Assessment of Risk Mitigation Strategies for Attacks on Bridges

Sebastian Thöns
Department of Civil Engineering
Technical University of Denmark, Denmark

Scientific Mission: Decision and Value of Information Analyses in Conjunction with Manmade Hazards

Scholar: Prof. Sebastian Thöns

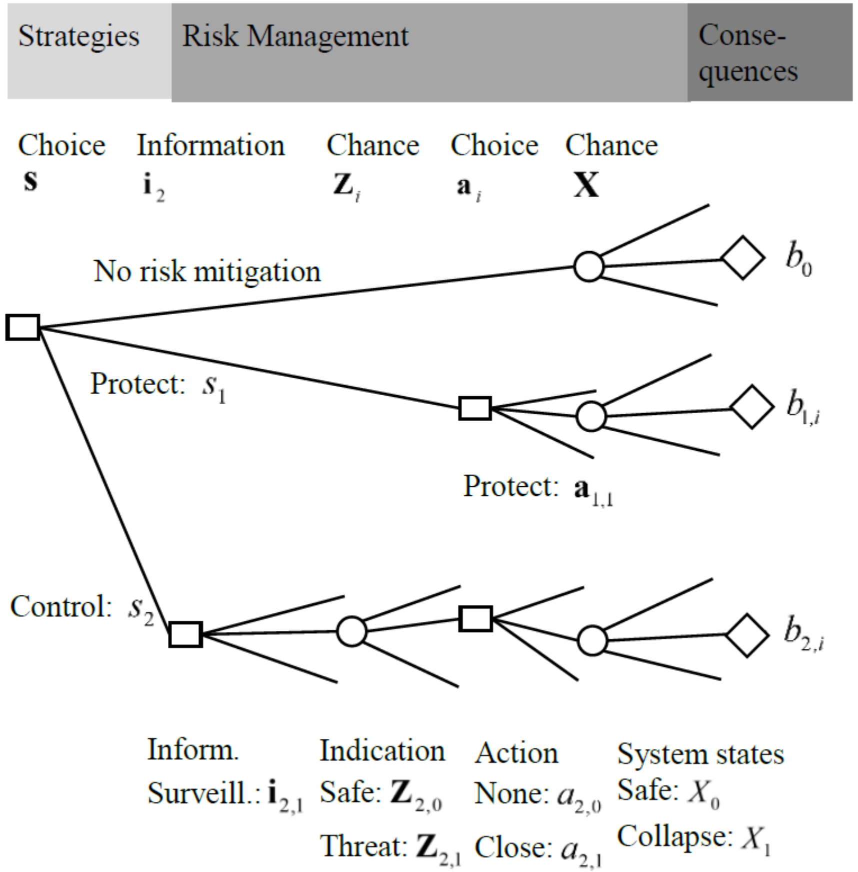
Home Institution: Technical University of Denmark, Lyngby, Denmark

