

Conference of European Directors of Roads

Technical Report 2017/06 TG Asset Management final report 2017







This report was compiled by CEDR Task Group N2

Task group leader: Fabio Pasquali

With contributions from the following countries:

Margo Briessinck	Belgium	Agency for Roads and Traffic (Flanders region)
Jaan Ingermaa	Estonia	Estonian Road Administration
Thomas Kranz	Germany	BASt - Federal Highway Research Institute
Viktor Bardoczky	Hungary	KKK - Coordination Center for Transport Development
Geraldine Walsh	Ireland	TII - National Roads Authority of Ireland
Fabio Pasquali	Italy	ANAS - National Road Agency of Italy
Jenne van der		
Velde	Netherlands	RWS-Rijkswaterstaat – National Roads and Water Agency
Natalia Ostrach	Poland	Polish Road Administration
Darko Kokot	Slovenia	Slovenian National Building and Civil Engineering Institute
Gonzalo Arias		Dirección General de Carreteras - INES Ingenieros
Hofman (1)	Spain	Consultores
Luzia Seiler	Switzerland	Bundesamt für Strassen (ASTRA)
Jason Glasser	United Kingdom	Highways of England

(1) With the collaboration of Marta Pertierra Rodríguez

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LIST OF ABBREVIATIONS

Asset Management
Common Framework for a European Life Cycle based Asset
Management Approach for transport infrastructure networks, a CSA
funded by the EC through H2020 (MG8.4b)
Asset Management System
Azienda Nazionale Autostrade e Strade (the National Italian Road
Agency/Body)
Bundesamt für Strassen (the National Swiss Road Agency/Body)
Benchmarking of expenditures and practices of maintenance and operation
Conference of European Directors of Roads/Conférence Européenne
des Directeurs des Routes
Chief Financial Officer
Design Build Finance Manage
Direcciòn Nacional de Carreteras (the Spanish National Road
Agency/Body)
Direkcija Republike Slovenije za infrastrukturo (the Slovenian
Infrastructure Agency; National Road Agency/Body)
Decision Support System
Integrated Asset Management Information System
Image Qualité des Ouvrages d'Art
Image Qualité du Réseau National
International Roughness Index
Information technology
Intelligent transport systems
Key performance indicator
Life cycle cost
Life cycle cost analysis
Level of service
National Asset Management Plan
National Road Authority (or Administration)
Operation and Management
Programme Asset Management
Pavement Management System
Performance indicators
World Road Association
Public private partnership
Rijkswaterstaat (the National Dutch Water and Road Agency/Body)
Service Level Agreement
CEDR's second Strategic Plan (2009–2013)
CEDR's third Strategic Plan (2013–2017)
Task Group/Technical Group



1 THE ROAD TO THE CREATION OF AN ASSET MANAGEMENT SYSTEM

1.1 Introduction

This report reflects the findings of the CEDR Task Group on Asset Management within CEDR Strategic Plan 3 - 2013-2017 (SP3), aiming to provide a perspective on strengthening of cooperation and learning from road agencies in Europe within the asset management arena.

The conclusions represent the outcome of the steps taken in the investigations. The first step was to identify and characterize the current frameworks in use in order to show commonalities, variations and differences in approaches (chapter 2). The second step was to enrich these views with an inventory of contemporary research initiatives in the field of asset management (chapter 3). In the third step the building blocks from step one and two are used to build a maturity matrix as a framework to strengthen inter-organizational learning (chapter 4). This maturity matrix is tested and refined in case studies in the fourth step (chapter 5).

The aim of the Task group as described in the CEDR SP3 was:

- 1. To analyse how the life cycle costs (LCC) are defined, how they are reflected in the accounting system, and how they are allocated to the various stretches of the road network;
- 2. To analyse the data collected in order to recommend a set of common definitions, language and a common core system, based on a risk based approach, framed in a comprehensive and enlarged "Best practice guide";
- To identify the necessary steps to set up an LCC integrated system for CEDR NRAs and to widen the LCC system into a comprehensive Asset Management system (AMS)
- 4. To prepare a best practice guide for the implementation of an Asset Management system for road authorities, able to provide both theoretical and practical tools to improve the quality and efficiency of road infrastructure through the effective management of assets in accordance with risk analysis, user expectations and government requirements;
- 5. To follow the process of development and introduction of the ISO 55000 Asset Management System Standard and discuss the option for CEDR members and, if necessarily, steering into the right direction;
- 6. To assess the option of launching a new international study like BEXPRAC, based on performance management, i.e. study based on a homogeneous comparison between CEDR member countries.

The goal of the TG has been to combine all six outputs with the need to deliver guidance for the implementation of asset management in Road authorities. In a dynamic complex economic environment road authorities are faced with ever increasing maintenance commitments and decreasing funding envelopes. Such



exigencies have forced road authorities to rethink their management strategies towards achieving more for less. Over the past decade or so, the concept and practise of asset management has provided the platform for change.

The first three tasks were all related to life cycle costs. Since this inherently links to any asset management system (AMS) it has not been dealt with separately.

Finally in addressing the overall objectives this report gives an overview of several frameworks and proposes a maturity matrix based on a simplified framework with five dimensions:

- stakeholders
- people and organisation
- strategy and planning
- asset knowledge and information
- risk management

In delivering this report it should be noted that the group examined AM related research which has been done or is still undergoing in order to provide a comprehensive outcome.

2. OVERVIEW OF THE EXISTING FRAMEWORKS

Clearly when considering the elements of the guidance document, reference must be made to the existing frameworks that exist for asset management. Too often guidance for asset management has focussed upon the "how to do", one time transformation programme as opposed to looking at the broader picture of embracing changes, adopting practises and principles and a process of continuous improvement.



Figure 2.1 "The Big Picture" - The Journey of Asset Management

This concept is very well captured by a tool (including an infographic) entitled "The Big Picture, the Journey of Asset management"¹ by the Institute of Asset Management. It describes the organisational journey to embracing effective asset

¹ The Big Picture, The Journey of Asset Management, The Institute of asset management. <u>https://theiam.org/knowledge/Big-Picture</u>, 2014



management, describing the behaviours of an organisation through improving levels of asset management maturity.

2.1 PAS 55:2008

PAS 55:2008 was first issued in 2004, then substantially updated in 2008, and became recognised as the international benchmark for optimal management of assets. It is published in two parts:

- Part 1: Specification for the optimized management of physical assets
- Part 2: Guidelines for the application of PAS55-1

In setting out its requirements 5 key assets are ascribed to asset management: Physical, Information, Intangible, Financial and Human. All have a critical interdependence however the focus of PAS is on the physical assets and the life cycle management of those assets in order for an organisation to achieve and realise best value for money. This is represented as illustrated in Figure 2.2 of PAS 55² (see next page) which reflects the "plan, do, check, act" methodology that underpins asset management.

² PAS55:2014-1:2014. Specification for the optimized management of physical assets





Figure 2.2 PAS55 Conceptual Model

As indicated earlier the physical assets form the key component of the system and the system is predicated on how those assets are:

- 1) Performing and monitored,
- 2) Acquired, utilized and disposed,
- 3) Controlled and enabled and aligned with not only the organizational values, functions and standards but also with asset management policy, strategy and objectives which ultimately feed into the organizational strategic plan.

Stakeholders needs, expectations, legal and environmental constraints guide the content of that strategic plan but for successful asset management, this plan must ultimately align with the management of its assets.

2.2 ISO 55000:2014 Series

The ISO 55000:2014 series for Asset Management was introduced in 2014 and comprises of 3 parts:



- ISO 55000: 2014 Asset Management Overview, Principles and Terminology
- ISO 55001: 2014 Asset management –Management systems Requirements
- ISO 55002: 2014 Asset management Management systems-Guidelines for the application of ISO 55001

The documents set out the requirements together with information and guidance for establishing, implementing, maintaining or improving asset management systems and asset management for organizations. It sets out the requirements for the 7 asset management dimensions as illustrated in Figure 2.3. These dimensions reflect the key fundamentals of asset management: Value, Alignment, Leadership and Assurance.



Figure 2.3 - The ISO55000 7 elements of Asset Management

Of key note however is the emphasis on dimensions which reflect asset management and management of the internal organization as opposed to asset management systems and the assets themselves. This represents a shift from PAS 55 where physical assets form the key consideration as they relate to and link with the overall organisational strategy. It also reflects the definition and very clear distinction set out within ISO 55000 between asset management and asset management systems. The distinction is noted in ISO 55000 as:



- Asset management system Set of interrelated or interacting elements to establish asset management policy, asset management objectives and processes to achieve those objectives
- Asset management Co-ordinated activity of an organization to realize the value from assets

Not all elements of asset management such as leadership, staff morale, and culture can be formalised through an asset management system and must therefore be managed by the organisation as distinct from the system. What is clear however is that the asset portfolio, the asset management system, and asset management within the organisation, must all be clearly interrelated and interlinked in order to realize value from the assets and for the organisation to meet its own and stakeholders' needs.

2.3 Rijkswaterstaat Maturity Matrix Model

Initial approaches to asset management can quite readily focus upon the systems and standards rather than the development of the overall strategic direction encompassing asset management policy, objectives and leadership. As an organisation matures in terms of its asset management implementation however it is important to understand the relationship between the systems, standards and the overall corporate policy and the overall alignment of one with the other. To facilitate this understanding and concept of asset management systems within the overall sphere of asset management, maturity models can be used. These models can be used to assist organisations in linking the strategic processes and goals with tactical and operational objectives. The level of maturity indicates the degree to which asset management is embedded in the organisation.

In 2011 and 2012 the Dutch Rijkswaterstaat applied the Infrastructure management maturity matrix to their organisation in order to assess the level of embedment of asset management. The matrix is based upon five maturity levels and seven asset management domains. This model was developed specifically for Rijkswaterstaat and their implementation strategy for asset management. Compared with other maturity models it has a stronger focus on organisational communication³ and is depicted in Figure 2.4.

³ "Asset Management Maturity in Public Infrastructure: the case of Rijkswaterstaat"





Figure 2.4 - Infrastructure Management Maturity Matrix for Rijkswaterstaat

2.4 AASHTO Transportation Asset Management Guide

2.4.1 Introduction

The Transportation Research Board's (TRB's) National Cooperative Highway Research Program (NCHRP) has issued a publication "AASHTO Transportation Asset Management Guide A Focus on Implementation" (TAM Guide)⁴. TAM Guide aims to help transportation agencies address strategic questions they confront in managing the surface transportation system.

2.4.2 A business model

The TAM Guide proclaims to be a business model which addresses five core questions:

• What is the current state of my assets?

⁴ AASHTO Transportation Asset Management Guide: A Focus on Implementation, 1st Edition, January 2011



- What are my required levels of service and performance delivery?
- Which assets are critical to sustained performance delivery?
- What are my best investment strategies for operations, maintenance, replacements and improvement?
- What is my best long-term funding strategy?

In general, this guide can be used as a modular, resource document; as a sequence of implementation steps; and for knowledge transfer and bridging the gaps.

The Guide starts with the definition according to the AASHTO's Subcommittee on Asset Management:

"Transportation Asset Management is a strategic and systematic process of operating, maintaining, upgrading and expanding physical assets effectively throughout their lifecycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision making based upon quality information and well-defined objectives."4

2.4.3 TAM implementation

There are 14 steps to implementation of TAM which are addressed and explored by the Guide (see Figure 2.5). The Guide is divided into two parts of which part 1 addresses first 8 steps, whereas part 2 addresses the last 6 steps.

