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Directors of Roads

Technical Report 2018-02

Common framework for a European Life Cycle based Asset
Management approach for transport infrastructure networks:
Final report of AM4INFRA project



AM4INFRA
cross-asset / cross-mode / cross-border

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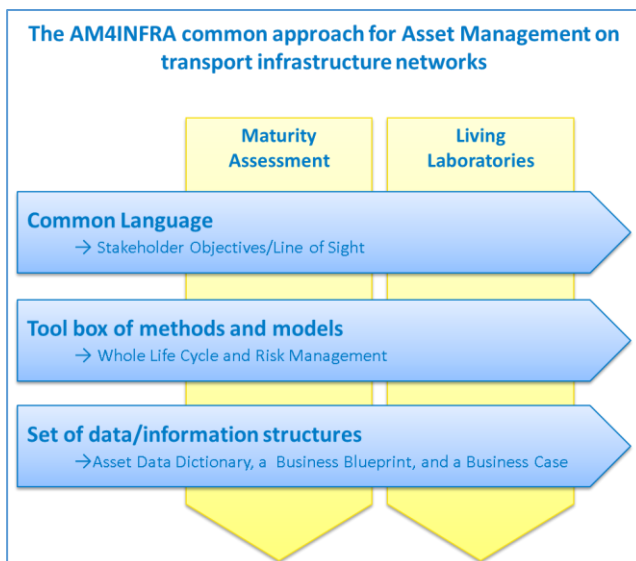
EXECUTIVE SUMMARY

This Technical report presents the results from the AM4INFRA project, which was conceived as a follow-up to the work of CEDR Task Group N2 on Asset Management, and which was funded by the European Commission¹.

To continue building upon the work of TG N2, five² of the eleven member countries in the TG N2 decided to join forces to develop and promote a first common approach for asset management on transport infrastructures, which would enable effective cooperation between CEDR's members across the trans-European (road) network.

The AM4INFRA project was executed in close cooperation with CEDR members and associated infrastructure managers in order to reinforce its objective to build a common, flexible approach for asset management for transport infrastructure networks that will ensure transparency and compatibility in planning and optimisation across asset types, across the modes, and across (national and organisational) borders.

Figure 1: The AM4INFRA common framework



Building on the sound practices of the five CEDR members in the project, the resulting approach provides a common language framework that spans the line of sight from policy outcomes on the network level to the condition and functionality of the individual assets. This framework as depicted in Figure 1.0 enables transport infrastructure managers to determine what synergetic benefits their mutual cooperation would bring in reference to their respective policy outcomes as well as how they could achieve such cooperation without abandoning their specific organisational contexts

¹ Grant Agreement Number:713793 (H2020-MG-8.4b-2015-smart governance, network resilience and streamlined delivery of infrastructure innovation)

² These are: RWS, HE, TII, ANAS, SIA/ZAG

(legislation, culture). This is supported by a tool box of methods and models for whole life cycle and risk management that enables transparent and fact- based decision making across the line of sight. This in turn is supported by a set of data and information structures and tools, including an Asset Data Dictionary providing common definitions, a common core model for an asset information management system facilitating the exchange and interoperability of data enabling the sharing and comparison of multiple datasets from different sources, and a Business Case providing a concrete example.

In order to relate the common approach to the objective of learning from the practices of the participating organisations, the project deployed two demonstration and verification activities:

- Following the model from CEDR TG N2, a maturity assessment was done in order to identify the individual strengths of the CEDR members involved in the project from which the other organisations can learn (see also ANNEX I).
- A series of three living laboratories were organised in which the approach was demonstrated and verified in a real practice context i.e. on existing section of the national (road) networks (see also ANNEX II).

Throughout the project the team engaged with CEDR members and relevant other stakeholders in order to raise awareness, trust, understanding and commitment for the common approach. The key events were the three living labs in which other network managers and operators were involved, such as Transport for London, Municipality of Rome, the A24-A25 Toll Motorway, and ProRail. In addition, the project organised a CEDR EB workshop in March 2018 on the common approach as well as a breakfast session with selected CEDR GB members on the legacy of the project (i.e. activities on Asset Management in CEDR after the project's ending in August 2018). The common view emerged that such legacy could be built through the launch of a Working Group on Network Governance.

In the successive chapters of this technical report, the set-up of the AM4INFRA project and its results are presented in concise terms. For further reference, chapter 3 provides hyperlinks to the relevant project deliverables.

In conclusion:

The AM4INFRA project has delivered a common approach for asset management on infrastructure networks. Although it has been built, demonstrated and verified for national road networks in particular, its applicability in essence extends to the supporting regional and municipal networks as well as towards the other modes (rail, waterways) for which several of CEDR's members are also responsible.

