EVALUATING BENEFITS ARISING FROM PAVEMENT ASSOCIATED TECHNOLOGY DEVELOPMENT WORK

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In This Presentation..

- Study Objectives
- General Concepts
- Generic Example
- Case Study : G1 Base Pavements
- Summary of Outcomes

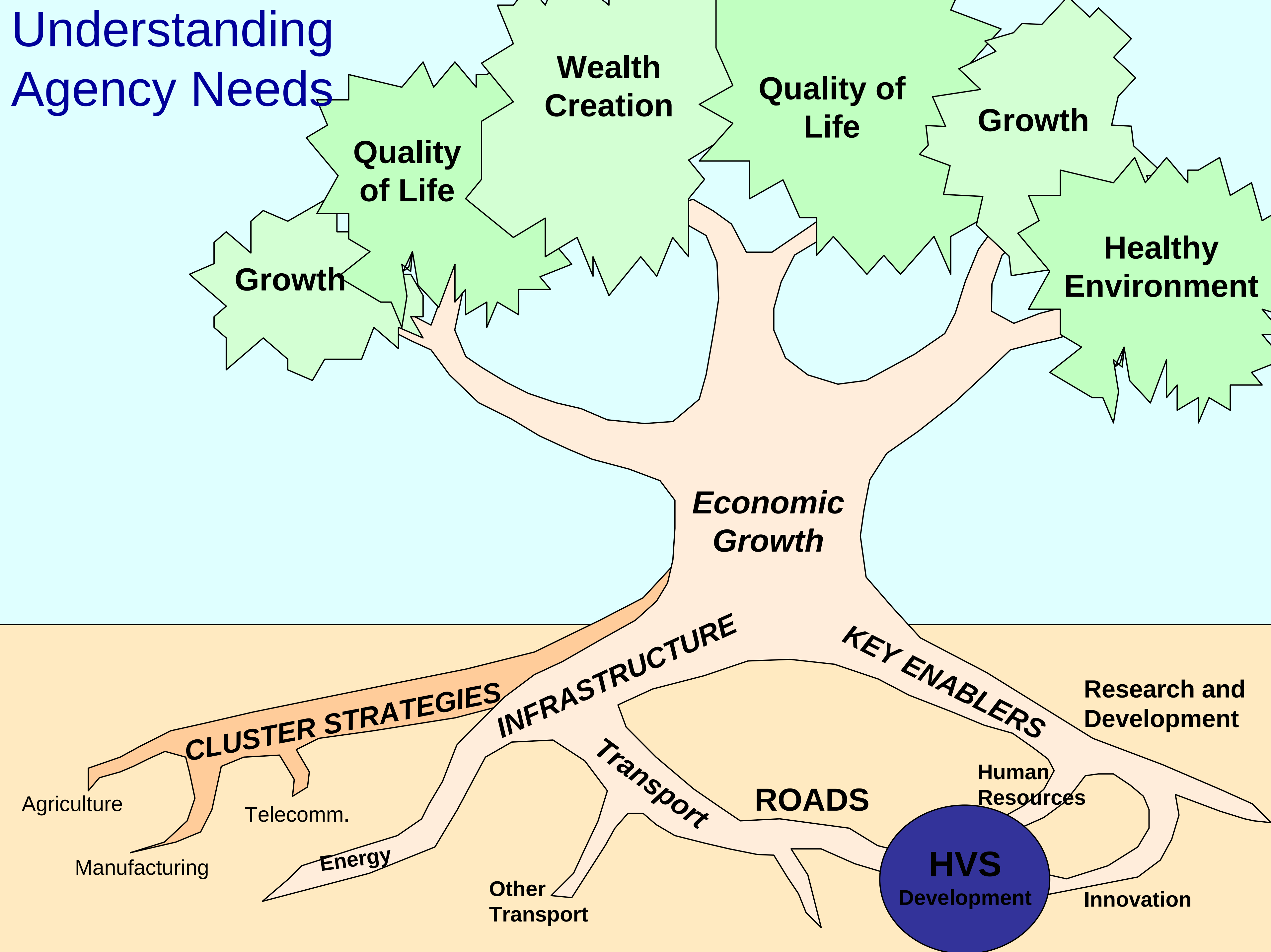
Study Objectives

- To clarify the key elements of benefit assessment;
- To develop a general approach for benefit assessment;
- To implement & evaluate the approach by focussing on G1 Base pavements
- To refine and document a framework for the assessment of other (past or future) HVS technology development projects.