Host: Prof. Mark Stewart

Host Institution: The University of Newcastle, Callaghan, NSW, Australia

Dates: 27 / November / 2017 - 22 / December / 2017

Approach

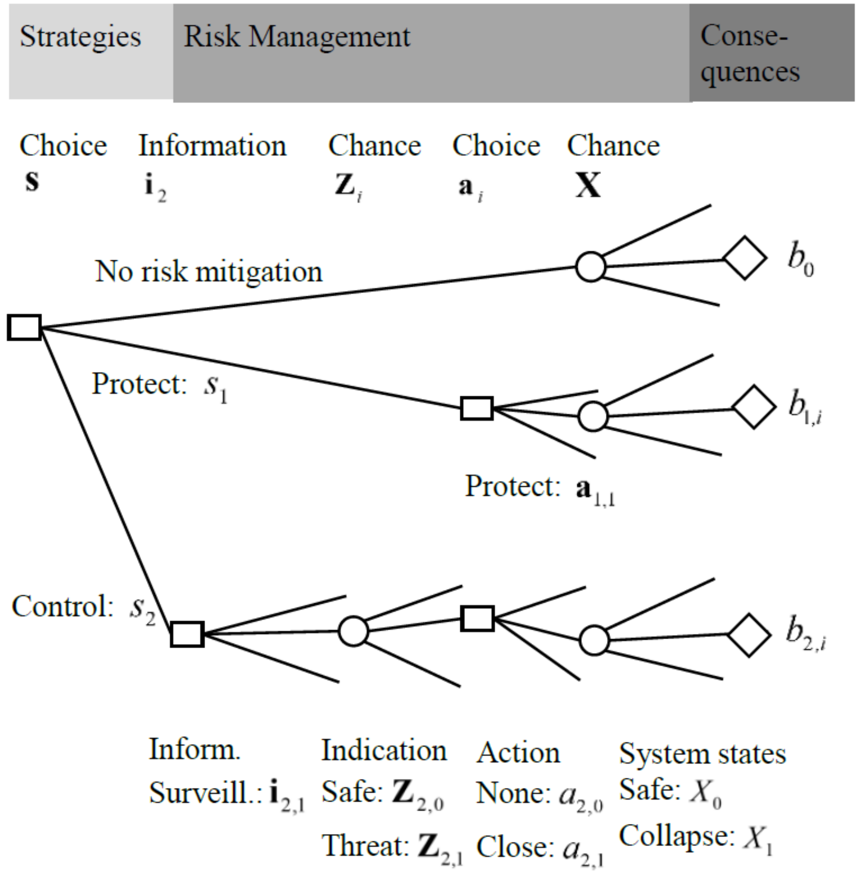


We analyse the value of risk mitigation measures for terrorist attacks with Improvised Explosive Devices (IEDs) for an iconic bridge structure.

- Decision maker is an authority responsible for the societal safety of the infrastructure.
- Mitigation strategies are protection measures and control, i.e. information acquirement
- The probability of collapse is calculated with the hazard H and the threat T events

$$P(X_1) = P(X_1 | H) \cdot P(H | T) \cdot P(T)$$

Approach

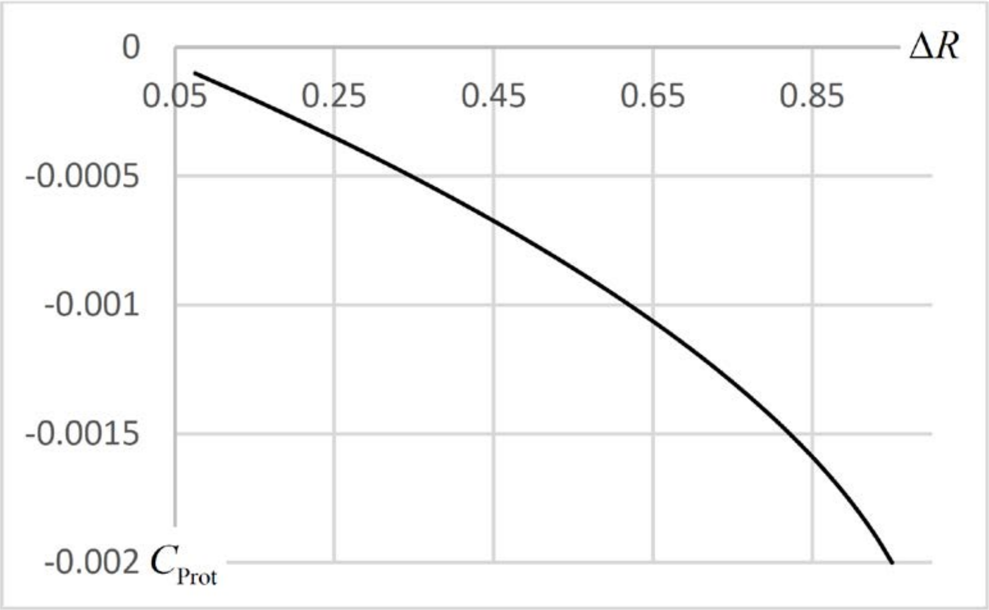


The value of the protect and control strategies is quantified.