An example from the USA

In the USA, the state DOTs, congregated in the AASHTO platform, have agreed on the collaborative development of AM-tooling in GIS-software.

The tooling is available to all states for implementation on a voluntary basis.

The key foundation for this initiative is the agreement on a GIS standard and the condition that all states speak the same language –both literally and figuratively). This supports their mutual sharing and learning (by doing).

As a consequence the agreement has shown to steepen the learning curve considerably.

The AM4INFRA has delivered a common approach that allows collaboration similar to this example: it provides a common language (Work Package 1), corresponding methods and models (Work Package 2) and consistent open data (Work Package 3).

Furthermore, the project has started to map where CEDR's members and their associates could reinforce each other on the management of their network assets, and where there are opportunities for learning from each other's strengths. The next step is collaboration in the wider application of the AM4INFRA common approach and establishing the priorities in the further (collaborative) development of the approach, and verification in real life contexts. This would bring a dual benefit to the organisations involved:

- "horizontal" benefit: It would enable organisations to establish a cooperative dialogue on Asset Management from common groundings and methodologies
- "vertical" benefit: it would reinforce the capability of involved organisations to compare its (progress in) implementation of a comprehensive Asset Management and Life Cycle Cost approach to a reliable benchmark.

Key issues to address on the short term include:

- (Emerging) common risks and opportunities for the networks of CEDR's members and their effect on their management (and that of their associates). These include renewal in response to the ageing of infrastructures, upgrading of network capabilities in order to accommodate Connected Automated Driving (CAD) or sustainability outcomes, etc.
- Current and future key performance indicators with a focus on the potential 'performance killers'.
- Current and future 'cost elephants' and the opportunities for responding through collaborative investment and innovation?

In support follow-up activities should address:

- The knowledge and competences we need to address the ageing of our infrastructure assets with a particular focus on building insight (and comparison) on how this issue manifests across Europe and from that the opportunities to learn from each other and where possible share relevant databases, methods, strategies and (inspection) abilities.
- The role and steering of markets in the management of our infrastructure assets with a particular focus on developing common tools and on opportunities from ICT and other (emerging) technology.
- Trans-European collaboration e.g. on construction and maintenance activities across a TEN-T corridor. A key issue would be to overcome barriers in (concerted) decision making and influencing EU-investments as well as in sharing and implementing knowledge and experiences.
- To further the implementation and use of the common framework and its associated tools with a particular focus upon the outcomes of the CEDR N2 maturity assessment

The recommended approach would be:

- To launch the proposed CEDR Working Group on Network Governance under the AP2019-2021, centered around a Standing Advisory Board to the CEDR GB.
- To build a knowledge portal on Governance in support of CEDR's members in their (voluntary) efforts to implement asset management systems in their network management. The portal would be centered around an evolving Community of Experts and providing access to a repository of relevant documents for reference (e.g. guidelines, case examples).
- To define stepping stones to innovate and validate the evolving common approach (senior experts in cooperation with CEDR EB).

- To gradually involve other infrastructure managers and stakeholders such as from the supporting regional and municipal (road) networks, the other modes (rail, waterways, ports), and the grids for data and energy (supporting the implementation of CAD and the greening of transport fuel pool).
- To foster wider dissemination and learning abilities concerning the (evolving) approach through appropriate activities, such as through additional living laboratories, communities of expertise, and maturity assessments.

Key message: The work and results of the project build on a shared language and learning by doing. This can be described in 5 simple steps;

Step 1: Common approach: To learn and grow as European network agencies we need a shared understanding of how we manage networks on the basis of the commonalities in our approaches (line-of-sight). This provides the ‘grammar’ for our common language.

Step 2: Supporting tools: On a more fundamental level tooling provides the insights on which decision making takes place. This tooling underpins the whole-life-cost and risk-based reasoning to optimize the use of our resources. These are the ‘words’ for our common language.

Step 3: Sharing data: The foundation of all is to enable understanding of data across our networks. This requires structuring and a dictionary for such data. This provides the alphabet for our common language.

Step 4: Identify most promising areas for learning: On the basis of our common language, learning and growing can take place. The asset management maturity assessments identified key areas to steepen the learning curve (annex I).

Step 5: Learning-by-doing: By using our common language, and applying this in a real-life context, with a specific focus on the key areas to steepen the learning curve, direct progress can be made. These are demonstrated and verified in the living labs as performed (annex II).

