Value engineering in Road Asset Management as a tool supporting the selection of design solutions

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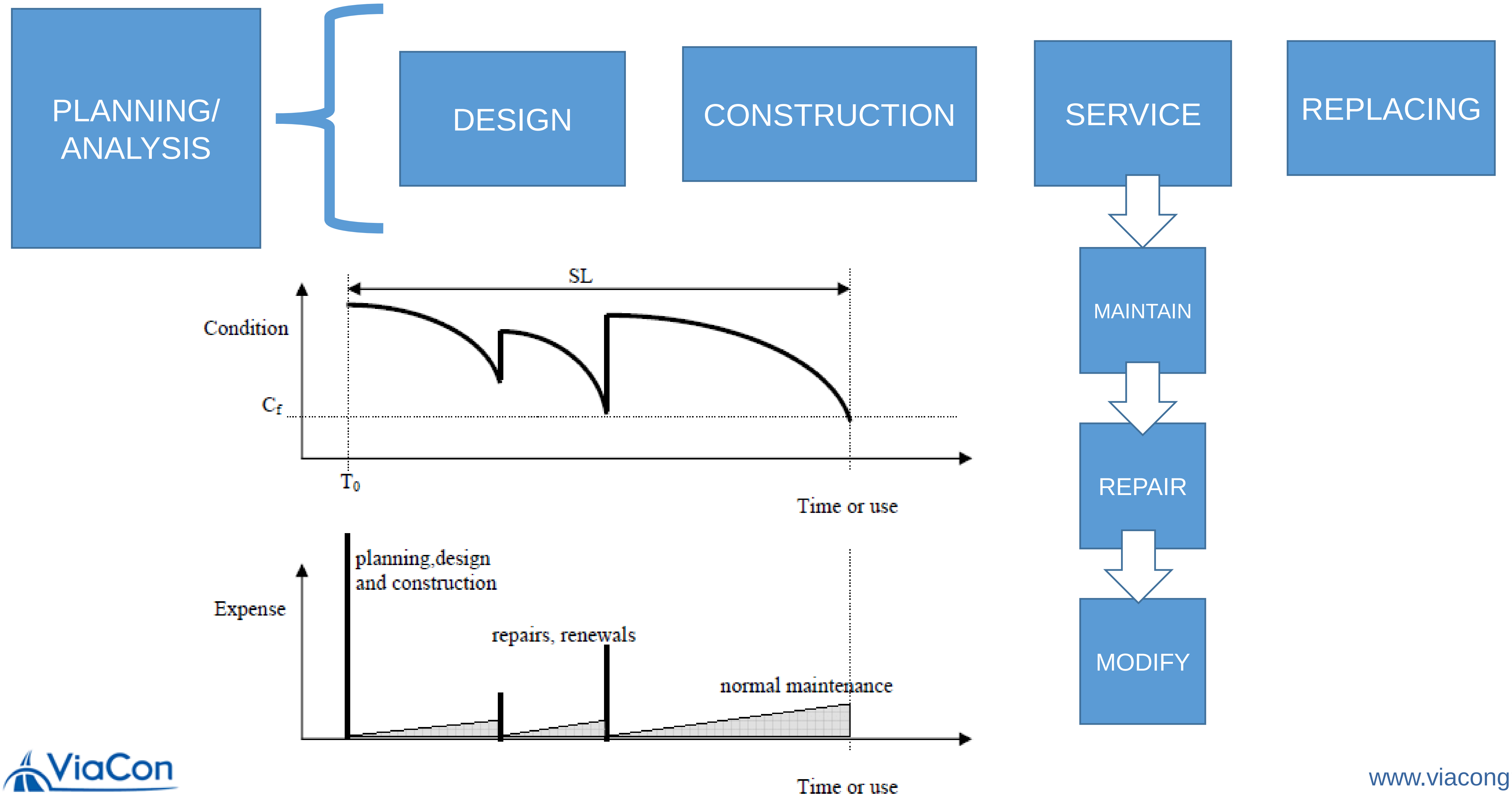
Presentation Plan

Infrastructure Asset Management

Infrastructure asset management is the combination of management, financial, economic, engineering, and other practices applied to physical assets with the objective of providing the required level of service in the most cost-effective manner. It includes the management of the entire lifecycle—including design, construction, commissioning, operating, maintaining, repairing, modifying, replacing and decommissioning/disposal—of physical and infrastructure assets

Source: Wikipedia

ASSET MANAGEMENT IN LCA CONTEXT



Introduction

1947 – General Electric introduced the concept in order to obtain better alternatives at lower cost

