Assessment and Rehabilitation of Central European Highway Structures

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FEHRL

Systematic decision making processes within Bridge Management System

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CERTAIN

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- BMS basic structure
- BMS in European countries
- Supporting materials and tools
- Previous projects (European, American)
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  - Recommendation
  - Conclusions

Introduction

- **WP2:**
  Structural Assessment and Monitoring (TUC, Spain, J. R. Casas)

- **Task 2.4:**
  Systematic decision making processes associated with maintenance and reconstruction of bridges
  (CDV, Czech Republic, J. Stryk)

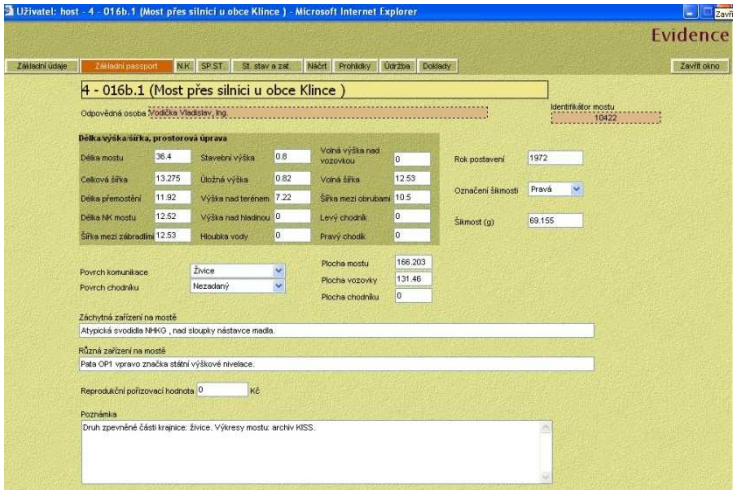
- **Deliverable D09:** *August 2009*
  Recommendation on systematic decision making …
  - **BMS in NMS**

Bridge management system

- commercial / own system
- bridge-level / network-level

- condition & structure safety assessment of bridges
- information on costs & technologies
- decision on maintenance, repair, rehabilitation, strengthening and reconstructions
- prediction
- prioritization

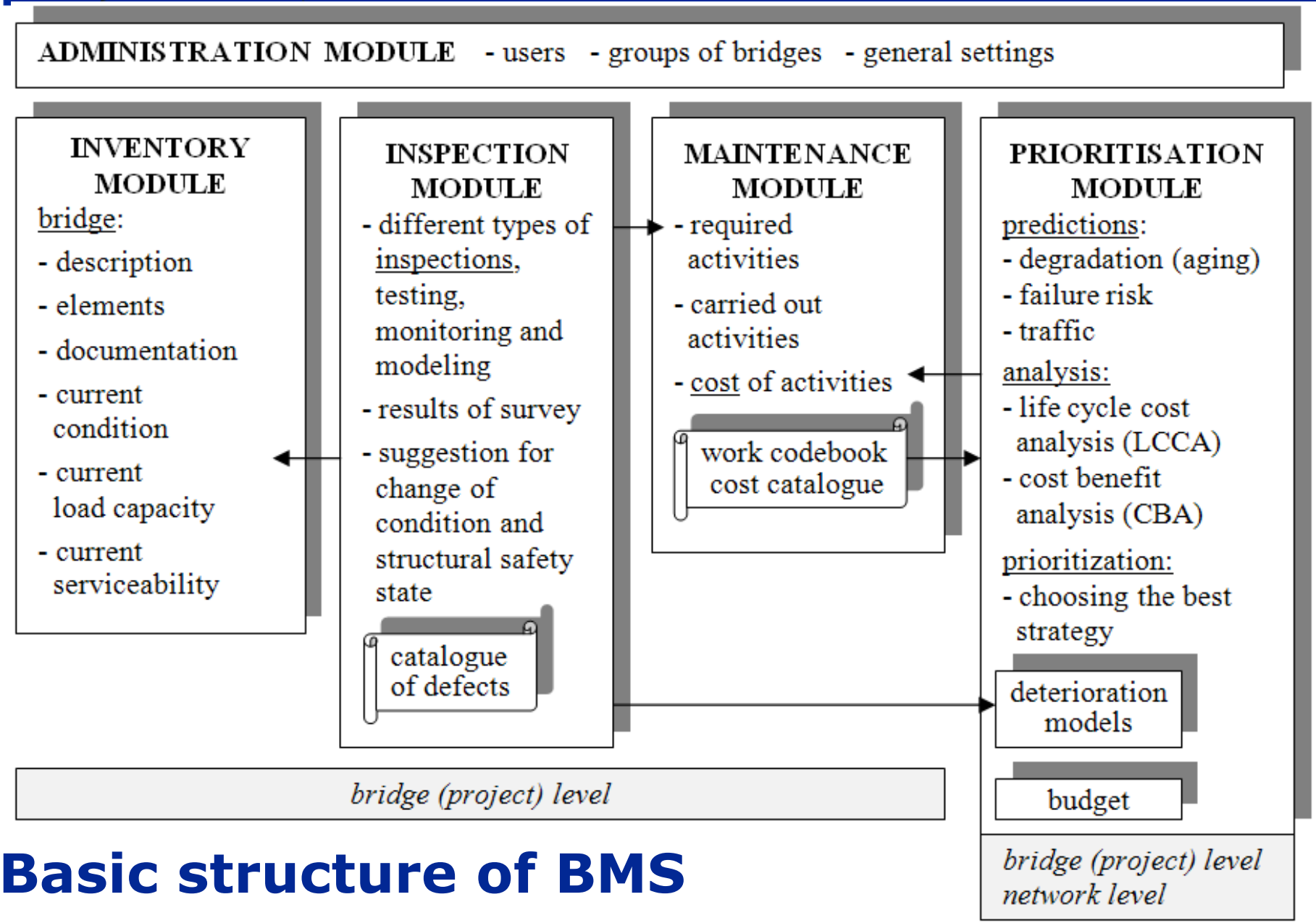
- questionnaire (14)
- national reports (7)