TABLE OF CONTENTS

| | |
|--|-----------|
| Executive summary | 3 |
| Table of contents | 7 |
| 1 Definition of the issue | 8 |
| 1.1 The challenge of ensuring a smoothly functioning transport network | 8 |
| 1.2 Asset management enables systematic decision making in infrastructure management | 8 |
| 1.3 a common asset management framework approach..... | 9 |
| 2 Results | 10 |
| 2.1 Stakeholder objectives/Line of Sight (Work Package 1). | 10 |
| 2.2 WHOLE Life Cycle Cost and risk based management (Work Package 2). | 13 |
| 2.3 Data and information Management (Work Package 3)..... | 18 |
| 2.3.1 Asset Data Dictionary (ADD) | 18 |
| 2.3.2 Business Blue Print (BBP) | 19 |
| 2.3.3 real case scenario | 20 |
| 2.4 Assessing organisational Maturity | 21 |
| 2.5 Demonstrating and verification..... | 23 |
| 3 References and Hyperlinks | 26 |
| 3.1 WP 1 deliverables: | 26 |
| 3.2 WP 2 deliverables: | 26 |
| 3.3 WP 3 deliverables: | 26 |
| 3.4 References | 27 |
| Annex I – Maturity assessment | 28 |
| Asset Knowledge and Information | 28 |
| Strategy and Planning | 28 |
| People and Organisation | 29 |
| Stakeholders..... | 29 |
| Risk Management..... | 30 |
| Annex II – Living LABS | 31 |
| Photo impression Living lab Eindhoven | 31 |
| Photo Impression Living Lab London | 34 |
| Photo impression Living Lab Rome | 35 |
| NEWSLETTER AM4INFRA Outcome LIVING LABS | 37 |

1 DEFINITION OF THE ISSUE

1.1 THE CHALLENGE OF ENSURING A SMOOTHLY FUNCTIONING TRANSPORT NETWORK

A smoothly functioning transport network is key to sustained success in modern economies. A densely webbed transport network such as the Trans-European Transport Network (TEN-T), supported by regional and local transport networks, secures connectivity between different countries and between different parts of a country. It links people to jobs, delivers products to markets, underpins supply chains and logistics, and supports domestic and international trade. The quality and completeness of a transport network, and how well it's managed, determine its contribution to a successful economy; at a local, regional, national and European level. Moreover, as economies grow, they demand more of the capacities and qualities of transport infrastructure.

Meeting these increasing demands and requirements poses significant challenges to policy-makers and managers of transport infrastructure across Europe that play across individual assets, borders and transport modalities. Not only have most transport infrastructure networks been built historically to meet the specific needs of different countries, but the majority of existing infrastructure is now also deteriorating at a significant pace. This brings some difficult decisions in the management of infrastructure. Is it better to invest in the construction of new infrastructure or carry out maintenance on the existing network? Which quality requirements are demanded or required of the assets and what is the cost of providing that level of service? Which assets should be first for replacement or maintenance and which ones can wait? How can a homogeneous level of service to the end-user across the complementary networks be ensured?

1.2 ASSET MANAGEMENT ENABLES SYSTEMATIC DECISION MAKING IN INFRASTRUCTURE MANAGEMENT

In general terms, asset management is a systematic process of developing, operating, maintaining, upgrading, and disposing of assets cost-effectively. Applied to infrastructure management it supports decision making on basis of insight into the condition of assets and the impact thereof on the routes and networks they form effectuating optimal service levels to the end-user (their functionality). Asset management also shows what levels of performance can be realised, as well as the cost and the risks involved. These insights enable balanced long-term strategic plans for the construction, management and maintenance of transport infrastructure. That then forms the basis for making transparent and consistent agreements across the entire line of sight from policies on mobility and transport to operations in the field.

Managing infrastructure assets in the context of such decisions is not new: infrastructure managers of all transport modes have been doing this for as long as they have existed. In the past, it was done implicitly and not always comparably, often based on expert judgement but with disparate approaches. Tasking in those days often focused on solely constructing and maintaining assets without factoring in long-term lifecycle aspects or overall network functionality.