Funding Agency Needs

- Refer to the SA National Research and Development Strategy.
- Two High Level Goals:
  - Quality of Life
  - Wealth Creation
- Gautrans Mission and Focus Areas:
  - Accelerated infrastructure development
  - Emphasis on job creation
  - Quality social service delivery

Understanding Agency Needs



How The HVS Programme Contributes

1. Better Business Performance (more cost effective and reliable roads)
2. Augments Technical Progress

- International Exposure
- High Tech developments & imports

3. Human Resource Development

- Educational value
- Improvements in SET Excellence

Contribution to **Better Business Performance**

1. More durable & cost effective materials and designs
2. More reliable design and construction
3. Optimized materials and pavement designs

Cost Effective Design

- HVS Testing on G1 base pavements facilitated the acceptance of an alternative to thick asphalt and concrete base pavements, with significant savings to the road-building industry
- ALF Testing on polymer modified materials for distressed intersections validated the use of reduced milling thickness, treatment frequency and overlay thickness. (B/C Ratio $\cong$ 2 to 3)

More Reliable Design and Construction

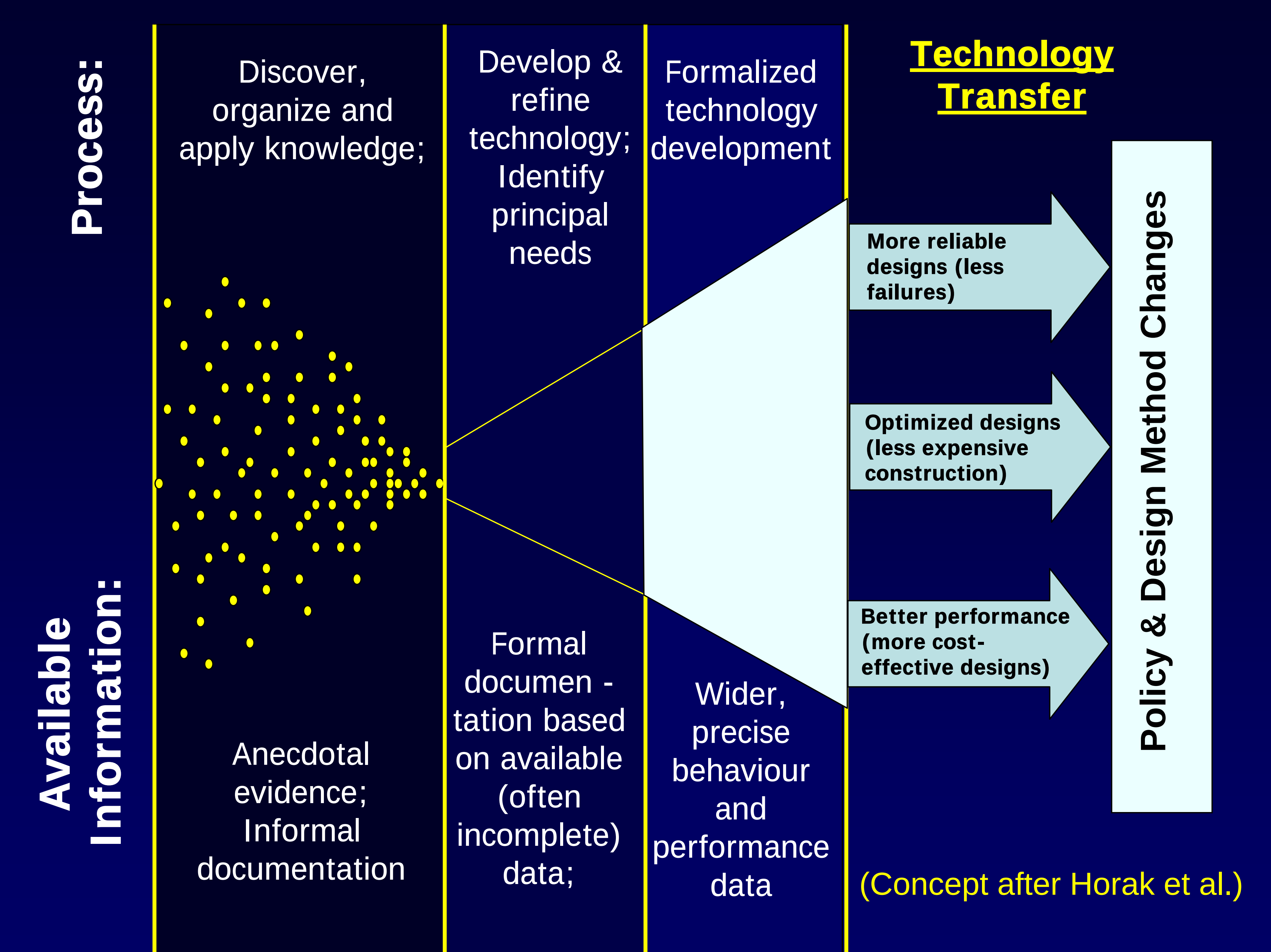
- HVS Testing on G1 materials quantified and highlighted the importance of density and timely maintenance. This raised awareness of maintenance and construction related to G1 base pavements
- ALF Testing lead to the uncovering of a new distress mechanism on CTB pavements where there was poor bonding between layers. This lead to improved construction practices and reduced premature failures (B/C Ratio $\cong$ 4 to 9)
- HVS testing on CTB pavements lead to the uncovering of a new distress mechanism in which the top part of the cemented base layer crushes under loading. The mechanism was included in SA design methods and reduced the incidence of premature failures on CTB pavements