Steps 10 to 14 describe the supporting tools, systems, and data needed which support implementation of TAM (steps 1 to 9). The Guide recognizes that although the sequence is presented, in practice, the steps will overlap or could occur simultaneously. This is of a particular note for step 9, the TAM Plan, which may be initiated early in the implementation process and be progressively improved and updated over time.



Chapter 2: Set the direction	Chapter 3: Align the organization	Chapter 4: Develop the TAMP	 Chapters 58: Processes, tools, systems
1 Set agency goals and objectives	4 Develop the change strategy	9 TAMP: Transportation Asset Management	10 Service Planning
2 Self-assessment and gap analysis	5 Integrate TAM Into agency culture	Pian	11 Life cycle management
3 Define scope of TAM in the approv	6 Integrate TAM into		TAM Integration
	Establish asset		13 systems
	management roles		14 and management
	8 Performance mgmt standards		

Figure 2.5 – Steps to implementation of Transportation Asset Management4

2.4.4 Self assessment and gap analysis

The second step to implementation is to assess the current status or maturity level of TAM and determine the actions that need to be taken to achieve TAM improvements. There are four key parts of this assessment which include4:

- Strategic self assessment this is done by using the tool, described in the Guide, to get a picture of where the agency is at present.
- TAM maturity model this concept is used to specify the relative position of the agency for each TAM process.
- TAM gap analysis this tool uses the maturity model as its scale.
- Identify appropriate TAM practice gives suggestions to consider when deciding what TAM practices to focus on.

In this self assessment phase a maturity scale was introduced. It is not intended to define if an Authority is "good" or "bad" but it is rather used to describe levels of TAM achievement in a way that allows an agency to locate its current position and to help it determine the next steps it should take. The Maturity scale can be seen from the following Figure 2.6.

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CAM Maturity Scale Level	Generalized Description
Initial	No effective support from strategy, processes, or tools. There can be tack of motivation to improve.
Awakening	Recognition of a need and basic data collection. There is often reliance on heroic effort of individuals.
Structured	Shared understanding, motivation, and coordination. Development of processes and tools.
Proficient	Expectations and accountability drawn from asset management strategy, processes, and tools.
Best Practice	Asset management strategies, processes, and tools are routinely evaluated and improved.

Figure 2.6 – TAM Maturity scale4

The TAM gap analysis process helps to identify the areas, deviating from the desired level of maturity, with a view to improving them in order to achieve the desired advancement in maturity.

The total TAM process embeds transportation asset management in the business planning of an organisation as illustrated in Figure 2.7



Figure 2.7 – Asset management drivers and relationships4

2.5 Asset Management Maturity Scale and Guidance

The IAM Asset Management Maturity Guide⁵ helps to define, scale and recognise the maturity of an organization with regard to its asset management. To this aim

⁵ Asset Management Maturity Scale and Guidance, the Institute of Asset Management, 2015



it contains the material developed in several studies and implemented in BSI PAS55 and ISO55001 standards.

The IAM maturity scale ranges from the Innocence to Excellence levels, and can be used by organisations to identify their strengths and areas of improvement, for benchmarking, for demonstrating competency or excellence to stakeholders, but it is also helpful when establishing processes and habits of continual improvement. Possibility of improvement and the organization maturity in asset management lies in processes of coordination, integrations, optimizations and alignments of multiple activities and in combining their effects.

The maturity scale developed presents attributes organization might expect in 39 subject areas, structured into 6 areas as shown in Fig 2.8, the "Asset Management Landscape".





Figure 2.8 – The Asset management landscape - 39 subject areas of IAM Maturity Guide5

With developing a maturity scale, IAM has addressed both:

- The maturity of the management system,
- The maturity of an organisation's asset management.

The scale itself contains 6 maturity levels which correspond to the range between 0 and 5:



- Innocent (scale 0),
- Aware (scale 1),
- Developing (scale 2),
- Competent (scale 3),
- Optimizing (scale 4),
- Excellent (scale 5).

Four of these maturity levels are easy to be perceived and can represent criteria for completion or adequacy, while two of them (Developing and Excellent) are more transitional in nature and can be treated as criteria or evidence of development in progress. Achieving the level 3 or "Competent" state is equivalent to comply with ISP55001.

The levels of maturity or an organisation's progress are also shown in the 'bow tie' illustration, developed by the IAM (Figure 2.9). An organisation begins implementing asset management with a process of alignment and integration, this state converges to the central state or a level of competence (good practice); continuing the process organisations expand their maturity and necessarily diverge in defining their further target levels of 'best appropriate practice'.



Figure 2.9 – Bow-tie illustration of the IAM Maturity Scale5

2.6 CEDR Asset Management Task Group – Phase 1 (2011-12)

CEDR included Asset Management in its SP2 - Second Strategic Plan 2009/13. This has been the activity of the then Task Group 3, concerning the "Investigation on the application of LCC principles and the relation to their accounting systems



among some selected NRAs" (hereinafter related to as the Investigation). At the end of its activities, the TG has released its Final report, later published on CEDR website.

Based on the previous CEDR report BEXPRAC (...), the report, completed in 2013, provided an in-depth analysis of the different criteria used by the participating NRAs for:

- i. Classifying their assets,
- ii. Building up an AM comprehensive approach, and
- iii. Setting a common grounding for LCC calculation and analysis.

The study has been based both on the analysis of the relevant existing literature on this issue and on the study of the experience in dealing with an integrated AM approach of seven NRAs (related to France, Italy, the Netherlands, Slovenia, Spain, Switzerland and UK). Three out of the above mentioned NRAs have shown a clearly advanced level in designing and implementing a system-based AM approach (the Netherlands, Switzerland and UK), whereas the other four have presented a more heterogeneous situation. In this situation some components are already in place at different levels of development, but there is no complete integration of all the system components.

After the combined examination of the wide literature on AM in the road environment and the situation of the seven NRAs that provided an in-depth information basis on the issue, the final report of the *Investigation* has brought to a set of activities and steps necessary to set up a comprehensive and integrated AM approach. The steps have been identified for the two cases that reflect the situation within CEDR: road agencies with a high degree of development of the system – i.e. a formal approach to AM, based on milestones and specific aims and activities - and NRAs with some components in place but no clear policy decision towards the creation of a complete AM system.

The final conclusions of the report suggest a number of 18 components/steps for the case of NRAs that have not yet started a long term plan of implementation of the AM system (see chart below).

STEP	COMPONENT
1	Create an asset inventory by identifying all relevant assets for road stretches: objects, components, and related standard maintenance costs (<i>this activity</i> doesn't apply to Group 2 NRAs, where an asset inventory has already been implemented, but it can be considered an initial step for other NRAs that are at the start of the AM/LCC development process within the organisation).



STEP	COMPONENT
2	Assess the state of all road elements/objects in a cyclical way, based on automated means.
3	Identify and monitor levels of service provided by the road network that have been developed with the shareholder.
4	Identify the safety needs of the road network.
5	Attribute past maintenance expenditures to road stretches through a specific IT system.
6	Over time, aggregate and provide a breakdown of costs for specific road components and elements within specific road stretches (particularly within large contracts that include different road works) through a common coding and classification.
7	Implement comprehensive accounting processes and IT tools in order to trace and update periodically the current expenditures by single objects and components of specific road stretches.
8	Evaluate technical and operational risks based, among other things, on a what-if analysis with probabilistic valuations.
9	Define the technical life-span of each component/work category.
10	Improve integration between technical and accounting IT systems using a common database linking asset inventory and asset expenditures.
11	Calculate life cycle cost expenditures relating to the technical life cycle of components/elements within road stretches.
12	Plan future expenditures for road stretches on the basis of past expenditures and projections stemming from infrastructure life cycle, taking into account the expected levels of service agreed with the shareholder.
13	Apply LCC analysis to new infrastructure already in the design phase in order to improve the planning of future maintenance expenditures.
14	Provide detailed information and data to financial departments by defining the timing of cash needs (also in relation to potential imbalances within the forecasted period).
15	Take into consideration and estimate the overall value of network assets based on a combination of historical costs data and gross replacements costs (brownfield-based) in case no historical data is available.





STEP	COMPONENT
16	Enhance the calculation of investment ratios based on overall asset value , which can over the years provide a framework for each specific asset and enable comparisons between different NRAs.
17	Identify potential increases/decreases in the overall asset value as a result of NRAs' policies.
18	Enhance budget negotiations with the shareholder thanks to a detailed assessment of the status of asset's value.

The final conclusions of the report related to NRAs where the process of implementation is well advanced identify 7 components/steps for improving the AM system (see chart below).

STEP	COMPONENT
A	Over time, aggregate and provide a breakdown of costs for specific road components and elements within specific road stretches (particularly within large contracts that include different road works) through a common coding and classification.
В	Implement comprehensive accounting processes and IT tools in order to trace and periodically update current expenditures by single objects and components of specific road stretches, periodically updated.
С	Improve integration between technical and accounting IT systems using a common database linking asset inventory and asset expenditures.
D	Take into consideration and estimate the overall value of network assets based on a combination of historical costs data and gross replacements
	costs (brownfield-based) in case no historical data is available.
E	costs (brownfield-based) in case no historical data is available. Enhance the calculation of investment ratios based on overall asset value , which can over the years provide a framework for each specific asset and enable comparisons between different NRAs.
F	 costs (brownfield-based) in case no historical data is available. Enhance the calculation of investment ratios based on overall asset value, which can over the years provide a framework for each specific asset and enable comparisons between different NRAs. Identify potential increases/decreases in the overall asset value as a result of NRAs' policies.



The picture supplied by the *Investigation* suggests a sequence of steps, for the two levels of maturity of a NRA. The same sequence can be seen from Figure 2.10.



Figure 2.10 – LCC / AM Core System in the CEDR 2013 report scheme

Figure 2.11 describes the differences in the state of the art of the CEDR NRAs which were more involved in the research.





Figure 2.11 – LCC / AM State of the art in the CEDR 2013 report scheme



3. THE STATE OF THE ART OF THE RESEARCH IN THE FIELD OF ASSET MANAGEMENT APPLIED TO ROAD TRANSPORTATION

Since 2006, NRA's have agreed to share their road research priorities and open up their research budgets. They have organised transnational research calls for research projects that effectively target NRA needs. The coordination of the research calls was funded under EU Framework Programmes: FP6 from 2006 to 2009 for Eranet Road, FP7 from 2009 to 2011 for Eranet Road II. The NRA's provided the funding for the projects. Since 2012 the joint research calls are organised under CEDR.

Several joint calls had AM related research projects, in particular:

- ENR2 call 2010: Effective asset management meeting future challenges 7 projects: SABARIS, EXPECT, HEROAD, SBAKPI, EVITA, ASCAM, PROCROSS
- ENR2 call 2011: Rapid and durable maintenance methods and techniques
 3 AM related projects: InteMat4PMS, MOBI-ROMA, Toolbox (+ Pothole, RecyPMA, STARs)
- CEDR call 2013: Ageing infrastructure management 2 AM related projects: X-ARA, RE-GEN (+ HI-SPEQ)
- CEDR call 2014: Asset management and maintenance 4 AM related projects: PREMiUM, ARISE, ISABELA, best4road (+ DRAT)
- CEDR call 2015: Asset information using BIM 1 project: INTERLINK
- Horizon 2020: AM4INFRA

The ARISE project finished in October 2016. Its final research report has been published by CEDR as Contractor Report 2017-01 "Implementation Guide for an ISO 55001 Management System" and is available on the CEDR website. The report offers guidance and advice to road organisations for establishing a formal AMS based on the ISO 55001 standard that will help organisations to obtain value from their assets.