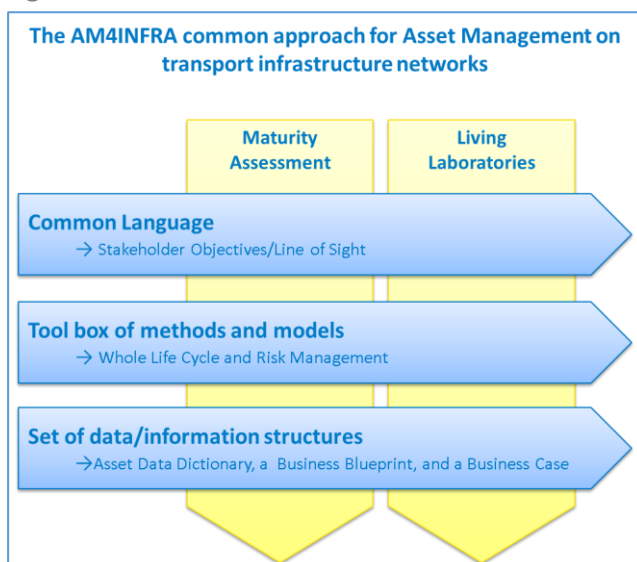
But this is neither sustainable nor today acceptable, recognising the importance of highly integrated and smoothly functioning infrastructure networks for the economic wellbeing of each country and the continent as a whole. Even more so, infrastructure managers are increasingly required to concentrate on the overarching functions of their networks, associated performance levels and

serviceability measures. This not only demands greater transparency and clarity for balanced decision-making within their networks, but also requires them to transcend the boundaries of their networks, organisations and countries.

1.3 A COMMON ASSET MANAGEMENT FRAMEWORK APPROACH

Network management and Asset Management by their very nature are very broad terms and can be difficult concepts and practices to readily implement. The AM4INFRA project has promoted and facilitated an integrated, systematic, common approach for Asset Management on transport infrastructure networks that is readily implemented, including a supporting tool box on critical elements (data, methods and models). The approach enables systematic, consistent translation of policy decisions on network level into the operational management and maintenance of the various assets in the infrastructure networks, such as surfaces, rails, bridges and runways.

Figure 1: The AM4INFRA common framework



The project was structured in to three principal work packages for delivery (horizontal blue arrows in the figure):

- Work package 1. Common Language: Stakeholders' focused objectives/Line of Sight.
- Work package 2. Tool box of methods and tools: Whole Life Cost and Risk Based Management.
- Work package 3. Set of data/information structures: Information and Data Management

In order to relate the common approach to the objective of learning from the practices of the participating organisations, the project deployed two demonstration and verification activities (the yellow arrows in the figure):

- a maturity assessment following the model from CEDR TG N2.
- three living laboratories on existing section of the national (road) networks.

In the next chapter the key results for each of the five elements in the figure are presented in concise terms.

2 RESULTS

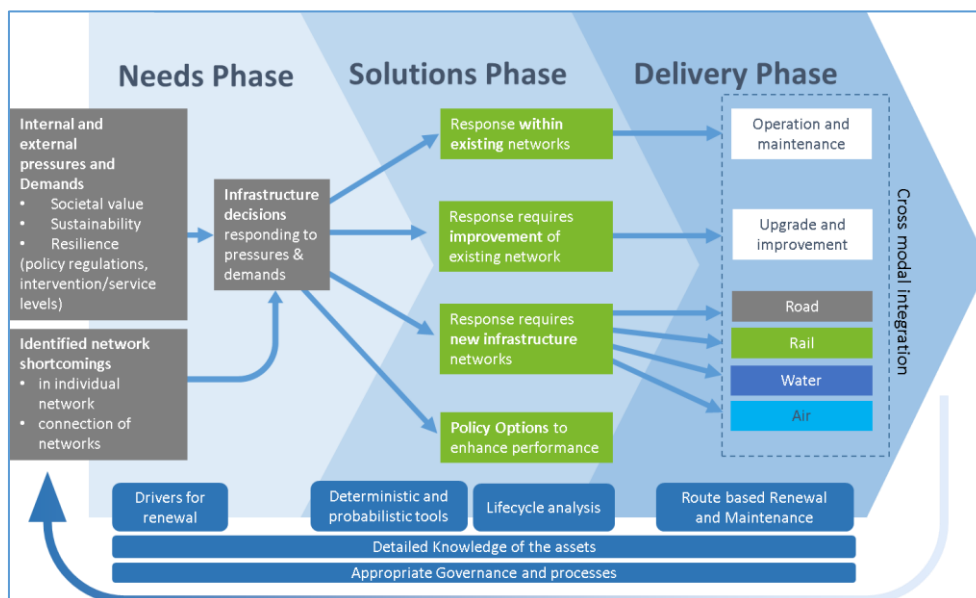
2.1 STAKEHOLDER OBJECTIVES/LINE OF SIGHT (WORK PACKAGE 1).

Key message 1: The asset manager relies on a variety of tools and methods in order to optimize the performance of existing networks and to optimize the value proposition of new infrastructure investments. Such optimization needs to be placed in a context of wider policy ambitions including concepts like resilience and sustainability. Balanced decision making determines the appropriate work stream for delivery; optimization current networks, improvement and upgrade of networks or development of new infrastructure.

