АБ11	МР	РЕК3	РЕК3
		2	ЯР	ЯР	АБ11	МР	МР	АБ11	ПИ	РЕК3	РЕК3
		3	ЯР	ЯР	АБ11	МР	АБ11	АБ11	ПИ	РЕК3	РЕК3
	2 - 3	0 - 1	ЗТ	АБ04	АБ11	ШПО	АБ04	АБ11	РЕК3	РЕК3	РЕК3
		2	ШПО	Ф304	АБ13	Ф304	АБ11	АБ13	РЕК3	РЕК3	РЕК3
		3	Ф304	АБ11	АБ13	АБ11	АБ13	АБ13	РЕК3	РЕК3	РЕК3
	4	0 - 1	ШПО	Ф304	АБ13	Ф304	АБ11	АБ13	РЕК3	РЕК3	РЕК3
		2	Ф304	АБ11	РЕК3	АБ11	АБ13	РЕК3	РЕК3	РЕК3	РЕК3
		3	РЕК3	РЕК3	РЕК3	РЕК3	РЕК3	РЕК3	РЕК3	РЕК3	РЕК3

Unsealed	Good	Fair	Poor	Bad	Very Bad
AADT<50	Routine				
50<AADT<200	Regravel				
200<AADT<500					

Penmac	Good	Fair	Poor	Bad	Very Bad
AADT<50	Routine				
50<AADT<200					
200<AADT<500		Seal	Overlay	Rehab PM	
500<AADT<1000					
1000<AADT<2500					
AADT>2500					

Asphalt concrete	Good	Fair	Poor	Bad	Very Bad
AADT<50	Routine				
50<AADT<200					
200<AADT<500		Seal	Overlay	Rehab AC	
1000<AADT<2500					
AADT>2500					

Cement concrete	Good	Fair	Poor	Bad	Very Bad
AADT<50	Routine				
50<AADT<200					
200<AADT<500		Overlay			
500<AADT<1000					
1000<AADT<2500					
AADT>2500					

First Priority, Second Priority, Third Priority, Routine maintenance only

Decision Matrix

- Depends on expected funding versus expected needs
  - Current budget

Unsealed	Good	Fair	Poor	Bad	Very Bad
AADT<50	Routine				
50<AADT<200					
200<AADT<500	Regravel				
Penmac	**Good**	**Fair**	**Poor**	**Bad**	**Very Bad**
AADT<50	Routine				
50<AADT<200					
200<AADT<500					
500<AADT<1000		Seal	Overlay	Rehab PM	
1000<AADT<2500	Seal				
AADT>2500					

Asphalt concrete	Good	Fair	Poor	Bad	Very Bad
AADT<50	Routine				
50<AADT<200					
200<AADT<500					
1000<AADT<2500		Seal	Overlay	Rehab AC	
AADT>2500					
Cement concrete	**Good**	**Fair**	**Poor**	**Bad**	**Very Bad**
AADT<50	Routine				
50<AADT<200					
200<AADT<500					
AADT>2500					

  - Increased budget

Unsealed	Good	Fair	Poor	Bad	Very Bad
AADT<50	Routine				
50<AADT<200	Regravel				
200<AADT<500					
Penmac	**Good**	**Fair**	**Poor**	**Bad**	**Very Bad**
AADT<50	Routine				
50<AADT<200		Seal	Overlay	Rehab PM	
200<AADT<500					
500<AADT<1000					
1000<AADT<2500					
AADT>2500					

Asphalt concrete	Good	Fair	Poor	Bad	Very Bad
AADT<50	Routine				
50<AADT<200					
200<AADT<500		Seal	Overlay	Rehab AC	
1000<AADT<2500					
AADT>2500					
Cement concrete	**Good**	**Fair**	**Poor**	**Bad**	**Very Bad**
AADT<50	Routine				
50<AADT<200					
200<AADT<500			Overlay		
AADT>2500		Overlay			

  - Optimal budget

Unsealed	Good	Fair	Poor	Bad	Very Bad
AADT<50	Routine				
50<AADT<200	Regravel				
200<AADT<500	Upgrade PM				
Penmac	**Good**	**Fair**	**Poor**	**Bad**	**Very Bad**
AADT<50	Routine				
50<AADT<200		Overlay		Rehab PM	
200<AADT<500					
500<AADT<1000					
1000<AADT<2500					
AADT>2500				Upgrade AC	