$$V_{s_{1,i}} = B_{1,i}\left(a_{i,l}^{\ *}\right) - B_0$$

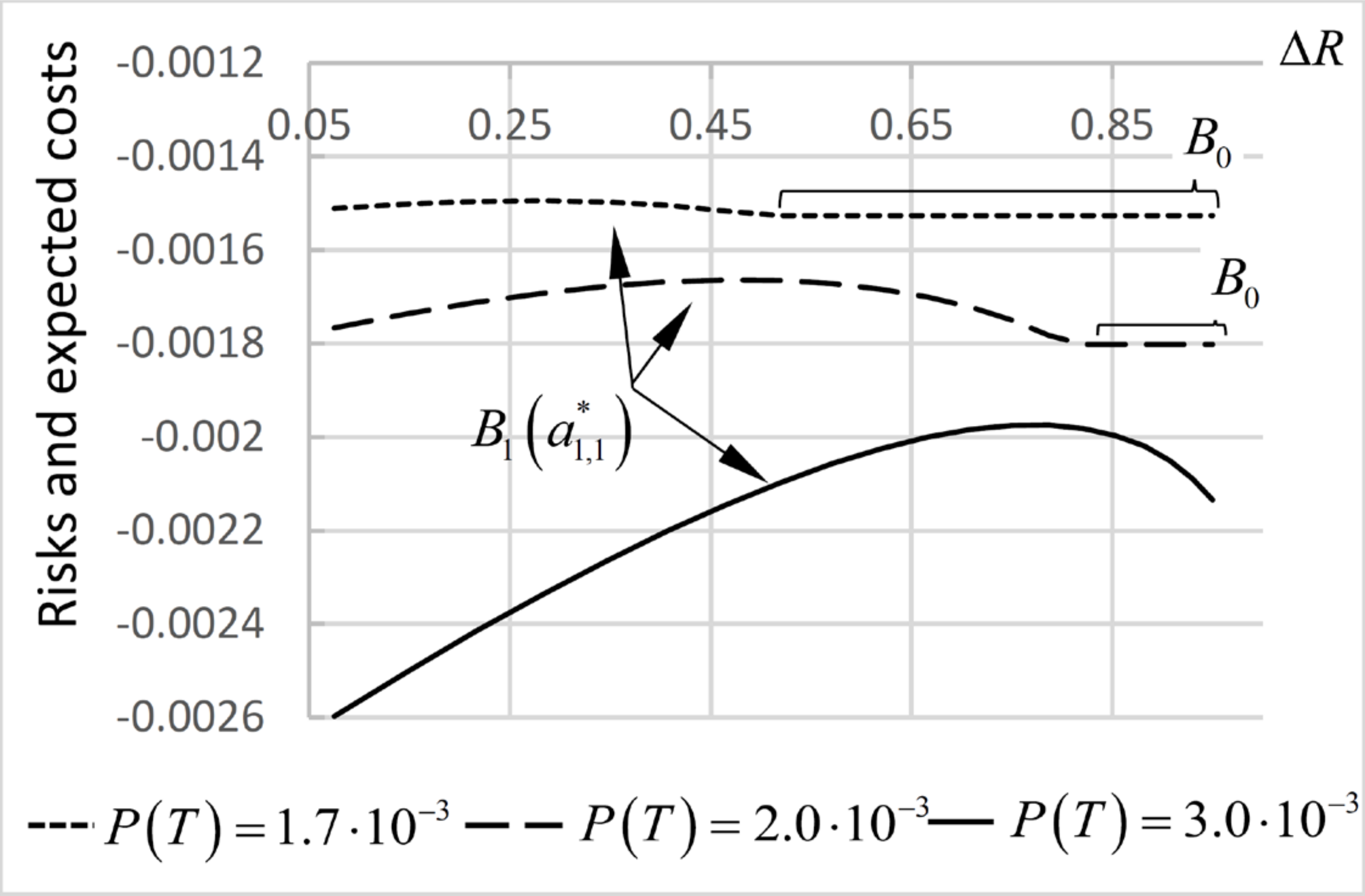
$$V_{s_{2,i}} = B_{2,i}\left(i_{i,j}^{*}, a_{i,l}^{\ *}\right) - B_0$$