Key message 2: To ensure effective and efficient use of resources, a consistent framework for reference, that links policy objectives for the network to condition and functioning of the individual assets, will be helpful. Such a framework provides a so-called ‘Line of Sight’ that can help in balancing efforts, avoiding losses by network incompatibilities and pushing symbiotic functioning of networks. The AM4INFRA project has delivered such common Line of Sight, including a detailed guideline for its application. See Figure 2

The activities have resulted in a common framework which establishes the tactical connection between strategic infrastructure policy objectives and the corresponding operational activities/works in the field (see also figure 2).

Figure 2: A “Line of Sight” framework



The figure shows the commonalities all NRAs share, and which are understood across all borders. This framework spans three project stages: Needs, Solutions and Delivery that combined from the co-called Line of Sight linking strategic infrastructure policy objectives (of the public asset owner) to the decision making of the asset manager, and to the corresponding operational activities/works in the field (by the service provider):

- **Needs stage:** The internal and external pressures that are encompassed in the needs stage, underpin the framework through which they are translated into concrete orders to service providers in the delivery stage, concerning the appropriate condition and functioning of the individual assets.
- **Solutions stage:** In this stage the appropriate workstream and further concrete steps are defined in order address the needs as defined in the previous stage. Typical activities in this stage are definition of the scope, budget and functional and/or technical requirements and process towards delivery.
- **Delivery stage:** The solution is materialized through management, improvement or upgrade works or new construction of assets. Tendering and contracting, realization, monitoring are typical activities in this stage.

The figure also presents how the three successive stages are linked to the six building blocks that provide the technical approach and methodology for optimising the efficient use of resources i.e. for decision making on Whole Life Costing and Risk Based management (for further detail, see section 2.2):

- Drivers for renewal
- Appropriate governance and processes
- Deterministic and probabilistic tools
- Lifecycle Analysis
- Route based renewal and maintenance
- Detailed knowledge of the assets

Across this so-called 'Line of Sight', the roles of asset owner, asset manager and (industrial) service provider have been identified to support the clear allocation of responsibilities and tasks which is an essential element of effective governance. This architecture sets out an overall decision tree which facilitates asset owners to manage their existing network better and help them understand where existing infrastructure can or cannot provide the levels of service demanded (see also figure).

In a generic way, it defines the various roles and responsibilities with the asset ownership, the asset manager and the service provider.

- At a **strategic level** the focus is on policy-makers and asset owners. How can they best strategically manage their assets – or invest in new assets – to achieve the greatest level of (societal) return on investment against the transport policy objectives?
- At a **tactical level** the framework assists asset owners and managers, e.g. at a regional level, to put their subsequent management objectives and strategic goals into practice (work flow).
- At an **operational level** the focus is on how it all translates into effective execution of the operational processes, including contracting works/projects with industrial service providers.

The architecture is generic in order to facilitate smart governance of integrated transport networks, enabling (and promoting) cross-modal and cross-border optimisation and associated guidance for users.

The internal and external pressures and demands in the needs stage, arise for the asset owner and are translated into performance levels that the asset manager has to provide. The issue as to how to best address these combined needs (i.e. to set the performance levels) is a complex optimisation process across often conflicting interests of societal value, sustainability and resilience.

The architecture provides the generic line-of-sight describing the basic steps each infrastructure agency will walk through in order to deliver their public value. These basic steps require, however, thorough analysis covering four major fields (described in detail in deliverable 1.2 – guideline for the use of the framework architecture). These fields are; optimisation for societal value (current needs and externalities), sustainability (value for future generations), resilience (maintain/recover value when disrupted) and cross-border and cross-modal optimisation (value from synergetic connected systems). These fields are briefly described below.

Societal value

The internal and external pressures and demands in the needs stage, are translated into performance levels that the asset manager has to provide. The issue as to how to best address these combined needs (i.e. to set the performance levels) is a complex optimisation process. This optimisation process does not only need to address primary needs, is also has to take into account the myriad of externalities associated with infrastructure development and the use of these networks. Optimisation of needs and externalities associated with the solutions provide the ingredients for optimisation in terms of societal value. Each country and/or organisation has its own regulations, traditions, and processes to deal with this variety of interests. Delivering on the needs, and simultaneously having keen eye on externalities and additional infrastructure-related values contribute to both the social licence to operate as well as delivery on the agreement with the asset owner.

Sustainability

Optimisation for current stakeholders alone can fall short in terms of value for the generations to come. The agenda, targets and policies on sustainability are determined on international, national and regional levels, and provide a mix themes and elements which need to be included in asset management activities of all sorts. These elements need to be included on top of stakeholder needs and externalities and can range from themes like materials, ecology and energy to social and economic sustainability issues.