3.1 ENR2 call 2010: Effective asset management meeting future challenges

The research focussed on the development of efficient management tools using a holistic approach covering all components of the road network (pavement, bridges, tunnels, gantries, signs, lighting systems, etc) and encompassing the whole service life "from cradle to grave" in order to maximise the potential benefits



of these important national assets. The programme was based on the following four objectives:

- Objective A: Meeting stakeholders' requirements and expectations,
- Objective B: Understanding asset performance,
- Objective C: Development of suitable Key Performance Indicators (KPIs) for the future,
- Objective D: Framework for optimised asset management.

Two research projects were selected for each of the objectives A, C and D, while only one project was selected under objective B. After the projects were finished a "Technical Report" and a "Social Benefit Report" were written to give a summary of the different projects and to highlight synergies between the projects. Following the final symposium in Copenhagen in May 2013 a "Supplementary Report on the case studies" was published. These three reports, as well as the project deliverables, are available on <u>https://sites.google.com/site/assetcall/</u>.

SABARIS (objective A)

Stakeholder Benefits and Road Intervention Strategies

The project covered the issue of definition of stakeholders and the measurement of their 'satisfaction' with road maintenance. The approach was very much project-focussed and SABARIS focussed on how directly-affected stakeholders in a scheme can be engaged before, during and after the scheme takes place.

Two case studies were chosen reflecting different scenarios:

- The A20 urban ring road in Rotterdam, Netherlands,
- The E17 inter-urban motorway between Ghent and Kortrijk in Belgium.

EXPECT (objective A)

Stakeholder Expectations and Perceptions of the future Road Transport System

The project has developed an innovative methodology of 'accompanied journeys' for assessing stakeholder perceptions and requirements in association with focus groups, which has been tested in a real environment. Stakeholders were representative of different categories of road user: car drivers, cyclists, motorcyclists, HGV drivers, bus drivers, disabled people and pedestrians.



The project also developed some tools to work alongside the methodology. These took the form of the multi-criteria analysis model, and a mobile device app (for data gathering on the journeys).

The final report is available on the website http://eranet-expect.brrc.be/.

HEROAD (objective B)

Holistic Evaluation of Road Assessment

The project carried out extensive desk study and research of common and best practice, and identified new challenges and technologies that might be brought to bear when considering a holistic approach. The project had a strong emphasis on data collection, and reported on issues concerning data quality. The HEROAD reports represent comprehensive summaries of current practice as well as aspirations for administrations moving towards a new holistic approach.

SBAKPI (objective C)

Strategic Benchmarking and Key Performance Indicators

The project developed ten strategic, network-level KPI's on a wide range of factors:

- Noise,
- Air quality,
- Water quality,
- Waste/natural resources,
- Climate change,
- Biodiversity,
- Stakeholder satisfaction,
- Safety,
- Development,
- Travel.

EVITA (objective C)

Environmental Indicators for the Total Road Infrastructure Asset

The project developed detailed, technical environmental KPI's (E-KPI's) in four domains



- Noise,
- Air pollution (including emissions of CO₂ from vehicles),
- Water pollution,
- Natural resources (including lifecycle CO₂ emissions arising from construction and maintenance activities).

For every E-KPI a common scale to describe performance has been adopted. This dimensionless index is on a scale from 0 (very good) to 5 (very poor).

The "Practical Guide for the use of e-KPIs in pavement management practice" is available on the website <u>http://e-kpi.fehrl.org/</u>.

ASCAM (objective D)

Asset Service Condition Assessment Methodology

The project focussed on End User Service Levels (EUSL's):

- Safety,
- Traffic delay/network availability,
- Risk,
- Cost,
- Noise.

To model unpredictable risks the Monte Carlo simulation was chosen. Three types of asset class were considered in the ASCAM model: pavements, structures and road equipment. The most tangible output from the ASCAM project is the demonstrator software.

PROCROSS (objective D)

Development of procedures for cross-asset management optimisation

The project addressed the challenge of how to optimise all maintenance activities across different sub-assets, to deliver the expectations and requirements of all stakeholders. The proof-of-concept model made use of some existing software tools and brought together data related to example sub-assets such as pavements, bridges, tunnels and noise barriers. A cost-benefit model was applied as the optimisation tool, in an iterative process, under a range of budget constraints.



3.2 ENR2 call 2011: Rapid and durable maintenance methods and techniques

The research programme aimed to promote new methods and techniques of road maintenance, which could meet the increasing needs of rapid and durable repair and improvement of road infrastructure. The programme was based on the following three objectives:

- Objective A: Safely optimising road network availability during maintenance,
- Objective B: Durable construction and maintenance methods,
- Objective C: Strategies for reducing maintenance costs.

One AM related research project was selected under objective B and two projects under objective C.

MOBI-ROMA (objective B)

Mobile Observation Methods for Road Maintenance Assessments

The project studied the road surface condition monitoring using data coming from vehicle's internal sensors through the CAN-bus, or simple devices mounted on the vehicle. Similar techniques with suitable sensors can be used also for assessing strength of road bed or need for winter maintenance. The three main data types used in the MOBI-ROMA pilot, which were collected using the floating car data methodology, were:

- Spring thaw detection,
- Winter road conditions,
- Pavement quality estimation.

InteMat4PMS (objective C)

Integration of material-science based performance models into life-cycle analysis processed in the frame of pavement management systems

The project presented an advanced analysis procedure that is able to significantly improve performance prediction modelling for asphalt road pavements. The key innovation is the consideration of material and structural pavement properties in pavement performance prediction in the frame of PMS. The needed information is obtained from material testing in the laboratory and from structural performance modelling.



Toolbox (objective C)

The project developed a concept for proper maintenance planning to assure the selection of adequate maintenance works to make effective use of the maintenance budget, based on available road condition data, to give minimal negative effects on road users, safety for road workers and the environment. The outcome was

- An optimization tool to identify maintenance candidates,
- An optimization tool that suggests practical section lengths

3.3 CEDR call 2013: Ageing infrastructure management

The aim of this research programme was to help road administrations develop a suitable technical and commercial governance structure for the future management of ageing infrastructure. The research will be used to develop a better understanding of future liabilities, maintenance costs, and the application of new technology driven condition assessment of road assets in a consistent manner. The programme was based on the following three themes:

- Understanding risk factors in managing ageing infrastructure,
- Common cost breakdown framework for road assets,
- High speed non-destructive condition assessment of road pavements and interacting assets.

X-ARA

Cross-Asset-Risk-Assessment

The main objective of the project is the development of a comprehensive risk assessment framework including a set of guidelines and a practical software tool (X-ARA risk tool) for the network level assessment of asset risks and impacts. The model takes into account high-level external variable factors affecting the different assets in an ageing road infrastructure, such as climate change, asset performance, funding/politics, demand (traffic), macro-economic and social factors.

RE-GEN

Risk Assessment of Ageing Infrastructure



The project provides road owners/managers with best practice tools and methodologies for risk assessment of critical infrastructure elements, such as bridges, retaining structures and steep embankments. Risk is being assessed considering not only the probability of failure of an element/network but also based upon the consequences of that failure.

3.4 CEDR call 2014: Asset management and maintenance

The aim of this research programme is to do research on Asset Management and Maintenance, building on the outcome of earlier research calls, in particular "Effective Asset Management meeting Future Challenges" (ENR call 2010). There are two themes, with three respectively two research projects:

Theme A: Road Asset Management

- Objective A: Road equipment asset management,
- Objective B: Why and how to implement ISO 55000,
- Objective C: Social benefits and costs.

Theme B: Road Maintenance

- Objective D: Use of standard ravelling tests to predict pavement durability,
- Objective E: Recommendations for maintenance procurement by investigating current practices.

For each objective of Theme A one research project was selected. One selected research project under Theme B is also AM related.

PREMIUM (objective A)

Practical Road Equipment Measurement Understanding and Management

The project aims to deliver improvements in the ability to manage road equipment by addressing the four key elements:

- Understanding the asset,
- Monitoring the asset,
- Evaluating condition,
- Management of the asset.

PREMiUM will consider the following assets:

- Road markings,
- Road signs,

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- Vehicle restraint systems,
- Noise barriers.

ARISE (objective B)

Application to Roads of ISO 55000 using Exemplars

The project will give clear and practical guidance on 'Why and How to implement ISO55000'. In that sense, this project does not create innovative techniques, but rather delivers good practice guidelines for road organisations founded specifically on the new ISO 55000 standard. An Asset Management System comprises the whole end-to-end process of asset management, defined in ISO55000 as including

- Context of the organisation,
- Leadership,
- Planning,
- Support,
- Operation,
- Performance evaluation,
- Improvement.

ARISE will identify some of the early adopters of ISO 55000 to take part in case studies.

ISABELA (objective C)

Integration of social aspects and benefits into life-cycle asset management

The project aims to define a holistic asset management framework for social key performance indicators (S-KPIs) and social benefit modelling in form of social effects (monetary and non-monetary), social backlog and social risk. The S-KPI's take into account are:

- Availability and disturbance (travel time, vehicle operating costs, etc.),
- Road safety (fatal and severe accidents related to asset condition),
- Environment (noise, air pollution, natural resources, etc.),
- Socio-economy (asset value, wider social effects, etc.).

best4road (objective E)



Best Practice Guidelines for Procurement of Road Maintenance

The project develops a best practice guidelines and tools for the efficient procurement of road maintenance in a changing world. Based on a comprehensive and integrative framework for maintenance procurement, the project brings together the extensive, but yet scattered procurement knowledge and experiences at NRA's in 11 countries (including the US and Australia).

3.5 CEDR call 2015: Asset information using BIM

The aim of this research programme is to improve interoperability within the European NRAs and its stakeholders by embedding the use of Building Information Management (BIM) based on open standards in their Asset Management and Construction processes. The specific objectives of the research are:

- To identify the needs among Europe's NRAs and its major stakeholders regarding the exchange of Building Information in a vendor-neutral way during the life cycle of assets.
- To identify what national building/asset information knowledge can be used for implementation on a European level and for further development.

This Call has the following four objectives:

- Objective A: Exploration of procuring asset information for better projects and Asset Management Systems,
- Objective B: Exploration of BIM data structures,
- Objective C: Design for common principles for a European object-type library,
- Objective D: Design and test a basic European object-type library and open BIM standards.

One project was selected for all objectives.

INTERLINK (objective A, B, C and D)

INformation managemenT for European Roads using LINKed data

The project provides an open, scalable, future-proof, basic European Road Object-Type Library (OTL) using the cutting-edge capabilities of Linked Data that meets the business needs of the NRAs and their supply chain. This OTL will be thoroughly tested via three trial cases. The project builds the launch of this European Road OTL initiative upon three pillars:



- The Technical Specification of the European Road OTL and the connections with existing BIM standards,
- The design of a Standardisation Body and a plan for its development beyond this project,
- Acceptance in Practice by the industry through engagement and dissemination.

3.6 Horizon 2020: AM4INFRA

The AM4INFRA project has been granted by the EC under the H2020 programme (H2020-MG-8.4 B – Smart Governance, Network Resilience and Streamlined Delivery of Infrastructure Innovation).