Lawrence D. Miles – was in charge of concept – Value Analysis

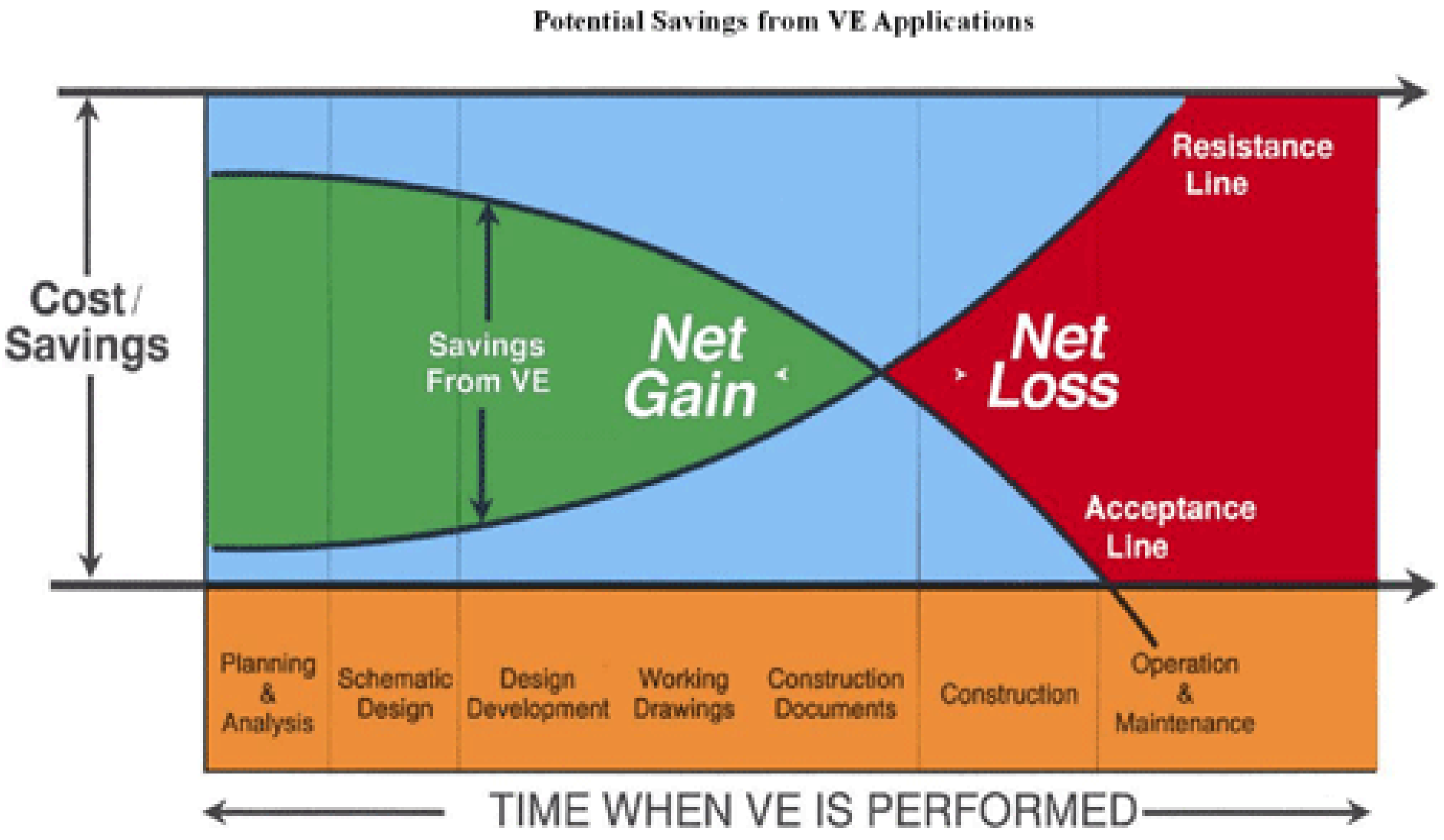
1957 – Value Analysis renamed to „Value Engineering” (VE) by Navy's Bureau of Ships and put into a formal VE program.

Concept 1947 → Value Analysis Lawrence D. Miles → Value Engineering 1957 → Formal VE program Navy's Bureau of Ships

Definition of Value Engineering

Value Engineering - systematic process of review and analysis of a project, during the concept and design phases, by a multidiscipline team of persons not involved in the project, that is conducted to provide recommendations for:

- providing the needed functions safely, reliably, efficiently, and at the lowest overall cost;
- improving the value and quality of the project;
- reducing the time to complete the project.



Picture 1. Cost/savings deriving from VE introduction vs time

TIME = MONEY

Saving by using Value Engineering in USA (bln USD) 2010-2015

Summary Of Past VE Savings Federal-Aid and Federal Lands Highway Programs						
	FY 2015	FY 2014	FY 2013	FY 2012	FY 2011	FY 2010
Number of VE Studies	135	215	281	352	378	402
Cost to Conduct VE Studies and Program Administration	$6.4 M	$8.7 M	$9.8 M	$12.0 M	$12.5 M	$13.6 M
Estimated Construction Cost of Projects Studied	$14.1 M	$20.9 B	$23.0 B	$30.3 B	$32.3 B	$34.2 B
Total Number of Proposed Recommendations	1.233	1,664	2,381	2,905	2,950	3,049
Total Value of Proposed Recommendations	$2.5 B	$3.0 B	$2.91 B	$3.78 B	$2.94 B	$4.35 B
Number of Approved Recommendations	504	697	1,011	1,191	1,224	1,315
Value of Approved Recommendations	$831 M	$1.73 B	$1.15 B	$1.15 B	$1.01 B	$1.98 B
Percent of Project Cost Saved	5.90%	8.32%	5.01%	3.78%	3.12%	5.79%
Return on Investment	129:1	200:1	118:1	96:1	80:1	146:1