BMS in European countries

Country	*Year of BMS starting*	*Prioritisation in BMS*	*No. of bridges managed*	*Used system/software*
Bulgaria	2004/2005	No	1.312	Scan print-Freissinet
Croatia **	developed now	Yes	800 on highways	Oracle 10.G
Czech republic	2002	Yes	20.490	IIS database + MS SQL Server
Estonia	2002	Yes	922	Pontis
France *	1999	No	9.000	own system
Germany *	2000/2001	Yes	38.000	SIB-Bauwerke; BMS-Optimisation-tools
Hungary	1996	Yes	6.000	adapted Pontis
Italy *	1986	Yes	3.626	Oracle, SQL server
Latvia	2002	Yes	1.775	LatBrutus
Serbia ***	1985	Yes	3.500	BPM
Slovakia	1998	Yes	7.664	Microsoft Access
Slovenia	1992	No	2.300	UNIX
UK	2001	Yes	8.600	Oracle
Ukraine ****	2006	Yes	2.203	Microsort Sql Server, Borland Delphi

* former EU members, ** candidate country, *** potential candidate country, **** membership possible



Basic structure of BMS

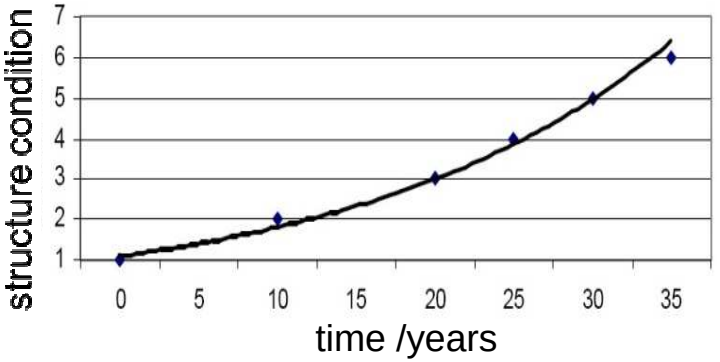
Bridge level & network level

- **bridge level**
  - condition assessment - rating of elements or structure
  - safety assessment - load carrying capacity, safety factors
  - economical optimisation (LCCA)
  - measures/activities with their urgency

- **network level**
  - state, regional or other programs and priorities
  - social and environmental consequences
  - prioritization of activities within limited budget
  - bridge priority list

Supporting materials and tools

- **Deterioration models**
  - for the whole bridge / its elements
  - based on inspections, experience and prediction
  - creation of bridge categories
  - determination of residual lifespan
- **Catalogue of defects**
  - identification of potential origins
  - anticipation of further progression
  - measures and their urgency
- **Cost catalogue**
  - for appropriate estimation of future agency costs
- **Traffic grow models**
  - to evaluate future load and requirements