Asphalt concrete	Good	Fair	Poor	Bad	Very Bad
AADT<50	Routine				
50<AADT<200					
200<AADT<500		Overlay		Rehab AC	
1000<AADT<2500					
AADT>2500					
Cement concrete	**Good**	**Fair**	**Poor**	**Bad**	**Very Bad**
AADT<50	Routine				
50<AADT<200					
200<AADT<500					
AADT>2500		Overlay			Rehab CC

RAMS analysis and planning

- Results of the RAMS analysis are the basis for planning
  - They are not necessarily the end result
- Combination of treatments into suitable packages
  - Avoiding very short treatment lengths
  - Creating more unified treatment approaches
- Combine economic criteria with other criteria
  - Use of other criteria will result in some changes to the ranking and selection
  - Changes should be limited to avoid much lower efficiency of investments

Example: Georgia

- HDM4 results for basis for planning
- Other criteria also applied
  - Difficulties getting objective data
- Final plan 80% in line with HDM4 results

Rehabilitation of: Sh37 Sadakhlo-Tsopi-Askhepi secondary road km3-km8 Section

Project Description

Following road section is part of rolling program for year 2018, section connects international road S07 Marneuli-Sadakhlo to Armenia border and provides access to social services to more than 1500 people. Road is considered importan in terms of Agriculture as well as providing minimum standard of mobility and integration.

Utilization		Class	Economic Indicators (mln. Gel) / Road Works			
Traffic (AADT)	250	1	Total Capital Cost	3.0	Pavement structure	n/a
Heavy Vehicles (%)	2.5		NPV	0.14	Bridge/Culvert/structure	n/a
[1]Condition	10.91	4	NPV/Cost Ratio	0.03	Traffic Safety	n/a
[2]Population Density	227	4	Cost/Pop. Ratio	0.002	Environment	n/a

Socio Economic Impact Assesment

Objective	Indicator	Unit
Enhanced National Connectivity	Part of Secondary Road connecting two international roads.	N
Enhanced Regional Connectivity	Distance from the centre of section to closest city centre.	34km
Enhanced economic activities	Number of registered businesses in the district where the section is located.	347
Population	Number of people living within 2km buffer along the road section.	1520
Education	Number of schools within 2 km buffer along the road section.	7
Tourism	Number of attraction within 2 km buffer along the road section.	2
Poverty	Percentage of people receiving government support within district where road section is located.	n/a
Life Line Road	The road is the only possibility for connecting the village to outside world.	y

Project Area Map

[1]Description of Condition Classes (Good, Fair; poor and Bad) is found in Chapter 4, section 1.1

Integrated or Separate

- The analysis/planning can be integrated or separate from the RAMS

- Separate (e.g. HDM4, dTIMS)
  - Data is exported from RAMS and imported into pavement management system (PMS)
  - PMS is used to carry out analysis
  - Results are exported from PMS and imported into RAMS
  - Results can be adjusted using other criteria (e.g. multicriteria analysis)
  - Results are shown in the RAMS (tables/maps)

- Integrated
  - RAMS includes planning module – often simplified (e.g. decision matrix)
  - Analysis is carried out using RAMS data
  - Results can be adjusted using other criteria (e.g. multicriteria analysis)
  - Results are shown in the RAMS (tables/maps)

Analysis software options

- Specialized software: HDM4/dTIMS
  - Needs identification, costing model, deterioration model
  - Requires trained staff, language issues
- Simplified software: RONET, Roads CBA
  - Excel-based, lacks deterioration modelling
  - Relatively easy to use, language can be adjusted
  - Can be programmed into RAMS (e.g. Vietnam)
- Decision matrix
  - Developed using specialized software, for specific road network and budget
  - Needs to be updated every 5 years or so
  - Simple to use and program into RAMS
- Simple formula
  - Multi-criteria analysis or prioritization formula
  - Easy to program, but often not very cost efficient

Example: Uzbekistan

- Started using HDM4
  - Complicated to use
  - No Russian language option

- Included programming module in Russian-language database
  - Based on results from HDM4 strategy analysis
  - Data can still be exported in HDM4 format