2,0 bln USD

ROI= 146

Description of Value Engineering process

Orientation phase

- Selection of project and team involed

Information phase

- Identification of needs of the project. High cost low value area’s specifed

Creative phase

- Creative development of alternatives that are cost effective and achieve the basic function

Functional phase

- Functional analysis of product/service

Development phase

- Judgement and ranking of ideas developed in former phase

Evaluation phase

- Final recommendation is developed. Detailed technical and economical assessment of it is conducted

Presentation phase

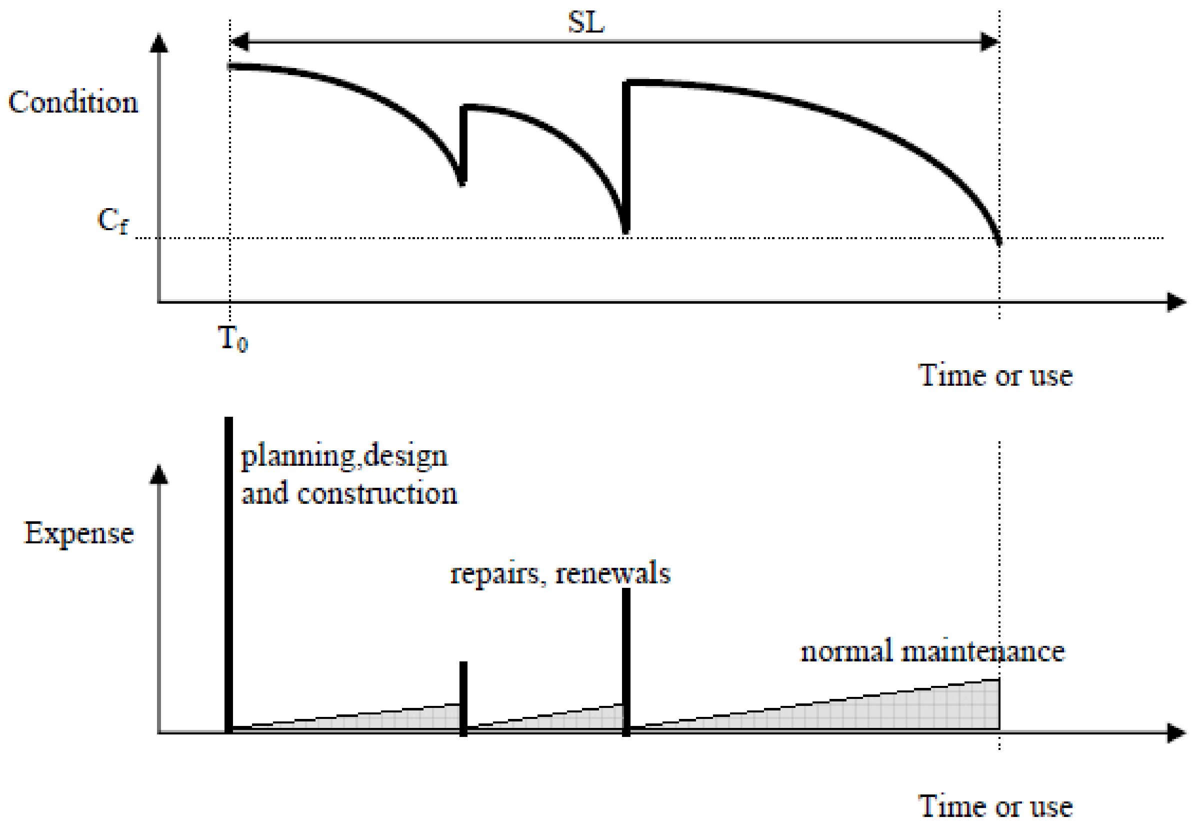
- Presentation of the best alternative/s to decision makers (VEP)-Value Engineering Proposal, including necessary action plan to introduce the decision

Implementation and follow up

- Conversion of approved decision into action.Summary report after successful completion

