THE IABMAS BRIDGE MANAGEMENT COMMITTEE
OVERVIEW OF EXISTING BRIDGE MANAGEMENT SYSTEMS

2012

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ABSTRACT

Infrastructure managers are increasingly using infrastructure management systems to support their decision making processes. Owners and developers of these systems can benefit from an up-to-date view of the capabilities of the most advanced of these systems and how their system compares to others. Such knowledge can be used to help determine future development of their systems or allow identification of who to contact to investigate in detail how others have done, or are doing, what they are planning to do.

To fill this knowledge gap the bridge management committee of IABMAS decided in July of 2008 to compile a report on the bridge management systems of the world to be issued in conjunction with the 2010 IABMAS conference. The first report was published in 2010. This version, the 2nd edition, is based on the completed questionnaires on 21 bridge management systems (Table 1), from 16 countries, being used to manage approximately 980’000 objects.

As the 2010 report did, this report provides a general overview of the bridge management systems and does not focus on the details of specific procedures used within the systems. It is expected that it will improve infrastructure management by reducing duplicate efforts in the integration of new functionality into management systems and by encouraging the development of ever better systems.

The main body of this report includes a summary of the information in the questionnaires and basic comparisons between the systems. The information summarized and compared includes:

- General system information,
- IT system information,
- Inventory information of the principal user,
- Inspection information, including structure types, and numbers of structures per structure type
- Intervention information, including data collection level, information on the assessment on the element level, information on the assessment on the structure level,
- Prediction information, including the aspects being modeled, and
- Operation information, with respect to data collection and quality assurance.

The questionnaires are given in the appendix.

1 INTRODUCTION

1.1 General

Infrastructure is vital to the prosperity and well-being of the people of a country. It should be managed to maximize its benefit to society; requiring the implementation and systematic following of appropriate procedures and practices to ensure that optimal intervention strategies are determined and followed. In order to handle the amount of information required to do this, for even moderately sized networks, an increasing number of infrastructure owners are supporting their decision making process with increasingly sophisticated computerized management systems.

Although ultimately it is expected that management systems will include all infrastructure objects[1] and their roles within their respective networks in an integrated manner, the current state of the art is the development and implementation of management systems that 'best match' current practice and decision making. Bridges, due to their individuality, complexity, and the significant impact on society if they do not function as intended, have often been the starting point for the development of these systems, and hence the use of the terminology bridge management system, even though many of these systems are often used to handle many other object types.

Owners and developers of bridge management systems can benefit from an up-to-date view of the capabilities of the most advanced of these systems and how their system compares to others. Such knowledge could be used to help determine future development of their systems or allow identification of who to contact to investigate in detail how others have done, or are doing, what they are planning to do.

To fill this knowledge gap the bridge management committee of IABMAS decided in July of 2008 to compile a report on the bridge management systems of the world. The first edition was issued at the IABMAS 2010 conference. The current report is the second version of this report to be issued in conjunction with the conference IABMAS 2012.

This report summarizes the information included in the questionnaires and provides basic comparisons among systems. Table 1 contains, for each system investigated, the country of ownership, the name of the owner, the name of the system, the abbreviation used for the system in this report, and the contact person for more information about the system and their e-mail address.

1.2 Current report

This report is based on the completed questionnaires on 21 bridge management systems (Table 1), from 16 countries, being used to manage approximately 980'000 objects. It provides a general overview of the bridge management systems and does not focus on the details of specific procedures used within the systems. For example, no information is given on how cost calculations are made, only whether or not they are made. This type of information can be found in other reports, for example [1, 2]. It is expected that this report will improve infrastructure management by reducing duplicate efforts in the integration of new functionality into management systems and by encouraging the development of ever better systems.

[1] An infrastructure object is an item in a network that is often considered as a single unit, e.g. bridge, road section, retaining wall. The word "object" is used instead of "structure" as many items that may be considered in management systems are not necessarily seen by all people as structures, e.g. a road sign or a culvert.

1.3 Structure of the questionnaire

The questionnaire is structured so that information with respect to the systems is entered in a standardized way, which will facilitate comparison among systems. The information is grouped as follows:

- Basic general information (i.e. general information on the management system),
- Basic IT information (i.e. general information about the information technology aspects of the management system),
- Basic inventory information (i.e. information on the infrastructure objects owned or managed by the user of the BMS, including structure types, numbers of structures per structure type, and archives, as well as how the location information, loading information and use information is entered),
- Inspection information (i.e. information about inspections where the information obtained is either entered into or used by the BMS, such as the information collected and how it is collected),
- Intervention information (i.e. information about maintenance and preservation activities such as repair, rehabilitation and reconstruction activities, that is either entered into or used by the management system,
- Prediction information (i.e. information on the aspects being predicted by the BMS, e.g. change in physical condition and performance indicators due to deterioration and the execution of interventions),
- Use Information (i.e. information on the special ways that the BMS is used),
- Operational information (i.e. information with respect to how data entered into the BMS is collected and how its quality is assured).

1.4 Changes to the questionnaire

The questionnaire on which this version of the report is based was improved from the questionnaire on which the 2010 version of the report was based. This was done based on the feedback from the members of the IABMAS Bridge Management Committee and from those who filled out the questionnaires:

- To alleviate ambiguity,
- to increase the value of the report for the end users, and
- to reduce the effort for respondents.

The following changes were made:

Inventory Information

- Rows were added under for:
    - Location (to allow entry of information related to the location of objects, e.g. location is recorded with a 3D referencing system)
    - Loading (to allow entry of information related to the type of loading information stored per object, e.g. maximum load carrying capacity)

  - Use (to allow entry of information related to the use of an object, e.g. number of vehicles per day)

Inspection Information

- the word “physical” was added to condition to clarify what is meant
- two distinct rows were added under both “element level” and “structure level” for
  - safety (probability of failure)
  - risk (probability of failure and consequences)

Intervention Information

- a distinct clarification were made between “interventions” and “intervention strategies” under element level, structure level and multiple structures level.
- “project level” was replaced with “multiple structures” level to reflect the intention of the question in the 2010 questionnaire.
- “accident cost” was added and “life cycle cost” was moved to the section on prediction information.

Prediction information

- the prediction section was changed to encourage entry of more specific information. The four rows are now
  - Deterioration (i.e. change in physical condition and performance indicators)
  - Improvement (i.e. change following an intervention in physical condition and performance indicators)
  - Intervention strategies (i.e. period of time used in the analysis, cost types used in the evaluation of strategies)
  - Work program (i.e. period of time used in the analysis, cost types used in the determination of work programs and information on whether or not budget constraints are included in the development of work programs)

Information Use

- a new section was made to include the information about how the system is used. This information was included under “prediction information” in the last questionnaire. In addition the movements of this section a new row for information pertaining to the use of the system to allow passage of heavy vehicles.

The improvements proposed enhanced the robustness of the information being collected and provides clearer overview of why we are collecting the information.

2 RECEIVED QUESTIONNAIRES

This version of the report is based on completed questionnaires of 21 management systems from all around the world. 18 of which were completed in 2011 and 3 of which were completed in 2009.

Table 1. Management Systems (1)

No.	Country	Owner	System		Contact person	
			Name	**Abb.**	**Name**	**E-Mail**
1	Canada	Ontario Ministry of Transportation and Stantec Consulting Ltd.	Ontario Bridge Management System	OBMS	Reed Ellis	rellis@stantec.com
2	Canada	Quebec Ministry of Transportation	Quebec Bridge Management System	QBMS	Reed Ellis	reed.ellis@stantec.com
3	Denmark	Danish Road Directorate	DANBRO Bridge Management System	DANBRO	Jorn Lauridsen	jorn.lauridsen@vd.dk
4	Finland	Finnish Transport Agency	The Finnish Bridge Management System	FBMS	Marja-Kaarina Söderqvist	Marja-Kaarina.Soderqvist@liikennevirasto.fi
5	Germany	German Federal Highway Research Institute	Bauwerk Management System	GBMS	Peter Haardt	Haardt@bast.de
6	Ireland	Irish National Road Association	Eirspan	Eirspan	Liam Duffy	lduffy@nra.ie
7	Italy	Autonomous Province of Trento	APT-BMS	APTBMS	Daniele Zonto	daniele.zonta@unitn.it
8*	Japan	Kajima Corporation and Regional Planning Institute of Osaka	BMS@RPI	RPIBMS	Makoto Kaneuji	mackaneuji@kajima.com
9	Korea	Korean Ministry of Land, Transport and Maritime Affairs	Korea Road Maintenance Business System	KRMBS	K.H. Park	paul@kict.re.kr.
10*	Latvia	Latvian State Road Administration	Lat Brutus	Lat Brutus	Ilmars Jurka	Ilmars@lvceli.lv
11	Netherlands	Dutch ministry of transport	DISK	DISK	Leo Klatter	leo.klatter@rws.nl
12	Poland	Polish Railway Lines	SMOK	SMOK	Jan Bien	Jan.Bien@pwr.wroc.pl
13	Poland	Local Polish Road Administrations	SZOK	SZOK	Jan Bien	Jan.Bien@pwr.wroc.pl
14	Spain	Spanish Ministry of Public Works	SGP	SGP	Joan R. Casas	joan.ramon.casas@upc.es
15	Sweden	Swedish Road Administration	Bridge and Tunnel Management System	BaTMan	Bosse Eriksson Lennart Lindlad	bo-eriksson@vv.se lennart.lindblad@vv.se

*. No response received from Contact person, thus the old data from questionnaires of 2010 was used.

Table 2. Management Systems (2)

No.	Country	Owner	System		Contact person*	
			Name	**Abb.**	**Name**	**E-Mail**
16	Switzer-land	Swiss Federal Roads Authority	KUBA	KUBA	Rade Hajdin	rade.hajdin@imc-ch.com
17*	United States of America	Alabama Department of Transportation	ABMS	ABMS	Eric Christie	christiee@dot.state.al.us
18	United States of America	American Association of State Highway and Transportation Officials	Pontis	Pontis	José Aldayuz	jaldayuz@mbakercorp.com
19	Vietnam	Vietnam Ministry of transportation	Bridgeman	Bridgeman	Nguyen Viet Trung	viettrungng@yahoo.com
20	Canada	Edmonton Ministry of Transportation	EBMS	EBMS	Reed Ellis	rellis@stantec.com
21	Canada	Prince Edward Island Dept. of Transporta[illegible]	PEI BMS	PEI BMS	Reed Ellis	rellis@stantec.com

*2010 questionnaires were used.

3 GENERAL SYSTEM INFORMATION

The following general system information is summarized in the report:

- The level of system ownership,
- The number of users of the system, and
- The years of the first and current version of the systems.

The following general system information is only provided in the questionnaires in the appendix:

- The name and the web page address of the owner of the system,
- The name and the web page address of the developers of the system, and
- The names of, and how to access, the references and manuals related to the system.

3.1 Level of ownership

The level of ownership indicates the level, i.e. country level, province, state canton or prefecture level, or country or municipality level, at which system changes are coordinated (Figure 1, Table 3). For example, if a system is listed as being on the country level than when a new version of the system is released, e.g. Pontis 5.2 to replace Pontis 5.1, the new version is seen as the most recent version of the systems, even if everyone that uses that system does not upgrade. This characterization includes systems owned by a government organization (e.g. KUBA is owned by the Federal Roads Authority of Switzerland) or a private organization (e.g. Pontis is owned by American Association of State Highway and Transportation Officials; a private organization) on a specific level. The majority of systems are owned at the country level (13/21), and only one (SZOK) was owned at a municipality level.

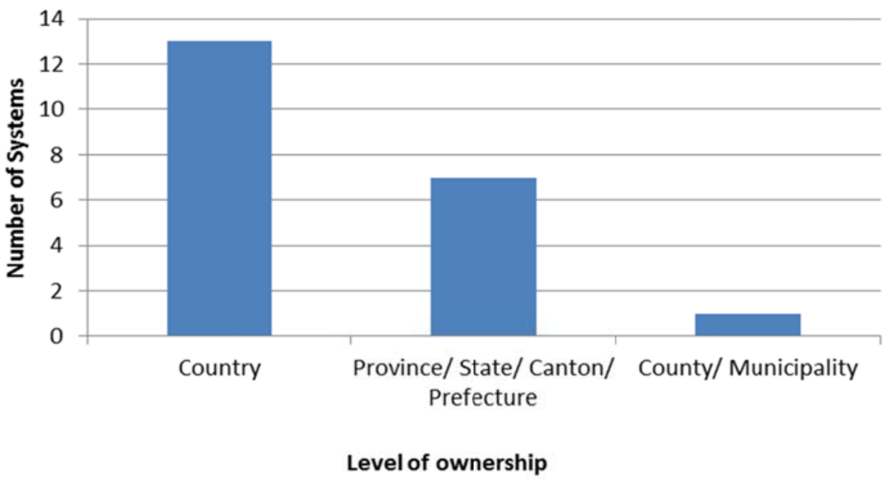

Figure 1. Level of ownership

Table 3. Level of ownership and number of users

No.	Country	Name	Owner			Number of users	
			Country	Province/ State/ Canton/ Prefecture	County/ Municipality	Single	Multiple
1	Canada	OBMS		1			1
2	Canada	QBMS		1		1	
3	Canada	EBMS		1			1
4	Canada	PEI BMS		1			1
5	Denmark	DANBRO	1				1
6	Finland	FBMS	1				1
7	Germany	GBMS	1				1
8	Ireland	Eirspan	1			1	
9	Italy	APTBMS		1		1	
10	Japan	RPIBMS		1			1
11	Korea	KRBMS	1				1
12	Latvia	Lat Brutus	1			1	
13	Netherlands	DISK	1			1	
14	Poland	SMOK	1			1	
15	Poland	SZOK			1		1
16	Spain	SGP	1				1
17	Sweden	BaTMan	1				1
18	Switzerland	KUBA	1				1
19	USA*	Pontis	1	1			1
20	USA*	ABMS		1			1
21	Vietnam	Bridgeman	1				1
Total			13	8	1	6	15

*USA – United States of America

3.2 Number of users

The number of users of each system (Table 3), indicated as either single or multiple, gives an indication of the extent of use of the systems (Figure 2). 15/21 of the systems are used by multiple users indicating that many bridge managers use the systems of others instead of developing their own. Cross-border users are rare. PONTIS is the only system that reports foreign users.

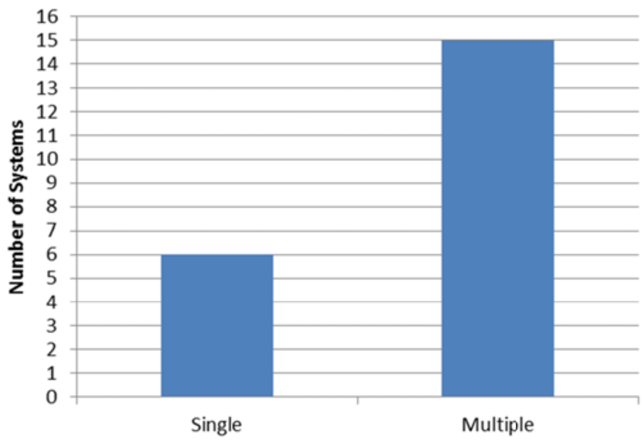

Figure 2. Number of users

3.3 Years of first and current versions

The years of the first and current versions of the systems give an indication of the use of systems and how actively systems are being modified (Figure 3, Table 4). Since the first release dates of systems are relatively evenly distributed over time, starting in 1975 with DANBRO, it can be inferred that there are steadily more administrations using management systems to support their decision making. Since the majority of systems (18/21) have new versions released in the last five year period and one, the GBMS, is scheduled for release in the near future, it can be inferred that systems, in general, are actively being developed.

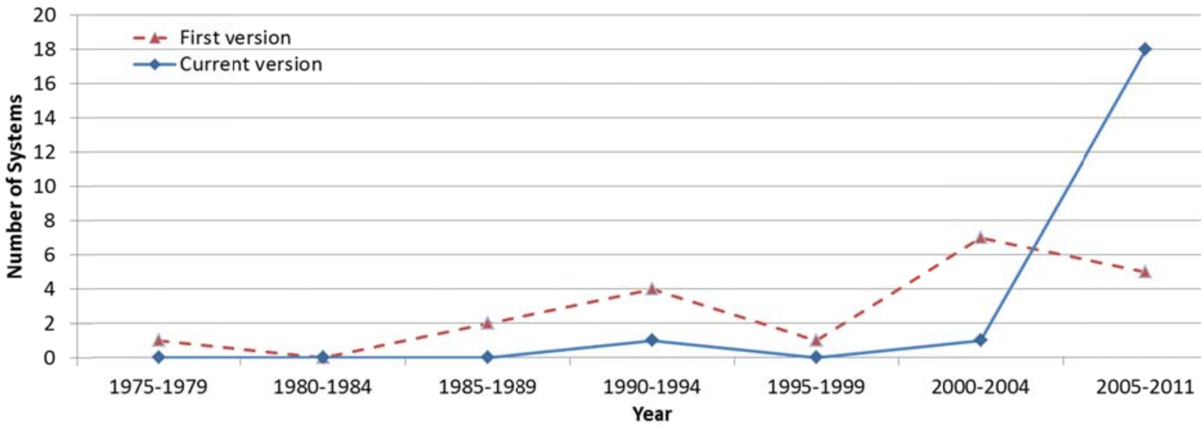

Figure 3. Years of first and current versions

Table 4. Years of first and current versions

No.	Country	Name	First version	Current version
1	Canada	OBMS	2002	2011
2	Canada	QBMS	2008	2009
3	Canada	EBMS	2006	2011
4	Canada	PEI BMS	2006	2011
5	Denmark	DANBRO	1975	2010
6	Finland	FBMS	1990	2010
7	Germany	GBMS	N/A	N/A
8	Ireland	Eirspan	2001	2008
9	Italy	APTBMS	2004	2011
10	Japan	RPIBMS	2006	2009
11	Korea	KRBMS	2003	2010
12	Latvia	Lat Brutus	2002	2004
13	Netherlands	DISK	1985	2006
14	Poland	SMOK	1997	2007
15	Poland	SZOK	2001	2010
16	Spain	SGP	2005	2011
17	Sweden	BaTMan	1987	2011
18	Switzerland	KUBA	1991	2011
19	USA	ABMS	1994	1994
20	USA	Pontis	1992	2011
21	Vietnam	Bridgeman	2001	2010

4 IT INFORMATION

The following IT information is summarized in the report:

- Type of architecture,
- Mode of data entry,
- Reporting capabilities, and
- Web access

Information on the system platform is only provided in the questionnaires in the appendix.

4.1 Type of architecture

A wide range of information over the architecture of the systems was given. The majority of systems are either two tier or three tier systems (Figure 4). More information with respect to the architecture can be found in the questionnaires in the appendix. Much of this information is not easily reducible.

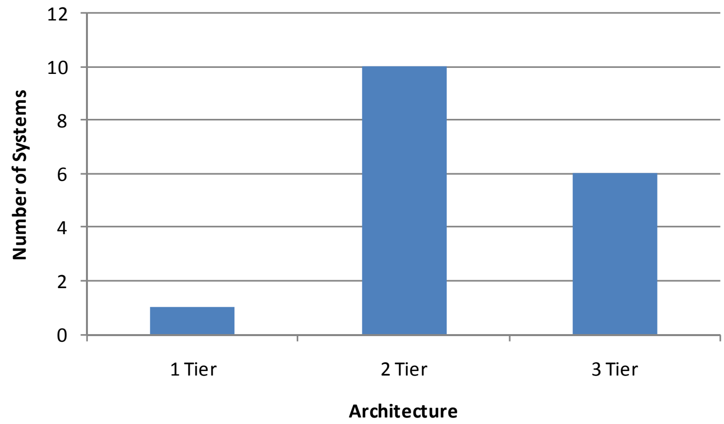

Figure 4. Type of architecture

Table 5. Type of architecture, mode of data entry, web access

No.	Country	Name	Type of system architecture			Mode of data entry*			Web Access	
			1 Tier	2 Tier	3 Tier	Desktop and portable computer	Only desktop computer	Un-clear	Yes	No
1	Canada	OBMS		1		1				1
2	Canada	QBMS		1		1			1	
3	Canada	EBMS		1		1			1	
4	Canada	PEI BMS		1		1			1	
5	Denmark	DANBRO		1			1		1	
6	Finland	FBMS		1			1			1
7	Germany	GBMS						1		
8	Ireland	Eirspan		1			1		1	
9	Italy	APTBMS			1			1	1	
10	Japan	RPIBMS	1			1				1
11	Korea	KRBMS			1		1		1	
12	Latvia	Lat Brutus			1		1			1
13	Netherlands	DISK			1		1			1
14	Poland	SMOK		1			1			1
15	Poland	SZOK		1			1			1
16	Spain	SGP		1			1		1	
17	Sweden	BaTMan			1		1		1	
18	Switzerland	KUBA			1	1			1	
19	USA	ABMS		1			1		1	
20	USA	Pontis		1		1			1	
21	Vietnam	Bridgeman	1				1			1
Total			2	12	6	7	12	2	12	8

*How data is entered into the system.

4.2 Mode of data entry

The majority (19/21) of systems have the capability to enter data at a desk top computer, whereas 7 systems have the ability to enter data both at a desk top computer and through mobile computers (Table 5, Figure 5).

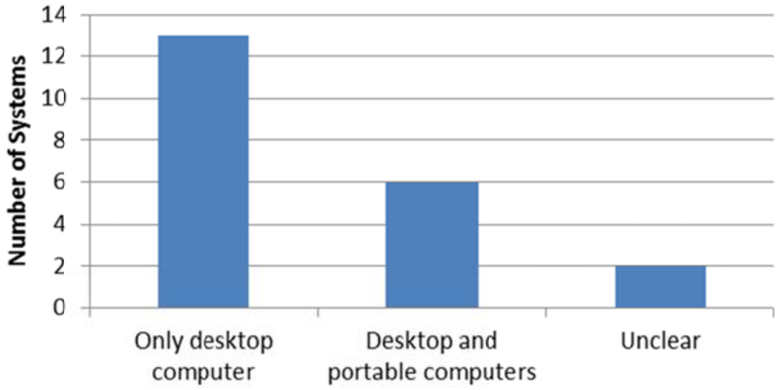

Figure 5. Mode of data entry

4.3 Reporting capabilities

All systems have reporting capabilities. As the GBMS is a prototype this information was not given.

4.4 Web access

12 of the systems allow access to information in the system over the internet (Table 5).

5 INVENTORY INFORMATION

The following inventory information is summarized in the report:

- The total number of objects in the system,
- The number of bridges, culverts, tunnels, retaining walls and other objects, in the system
- The archived construction information in the system
- The archived inspection reports
- The intervention history in the system
- The location (2D or 3D coordinates)
- The loading information and,
- The information regarding the use of the object (e.g., daily traffic volume)

5.1 Total number of objects

The inventory information reported is that of the principal user. This was possible for all systems except for Pontis. As Pontis is owned by a private company (at the country level) it is used on principally on the state level, being licensed to 44 of the States in the USA, and therefore has no single principal user. For

Pontis, the approximate numbers of objects given are those in all of the States in the USA. The total number of objects per system range from zero, for SZOK where the numbers were not given, to 750’000 for Pontis (Figure 6).