Four CEDR members are direct beneficiaries in the AM4INFRA project:

- 1. RWS Rijkswaterstaat Ministry of Infrastructure and the Environment The Netherlands
- 2. HE Highways England United Kingdom
- 3. ANAS Italian National Road Authority Italy
- 4. TII Transport Infrastructures Ireland Ireland

Building on their, best practices and contemporary experiences with the development and application of asset management in their networks' governance they aim to deliver a common European framework approach for transport infrastructure asset management that enables consistent and coherent cross-asset, cross-modal and cross-border decision making. The project refers to several past and current development actions on asset management, such as the CEDR trans-national Calls of 2010, 2011, 2012, 2014 and 2015.

The overall concept comprises 3 major elements: *common language, common data and data management*, and *common approach* represented as three separate cogwheels (see figure 3.1).

Common language. The stakeholders (asset owners, asset managers and service providers set in the context of end-users of the networks) will be provided with a common set of principles, definitions and key performance indicators (e.g. on reliability, availability, maintainability, safety and resilience) in order to support them in their efforts to optimize their transport networks across the assets, across the modes and across the borders. The common language enables them to communicate, learn and coordinate consistently and maximize effectiveness and efficiency of investments and related decision making. The common language provides guidance to determine fit for purpose strategic policy goals, network service level agreements and asset performance levels.



- **Common data and data management.** The stakeholders (owners, managers and service providers) will be provided with meaningful standards for cross-European information management (which data, how to use it, and how to translate it into the required information). It enables them to derive to a European information management model supporting their tasks to be executed interoperable across modes and across borders.
- **Common approach.** The stakeholders (owners, managers and service providers) will be provided with meaningful criteria and models to quantify performance, risk and life cycle cost building on a coherent set of common methodologies to balance life cycle performance, risk and cost on network and asset level. This in turn will enable them to manage their complex network systems under changing demands and requirements.

Together these three elements form the (flexible) **common framework** that can be implemented by the National Infrastructure Authorities (NIAs) in their chosen actions. In order to support the **Roll out** of the common framework in the NIAs organizations, replication, dissemination and communication activities will be unfold.



Figure 3.1 – AM4INFRA – The project scheme

The innovations proposed by AM4INFRA are:

 To provide National Infrastructure Agencies (NIAs) with insight to how asset management practices would support the development of network management strategy, adoption of decision making processes, operational requirements and how asset knowledge can be utilized;



- To provide NIAs with a common, practical framework for a life cycle and risk based Asset Management approach capable of governance on the highest aggregation level of (cross-modal) network considerations;
- To enable NIAs in acquiring meaningful data and sharing knowledge and good practices to achieve "learning by doing" and continuous improvement of the operations
- To connect NIAs of different transport modes in terms of AM systems, methodologies, practices, in order to ease a comprehensive multi-modal management of mobility needs and expectations;
- To provide NIAs the means for replication and wider roll-out of the developed solutions, which is crucial to create impact beyond this project.

AM4INFRA started on 1 September, 2016 and will end on 31 August, 2018.



4. THE APPROACH OF THE SP3 - N2 WORKING GROUP

4.1 Background

In the CEDR strategic plan there are six key expected outputs for the SP3 – N2 "Life Cycle Cost – Asset Management" Task Group:

- 1. For all NRAs (CEDR members), to identify the steps for setting up a comprehensive LCC-AM approach;
- 2. For more advanced NRAs (CEDR members) on this process, an updating of contributions, solutions, technologies, etc.;
- 3. For less advanced NRAs (CEDR members) on this process, a clear set of guidelines, based on best practices and state of the art;
- 4. For all NRAs (CEDR members), some concrete applications of practices and procedures, through the carrying on of road surveys extended to road sections managed by the TG members;
- 5. Un updating of ISO processes and procedures applied to the AM process;
- 6. A clear link with activities on AM carried out by international organizations, academia, etc.

The goal of the TG has been to combine all six outputs with the need to deliver guidance for the implementation of asset management in Road authorities. In a dynamic complex economic environment road authorities are faced with ever increasing maintenance commitments and decreasing funding envelopes. Such exigencies have forced road authorities to rethink their management strategies towards achieving more for less. Over the past decade or so, the concept and practise of asset management has provided the platform for change.

PAS 552 introduced in 2004 pioneered strategic thinking, rational decision making, life-cycle costing and overall policy making with regard to an authority' assets. Early emphasis was on the more traditional assets such as pavements and bridges but the agenda has now changed to focus upon the ancillary road assets such as signage, signalization, delineation, ITS, vehicle restraint systems etc, which together with pavements and bridges, constitute the road infrastructure asset. Road agencies vary in their approach to asset management as does indeed the level of maturity of asset management within the respective agencies. The early pioneers who embraced PAS 552 may fundamentally be further along in their asset management philosophy and practises than those that are currently starting out and this is key point which needs to be borne in mind. The "best practise" guidance document will need to reflect the varying levels of asset management maturity that exist within Road Authorities. The key deliverable will be such that regardless of the level of penetration of asset management within


any Road Authority this document can be used to guide and mentor to the next level.

In considering that task at hand it was initially appropriate for the group to consider the title of the document. It was felt that the use of the words "best practice" were inappropriate. To use such a reference could indicate that there is perhaps only one best practise in implementing asset management. This is not the case. Road Authorities vary in their approaches in the management of their networks and hence best practise for any organisation may not necessarily suit that of another. With this in mind the group decided it was more appropriate to draft a guidance document entitled "Asset Management – key considerations for implementation".

4.2 The CEDR TG N2 Asset Management Model and Maturity Matrix

4.2.1 Introduction to the proposed approach

From an examination of these existing frameworks, an evolution was apparent from the original PAS 55 with a key focus upon the asset set and asset knowledge to the current ISO 55000 which embraces and emphasises the wider values and concepts of asset management within the 7 element framework. These concepts also underpin the Infrastructure maturity matrix model as applied in the Rijkswaterstaat coupled with additional maturity parameters providing a measure or benchmark of asset management within any organization.

Building upon this knowledge the Task Group identified 5 main domains which they considered embraced the implementation of asset management:

- Asset Knowledge and Information,
- Strategy and planning,
- People and organisation,
- Stakeholders and customers (including market approach and procurement strategies),
- Risk.

The relation between these five dimensions is shown in the following chart (Figure 4.1, based on IAM's asset management model of PAS 55)⁶.

⁶ See "Asset management – an anatomy" version 1.1", The Institute of Asset Management, February 2012





Figure 4.1 - The approach of the N2 Task Group: the 5 elements of asset management

A fully operational asset management system should cover all these dimensions, even though it is fair to say that not every NRA may approach it in the same formal manner. Each of these elements is interlinked and bears an important influence of the implementation of asset management within any organisation. A pictorial representation of asset management incorporating the 5 elements is outlined in Fig 4.2 below.





Figure 4.2 - The approach of the N2 Task Group: interaction of the 5 elements of asset management

In order to understand the application and maturity of asset management for each organisation within the working group, a set of questions was developed for each of these 5 key elements. Elements of PAS 55, ISO 55000 and the maturity matrix were taken into account in working up the questionnaire as presented in Appendix 1. The results of the questionnaire as completed by each organisation subsequently form the basis of the discussion for the remaining chapters of this report.

4.2.2 Description of the domains of the proposed asset management model

Domain 1 – Asset information and knowledge

The basis of asset management is data and information about the assets that are managed. All NRA's started with collecting asset data and some have been doing this for 20 years or more.

Assets can be grouped into the following categories:

• pavements,



- structures (bridges, tunnels, earthworks, ...),
- road equipment (safety barriers, drainage, noise barriers, road signs, road markings, lighting, roadside equipment, ...).

Pavements and structures have a long history of data collection, while road equipment is only recently been getting the attention it deserves⁷. The data collected consists of inventory and condition data. Depending on the asset type the inventory data consists of the location of the asset, date of construction, investment cost, type, geometrical data, material data and components.

asset	type	geometry	material	components
pavement		width	asphalt	foundation
		thickness	concrete	
		number of lanes	composite	
			gravel	
bridge	beam bridge	span	concrete	bridge deck
	arch bridge	width	steel	abutments
	cable stayed	height	stone	bearings
	suspended		composite	joints
	viaduct			foundations
				wing walls
tunnel		length		
		width		
		height		
safety barriers			concrete	
			steel	
noise barriers	reflective	length	concrete	panels
	absorbing	height	aluminium	columns
			synthetic (plastic)	
			green	
road signs	regulatory (traffic	size		illumination
	direction			pole
	information			portal
road markings	continuous	width	paint	
	broken line		thermoplastic	
roadside	VMS			
equipment	CCTV			
	traffic counters]		
	weather station	1		

Table 4.1 - Examples of inventory data

The condition data is collected regularly, usually every 1 to 3 years for pavements and road equipment, up to 6 years for structures.

For pavements the condition data mostly consists of surface characteristics: skid resistance, longitudinal evenness (roughness), transversal evenness (rutting), surface distresses (cracking, potholes, ravelling ...), (macro) texture, tyre/road

⁷ The CEDR joint research call 2014 on "Asset management and maintenance" has a research objective about road equipment, called PREMiUM



noise, etc. These properties are usually collected with vehicles that can measure at traffic speed⁸. The bearing capacity of a road structure can be measured with a falling weight deflectometer, which is a time-consuming survey. However traffic speed deflectometers will become more common.

The condition of structures is usually determined by (visual) inspections. Road equipment is also surveyed visually. For some assets, more quantitative methods are available, such as the retroreflectivity of road signs and road markings or the acoustic performance of noise barriers. The inventory and condition data can take up a lot of data, so they are usually managed in a (relational) database. To visualise the data, a GIS tool can be used. When the inventory and condition data is combined with other information, it becomes asset knowledge. The knowledge of an asset can be expanded with the historical maintenance and their cost. For pavements different evolution models are used to predict the future condition of the road in a pavement management system (PMS).

Assets' data and information are the basis of Asset Management, and therefore, its collection, register and monitoring are of crucial importance. The task group has grouped NRA's asset into two main categories: 1. main assets, which include pavements and structures and in most NRAs there is a long history of data collection for them; and 2. ancillary assets, which include secondary road elements. In this latter case, the data collection tends to be more limited in nature both in terms of the extent and type of data collection. Progressively however and owing to improved technologies there is an increasing focus upon the collection of data for these ancillary assets. Optimum asset management demands that data and condition parameters must be established and collected for the entire asset within the road corridor. This approach was identified by the Australian Road Research board in its report: "a generic framework for the management of road related assets where assets and their associated management must be considered in terms of their criticality. Figure 4.5 illustrates the variety of assets within the road corridor which must be considered.

⁸ More information on this issue con be found in "State of the art in monitoring road condition and road/vehicle interaction", PIARC report, 2015.





Figure 4.3 - Assets within the road corridor 9

Domain 2 - Strategy and planning

This domain is related to the long-term approach of the organization and includes a set of strategic statements that describe the current status and objectives for the assets, asset management activities and capabilities; the current and future levels of service (LoS) the organisation aims to deliver; the criticality, risk, prioritization and decision making criteria; and the strategies for enablers (human factors, asset information and risk management). The effective management of all assets relies on good asset management processes and practises to be fully embedded in all parts of the organisation and indeed its supply chain.

Asset knowledge is the basis for decision making regarding maintenance planning and the development of maintenance strategies. Given a set of activities, procedures and techniques to collect and classify asset data, the strategic domain refers to the way those data are used in order to transform single data into a complex system in which the whole road asset can be broken down into components, needs and decisions.