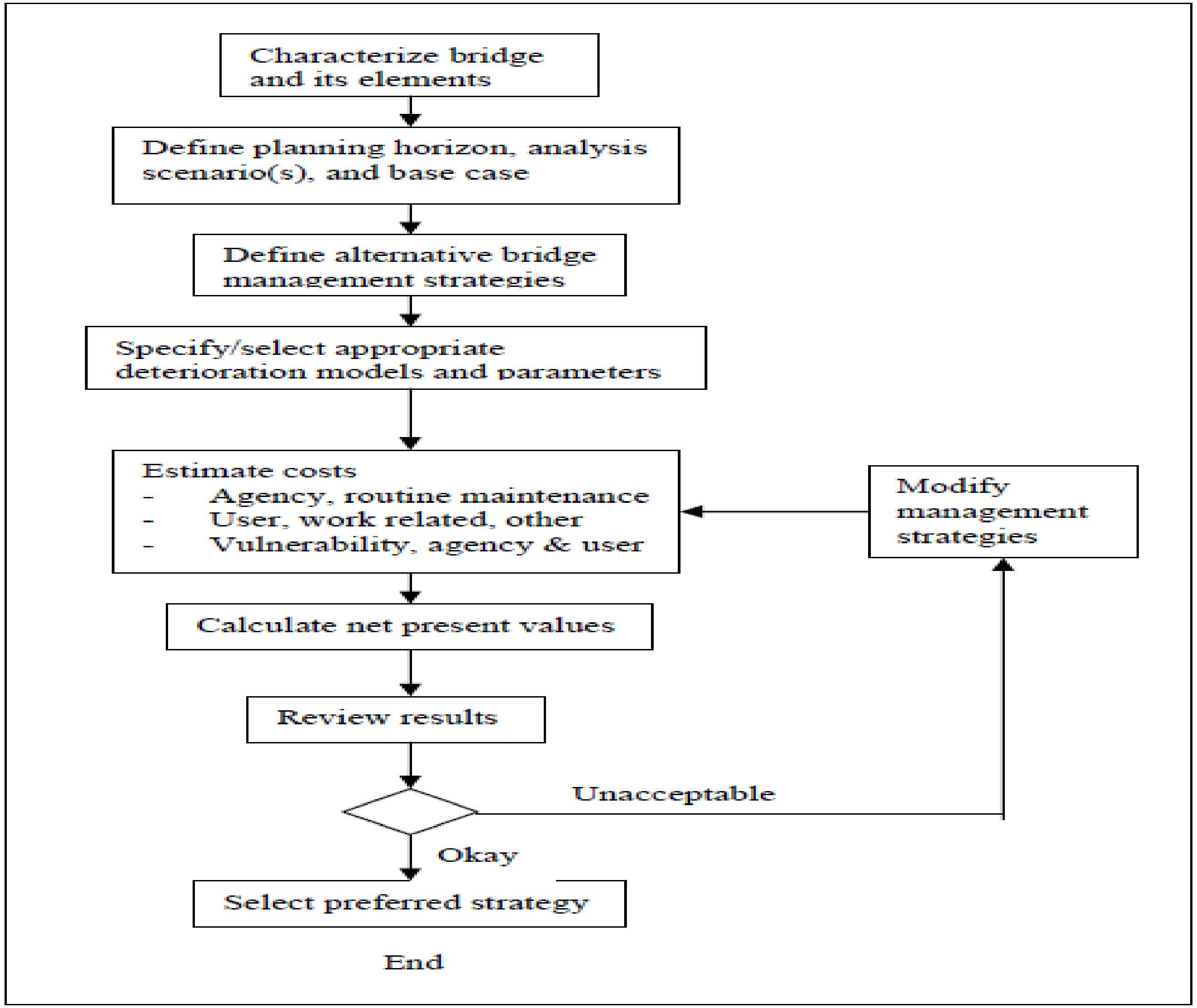
LCCA – Life cycle cost analysis

Planning Designing → Production Construction → Service → Maintenance Repair → Replacement Demolition



Picture 2. Change of condition and expenses of any product during service life (SL)

LCCA – Life cycle cost analysis



Picture 3. LLCA in bridge engineering after NCHRP

LCCA – Calculation model

$$PV = A + PVAs + PAr + PVrs$$

$PV - present\ value\ of\ total\ cost$

A – initial investment cost (including design and construction)

PVAs – present value of future repairs

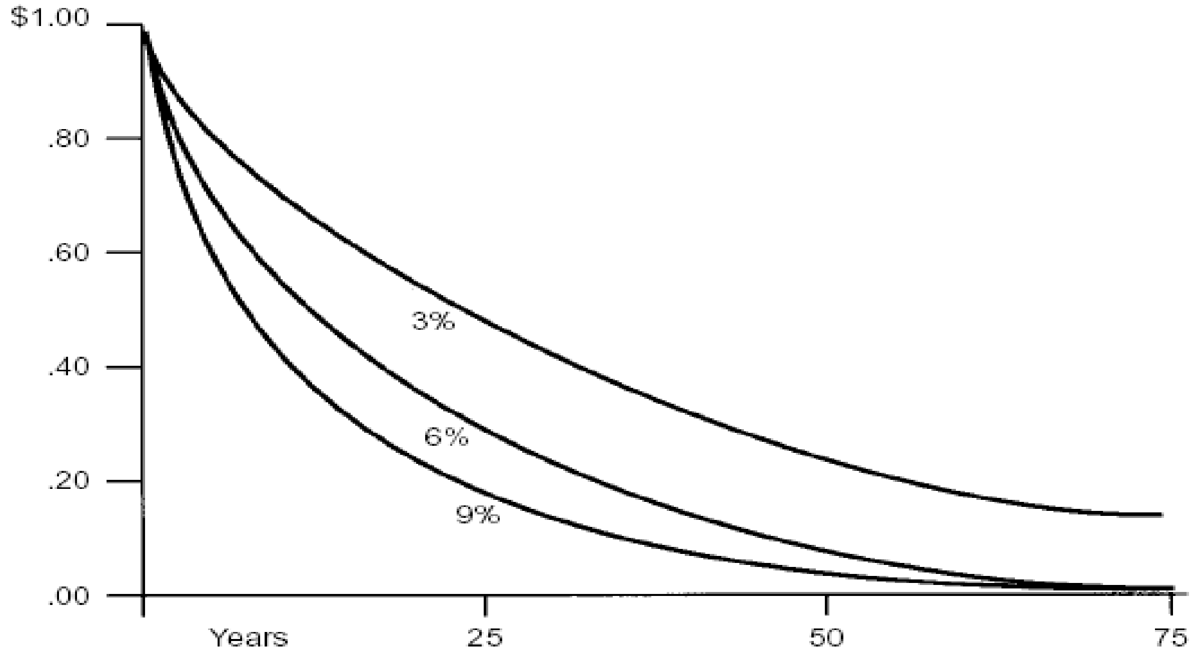
PVAr- present value of future maintenance costs