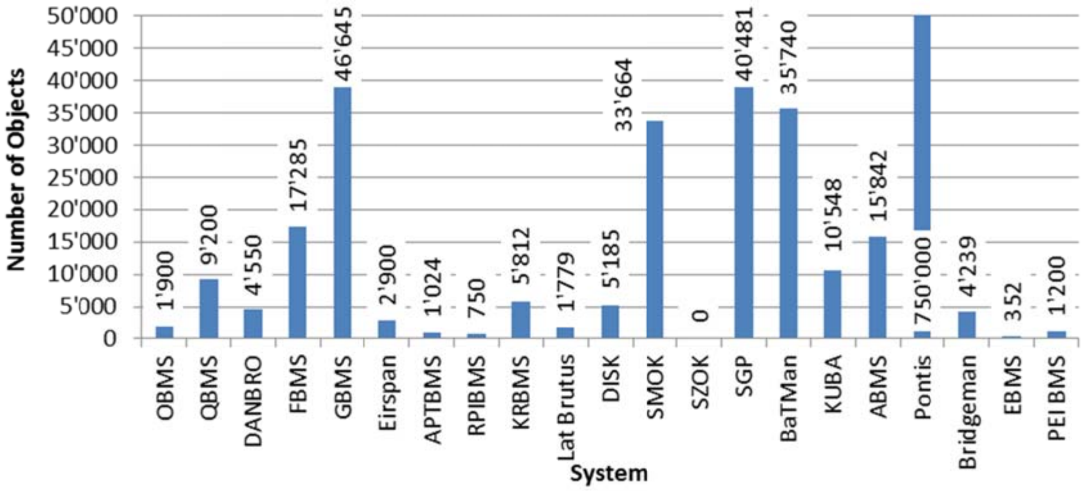

Figure 6. Total number of objects per principal user

Table 6. Number of objects per object type

No	Country	Name	Bridges	Culverts	Tunnels	Retaining Walls	Other objects	Total
1	Canada	OBMS	2'800	1'900	0	700	0	5'400
2	Canada	QBMS	8'700	0	0	500	0	9'200
3	Canada	EBMS	352	0	0	0	0	352
4	Canada	PEI BMS	800	400	0	0	0	1'200
5	Denmark	DANBRO	2'250	0	0	0	0	2'250
6	Finland	FBMS	13'787	3'078	0	0	200	17'065
7	Germany	GBMS	38'806	152	234	7'289	19	46'500
8	Ireland	Eirspan	2'900	0	0	0	0	2'900
9	Italy	APTBMS	1'024	0	0	0	0	1'024
10	Japan	RPIBMS	750	0	0	0	0	750
11	Korea	KRBMS	5'481	0	0	0	0	5'481
12	Latvia	Lat Brutus	934	845	0	0	0	1'779
13	Netherlands	DISK	4'180	650	7	20	161	5'018
14	Poland	SMOK	7'902	24'189	414	771	0	33'276
15	Poland	SZOK	0	0	0	0	0	0
16	Spain	SGP	23'567	7'390	0	0	4'762	35'719
17	Sweden	BaTMan	33'000	300	0	1'700	370	35'370
18	Switzerland	KUBA	4'127	1'250	1'500	1'587	908	9'372
19	USA	ABMS	9'728	6'112	2	0	0	15'842
20	USA	Pontis	500'000	250'000	0	0	0	750'000
21	Vietnam	Bridgeman	4'239	0	0	0	0	4'239
Total			665'327	296'266	2'157	12'567	6'420	982'737

5.2 Number of bridges, culverts, tunnels, retaining walls and other objects

The predominant use of the systems is for bridges, although SMOK has more culverts than bridges (24'189 vs. 7'902). The total number of objects per object type can be seen for all systems in Table 7, and for all systems except Pontis in Figure 7 Pontis has approximately 250'000 culverts and 500'000 bridges. For Pontis, no other object types were reported although it is known that at least some states use it for the management of sign structures, high mast light poles, traffic signal mast arms, retaining walls, tunnels, and drainage structures. The percentage of total number of object type/ total number of objects can be seen in Figure 8 and Table 6. It can be seen that some systems are used to deal exclusively with bridges, such as APTBMS, Bridgeman and Eirspan, whereas others are used to deal with a wide range of infrastructure objects, such as SMOK , BatMan and KUBA. In Figure 9 the percentage of object types in all systems are shown.

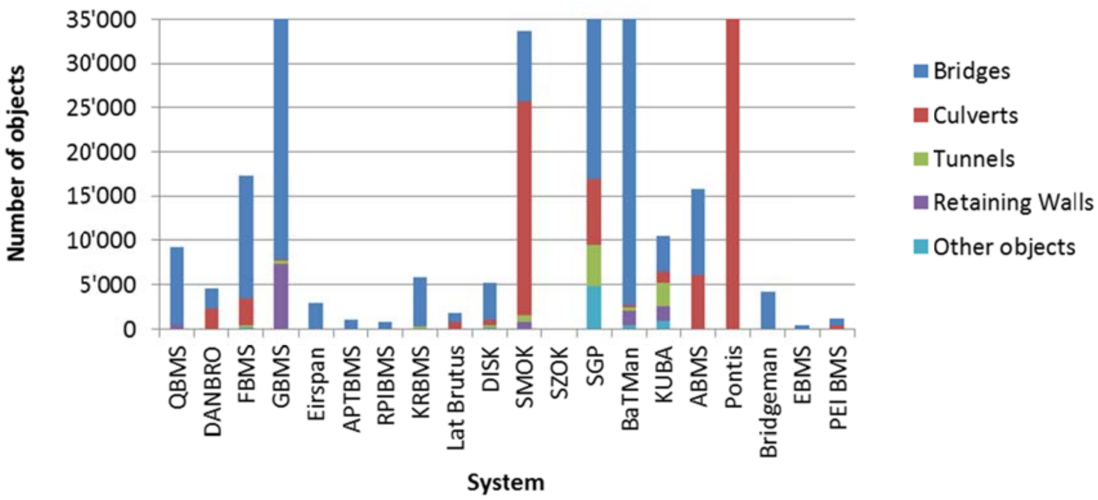

Figure 7. Total number of objects per object type per principal user

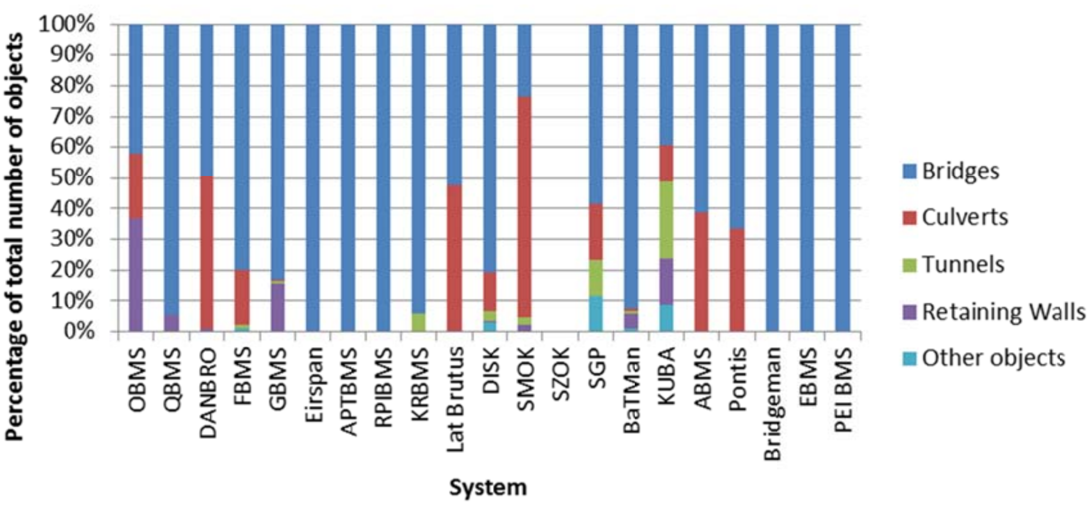

Figure 8. Percentage of total number of object types in each system

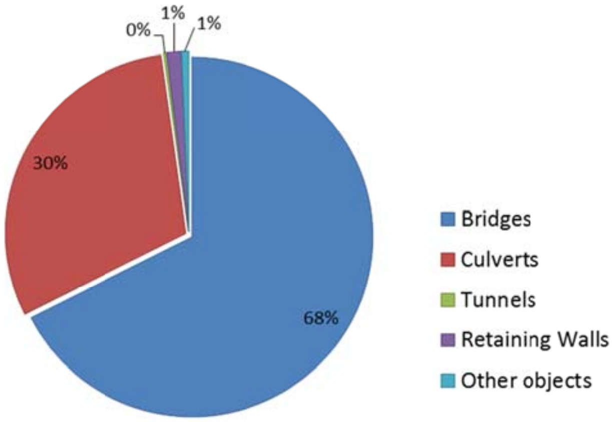

Figure 9 . Percentage of object types in all systems

5.3 The archived construction information in the system

Seven of the systems permit basic construction information to be archived in the system, although the majority of systems allow the information to be either stored in some way or referenced (Figure 10). It was assumed that if data could be entered into the system that reports could also be uploaded.

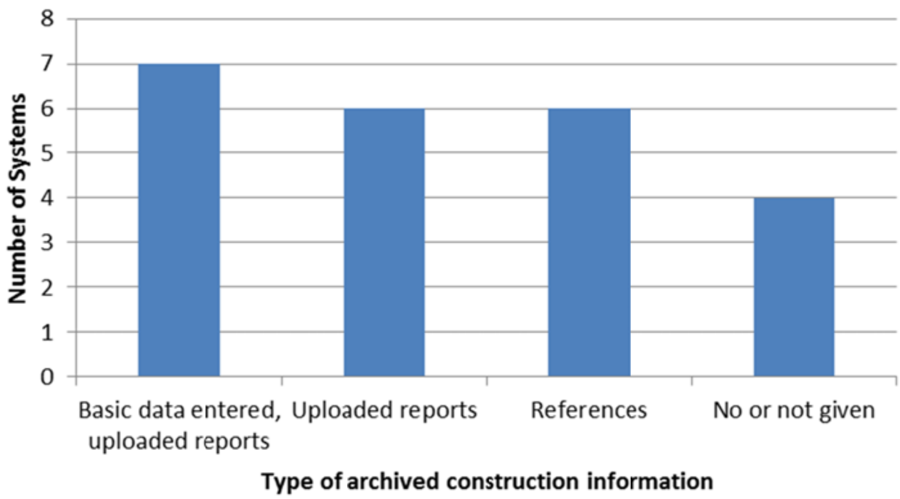

Figure 10. Archived construction information

Table 7. Archived construction information

No.	Country	Name	Basic data entered, uploaded reports	Uploaded reports	References	No or not given
1	Canada	OBMS	1			
2	Canada	QBMS	1			
3	Canada	EBMS	1			
4	Canada	PEI BMS	1	1	1	
5	Denmark	DANBRO		1		
6	Finland	FBMS				1
7	Germany	GBMS				1
8	Ireland	Eirspan		1		
9	Italy	APTBMS		1		
10	Japan	RPIBMS		1		
11	Korea	KRBMS			1	
12	Latvia	Lat Brutus			1	
13	Netherlands	DISK			1	
14	Poland	SMOK			1	
15	Poland	SZOK			1	
16	Spain	SGP		1		
17	Sweden	BaTMan	1			
18	Switzerland	KUBA	1			
19	USA	Pontis	1			
20	USA	ABMS				1
21	Vietnam	Bridgeman				1
Total			7	6	6	4

5.4 *The archived inspection reports*

Except Bridgeman all systems currently in operation allow archiving of inspection information.

5.5 *The intervention history in the system*

Most of the systems (19 systems) currently in operation allow archiving of intervention history. Information for the SZOK was not given

5.6 *The location of the objects in the system (2D or 3D coordinates)*

ALL of the systems allow the location information to be archived in the system (Table 8).

5.7 *The loading information*

ALL of the systems allow the loading information to be archived in the system.

5.8 *The information regarding the use of the object*

Majority of the systems permit the information about use of the object to be archived in the system.

Table 8. Inventory information archived in the systems

No.	Country	Name	Inspection data	Intervention history	Location data	Loading data	Use
1	Canada	OBMS	1	1	1	1	1
2	Canada	QBMS	1	1	1	1	1
3	Canada	EBMS	1	1	1	1	1
4	Canada	PEI BMS	1	1	1	1	1
5	Denmark	DANBRO	1	1	1	1	
6	Finland	FBMS	1	1			
7	Germany	GBMS	1	1	1	1	1
8	Ireland	Eirspan	1	1	1	1	1
9	Italy	APTBMS	1	1	1	1	1
10	Japan	RPIBMS	1	1	1	1	1
11	Korea	KRBMS	1	1	1	1	1
12	Latvia	Lat Brutus	1	1	1	1	1
13	Netherlands	DISK	1	1	1	1	
14	Poland	SMOK	1	1	1	1	
15	Poland	SZOK	1		1	1	
16	Spain	SGP	1	1	1	1	1
17	Sweden	BaTMan	1	1	1	1	1
18	Switzerland	KUBA	1	1	1	1	
19	USA	ABMS	1	1	1	1	1
20	USA	Pontis	1	1	1	1	1
21	Vietnam	Bridgeman			1	1	1
Total			20	19	20	20	15

6 INSPECTION INFORMATION

The following inspection information is summarized in the report:

- Level of information storage (element or structure),
- Type of information handled on element level,
- Type of information handled on structure level

6.1 Level of information storage

All systems currently in operation allow the storing of inspection information at both the element and structure level. The only system where this was not reported was the GBMS, the prototype.

6.2 Information handled on the element level

The following was reported on the element level (Table 9):

- All of the systems handle information on condition.
- Eleven of the systems handle information on load carrying capacity.

- Fourteen of the systems handle information related to safety and risk

It seems to the authors that the question was not fully understood by the people who completed the questionnaires. “element level” is meant to refer to structural components of a bridge such as deck, expansion joints, girders, columns, abutments, bearings, etc. By that definition, it is doubtful that any of the systems have load-carrying capacity, safety, or risk data at that level. Typically the element level is used only for condition data.

Table 9. Collection of inspection data and ability to enter the information

No	Country	Name	Condition	Load carrying capacity	Safety	Risk
1	Canada	OBMS	1	1	1	1
2	Canada	QBMS	1	1	1	1
3	Canada	EBMS	1	1	1	1
4	Canada	PEI BMS	1	1	1	1
5	Denmark	DANBRO	1		1	1
6	Finland	FBMS	1		1	1
7	Germany	GBMS	1			
8	Ireland	Eirspan	1		1	1
9	Italy	APTBMS	1	1	1	1
10	Japan	RPIBMS	1		1	1
11	Korea	KRBMS	1			
12	Latvia	Lat Brutus	1	1	1	1
13	Netherlands	DISK	1		1	1
14	Poland	SMOK	1			
15	Poland	SZOK	1			
16	Spain	SGP	1	1	1	1
17	Sweden	BaTMan	1			
18	Switzerland	KUBA	1	1		
19	USA	ABMS	1	1	1	1
20	USA	Pontis	1	1	1	1
21	Vietnam	Bridgeman	1	1		
		Total	21	11	14	14

Although not specifically requested in the questionnaire, information was provided on the number of condition states used in each system (Figure 11, Table 10).

The majority of systems use ratings of 5 condition states or fewer. Although noted in the questionnaire as "not given" it is known that Pontis can handle up to five condition states. In Pontis the number of condition states used depends on the organization that licenses it. The range of condition states currently being used in BMSs is four to five, with five being the most common.

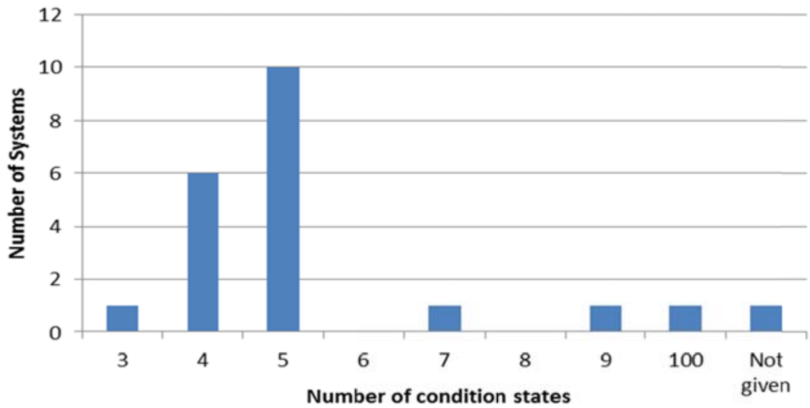

Figure 11. Number of condition states

Table 10. Number of condition states

No.	Country	Name	Number of condition states								
			3	4	5	6	7	8	9	100	Not given
1	Canada	OBMS		1							
2	Canada	QBMS		1							
3	Canada	EBMS			1						
4	Canada	PEI BMS		1							
5	Denmark	DANBRO			1						
6	Finland	FBMS		1							
7	Germany	GBMS		1							
8	Ireland	Eirspan			1						
9	Italy	APTBMS			1						
10	Japan	RPIBMS			1						
11	Korea	KRBMS			1						
12	Latvia	Lat Brutus		1							
13	Netherland	DISK					1				
14	Poland	SMOK			1						
15	Poland	SZOK			1						
16	Spain	SGP								1	
17	Sweden	BaTMan	1								
18	Switzerland	KUBA			1						
19	USA	ABMS							1		
20	USA	Pontis			1						
21	Vietnam	Bridgema									1
Total			1	6	10	0	1	0	1	1	1

6.3 Information handled on the structure level

The following was reported that on the structure level (Table 11):

- All of the systems except RPIBMS handle condition information from inspections. Pontis, the Canadian systems and RPIBMS generate a condition rating for the structure based on element level information.
- Seventeen systems handle information on load carrying capacity.
- Fifteen of the systems handle information from inspections with respect to safety. The same ambiguity exists on the structure level as on the element level, though.
- Fourteen of the systems handle information from inspections with respect to risk.

Table 11. Ability to enter condition, load carrying capacity, safety and risk on the structure level

No.	Country	Name	Condition	Load carrying capacity	Safety	Risk
1	Canada	OBMS	1	1	1	1
2	Canada	QBMS	1	1	1	1
3	Canada	EBMS	1		1	1
4	Canada	PEI BMS	1		1	1
5	Denmark	DANBRO	1		1	1
6	Finland	FBMS	1		1	1
7	Germany	GBMS	1			
8	Ireland	Eirspan	1		1	1
9	Italy	APTBMS	1	1	1	1
10	Japan	RPIBMS			1	1
11	Korea	KRBMS	1			
12	Latvia	Lat Brutus	1	1	1	1
13	Netherlands	DISK	1		1	1
14	Poland	SMOK	1			
15	Poland	SZOK	1			
16	Spain	SGP	1	1	1	1
17	Sweden	BaTMan	1			
18	Switzerland	KUBA	1	1		
19	USA	ABMS	1	1	1	1
20	USA	Pontis	1	1	1	1
21	Vietnam	Bridgeman	1	1		
Total			20	17	15	14

7 INTERVENTION INFORMATION

The following intervention information is summarized in the report:

- The type of interventions handled on the element level,
- The type of interventions handled on the structure level,
- The type of interventions handled on the Multiple structures level, and
- The type of costs information handled.

7.1 Information handled on the element level

The following was reported that on the element level (Table 12):

- Sixteen of the systems have predefined interventions.
- Twenty of the systems allow user defined interventions.

Table 12. Intervention information on the element, structure and multiple structures level

No.	Name	Element level		Structure level		Multiple structures level	
		Predefined standard	User defined/ custom	Predefined standard	User defined/ custom	Predefined standard	User defined/ custom
1	OBMS	1	1	1	1	1	1
2	QBMS	1	1	1	1	1	1
3	EBMS	1	1	1	1	1	1
4	PEI BMS	1	1	1	1	1	1
5	DANBRO	1	1	1	1		
6	FBMS	1	1	1	1		1
7	GBMS			1	1		
8	Eirspan	1	1		1		
9	APTBMS	1	1				
10	RPIBMS	1	1	1	1		
11	KRBMS	1	1	1	1		
12	Lat Brutus	1	1		1		1
13	DISK	1	1		1		
14	SMOK		1		1		1
15	SZOK		1		1		1
16	SGP	1	1	1	1	1	
17	BaTMan		1		1		1
18	KUBA	1	1	1	1	1	1
19	ABMS	1	1	1	1		
20	Pontis	1	1	1	1	1	1
21	Bridgeman		1		1		1
	Total	16	20	13	20	7	12

7.2 Information handled on the structure level

The following was reported on the structure level (Table 12):

- Thirteen of the systems have predefined interventions.
- Twenty of the systems allow user defined intervention.

7.3 Information handled on the project level

The following was reported on the multiple structures level (Table 12):

- Seven of the systems have predefined interventions.
- Twelve of the systems allow user defined intervention.

7.4 Cost Information

The following was reported with respect to intervention costs (Figure 12 and Table 13):

- Seventeen of the systems can handle intervention cost information. The exceptions are the KRSBM and SZOK.
- Only a minority of systems (i.e., 6 systems) handle inspection costs.
- Majority of the systems (i.e., 19 systems) handle intervention costs.
- Nine of the systems handle traffic delay costs. These systems either calculate or allow entry of the costs of traffic delay.
- Six of the systems handle accident costs. These systems either calculate or allow entry of the accident costs.
- Six of the systems consider environmental costs.

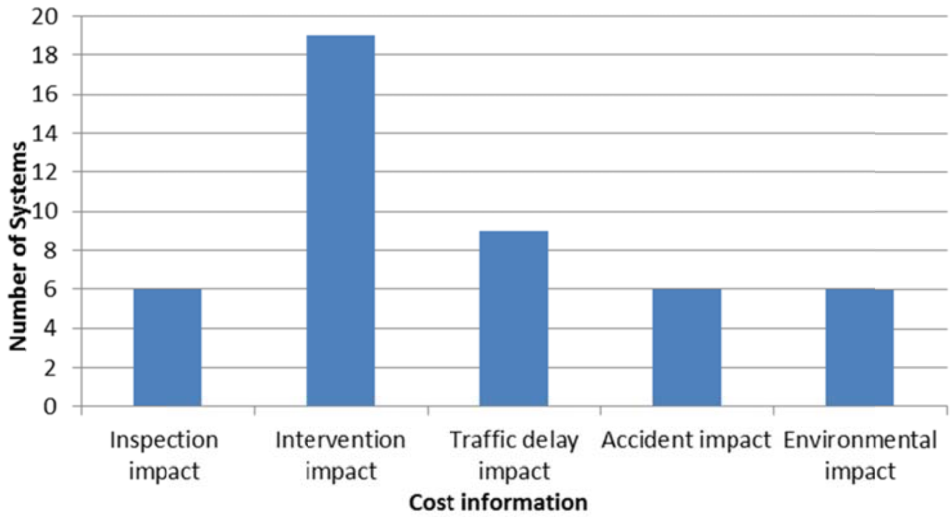

Figure 12. Cost information

Table 13. Cost information

No.	Country	Name	Cost information				
			Inspection cost	Intervention cost	Traffic delay cost	Accident cost	Environm-ental cost
1	Canada	OBMS		1	1		1
2	Canada	QBMS		1	1	1	1
3	Canada	EBMS		1	1	1	1
4	Canada	PEI BMS		1	1	1	1
5	Denmark	DANBRO	1	1	1		1
6	Finland	FBMS		1			
7	Germany	GBMS		1	1	1	1
8	Ireland	Eirspan		1			
9	Italy	APTBMS	1	1			
10	Japan	RPIBMS	1	1		1	
11	Korea	KRBMS					
12	Latvia	Lat Brutus		1			
13	Netherlands	DISK	1	1			
14	Poland	SMOK		1			
15	Poland	SZOK					
16	Spain	SGP		1	1		
17	Sweden	BaTMan	1	1	1		
18	Switzerland	KUBA		1			
19	USA	ABMS	1	1			
20	USA	Pontis		1	1	1	
21	Vietnam	Bridgeman		1			
0	Total		6	19	9	6	6

8 PREDICTION INFORMATION

The following prediction information is summarized in the report:

Predictive capabilities of the systems;

- Deterioration, i.e. change in:
  - Physical condition
  - Performance indicators
- Effects of intervention/Improvement, i.e. change following an intervention in:
  - Physical condition
  - Performance indicators
- Optimal intervention strategies:
  - Period of time analyzed
  - Cost types
- Work program:
  - Period of time analyzed
  - Cost types
  - Budget constraints

The following was reported with respect to predictive capabilities (Figure 13, Table 14):

- Fourteen of the systems can predict deterioration. Seven of these systems are reported to use probabilistic methods.
- Thirteen of the systems are reported to predict improvement, i.e. the improvement due to future interventions, of which nine are reported to use probabilistic methods.
- Fifteen of the systems are capable of determining optimal intervention strategies.
- Thirteen of the systems are reported to provide work program.