The domain has been organised in the questionnaire by identifying the maintaining strategies (short and medium versus long term decisions and assessment, investment phase analysis versus life cycle cost, etc.) and the

⁹ A generic framework for the management of road related assets, ARRB, APOR447-13, December 2013



criteria for cost assessment. Furthermore, the way benefits associated to investment decisions and/or maintenance policies are measured is also stressed: a comprehensive system of comparison of expected benefits and estimated costs allows to plan the activities of the NRA in the best way vis-à-vis the Government and the various stakeholders. An appropriate set of KPIs, Key Performance Indicators, makes it possible the monitoring of the data and the extraction from them of the relevant information for the decision process.

The definition of the Levels of Service is part of this exercise; it is the key point both for the definition of the strategy and the setting of the plans at the different time horizons.

Domain 3 - People and organisation

ISO 55000 states that: 'An Asset Management system is used to direct, coordinate and control Asset Management activities. It provides improved risk control and assures the achievement of Asset Management objectives on a consistent basis. However, not all Asset Management activities can be formalised through an Asset Management system; for example, aspects such as leadership, culture, motivation, etc are not managed through the Asset Management system, but they can have a significant influence on the achievement of Asset Management objectives^{'10}. A clear distinction is therefore made between the asset management system within the organisation and asset management for the organisation.

Through work undertaken by the Institute of Asset Management there is now a broader definition for the Asset management landscape¹¹ which further supports the important contribution of the role of both people and the organisational structure to Asset management. This landscape is underpinned by a maturity matrix which comprises of 39 subject areas and six levels which reflect the maturity of both the asset management system and asset management itself. Most notably it includes a number of key considerations on both the organisation and people enablers. Aspects such as procurement and supply chain management, asset management leadership, organisational structure and culture and competence management are defined as key enablers on the path to mature and competent asset management.

The role of both people and the organizational structure in the agency's path to a competent and mature asset management is embraced within in this domain. It includes a number of considerations related to the organization and people enablers, including aspects such as leadership, culture and competence

¹⁰ ISO55001:2014 Asset management –Management Systems Guidelines

¹¹ Asset management Maturity Scale and Guidance; The Institute of asset management, Ver 1.0, June 2015



management which have a great impact on the extent to which Asset Management is adopted and implemented in a NRA.

The aspects introduced in the matrix deal with organization (engagement at all levels, alignment of strategic goals with organizational objectives), motivation (awareness of the overall design of the AM system, control over a wide part the whole process by the people implied in the system), training (acquisition of general and specific tools according to the different stages development of the system).

Domain 4 – Stakeholders and customers

Road infrastructure and transport stakeholders¹² include Stakeholder, as per definition in ISO55000, "a person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity", i.e. not only the road users and the road owners, but also people living nearby the road network and all bodies which ultimately are influenced by it. Their needs and expectations have to be considered when creating, acquiring, operating, maintaining and improving transport assets.

"Stakeholders" is a dimension that influences objectives of an organization that manages transport assets and which needs to be considered when establishing, implementing, maintaining and improving assets and asset management. This domain specifically deals with procurement strategies, funding settlements, suppliers and customers. Strategies and policies must be cognisant of the local and national influences in establishing specific performance standards which can meet stakeholder requirements and also align with corporate delivery policies.

Road managers/operators, in some way, have to report and communicate with all road infrastructure and transport stakeholders. These traditionally include the road users and the road owners, but to an increasing extent the people living nearby the road network and all bodies which ultimately are influenced by the road network. Increasingly needs and expectations expressed by all these stakeholders deal with socio-economic development and environment preservation in addition to asset preservation and user safety.

In the Task group questionnaire a number of key questions were set with regard to stakeholders in order to gain knowledge about the current practices within some CEDR members. These questions address procurement strategies, funding settlements, "suppliers" and "customers".

From a review of the participating organisations there have been some key points found.

¹² Stakeholder = person or organisation that can affect, be affected by, or perceive themselves to be affected by a decision or activity (ISO55000).



<u>Procurement strategy</u>: Normally, services and works are procured in accordance with EU and national procurement requirements, sometimes complemented with internal formal procedures or guidelines.

<u>Setting funds for AM</u>: Organizations seek for investment, maintenance and routine maintenance funds through the parent Ministries and State budget. Long-term set budgets based on long-term (State budget) strategies are quite rare. As opposite, very often organizations depend on annual decisions/budgets allocated or few years' funding which in fact doesn't support long term planning. Typically, key information that is used to support funding submissions includes condition survey outputs and the impact of future budget scenarios from prepared and analysed by the pavement management and bridge management systems. Sometimes funding is not clearly based on the asset information but rather on political decisions.

<u>Performance of suppliers</u>: The performance of contractors is depending on the contract and varies with each contract. One way to follow the performance is to control the quality of executed services and works by supervisors and independent third party control, where these apply. Another way is to use key performance indicators (KPIs) to score suppliers and include these in contracts. Through contracts, Terms of Reference (ToRs) or tender documents organisational needs can be transferred into requirements with which supplier objectives / culture are aligned with organizational objectives.

Active communication with customers: Usually organizations are collecting customer needs, comments, feedback and proposals. There are a number of options how to do this: "traditional" ways like by national customer surveys and regional surveys, by occasional interviews, using questionnaires, open e-mail contacts, P.O. boxes for collecting mail; "information society" ways include communication through organization websites, dedicated e-mail addresses, Twitter accounts. Customer base is broken down into different categories, like Ministries, media, interested public, international institutions and governmental bodies, forwarding agents and carriers, local communities, road users. Customer feedback is collected through the internal channels and reacted upon, in a timely manner in accordance with internal action plans. Sometimes, the feedback is being shaped to be able to be used for setting asset service levels.

Domain 5 - Risk

Risk assessment is the engine of the asset management system. Risk is relevant to all elements within an organisation and it is important that a consistent and joined up approach is adopted across the entire organisation. All decision-making processes must include risks and benefits considerations throughout all stages of the asset's life-cycle; it is critical that the NRAs have the adequate policies and processes in place to identify, assess, analyze and treat risks and opportunities. Not all risks are equal and a widely developed risk analysis gives the NRA



invaluable information on recommended changes in NRA's activities and policies, cost and benefits assessments and the related consequences on the defined level of service of the different components of the infrastructure.

The questionnaire was framed to investigate the existence in the organization of a regular procedure of managing risks across an asset lifecycle (creation, maintenance, operation, and disposal), the categories of risk managed and the way they are analysed, controlled and eventually managed.



4.3 Research projects vs. asset management Domains

The different research projects described under Chapter 3 can be positioned in main domains of the AM model as identified by the Task Group, as shown in Figure 4.3.



Figure 4.4 - Coverage of the research projects (1) = stakeholders, (2) = people and organisation, (3) = strategy and planning, (4) = asset knowledge and information, (5) = risk management

4.4. The CEDR Maturity Matrix and Maturity Level

4.4.1. Definition of the CEDR AM Maturity Levels

Maturity measurements can support organisations in identifying their strengths and weaknesses in relation to their intended goals. This enables organisation not only to find out what to do but also how to operate their primary processes efficiently. It can support organisations to link their strategic processes with processes on a tactical and operational level, and therefore connects the asset owner (e.g. the national government), with the asset manager (e.g. the national highway agency), the service providers (e.g. a contractor or professional service firms) and the asset users (e.g. the car owner). Based on the previous work



developed by the IAM and the Global Forum on Maintenance & Asset Management (GFMAM), the Task Group has developed a maturity scale and has established four generic maturity levels as described in the following table:

	Maturity Level	Description	Equivalence to IAM
1	Initial / Entry	The agency either has not recognised the need for this requirement or if it has recognised it, there is no evidence of intent to progress it.	Levels 0 & 1
2	Basic / Marginal	The agency has identified the way to achieve the requirements and can demonstrate some progress in achieving them. Procedures however may not be clearly set out or repeatable.	Level 2
3	Competent / Proficient	No formal ISO system applied but the agency can demonstrate that it achieves relevant requirements set out in ISO55001 in a systematic and consistent way.	Level 3
4	Excellent / Optimized	The agency has deployed and can demonstrate that it achieves all requirements set out in ISO55001, exceeds some of them and that is systematically looking for optimizations in its Asset Management practice, maximizing value from the management of its assets.	Level 4 & 5

Table 4.4 - CEDR Task Group Generic Asset Management Maturity Scale

4.4.2 CEDR Task Group Asset Management Maturity Evaluation Questionnaire

A questionnaire was developed by the Task Group, based upon the maturity scale set out in Table 4.2 and the components within the 5 AM domains. This questionnaire was developed and organised into 7 spreadsheet tabs:



- Tab 1: MATURITY SCALE → Generic description of each maturity level as defined by the Task group.
- Tabs 2 to 6: QUESTIONNAIRE → Questions presented for each domain defined by the Task group:

Asset information and knowledge: The questions of this domain intend to investigate about the completeness, accuracy and up-to-date level of the inventory, the type and number of assets being registered, the integration and systematisation of the processes within the organization, and the alignment of this domain with the agency's strategy.

Strategy and planning: This set of questions aims to explore the level of development, application and documentation of NRA's strategies and policies; the existence of a methodology and the necessary tools to materialize the AM strategy; the way Life cycle costs, LCC are calculated; and how they are followed consistently across the agency.

People and organisation: This domain has been organized in two sub areas. The first, related to the organization, evaluates the awareness of Asset Management and the formal frameworks across the agency, the engagement at all levels and alignment of strategic goals with organizational objectives. The second one deals with Resource & competence management, and investigates the recruitment, training, competence and individual development strategies.

Stakeholders and customers: These questions intend to explore the procurement strategy (the level of standardization of the contracting processes and the consistency of outsourced activities with Asset Management requirements); the monitoring of suppliers' performance; the level to which supply chain relationships are based on long-term/risk-sharing strategies; the stakeholder's engagement and the level to which customer feedback is taken into account in the decision making processes.

Risk management: This set of questions investigates about the existence of a regular and consistent procedure for managing risks across assets' lifecycle.

- Tab 7: Analysis → This tab shows the results of the evaluation exercise as questions are answered in the questionnaire tabs, giving the global score of AM Maturity and highlighting the areas where there is need for improvement.
- A copy of the maturity evaluation questionnaire is set out in Appendix 2.



4.4.3 Questionnaire Results: Overall Score

The answers provided for each question are scored and the results obtained are displayed in the Analysis tab. The scores for each question range from 1 to 4 as per the maturity levels, which are used to calculate the score for each subarea and then for the global Asset Management (average of the scores obtained in each question).

Following discussion within the group, it was agreed that the cases of agencies where the maximum score of 4 could be achieved for asset management are very limited (the agency would have to score 4 in all the questions of the 5 questionnaire tabs). Therefore, the following ranges have been determined to facilitate better interpretation of the overall scored obtained for Asset Management within the agency.

Score Range	Overall Level of Maturity
1 – 1.6	Initial / Entry
1.7 – 2.4	Basic / Marginal
2.5 – 3.3	Competent / Proficient
3.4 – 4	Excellent / Optimized

Table 4.3 Score ranges for the overall level of maturity



5. VALIDATION OF MATURITY MATRIX

Validation of the maturity matrix was seen as the key next step of the process. At this stage, this has been developed through one organisation, hereinafter referred to as NRA#1. The sheet entitled 'Analysis' with the graphics prepared and illustrated have been used as a summary of all the results obtained by the analysis performed. The main results are described in sections 5.1 to 5.5 respectively.