$PVArs$- present value of future replacement/reconstruction costs

LCCA – Calculation model

As commonly known in economics the later the spending of money the better:

Present Value of $1.00 Expended at Various Intervals and Discount Rates			
	Discount Rate		
Year	3%	6%	9%
0	1.00	1.00	1.00
25	.48	.23	.12
50	.23	.05	.01
75	.11	.01	.01



Present Value of $1.00 Expended at Various Intervals and Discount Rates

Picture 4. Present value (PV) of future spend of single USD at various discount rates

LCCA – Calculation model

$$PVAs = As/(1+dr)^n \quad (2)$$

$$PVAr = Ar * ((1+dr)^n - 1) / (dr(1+dr)^n) \quad (3)$$

$$PVArs = Ars / (1+dr)^n$$

$$d_r = (1+d)/(1+I) - 1$$

I - inflation rate

d - discount rate

dr- real discount rate

n- number of years after completion of construction works an occurrence of repair/replacement

As- cost of the planned repair

Ar- recurring maintenance annual cost

Ars- replacement cost

PV- present value

Value Engineering of buried flexible structures

Example 1

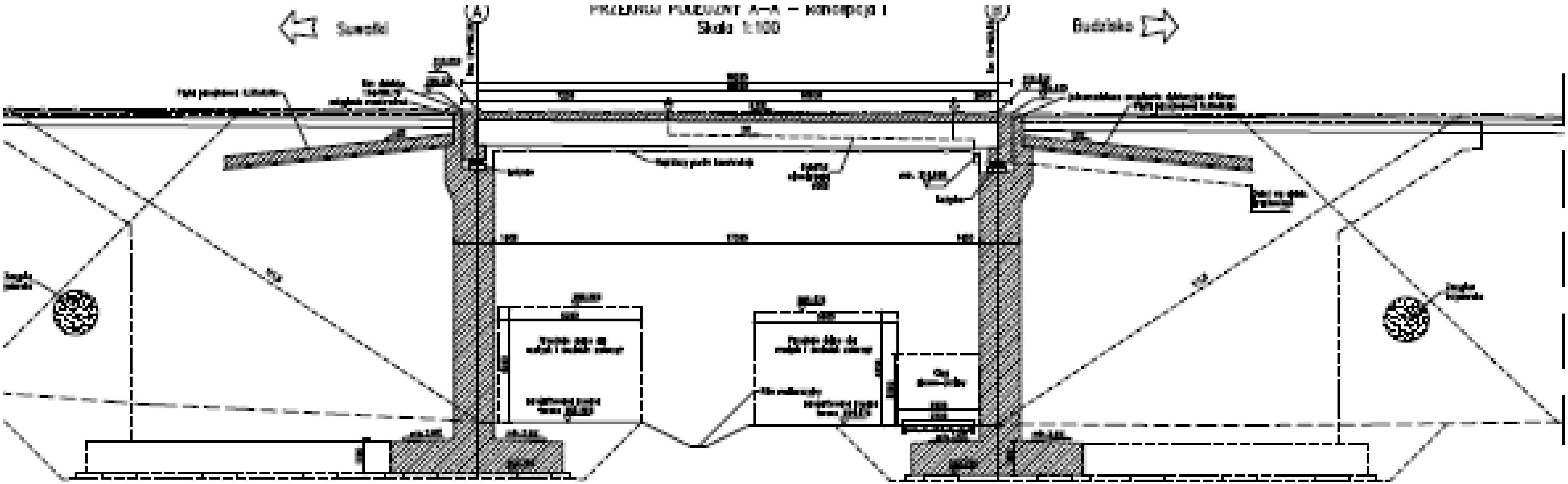
Picture 5. Two bridges having the same function concrete and buried corrugated steel bridge

SCOPE OF ANALYSIS

The scope of this analysis does not take into acocunt :

overal agency costs, environmental footprint, social costs, related road costs like grade line change etc.