Resilience

The resilience of the transportation networks is the ability of transportation systems to retain performance during and after disruption, undergoing little to no loss of performance, and their ability to return to the normal state of operation quickly after disruption. Hence, the concept of resilience is broad and from the transport system's perspective may cover various factors, extending from withstanding disruption, absorb disturbance, act effectively in a crisis, and adapt to changing conditions, including climate change, and growth over time. Two main dimensions can be identified, the technical and the organizational dimension. Technical dimension: covers the ability of the physical system(s) to perform to an acceptable/desired level when subject to a hazard event. The organizational dimension covers the capacity of an organization to make decisions and take actions to plan, manage and respond to a hazard event in order to achieve the desired resilient outcomes.

Cross-border and cross-modal optimization

Individual networks, limited by national borders or modality (rail, road or waterways), are often valuable by itself as a variety of users will be served well by these. However, for international travel

and trade, efficient supply chains and high connectivity, well-connected networks offer far superior value. Therefore, optimisation of these individual networks need to be done taking account of the wider context. Optimisation according to primary needs falls short of living up to the potential for society. In practice this means that interaction with neighbouring infrastructure agencies is worthwhile and pays off for both in terms of public value as well as effectiveness of responsible agencies.

2.2 WHOLE LIFE CYCLE COST AND RISK BASED MANAGEMENT (WORK PACKAGE 2).

Key message 1: To learn and grow as European network agencies we need a common language. The six building blocks, underpinning whole life cycle and risk based approaches, provide the words for this common language. The six building blocks commonly used by any infrastructure agency are;

1. Agreed service level
2. Appropriate governance and processes
3. Deterministic and probabilistic tools
4. Whole life cost calculation
5. Route based renewal and maintenance
6. Detailed knowledge of the assets

Key message 2: Not every organisation is as mature in implementing asset management; examples of good practises and learning outcomes from existing case studies are used to validate the six key building blocks which can be used at every stage of development.

The AM4INFRA activities have resulted in a tool box of tools and practices for lifecycle and risk-based approaches for transport infrastructure asset management, supported by evidence of their implementation, with particular application to assessing and prioritising investment for renewals and maintenance needs for the medium term (5-10 year horizon) and identifying and evaluating determining risks and benefits for the longer term (ie typically 10-30 years).

Recognising variability in maturity and in current approaches across Europe, and a need to allow a degree of flexibility the activities defined six fundamental building blocks representing established approaches, across Europe, for managing risk and life cycle models within an asset management framework. The presented building blocks were tested and validated by obtaining and reviewing examples of good asset management practice, from the AM4INFRA project partners, at the strategic, tactical and operational levels:

Drivers for renewal

- Defining triggers for intervention provides a direct link between the asset performance and investment decision making and an effective mechanism for controlling risk

Appropriate governance and processes

- Robust governance structures and process are essential for the identification, evaluation and control of risk in transport infrastructure asset management. Risk management may be an explicit element of the process.

Detailed knowledge of the assets

Lifecycle and risk-based approaches require asset data and information for effective implementation. Greater completeness, accuracy and currency reduces the uncertainty of decisions made on the basis of this data and information

Deterministic and probabilistic tools

- These tools include for uncertainty within the models. They provide a means for evaluating and managing that uncertainty in developing of programmes (tactical) and solutions (operational), providing an effective means of assessing and controlling risk

Lifecycle analysis

- Lifecycle-based approaches permit asset investment decisions to be planned on a rational basis over a timescale consistent with the life of the asset and, equally, determination of required resourcing levels for maintenance and renewals to guard against risk of failure

Route-based renewal and maintenance

- A route-based approach brings together the various building blocks and elements of the framework that is focussed on managing the risks to the delivery of safer, reliable and efficient end to end journeys for the users of transport infrastructure.

From the validation, key themes were identified for each of the six building blocks that may be of value to asset owners, managers and/or operators embarking upon or further developing their own implementation of infrastructure asset management.

| Building block | Good practice theme | Building block | Good practice theme |
|---|------------------------------------|--|---|
| Drivers for renewal | Statutory obligation | Detailed knowledge of the asset | Asset data system/Asset information system |
| | Requirements for regulated service | | Asset Performance models |
| | Strategic Objective | | Survey regime |
| | Performance indicators | | Asset data |
| | Functional requirements | | Deterioration modelling |
| | Performance requirements | | Programme development |
| Appropriate governance and processes | Investment strategy | Deterministic and probabilistic tools | Solution development |
| | Asset Management Strategy | | Lifecycle analysis |
| | Asset Management System | | Cost-benefit analysis |
| | Clear process | | Optimisation of investment over asset lifecycle |
| | Organisational structure) | | Investment scenario planning |
| | Programme development | | Route-based strategy |
| Appropriate governance and processes | Service Provider contracts | Whole life cost calculation | Cross-jurisdictional coordination |
| | Stakeholder engagement | | Cross-mode coordination |
| | Independent audit | | Cross-asset coordination |
| | | | Resilience |
| | | | Route criticality |
| | | | |

Based on the good practice case examples it was possible to assess areas where the good practices were established, under development or identified as an area for future development by the NIAs.