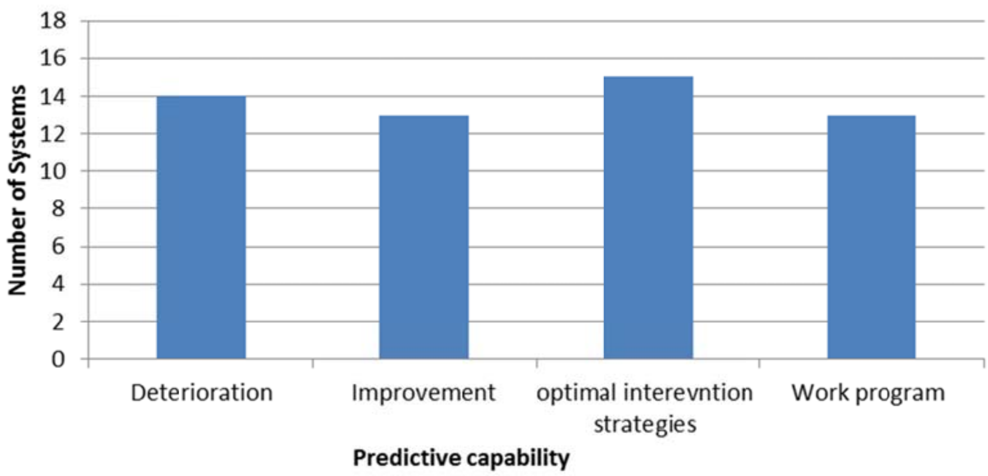

Figure 13. Predictive capabilities

Table 14. Predictive capabilities

No.	Name	Deterioration				Improvement				optimal intervention strategies		Work program	
		Yes	Yes		No	Yes	Yes		No	Yes	No	Yes	No
			Prob	Det			Prob	Det					
1	OBMS	1	1			1	1			1		1	
2	QBMS	1	1			1	1			1		1	
3	EBMS	1	1			1	1			1		1	
4	PEI BMS	1	1			1	1			1		1	
5	DANBRO	1				1	1			1		1	
6	FBMS	1				1				1		1	
7	GBMS	1				1	1			1		1	
8	Eirspan				1				1		1		1
9	APTBMS	1	1			1	1			1		1	
10	RPIBMS	1				1					1		
11	KRBMS	1				1				1		1	
12	Lat Brutus				1				1		1		
13	DISK				1				1	1			
14	SMOK				1				1	1		1	
15	SZOK	1							1		1		1
16	SGP				1				1		1		1
17	BaTMan	1		1		1		1		1		1	
18	KUBA	1	1			1	1			1		1	
19	ABMS				1				1	1			
20	Pontis	1	1			1	1			1		1	
21	Bridgeman				1				1		1		1
	Total	14	7	1	7	13	9	1	8	15	6	13	4

8.1 Planning time frames

Although not asked in the questionnaires, it was possible in many cases to deduce the planning time frames (Figure 14, Table 15 and Table 16).

Two time frames were considered:

- a short time frame – for the development of work programs, and
- a long time frame – for the prediction of future budgets and the development of maintenance policies.

The difference between the predictions may either be different methods of calculation or simply a recommendation of what may be viably considered and what not. In the analysis, the long time frame was taken to be identical to that of the short, if only one predictive period was specified. The short time frame prediction periods for Pontis were not given in the questionnaire, most likely because the agencies that license Pontis are able to configure the work program horizon, i.e. short time frame, to be any period from five years to 30 years to fit their budgeting processes. A ten-year horizon is most common. Although the long time frame prediction periods, seen the users of Pontis, was not reported, most likely due to the freedom agencies that license Pontis have in defining it.

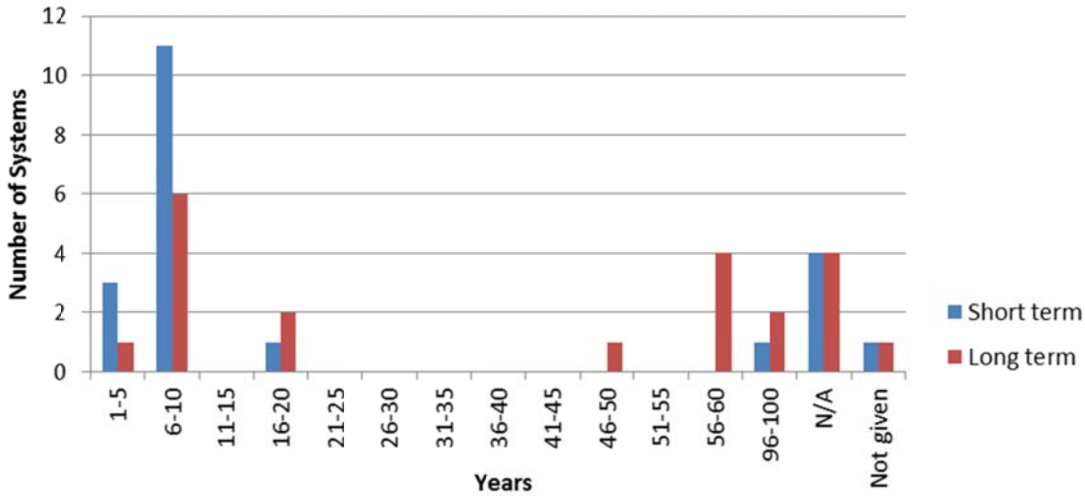

Figure 14. Planning time frames

Table 15. Time frame for short-term predictions

No.	Name	Short term														
		1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	96-100	N/A	Not given
1	OBMS		1													
2	QBMS		1													
3	EBMS		1													
4	PEI BMS		1													
5	DANBRO		1													
6	FBMS		1													
7	GBMS		1													
8	Eirspan		1													
9	APTBMS	1														
10	RPIBMS													1		
11	KRBMS														1	
12	Lat Brutus														1	
13	DISK		1													
14	SMOK		1													
15	SZOK		1													
16	SGP														1	
17	BaTMan				1											
18	KUBA	1														
19	ABMS	1														
20	Pontis															1
21	Bridgeman														1	
	Total	3	11	0	1	0	0	0	0	0	0	0	0	1	4	1

Table 16. Time frame for long-term predictions

No	Name	Long term														
		1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	96-100	N/A	Not given
1	OBMS												1			
2	QBMS												1			
3	EBMS												1			
4	PEI BMS												1			
5	DANBRO		1													
6	FBMS		1													
7	GBMS				1											
8	Eirspan		1													
9	APTBMS										1					
10	RPIBMS													1		
11	KRBMS														1	
12	Lat Brutus														1	
13	DISK		1													
14	SMOK		1													
15	SZOK		1													
16	SGP				1										1	
17	BaTMan															
18	KUBA													1		
19	ABMS	1														
20	Pontis															1
21	Bridgeman														1	
0	Total	1	6	0	2	0	0	0	0	0	1	0	4	2	4	1

9 INFORMATION USE

The following was reported with respect to the use of prediction information (Figure 15 and Table 17):

- Eighteen of the systems are used to prepare budgets.
- Eleven of the systems are used to set performance standards.
- Seven of the systems are used to match funding sources.
- Seven of the systems are used to manage special transports

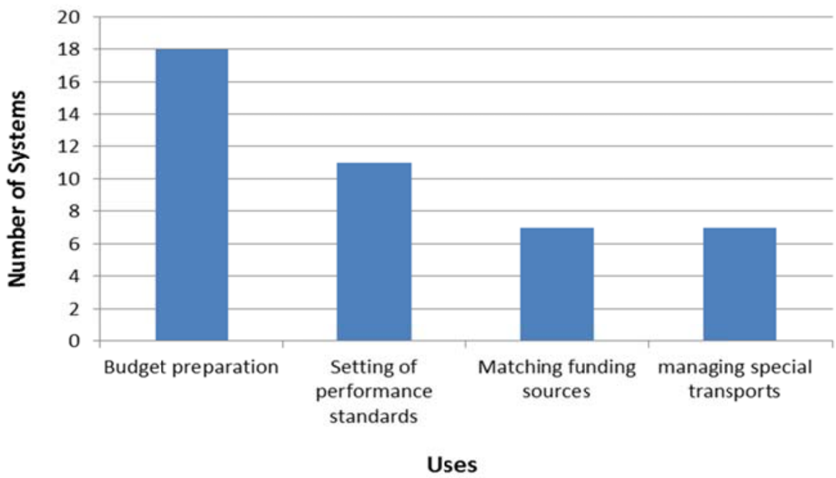

Figure 15. Uses of prediction information

Table 17. Uses of prediction information

No	Country	Name	Used for			
			Budget preparation	Setting of performance standards	Matching funding sources	managing special transports
1	Canada	OBMS	1	1		1
2	Canada	QBMS	1	1		1
3	Canada	EBMS	1	1		
4	Canada	PEI BMS	1	1		
5	Denmark	DANBRO	1	1		1
6	Finland	FBMS	1	1	1	
7	Germany	GBMS	1			
8	Ireland	Eirspan				
9	Italy	APTBMS	1		1	1
10	Japan	RPIBMS	1	1	1	
11	Korea	KRBMS	1	1		
12	Latvia	Lat Brutus	1		1	
13	Netherlands	DISK	1			
14	Poland	SMOK	1			
15	Poland	SZOK				
16	Spain	SGP	1	1	1	
17	Sweden	BaTMan	1	1	1	1
18	Switzerland	KUBA	1			1
19	USA	ABMS	1			
20	USA	Pontis	1	1	1	1
21	Vietnam	Bridgeman				
Total			18	11	7	7

10 OPERATION INFORMATION

The following operation information is summarized in the report:

- Data collection information, and
- The quality assurance education and qualification information of those that use the system

10.1 Data collection

It was reported that in the majority of system (Figure 16, Table 18), that:

- Inventory information is normally collected and entered by both the infrastructure owner and private companies
- Inspection and assessment information is normally collected and entered by the infrastructure owners and private companies, and
- Intervention information is normally entered by the infrastructure owner. The planning of interventions using the system is normally only done by the owner.

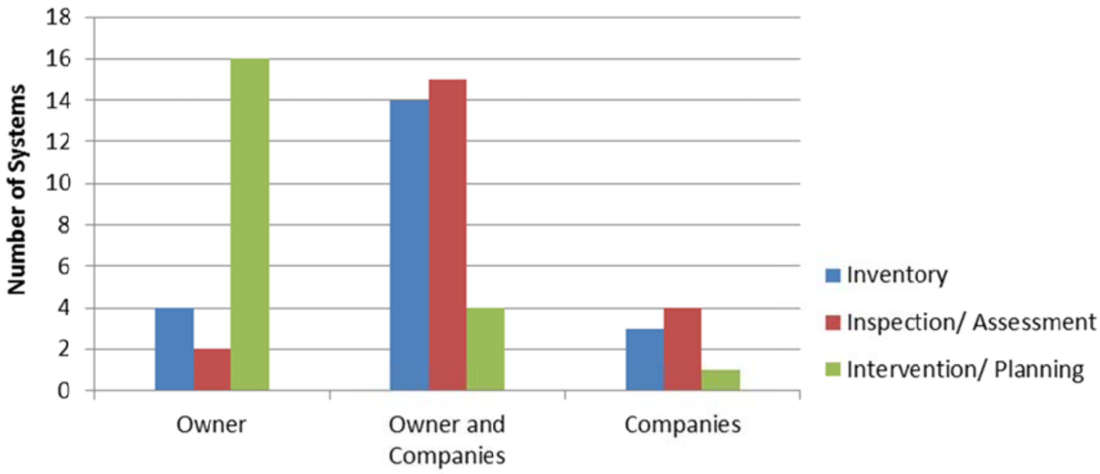

Figure 16. Rights to use

Table 18. Rights to use

No.	Name	Inventory			Inspection/ Assessment			Intervention/ Planning		
		Owner	Owner and Companies	Companies	Owner	Owner and Companies	Companies	Owner	Owner and Companies	Companies
1	OBMS		1			1		1		
2	QBMS		1			1		1		
3	DANBRO		1			1		1		
4	FBMS		1			1			1	
5	GBMS	1			1			1		
6	Eirspan		1			1		1		
7	APTBMS			1		1		1		
8	RPIBMS		1			1			1	
9	KRBMS	1				1		1		
10	Lat Brutus		1				1	1		
11	DISK		1				1	1		
12	SMOK		1			1		1		
13	SZOK		1			1		1		
14	SGP			1			1			1
15	BaTMan		1			1			1	
16	KUBA			1			1	1		
17	ABMS	1				1		1		
18	Pontis		1			1			1	
19	Bridgeman	1			1			1		
20	EBMS		1			1		1		
21	PEI BMS		1			1		1		
	Total	4	14	3	2	15	4	16	4	1

10.2 Education and qualification

The following was reported (Figure 17) with respect to the education and qualification of those that use the systems:

- For all of the systems there are educations for inspectors that entered data into the system.
- For seventeen of the systems there are certifications of inspectors that enter data into the system.
- For fifteen of the systems there are educations provided for users of the system.
- For six of the systems there are certifications of the users of the systems.
- For eleven of the systems there are audits to use and verify data
- For five of the systems there are audits to verify predictions

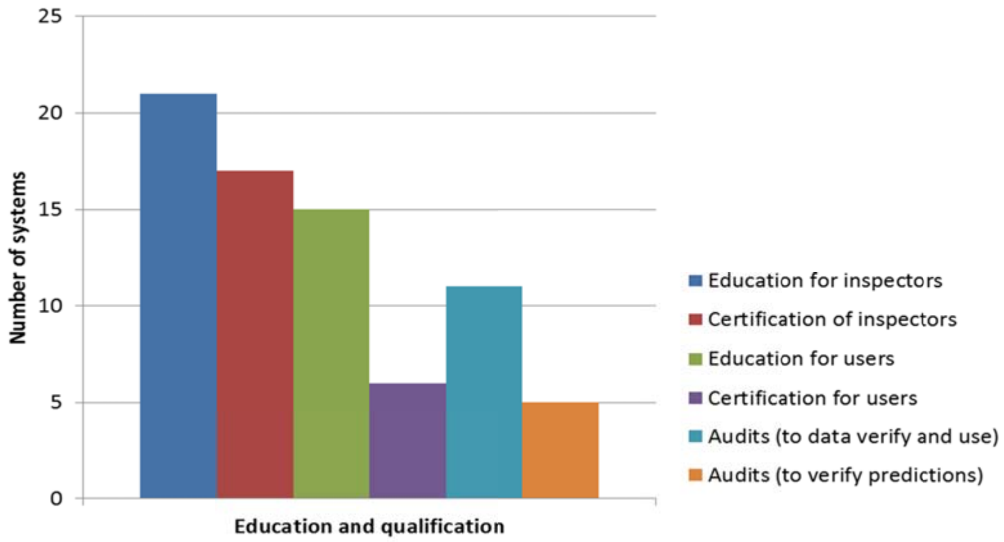

Figure 17. Education and qualification

Table 19. Quality assurance

No.	Name	Education for inspectors	Certification of inspectors	Education for users	Certification for users	Audits (to data verify and use)	Audits (to verify predictions)
1	OBMS	1	1			1	1
2	QBMS	1	1	1			
3	EBMS	1	1	1	1	1	1
4	PEI BMS	1	1	1	1	1	1
5	DANBRO	1	1	1		1	
6	FBMS	1	1	1			
7	GBMS	1		1			
8	Eirspan	1	1			1	
9	APTBMS	1		1		1	
10	RPIBMS	1	1	1	1		
11	KRBMS	1	1	1		1	1
12	Lat Brutus	1	1				
13	DISK	1	1				
14	SMOK	1	1	1	1	1	1
15	SZOK	1	1	1	1		
16	SGP	1	1				
17	BaTMan	1		1		1	
18	KUBA	1		1		1	
19	ABMS	1	1				
20	Pontis	1	1	1		1	
21	Bridgeman	1	1	1	1	1	
Total		21	17	15	6	11	5

11 COMPARISON OF THE REPORTS 2010 AND 2012

For this edition of the report the questionnaire was improved to increase the value of the report for the end users, to include more bridge management systems, and to reduce the effort for respondents (as explained in section 1.6). Three systems were added, namely; Bridgeman, EBMS and PEI-BMS. For three of the systems i.e., ABMS, LatBrutus and RPIMS, the data from the old questionnaires was used.

Although two years is not a large amount of time there are a few trends that can be seen when comparing the information contained in these two reports.

11.1 Data collection capability

The capability of using only desktop computer are increased approximately 7% and capability using both desktop and portable computers are increased by 40 % (see Figure 18).

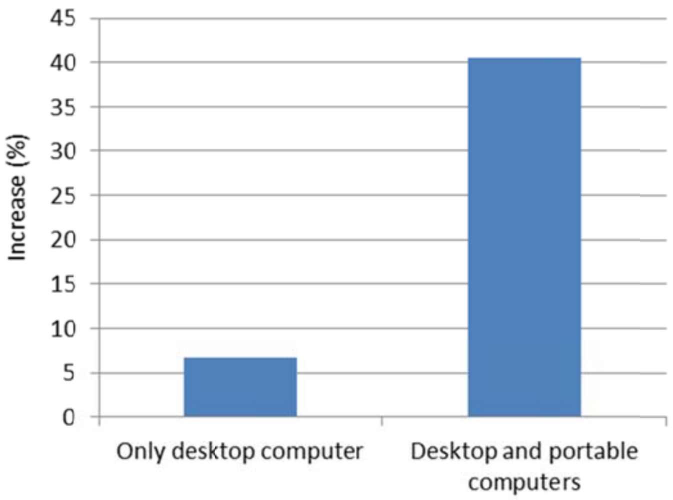

Figure 18. Increase in data collection capability of the systems

11.2 Type of archived construction information:

In general an increase of 30% in basic data entered and uploaded reports can be seen. Numbers of systems that include references in the archived construction information are increased by 15% (see Figure 19)

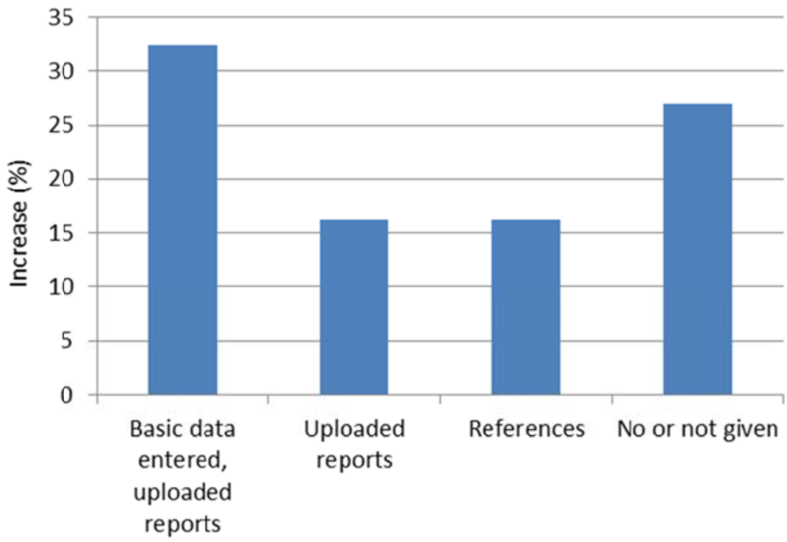

Figure 19. Increase in different types of archived construction information from 2010 to 2011

11.3 Capability for quality assurance

With respect to the capability of systems for quality assurance it can be seen that education and certification for inspectors has increased by 19% and 18% respectively. Education and certification for users has increased by 29% and 81% respectively (Figure 20).

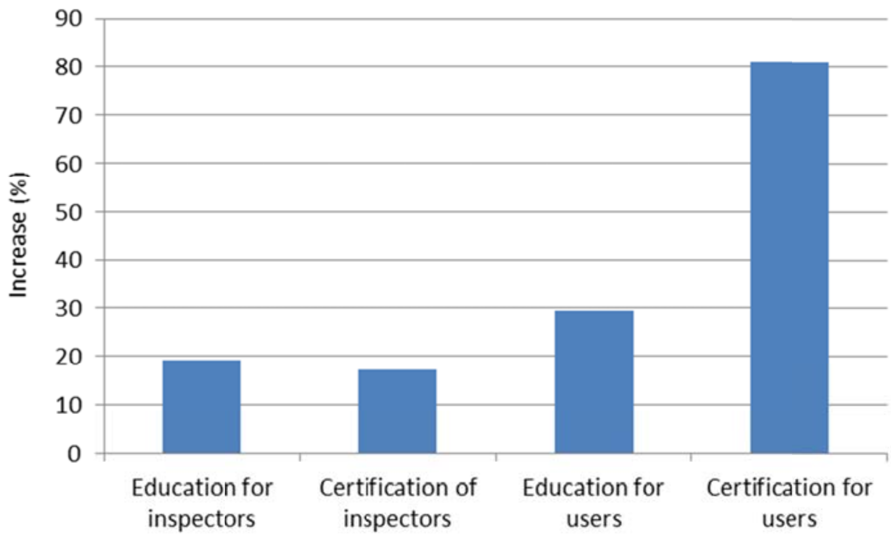

Figure 20. Comparison of the systems in capability for quality assurance in 2010 and 2011

11.4 Number of objects per object type

The number of objects considered in the system has increased for all object types in the majority of systems. This is most likely due to the more accurate numbers reported in the most recent questionnaires. The exception is the number of culvert which decreased by 1.2 % (Figure 21). The decrease can be principally attributed to the questionnaire on DANBRO. DANRBO was reported to contain information on 6000 culverts in 2010 while this number was changed to 0 in the most recent questionnaire.

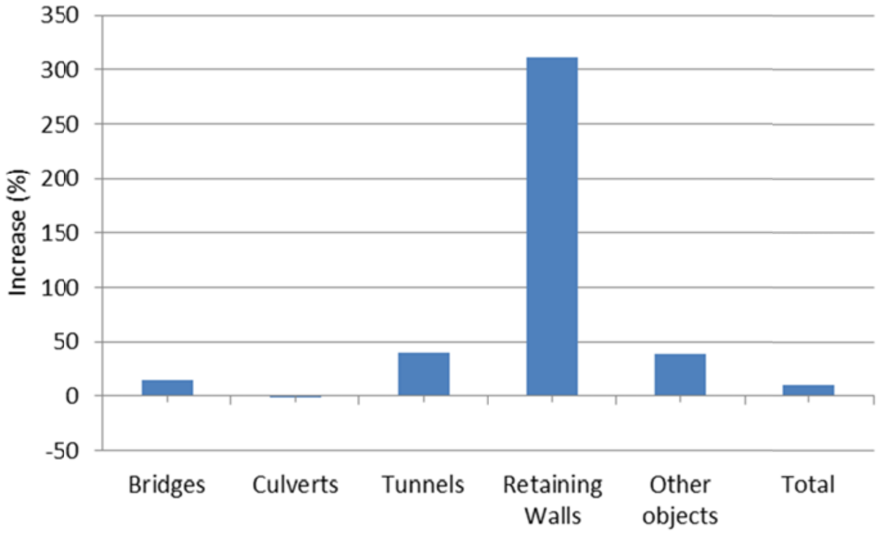

Figure 21. Increase in the number of object types considered in systems from 2010 to 2012

12 SUMMARY AND CONCLUSIONS

Infrastructure managers increasingly use management systems to support their decision-making processes with respect to the infrastructure objects for which they are responsible. These systems are being either developed internally by the managing organization itself (with or without the help of private companies) or are being bought off-the-shelf and modified to suit their needs.

At least partially due the active development of these systems and the many different sources from which this development is taking place, most owners and developers of these systems lack an up-to-date view of the capabilities of the most advanced of these systems and how their system compares to others. Such knowledge could be used to help determine future development of their systems or allow identification of who to contact to investigate in detail how others have done, or are doing, what they are planning to do.

This report, which was based on the completed questionnaires on 21 bridge management systems (Table 1), from 16 countries, being used to manage approximately 980’000 objects, helps to fill this gap by providing a general overview of the surveyed management systems.

It is expected that this report will improve infrastructure management by reducing duplicate efforts in the integration of new functionality into management systems and by encouraging the development of ever better systems.

Some specific conclusions emerging from the synthesis of the questionnaires are included in the following two subsections.

12.1 On the BMSs in the report

A majority of the systems included in this report are used by multiple users, 15/21 (paragraph 3.2), and with the exception of PONTIS all systems are used within one country. This is most likely due to the differences in bridge management practices between countries. It also indicates that when off the shelf systems are adopted by an agency that they are significantly modified, resulting in a new system and hence a new name (e.g. Eirspan that was developed using DANBRO as a starting point). Based on this observation, it is suggested that the need for standardization in the field of bridge (or infrastructure) management be investigated. It is the authors' opinion that a certain level of standardization could potentially enhance the exchange of knowledge and experience between managing agents, and improve the usefulness of management systems.

12.2 On the process of compiling this report

The process of sending out questionnaires, responding and compiling the report did not include a feedback loop to check the completeness of this information and the interpretation of the answers provided in the questionnaires with the respondents. Such a feedback loop will enhance the quality of the report in terms of consistency and synchronisation of information in the main part of the report and questionnaires in the appendices.

13 REFERENCES

[1] Arches. *Assessment and Rehabilitation of Central European Highway Structures, Recommendation on Systematic Decision Making Processes Associated with Maintenance and Reconstruction of Bridges.* Deliverable D09, 2009.

[2] BRIME. *Bridge Management in Europe, Final report.* European Commission DG VII, 4th Framework Programme (www.trl.co.uk/brime/index.htm), 2001.

[3] Markow, M.J., and W.A. Hyman. *Bridge management systems for transportation agency decision making.* Vol. 397. Transportation Research Board, 2009.