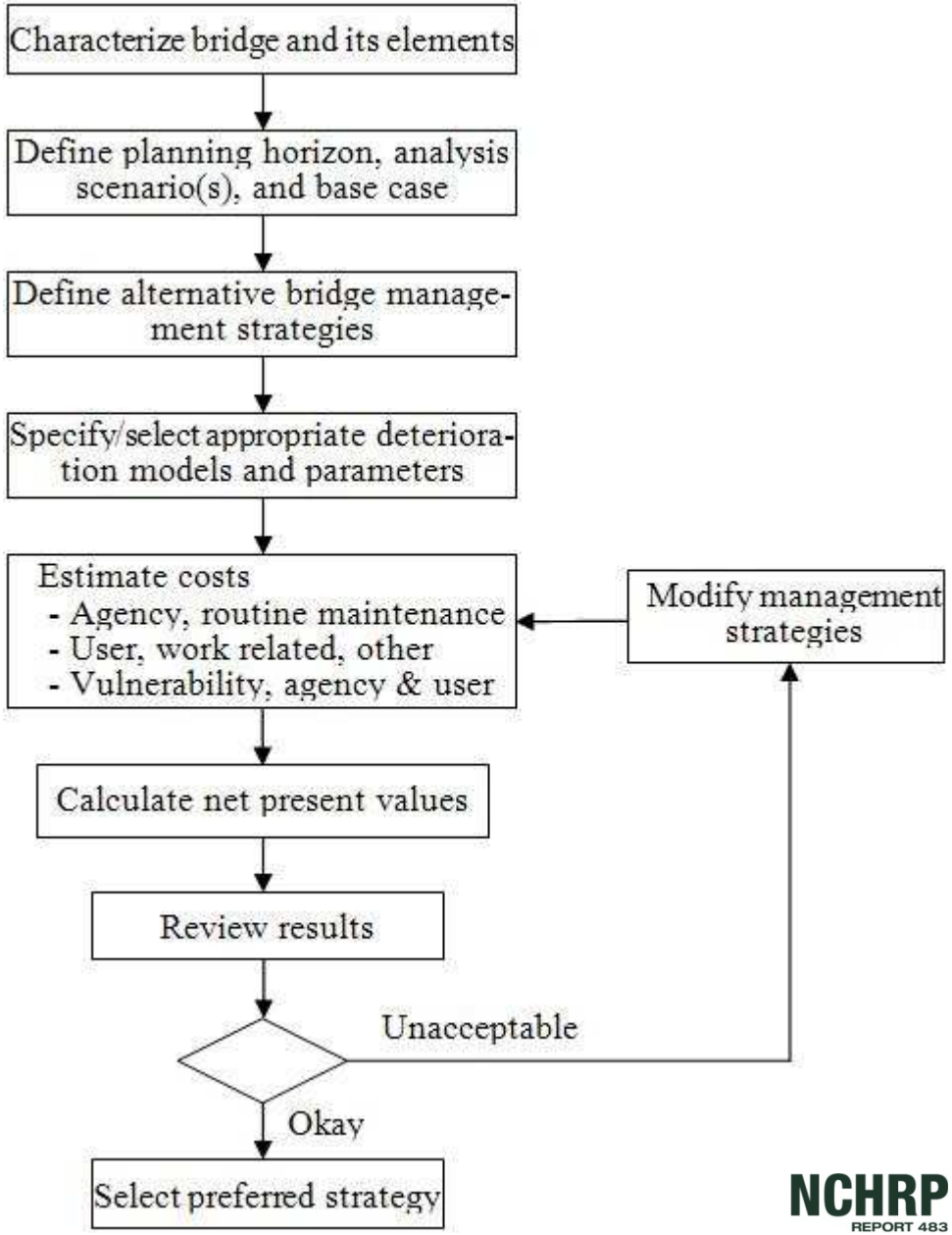
č. položky	popis	m.j.	cena
423 12-1123	Osazení mostních prefabrikovaných nosníků z BŽ na ložiska po částech, v.mostu <20m 10-25t	KUS	22 087.53
423 12-1124	Osazení mostních prefabrikovaných nosníků z BŽ na ložiska po částech, v.mostu <20m25-40t	KUS	84 218.05
423 12-1125	Osazení mostních prefabrikovaných nosníků z BŽ na ložiska po částech, v.mostu <20m 40-70t	KUS	201 907.37
423 13-1111	Osazení mostních prefabrikovaných nosníků z BP na ložiska vcelku, v.mostu <15m 5-10t	KUS	4 704.31
423 13-1112	Osazení mostních prefabrikovaných nosníků z BP na ložiska vcelku, v.mostu <15m 5-10t	KUS	9 120.31
423 13-1113	Osazení mostních prefabrikovaných nosníků z BP na ložiska vcelku, v.mostu <15m 10-25t	KUS	22 078.98
423 13-1114	Osazení mostních prefabrikovaných nosníků z BP na ložiska vcelku, v.mostu <15m 25-40t	KUS	59 588.44