Example: Kyrgyz

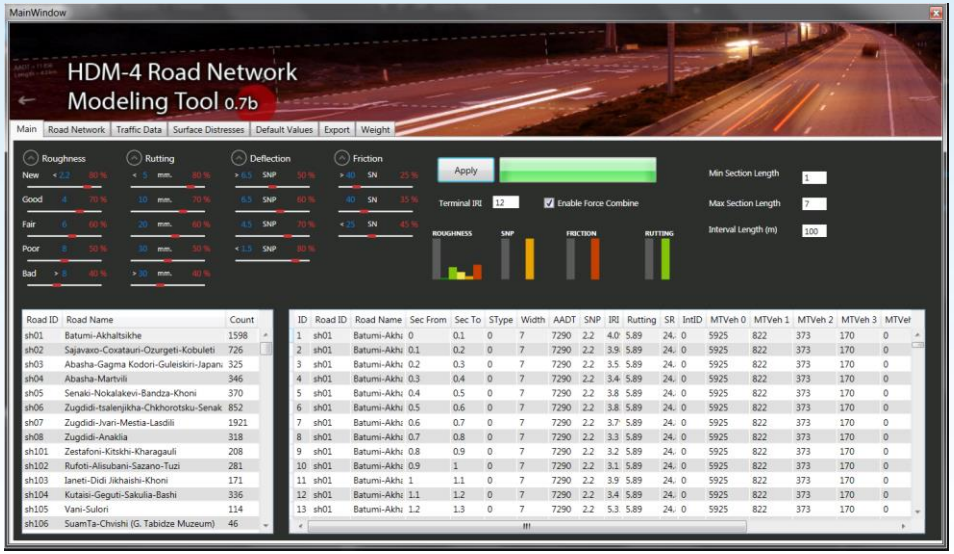
- HDM4 Strategy Analysis to determine optimal treatments
  - Depending on traffic volume and road condition

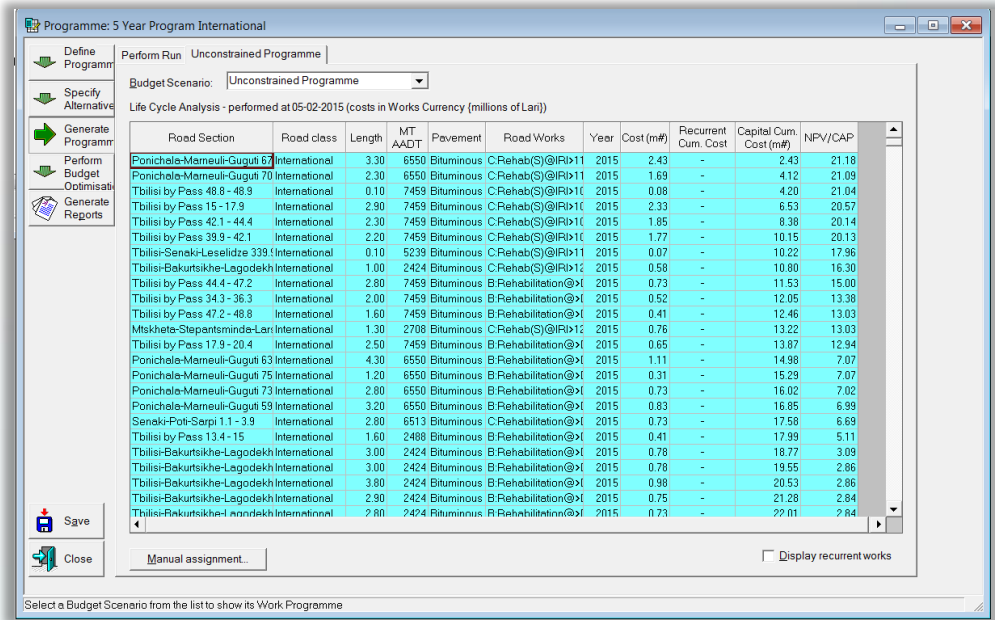
- Basis for planning module in RAMS
  - RM: Routine maintenance
  - CS: Crack Sealing
  - PAT: Patching
  - LR: Local Repair
  - EB: Edge Break Repair
  - REP: Reprofiling
  - SBST: single surface dressing
  - DBST: double surface dressing
  - AC0x: x cm asphalt concrete overlay
  - MR0x: x cm milling + replacing of asphalt
  - AC13: asphalt surface and base overlay
  - RECY: recycling of asphalt layers
  - RECO: reconstruction