[4] Small, E.P., T. Philbin, M. Fraher, and G.P. Romack. The current status of bridge management system implementation in the United States, 1999.

14 QUESTIONNAIRES

14.1 Ontario bridge management system, OBMS

<table>
<tr><td colspan="3">Name (version)</td><td colspan="4">Ontario Bridge Management System – OBMS 2.0.1 (2008)</td></tr>
<tr><td rowspan="7">Basic information</td><td colspan="2">Aspect</td><td colspan="4">description</td></tr>
<tr><td colspan="2">Owner (webpage)</td><td colspan="4">Ontario Ministry of Transportation (MTO) and Stantec Consulting Ltd.
http://www.mto.gov.on.ca/english/ and www.stantec.com</td></tr>
<tr><td colspan="2">Date implemented
(current / first version)</td><td colspan="4">Version 1.0 (2002)
Current Version 2.0.1 (2008)</td></tr>
<tr><td colspan="2">Developer(s) (webpage)</td><td colspan="4">Stantec Consulting Ltd. (www.stantec.com)</td></tr>
<tr><td colspan="2">References, Manuals & Catalogues</td><td colspan="4">Ontario Structure Inspection Manual (OSIM)
http://www.mto.gov.on.ca/english/ (English)</td></tr>
<tr><td colspan="2">Users (Principal / Other)</td><td colspan="4">Ontario Ministry of Transportation (MTO), municipal agencies in Ontario, other Canadian Provinces, engineering firms</td></tr>
<tr><td rowspan="6">IT information</td><td colspan="2">Aspect</td><td colspan="4">description</td></tr>
<tr><td colspan="2">Platform</td><td colspan="4">Oracle and Microsoft Access</td></tr>
<tr><td colspan="2">Architecture</td><td colspan="4">Client - Server, and Local Database (eg in field)</td></tr>
<tr><td colspan="2">Data collection capabilities</td><td colspan="4">Desktop computer, and Tablet Computers (eg. in field)</td></tr>
<tr><td colspan="2">Reporting capabilities</td><td colspan="4">Crystal Reports, inventory, inspection, analysis results</td></tr>
<tr><td colspan="2">Web access</td><td colspan="4">No.</td></tr>
<tr><td rowspan="6">Inventory information (of principal user)</td><td>Structure types</td><td>No.</td><td>Structure types</td><td>No.</td><td>Structure types</td><td>No.</td></tr>
<tr><td>Bored tunnels</td><td></td><td>Locks and sluices</td><td></td><td>Weirs</td><td></td></tr>
<tr><td>Bridges</td><td>2,800</td><td>Retaining Walls</td><td>700</td><td>Quays</td><td></td></tr>
<tr><td>Culverts</td><td>1,900</td><td>Storm surge barriers</td><td></td><td>Piers</td><td></td></tr>
<tr><td>Cut and cover tunnels</td><td></td><td>Support structures</td><td></td><td></td><td></td></tr>
<tr><td>Galleries</td><td></td><td>Protection structures</td><td></td><td></td><td></td></tr>
</table>

	Information type	description
Inventory information (of principal user)	Construction data	Bridge historical maintenance, rehabilitation, replacement contract cost information.
	Inspection reports	Stored in system, with photos, viewed or printed pdf reports optional.
	Intervention history	Bridge historical maintenance, rehabilitation, replacement contract cost information.
	Location (e.g. 3D coordinates are recorded)	GIS coordinates and linear highway referencing are used
	Loading (e.g. maximum load carrying capacity is stored)	Design load, year, Code/Standard, current load rating
	Use (e.g. number of vehicles per day is stored)	Traffic volume, truck %, classification stored for each roadway, optional link to Highway Information System

Inspection information	**Data collection level**	**description**
	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Detailed Visual Inspection of all bridge elements (condition state, severity and extent of defects), and Performance Deficiencies (e.g., safety or load carrying capacity)
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Appraisals for Live Load Capacity, Fatigue, Seismic, Scour, Barriers / Railings/ Curbs
	Assessment on element level	**description**
	Condition (physical)	Four (4) condition states, defects identified and quantified by Detailed Visual Inspection to enable determination of repairs
	Load carrying capacity	Load carrying capacity recorded and compared to legal axle loads.
	Safety (probability of failure)	Element level Performance Measures are recorded (load capacity, safety, performance).
	Risk (probability and consequences of failure)	Assessed by inspector and included in priority and timing of recommendations. Risk not specifically determined.
	Assessment on structure level	**description**
	Condition (physical)	Bridge Condition Index (BCI) out of 100, based on element level condition
	Load carrying capacity	Appraisal Rating for Load Capacity, Live Load Capacity, and Posted Load Limits (axles – tonnes)
	Safety (probability of failure)	Appraisal Rating for Barriers/Railings, Fatigue, Seismic, Scour
	Risk (probability and consequences of failure)	Assessed by inspector and included in priority and timing of recommendations. Risk not specifically determined.

Intervention information	**Element level**	**description**
	Predefined standard interventions (based on condition state or time)	Default treatments for maintenance, repair, rehabilitation and replacement, including unit costs and effectiveness. Based on condition and lifecycle cost analysis.
	User defined interventions (based on condition state or time)	Unlimited user defined treatments for maintenance, repair, rehabilitation and replacement, including unit costs and effectiveness. Based on condition and lifecycle cost analysis.
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	Structure level projects consist of optimized element treatments. Recommended actions, timing and costs developed from Element Level and selected based on lifecycle cost analysis.
	User defined interventions (based on condition state or time)	Yes. User defined projects can be assembled easily. BMS determines costs and benefits based on lifecycle cost analysis. User can override BMS generated projects.
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	Feasible Projects from structure level (for all structure types) are compared at network level on the basis of benefit/cost ratio. Prioritized work program and costs developed to suit user specified budgets.
	User defined interventions (based on condition state or time)	Yes.
	Costs	**description**
	Inspection cost	Cost of inspections is not included.
	Intervention cost	Intervention costs are calculated by BMS at element level for specific treatments, and optimized into projects.
	Accident costs	Not included.
	Traffic delay cost	Yes, included in user defined project cost factors
	Environmental cost	Yes, included in user defined project cost factors
	Other cost	

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Default and User Defined Markovian deterioration models for each element/material type. Bridge condition index (BCI) forecasted using same deterioration models.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Improvements in element condition due to future intervention accounted for and then deteriorated using same deterioration models. Improvement in BCI also accounted for.
	Optimal intervention strategies - Period of time analyzed - Cost types	Optimal intervention strategies based on maximizing benefits, minimizing cost based on lifecycle costs. Lifecycle period is usually 50 – 75 years. Budget forecasting and project priority list is 10 year budgeting period.
	Work program - Period of time analyzed - Cost types - Budget constraints	Lifecycle analysis period is flexible, usually 50 – 75 years. Budget forecasting and project priority list is produced for 10 year period. Unlimited budget scenarios can be specified for maintenance, repair, rehabilitation and replacement work.
Information Use	**Aspect**	**description**
	For budget preparation	Yes. optimized work programs are produced for total needs and any user defined budget scenario.
	For setting of performance standards (e.g. target average condition states)	Target Bridge Condition Index (BCI) can be specified for the Network Level. Budgets are determined to meet specified condition targets..
	For matching funding sources	Not in BMS. This is done separately.
	For managing special (overweight) transports (e.g. granting permits to cross)	Done in separate system.
	Additional	A feature in the Network Analysis enables budget setting for predefined Regions, instead of the Provincial total budget. Projects are prioritized to suit these budget constraints and distributed to the Regions accordingly, resulting in a different set of projects than calculated using a global Provincial budget.

	Data collection	data collecting group
Operational information	Inventory	Owner and engineering consultants
	Inspection/assessment	Owner and engineering consultants. OBMS prepares check-out/check-in database for selected structures to provide to consultants.
	Intervention/planning	Owner. Owner also uses information from BMS in independent Excel algorithms to help prioritise work.
	Additional	For some clients using OBMS, Stantec performs budgeting and prioritization service on fee for service basis.
	Quality assurance	**description**
	Education for inspectors	Inspections performed by or under direct supervision of Professional Engineer with background in bridge inspection.
	Certification of inspectors	All inspectors required to complete basic training course, and regular MTO update inspection courses.
	Education for users	Nothing specific. Most users are generally inspectors and engineers
	Certification for users	Nothing specific. Most users are generally inspectors and engineers
	Audits (to verify data entry and use)	Yes by MTO.
	Audits (to verify prediction capabilities of system)	Condition index BCI extensively calibrated and verified by MTO. Prediction capabilities verified by developer.
	Other …	
Additional	Tablet Computers	Full BMS is available in Tablet Computer version.

14.2 Quebec bridge management system, QBMS

Name (version)		**Quebec Bridge Management System (MPS 2008)**
Basic information	**Aspect**	**description**
	Owner (webpage)	Quebec Ministry of Transportation (MTQ) http://www.mtq.gouv.qc.ca/portal/page/portal/accueil_en
	Date implemented (current / first version)	Version 1.0 (2008) Current Version 1.0 (MPS 2009)
	Developer(s) (webpage)	(MPS) Stantec Consulting Ltd. (www.stantec.com)
	References, Manuals & Catalogues	Quebec Structure Inspection Manuals http://www1.mtq.gouv.qc.ca/en/pub_ligne/index.asp (French)
	Users (Principal / Other)	Quebec Ministry of Transportation (MTQ)
IT information	**Aspect**	**description**
	Platform	Oracle, Microsoft SQL Server, and Microsoft SQL Express
	Architecture	Client Server, and Local Database
	Data collection capabilities	Desktop computer
	Reporting capabilities	Crystal Reports, inventory, inspection, analysis results.
	Web access	Yes inventory and inspection.

Inventory information (of principal user)	**Structure types**	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
	Bored tunnels		Locks and sluices		Weirs	
	Bridges	8,700	Retaining Walls	500	Quays	
	Culverts		Storm surge barriers		Piers	
	Cut and cover tunnels		Support structures			
	Galleries		Protection structures			

Inventory information (of principal user)	**Information type**	**description**
	Construction data	Bridge historical maintenance, rehabilitation, replacement contract cost information.
	Inspection reports	Stored in system, .pdf reports optional.
	Intervention history	Bridge historical maintenance, rehabilitation, replacement contract cost information.
	Location (e.g. 3D coordinates are recorded)	GIS coordinates
	Loading (e.g. maximum load carrying capacity is stored)	Detailed Live load rating factors and calculation information stored.
	Use (e.g. number of vehicles per day is stored)	Detailed traffic volume, truck %, and classification stored for each roadway on / under structure.

Inspection information	**Data collection level**	**description**
	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Detailed Visual Inspection of all bridge elements (condition state, severity and extent of defects)
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Live Load Capacity Rating, Indices for Seismic Vulnerability, Historic Structure, Functionality.
	Assessment on element level	**description**
	Condition (physical)	Four (4) condition states, defects identified and quantified by Detailed Visual Inspection to enable determination of repairs
	Load carrying capacity	Detailed load carrying capacity calculations recorded and compared to legal axle loads for element shear, flexure, and torsion.
	Safety (probability of failure)	Element level Performance Measures are recorded (load capacity, safety, performance). Accident risk considered in functional improvement models.
	Risk (probability and consequences of failure)	Assessed by inspector and included in priority and timing of recommendations. Risk not specifically determined.
	Assessment on structure level	**description**
	Condition (physical)	Bridge Condition Index (BCI) out of 100, based on element level condition
	Load carrying capacity	Detailed load carrying capacity calculations recorded and compared to legal axle loads for element shear, flexure, and torsion.
	Safety (probability of failure)	Appraisal Rating for Barriers/Railings, Fatigue, Seismic, Scour
	Risk (probability and consequences of failure)	Assessed by inspector and included in priority and timing of recommendations. Risk not specifically determined.
	Additional:	Historic Structure Index, Functionality Index

	Element level	description
Intervention information	Predefined standard interventions (based on condition state or time)	Default treatments for maintenance, repair, rehabilitation and replacement, including unit costs and effectiveness. Based on condition and lifecycle cost analysis.
	User defined interventions (based on condition state or time)	Unlimited user defined treatments for maintenance, repair, rehabilitation and replacement, including unit costs and effectiveness. Based on condition and lifecycle cost analysis.
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	Structure level projects consist of optimized element treatments. Recommended actions, timing and costs developed from Element Level and selected based on lifecycle cost analysis. Functional Improvements also calculated (widening, strengthening).
	User defined interventions (based on condition state or time)	Yes. User defined projects can be assembled easily. BMS determines costs and benefits based on lifecycle cost analysis. User can override BMS generated projects.
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	Feasible Projects from structure level (for all structure types) are compared at network level on the basis of benefit/cost ratio. Prioritized work program and costs developed to suit user specified budgets.
	User defined interventions (based on condition state or time)	Yes.
	Costs	**description**
	Inspection cost	Cost of inspections is not included.
	Intervention cost	Intervention costs are calculated by BMS at element level for specific treatments, and optimized into projects.
	Accident costs	Yes, in accident risk model for functional improvements (e.g. widening).
	Traffic delay cost	Yes, included in user defined project cost factors
	Environmental cost	Yes, included in user defined project cost factors
	Other cost	Functional Improvements (widening, strengthening)

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Default and User Defined Markovian deterioration models for each element/material type. Bridge condition index (BCI) forecasted using same deterioration models.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Improvements in element condition due to future intervention accounted for and then deteriorated using same deterioration models. Improvement in BCI also accounted for.
	Optimal intervention strategies - Period of time analyzed - Cost types	Optimal intervention strategies based on maximizing benefits, minimizing cost based on lifecycle costs. Lifecycle period is usually 50 – 75 years. Budget forecasting and project priority list is 10 year budgeting period.
	Work program - Period of time analyzed - Cost types - Budget constraints	Lifecycle analysis period is flexible, usually 50 – 75 years. Budget forecasting and project priority list is produced for 10 year period. Unlimited budget scenarios can be specified for maintenance, repair, rehabilitation and replacement work.
Information Use	**Aspect**	**description**
	For budget preparation	Yes. Optimized work programs are produced for total needs and any user defined budget scenario.
	For setting of performance standards (e.g. target average condition states)	Target Bridge Condition Index (BCI) can be specified for the Network Level. Budgets are determined to meet specified condition targets..
	For matching funding sources	Not in BMS. This is done separately.
	For managing special (overweight) transports (e.g. granting permits to cross)	Done in separate system.
	Additional	A feature in the Network Analysis enables budget setting for predefined Districts, instead of the Provincial total budget. Projects are prioritized to suit these budget constraints and distributed to the Districts accordingly, resulting in a different set of projects than calculated using a global Provincial budget.

Operational information	**Data collection**	**data collecting group**
	Inventory	Owner and engineering consultants
	Inspection/assessment	Owner and engineering consultants. BMS prepares check-out/check-in database for selected structures to provide to consultants.
	Intervention/planning	Owner.
	Additional	Functional improvement projects are also generated based on benefits of removing weight restrictions or reduction accidents.
	Quality assurance	**description**
	Education for inspectors	Inspections performed by or under direct supervision of Professional Engineer with background in bridge inspection.
	Certification of inspectors	All inspectors required to complete detailed inspection training course, and regular MTO update inspection courses.
	Education for users	Internal training.
	Certification for users	No.
	Audits (to verify data entry and use)	
	Audits (to verify prediction capabilities of system)	
	Other …	
Additional	Electronic Dashboard	Powerful project level electronic dashboard available. See references: a) Design and Implementation of a New Bridge Management System for the Ministry of Transport of Québec, IABMAS '08 Korea b) The Québec Ministry of Transport's Bridge Project Tactical Planning Dashboard, Transportation Association of Canada, Toronto 2008.

14.3 Danish bridge management system, DANBRO

Name DANBRO		**2.0**
Basic information	**Aspect**	**description**
	Owner (webpage)	www.vd.dk
	Date implemented (current / first version)	2010 /1975 (estimate)
	Developer(s) (webpage)	-
	References, Manuals & Catalogues	Yes, both printed and in help function
	Users (Principal / Other)	Owners of structures on the national and regional road network, consultants and contractors
IT information	**Aspect**	**description**
	Platform	Citrix
	Architecture	
	Data collection capabilities	
	Reporting capabilities	Capable of printing all necessary reports
	Web access	Yes

Inventory information (of principal user)	**Structure types**	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
	Bored tunnels		Locks and sluices		Weirs	
	Bridges + Culverts	2250	Retaining Walls		Quays	
	Culverts		Storm surge barriers		Piers	
	Cut and cover tunnels		Support structures			
	Galleries		Protection structures			

Inventory information (of principal user)	**Information type**	**description**
	Construction data	Yes
	Inspection reports	Yes
	Intervention history	Yes
	Location (e.g. 3D coordinates are recorded)	Yes
	Loading (e.g. maximum load carrying capacity is stored)	Yes
	Use (e.g. number of vehicles)	No

Inspection information	**Data collection level**	**description**
	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Visual, non destructive
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Visual, non destructive
	Assessment on element level	**description**
	Condition (physical)	Yes assessed on a scale from 1 to 5
	Load carrying capacity	Yes
	Safety (probability of failure)	Yes
	Risk (probability and consequences of failure)	Yes
	Assessment on structure level	**description**
	Condition (physical)	Yes assessed on a scale from 1 to 5
	Load carrying capacity	Yes
	Safety (probability of failure)	Yes
	Risk (probability and consequences of failure)	Yes

Intervention information	**Element level**	**description**
	Predefined standard interventions (based on condition state or time)	Yes, catalogue of standard repair works
	User defined interventions (based on condition state or time)	Yes
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	Yes, catalogue of standard repair works
	User defined interventions (based on condition state or time)	Yes
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	No
	User defined interventions (based on condition state or time)	No
	Costs	**description**
	Inspection cost	Yes
	Intervention cost	Yes
	Accident costs	No
	Traffic delay cost	Yes
	Environmental cost	(Yes)
	Other cost	

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Yes
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Yes
	Optimal intervention strategies - Period of time analyzed - Cost types	Yes
	Work program - Period of time analyzed - Cost types - Budget constraints	Yes
Information Use	**Aspect**	**description**
	For budget preparation	Yes, primarily
	For setting of performance standards (e.g. target average condition states)	Yes
	For matching funding sources	No
	For managing special (overweight) transports (e.g. granting permits to cross)	Yes
	Additional	

Operational information	**Data collection**	**data collecting group**
	Inventory	Yes
	Inspection/assessment	
	Intervention/planning	
	Additional	
	Quality assurance	**description**
	Education for inspectors	Yes
	Certification of inspectors	No
	Education for users	yes
	Certification for users	No
	Audits (to verify data entry and use)	Yes
	Audits (to verify prediction capabilities of system)	No
	Other …	
Additional		

14.4 Finnish bridge management system, FBMS

<table>
<tr><td colspan="3">Name (version)</td><td colspan="5">The Finnish BMS (Bridge Register & Project Level BMS)</td></tr>
<tr><td rowspan="7">Basic information</td><td colspan="2">Aspect</td><td colspan="5">description</td></tr>
<tr><td colspan="2">Owner (webpage)</td><td colspan="5">Liikennevirasto (The Finnish Transport Agency, FTA)
www.liikennevirasto.fi</td></tr>
<tr><td colspan="2">Date implemented (current / first version)</td><td colspan="5">2010 / 1990 & 1995</td></tr>
<tr><td colspan="2">Developer(s) (webpage)</td><td colspan="5">Liikennevirasto (www.Liikennevirasto.fi)</td></tr>
<tr><td colspan="2">References and Manuals (available at - languages)</td><td colspan="5">User handbooks for Bridge Register and the Project Level BMS (Hanke-Siha) (in Finnish)
Inspection guidelines and handbook (in Finnish)</td></tr>
<tr><td colspan="2">Users (Principal / Other)</td><td colspan="5">Liikennevirasto / cities and communities, consultants companies</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td rowspan="6">IT information</td><td colspan="2">Aspect</td><td colspan="5">description</td></tr>
<tr><td colspan="2">Platform</td><td colspan="5">Oracle 8 database, Oracle Forms 5, running in Citrix-</td></tr>
<tr><td colspan="2">Architecture</td><td colspan="5">Client- Server</td></tr>
<tr><td colspan="2">Data collection capabilities</td><td colspan="5">Data entered manually</td></tr>
<tr><td colspan="2">Reporting capabilities</td><td colspan="5">70 ready to use -reports with Visual Basic, Oracle Reports , can be printed in PDF, Excel and Word format
Add hoc reports with SQL*Plus, printed in Ascii and Excel - format</td></tr>
<tr><td colspan="2">Web access</td><td colspan="5">No, a special web-portal from outside FTA to Citrix server</td></tr>
<tr><td rowspan="7">Inventory information (of principal user)</td><td>Structure types</td><td>No.</td><td>Structure types</td><td>No.</td><td>Structure types</td><td colspan="2">No.</td></tr>
<tr><td>Bored tunnels</td><td>on-going
data collection (about 20)</td><td>Locks and sluices</td><td>0</td><td>Weirs</td><td colspan="2">0</td></tr>
<tr><td>Bridges</td><td>11487+2300</td><td>Retaining Walls</td><td>0</td><td rowspan="2">Quays
Piers</td><td rowspan="2" colspan="2">about
200 together</td></tr>
<tr><td>Culverts</td><td>3078</td><td>Storm surge barriers</td><td>0</td></tr>
<tr><td>Cut and cover tunnels</td><td>0</td><td>Support structures</td><td>0</td><td></td><td colspan="2"></td></tr>
<tr><td>Galleries</td><td>0</td><td>Protection structures</td><td>0</td><td></td><td colspan="2"></td></tr>
</table>

Inventory information (of principal user)	**Archives**	**description**
	Construction data	Manual bridge folders for planning, design, calculations, construction papers
	Inspection reports	Special inspection reports and research results are preserved in manual archives and bridge folders (basic inputs to Bridge Register)
	Intervention history	Yes, older repair data (before 1985) not complete
Inspection information	**Data collection level**	**description**
	Element level	Visual inspections with damage description and estimated repair measures and costs with photos, drawings, test results
	Structure level	Visual inspections with damage description and estimated repair measures and costs with photos, drawings, test results
	Assessment on element level	**description**
	Condition	The nine main structural parts' condition is evaluated by the inspector, rates 0-4 (very good - very poor)
	Safety, vulnerability, risk	Is taken into consideration by giving the "repair urgency" grade (immediate, in 2 years, in 4 years, later, no repair) Estimated condition with age behaviour curves can be predicted.
	Load carrying capacity	Only remark "the damage has effect to the load carrying capacity"
	Assessment on structure level	**description**
	Condition	The overall condition is evaluated by the inspector, rates 0-4 (very good - very poor)
	Safety	Conclusions can be drawn from the element level
	Load carrying capacity	Loading tests, evaluation of the need of load limitations, Calculations for special heavy transports.
	Additional Maintenance target measures	1) Bridges in "bad condition", the measure "official condition class" (1-5, very poor to very good) is calculated from the condition and damage information given by the inspector. Bad condition means the classes 1 and 2. 2) Sum of damage points, calculated from the damage information given by the inspector. Varies somehow with railway bridges, the final decision has not been made yet.

	Element level	description
Intervention information	Predefined standard	Lists of parameters. Inspection handbook gives rules for actions according to structure and damages (Bridge Register and BMS)
	User defined/custom	In BMS yes
	Intervention strategy	Repair urgency class (immediate, in 2 years, in 4 years, later, no repair) for every recorded damage
	Structure level	**description**
	User defined/custom	In BMS yes
	Predefined standard	Lists of parameters. Inspection handbook gives rules for actions according to structure and damages (Bridge Register and BMS)
	Intervention strategies	Repair urgency, written recommendations by the inspector, the next year of inspection by the inspector
	Project level	**description**
	User defined/custom	Yes
	Predefined standard	SILKO Bridge Repair Manual
	Intervention strategies	Repair index, Reconstruction index, optimal repair policy in BMS
	Costs	**description**
	Inspection cost	No
	Intervention cost	Yes
	Traffic delay cost	No
	Indirect user cost	No
	Life-cycle costing	No
	Prioritization	**description**
	Performance measures	Repair index, Reconstruction index, Damage Index
Prediction information	**Aspect**	**description**
	Deterioration	Age behaviour models for structural elements' deterioration
	Improvement (e.g. repair, rehabilitation, reconstruction)	Repair measure models
	Cost	LCA and LCC analyses
	Planning time-frame	Repair programs for coming 6 years

	Use	description
Prediction information	For budget preparation	Yes, by the bridge engineer in the road region
	For setting of performance standards	Yes, by FTA
	For matching funding sources	Yes, by FTA
	Additional	

	Data collection	data collecting group
Operational information	Inventory	Road regions have the responsibility of basic data collection, engineering companies' inspection consultants possibly input the data, too.
	Inspection/assessment	Engineering companies' inspection consultants
	Intervention/planning	Planning is made by bridge engineers, consultant companies can be involved in some cases
	Additional	
	Quality assurance	**description**
	Education for inspectors	Inspection training course, 3-4 days theory, 1 day in situ training, 1 day examination (theory and in situ inspection)
	Certification of inspectors	Inspection course examination, no inspections without it.
	Education for users	Bridge Register basic course 2 days, BMS basic course 2 days
	Certification for users	The Bridge Register course (no examination demands
	Other … Bridge Inspector Qualifications	Yearly training day for bridge inspectors is obligatory. This means "calibration" of inspectors, everyone inspects the same bridge, data is inputted into the Bridge Register. Statistical measures of divergence are calculated. The results lead to "inspector's quality points", which are used when comparing the inspection offers in competitive biddings. If someone does not participate, the quality points from the earlier year are reduced according special rules.
Additional	Inspection Quality Report	A report of inspection quality is produced yearly to follow the data quality.