Value Engineering of buried flexible structures
Example 1

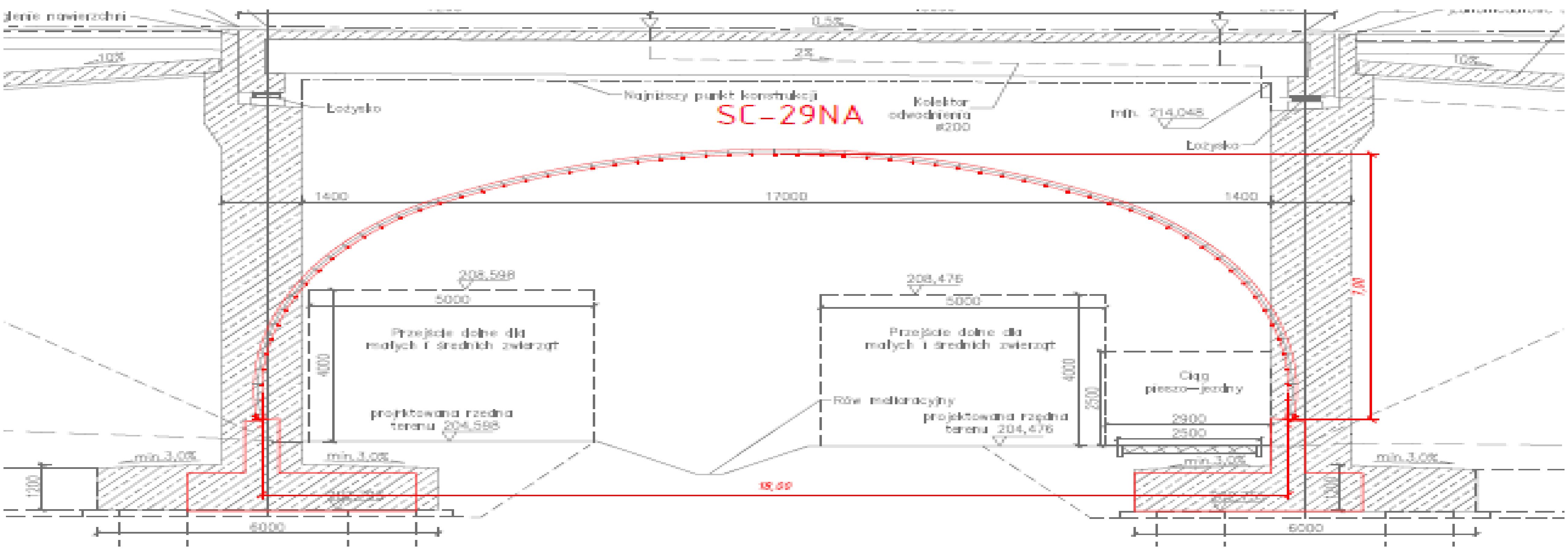


Picture 6. longitudinal section of concreto bridge – Alternative 1.

Span – 17,0m

Length – 29,0m

Value Engineering of buried flexible structures
Example 1



Picture 7. Cross section of buried corrugated steel structure – Alternative 2.

Span – 18,0 m

Bottom length – 56,0 m

Value Engineering of buried flexible structures

Example 1

	LCA MODEL				
	FILL IN GREEN				
1/	function		Underapss		
2/	load class		A	Polish standard	
3/	design life		100	years	
4/	environment		medium aggressive		
5/	span		17	18	m
6/	bottom length		29	56	m
7/	cover		0	3	m
8/	thickness of the wall		**Alt 1**	**Alt 2**	**Alt 3**
	[mm]		n/a	7/ 5,5	0
9/	Alternatives		**Alt 1**	**Alt 2**	**Alt 3**
			Concrete	Corrugated steel	
10/	material life time (years)		100	100	0
10/	total investment costs [pln]		**Alt 1**	**Alt 2**	**Alt 3**
			2421000	2250000	0
11/	REPAIRS COST	YEAR OF SERVICE	**Alt 1**	**Alt 2**	**Alt 3**
	[pln]	10	137152	0	0
		20	345509	0	
		30	137152	100000	0
		40	345509	0	
		50	137152		
		60	345509	100000	
		70	137152		
		80	345509		
		90	137152	100000	
		100			
			2067794,08	300000	
12/	AVERAGE ANNUAL MAINTENACE COST		**Alt 1**	**Alt 2**	**Alt 3**
	Ar [pln]		1340	650	0
13/	REPLACEMENT COST				
		YEAR	**Alt 1**	**Alt 2**	**Alt 3**
		100	3300000	2500000	0