		Rut	Rut < 20 mm			Rut > 20 mm		
Traffic (AADT)	Cracks	Potholes	IRI: < 3.5	IRI: 3.5 - 5.5	IRI: > 5.5	IRI: < 3.5	IRI: 3.5 - 5.5	IRI: > 5.5
< 300	< 40 m2	0 - 1	RM	RM	LR	LR	LR	MR4
		2	PAT	PAT	LR	LR	REP	MR4
		3	PAT	PAT	LR	LR	MR4	RECO1
	40-200 m2	0 - 1	CS	CS	SBST	LR	REP	MR4
		2	CS+PAT	CS+PAT	SBST	LR	MR4	MR4
		3	SBST	SBST	SBST	RECO1	RECO1	RECO1
	> 200 m2	0 - 1	SBST	SBST	MR4	MR4	MR4	MR4
		2	SBST	SBST	MR4	MR4	MR4	MR4
		3	RECO1	RECO1	RECO1	RECO1	RECO1	RECO1
300- 1000	< 40 m2	0 - 1	RM	RM	LR	LR	LR	RECO1
		2	PAT	PAT	LR	LR	REP	RECO1
		3	PAT	PAT	LR	LR	MR4	RECO1
	40-200 m2	0 - 1	CS	CS	DBST	LR	REP	RECO1
		2	CS+PAT	CS+PAT	DBST	LR	MR6	RECO1
		3	DBST	DBST	DBST	RECO1	RECO1	RECO1
	> 200 m2	0 - 1	DBST	DBST	MR6	MR6	MR6	RECO1
		2	DBST	DBST	MR6	MR6	MR6	RECO1
		3	RECO1	RECO1	RECO1	RECO1	RECO1	RECO1
1000-3000	< 40 m2	0 - 1	RM	RM	LR	LR	REP	RECO2
		2	PAT	PAT	LR	MR4	MR6	RECO2
		3	PAT	PAT	OL4	MR6	MR6	RECO2
	40-200 m2	0 - 1	CS	CS	OL4	RECO2	RECO2	RECO2
		2	CS+PAT	CS+PAT	OL6	RECO2	RECO2	RECO2
		3	OL4	OL6	OL6	RECO2	RECO2	RECO2
	> 200 m2	0 - 1	DBST	DBST	MR6	RECO2	RECO2	RECO2
		2	DBST	MR6	RECO2	RECO2	RECO2	RECO2
		3	RECO2	RECO2	RECO2	RECO2	RECO2	RECO2
>3000	< 40 m2	0 - 1	RM	RM	LR	LR	REP	RECO3
		2	PAT	PAT	LR	MR4	MR6	RECO3
		3	PAT	PAT	OL6	MR6	RECO3	RECO3
	40-200 m2	0 - 1	CS	OL4	OL6	MR6	RECO3	RECO3
		2	OL4	OL6	OL8	RECO3	RECO3	RECO3
		3	OL6	OL8	OL11	RECO3	RECO3	RECO3
	> 200 m2	0 - 1	MR4	MR6	MR8	RECO3	RECO3	RECO3
		2	MR6	MR8	RECO3	RECO3	RECO3	RECO3
		3	RECO3	RECO3	RECO3	RECO3	RECO3	RECO3

Example: Georgia

- Use HDM4 programme analysis for planning
- Developed specific software to identify homogeneous road sections for use in HDM4
- Use additional criteria to finalize draft plan prepared using HDM4





Data analysis costs

- Equipment and software
  - Off-the-shelf HDM4 $4,000-$5,000 per license
  - Custom made Depends on complexity
- Operation
  - Staff + training
  - Operational expenses (paper, ink, internet, etc.)
- Maintenance
  - Service license for off-the-shelf software/equipment
  - Service contract for custom-made software/equipment

Data analysis

- What prioritization criteria to use
- How to combine the different prioritization criteria
- To use a detailed or basic analysis
- To have an integrated/separate analysis function