*The programs are old. A new design is going on. The design work has started in the end of September 2010. Both the Bridge Register and the Project Level BMS (Hanke-Siha) will be totally renewed. This means that new features and possibilities for new data will be added.

The principles of the new management system have been completed, the modeling work is going on. The new programs should be in use in 2013.

The new system will be for all the engineering structures (bridges, tunnels, piers, quays, channels, retaining walls, noise barriers etc. The management system will be based on multi objective optimization and life cycle analyses. Benefits for repair actions will be calculated.

The organization of the former Finnish Road Administration has been changed. A new agency has started in the beginning of 2010. The Road Administration, The Railway Administration and The Maritime Administration have been merged together. This also means that our BMS will consist of all the engineering structures managed by the three former administrations.

14.5 German bridge management system, GBMS

	Name (version)		XXX (20XX)			
Basic information	**Aspect**		**description**			
	Owner (webpage)		Federal State (BMVBS) an the 16 "Länder" ("Federal States")			
	Date implemented (current / first version)		Version 1.8 SP2.2			
	Developer(s) (webpage)		WPM-Ingenieure (www.wpm-ingenieure.de)			
	References, Manuals & Catalogues		User manual SIB-Bauwerke Version 1.8 in German language			
	Users (Principal / Other)		BASt, Federal Ministry (BMVBS), Road Authorities, Engineering Consultants			
IT information	**Aspect**		**description**			
	Platform		Oracle/ MS SQL Server; Windows Xp			
	Architecture		Client-Server, Database			
	Data collection capabilities		Data are entered manually in a desk top computer or Laptop			
	Reporting capabilities		Structure Log, Inspection Report, special Reports (tabular)			
	Web access					
Inventory information (of principal user)	**Structure types**	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
	tunnels	108	Locks and sluices	0	Weirs	0
	Bridges	38.80	Retaining Walls	7289	Quays	0
	Culverts	152	Storm surge barriers	0	Piers	0
	Cut and cover tunnels	126	Support structures	0	Traffic Sign Bridges	13.543
	Galleries	19	Protection structures	0		
	Information type		**description**			
	Construction data		Included in SIB-Bauwerke			
	Inspection reports		Included in SIB-Bauwerke			
	Intervention history		History of Damage Data since Version 1.7			
	Location (e.g. 3D coordinates are recorded)		Location in Compliance with Road Database (TT-SIB, NWSIB, SIB Hessen)			
	Loading (e.g. maximum load carrying capacity is stored)		Bridge Classes corresponding to German Standard DIN 1072/EC 1 (LM1, BK 60/30, BK 60, BK 45, …) in Database			
	Use (e.g. number of vehicles per day is stored)		Yes (reduced Traffic Volume Data). Full Information available in Road Databases			

	Data collection level	description
Inspection information	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Visual inspection (damage description according to Guideline RI-EBW-PRÜF); other Information can be stored (test results, pictures, drawings, …)
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Aggregated information from Element Level
	Assessment on element level	**description**
	Condition (physical)	Description of each Damage related to 3 criteria (Structural Stability, Traffic Safety and Durability (Rating 0 – 4))
	Load carrying capacity	Not on Element Level
	Safety (probability of failure)	See “Condition”; no calculation of probability of failure
	Risk (probability and consequences of failure)	See “Condition”; no calculation of probability of failure; conse-quences of failure derived from damage rating (RI-EBW-PRÜF)
	Assessment on structure level	**description**
	Condition (physical)	Aggregated from all elements and all damage criteria; worst condition is authoritative
	Load carrying capacity	Description of Bridge Classes (DIN 1072)
	Safety (probability of failure)	See “Element Level”
	Risk (probability and consequences of failure)	See “Element Level”

	Element level	**description**
Intervention information	Predefined standard interventions (based on condition state or time)	Not on Element Level
	User defined interventions (based on condition state or time)	Not on Element Level
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	Intervention time addicted from condition index on structure level
	User defined interventions (based on condition state or time)	User can define measure recommendation with time frame
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	No, is calculated in Bridge Management System (BMS)
	User defined interventions (based on condition state or time)	No, is calculated in Bridge Management System (BMS)
	Costs	**description**
	Inspection cost	No
	Intervention cost	Yes in BMS
	Accident costs	Yes in BMS
	Traffic delay cost	Yes in BMS
	Environmental cost	Yes in BMS
	Other cost	No

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Deterioration Models are included in the BMS. They use the change of Performance indicators based on curves of physical condition change.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Improvement because of repair actions are part of the BMS
	Optimal intervention strategies - Period of time analyzed - Cost types	Cost-Benefit-Optimization on Object (Structure)Level; Knapsack-Algorithm on Network Level (financial and quality scenario)
	Work program - Period of time analyzed - Cost types - Budget constraints	- Proposal for 6 years (years 7 – 20 are in the system but only use to indentify necessary following actions) - Direct costs on object level included - Budget constraint for optimization on Network Level
Information Use	**Aspect**	**description**
	For budget preparation	Yes, but current BMS-Version is not yet in operation phase
	For setting of performance standards (e.g. target average condition states)	Not yet, but possible in the future
	For matching funding sources	No
	For managing special (overweight) transports (e.g. granting permits to cross)	No. For this purpose a new program bases on SIB-Bauwerke data is under development
	Additional	-

Operational information	Data collection	data collecting group
	Inventory	Responsible are the "Länder", but they can involve engineering companies
	Inspection/assessment	Responsible are the "Länder", but they can involve engineering companies
	Intervention/planning	Is part of half-year-meeting between Federal State an "Länder"
	Additional	-
	Quality assurance	**description**
	Education for inspectors	Training course (www.vfib-ev.de (only available in German))
	Certification of inspectors	No official "Certification"
	Education for users	Training course (www.vfib-ev.de (only available in German))
	Certification for users	No
	Audits (to verify data entry and use)	No
	Audits (to verify prediction capabilities of system)	No

14.6 Ireland's bridge management system, Eirspan

Name (version)		**XXX (20XX)**			
Basic information	**Aspect**	**description**			
	Owner (webpage)	www.nra.ie			
	Date implemented (current / first version)	September 2001			
	Developer(s) (webpage)	www.nra.ie			
	References, Manuals & Catalogues	Manuals not published, used internally			
	Users (Principal / Other)	NRA and consultants			
IT information	**Aspect**	**description**			
	Platform	Interbase			
	Architecture				
	Data collection capabilities	Data entered manually on computer			
	Reporting capabilities	Can print basic reports with photos, or save as pdf file.			
	Web access	To Routine inspection module only			

Inventory information (of principal user)	**Structure types**	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
	Bored tunnels	0	Locks and sluices	0	Weirs	0
	Bridges	2,900	Retaining Walls	?	Quays	0
	Culverts	incl	Storm surge barriers	0	Piers	0
	Cut and cover tunnels	0	Support structures	?		
	Galleries	0	Protection structures	0		

Inventory information (of principal user)	**Information type**	**description**
	Construction data	Form of construction, materials for each main element
	Inspection reports	Full inspection report recorded
	Intervention history	Archive module permits this info to be recorded.
	Location (e.g. 3D coordinates are recorded)	X and y co-ords recorded
	Loading (e.g. maximum load carrying capacity is stored)	Facility exists but is not used.
	Use (e.g. number of vehicles per day is stored)	Basic traffic details are entered manually.

	Data collection level	description
Inspection information	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Visual inspection. Condition rating, damage description, repair type, photos and repair costs are stored.
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Visual inspection based on element condition ratings. Intrusive investigations are only used to establish characteristics for structural assessment.
	Assessment on element level	**description**
	Condition (physical)	Visual inspection, Condition rating 0 to 5.
	Load carrying capacity	Special Inspection for load carrying capacity can be requested by inspecting engineer.
	Safety (probability of failure)	Condition rating of 4 or 5 triggers notification to Client for action.
	Risk (probability and consequences of failure)	Engineering judgement used by inspecting engineer and appropriate condition rating chosen (see above)
	Assessment on structure level	**description**
	Condition (physical)	Chosen from worst condition rating of important elements.
	Load carrying capacity	Special Inspection for load carrying capacity can be requested by inspecting engineer.
	Safety (probability of failure)	Condition rating of 4 or 5 triggers notification to Client for action.
	Risk (probability and consequences of failure)	No formal system of rating risk, but it is considered during inspection.

Intervention information	**Element level**	**description**
	Predefined standard interventions (based on condition state or time)	List of predefined interventions given in manual.
	User defined interventions (based on condition state or time)	Facility exists for user to add custom interventions.
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	No.
	User defined interventions (based on condition state or time)	Remarks field exists for user to populate; element level interventions are addressed more specifically.
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	No. Preliminary ranking of element and structure repairs available on database. Judgement used by bridge managers to prioritise on network level.
	User defined interventions (based on condition state or time)	See above.
	Costs	**description**
	Inspection cost	Not recorded in database but monitored elsewhere.
	Intervention cost	Yes
	Accident costs	No
	Traffic delay cost	No
	Environmental cost	No
	Other cost	

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Not modelled in the BMS.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Not modelled in the BMS.
	Optimal intervention strategies Period of time analyzed Cost types	Not modelled in the BMS.
	Work program Period of time analyzed Cost types Budget constraints	Not modelled in the BMS.
Information Use	**Aspect**	**description**
	For budget preparation	Standard cost of interventions is available but inaccurate given difficulties of identifying unit costs which are influenced by many varied parameters (size of repair, need for traffic management, etc)
	For setting of performance standards (e.g. target average condition states)	Not used
	For matching funding sources	Not used
	For managing special (overweight) transports (e.g. granting permits to cross)	Not used. This is a function undertaken by Local Authorities.
	Additional	

Operational information	**Data collection**	**data collecting group**
	Inventory	Engineering consultants.
	Inspection/assessment	Engineering consultants.
	Intervention/planning	Client and Engineering consultants.
	Additional	
	Quality assurance	**description**
	Education for inspectors	Inspectors must attend 4-day workshop given by Client (National Roads Authority). Manuals made available. Minimum qualifications and experience requirements for inspectors. CVs vetted.
	Certification of inspectors	No ‘examination’ during workshop. Minimum experience and qualifications requirements considered adequate.
	Education for users	New users attend Inspection workshop and learn on-the-job.
	Certification for users	No.
	Audits (to verify data entry and use)	Selection of Inspection reports checked by NRA bridge managers.
	Audits (to verify prediction capabilities of system)	None.
	Other …	
Additional	Bridge is considered to have span greater than 2.0m	

14.7 The Autonomous Province of Trento, APTBMS

Name (version)		**APT-BMS (2011)**
Basic information	**Aspect**	**description**
	Owner (webpage)	Provincia Autonoma di Trento (Autonomous Province of Trento) (http://bms.heidi.it/ - guest access: user: sguest; passwd: sguest)
	Date implemented (current / first version)	2011 / 2004
	Developer(s) (webpage)	University of Trento, Department of Mechanical and Structural Engineering (http://www.ing.unitn.it/dims)
	References, Manuals & Catalogues	3 User manuals and 11 procedures (http://bms.heidi.it/ – available at the front page; in Italian)
	Users (Principal / Other)	Provincia Autonoma di Trento (Autonomous Province of Trento / None)
IT information	**Aspect**	**description**
	Platform	Microsoft SQL
	Architecture	Client, Application Server, Database, Data Anlysis Server
	Data collection capabilities	1 TB (can be expanded)
	Reporting capabilities	Reports, graphical, tabular, GIS
	Web access	Yes

Inventory information (of principal user)	**Structure types**	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
	Bored tunnels		Locks and sluices		Weirs	
	Bridges	1024	Retaining Walls		Quays	
	Culverts		Storm surge barriers		Piers	
	Cut and cover tunnels		Support structures			
	Galleries		Protection structures			

Inventory information (of principal user)	Information type	description
	Construction data	Any digital design document can be uploaded into the database; reference to hard paper archives is also included
	Inspection reports	Current and past inspection report are generated on demand
	Intervention history	Past intervention are listed, design document can be uploaded
	Location (e.g. 3D coordinates are recorded)	UTM coordinates, linear road coordinates (road number, km-m)
	Loading (e.g. maximum load carrying capacity is stored)	Design class, nominal load carrying capacity; load limitations.
	Use (e.g. number of vehicles per day is stored)	Average Daily Traffic; Heavy Load Maximum Daily Traffic

Inspection information	Data collection level	description
	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Each SU and C (see below) includes a set of Standard Elements (SE), which are specified in terms of quantity and Condition State.
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Inspection report and summary. In addition, the bridge is broken down into Structural Units (SU), such as deck, piles, abutments, which are defined as conceptual entities characterized by common attributes (such as length, material, typology, spatial location…). The spatial arrangement of SUs is defined through logical entities labeled connections (C).
	Assessment on element level	**description**
	Condition (physical)	Evaluated at the element level on the basis of a procedure that acknowledges AASHTO Commonly Recognized (CoRe) Standard Element System (3 to 5 possibly conditions identified based on visual inspection.
	Load carrying capacity	Recorded at the structure level.
	Safety (probability of failure)	Safety evaluated at the structural unit level, based on formal safety evaluation procedures.
	Risk (probability and consequences of failure)	Risk evaluated at the bridge level.

	Assessment on structure level	**description**
Inspection information	Condition (physical)	Different condition indices (overall CS, apparent age) computed from the condition of the single elements.
	Load carrying capacity	Computed from unit level
	Safety (probability of failure)	Formally assessed for sub-standard bridges, or assumed based on design code.
	Risk (probability and consequences of failure)	Five risk factors considered: failure of a principal element; failure of a secondary element; pile collapse due to scour; road accident due to sub-standard guardrails; loss of life due to earthquake.
	Additional:	No

Intervention information	Element level	description
	Predefined standard interventions (based on condition state or time)	User can define effect of interventions.
	User defined interventions (based on condition state or time)	Effect of standard interventions are predefined, can be customized by user.
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	No
	User defined interventions (based on condition state or time)	No
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	No
	User defined interventions (based on condition state or time)	No
	Costs	**description**
	Inspection cost	Yes
	Intervention cost	Yes
	Accident costs	No
	Traffic delay cost	No
	Environmental cost	No
	Other cost	No

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Effect on physical condition state based on Markovian models.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Effect on physical condition state based on Markovian models.
	Optimal intervention strategies - Period of time analyzed - Cost types	5-year time span for short term intervention scenarios and 50- year time span for strategic planning. LCC evaluated based on intervention scenario and maintenance strategy.
	Work program - Period of time analyzed - Cost types - Budget constraints	Work program pre-assigned by user: maintenance interval and cost can be defined.
Information Use	**Aspect**	**description**
	For budget preparation	Yes
	For setting of performance standards (e.g. target average condition states)	No
	For matching funding sources	Yes
	For managing special (overweight) transports (e.g. granting permits to cross)	Yes
	Additional	For evaluating network operation in post-earthquake scenarios.

Operational information	**Data collection**	**data collecting group**
	Inventory	Assigned to professional engineers.
	Inspection/assessment	Owner (APT) for 1-year routine inspection. Assigned to professional engineers for 3-year principal inspections and formal safety evaluation.
	Intervention/planning	Owner (APT)
	Additional	
	Quality assurance	**description**
	Education for inspectors	Mandatory training course offered by university. On-site support at the first inspection.
	Certification of inspectors	No
	Education for users	Yes
	Certification for users	No
	Audits (to verify data entry and use)	Yes
	Audits (to verify prediction capabilities of system)	No
	Other …	No
Additional		Management and use of monitoring data for selected bridges.

14.8 Japanese bridge management system, RPIBMS

Name (version)			**BMS@RPI**			
Basic information	**Aspect**		**description**			
	Owner (webpage)		Kajima Corporation (http://www.kajima.com) Regional Planning Institute of Osaka (http://www.rpi.or.jp/)			
	Date implemented (current / first version)		2009/2006			
	Developer(s) (webpage)		Kajima Corporation (http://www.kajima.com)			
	References and Manuals (available at - languages)		User manuals and administration manuals are available in Japanese language.			
	Users (Principal / Other)		Aomori Prefectural Government , Ibaraki Prefectural Government/ other cities			
IT information	Aspect		description			
	Platform		Microsoft Windows XP/Vista, Microsoft Access			
	Architecture		Desktop application			
	Data collection capabilities		Pen tablet PC, Digital Camera			
	Reporting capabilities		Graphical inspection report			
	Web access		N/A			
Inventory information (of principal user)	Structure types	No.	Structure types	No.	Structure types	No.
	Bored tunnels	0	Locks and sluices	0	Weirs	0
	Bridges	750	Retaining Walls	0	Quays	0
	Culverts	0	Storm surge barriers	0	Piers	0
	Cut and cover tunnels	0	Support structures	0		
	Galleries	0	Protection structures	0		
	Archives		**description**			
	Construction data		Construction data can be stored in the form of PDF.			
	Inspection reports		Inspection data are updated periodically.			
	Intervention history		Inspection data after the intervention can be recorded.			

	Name (version)	BMS@RPI
Inspection information	**Data collection level**	**description**
	Element level	The element level visual inspection are performed and damage description, type of deterioration with the degree of deterioration progress can be recorded at the bridge inspection site using tablet PC.
	Structure level	
	Assessment on element level	**description**
	Condition	Condition state criteria (1-5) based on visual inspection are established on 35 different type of element and deterioration.
	Safety, vulnerability, risk	According to the level of damage, the element which needs prompt action for the safety reason are designated based on the visual inspection.
	Load carrying capacity	No
	Assessment on structure level	**description**
	Condition	Each element is divided into unit, and the inspection is performed on unit basis. The condition of the structure can be assessed as an aggregation of unit.
	Safety	Assessment of safety is not performed on structure level, but the safety of the structure can be assessed if there is any heavily damaged unit in the structure.
	Load carrying capacity	Load carrying capacity is not assessed on structure level.
	Additional	none
Intervention information	**Element level**	**description**
	Predefined standard	Standard intervention for each type of element and deterioration is pre-determined.
	User defined/custom	User can define the intervention.
	Intervention strategy	Several intervention strategies are implemented.
	Structure level	**description**
	User defined/custom	User can choose replacement of the structure.
	Predefined standard	Replacement of the structure is predefined for particular type of damage of the element and the structure.
	Intervention strategies	Cathodic protection can be chosen as a structure level intervention against salt damage of the concrete.
	Project level	**description**
	User defined/custom	No
	Predefined standard	No
	Intervention strategies	No
	Costs	**description**
	Inspection cost	Not included in the BMS.
	Intervention cost	Yes
	Traffic delay cost	No
	Indirect user cost	Yes
	Life-cycle costing	LCC are obtained for the structure level as well as unit or element level.
	Prioritization	**description**
	Performance measures	Different interventions are predetermined according to the performance target levels.

Name (version)		BMS@RPI
Prediction information	**Aspect**	**description**
	Deterioration	The deterioration model curves are established with four deterioration speeds for each type of element and deteriorations.
	Improvement (e.g. repair, rehabilitation, reconstruction)	The level of improvement after repair, rehabilitation and replacement for each type of element and deterioration are provided together with the deterioration model curve after the interventions.
	Cost	Cost is not variant according time.
	Planning time-frame	Up to 100 years.
	Use	**description**
	For budget preparation	Yes. Our BMS has budget simulation function.
	For setting of performance standards	User can set performance standard for each bridge by selecting appropriate Maintenance Scenarios which indicate performance level of element.
	For matching funding sources	Yes. By using the budget simulation function, user can easily find the best suitable intervention strategy for multi bridges which matches funding resources.
	Additional	No
Operational information	**Data collection**	**data collecting group**
	Inventory	Owner. Can be assigned to engineering companies.
	Inspection/assessment	Owner. Can be assigned to engineering companies.
	Intervention/planning	Owner. Can be assigned to engineering companies.
	Additional	No
	Quality assurance	**description**
	Education for inspectors	Training course is provided for users by RPI.
	Certification of inspectors	RPI will provide the certificate of finishing standard BMS inspection course.
	Education for users	Training course is provided for users by RPI.
	Certification for users	RPI will provide the certificate of finishing standard BMS education course
	Other …	User can share information through user meeting of BMS@RPI.

14.9 Korea Road Maintenance Business System, KRMBS

Name (version)		Korean National Road BMS
Basic information	**Aspect**	**description**
	Owner (webpage)	Korean ministry of land, transportation and maritime affairs (http://www.mltm.go.kr)
	Date implemented (current / first version)	2010/2003 - Korea Road Maintenance Business System (Bridge Information Management System) A new version of BMS, "Bridge Information Analysis System" is under developing (The official version is scheduled for completion in 2012). This new system will be partially connected with the construction portal system, CALS (http://www.calspia.go.kr) and the facility management system, FMS (http://www.fms.or.kr).
	Developer(s) (webpage)	Korea Institute of Construction Technology (http://www.kict.re.kr)
	References, Manuals & Catalogues	User and administrator manuals will be prepared for the newly developed system
	Users (Principal / Other)	Ministry of Land, Transport and Maritime Affairs / Regional Administration Office for National Road Management
IT information	**Aspect**	**description**
	Platform	Windows Server, Oracle, Java/JSP
	Architecture	Application & WEB Server, Database, Client, Smart Phone
	Data collection capabilities	Data can be entered by using a desk top computer or a smart phone (in the field) (through web-based networking)
	Reporting capabilities	Inventory, inspection, and analysis reports, graphical and tabular
	Web access	Yes

<table>
<tr><td rowspan="14">Inventory information</td><td>Structure types</td><td>No.</td><td>Structure types</td><td>No.</td><td>Structure types</td><td>No.</td></tr>
<tr><td>Bored tunnels</td><td>0</td><td>Locks and sluices</td><td>0</td><td>Weirs</td><td>0</td></tr>
<tr><td>Bridges</td><td>5,481</td><td>Retaining Walls</td><td>0</td><td>Quays</td><td>0</td></tr>
<tr><td>Culverts</td><td>0</td><td>Storm surge barriers</td><td>0</td><td>Piers</td><td>0</td></tr>
<tr><td>Cut and cover tunnels</td><td>0</td><td>Support structures</td><td>0</td><td></td><td>0</td></tr>
<tr><td>Galleries</td><td>0</td><td>Protection structures</td><td>0</td><td></td><td>0</td></tr>
<tr><td colspan="2">Information type</td><td colspan="4">description</td></tr>
<tr><td colspan="2"></td><td colspan="4"></td></tr>
<tr><td colspan="2">Construction data</td><td colspan="4">Structural analysis reports, drawings, construction progress reports, and etc. are stored in the Construction CALS portal system (http://www.calspia.go.kr)</td></tr>
<tr><td colspan="2">Inspection reports</td><td colspan="4">Regular and irregular inspection reports for important bridges (class 1 and 2) are stored in the Facility Management System (FMS, http://www.fms.or.kr)</td></tr>
<tr><td colspan="2">Intervention history</td><td colspan="4">Regular and irregular intervention history for important bridges (class 1 and 2) are stored in FMS.</td></tr>
<tr><td colspan="2">Location (e.g. 3D coordinates are recorded)</td><td colspan="4">X Y coordinates (longitude and latitude) and road coordinates (road number)</td></tr>
<tr><td colspan="2">Loading (e.g. maximum load carrying capacity is stored)</td><td colspan="4">Design class based on the construction specification is stored. Results of proof load test, if any, are also stored (in FMS).</td></tr>
<tr><td colspan="2">Use (e.g. number of vehicles per day is stored)</td><td colspan="4">Daily traffic volume (deduced from adjacent measure stations), weather condition, network information, GIS information, site photos, etc. are also available.</td></tr>
</table>

Inspection information	Data collection level	description
	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	**Regular visual inspections** containing damage descriptions are performed twice per year for bridges in class 1 and 2. Other information can be stored, e.g. test results, plans, photos. Non-destructive and/or destructive tests are performed as **a periodical detailed inspection and diagnosis** for bridges in class 1 and 2. Also **a need-based detailed inspection and diagnosis** can be performed depending on the primary visual inspection results Predicted condition and safety performance levels based on inspection DB, expert's opinions and pre-calculated structural analysis considering deterioration are stored in DB.
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Integrated and inferred from element level. Proof-load test may be conducted according to the results of regular inspections.
	Assessment on element level	**description**
	Condition (physical)	Elements have a condition states (levels) rating from A(best) to E(worst) based on a visual inspection. Safety of members is calculated from structural analysis as a detailed inspection and diagnosis is conducted.
	Load carrying capacity	Concrete coring and strain gauge tests (associated with a proof-load test) are performed if it is necessary based on regular inspection results for bridges in class 1 and 2.
	Safety (probability of failure)	Deterministic (not probabilistic) safety assessment is performed if it is necessary based on regular inspection results for bridges in class 1 and 2.
	Risk (probability and consequences of failure)	Risk analysis is performed yet.
	Assessment on structure level	**description**
	Condition (physical)	Integrated and assessed from the condition level of elements based on a pre-defined weighted function.
	Load carrying capacity	Proof-load test is performed if it is necessary based on regular inspection results for bridges in class 1 and 2.
	Safety (probability of failure)	Deterministic (not probabilistic) safety assessment is performed if it is necessary based on regular inspection results for bridges in class 1 and 2.
	Risk (probability and consequences of failure)	Risk analysis is performed yet.