The table below summarises these findings which are further verified by some case studies demonstrating good practise:

| Building Blocks (BB) | Drivers for Renewal | Whole Life Cost Calculation | Deterministic and probabilistic tools | Appropriate governance processes | Detailed Knowledge of the assets | Route based renewal and maintenance |
|---------------------------|---------------------|-----------------------------|---------------------------------------|----------------------------------|----------------------------------|-------------------------------------|
| Asset Scheme | | | | | | |
| Structures | Green | Yellow | Green | Green | Green | Green |
| Pavements | Green | Yellow | Green | Green | Green | Green |
| Drainage | Green | Yellow | Green | Green | Yellow | Green |
| Earthworks | Green | Yellow | Green | Green | Green | Green |
| AM Planning | Green | Red | Yellow | Green | Yellow | Yellow |
| Structures TII | Green | Red | Red | Green | Green | Green |
| Luas Rail Replacement TII | Green | Red | Yellow | Green | Yellow | Yellow |
| Pavements TII | Green | Yellow | Green | Green | Yellow | Green |
| Key | | | | | | |
| BB - Good practice | | Green | | | | |
| BB - Under development | | Yellow | | | | |
| BB - Not yet | | Red | | | | |

Case study example: Drivers for renewals

Performance Indicators

D2.2 Report Case Example E: Highways England – asset management planning

Highways England has a suite of KPIs which it must deliver under the terms of its Licence from DfT, one of which is specifically related to the condition of the highway asset. These are supplemented by further PIs which provide the facility for more detailed reporting and monitoring.

D2.2 Report. RWS Reference document 3-02. Assessment and management of risks at bridge and network levels.

RWS has developed a suite of Performance Indicators that relate risk at asset level to network performance for the prioritisation of maintenance. The PIs cover:

- Reliability
- Availability
- Maintainability
- Safety
- Security

Case study example: Appropriate governance and processes

Service Provider Contracts

D2.2 Report Case Example P: TII LUAS light rail system, rail replacement

TII make use of service provider contracts for operation and maintenance of the network to “facilitate the performance of corrective and preventative maintenance to sustain the asset condition and passenger service operation” while retaining the responsibility for asset renewal. TII have noted that too long duration service contracts adversely affect market

The third and final phase as to develop best practice guidance based on the common framework for a lifecycle and risk-based approach that was developed and validated in the earlier phases.

The guidance aims to explain and illustrate the value and application of the six building blocks, together with themes that were identified within them from the case examples, in the context of application at the strategic, tactical and/or operational levels by asset owners, asset managers and/or service providers. Some of the case examples from the review undertaken in phase 2 have been highlighted to illustrate how the framework may be interpreted and applied for NIAs with differing circumstances, requirements and levels of asset management maturity.

Key message 1: Data in itself is a major asset in the management of transport infrastructure.

Key message 2: Effective cooperation across the line of sight is only possible when all parties apply a clear framework for data and information provision. The common framework offers an asset data dictionary, a proposed system architecture and blueprint as well as guidelines for setting up the information and communications technology (ICT) side of an asset-management system.

In summary, the six building blocks represent a framework of core principles to support a lifecycle and risk-based approach to transport infrastructure asset management that has been tested and validated through the review of good practice and the Living Labs. The framework is not intended to provide or imply a particular methodology or approach under the building block themes, as this will need to be tailored to the particular needs and circumstance of the location and operating environment, such as funding and governance arrangements, rather the main elements that should be implemented to support effective asset management and investment planning for renewal and maintenance.