5.1 Asset knowledge and information

Figure 5.1 shows the situation for the NRA#1 related to the 'Asset knowledge and information', an almost "competent" situation, which means that the agency can demonstrate that it achieves relevant requirements set out in ISO 55001 in a systematic and consistent way.

The information is collected actively under some standards in its different aspects (inventory, condition of assets, historical data, etc.). However, the lack of a depreciation model and the fact that there is not a complete GIS tool and deterioration condition model (with the exception of a few assets), implies that the agency is competent or proficient as opposed to optimized (global score of 2.57).

To improve the actual situation it is necessary to implement a depreciation model and work on the factors with a score of 2 and to apply them to all assets of the NRA.





Figure 5.1 – Asset knowledge and information



5.2 Strategy and planning

As shown in the Figure 5.2, the situation for the NRA#1 related to the 'Strategy and planning' is at an initial level (global score of 1.67), mainly because it is not mandatory to implement a global asset management system in the organisation (no AM policy).

Different aspects of routine maintenance or Levels of Service have a long history in the organisation (since the late 80's) while other aspects such as risk analysis or social benefit are not considered within the overall agencies objectives and operations.



Figure 5.2 – Strategy and planning



5.3 **People and organisation**

As shown in Figure 5.3, the situation for the NRA#1 related to the 'People and organisation' is at a basic or marginal level (global score is 1.75). There is not an overall plan for recruitment and development of the staff, and most of the opportunities come from the retirement of current staff and the external political situation. There is no overall agency wide policy that establishes and assesses individual objectives and or performance measures.



Figure 5.3 – People and organization



5.4 Stakeholders and customers

Figure 5.4 below shows the assessment for NRA#1 related to the 'Stakeholders and customers' domain demonstrating that the level of maturity is "basic" with an overall score of 1.6. As illustrated in the graphic, the relationship between the NRA and the suppliers is strong with a "competent" scoring. There are well defined relationships between the NRA#1 and suppliers and significant experience on outsourcing services.

However, it is clear that the situation with customers is vastly different and requires significant work and resources to deliver a high level of asset management embedment within the agency.



Figure 5.4 – Stakeholders and customers

5.5 Risk management



As it can be seen in Figure 5.5 below, the analysis for the NRA#1 as it relates to 'Risk management' illustrates a "basic" maturity level, with a score of 2.0 but with some strong differences. The aspects related to suppliers risk identification are quite competent while the visibility and understanding of risk through all levels of the organisation is still in an "initial" position and there is not a risk management process in place.



Figure 5.4 – Risk management

5.6 Overall maturity score



The global score for the five different topics analysed is 2.00, which means **initial maturity level for the NRA#1**, with a quite competent position in 'Asset management and information' and a basic maturity level for 'Stakeholders and customers' and 'Risk management'. The weakest topics at present are 'Strategy and planning' and 'People and organisation', which are still at an initial maturity level.



6. CONCLUSIONS

In order to reinforce cooperation and learning between European road agencies, the CEDR Task Group on Asset Management (N2) has investigated the state of the art on transport infrastructure asset management among CEDR's members.

In a first step the current frameworks in use were identified and characterized in order to map commonalities, variations and differences in approaches (chapter 2).

In a second step these views were enriched with an inventory of contemporary research initiatives in the field of asset management (chapter 3).

In a third step the findings from step one and two were used to build a maturity matrix as a framework to strengthen inter-organizational learning (chapter 4).

In a final step this maturity matrix was tested and fine-tuned in several case studies (chapter 5). From this final step following conclusions and recommendations were drawn.

• Although at first look the participating agencies apply a wide variety of asset management frameworks, the underlying fundamental principles showed to be quite similar.

These fundamental principles are:

- the reasoning in chains of action from minister to market,
- interdisciplinary approaches and logical linking of object, asset and network performance.
- Life cycle analysis (which perhaps was the most evident commonality as all agencies appear to be fully engaged in and making progress on this topic.
- In addition to commonalities on fundamental principles, the task group found that the participating agencies faced common challenges as well. Most notable is the challenge of linking current investment decisionmaking to the long term perspectives that are inherently induced by the long life spans of those same infrastructure investments.
- The task group found that agencies could easily relate to each other when engaged in 'system thinking' as this would capture commonalties as described. Such thinking would provide a common language to the sector, in particular where it accommodates reconciling the bottom-up and topdown reasoning that both were found in the inventorisation.
- A key conclusion is that integration of stakeholder roles and interests needs further attention.



- The findings also show that a strong focus on the system itself comes naturally, but the awareness (and inclusion) of the wider context of asset management considerations as well as the link between the road network and other modalities need reinforcement.
- Benchmarking in terms of comparison on the basis of existing frameworks or KPI's appears to be troublesome due to differences in definitions and structure.
- However, the task group finds that through a format of maturity-matrices and maturity-checks this barrier can be overcome. Use of maturity checks was found to be helpful in guiding the conversation and provided practical pointers for participating agencies.
- In general the use of maturity matrices were found to be effective and instrumental to inter-organizational learning. The case studies provided feedback for further refinements of these maturity checks and it is recommended to proceed on this path to keep steepening the learning curve.

Work will continue work on maturity checks through the AM4INFRA project in which five members of task group N2 take part. A key deliverable of the project is to assess the replication potential of its core product: a common framework on asset management that is validated for road. Such assessment should start with a maturity check.

In due course, consideration may be given to a CEDR Working Group on 'Governance'. This would ensure that CEDR members have access to the results of the AM4INFRA project (ending in august 2018) as well as could apply for assistance on implementing the common framework at their own chosen action, for example by setting up living labs in order to adapt and validate the common frame work to their own institutional setting (benchmarking KPIs comparison).



Appendix 1: The questionnaire elaborated by the Working Group

Asset knowledge and information

_				paver	nents			structures					road ec	uipment		
	AM component		asphalt	concrete	composite	gravel	bridges	tunnels	under / over pass and other structures (i.e. walls)	drainage	safety barriers	noise barriers	road signs	road markings	lighting	EM installation
	1 data collection															
	inventory)	yes	yes	yes	yes	yes	yes	yes	no	no	yes	yes	yes	yes	yes
	1	1. 1	Yes				yes	yes	yes	no	no	yes	yes	yes	yes	yes
	1	1.1														
	1	1.2	Since 2001												•	
	condition data (available main data)	1.3	KALIIIIIII													
	1	1.4														
	1	1.5														
	maintenance history															
	historical investment cost									1	1	1				
	2	2														
	2	2.1								1	1					
	historical maintenance cost 2.2															
	2	2.3														
	2	2.4									-					
	2 data management															
	relational database															
	GIS TOOI															
	3 performance prediction															
	condition model (deterioration)															
	asset value model (depreciation model)															
	performance indicators															

1 Yes/No (if yes, items 1.1, 1.2, ... follow)

1.1 List of data collected data for each item (asphalt, concrete, ...)

1.2 Data are collected since ... (year)

1.3 Number of years of homogenous/comparable data collected

1.4 How often are 1.1 data collected (more times per year, every year, every two years, ...)

1.5 How are 1.1 data collected (high efficiency vehicles vs. specific survey)

Strategy and planning

We recommend to fill the table for groups of items (pavements, structires, etc.) instead of for specific items (asphalt, concrete, etc.). Legenda applies to all groups of items

		pavements				structures			road equipment								
AN	I component	asphalt	concrete	composite	gravel		bridges	tunnels		safety barriers	drainage	noise barriers	road signs	road markings	lighting	EM installation	
4	maintenance strategies																
	treatment/maintenance catalog																
	cost calculation (LCC)																
	construction																
	maintenance																
	routine maintenance																
	road user cost (VOC)																
	social cost (stakeholders)																
	benefit calculation																
	condition																
	asset value																
	social benefit (stakeholders)																
	Level of Service (LoS)																
	risk calculation																
5	optimisation maintenance																
	cost benefit analysis model	see (6)															
	network optimisation model	if yes describe															
	work prioritisation model	if yes describe															
	risk analysis model	see (7)															
	KPI's																
6	cross asset optimization																
											L						
									To be valid	lated by DCEC	Т						
				-				-	- Servizio ii	mpianti				-			

tecnologici

4 Asset value calculation (yes/no)

4.1 If 4.1 is yes, who calculates asset values?

4.2 If 4.1 is yes, for which asset is value calculated?

4.3 If 4.1 is yes, which department/unit calculates asset value?

4.4 If 4.1 is yes, is asset value published in the balance cheet?

5 Level of sercice (LoS)

5.1 If 5.1 is yes, who defines LoS?

5.2 If 5.1 is yes, are LoS agreed upon? Whith whom?

6 Cost benef analysis (CBA)

6.1 If 6.1 is yes, for which projects is CBA carried on?

6.2 If 6.1 is yes, is CBA made public/published?

7 Risk analysis model

7.1 If 7.1 is yes, describe the model, theprocedures, the outputs

7.2 If 7.2 s yes, which is the dept/unit responsible?

7.3 If 7.2 s yes, for which items is risk analysis carried on?

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People and or	ganisation							
AM component			Organisation					
7	Organisation	Response	Description					
	Organisational awareness of formal Asset Management framework (PAS55 / ISO55000)	[Yes / No]	Brief details of current overall AM maturity and aspiration for your organisation					
	Strategic Documentation (To confirm organisational aims and objectives)	Please confirm documents in place	Brief description of document(s) purpose					
	Do you set annual / longer term organisational objectives and targets	[Yes / No]	Brief description of the (i) annual and (ii) longer term targets, that are in place and how these are derived (ie describe if these are top down set targets, or derived from bottom up identification processes)					
	How does your organisation ensure that any set targets are appropriate and align with the long term ambition of the organisation	Brief description of any organisation target related assurance / review processes in place and whether carried out directly or by a third party.						
	Is your senior leadership / Board fully engaged with asset maintenance / management	[Yes / No]	Brief description of the level of senior leadership engagement with asset maintenance					
	People							
	Is there a workforce strategy to provide structure for staff requirements and development	[Yes / No]	Brief description of approach to recruiting and developing required staff levels					
	Do you define your organisation's staffing requirements and measure individual performance	[Yes / No]	Brief description of how your organisation defines its staff requirements (number and skills) and how these are achieved					
	Does your organisation set personal staff objectives and are these actively aligned with organisational objectives	[Yes / No]	How does your organisation set personal objectives and is there assurance that these align with organisational objectives					

Stakeholders a	and customers (incl. market approach, procu	rement strategy)					
AM component			Organisation				
All component	Procurement Strategy		organiaaton				
	Does your organisation have a procurement strategy, defining how you will acquire the required services and products	[Yes / No]	Brief description of how your organisation defines how it will acquire the services it requires to deliver objectives				
	Funding settlements						
	How does your organisation seek funding for asset maintenance activity	Brief descrij	otion of how your organisation seeks funding for asset maintenance activities				
	What are the key asset information sets that are used to support funding submissions	Brief description of the ke	y information that is used to underpin and support asset maintenance funding submissions				
	Suppliers						
	Does your organisation have an operating model - defining the degree of outsourced / direct service and product delivery	[Yes / No]	Brief description of approach to recruiting and developing required staff levels				
	Do you measure the performance of your suppliers	[Yes / No]	Brief description of the process for measuring and reporting your supplier performance				
	How do you ensure that your supplier objectives / culture are aligned with your organisational objectives		Brief description of your organisation's approach to aligning supplier behaviour and performance with your organisation's targets.				
	Customers						
	Does your organisation actively engage with customers to seek their views and comments on the organisation's performance	[Yes / No]	Brief description of approach to seeking customer views				
	How do you collect customer feedback	Description of how you collect customer feedback information					
	How do you report customer feedback	Description	of how you report customer feedback information through your organisation				
	Do you break down your customer base into different categories	[Yes / No]	Brief description of the customer categories you adopt and how information for the different categories are collected				
	How is customer feedback used to inform the development of organisational objectives / continuous improvement	Brief description of the	process for reviewing customer feedback and business targets / change that they inform				