Intervention information (보수,보강)	Element level	description
	Predefined standard interventions (based on condition state or time)	Standard interventions according to condition state (level) of element are predefined. They can be modified by users.
	User defined interventions (based on condition state or time)	User can define custom interventions into the system.
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	Some strengthening interventions for structure level are pre-defined.
	User defined interventions (based on condition state or time)	User can define custom interventions in the system.
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	No
	User defined interventions (based on condition state or time)	No
	Costs	**description**
	Inspection cost	Include all inspection costs, such as periodic inspection, detailed inspection, diagnosis, and detailed diagnosis
	Intervention cost	Intervention costs are specified at element level for predefined treatments.
	Accident costs	No
	Traffic delay cost	Included (when estimating the user cost)
	Environmental cost	No
	Other cost	Detour cost is included (When estimating the user cost)

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Deterioration model based on regression of historical condition state data is embedded in the system.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Improvement model of condition state due to interventions is embedded in the system.
	Optimal intervention strategies - Period of time analyzed - Cost types	Optimal intervention strategies can be obtained in termed of both period time and cost type analysis based on generic optimization engine.
	Work program - Period of time analyzed - Cost types - Budget constraints	- period of time analysis can be conducted by administrators or users - expected costs of interventions according to various intervention strategies can be computed and assigned on element level - budget constraints can be treated in this system
Information Use	**Aspect**	**description**
	For budget preparation	Yes, the information of budget preparation can be provided for decision makers of administration.
	For setting of performance standards (e.g. target average condition states)	Yes, the expected performance level can be set in the system by decision makers of administration.
	For matching funding sources	No
	For managing special (overweight) transports (e.g. granting permits to cross)	No
	Additional	

Operational information	**Data collection**	**data collecting group**
	Inventory	By Regional Administration Office of National Road Management
	Inspection/assessment	Generally, by inspectors of Regional Administration Office for National Road Management. In case of detailed inspection and diagnosis, special inspectors from some private engineering companies can contribute.
	Intervention/planning	Managers and operators of the system
	Additional	
	Quality assurance	**description**
	Education for inspectors	Special inspectors with official license are required to complete periodical training courses.
	Certification of inspectors	An official examination has to be passed to get the certification of inspector.
	Education for users	Once a year (about two days) for system end users.
	Certification for users	No special certifications for end users.
	Audits (to verify data entry and use)	System developers, operators and managers
	Audits (to verify prediction capabilities of system)	Verified externally by professors and experts in field of bridge management
	Other …	
Additional		

14.10 Latvian bridge management system, Lat Brutus

<table>
<tr><th colspan="3">Name (version)</th><th colspan="4">Lat Brutus (3.1)</th></tr>
<tr><td rowspan="6">Basic information</td><td colspan="2">Aspect</td><td colspan="4">description</td></tr>
<tr><td colspan="2">Owner (webpage)</td><td colspan="4">State Joint Company LATVIAN STATE ROADS (www.lvceli.lv)</td></tr>
<tr><td colspan="2">Date implemented (current / first version)</td><td colspan="4">2004/2002</td></tr>
<tr><td colspan="2">Developer(s) (webpage)</td><td colspan="4">Norwegian Public Road Administration (www.vegvesen.no) and
Latvian Road Administration (www.lvceli.lv)</td></tr>
<tr><td colspan="2">References and Manuals (available at - languages)</td><td colspan="4">Users manual Lat Brutus – in English ()</td></tr>
<tr><td colspan="2">Users (Principal / Other)</td><td colspan="4">State Joint Company LATVIAN STATE ROADS ()</td></tr>
<tr><td rowspan="6">IT information</td><td colspan="2">Aspect</td><td colspan="4">description</td></tr>
<tr><td colspan="2">Platform</td><td colspan="4">Oracle 8i</td></tr>
<tr><td colspan="2">Architecture</td><td colspan="4">Client, Application server, Database.</td></tr>
<tr><td colspan="2">Data collection capabilities</td><td colspan="4">Data is entered manually in a desk top computer</td></tr>
<tr><td colspan="2">Reporting capabilities</td><td colspan="4">Reports and tabular.</td></tr>
<tr><td colspan="2">Web access</td><td colspan="4">No</td></tr>
<tr><td rowspan="10">Inventory information (of principal user)</td><td>Structure types</td><td>No.</td><td>Structure types</td><td>No.</td><td>Structure types</td><td>No.</td></tr>
<tr><td>Bored tunnels</td><td>0</td><td>Locks and sluices</td><td>0</td><td>Weirs</td><td>0</td></tr>
<tr><td>Bridges</td><td>934</td><td>Retaining Walls</td><td>0</td><td>Quays</td><td>0</td></tr>
<tr><td>Culverts</td><td>845</td><td>Storm surge barriers</td><td>0</td><td>Piers</td><td>0</td></tr>
<tr><td>Cut and cover tunnels</td><td>0</td><td>Support structures</td><td>0</td><td></td><td></td></tr>
<tr><td>Galleries</td><td>0</td><td>Protection structures</td><td>0</td><td></td><td></td></tr>
<tr><td colspan="2">Archives</td><td colspan="4">description</td></tr>
<tr><td colspan="2">Construction data</td><td colspan="4">Reference to archives is included in the system.</td></tr>
<tr><td colspan="2">Inspection reports</td><td colspan="4">Inspection reports originally are archives.</td></tr>
<tr><td colspan="2">Intervention history</td><td colspan="4">Intervention is contained in uploaded reports.</td></tr>
</table>

	Name (version)	**Lat Brutus (3.1)**
Inspection information	**Data collection level**	**description**
	Element level	Visual inspections containing damage description are performed. Other information can be stored, e.g. test results, plans, photos.
	Structure level	Aggregated from element level.
	Assessment on element level	**description**
	Condition	Elements have a condition rating (1-4) based on visual inspection.
	Safety, vulnerability, risk	Elements have a safety rating (1-4) based on visual inspection.
	Load carrying capacity	Elements have a carrying capacity rating (1-4) based on visual inspection.
	Assessment on structure level	**description**
	Condition	Aggregated from all elements in a structure. Condition can be assigned by user.
	Safety	Although not standard. Safety risk aggregated from element level can be assigned by the user.
	Load carrying capacity	Although not standard. Risk of insufficient load carrying capacity can be assigned by the user.
	Additional	-
Intervention information	**Element level**	**description**
	Predefined standard	Standard interventions for reference strategies are predefined. They can be modified by the user.
	User defined/custom	User can define custom interventions.
	Intervention strategy	Reference strategies are available. They can be overruled by the user.
	Structure level	**description**
	User defined/custom	Composed by user from element level interventions.
	Predefined standard	No
	Intervention strategies	No
	Project level	**description**
	User defined/custom	Yes
	Predefined standard	No
	Intervention strategies	Composed by the user.
	Costs	**description**
	Inspection cost	No
	Intervention cost	Yes
	Traffic delay cost	No
	Indirect user cost	No
	Life-cycle costing	No
	Prioritization	**description**
	Performance measures	Interventions are characterized with risk level and optimal and ultimate intervention times.

	Name (version)	**Lat Brutus (3.1)**
Prediction information	**Aspect**	**description**
	Deterioration	No
	Improvement (e.g. repair, rehabilitation, reconstruction)	No
	Cost	No
	Planning time-frame	No
	Use	**description**
	For budget preparation	Yes
	For setting of performance standards	No
	For matching funding sources	Yes
	Additional	-
Operational information	**Data collection**	**data collecting group**
	Inventory	Manager (Latvian State Roads) can be assigned to engineering companies.
	Inspection/assessment	Inspectors from engineering companies.
	Intervention/planning	Manager (Latvian State Roads)
	Additional	-
	Quality assurance	**description**
	Education for inspectors	Training course at university developed with manager and university.
	Certification of inspectors	Personal certificate based on minimal requirements.
	Education for users	No
	Certification for users	Inspectors: personal certificate based on minimal requirements.
	Other …	User group (Latvian State Roads and engineers from private companies) discusses problems and solutions to improve quality.

14.11 Dutch bridge management system, DISK

Name (version)		**DISK**
Basic information	**Aspect**	**description**
	Owner (webpage)	Rijkswaterstaat (Dutch Ministry of Infrastructure and the Environment) (www.rijkswaterstaat.nl)
	Date implemented (current / first version)	2006 / 1985
	Developer(s) (webpage)	Rijkswaterstaat (www.rijkswaterstaat.nl)
	References, Manuals & Catalo gues	Users manual DISK 2006, Administration manual (on de mand available by helpdesk disk@rws.nl) in Dutch
	Users (Principal / Other)	Rijkswaterstaat (Dutch Ministry of Infrastructure and the Environment), National highways and water network / No ne
IT information	**Aspect**	**description**
	Platform	Microsoft SQL 2008
	Architecture	Client, Application Server, Database
	Data collection capabilities	Data is entered manually in a desk top computer
	Reporting capabilities	Reports, graphical and tabular
	Web access	Yes

Inventory information (of principal user)

Structure types	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
Bridges	4180	Locks and sluices	147	Quays	0
Culverts	650	Retaining Walls	20	Piers	0
Immersed tunnels	9	Storm surge barriers	4	Support structures	0
Cut and cover tunnel	6	Weirs	10	Protection structures	0
Bored tunnels	1	Galleries	0		

Information type	**description**
Construction data	Reference to archives is included in the system
Inspection reports	Most recent data life in system. Inspection reports are uploa ded (pdf)
Intervention history	Intervention history is contained in uploaded reports (histor y is not complete)
Location (e.g. 3D coordinate s are recorded)	X Y coordinates and road coordinates (road number, km-m) . GIS application is available.
Loading (e.g. maximum load carrying capacity is stored)	Design class from construction code is stored
Use (e.g. number of vehicles per day is stored)	No. Stored in Network Information System that communica tes with DISK

Inspection information	**Data collection level**	**description**
	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Visual inspections result in damage descriptions and are basis for conditions and risk assessment. Other information can be stored, e.g. test results, plans, photos
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Aggregated from element level (see next section)
	Assessment on element level	**description**
	Condition (physical)	Elements have a condition rating (0 - 6) based on visual inspection
	Load carrying capacity	Although not standard; risk of insufficient load carrying capacity can be assigned by user
	Safety (probability of failure)	Safety is treated as one of the risks, see next item
	Risk (probability and consequences of failure)	Risk (RAMS) assessed from damage. The risk level (1 – 5) is based on possible effects on functions of the structure
	Assessment on structure level	**description**
	Condition (physical)	Condition on element level is weighted with risk assigned and aggregated from all elements into a structure quality index. Automated computed value, can be overruled by user. This quality index is a mix of condition and risk
	Load carrying capacity	Although not standard; risk of insufficient load carrying capacity can be assigned by user
	Safety (probability of failure)	Although not standard; safety risk aggregated from element level can be assigned by the user
	Risk (probability and consequences of failure)	On structure level the quality index is a mix of condition and risk. See condition.
	Additional:	

Intervention information	Element level	description
	Predefined standard interventio ns (based on condition state or t ime)	Standard interventions for reference strategies are predefin ed. They can be modified by the user.
	User defined interventions (bas ed on condition state or time)	User can define custom interventions
	Structure level	**description**
	Predefined standard interventio ns (based on condition state or t ime)	Interventions on element level are presented on structure le vel in a maintenance plan with optimal and ultimate year of execution
	User defined interventions (bas ed on condition state or time)	Interventions on element level are presented on structure le vel in a maintenance plan with optimal and ultimate year of execution
	Multiple structures level	**description**
	Predefined standard interventio ns (based on condition state or t ime)	No, is treated in network planning system, together with ot her object classes, pavements, ITS and such.
	User defined interventions (bas ed on condition state or time)	No, is treated in network planning system
	Costs	**description**
	Inspection cost	No, except for special inspections
	Intervention cost	Yes
	Accident costs	No
	Traffic delay cost	No
	Indirect user costs	No

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Deterioration is not modeled in the system. Offline models a re available to correspond with information in the system
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Improvements, due to interventions, are not modeled in the system
	Optimal intervention strategies - Period of time analyzed - Cost types	Not in the system. Information from the system is used in off line analysis
	Work program - Period of time analyzed - Cost types - Budget constraints	- year+ 1 .. – year +10 (later years are in the system, but incomplete and not used for operational planning) - costs of interventions assigned on element level - budget constrains are treated in network planning system
Information Use	**Aspect**	**description**
	For budget preparation	Yes, costs are fed into the network planning system
	For setting of performance sta ndards (e.g. target average con dition states)	The structure quality index (see assessment inspection on str ucture level) is used as a KPI on network level.
	For matching funding sources	Not in the system. Matching funding sources is a feature of t he network planning system.
	For managing special (overwe ight) transports (e.g. granting permits to cross)	Basic information like design class and results of assessment s on capability for overweight transport is in the system. Ope rations for special transports are treated in another system us ing this information.
	Additional	

Operational information	**Data collection**	**data collecting group**
	Inventory	Owner (Rijkswaterstaat), can be assigned to engineering co mpanies
	Inspection/assessment	Inspectors from engineering companies
	Intervention/planning	No, is treated in network planning system
	Additional	The system contains a module for inspection planning
	Quality assurance	**description**
	Education for inspectors	One-day training for inspectors in use of the system
	Certification of inspectors	Personal certificate based on minimal requirements, ie comp letion of a proof inspection.
	Education for users	One-day training for other users (not inspectors) in use of th e system. Mandatory for granting access to the system.
	Certification for users	No, except for minimal requirements; see inspectors and use rs
	Audits	Audits are performed within surveillance process for inspect ion contracts
	Other	Two user groups exist; inspectors (from private companies) and other users (most Rijkswaterstaat). These groups discuss problems and solutions to improve quality.

14.12 Polish management system 1, SMOK

Name (version)		**SMOK (1997)**
Basic information	**Aspect**	**description**
	Owner (webpage)	PKP Polish Railway Lines S.A. (www.plk-sa.pl)
	Date implemented (current / first version)	1997, advanced version pilot implementation in 2001
	Developer(s) (webpage)	Wrocław University of Technology (www.pwr.wroc.pl)
	References, Manuals & Catalogues	Manuals: "Computer inventory of engineering structures", "Manual of bridge inspector" (in Polish)
	Users (Principal / Other)	PKP Polish Railway Lines S.A. / None
IT information	**Aspect**	**description**
	Platform	Microsoft Windows, database: MS Jet and proprietary
	Architecture	Clients at different levels of infrastructure administration, using an individual system of data exchange
	Data collection capabilities	Data is entered manually in a desk top computer
	Reporting capabilities	Reports, graphical and tabular (predefined and defined by users)
	Web access	No

Inventory information (of principal user)	**Structure types**	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
	Bored tunnels	26	Locks and sluices	0	Weirs	0
	Bridges	7902	Retaining Walls	771	Quays	0
	Culverts	24 189	Storm surge barriers	0	Piers	0
	Cut and cover tunnels	388	Support structures	0		
	Galleries	0	Protection structures	0		

Inventory information (of principal user)	**Information type**	**description**
	Construction data	Yes. Reference to archives is included in the system.
	Inspection reports	Direct input of inspection data to the system by bridge inspectors, reports are automatically generated.
	Intervention history	Direct input of intervention data to the system
	Location (e.g. 3D coordinates are recorded)	X Y coordinates and railway line coordinates (line number, km-m) as well as unique ID number of the structure
	Loading (e.g. maximum load carrying capacity is stored)	Design load class from construction code and current acceptable load class are stored in the system.
	Use (e.g. number of vehicles per day is stored)	No

Inspection information	Data collection level	description
	Element level (type of inspection method possible, e. g visual, non-destructive, destructive)	Inspection types: basic (visual), detailed (non-destructive), special (e.g. load tests, destructive tests). Identified types of defects, their intensity and extent are stored in the system data base. Other information can be stored, e. g. test results, plans, photos
	Structure level (type of inspection method possible, e. g visual, non-destructive, destructive)	Inspection types: current (visual), basic (visual), detailed (non-destructive), special (e. g. load tests, destructive tests). information are aggregated from element level.
	Assessment on element level	**description**
	Condition (physical)	Elements have a condition rating (0 - 5) based on visual inspection and test results. Condition assessment is supported by the expert system BEEF (Bridge Evaluation Expert Function).
	Load carrying capacity	Defined on structure level.
	Safety (probability of failure)	Partly included in the condition rating system.
	Risk (probability and consequences of failure)	No.
	Assessment on structure level	**description**
	Condition (physical)	Condition vector based on condition rating of main structure elements.
	Load carrying capacity	Can be based on individual calculations or on administrative decision.
	Safety (probability of failure)	Partly included in the condition rating system.
	Risk (probability and consequences of failure)	No.
	Additional:	No.

Intervention information	Element level	description
	Predefined standard interventions (based on condition state or time)	No.
	User defined interventions (based on condition state or time)	User can define custom interventions using the predefined list of maintenance and rehabilitation activities.
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	No.
	User defined interventions (based on condition state or time)	User can define custom interventions using the predefined list of maintenance and rehabilitation actions.
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	No.
	User defined interventions (based on condition state or time)	User can define custom interventions using the predefined list of maintenance and rehabilitation actions.
	Costs	**description**
	Inspection cost	No.
	Intervention cost	Yes. Costs of custom maintenance and rehabilitation actions are defined.
	Accident costs	No.
	Traffic delay cost	No.
	Environmental cost	No.
	Other cost	No.

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Deterioration is not modeled in the system.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Improvements, due to interventions, are not directly modeled in the system. Influence of the intervention is evaluated during inspection after completing the maintenance or rehabilitation action.
	Optimal intervention strategies - Period of time analyzed - Cost types	Ranking list based on structure condition is created by the system. Ranking rules can be defined by the user.
	Work program - Period of time analyzed - Cost types - Budget constraints	Work program for the next year is based on: - ranking list of the structures, - budget constrains.
Information Use	**Aspect**	**description**
	For budget preparation	Yes, costs are fed into network planning system.
	For setting of performance standards (e.g. target average condition states)	No.
	For matching funding sources	Not in the system. Information is used in offline analysis.
	For managing special (overweight) transports (e.g. granting permits to cross)	Not in the system. Information is used in offline analysis.
	Additional	No.

Operational information	**Data collection**	**data collecting group**
	Inventory	Network owner or inspectors from consulting companies.
	Inspection/assessment	Network owner or inspectors from consulting companies.
	Intervention/planning	Owner.
	Additional	No.
	Quality assurance	**description**
	Education for inspectors	Training course at Wrocław University of Technology developed in cooperation of owner and university. Mandatory for inspectors and other system users. Manuals.
	Certification of inspectors	Certification by network owner based on training courses results.
	Education for users	Post-graduate courses at Wroclaw University of Technology. Manuals.
	Certification for users	Inspectors: personal certificate for each type of inspection.
	Audits (to verify data entry and use)	Audits performed by Wrocław University of Technology or private consultants.
	Audits (to verify prediction capabilities of system)	Audits performed by Wrocław University of Technology or private consultants.
	Other …	No

14.13 Polish management system 2, SZOK

Name (version)		SZOK (20)
Basic information	**Aspect**	**description**
	Owner (webpage)	Universal Systems, Wroclaw
	Date implemented (current / first version)	2010 / 2001
	Developer(s) (webpage)	Universal Systems / Wrocław University of Technology (www.pwr.wroc.pl)
	References, Manuals & Catalogues	User Manual (in Polish).
	Users (Principal / Other)	Regional and local road administration, about 20 installations in Poland.
IT information	**Aspect**	**description**
	Platform	Microsoft Windows, and proprietary object-oriented database.
	Architecture	Desktop, local system.
	Data collection capabilities	Data is entered manually in a desk top computer.
	Reporting capabilities	Reports, graphical and tabular (predefined).
	Web access	No

Inventory information (of principal user)	Structure types	No.	Structure types	No.	Structure types	No.
	Bored tunnels	n/a	Locks and sluices	n/a	Weirs	n/a
	Bridges	n/a	Retaining Walls	n/a	Quays	n/a
	Culverts	n/a	Storm surge barriers	n/a	Piers	n/a
	Cut and cover tunnels	n/a	Support structures	n/a		
	Galleries	n/a	Protection structures	n/a		

Inventory information (of principal user)	Information type	description
	Construction data	Yes. Reference to archives is included in the system.
	Inspection reports	Direct input of inspection data to the system by bridge inspectors, reports are generated automatically on demand.
	Intervention history	No.
	Location (e.g. 3D coordinates are recorded)	X Y coordinates and road coordinates (road number, km-m) as well as unique ID number of the structure
	Loading (e.g. maximum load carrying capacity is stored)	Design class from construction code and current acceptable load class are stored in the system.
	Use (e.g. number of vehicles per day is stored)	No

Inspection information	Data collection level	description
	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Inspection types: basic (visual), detailed (non-destructive), special (e.g. load tests, destructive tests). Identified types of defects are stored in the system data base. Other information can be stored, e.g. test results, plans, photos
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Inspection types: current (visual), basic (visual), detailed (non-destructive), special (e.g. load tests, destructive tests). information are aggregated from element level.
	Assessment on element level	**description**
	Condition (physical)	Elements have a condition rating (0 - 5) based on visual inspection and test results.
	Load carrying capacity	Defined on structure level.
	Safety (probability of failure)	Partly included in the condition rating system
	Risk (probability and consequences of failure)	No.
	Assessment on structure level	**description**
	Condition (physical)	Structure condition assessment based on condition rating of main structure elements.
	Load carrying capacity	Can be based on individual calculations or on administrative decision.
	Safety (probability of failure)	Partly included in the condition rating system.
	Risk (probability and consequences of failure)	No.

Intervention information	Element level	description
	Predefined standard interventions (based on condition state or time)	No.
	User defined interventions (based on condition state or time)	User can define maintenance and rehabilitation activities.
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	No.
	User defined interventions (based on condition state or time)	User can define maintenance and rehabilitation activities.
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	No.
	User defined interventions (based on condition state or time)	User can define maintenance and rehabilitation activities.
	Costs	**description**
	Inspection cost	No.
	Intervention cost	No.
	Accident costs	No.
	Traffic delay cost	No.
	Environmental cost	No.
	Other cost	No.

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Deterioration is not modeled in the system.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Improvements, due to interventions, are not directly modeled in the system. Influence of the intervention is evaluated during inspection after completing the maintenance or rehabilitation action.
	Optimal intervention strategies - Period of time analyzed - Cost types	No.
	Work program - Period of time analyzed - Cost types - Budget constraints	No.
Information Use	**Aspect**	**description**
	For budget preparation	No.
	For setting of performance standards (e.g. target average condition states)	No.
	For matching funding sources	Not in the system. Information is used in offline analysis.
	For managing special (overweight) transports (e.g. granting permits to cross)	Not in the system. Information is used in offline analysis.
	Additional	No.