Determination of costs

- **Agency costs**
  - design, construction, inspection, maintenance and operation of a bridge, rehabilitation and replacement costs
    - known costs from realized activities
    - determined by qualified estimate
- **Road user costs**
  - time costs
    - from traffic delays
    - connected to traffic detours
  - vehicle operating costs
  - accident costs
- **Other costs**
  - vulnerability costs
  - third party costs
  - environmental costs

Bridge LCCA

- **bridge level**
  - planning horizon
  - differenet strategies
    - do nothing
    - MR&R (in more variants)
    - total reconstruction
  - calculation of costs
    - agency
    - user
    - other (vulnerability)
  - optimisation from economical point of view



BRIME decision system, 2000

- Global **cost function C**:

$$C = C_C + C_I + C_M + C_R + C_F + C_U + C_O - V_S$$

C_C	construction costs	C_F	failure (vulnerability) costs
C_I	inspection costs	**C_U**	**road user costs**
C_M	maintenance costs	C_O	other costs
C_R	repair costs	V_S	salvage value of the bridge

- Repair/replacement decision is made according to **repair index RI** of each alternative:

$$RI = \frac{(C_I + C_M + C_R + C_F + C_U + C_O - V_S)_{\text{Repair or replacement}}}{(C_I + C_M + C_F + C_U + C_O - V_S)_{\text{No action or reference alternative}}}$$

European and American projects

BRIME
BRIdge Management in Europe

Bridge Management of Europe, **FP4, 1999** www.trl.co.uk/brime/index.htm

COST 345

Procedures required for the Assessment of Highway Structures, **COST ,2002** http://cost345.zag.si/

SAMARIS

Sustainable and Advanced MAterials for Road InfraStructure, **FP5, 2006** http://samaris.zag.si/

SAMCO
Structural Assessment Monitoring and COntrol

Structural Assessment Monitoring and Control, **FP5, 2006**
http://www.samco.org

NCHRP REPORT 483

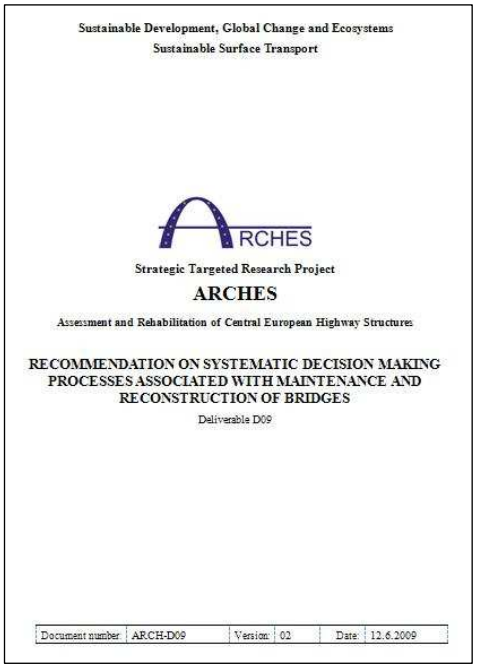
Bridge Life-Cycle Cost Analysis, **USA, 2003**
http://www.trb.org/news/blurb_detail.asp?id=1325

NCHRP REPORT 590

Multi-objective optimization for bridge management systems, **USA, 2007** http://www.trb.org/news/blurb_detail.asp?id=1325