Optimized Designs

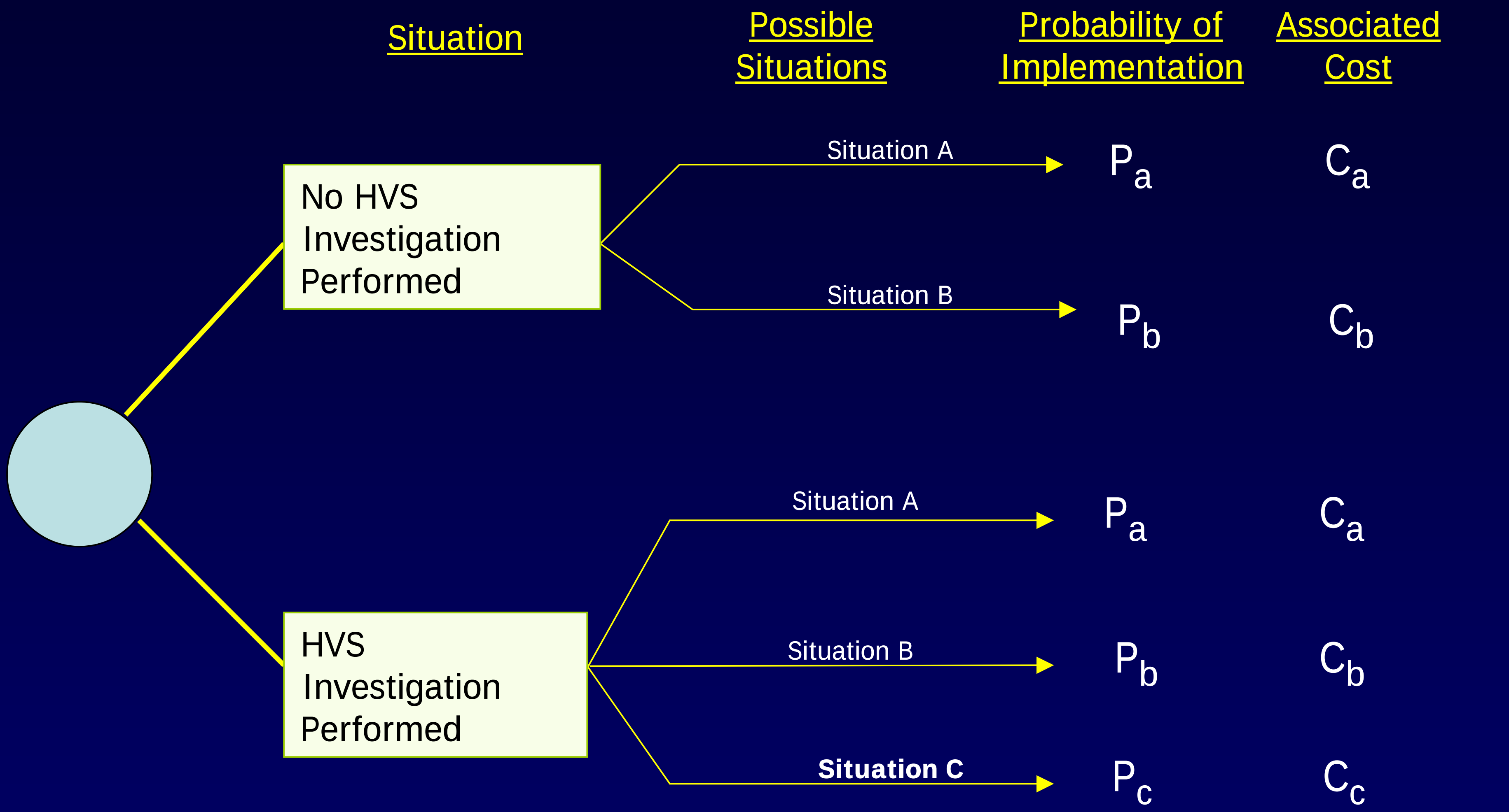
- HVS Testing on G1 materials offered a design method for G1 materials which significantly reduced the thickness of base layers used at the time (B/C Ratio $\cong$ 2 to 6)
- HVS programme data on Foamed Bitumen materials facilitated the development of a structural design method for foamed bitumen materials. This method offered practitioners with a rational method to analyze and compare pavements with or without foamed bitumen treatments.