Operational information	**Data collection**	**data collecting group**
	Inventory	Network owner or inspectors from consulting companies.
	Inspection/assessment	Network owner or inspectors from consulting companies.
	Intervention/planning	Owner.
	Additional	No.
	Quality assurance	**description**
	Education for inspectors	Training course at Wrocław University of Technology developed in cooperation of owner and university. Mandatory for inspectors and other system users. Manuals.
	Certification of inspectors	Certification by network owner based on training courses results.
	Education for users	Post-graduate courses at Wroclaw University of Technology. Manuals.
	Certification for users	Inspectors: personal certificate for each type of inspection.
	Audits (to verify data entry and use)	No.
	Audits (to verify prediction capabilities of system)	No.
	Other …	No.
Additional	Comments	Number of structures included in the system depends on each individual installation (local road administration).

14.14 Spanish management system, SGP

Name (version)		**SGP 2.0**
Basic information	**Aspect**	**description**
	Owner (webpage)	Ministerio de Fomento http://www.fomento.es/MFOM/LANG_CASTELLANO/DIRECCIONES_GENERALES/CARRETERAS/
	Date implemented (current / first version)	2011 / 2005
	Developer(s) (webpage)	GEOCISA http://www.geocisa.com/sistemagestpuentes.html
	References and Manuals (available at - languages)	Inventory Manual, Maintenance Manual (Main Inspections and Basic Inspections), User Manual, Installation Manual
	Users (Principal / Other)	Ministerio de Fomento, Road Demarcations, Road Maintenance Areas.
IT information	**Aspect**	**description**
	Platform	Microsoft Visual FoxPro 7.0 – MapObjects 2.0 (GIS)
	Architecture	Client / Server Application. There is also a web version.
	Data collection capabilities	Data is entered manually in a desktop computer. there is a program that uploads data to the central database. You can also enter data directly into the database.
	Reporting capabilities	Alphanumeric and graphic reports.
	Web access	Yes, web access to the same data.

Inventory information (of principal user)

Structure types	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
Bridges	12337	Footbridges	593		
Large dimensions structures	1930	Pedestrian underpass	130		
Culverts	7390				
Pipes	2832				
Pontoon bridges	10637				

Information type	**description**
Construction data	The application allows the introduction of construction documents.
Inspection reports	The application allows the introduction of inspection reports.
Intervention history	The application allows the introduction of intervention documents.
Location	The application allows the introduction of geographic coordinates (UTMx and UTMy) and road coordinates (road number, km-m)
Loading	Maximum load carrying capacity is stored
Use	Number of vehicles per day and percentage of heavy vehicles

Inspection information	Data collection level	description
	Element level	Damage indexes, damage measurements, damage descriptions, plans, graphical information, …
	Structure level	Inspection data are used by a decision algorithm to generate a bridge state index (structure index).
	Assessment on element level	**description**
	Condition	Elements have an index (0 - 100) based on all their damages (element index). Each damage is evaluated by three factors (extension, intensity and evolution), there are a fixed criteria in order to avoid subjectivity. The inspector may change this index.
	Load carrying capacity	Load carrying capacity information is only available in inventory module.
	Safety, vulnerability, risk	Safety risk assessed from damage depends on the element index. There are criteria for the index ranges.
	Assessment on structure level	**description**
	Condition	Structure also has an index (0 – 100) based on all the structure damages. The application uses a decision algorithm. The inspector may change this index.
	Load carrying capacity	Load carrying capacity information is only available in inventory module.
	Safety, risk	Safety risk assessed from damage depends on structure index. There are criteria for the index ranges. Worst recommends urgent action.
	Additional	Principal inspections planning. It makes possible to follow the maintenance evolution of each structure using graphs.

Intervention information	Element level	description
	Predefined standard interventions (based on condition state or time)	There are repair recommendations catalogues in the dababase. Each damage has one or more repairs
	User defined interventions (based on condition state or time)	Inspector/user can change any information about the interventions.
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	Recommendations on structure level are the same as on element level, but the application prioritizes repairs according the elements state (damages state), for one structure or a set of structures.
	User defined interventions (based on condition state or time)	Inspector/user can change any information about the interventions.
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	The application prioritizes repairs according to the elements state (damages state) for a set of structures. Structures with higher index have higher priority. Optimization algorithms exist
	User defined interventions (based on condition state or time)	Inspector/user can change any information about the strategies.
	Costs	**description**
	Inspection cost	No
	Intervention cost	There are costs catalogues in the dababase. The application calculates repair budgets and cost forecast.
	Accident costs	No
	Traffic delay cost	Traffic delay cost can be included in database and used to calculate the final cost.
	Indirect user cost	See next section (Other costs)
	Other costs	Indirect user cost can be included in database and used to calculate the final cost, e.g. methods access (scaffolding, crane…)

	Aspect	description
Prediction information	Deterioration	No. Evolution models are not implemented.
	Effects of intervention / Improvement	No.
	Optimal intervention strategies	No.
	Work program	No.
Information Use	**Aspect**	**description**
	For budget preparation	The cost catalogues are used to prepare repair budgets. The application calculates the budget needed for repair (for each structure damage).
	For setting of performance standards	Information about condition states is used for setting of performance standards (periodic inspections are performed on all structures; repairs, instrumentations and special inspections are performed on worst state structures)
	For matching funding sources	Money from funding sources is introduced into the application and then, the repairs that can be done with this money available are calculated, based on the state conditions of the structures and their priority..
	For managing special (overweight) transports	Only the maximum load carrying capacity is stored. The application could calculate if a structure can bear the special transport only based on this parameter.
	Additional	---
Operational information	**Data collection**	**data collecting group**
	Inventory	The owner (Ministerio de Fomento) selects engineering companies.
	Inspection/assessment	Inspector of engineering companies.
	Intervention/planning	Rehabilitation and construction companies.
	Additional	---
	Quality assurance	**description**
	Education for inspectors	Through training courses.
	Certification of inspectors	Inspectors have to pass a test.
	Education for users	Through manuals.
	Certification for users	No.
	Other …	The developer company solves issues by phone and email. Also a web page has been developed, and it includes a technical forum to solve any queries regarding both methodological issues as well as software-related problems.

Additional		- GIS (GEOGRAPHYC INFORMATION SYSTEM) is included. - Photographs (.bmp,.jpg,...formats) AND drawings (.dwg, .dwf,... formats) can be shown. - Documents are opened automatically (.doc, .xls, .pdf,... formats) - Queries can be customize by the user - Statistical graphics - Special inspections module.

14.15 Bridge and Tunnel Management system, BaTMan

Name (version)		**BaTMan 4.2 (2011)**
Basic information	**Aspect**	**description**
	Owner (webpage)	Swedish Transport Administration (www.trafikverket.se and http://batman.vv.se)
	Date implemented (current / first version)	2011 / 1987
	Developer(s) (webpage)	Swedish Transport Administration (www.trafikverket.se)
	References, Manuals & Catalogues	Available in the system BaTMan [Bridge and Tunnel Management system] in Swedish (http://batman.vv.se)
	Users (Principal / Other)	Swedish Transport Administration, Swedish Association of Local Authorities (about 70 out of 290), City of Stockholm, Stockholm Transport, State-subsidized private Roads, Port of Gothenburg, Consultants and Contractors.

IT information	**Aspect**	**description**
	Platform	MS SQL 2008
	Architecture	Web client, Application server, Database
	Data collection capabilities	Data is entered manually in computers
	Reporting capabilities	Reports, graphical and tabular
	Web access	Yes

Inventory information (of principal user)	**Structure types**	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
	~~Bored~~ tunnels 1)	1090	Locks and sluices	-	Weirs	-
	Bridges 2)	33000	Retaining Walls	1700	Quays	370
	Culverts	-	Storm surge barriers	-	Piers	-
	Cut and cover tunnels	-	Support structures	-	Others 3)	4200
	Galleries	-	Protection structures	-		

	Information type	description
Inventory information	Construction data	In the system - Basic data, type of construction, material, length, elements, drawings etc. More data is available in physical archives as original drawings etc.
	Inspection reports	Inspection data is entered manually. Documents as photo, reports, drawings etc.
	Intervention history	In the system and in physical archives.
	Location (e.g. 3D coordinates are recorded)	Yes
	Loading (e.g. maximum load carrying capacity is stored)	Yes
	Use (e.g. number of vehicles per day is stored)	Yes

1) All tunnels, concrete, stone.

2) The BaTMan system covers bridges with a theoretic span length > 2,0 m.

3) Ferry berths, some culverts (theoretical span length ≤ 2,0 m), noise barriers etc.

Inspection information	**Data collection level**	**description**
	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Major inspections (maximum time interval of 6 years), principally visual, including some non-destructive testing. (Physical focus).
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Aggregated from element level. (Functional focus).
	Assessment on element level	**description**
	Condition (physical)	The inspections shall reveal the physical and functional condition of the structures and shall provide the basis for the planning and implementation of measures required to comply with the specified requirements in both the short and long term. Physical condition is described using the measurement variable defined for each method of measurement. Functional condition for the elements has a condition rating (0 - 3).
	Load carrying capacity	Principally not used on element level.
	Safety (probability of failure)	Principally not used on element level.
	Risk (probability and consequences of failure)	Principally not used on element level.
	Assessment on structure level	**description**
	Condition (physical)	See “element level”.
	Load carrying capacity	All structures have a load-bearing capacity classification for specified reference vehicles according to a national code.
	Safety (probability of failure)	General safety classes for all structures and individual safety index for some structures.
	Risk (probability and consequences of failure)	A management (inspection and planning) process also considering risks is under development.
	Additional:	

Intervention information	Element level	description
	Predefined standard interventions (based on condition state or time)	No.
	User defined interventions (based on condition state or time)	Yes. On the inspection occasion necessary remedial activities are proposed by the inspectors for existing defects.
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	No.
	User defined interventions (based on condition state or time)	(Object level). In conjunction with the inspections a socio-economic optimum intervention strategy is chosen for a structure. The strategy, considering both maintenance and improvements, is based on the proposed remedial activities for the elements, see above. In some cases also a second best strategy is described, applicable if the optimum strategy cannot be funded. The planning horizon for a strategy is the (remaining) functional life span of the road connection (LCC) to which the structure belongs.
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	No.
	User defined interventions (based on condition state or time)	(Network (stock) level). When working out yearly work plans within the short term planning sometimes also intervention strategies for combination of structures (bridges, pavements etc) are considered. These network optimum strategies are based on the object level strategies, see above. The aim is to reduce the total socio economic cost. System support for this is under development.
	Costs	**description**
	Inspection cost	Individually only for major structures.
	Intervention cost	Yes. Maintenance, improvements and replacements.
	Accident costs	No.
	Traffic delay cost	Yes. Time cost and vehicle operation cost.
	Environmental cost	No.
	Other cost	Costs for planning and design of interventions.

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Object level: No models. Strategic level: Simple models for the deterioration of some key performance indicators in the long term planning module.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Object level: Information of possible consequences for the functional performance of the structures if a chosen/proposed intervention strategy cannot be carried out. Strategic level: Simple models for the effects on some key performance indicators in the long term planning module.
	Optimal intervention strategies - Period of time analyzed - Cost types	Long-term planning based on, partly engineering intervention data (see above) from the object level planning for the first five years, partly simulation intervention data for the rest of the planning period, up to 20 years. • Maximum 20 years. • All (operation, maintenance, improvement and risk-reduction)
	Work program - Period of time analyzed - Cost types - Budget constraints	Short-term planning system module based on engineering intervention data (see above). • 3-5 years • All (operation, maintenance, improvement and risk-reduction) • Budget constraints are considered
Information Use	**Aspect**	**description**
	For budget preparation	Yes.
	For setting of performance standards (e.g. target average condition states)	Yes. In the strategic planning.
	For matching funding sources	Yes. Yearly adaptation to available funds with the help of a socio-economic prioritization system function.
	For managing special (overweight) transports (e.g. granting permits to cross)	Yes. BaTMan is a sub system to the administrative TRIX system for managing special transports.
	Additional	

Operational information	**Data collection**	**data collecting group**
	Inventory	Own staff (in general) and consultants
	Inspection/assessment	Inspections: Own staff and consultants (in general) Assessment/planning: Own staff (in general) and consultants
	Intervention/planning	Own staff (in general) and contractors
	Additional	
	Quality assurance	**description**
	Education for inspectors	Yes. Yearly training courses arranged by the Administration.
	Certification of inspectors	No. However, a demand of having passed the examination of the theoretical part of the training course.
	Education for users	Yes. Yearly training courses arranged by the Administration.
	Certification for users	No. However, a user authorization system.
	Audits (to verify data entry and use)	Yearly check-ups of the quality of important data and feed-back to the organization.
	Audits (to verify prediction capabilities of system)	No special audit.
	Other …	User group with representatives for all users (state, cities, municipalities, railroad owners etc.) for discussions on the management and development of the system.

14.16 Swiss bridge management system, KUBA

	Name (version)	**KUBA 5 (2011)**
Basic information	**Aspect**	**description**
	Owner (webpage)	Swiss Federal Roads Office – FEDRO
	Date implemented (current / first version)	2011 / 1989
	Developer(s) (webpage)	Concept and functional design: Swiss Federal Roads Office / Infrastructure Management Consultants LLC, Zurich www.imc-ch.com Coding: CAD Rechenzentrum AG, Allschwil www.cadrz.ch
	References, Manuals & Catalogues	User Manual (German, French, Italian), Administration and deployment manual (German only), Operation manual, Data Collection Guidelines (German, French, Italian), Inspection Manual (German, French), Technical catalogues (German, French, Italian) Available at: www.astra.admin.ch
	Users (Principal / Other)	Swiss Federal Roads Office, Almost all Swiss cantons, various cities and communities in Switzerland
IT information	**Aspect**	**description**
	Platform	Web client (not browser, self-installing Windows XP, Vista, 7 client; port 8000), :NET IIS Application server, Oracle or SQL Server Web Browser (IE, Firefox, Opera) for read-only Mobile Client: Window 7, SQL Server
	Architecture	Three tier architecture
	Data collection capabilities	Manually: Desktop, Mobile Client Mass Collection: XML and INTERLIS 2 interface
	Reporting capabilities	Ad-hoc reporting aided by data universe (similar to Data Objects) Combined GIS and alphanumeric ad hoc reporting Pre-prepared reports: Inventory, Inspection and performed interventions
	Web access	Yes, read only

<table>
<tr><td rowspan="14">Inventory information (of principal user)</td><td>Structure types[2]</td><td>No.</td><td>Structure types</td><td>No.</td><td>Structure types</td><td>No.</td></tr>
<tr><td>Bored tunnels</td><td>142</td><td>Locks and sluices</td><td>-</td><td>Weirs</td><td>-</td></tr>
<tr><td>Bridges</td><td>4127</td><td>Retaining Walls</td><td>1587</td><td>Quays</td><td>-</td></tr>
<tr><td>Culverts</td><td>1025</td><td>Storm surge barriers</td><td>-</td><td>Piers</td><td>-</td></tr>
<tr><td>Cut and cover tunnels</td><td>268</td><td>Support structures</td><td>60</td><td></td><td></td></tr>
<tr><td>Galleries</td><td>122</td><td>Protection structures</td><td>726</td><td></td><td></td></tr>
<tr><td colspan="2">Information type</td><td colspan="4">description</td></tr>
<tr><td colspan="2">Construction data</td><td colspan="4">The structure can be modeled as a hierarchical tree with arbitrary number of hierarchy levels. At each level data such as type, construction type, user materials, construction method, dimensions and quantity can be collected.</td></tr>
<tr><td colspan="2">Inspection reports</td><td colspan="4">Inspection data such as condition class, recommended intervention, extent of damage, individual damages can be collected at each hierarchy level.</td></tr>
<tr><td colspan="2">Intervention history</td><td colspan="4">Data on executed intervention such as intervention type, extent of intervention and costs can be collected at each hierarchy level.</td></tr>
<tr><td colspan="2">Location (e.g. 3D coordinates are recorded)</td><td colspan="4">Planar coordinates of a bridge middle point and of bridge outline (essentially a plygon) as well as linear coordinates (from – to) can be collected at each hierarchy level.</td></tr>
<tr><td colspan="2">Loading (e.g. maximum load carrying capacity is stored)</td><td colspan="4">The load model used for design or assessment can be stored as reference load model. Simplified structural system can be stored as well.</td></tr>
<tr><td colspan="2">Use (e.g. number of vehicles per day is stored)</td><td colspan="4">No. These data can be obtained from an appropriate application over web service.</td></tr>
</table>

[2] Only FEDRO; roughly the same number of structures are in cantonal databases.

Inspection information	**Data collection level**	**description**
	Element level (type of inspection method possible, e.g. visual, non-destructive, destructive)	Visual inspections with quantification of damage extent and damage description (based on catalogue), photos, damage plans etc. Some data from non-destructive methods (potential measurements) can be stored as well.
	Structure level (type of inspection method possible, e.g. visual, non-destructive, destructive)	Generally there is no difference between element level and structure level.
	Assessment on element level	**description**
	Condition (physical)	The condition rating (1-5) refers to physical condition.
	Load carrying capacity	A special mode allows the quick assessment of load carrying capacity for a given loading.
	Safety (probability of failure)	No. The concept is prepared at will be implemented in KUBA 5.2
	Risk (probability and consequences of failure)	See line above.
	Assessment on structure level	**description**
	Condition (physical)	No automatic calculation.
	Load carrying capacity	See former chapter.
	Safety (probability of failure)	See former chapter.
	Risk (probability and consequences of failure)	See former chapter.
	Additional:	Based on recent research the risk concept allows coupling between collected damage data and risk

Intervention information	**Element level**	**description**
	Predefined standard interventions (based on condition state or time)	Yes, based on condition state and damage process, not time.
	User defined interventions (based on condition state or time)	Yes, based on condition state and damage process, not time.
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	Yes, but rather general (Replacement, Rehabilitation, Repair etc.). However the system is meta data controlled so an owner can decide on his own on which hierarchy level which standard intervention would apply.
	User defined interventions (based on condition state or time)	See line above.
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	In general yes, since the application is meta data controlled.
	User defined interventions (based on condition state or time)	See line above.
	Costs	**description**
	Inspection cost	Inspection and assessment costs are not collected.
	Intervention cost	Yes
	Accident costs	No, not in KUBA but available from other system.
	Traffic delay cost	No, not in KUBA but available from other system.
	Environmental cost	No.
	Other cost	No

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Physical deterioration is modeled by Markov chains. No change in performance indicators is modeled.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Change in physical condition due to standard interventions is modeled. No change in performance indicators is modeled.
	Optimal intervention strategies - Period of time analyzed - Cost types	Optimal and minimal (only in condition state 5) intervention strategies are estimated by the system both for elements and structures. Analysis period of time for elements is infinite and for structures is reasonable to analyze a time period up to 25 years. The construction costs are considered on element level. On structure level user costs, setup costs, traffic control costs, design costs and assessment costs are considered.
	Work program - Period of time analyzed - Cost types - Budget constraints	Based on optimal element strategies application establishes a work program. The time horizon is infinite but it is reasonable to analyze up to 25 years. Construction costs, user costs, setup costs, traffic control costs, design costs and assessment costs are considered. Work program can be established for arbitrary budget constraints.
Information Use	**Aspect**	**description**
	For budget preparation	Yes.
	For setting of performance standards (e.g. target average condition states)	In current practice no, in theory possible
	For matching funding sources	No
	For managing special (overweight) transports (e.g. granting permits to cross)	Yes, granting crossing permits.
	Additional	

Operational information	Data collection	data collecting group
	Inventory	Owner but recently also private consultants
	Inspection/assessment	Mostly private consultants
	Intervention/planning	Mostly private consultants
	Additional	Structural data by private consultants, overweight transport data by owner.
	Quality assurance	**description**
	Education for inspectors	Yes.
	Certification of inspectors	No
	Education for users	Yes
	Certification for users	No
	Audits (to verify data entry and use)	Yes. Several audits have been already performed
	Audits (to verify prediction capabilities of system)	No.
	Other …	

14.17 Alabama bridge management system, ABMS

Name (version)			**ABMS**			
Basic information	**Aspect**		**description**			
	Owner (webpage)		Alabama Department of Transportation (www.dot.state.al.us)			
	Date implemented (current / first version)		1994			
	Developer(s) (webpage)		ALDOT(www.dot.state.al.us)			
	References and Manuals (available at - languages)		Bridge Inspection Manual and ABMS User Manual (http://www.dot.state.al.us/Docs/Bureaus/Maintenance/Bridge+Maintenance/Bridge+Inspection.htm)			
	Users (Principal / Other)		ALDOT, Counties and Cities			
IT information	**Aspect**		**description**			
	Platform		IBM Mainframe, ASP.Net			
	Architecture		DB2, CICS			
	Data collection capabilities		Data is entered manually using computer			
	Reporting capabilities		Standard reports, Access for adhoc reports			
	Web access		Web access is available to outside agencies to the mainframe through an Apache server			
Inventory information (of principal user)	**Structure types**	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
	Bored tunnels	2	Locks and sluices		Weirs	
	Bridges	9728	Retaining Walls		Quays	
	Culverts	6112	Storm surge barriers		Piers	
	Cut and cover tunnels		Support structures			
	Galleries		Protection structures			
	Archives		**description**			
	Construction data		Stored in Document Management System			
	Inspection reports		Stored in Bridge Management System (ABMS)			
	Intervention history		Stored in ABMS			

	Name (version)	ABMS
Inspection information	**Data collection level**	**description**
	Element level	Visual inspections are performed on a set of agency defined elements
	Structure level	Plans, photos, maintenance needed is stored by structure
	Assessment on element level	**description**
	Condition	Elements have a condition rating (1-9) based on visual inspection
	Safety, vulnerability, risk	Safety requirements are based on conditions. Posting recommendations begin for conditions of 4 or less
	Load carrying capacity	See above
	Assessment on structure level	**description**
	Condition	Based on condition from elements
	Safety	Same as element
	Load carrying capacity	Determined by structure analysis or by conditions as listed above
	Additional	
Intervention information	**Element level**	**description**
	Predefined standard	Standard interventions are predefined
	User defined/custom	Interventions can be user defined but not captured in system
	Intervention strategy	
	Structure level	**description**
	User defined/custom	No
	Predefined standard	Posting recommendation begin when conditions are 4 or less
	Intervention strategies	No
	Project level	**description**
	User defined/custom	No
	Predefined standard	No
	Intervention strategies	No
	Costs	**description**
	Inspection cost	Inspection costs stored by structure
	Intervention cost	The intervention performed is stored by structure
	Traffic delay cost	no
	Indirect user cost	no
	Life-cycle costing	No
	Prioritization	**description**
	Performance measures	

Name (version)		ABMS
Prediction information	**Aspect**	**description**
	Deterioration	No
	Improvement (e.g. repair, rehabilitation, reconstruction)	Repair needed is captured in the system for each structure
	Cost	Cost are estimated by activity and stored for each structure
	Planning time-frame	Planning for maintenance is yearly, replacement done on 5 year plan but later years are stored
	Use	**description**
	For budget preparation	Information is used for budget and project planning
	For setting of performance standards	no
	For matching funding sources	no
	Additional	
Operational information	**Data collection**	**data collecting group**
	Inventory	Owner
	Inspection/assessment	Owner – can be consultant
	Intervention/planning	Owner
	Additional	
	Quality assurance	**description**
	Education for inspectors	NHI 2-week Safety inspection of In-Service Bridges and ALDOT 2-day Annual Bridge Inspection Refresher Course
	Certification of inspectors	Minimum qualifications must be meet and must attend 2-day school at least every 2 years to keep certification
	Education for users	ALDOT 2-day Annual Bridge Inspection Refresher Course
	Certification for users	Must be certified to enter inspection data
	Other …	

14.18 AASHTO bridge management system, Pontis

Name (version)		**Pontis 5.1.2 (Client Server & Web Version)**
Basic information	**Aspect**	**description**
	Owner (webpage)	AASHTO, http://www.aashtoware.org InspectTech(contractor) http://www.inspecttech.com
	Date implemented (current / first version)	Pontis 5.1.2 – 2011
	Developer(s) (webpage)	http://pontis.inspecttech.com/
	References, Manuals & Catalogues	Technical Manual, Technical Notes, User Manuals, Installation Guides
	Users (Principal / Other)	46 Transportation Agencies in the US (Two International Licenses Italy)
IT information	**Aspect**	**description**
	Platform	WinXP SP3, Win7, Oracle(10g, 11g), SQL Server(2005, 2008)
	Architecture	Microsoft .Net 4.0
	Data collection capabilities	Bridge, Element, Inspection and Roadway levels. Open database architecture and GUI allows for full customization and Internationalization. Multimedia, photos, videos, reports
	Reporting capabilities	Crystal Reports
	Web access	Yes (Internet Explorer 8)

Inventory information (of principal user)	**Structure types**	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
	Bored tunnels	User defined	Locks and sluices	User defined	Weirs	User defined
	Bridges	User defined	Retaining Walls	User defined	Quays	User defined
	Culverts	User defined	Storm surge barriers	User defined	Piers	User defined
	Cut and cover tunnels	User defined	Support structures	User defined		
	Galleries	User defined	Protection structures	User defined		