Risk								
AM component			Organisation					
-	Lifecycle Risk	Response	Description					
	Does your organisation have a process for managing risks across an asset lifecycle (creation, maintenance, operation, disposal)	[Yes / No]	Brief details of current approach to asset lifecycle risk management. Describe what asset categories are subject to risk management processes and how these are reported.					
	What are the main categories of risk your organisation manages and reports	Brief description of the different risk categories that are measured for your organisation (please don't include project specific ris						
How are all the different risk management proc across the organisation collated and reported to through the organisation		Brief description of the process for bringing together the risk reporting and how these risks are subsequently communicated						
	Is this asset lifecycle risk management process open and visible through all levels of the organisation	[Yes / No]	Brief description of the level of visibility and involvement of different levels from individual staff members to different groups / teams through to senior organisation leadership					
	How do you ensure that your risk management processes are effective and provide the required level of control	Brief description of any procedures in place to measure the effectiveness of your risk management processes and revise / mitigation measures as appropriate						
	Risk Coordination							
	Are your suppliers required to identify and manage risks	[Yes / No]	Brief description of what risks your suppliers manage and how these are established / reviewed					
	Do your supplier risks form part of your organisational risk management	[Yes / No]	Brief description of how organisational risks and supplier risks are coordinated together					



Appendix 2: Instructions to respond to the Asset Management Maturity Evaluation Questionnaire



Directors of Roads

Instructions to respond to the Asset Management Maturity Evaluation Questionnaire

Draft paper

Version 2.0

July 2016



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1 BASIC PRINCIPLES OF ASSET MANAGEMENT

1.1 DEFINITION

ISO 55000 defines Asset Management as *the coordinated activities of an organization to realize value from assets* (asset = something that has potential or actual value to an organization).

The Institute of Asset Management, IAM, expands this definition and defines Asset Management as the "discipline that provides techniques for converting the fundamental aims of an organisation into the practical implications for choosing, acquiring (or creating), operating and maintaining appropriate assets to deliver those aims; while seeking the best total value approach (the optimal combination of costs, risks, performance and sustainability)¹³.

1.2 EXISTING FRAMEWORKS

1.2.1 PAS 55:2008

PAS 55:2008 was first issued in 2004 and became recognised as the international benchmark for optimal management of assets. It was published in two parts:

- Part 1: Specification for the optimized management of physical assets
- Part 2: Guidelines for the application of PAS55-1

1.2.2 ISO 55000:2014 series

The ISO 55000:2014 series for Asset Management was introduced in 2014 and comprises of 3 parts which set out the requirements, information and guidance for establishing, implementing, maintaining or improving asset management systems and asset management for organizations.

- ISO 55000: 2014 Asset Management Overview, Principles and Terminology
- ISO 55001: 2014 Asset management –Management systems Requirements
- ISO 55002: 2014 Asset management Management systems- Guidelines for the application of ISO 55001

Concerning to the requirements for compliance, section 4.4 of ISO 55002 states that: "compliance with all the requirements of ISO 55001 represents achieving the minimum standard for an effective AM system and should not be seen as the final goal."

¹³ An Anatomy of Asset Management, Issue 1.1, February 2012, The Institute of Asset Management.



1.3 CHARACTERISTICS OF GOOD ASSET MANAGEMENT

Any organization willing to achieve good Asset Management, should take the following characteristics into consideration. Asset management must be:

- a) Multi-disciplinary: It must be agency wide, cross departments and discipline boundaries and avoid silos.
- b) Systematic: It must be applied in a rigorous and structured manner, which is achieved through a management system.
- c) Systems-oriented: It must focus on assets systems, not on isolated assets, looking for the net total value.
- d) Risk-based: Risk considerations must be included into all decision-making.
- e) Optimal: It has to find the best compromise between conflicting objectives (i.e. capital investment costs vs. operating expenditures).
- f) Sustainable: It must optimize asset life cycle value, and should include ongoing system performance, environmental and other long term consequences.
- g) Integrated: It should consider all areas that participate in the AM as a whole, not just as the sum of the parts.
- h) Cyclical : it must involve continuous review and learning process to ensure that systems and processes are clearly aligned with the organisational strategic objectives and can continuously meet the organisation's needs

1.4 KEY CONCEPTS

In order to fully comprehend AM, it is essential to clarify the following key concepts:

- Assets' Value: The value of an asset depends on the point of view of each stakeholder. In terms of AM, the value must reflect the mix of stakeholders and their expectations, which most times are competing expectations that will require trade-offs between the different interests. It also involves a mix of tangible and intangible benefits or risks that will need quantification for a combined consideration.
- Levels of granularity: Assets have different levels of granularity (individual assets, asset systems and asset portfolios). To maximise value, organizations must understand the inputs, costs and risks at individual asset level and the benefits and performance realization at higher levels (asset systems and asset portfolios), considering different timescales and horizons.
- **Asset Life Cycles**: In order to avoid a "short-term" approach, life cycle costs and value realization periods must be understood.
- **Optimized decision-making**: During the decision-making process, the organization must find a compromise between opposing interests (i.e. asset utilization versus asset maintenance). An optimized decision-making process is about finding the optimal combination of interests, risks, benefits... that returns the best net value, taking into consideration indirect or intangible impacts, risk exposures, and long-term effects.
- **Asset Management System**: The management system used to direct, control and coordinate the different aspects, especially the physical ones, of Asset Management.



- Line of sight: The strategic plan of any organization must be clearly connected to the onthe-ground daily activities of individual departments. The organization's staff must understand the reasons for their activities (why the task is needed, not just how to do it), as helps with prioritization, coordination and stimulates creativity and innovation. At the same time, the organization's strategy and senior management decisions must be based in fact-based realities. The conclusion is that there must be visibility and clarity in both directions, i.e. top down and bottom up, between the organization's different levels.

1.4 ASSET MANAGEMENT MATURITY AND ITS EVALUATION

Asset Management maturity has been defined by the Global Forum on Maintenance and Asset Management, GFMAM, as "the extent to which the capabilities, performance and ongoing assurance of an organisation are fit for purpose to meet the current and future needs of its stakeholders, including the ability of an organisation to foresee and respond to its operating context."¹⁴

When evaluating its own Asset Management maturity, an organization should give special consideration must to:

- The capabilities of the organization and their integration to achieve its objectives;
- The performance and the value being delivered to the stakeholders, including the achievement of the organization's objectives;
- How well the Asset Management System is integrated with other business systems and processes;

- The continual evolution of AM best practices and the consequent need for a continuous update of the definitions and maturity requirements for higher levels of maturity;

- The fact that best practices may be specific for each organisational context, industry, culture and stakeholder.

The evolution of an organisation's maturity goes from lower maturity levels, which tend to focus on being process-aligned, disciplined and integrated (evaluated by the compliance against the requirements set in ISO 55001), towards higher maturity levels which are related to more holistic, proportionate and 'behavioural' characteristics. The focus of the organization at the first levels of maturity should be to integrate and achieve a coordinated control of their processes, whereas the focus of the higher levels should be to optimise and fine-tune their activities.

When evaluating the Asset Management maturity of an organization it is crucial to consider its operational context. In order to determine the operational context of the organisation, the following characteristics must be analysed:

- Asset systems criticality: It refers to the importance of managing the assets optimally and the scale of the consequences of not doing so.
- Scale and complexity of assets portfolio: It measures the difficulty of managing the assets optimally.
- Volatility of business environment: It highlights the constraints/opportunities to manage assets optimally over their whole life cycle.

¹⁴ Asset Management Maturity. A Position Statement, First Edition, October 2015, Global Forum on Maintenance and Asset Management (GFMAM)



In the case of National Road Networks, their organisational context is characterized by high asset system criticality, high portfolio volumes/complexity, and low business environment volatility. This context has been considered by the CEDR Asset Management TG N2 when preparing the maturity evaluation questionnaire attached to this document.

1.5 MAIN BIBLIOGRAPHY

- An Anatomy of Asset Management, Issue 1.1, February 2012, The Institute of Asset Management (IAM).
- Asset Management Maturity Scale and Guidance, Version 1.0, June 2015, the Institute of Asset Management (IAM).
- Asset Management Maturity. A Position Statement. First Edition, October 2015, Global Forum on Maintenance & Asset Management (GFMAM).



2 CEDR TASK GROUP N2 ASSET MANAGEMENT – ASSET MANAGEMENT MATURITY EVALUATION

2.1 INTRODUCTION TO THE CEDR TG N2 ASSET MANAGEMENT MODEL

In consideration of the deliverables of the Asset Management Task Group, a number of existing frameworks were examined by the group with the objective of developing an Asset Management model that could be adapted to best fit individual National Road Agencies, NRA's requirements. Following this review 5 main domains of asset management were identified. Each domain is interlinked and influences the implementation of asset management within any organisation.

- Asset Knowledge and Information
- Strategy and planning
- Stakeholders and customers (including market approach and procurement strategies)
- People and organisation
- Risk



Figure 1. The five elements of Asset Management according to CEDR- TG- N2

In order to evaluate the agency's maturity in the implementation of Asset Management, the CEDR Task Group developed an Asset Management Maturity Evaluation Questionnaire. Further instructions to respond to this questionnaire are detailed in section 0.


2.2 DESCRIPTION OF THE AM DOMAINS

Asset information and knowledge

Assets' data and information are the base of AM and therefore, its collection, register and monitoring is of crucial importance. For the purposes of the questionnaire and for all NRAs, assets can be grouped into the following two categories:

- Main assets: Pavements and structures (bridges, tunnels, earthworks). In most NRAs there is a long history of data collection of these assets.
- Ancillary assets: Safety barriers, drainage, noise barriers, road signs, road markings, lighting, roadside equipment and any other secondary road element. In these cases, data collection tends to be more limited in nature both in terms of the extent and type of data collection.

The questions set for this domain has been organised in three subareas: **data collection, data management and performance prediction.**

The level of maturity will be evaluated on the basis of the completeness, accuracy and up-todate level of the inventory; the type and number of assets being registered i.e. some assets, all main assets, main and ancillary assets; the integration and systematisation of the processes within the organization and the alignment of this domain with the agency's strategy.

Domain 2 - Strategy and planning

Strategy and planning refers to the long-term approach of the organization and includes a set of strategic statements that describe the current status and objectives for the assets, asset management activities and capabilities; the current and future LoS the organisation aims to deliver; the criticality, risk, prioritization and decision making criteria; and the strategies for enablers (human factors, asset information and risk management).

The domain has been organized in the questionnaire in four subareas: Asset Management policy; asset creation, acquisition and configuration management strategy; maintenance strategies; and optimisation maintenance.