Strategy protect

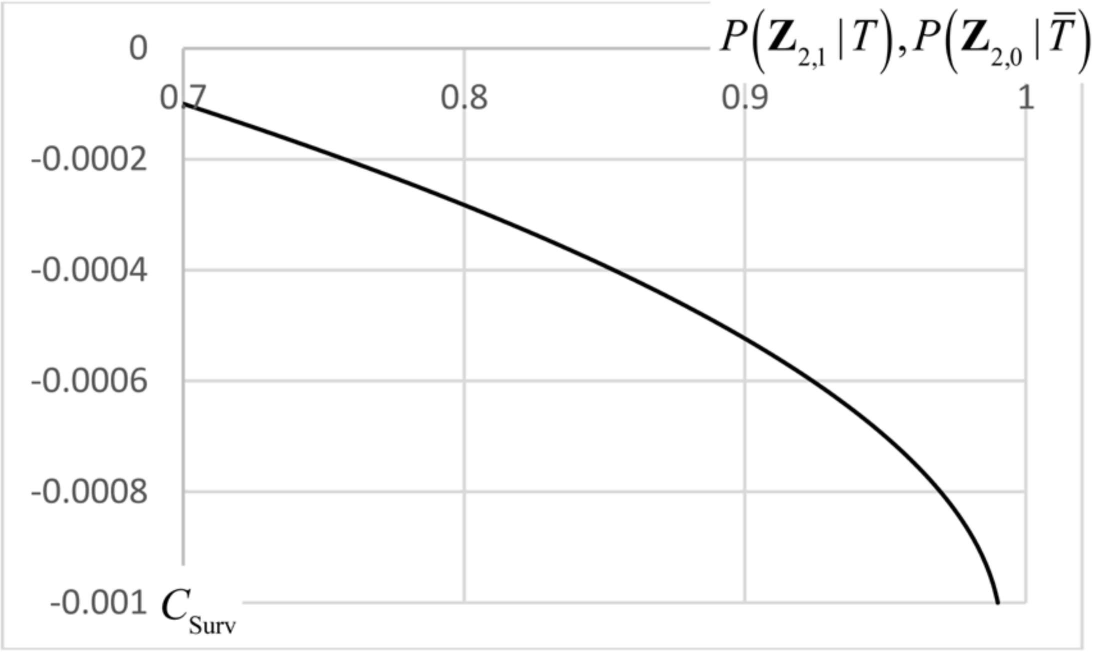


Nodes, states		Consequences	Prob.
Protective actions	a_0	0	-
	$\mathbf{a}_{1,1}$	[-0.0001…-0.002]	$\Delta R(\mathbf{a}_{1,1}) = [0.075 \rightleftharpoons 0.95]$
System states	X_0	0	$1 - P(C)$
	X_1	U(-10.0,-5.0)	$P(C)$