1. Total investment costs
2. Repair costs
3. Maintenance costs
4. Replacement costs

Value Engineering of buried flexible structures

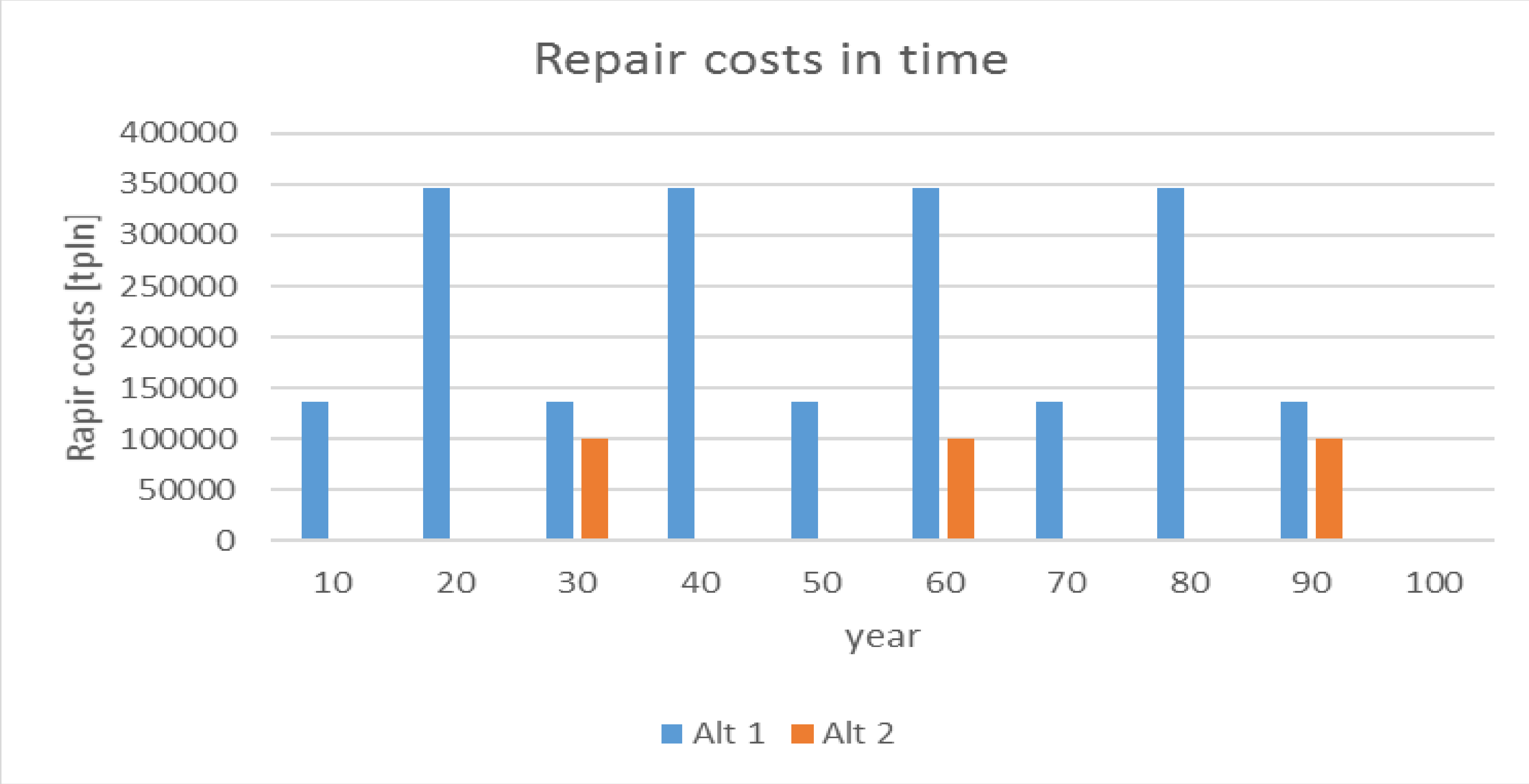
Example 1

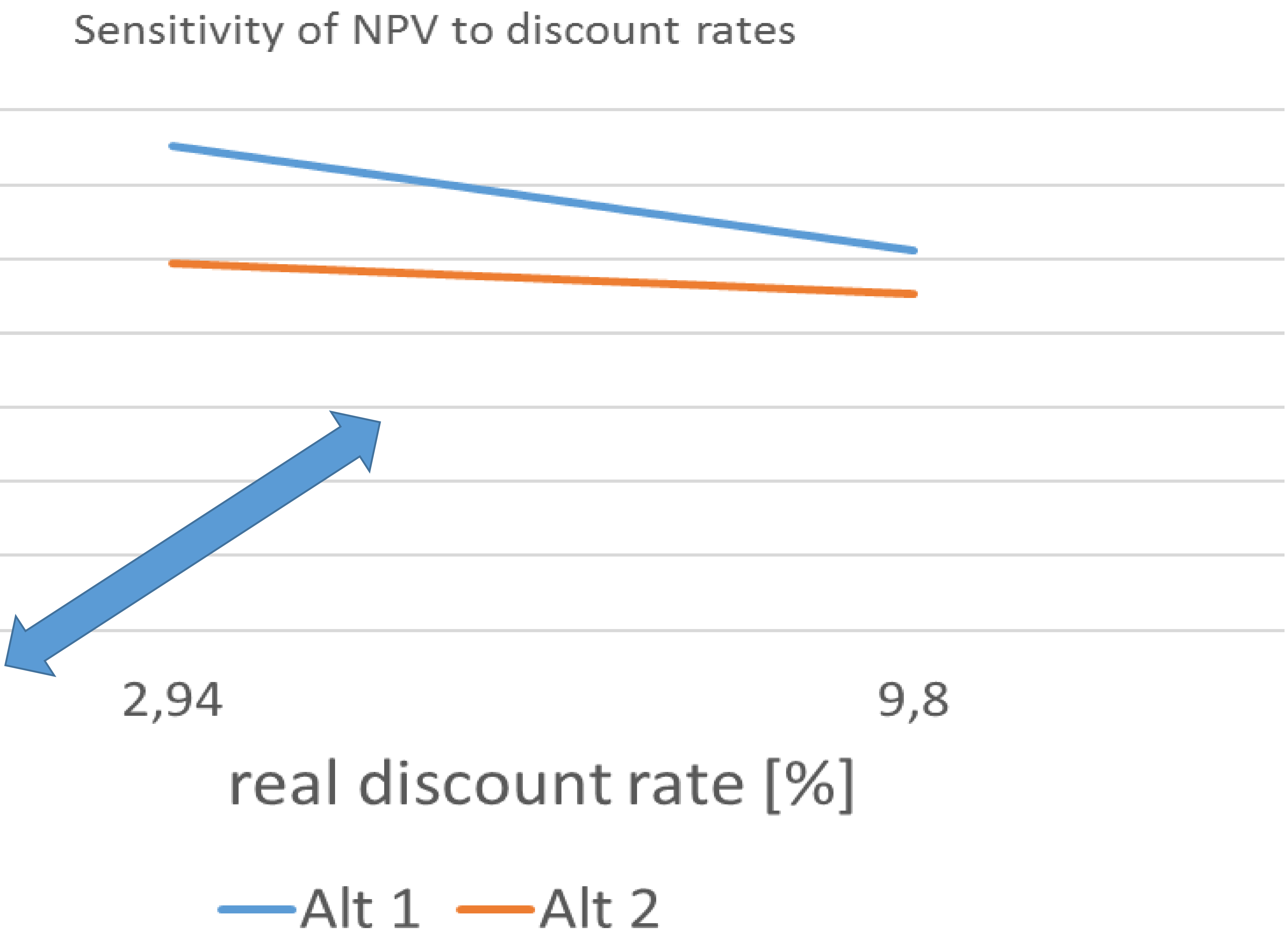
NOMINAL DISCOUNT RATE	d=	5%	5%
AVERAGE ANNUAL INFALTION	I=	2%	2%
REAL DISCOUNT RATE	dr=	2,94%	2,94%