KEY CHALLENGES

- Conceptual & Time Related Separation Between Project Impacts and Realized Benefits
- Several projects and processes contribute to Realized Benefits
- Subjective Estimates are Needed to Quantify Benefits


Process:
Available Information:
Discover, organize and apply knowledge;
Develop & refine technology; Identify principal needs
Formalized technology development
Technology Transfer
Anecdotal evidence; Informal documentation
Formal documen - tation based on available (often incomplete) data;
Wider, precise behaviour and performance data
More reliable designs (less failures)
Optimized designs (less expensive construction)
Better performance (more cost-effective designs)
Policy & Design Method Changes
(Concept after Horak et al.)

The Need For Subjective Data



Effective cost for situation i is: $(P_i) \times (C_i)$

Addressing Challenges to Benefit Assessment:

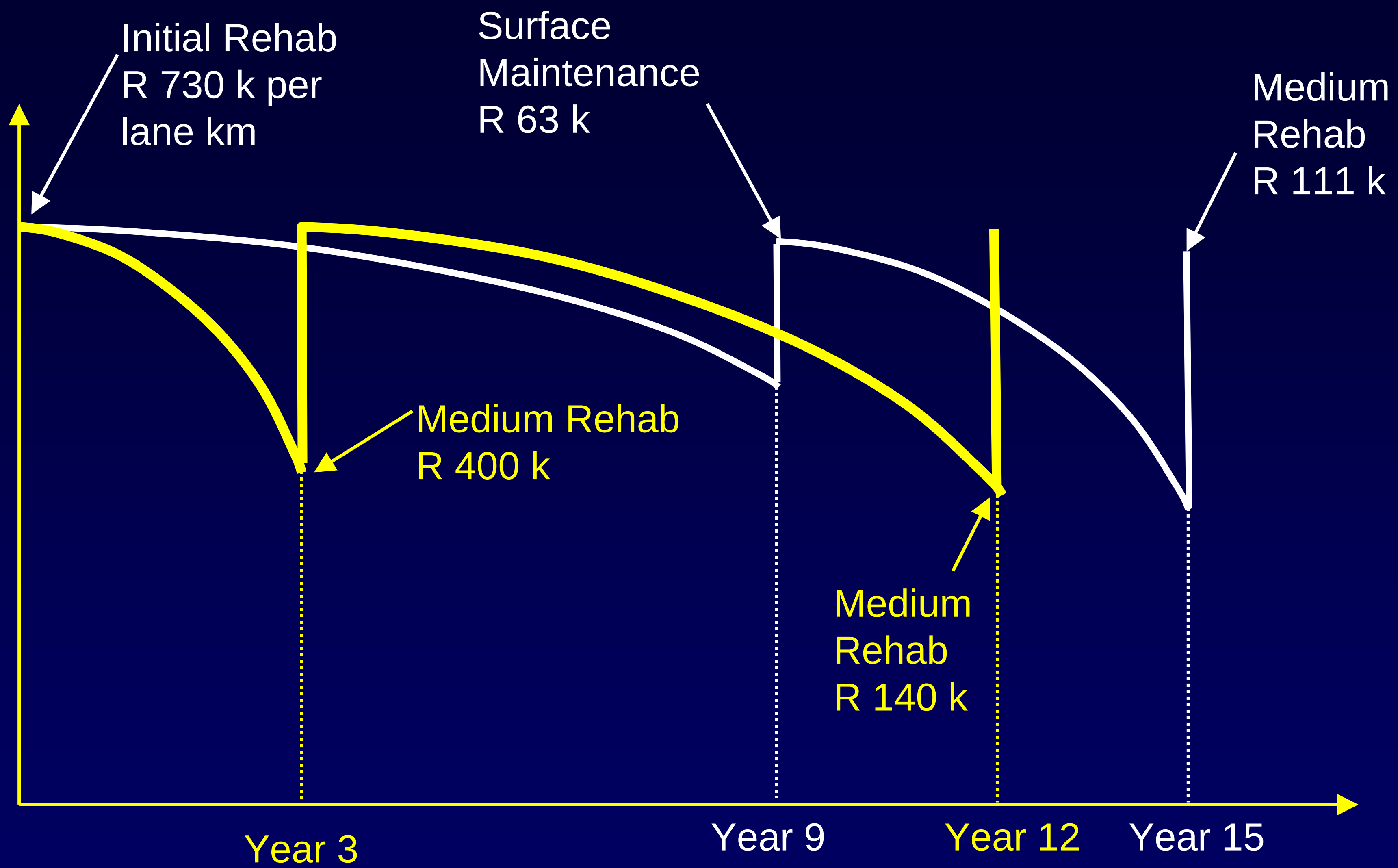
- Clarify the findings and impacts of development work
- Survey system users to obtain subjective estimates of impacts
- Assign a contribution ratio
- Use probability ranges