The maturity evaluation will be based on the level of development, application and documentation of the strategies and policies; the existence of a methodology and the necessary tools to materialize the AM strategy; the way LCC are calculated; again on the integration and systematisation of the processes within the organization, and how they are followed consistently across the agency.

Domain 3 - People and organisation

This domain refers to the role of both people and the organizational structure in the organization's path to a competent and mature asset management, and includes a number of considerations related to the organization and people enablers. Aspects such as leadership, culture and competence management have a great impact on the extent that Asset Management is implemented on a NRA.



This domain has been organized in two sub areas:

Organization, which evaluates the organization's awareness of Asset Management and the formal frameworks, engagement at all levels and alignment of strategic goals with organizational objectives; and

Resource & competence management, which refers to the recruitment strategy, training and competence management, and individual performance.

The level of maturity will be evaluated on the basis of the knowledge and understanding of PAS55 and ISO55000 across the agency, the existence of organizational objectives and targets and their alignment with the ambition of the organization, the existence of a Strategic Business Plan that includes the Asset Management needs of the organization, the engagement of senior leadership, and a resourcing and competence strategy that identifies any gaps in competence and supports the recruitment, training and individual development of the staff.

Domain 4 – Stakeholders and customers

Stakeholder, as defined by ISO55000, "is a person or organisation that can affect, be affected by, or perceive themselves to be affected by a decision or activity".

Stakeholders needs and expectations have to be considered when creating, acquiring, operating, maintaining and improving transport assets. Traditionally, road infrastructure and transport stakeholders included the road users and the road owners. However, people living nearby the road network and all bodies which ultimately are influenced by it are increasingly recognised as stakeholders as well.

This domain includes different aspects of stakeholder's relations: **the procurement strategy**, **the funding settlements**, **suppliers and customers**.

The maturity evaluation will be based on the level of standardization of the contracting processes and the consistency of outsourced activities with Asset Management requirements; the level of control of suppliers' performance; the level to which supply chain relationships are based on long-term/risk-sharing strategies; the stakeholder's engagement and the level to which customer feedback is taken into account in the decision making processes.

Domain 5 – Risk management

Risk assessment and management underpins asset management. Risks and benefits considerations and their costing must be included in all decision-making processes, throughout all stages of the asset's life-cycle. It is crucial that he NRAs have in place the adequate policies and processes to identify, assess, analyze and treat risks and opportunities.

This domain is divided in two subareas: lifecycle risks and risk coordination.

The level of maturity of an organisation in this domain is evaluated by the level of consistency and integration of risk management across the organisation and the asset's lifecycle; the collection and reporting of risks; the visibility and effectiveness of risk management processes;



the level of shutdowns' anticipation and prevision; and the level of coordination between the supply chain risks and the agency's ones.

2.3 DEFINITION OF THE CEDR AM MATURITY LEVELS

Based on the previous work developed by the IAM and the GFMAM, and with the aim of adapting the maturity level scale developed by the IAM in June 2015 (composed of six different maturity levels), the CEDR task group has developed its own maturity scale and has established four generic maturity levels as described in *Table 4.4 - CEDR Task Group Generic Asset Management Maturity Scale* below:

Maturity Level		Description	Equivalence to IAM
1	Initial / Entry	The agency either has not recognised the need for this requirement or if it has recognised it, there is no evidence of intent to progress it.	Levels 0 & 1
2	Basic / Marginal	The agency has identified the way to achieve the requirements and can demonstrate some progress in achieving them. Procedures however may not be clearly set out or repeatable.	Level 2
3	Competent / Proficient	No formal ISO system applied but the agency can demonstrate that it achieves relevant requirements set out in ISO55001 in a systematic and consistent way.	Level 3
4	Excellent / Optimized Systematically looking for optimizations in its Asset Management of its assets.		Level 4 & 5

Table 1. CEDR Task Group Generic Asset Management Maturity Scale

These generic definitions are a starting point to help understand the required capabilities and level of implementation of asset management within an organisation in order to achieve each level of maturity in general terms. However, specific answers for each question and level of maturity are detailed in the Evaluation Questionnaire. This explains in a more specific way the symptoms expected at each level and the minimum requirements to move to the upper levels of the maturity scale.



2.4 CEDR AM MATURITY EVALUATION QUESTIONNAIRE

Organisation of the Questionnaire

The AM Maturity Evaluation Questionnaire developed by the CEDR Task Group is organised in 7 different tabs:

- Tab 1: Maturity Scale → You can find in this tab the generic description of each maturity level as defined by the CEDR:
- Tabs 2 to 5: Questionnaire → These five tabs set out the questions presented for each domain described in section 73 (Asset Knowledge and Information, Strategy and Planning, People and Organization, Stakeholders and Customers, and Risk Management). These are the tabs that the NRA will have to complete when answering the Evaluation Questionnaire.
- Tab 6: Analysis → This tab will show the results of the evaluation exercise as questions are answered in the previous tabs (2 to 5), and it gives the agency information on the maturity level of each Asset Management domain and each subarea within those domains, highlighting the areas where there is need for improvement. This tab has a column on the right of the table which shows the result obtained for each subarea (i.e. 1. data collection), calculated as the average of the scores given for each question (i.e. 1.4.inventory). There are also five radar charts corresponding to each domain at the right of the Analysis table. They are a graphic representation of the NRA's maturity in each Asset Management domain.
- Tab 7: 39 AM Subjects Equivalence → As the CEDR Task Group model is based upon the IAM Asset Management Maturity Scale and Guidance, a tab has been included to reference the questions in the CEDR questionnaire to the 39 subjects identified by IAM. This is added with the aim of helping the NRA to get a more extensive description of each area/subject of the Asset Management should it be needed.

Instructions to respond to the AM Maturity Evaluation Questionnaire

As mentioned above, when responding to the questionnaire, NRAs must only fill in the tabs 2 to 5: Asset Knowledge and Information, Strategy and Planning, People and Organization, Stakeholders and Customers, and Risk Management.

In each tab, there is a set of questions grouped in different subareas. For each question, the questionnaire gives four possible answers that represent the attributes and symptoms expected at each level of maturity. The NRA must choose the answer that best reflects the current reality of the agency and mark it with an "X" inside the box located below the answer, as shown in *Figure 2*.

Attention must be given to selecting only one out of the 4 possible answers. If two answers are selected for the same question, the questionnaire will mark that error in red showing the invalidity of the answer (*Figure 3*).

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Asset knowledge and Information		GENERAL DEFINITION OF MATURITY LEVILS (UNIDOSID)			
		The agency either has not encounted the next for this requirement or if it has recognised it, there is no evidence of intent to progress it.	The approxy has identified the way to actness the requirements and can demonstrate some progens is achieving them. Procedures however may not be charry set out or requirable	No forma (SD system applied but the aporty can demonstrate that it autores retenant requirements ant out in (SD 55001 in a systematic and campiteed way.	The agency has deployed and can descend table that it actives all implements set out in ISO SSOIT, encents some af these and that is synthesized of a same fits Asset for aptivitizations in its Asset formagement processor, maximizing value from the management of its assets.
		RATURUTY LEVELS			
	All component	1	2	1	
-14	asset information strategy	The NVA does not exception the need for an Asset Edoemation Startage and to is not constitued to develop it part	The MPA reacts to put a manage in place, has identified the means to autoening it and care demonstrate progress in the defective of an accel education strategy. However, protectives are not eveloping and out, with thread constrates and coordination reacts data spensy.	The NDA has developed an Arsen Intomaton Strangs which is documented and constituent with the agency's Accel Management Strategy The development of the strategy considers the significance of identified toks on information requirements, the information requirements for and the exchange of identificance with makeholders	The manegain fully integrated with the objecter builties processes and enabling increasing and it requires optimization of users information optimized and ingle and independent processes and inglements increasing processes.
1.2	standerds for data collection	There is not a constituter shutton, former or standards for collecting and anoing assert information when the spipe,	The MRA has set the guidelines for the collection and registration of data and asset Aformation, but the indemonstration of the guidelines in the recording process is no set adviewed.	The NDA has developed mechanisms ensure a constitute approach to the necessing of asset internation, defeng also the quality and annurary required for all asset information, and negocity those standards in the collection and regimination processes.	The NUA can demonstrate appropriate and proportionate application of the asset biomation mandards and a systematical and uncleared and a systematical and consistent afford is optimising a spacetose in this industry. There are governance processes in place or assessment the data and elemation is this purpose and constants with the established mandards.

Figure 2. How to mark an answer in the questionnaire

Asset knowledge and information		GENERAL DEFINITION OF MATURITY LEVELS (DYODOWD)				
		The agency either has out recognised the need for this requirement or If it has recognised it, there is no evidence of intent to programs it.	The agency has identified the way to achieve the requirements and can demonstrate some progens in achieving them. Procedures boorsver may not be cleary set out or repeatable	Sto formal ISO system applied but the agency can decombiste that it achieves relevant requirements art aut in ISO 55001 in a systematic and constituent way.	The agency has deployed and can demonstrate that it achieves all vegurements set out in ISO 56007, exceeds some of them and that is aystematically usering for optimizations in its Asset Management practice, maximum value from the management of its assets.	
		MATURITY LEVELS				
	All component	1	2	3		
1	data conection		The NBA intends to put a strategy in	The NFA has developed an Asset Information Strategy which is	The strategy is fully integrated with the	
1.1	asset information strategy	The NRA does not recognise the need for an Asset Information Strategy and a is not committed to develop it yet.	place, has identified the means to achieving it and can demonstrate progress in the definition of an asset information strategy. However, processes are not well integrated yet, with limited consistency and coordination across the agency.	documented and consistent with the agency's Asset Management Stategy. The development of the strategy considers the significance of identified taks on information requirements, the information required for key decisions and the eichange of information with stateholders.	relevant business processes and enabling technology; and it requires optimisation of costs, lisks and performance of asser information systems. The NRA proactively investigates and implements innovative solutions to optimize and improve the processes.	
			×			
1.2	standards for data collection	There is not a consistent structure, format or standards for collecting and proving asset information within the NPA	The NBA has set the guidelines for the collection and registration of data and asset information, but the implementation of the guidelines in the recording process is not yet achieved.	The NPA has developed standards to ensure a consistent approach to the recording of asset information, defining also the quality and accuracy required for all asset information, and respects those standards in the collection and registration processes	The NPIA can demonstrate appropriate and proportion are application of the asset information standards and a systematical and consistent effort in optimising its practices in this subject. There are governance processes in place to assure that the data and informations in K for propose and consistent with the astabilished available.	

Figure 3. Error showing that two answers are selected at the same time

Questionnaire results: Overall Score

The answers given for each question are scored and the results obtained are displayed in the Analysis tab. The scores for each question range from 1 to 4 as per the maturity levels. The

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score for each subarea and then for the global Asset Management are calculated as the average of the scores obtained in each question.

When interpreting the overall score obtained for the global Asset Management, the following score ranges must be considered:

Score Range	Overall Level of Maturity
1 – 1.6	Initial / Entry
1.7 – 2.4	Basic / Marginal
2.5 - 3.3	Competent / Proficient
3.4 – 4	Excellent / Optimized

Table 2. Score ranges for the overall level of maturity

These score ranges have been established to account the fact that achieving a score of 4 for the overall of the Asset Management is almost impossible as the agency would have to score 4 in all the questions.



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22-28 Avenue d'Auderghem 1040-Brussels Tel. : + 32 (0) 27 71 2478 email : information@cedr.eu

www.cedr.eu