	Information type	description
Inventory information	Construction data	Yes
	Inspection reports	Yes
	Intervention history	Yes
	Location (e.g. 3D coordinates are recorded)	Yes(Longitude, Latitude)
	Loading (e.g. maximum load carrying capacity is stored)	Yes
	Use (e.g. number of vehicles per day is stored)	Yes

Inspection information	Data collection level	description
	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Yes
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Yes
	Assessment on element level	**description**
	Condition (physical)	Yes
	Load carrying capacity	Yes
	Safety (probability of failure)	No (Planned 5.2)
	Risk (probability and consequences of failure)	No (Planned 5.2)
	Assessment on structure level	**description**
	Condition (physical)	Yes
	Load carrying capacity	Yes
	Safety (probability of failure)	Yes
	Risk (probability and consequences of failure)	Yes
	Additional:	-

Intervention information	**Element level**	**description**
	Predefined standard interventions (based on condition state or time)	Yes
	User defined interventions (based on condition state or time)	Yes
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	Yes
	User defined interventions (based on condition state or time)	Yes
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	Yes
	User defined interventions (based on condition state or time)	Yes
	Costs	**description**
	Inspection cost	No
	Intervention cost	Yes
	Accident costs	Yes
	Traffic delay cost	Yes
	Environmental cost	No
	Other cost	No

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Yes
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Yes
	Optimal intervention strategies - Period of time analyzed - Cost types	Yes
	Work program - Period of time analyzed - Cost types - Budget constraints	Yes
Information Use	**Aspect**	**description**
	For budget preparation	Yes
	For setting of performance standards (e.g. target average condition states)	Yes
	For matching funding sources	Yes
	For managing special (overweight) transports (e.g. granting permits to cross)	Yes
	Additional	-

Operational information	**Data collection**	**data collecting group**
	Inventory	Bridge Maintenance Engineers
	Inspection/assessment	Bridge Inspectors
	Intervention/planning	Bridge Maintenance Engineers
	Additional	Planners
	Quality assurance	**description**
	Education for inspectors	National Highway Institute (NHI) training, Annual Pontis User Group Training Meeting; Webinars
	Certification of inspectors	NHI
	Education for users	Annual Pontis User Group Training Meeting; Webinars
	Certification for users	No
	Audits (to verify data entry and use)	No
	Audits (to verify prediction capabilities of system)	No
	Other …	-
Additional		

14.19 Vietnamese *bridge management system, BRIDGEMAN*

<table>
<tr><td colspan="3">Name (version)</td><td colspan="4">BRIDGEMAN (before 2001), HDM-4(2001), ROSY (2001), and self-developed excel or access programs (however, the use is not national wide)</td></tr>
<tr><td rowspan="7">Basic information</td><td colspan="2">Aspect</td><td colspan="4">description</td></tr>
<tr><td colspan="2">Owner (webpage)</td><td colspan="4">MoT (Ministry of Transport)
http://www.mt.gov.vn/eDefault.aspx?tabid=8</td></tr>
<tr><td colspan="2">Date implemented
(current / first version)</td><td colspan="4">Software like BRIDGEMAN, HDM-3, ROSY were implemented in Vietnam before 2001, but after donors like World bank, ADB completed their projects. Those software were abandont. Most current program used under World bank funded project is HDM4. Some self-developed programs but only used as database system, not use for optimization</td></tr>
<tr><td colspan="2">Developer(s) (webpage)</td><td colspan="4">http://www.hdmglobal.com/</td></tr>
<tr><td colspan="2">References, Manuals & Catalogues</td><td colspan="4">http://www.hdmglobal.com/</td></tr>
<tr><td colspan="2">Users (Principal / Other)</td><td colspan="4">MoT, VRA (Vietnamese road administration), and their regional offices</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td rowspan="6">IT information</td><td colspan="2">Aspect</td><td colspan="4">description</td></tr>
<tr><td colspan="2">Platform</td><td colspan="4">Microsoft SQL 2000</td></tr>
<tr><td colspan="2">Architecture</td><td colspan="4">Database, Client</td></tr>
<tr><td colspan="2">Data collection capabilities</td><td colspan="4">Data is entered manually in a desk top PC, or imported from excel or access files collected from regional offices.</td></tr>
<tr><td colspan="2">Reporting capabilities</td><td colspan="4">Only function as database</td></tr>
<tr><td colspan="2">Web access</td><td colspan="4">No</td></tr>
<tr><td rowspan="6">Inventory information (of principal user)</td><td>Structure types</td><td>No.</td><td>Structure types</td><td>No.</td><td>Structure types</td><td>No.</td></tr>
<tr><td>Bored tunnels</td><td>NA</td><td>Locks and sluices</td><td>NA</td><td>Weirs</td><td>NA</td></tr>
<tr><td>Bridges</td><td>4239</td><td>Retaining Walls</td><td>NA</td><td>Quays</td><td>NA</td></tr>
<tr><td>Culverts</td><td>NA</td><td>Storm surge barriers</td><td>NA</td><td>Piers</td><td>NA</td></tr>
<tr><td>Cut and cover tunnels</td><td>NA</td><td>Support structures</td><td>NA</td><td></td><td></td></tr>
<tr><td>Galleries</td><td>NA</td><td>Protection structures</td><td>NA</td><td></td><td></td></tr>
</table>

Inventory information (of principal user)	Information type	description
	Construction data	Reference to archives is not included in the system
	Inspection reports	Inspection reports are not included, only aggregate data is entered
	Intervention history	Historical data is not completed and in low level, a detail of interventions on objects are not for all objects
	Location (e.g. 3D coordinates are recorded)	X Y coordinates and road coordinates (road ID, km-m)
	Loading (e.g. maximum load carrying capacity is stored)	Design class from construction code is stored (mostly for the new bridges), but design class for intervention is not sufficient for all intervention types, especially routine maintenance.
	Use (e.g. number of vehicles per day is stored)	Yes. Average annual traffic volume is stored, group of vehicle class (type, weight) is divided.

Inspection information	Data collection level	description
	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Monthly visual inspection is carried out and reported. If serious damage is found, additional visual inspection is required. However, its report is not included in the database of HDM-4 or other program, it is only recorded by excel, word, or access file.
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Monthly visual inspection is carried out and reported. If serious damage is found, additional visual inspection is required. However, its report is not included in the database of HDM-4 or other program, it is only recorded by excel, word, or access file.
	Assessment on element level	**description**
	Condition (physical)	There is a specification (standard) for inspection (22TCN 170-87), which is borrowed from Russian code book. It is a main indicator to define risk
	Load carrying capacity	There is a specification (standard) for inspection (22TCN 170-87), which is borrowed from Russian code book. It is a main indicator to define risk
	Safety (probability of failure)	No probability of failure is estimated. Attention to safety is paid only when and where necessary
	Risk (probability and consequences of failure)	No probability of failure is estimated. Attention to risk is paid only when and where necessary
	Assessment on structure level	**description**
	Condition (physical)	There is a specification (standard) for inspection (22TCN 170-87), which is borrowed from Russian code book. It is a main indicator to define risk
	Load carrying capacity	There is a specification (standard) for inspection (22TCN 170-87), which is borrowed from Russian code book. It is a main indicator to define risk
	Safety (probability of failure)	No probability of failure is estimated. Attention to safety is paid only when and where necessary
	Risk (probability and consequences of failure)	No probability of failure is estimated. Attention to risk is paid only when and where necessary
	Additional:	

	Element level	description
Intervention information	Predefined standard interventions (based on condition state or time)	No
	User defined interventions (based on condition state or time)	Yes,
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	No
	User defined interventions (based on condition state or time)	Yes
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	No
	User defined interventions (based on condition state or time)	Yes
	Costs	**description**
	Inspection cost	No
	Intervention cost	Yes, but not sufficient for all intervention types
	Accident costs	No
	Traffic delay cost	No
	Environmental cost	No
	Other cost	

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	No, HDM-4 only store the data, but not for predicting future condition of the bridge. It only predicts the pavement section by calibration given monitoring data. And the bridge is included in the database but it is only functioning as raw data.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	NO
	Optimal intervention strategies - Period of time analyzed - Cost types	No
	Work program - Period of time analyzed - Cost types - Budget constraints	No
Information Use	**Aspect**	**description**
	For budget preparation	No
	For setting of performance standards (e.g. target average condition states)	No
	For matching funding sources	No
	For managing special (overweight) transports (e.g. granting permits to cross)	No
	Additional	

Operational information	**Data collection**	**data collecting group**
	Inventory	No
	Inspection/assessment	No
	Intervention/planning	No
	Additional	
	Quality assurance	**description**
	Education for inspectors	Yes
	Certification of inspectors	Yes
	Education for users	Yes
	Certification for users	Yes
	Audits (to verify data entry and use)	Yes
	Audits (to verify prediction capabilities of system)	No
	Other …	
Additional		

14.20 Edmonton bridge management system, EBMS

Name (version)		**Edmonton BMS – EBMS (2011)**
Basic information	**Aspect**	**description**
	Owner (webpage)	http://www.edmonton.ca/transportation.aspx
	Date implemented (current / first version)	Current version Stantec BMS (2011)
	Developer(s) (webpage)	Stantec Consulting Ltd. (www.stantec.com)
	References, Manuals & Catalogues	Alberta BIM Inspection Manual http://www.transportation.alberta.ca/ Ontario Structure Inspection Manual (OSIM) http://www.mto.gov.on.ca/english/ (English)
	Users (Principal / Other)	City of Edmonton, Department of Transportation
IT information	**Aspect**	**description**
	Platform	Microsoft Access, Windows XP and Windows 7 64 bit. (Oracle and SQL Server optional)
	Architecture	Client / Server, Network database. Local check-out database for external users (inspection firms)
	Data collection capabilities	Desktop computer, laptop/tablet computers, optional handheld Smartphone BMS
	Reporting capabilities	Crystal Reports graphical, tabular. Also exports to MS Word and Excel
	Web access	Yes, optional.

Inventory information (of principal user)	**Structure types**	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
	Bored tunnels		Locks and sluices		Weirs	
	Bridges	352	Retaining Walls		Quays	
	Culverts		Storm surge barriers		Piers	
	Cut and cover tunnels		Support structures			
	Galleries		Protection structures			

Inventory information (of principal user)	**Information type**	**description**
	Construction data	Original construction contract cost information.
	Inspection reports	Stored in system, optional PDF stored. Final closed inspection can be locked.
	Intervention history	Historical maintenance, rehabilitation contract cost information.
	Location (e.g. 3D coordinates are recorded)	GIS X Y coordinates, linear referencing, and road km. Displayed in optional BMS Mapping module.
	Loading (e.g. maximum load carrying capacity is stored)	Design standard, load rating and calculation information, and legal axle loads
	Use (e.g. number of vehicles per day is stored)	Detailed traffic volume, truck %, and classification stored for each roadway on / under structure.

Inspection information	**Data collection level**	**description**
	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Detailed Visual Inspection of all bridge elements (condition state, severity and extent of defects). Inspection photos, plans, other documents also stored. Photo management system allows storage and retrieval of photos by element, defect type, severity etc.
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Live Load Capacity Rating, appraisal indices for seismic, fatigue, scour, flooding vulnerability stored and used in overall index. Functional improvement data stored (need for strengthening, widening etc.)
	Assessment on element level	**description**
	Condition (physical)	Five (5) condition states, defects identified and quantified by Detailed Visual Inspection to enable determination of repairs. Timing and criticality of repairs is recorded.
	Load carrying capacity	Detailed load carrying capacity calculations recorded for element shear, flexure, and torsion and compared to legal axle loads to determine need for strengthening. Benefits determined from traffic and truck axle distribution models.
	Safety (probability of failure)	Element level Performance Measures are recorded (e.g. load capacity, safety, barrier performance). Criticality and structural behavior of each element considered in risk analysis. Accident risk considered in functional improvement models.
	Risk (probability and consequences of failure)	Element risk determined considering element behavior, defect criticality. Also assessed by inspector and included in priority and timing of recommendations.
	Assessment on structure level	**description**
	Condition (physical)	Bridge Condition Index (BCI) out of 100, based on element level condition. Structure Urgency and Criticality Rating automatically calculated based on structural behavior, condition, criticality of defects, traffic etc.
	Load carrying capacity	Need for strengthening determined from element level load rating calculations. Benefits determined from traffic and truck axle distribution models.
	Safety (probability of failure)	Appraisal Rating for Barriers/Railings, Fatigue, Seismic, Scour, Flooding vulnerability.
	Risk (probability and consequences of failure)	Overall risk determined for each structure based on probability and consequences of failure. A network wide risk profile is produced automatically.

Intervention information	Element level	description
	Predefined standard interventions (based on condition state or time)	Default treatments for maintenance, repair, rehabilitation and replacement, including unit costs and effectiveness. Based on condition and lifecycle cost analysis.
	User defined interventions (based on condition state or time)	Unlimited user defined treatments for maintenance, repair, rehabilitation and replacement, including unit costs and effectiveness. Based on condition and lifecycle cost analysis.
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	Structure level projects consist of optimized element treatments. Recommended actions, timing and costs developed from Element Level and selected based on lifecycle cost analysis.
	User defined interventions (based on condition state or time)	Yes. User defined projects can be assembled easily. BMS determines costs and benefits based on lifecycle cost analysis. User can override BMS generated projects.
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	Feasible Projects from structure level (for all structure types) are compared at network level on the basis of benefit/cost ratio. Prioritized work program and costs developed to suit user specified budgets.
	User defined interventions (based on condition state or time)	Yes. Can override network priority list.
	Costs	**description**
	Inspection cost	Cost of inspections is not included.
	Intervention cost	Intervention costs are calculated by BMS at element level for specific treatments, and optimized into projects.
	Accident costs	Yes, in accident risk model for functional improvements (eg widening).
	Traffic delay cost	Yes, included in user defined project cost factors and in functional improvement models for widening and strengthening.
	Environmental cost	Yes, included in user defined project cost factors and in functional improvement models for widening and strengthening.
	Other cost	Functional Improvement costs (widening, strengthening)

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	For City unique 5 condition state inspection, default and User Defined Markovian deterioration models for each element/material type. Bridge condition index (BCI) forecasted using same deterioration models.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Improvements in element condition due to future intervention accounted for and then deteriorated using same deterioration models. Improvement in BCI also accounted for.
	Optimal intervention strategies - Period of time analyzed - Cost types	Optimal intervention strategies based on maximizing benefits, minimizing cost based on lifecycle costs. Lifecycle period is usually 50 – 75 years. Budget forecasting and project priority list is 10 year budgeting period.
	Work program - Period of time analyzed - Cost types - Budget constraints	Lifecycle analysis period is flexible, usually 50 – 75 years. Budget forecasting and project priority list is produced for 10 year period. Unlimited budget scenarios can be specified for maintenance, repair, rehabilitation and replacement work.
Information Use	**Aspect**	**description**
	For budget preparation	Yes. Optimized work programs are produced for total needs and any user defined budget scenario.
	For setting of performance standards (e.g. target average condition states)	Target Bridge Condition Index (BCI) can be specified for the Network Level. Budgets are determined to meet specified condition targets..
	For matching funding sources	Not in BMS. This is done separately.
	For managing special (overweight) transports (e.g. granting permits to cross)	Done in separate system.
	Additional	A feature in the Network Analysis enables budget setting for predefined City Districts, instead of the City total budget. Projects are prioritized to suit these budget constraints and distributed to the Districts accordingly, resulting in a different set of projects than calculated using a global City budget.

Operational information	**Data collection**	**data collecting group**
	Inventory	Owner and engineering consultants
	Inspection/assessment	Owner and engineering consultants. BMS prepares check-out/check-in database for selected structures to provide to consultants.
	Intervention/planning	Owner.
	Additional	Functional improvement projects are also generated based on benefits of removing weight restrictions or reduction accidents.
	Quality assurance	**description**
	Education for inspectors	Owner and engineering consultants
	Certification of inspectors	Owner and engineering consultants. BMS prepares check-out/check-in database for selected structures to provide to consultants.
	Education for users	Owner.
	Certification for users	Functional improvement projects are also generated based on benefits of removing weight restrictions or reduction accidents.
	Audits (to verify data entry and use)	Yes
	Audits (to verify prediction capabilities of system)	Yes
	Other …	
Additional	GIS Mapping Module	Optional mapping module for BMS displays inventory and condition data, as well as project timing and priorities on map.

14.21 Prince Edward Island bridge management system , PEI-BMS

	Name (version)	**PEI BMS (2011)**
Basic information	**Aspect**	**description**
	Owner (webpage)	http://www.gov.pe.ca/tir/index.php3?lang=E
	Date implemented (current / first version)	Current version Stantec BMS (2011) First version OBMS 2.2 (2006)
	Developer(s) (webpage)	Stantec Consulting Ltd. (www.stantec.com)
	References, Manuals & Catalogues	Ontario Structure Inspection Manual (OSIM) http://www.mto.gov.on.ca/english/ (English)
	Users (Principal / Other)	Prince Edward Island Dept. of Transportation and Infrastructure Renewal / Local engineering firms on inspection contracts

IT information	**Aspect**	**description**
	Platform	Microsoft Access, Windows XP and Windows 7 64 bit. (Oracle and SQL Server optional)
	Architecture	Client / Server, Network database. Local check-out database for external users (inspection firms)
	Data collection capabilities	Desktop computer, laptop/tablet computers, handheld Smartphone BMS
	Reporting capabilities	Crystal Reports graphical, tabular. Also exports to MS Word and Excel
	Web access	Yes, optional.

Inventory information (of principal user)	**Structure types**	**No.**	**Structure types**	**No.**	**Structure types**	**No.**
	Bored tunnels		Locks and sluices		Weirs	
	Bridges	800	Retaining Walls		Quays	
	Culverts	400	Storm surge barriers		Piers	
	Cut and cover tunnels		Support structures			
	Galleries		Protection structures			

Inventory information (of principal user)	**Information type**	**description**
	Construction data	Original construction contract cost information.
	Inspection reports	Stored in system, optional PDF stored. Final closed inspection can be locked.
	Intervention history	Historical maintenance, rehabilitation contract cost information.
	Location (e.g. 3D coordinates are recorded)	GIS X Y coordinates, linear referencing, and road km. Displayed in optional BMS Mapping module.
	Loading (e.g. maximum load carrying capacity is stored)	Design standard, load rating and calculation information, and legal axle loads
	Use (e.g. number of vehicles per day is stored)	Detailed traffic volume, truck %, and classification stored for each roadway on / under structure.

Inspection information	Data collection level	description
	Element level (type of inspection method possible, e.g visual, non-destructive, destructive)	Detailed Visual Inspection of all bridge elements (condition state, severity and extent of defects). Inspection photos, plans, other documents also stored. Photo management system allows storage and retrieval of photos by element, defect type, severity etc.
	Structure level (type of inspection method possible, e.g visual, non-destructive, destructive)	Live Load Capacity Rating, appraisal indices for seismic, fatigue, scour, flooding vulnerability stored and used in overall index. Functional improvement data stored (need for strengthening, widening etc.)
	Assessment on element level	**description**
	Condition (physical)	Four (4) condition states, defects identified and quantified by Detailed Visual Inspection to enable determination of repairs. Timing and criticality of repairs is recorded.
	Load carrying capacity	Detailed load carrying capacity calculations recorded for element shear, flexure, and torsion and compared to legal axle loads to determine need for strengthening. Benefits determined from traffic and truck axle distribution models.
	Safety (probability of failure)	Element level Performance Measures are recorded (e.g. load capacity, safety, barrier performance). Criticality and structural behavior of each element considered in risk analysis. Accident risk considered in functional improvement models.
	Risk (probability and consequences of failure)	Element risk determined considering element behavior, defect criticality. Also assessed by inspector and included in priority and timing of recommendations.
	Assessment on structure level	**description**
	Condition (physical)	Bridge Condition Index (BCI) out of 100, based on element level condition. Structure Urgency and Criticality Rating automatically calculated based on structural behavior, condition, criticality of defects, traffic etc.
	Load carrying capacity	Need for strengthening determined from element level load rating calculations. Benefits determined from traffic and truck axle distribution models.
	Safety (probability of failure)	Appraisal Rating for Barriers/Railings, Fatigue, Seismic, Scour, Flooding vulnerability.
	Risk (probability and consequences of failure)	Overall risk determined for each structure based on probability and consequences of failure. A network wide risk profile is produced automatically.
	Additional:	

	Element level	description
Intervention information	Predefined standard interventions (based on condition state or time)	Default treatments for maintenance, repair, rehabilitation and replacement, including unit costs and effectiveness. Based on condition and lifecycle cost analysis.
	User defined interventions (based on condition state or time)	Unlimited user defined treatments for maintenance, repair, rehabilitation and replacement, including unit costs and effectiveness. Based on condition and lifecycle cost analysis.
	Structure level	**description**
	Predefined standard interventions (based on condition state or time)	Structure level projects consist of optimized element treatments. Recommended actions, timing and costs developed from Element Level and selected based on lifecycle cost analysis.
	User defined interventions (based on condition state or time)	Yes. User defined projects can be assembled easily. BMS determines costs and benefits based on lifecycle cost analysis. User can override BMS generated projects.
	Multiple structures level	**description**
	Predefined standard interventions (based on condition state or time)	Feasible Projects from structure level (for all structure types) are compared at network level on the basis of benefit/cost ratio. Prioritized work program and costs developed to suit user specified budgets.
	User defined interventions (based on condition state or time)	Yes. Can override network priority list.
	Costs	**description**
	Inspection cost	Cost of inspections is not included.
	Intervention cost	Intervention costs are calculated by BMS at element level for specific treatments, and optimized into projects.
	Accident costs	Yes, in accident risk model for functional improvements (eg widening).
	Traffic delay cost	Yes, included in user defined project cost factors and in functional improvement models for widening and strengthening.
	Environmental cost	Yes, included in user defined project cost factors and in functional improvement models for widening and strengthening.
	Other cost	Functional Improvement costs (widening, strengthening)

	Aspect	description
Prediction information	Deterioration, i.e. change in - Physical condition - Performance indicators	Default and User Defined Markovian deterioration models for each element/material type. Bridge condition index (BCI) forecasted using same deterioration models.
	Effects of intervention/ Improvement, i.e. change following an intervention in - Physical condition - Performance indicators	Improvements in element condition due to future intervention accounted for and then deteriorated using same deterioration models. Improvement in BCI also accounted for.
	Optimal intervention strategies - Period of time analyzed - Cost types	Optimal intervention strategies based on maximizing benefits, minimizing cost based on lifecycle costs. Lifecycle period is usually 50 – 75 years. Budget forecasting and project priority list is 10 year budgeting period.
	Work program - Period of time analyzed - Cost types - Budget constraints	Lifecycle analysis period is flexible, usually 50 – 75 years. Budget forecasting and project priority list is produced for 10 year period. Unlimited budget scenarios can be specified for maintenance, repair, rehabilitation and replacement work.
Information Use	**Aspect**	**description**
	For budget preparation	Yes. Optimized work programs are produced for total needs and any user defined budget scenario.
	For setting of performance standards (e.g. target average condition states)	Target Bridge Condition Index (BCI) can be specified for the Network Level. Budgets are determined to meet specified condition targets..
	For matching funding sources	Not in BMS. This is done separately.
	For managing special (overweight) transports (e.g. granting permits to cross)	Done in separate system.
	Additional	A feature in the Network Analysis enables budget setting for predefined Districts, instead of the Provincial total budget. Projects are prioritized to suit these budget constraints and distributed to the Districts accordingly, resulting in a different set of projects than calculated using a global Provincial budget.

Operational information	**Data collection**	**data collecting group**
	Inventory	Owner and engineering consultants
	Inspection/assessment	Owner and engineering consultants. BMS prepares check-out/check-in database for selected structures to provide to consultants.
	Intervention/planning	Owner.
	Additional	Functional improvement projects are also generated based on benefits of removing weight restrictions or reduction accidents.
	Quality assurance	**description**
	Education for inspectors	Owner and engineering consultants
	Certification of inspectors	Owner and engineering consultants. BMS prepares check-out/check-in database for selected structures to provide to consultants.
	Education for users	Owner.
	Certification for users	Functional improvement projects are also generated based on benefits of removing weight restrictions or reduction accidents.
	Audits (to verify data entry and use)	Yes
	Audits (to verify prediction capabilities of system)	Yes
	Other …	
Additional	GIS Mapping Module	Optional mapping module for BMS displays inventory and condition data, as well as project timing and priorities on map.