➢ Framework for Benefit Assessment Outlined (tested on G1 Pavements)

Generic Example: More Reliable Design & Construction Practice

- 2 Year development at R 8 million total cost
- Development leads to more reliable design practices for a specific material or construction type
- Before implementation of findings, 5 % of network showed some form of premature distress (long term, network wide)
- After implementation of findings, 2 % reduction in premature distress (long term, network wide)
- Development effort contributed 60% to the eventual findings

Typical Life Cycle Cost



Discounted Life Cycle Cost For Premature Failure
= R 905 k **– R 1,270 k** = **-R 365 k per lane km**

2 % Reduction in Premature Failures

2 Lane Km Rehab per Year	'Savings' per Year	Discounted (8%) Total Savings over 10 Years
100 km	R 878,000	R 6,364,000
250 km	R 2,195,000	R 15,911,000
350 km	R 3,073,000	R 22,276,000
500 km	R 4,391,000	R 31,823,000

This example considers one impact only, and does not take indirect benefits into account

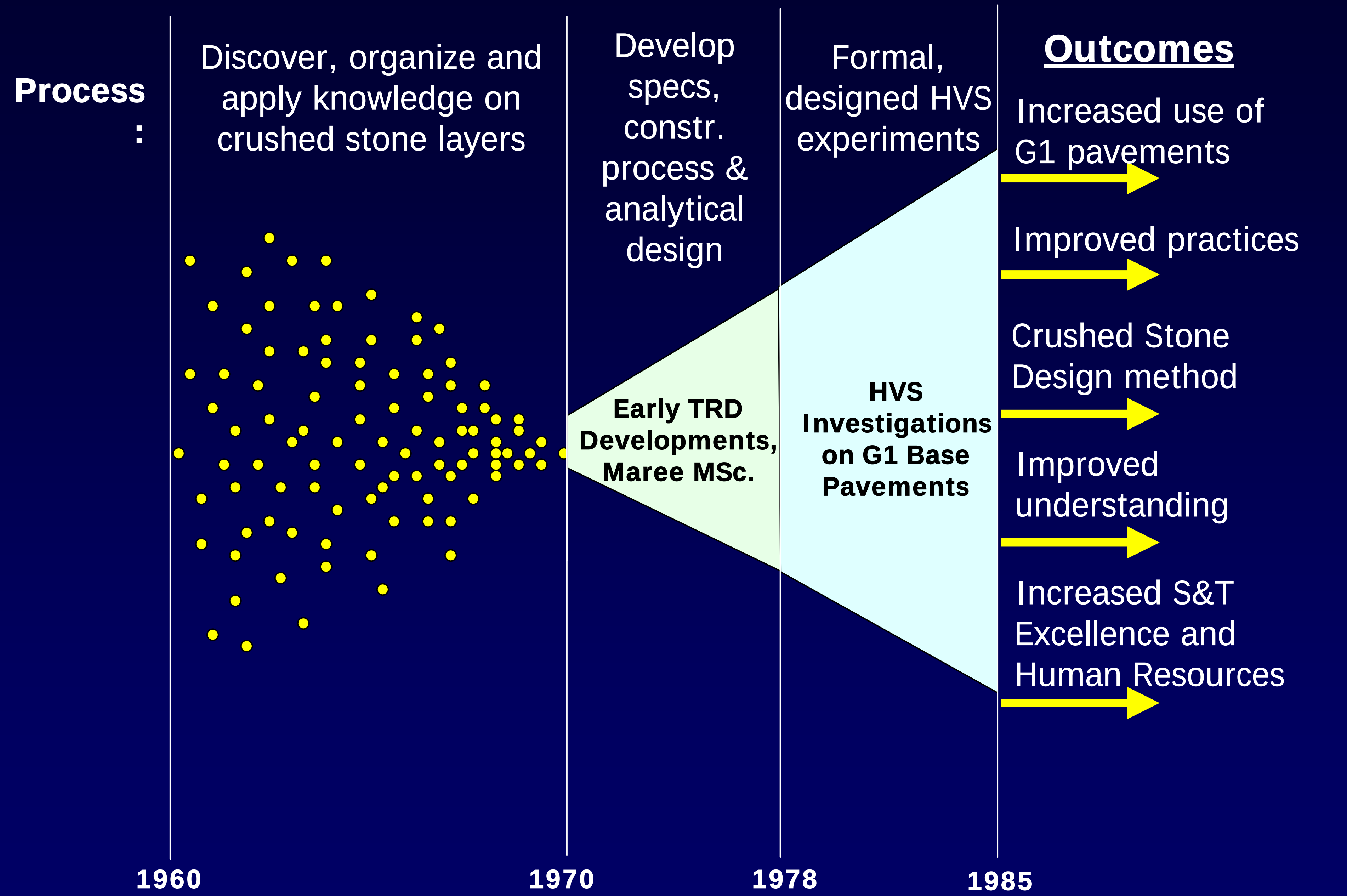
Case Study : G1 Base Pavements

- Basic development of the high quality crushed stone (G1) concept in 1960 to 1978
- Focused research (HVS & other) on G1 base pavements in 1978 to 1985

Key Impacts:

- Increased use of G1 base pavements
- New design method for crushed stone materials
- Better understanding of behaviour & performance