Deliverable D09

- **Bridge management system**
  - Structure of BMS
  - Supporting materials
  - Cost categories
  - Bridge life cycle cost analysis
  - Decision making processes within BMS
- **State of the art**
  - Literature review - reports
  - Literature review - conference paper
  - National reports (7 countries - CZ, SK, BG, LV, EE, IT, FR)
  - Questionnaire survey (14 countries)
- **Recommendation on BMS & conclusions**


Sustainable Development, Global Change and Ecosystems
Sustainable Surface Transport

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Strategic Targeted Research Project

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Assessment and Rehabilitation of Central European Highway Structures

RECOMMENDATION ON SYSTEMATIC DECISION MAKING PROCESSES ASSOCIATED WITH MAINTENANCE AND RECONSTRUCTION OF BRIDGES

Deliverable D09

Document number	ARCH-D09	Version	02	Date	12.6.2009

Recommendation

- **Connection of BMS to current system**
  - based on current assessment processes used in the country
  - develop own system / buy commercial software
  - preferred usage of internet application
- **Structure of BMS**
  - the basic structure of the BMS should be as follows:
    - administration module
    - inventory module
    - inspection module:
      - condition assessment - condition rating
      - structure safety assessment - evaluated load carrying capacity
    - maintenance (financial) module:
      - determination of costs
    - prioritization (optimisation) module

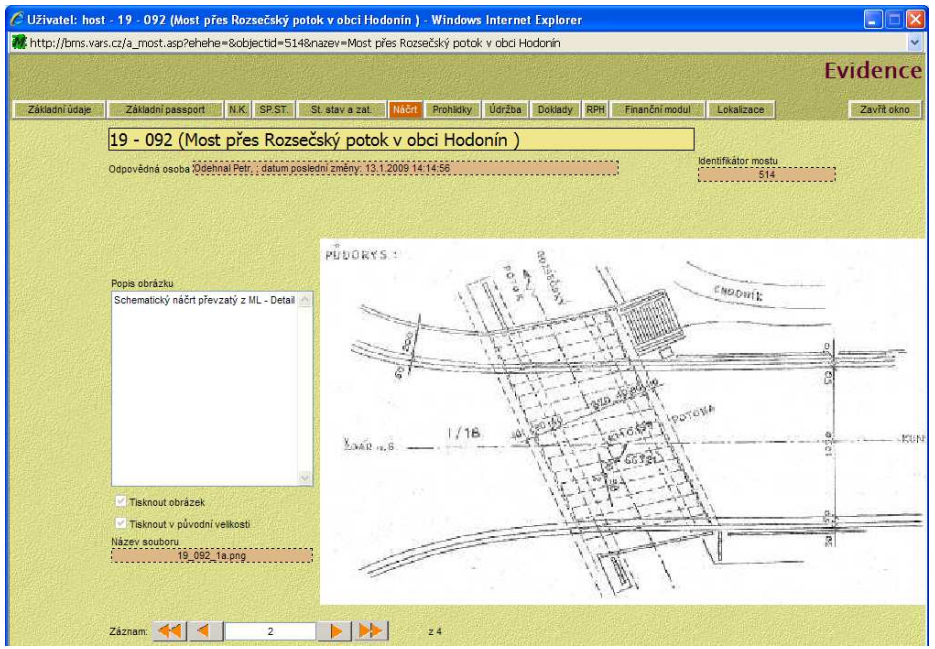
Recommendation

- **Decision making processes within BMS**
  - bridge (project) level (LCCA) / network level (multicriterial analysis)
  - short-term planning and long-term planning
  - deterioration models & planning horizon & cost categories
- **Asset management**
  - connection of BMS with PMS, tunnel MS and management systems of other assets

BMS in the Czech Republic

Basic information are public through internet: http://bms.vars.cz

- inventory data
- description of substructure & superstructure
- condition & load carrying capacity
- schemes, documents
- inspections
- maintenance
- net present value (NPV)
- **optimization module**
- location (map)



Conclusions

- BMS is a basic tool for optimal **planning of maintenance /repair/replacement** of bridges
- most countries prefer usage of their own developed BMS or at least adjusted commercial BMS
- BMS is useful even in case of **limited resources** for MR&R
- for optimal BMS functionality you need **enough correct data**
- the planning could be based on **sufficient bridge assessment**
- **uncertainties** in BMS processes should be **minimised**
- the **importance** of other than agency **costs** on decision making process must be clarified
- each system is as good as **people** who work with it

Thank you for your attention.

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(Czech Republic)**

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Environment**

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