Net Present Value	**Alt.1**	**Alt.2**
NPV=	**3262832**	**2475450**

INVESTEMENT	**Alt.1**	**Alt.2**
A=	**2421000**	**2250000**

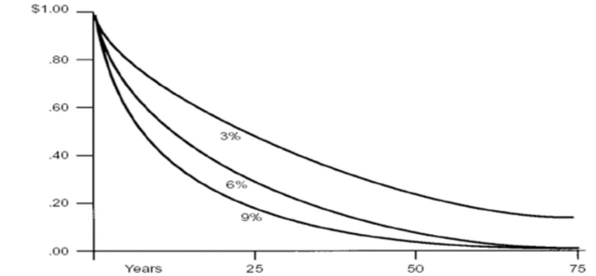
SELECTION	0	Alt.2


Repair costs in time
400000
350000
300000
250000
200000
150000
100000
50000
0
Rapir costs [tpln]
10
20
30
40
50
60
70
80
90
100
year
Alt 1
Alt 2



Present Value of $1.00 Expended at Various Intervals and Discount Rates

Year	Discount Rate 3%	6%	9%
0	1.00	1.00	1.00
25	.48	.23	.12
50	.23	.05	.01
75	.11	.01	.01



Present Value of $1.00 Expended at Various Intervals and Discount Rates

Value Engineering of buried flexible structures

Example 2

Picture 8. Three pipes used to build a culvert
alt.1/ Corrugated steel pipe (CSP) galvanized
alt.2/ Corrugated steel pipe (CSP) in trenchcoat
alt.3/ Reinforced concrete pipes (RCP)

Value Engineering of buried flexible structures

Example 2

	LCA MODEL				
	FILL IN GREEN				
1/	function		culvert		
2/	load class		A	Polish standard	
3/	design life		100	years	
4/	environment		medium aggressive		
5/	span		1500	mm	
6/	bottom length		20	m	
7/	cover		1,2	m	
8/	thickness of the wall		**Alt 1**	**Alt 2**	**Alt 3**
	[mm]		2	2	70
9/	Alternatives		**Alt 1**	**Alt 2**	**Alt 3**
			HC Zn600	HCTC	concrete pipes
10/	material life time (years)		25	100	100
10/	total investment costs		**Alt 1**	**Alt 2**	**Alt 3**
			80000	95000	120000
11/	REPAIRS COST	YEAR OF SERVICE	**Alt 1**	**Alt 2**	**Alt 3**
	[pln]	25	30000	0	0
		40	20000	20000	
		50	20000	0	20000
		75	20000	20000	
12/	AVERAGE ANNUAL MAINTENACE COST		**Alt 1**	**Alt 2**	**Alt 3**
	Ar [pln]		500	300	200
13/	REPLACEMENT COST				
		YEAR	**Alt 1**	**Alt 2**	**Alt 3**
		100	80000	140000	165000

Value Engineering of buried flexible structures

Example 2

NOMINAL DISCOUNT RATE	d=	5%	5%	5%
AVERAGE ANNUAL INFALTION	I=	2%	2%	2%
REAL DISCOUNT RATE	dr=	2,94%	2,94%	2,94%

Net Present Value	Alt.1	Alt.2	Alt.3
NPV=	**124453**	**120898**	**140210**

INVESTEMENT	Alt.1	Alt.2	Alt.3
A=	**80000**	**95000**	**120000**

SELECTION	0	Alt.2	0

Summary

1. Road Asset Management is driven by Value Engineering (VE) at planning stage

2. (VE) is an unbias evaluation method helping in selection of optimal solutions

3. (VE) has been used successfully worlwide and saved a lot of tax payers money

4. Road Asset Managers shoudl have an input into VE at planning stage

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