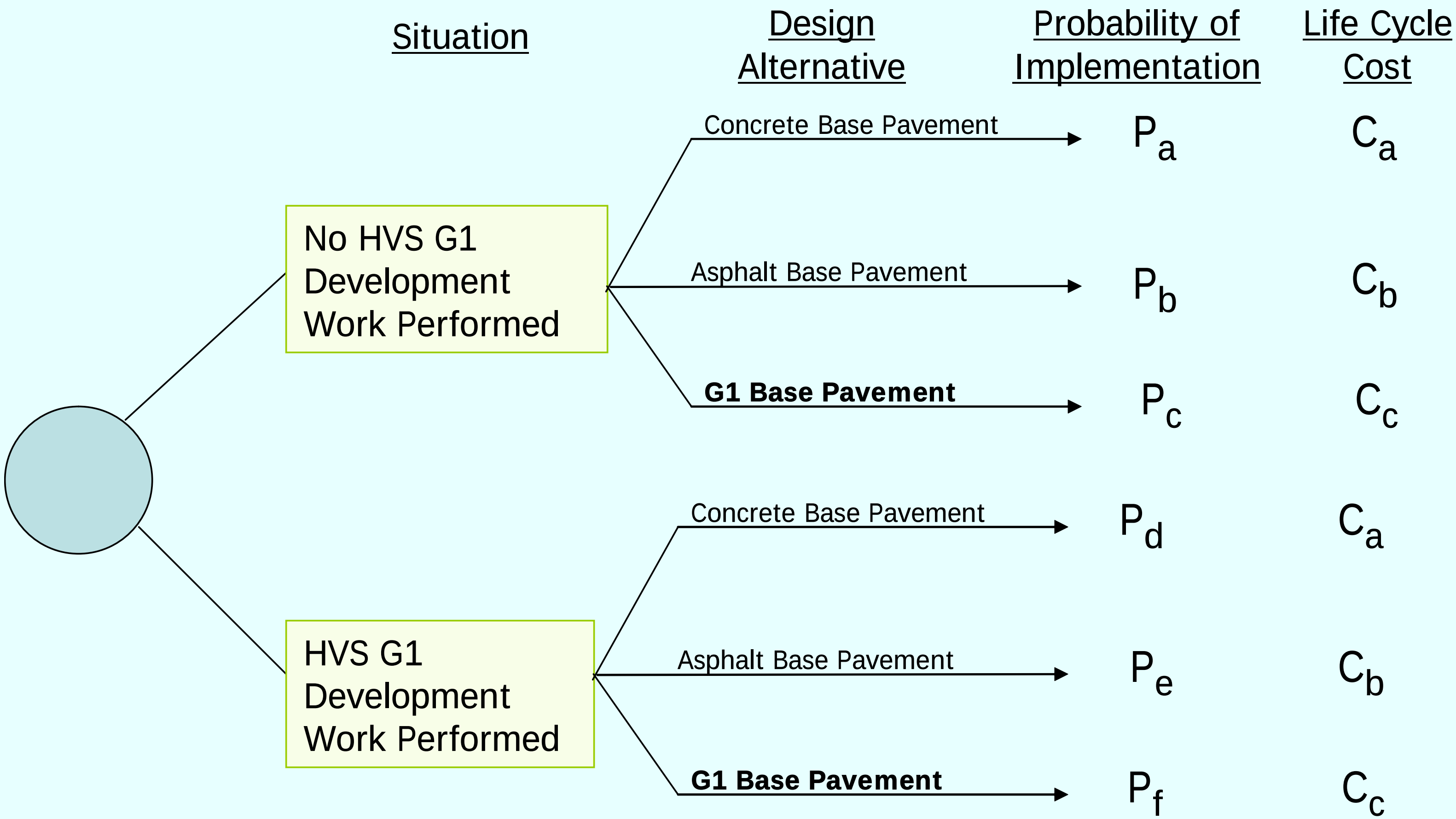
G1 Projects: HVS Context (after Horak et al)



Economic Benefit Assessment: Three Main Benefits

1. Increased use of G1 versus Concrete or Asphalt
2. Increased use of 150 mm instead of 200 mm
3. Better construction and maintenance practices (reduced risk of early failure)

Quantification Methodology



Notation:

P_i = Probability that option i would be implemented

C_i = Discounted life cycle cost for alternative i

Effective cost for alternative i is: $(P_{i)}$ x (C_i)

Ensuring Credibility

- Interviews with “System Users”
- Basie Nothnagel
- Emile Horak
- Pieter Strauss
- Dennis Rossmann
- Hoffie Maree
- Gawie Jordaan
- Louw Kannemeyer

Interviews used to validate <u>impacts</u> and <u>HVS contribution</u> to impacts

Roads with > 3 MESA Design Traffic					
Situation	**Performance Alternatives**	**Probability of Realizing**	**Life Cycle Cost**	**Adjusted Cost**	**Total Adjusted Cost**
Without HVS Test Programme	**Typical**	0.6	R 18.97	R 11.38	
	Delayed Maintenance	0.3	R 20.91	R 6.27	**R 20.34**
	Poor Construction	0.1	R 26.88	R 2.69	
With HVS Test Programme	**Typical**	0.8	R 18.97	R 15.18	
	Delayed Maintenance	0.15	R 20.91	R 3.14	**R 19.66**
	Poor Construction	0.05	R 26.88	R 1.34	

Savings	R 0.69	per square metre
	R 2.67	per metre of 3.9 m wide lane
	R 2,674.18	per Km of 3.9 m wide lane

