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Faculty of Engineering Science and Technology
Department of Marine Technology

Sustainable Arctic Sea Transport Group – SAST
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Cost–Benefit–Risk Analysis

Theoretical background and NSR vs. SCR example

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Presented by

Aleksandar-Saša Milaković, MSc Nav Arch
PhD Candidate, IMT, NTNU, Trondheim, Norway
“Arctic field logistics and transarctic shipping”

Theoretical background of CBRA

Cost-Benefit-Risk Analysis (CBRA) is a systematic approach to estimating the strengths and weaknesses of alternatives with two basic purposes:

1) To determine if an investment/decision is sound – verifying whether its benefits outweigh the costs, and by how much, taking into account possible risks

2) To provide a basis for comparing projects – which involves comparing the total expected cost of each option against its total expected benefits

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Theoretical background of CBRA

Cost-Benefit-Risk Analysis (CBRA)

Cost-Benefit Analysis (CBA)

1) Breakdown the plan/process into its elements by drawing up a flowchart or list of inputs, outputs, activities and events
2) Calculate or estimate the cost and benefit associated with each element - include if possible all direct and indirect costs and benefits, transformed to the same unit, usually monetary one
3) Compare the costs and benefits using the concept of **Net Present Value (NPV)**

Risk Analysis (RA)

4) Rank the elements into a hierarchy that reflects their positive/negative impact on the whole process
5) Estimate consequence (*C*) of occurrence for each element using the same unit as in (2)
6) Estimate the probability (*P*) of occurrence for each element
7) Multiply the probability of occurrence for each element by its consequence – ***Risk = P × C***
8) Compare the risk (7) with the costs and benefits ratio calculated in (3)

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Theoretical background of CBRA

Cost-Benefit-Risk Analysis (CBRA)

Cost-Benefit Analysis (CBA)

Risk Analysis (RA)

Net Present Value (NPV):

"In effect the NPV shows how much better off the shipowner is in putting his money into this project rather than the US Stock Market."
(Ref. Stopford, M., 2003, Maritime Economics)

$$\mathrm{NPV}(i,N) = \sum_{t=0}^{N} \frac{R_t}{(1+i)^t}$$

t – the time of the cash flow
N – the number of time steps
i – the discount rate, i.e. the return that could be earned per unit of time on an investment with similar risk
R_t – the net cash flow i.e. cash inflow minus cash outflow at time t

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CBRA of NSR vs. SCR route selection

How to estimate whether or not an investment into an ice classed vessel (fleet) and using the NSR is more profitable than building a conventional vessel (fleet) and using the SCR?

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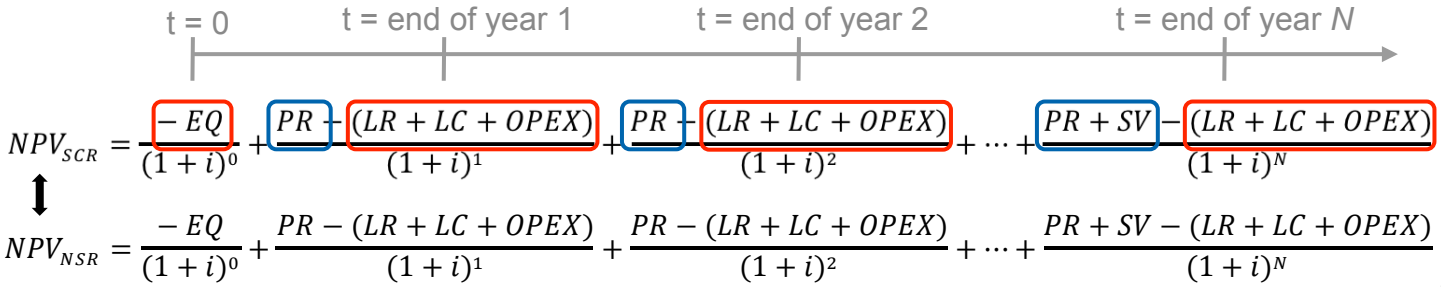
CBRA of NSR vs. SCR route selection

Cost-Benefit Analysis (CBA)

General parameters	Costs	Benefits
- Licefycle expectancy (*N*) = ? years - Discount rate or interest (*i*) = ? %	Costs of financing: - Equity (*EQ*) = ? $ - Yearly loan repayment (*LR*) = ? $ - Yearly cost of loan (*LC*) = ? $ Operational (OPEX) costs per year: - Fuel (*FC*) = ? $ - Crew (*CR*) = ? $ - Administration (*AD*) = ? $ - Port handling (*PH*) = ? $ - Insurance (*IN*) = ? $ - Maintenance (*MA*) = ? $ - Seaway specific fee (*SF*) = ? $	- Vessel's scrap value at the end of lifecycle (*SV*) = ? $ - Profit from cargo transported per year (*PR*) = ? $



If $NPV_{NSR} > 0$, and $NPV_{NSR} > NPV_{SCR}$, NSR is a preferred alternative, and vice versa

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CBRA of NSR vs. SCR route selection

Risk Analysis (RA)

Suez Canal Route	Northern Sea Route	
- Environmental pollution - Crew accident	- Environmental pollution - Crew accident	COMMON RISKS
- Piracy	- Hull damage due to ice - Engine damage due to ice - Delay due to ice/weather - Icebreaker unavailability - Political instability	ROUTE-SPECIFIC RISKS
	Increased traffic volumes resulting in: - Reduced IB fees - Increased safety - Reduced insurance premiums	"POSITIVE" RISKS

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CBRA of NSR vs. SCR route selection

Risk Analysis (RA)

Suez Canal Route	Northern Sea Route
- Environmental pollution ***P*** **[%] = ?, *C* [$] = ?**	- Environmental pollution ***P*** **[%] = ?, *C* [$] = ?**
- Crew accident ***P*** **[%] = ?, *C* [$] = ?**	- Crew accident ***P*** **[%] = ?, *C* [$] = ?**
- Piracy ***P*** **[%] = ?, *C* [$] = ?**	- Hull damage due to ice ***P*** **[%] = ?, *C* [$] = ?**
	- Engine damage due to ice ***P*** **[%] = ?, *C* [$] = ?**
	- Delay due to ice/weather ***P*** **[%] = ?, *C* [$] = ?**
	- Icebreaker unavailability ***P*** **[%] = ?, *C* [$] = ?**
	- Political instability ***P*** **[%] = ?, *C* [$] = ?**
	- Increased traffic volumes resulting in:
	- Reduced IB fees ***P*** **[%] = ?, *C* [$] = ?**
	- Increased safety ***P*** **[%] = ?, *C* [$] = ?**
	- Reduced insurance premiums ***P*** **[%] = ?, *C* [$] = ?**

$$\sum_{R=1}^{N_R} Risk_{SCR} \quad NPV_{SCR}$$

Cost-Benefit-Risk Analysis

$$\sum_{R=1}^{N_R} Risk_{NSR} \quad NPV_{NSR}$$

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