Results for strategy protect

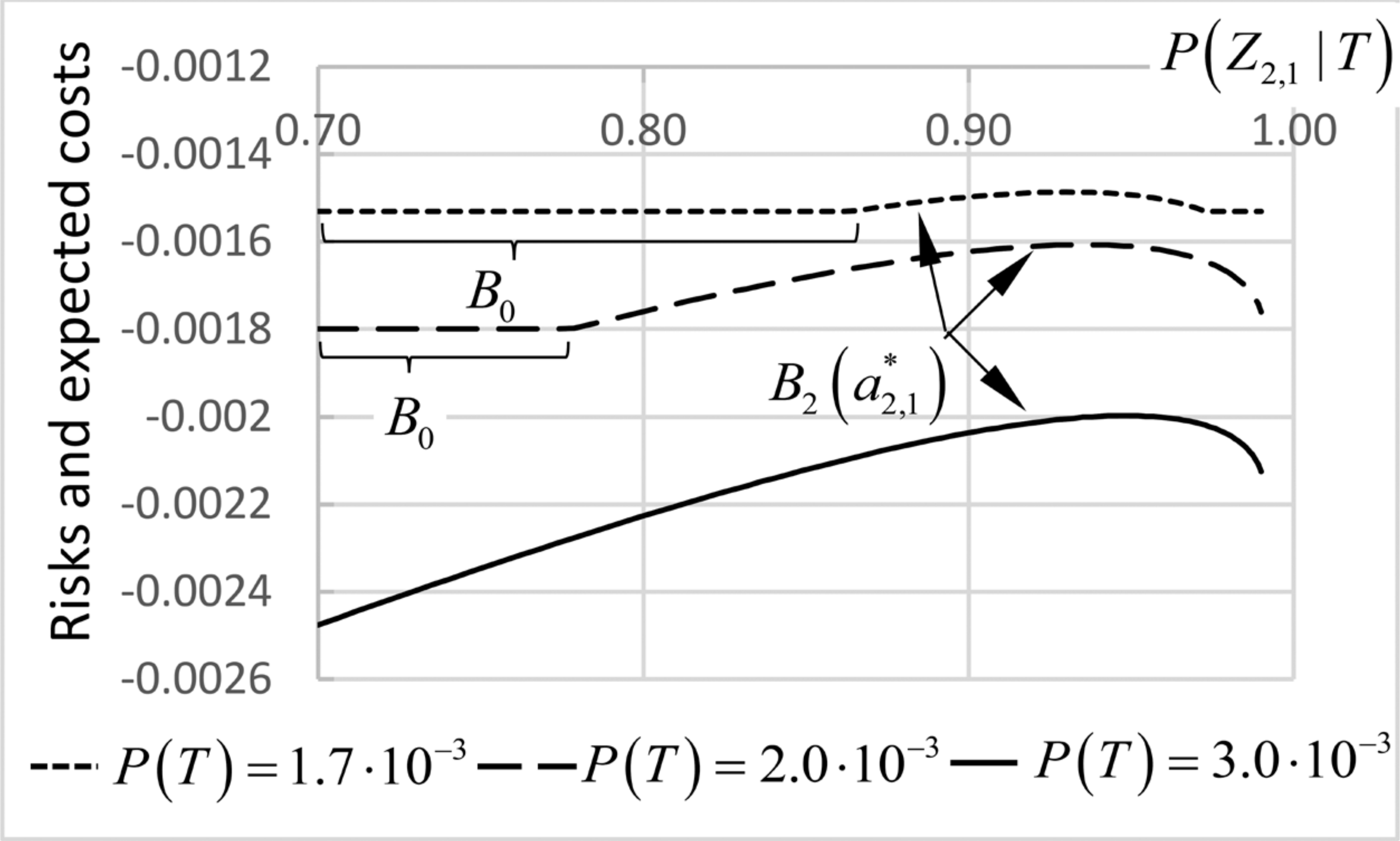


Strategy control



States	Consequences	Prob.	
i_2	[-1.0E-4… -1.0E-3]	-	
		X_0	X_1
$\mathbf{Z}_{2,0}$	-	[0.7…0.99]	[0.3…0.01]
$\mathbf{Z}_{2,1}$	-	[0.3…0.01]	[0.7…0.99]
$a_{2,0}$	0	-	
$a_{2,1}$	2.72E-3	-	
X_0	0	$1-P''(C)$	
X_1	U(-10.0,-5.0)	$P''(C)$	
$X_1 \mid a_{2,1}$	U(-5.0,-1.0)	$P''(C)$	

Results for strategy control



Conclusions

1. The threat probability assumption is critical and usually unknown.

2. The implementation of mitigation strategies should not just be based not the maximised expected value.

Standardisation requirements

1. Background for efficiency and implementation of protective should be clarified.

2. Rules for implementing mitigation measures should be derived and incorporated to standards.

3. Decision theoretical efficiency assessment should be allowed for “overruling”.

Thank you for your attention.

DTU

ERDA
Engineering Risk and
Decision Analysis