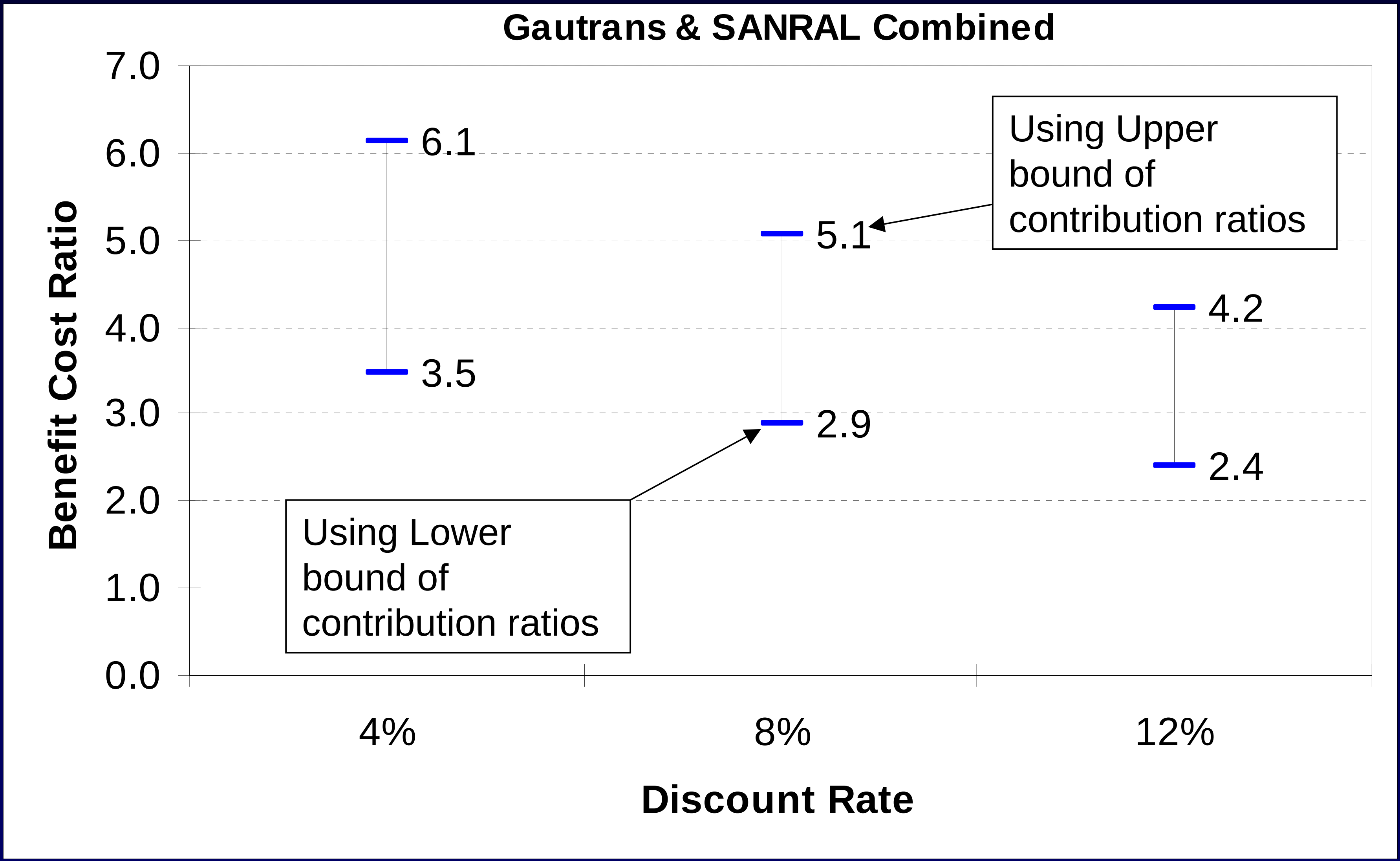
Cost Scaling:	**Owner**	**Km**	**Saving**
	GAUTRANS	301	R 804,928
	SANRAL	1077	R 2,880,090

Total Aggregated Saving Estimate = R 3,685,018

COST OF DEVELOPMENT

1. Gautrans (TRD) experiments: costs obtained from HVS Operational Budget
2. NDOT experiment: costs estimated on basis of Cost per E80 repetition
3. 20% Additional cost was added for analysis and documentation

Summary: Combined



PROJECT OUTCOMES

- Better understanding and general approach
- Framework for evaluating future benefits
- Guidelines for work proposals to better evaluate benefits upfront
- Guidelines were developed to collect and monitor indicators related to indirect benefits