2.3 DATA AND INFORMATION MANAGEMENT (WORK PACKAGE 3).

2.3.1 ASSET DATA DICTIONARY (ADD)

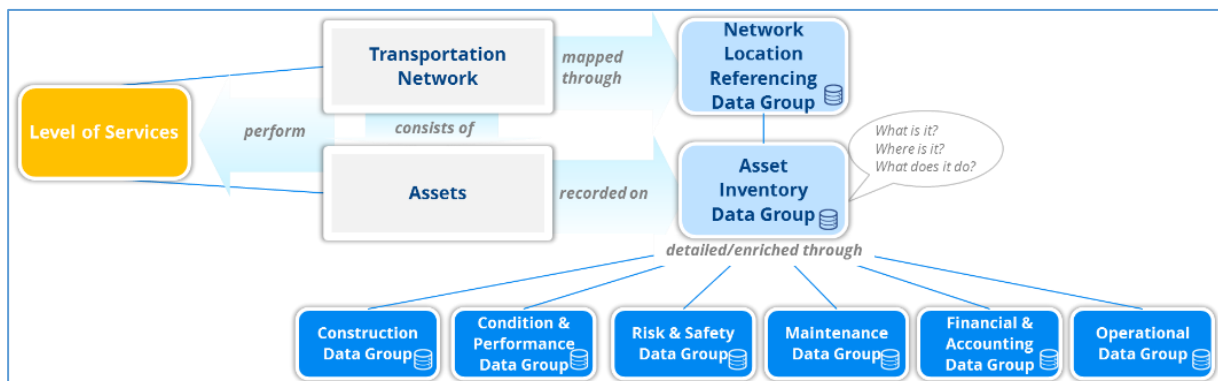
To support improvement of asset data management across transportation network stakeholders (owners, managers and operators) AM4INFRA project designed an Asset Data Dictionary as first pillar of an asset data common approach. An Asset Data Dictionary (ADD) identifies which are the relevant information and related attributes that can constitute a common data dictionary for asset data management.

ADD has the following hierarchical structure:

- Data Group (“Domain”): a logical grouping of data associated to a specific asset management field/knowledge (e.g. maintenance process, road infrastructure, etc.)
- Dataset: data set corresponds to the contents of a single table where each row corresponds to a given data item of the data set in question;
- Data Item: basic element, with its own description, corresponding to the lowest object of asset dictionary;

Regarding Asset Data Dictionary contents, they can be summarized as follows:

- Two core data groups (Network Location Referencing, Asset Inventory) to identify both the network topological model and the asset register; within asset register, asset types should be characterized according to the network type (e.g. road, rail or waterway);
- Six data groups, which information could be common across transportation assets (Construction, Condition & Performance, Risk & Safety, Maintenance, Financial & Accounting, Operational);



2.3.2 BUSINESS BLUE PRINT (BBP)

The drawing up of a Business Blue Print (BBP) related to an Asset Information Management Core System (AIMCS) has represented the second pillar for the development of a common approach for asset information management.

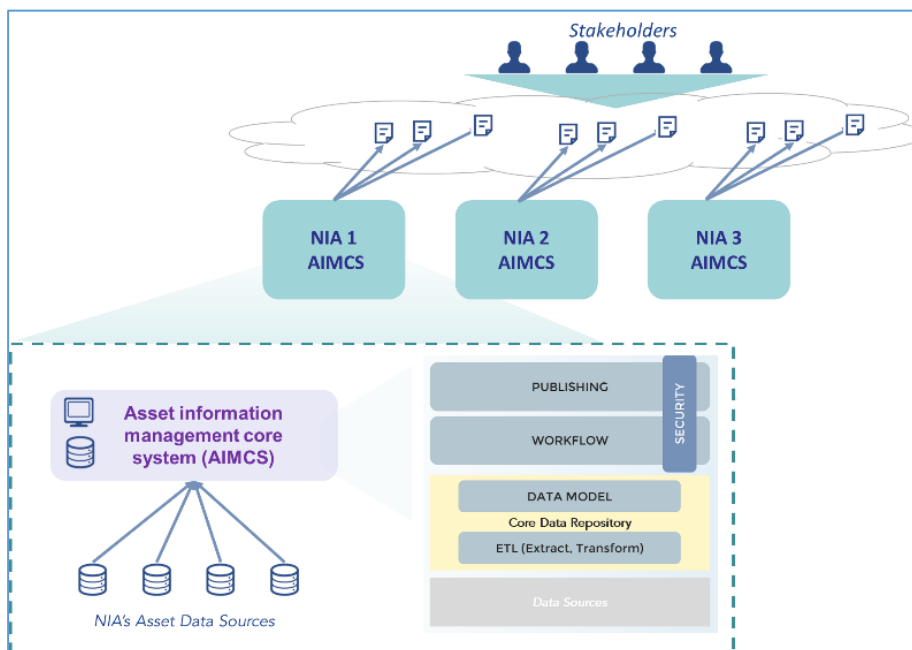
BBP is a detailed document about the scope, the specifications and the completeness of an IT solution (details, components, processes, users, functions, programs, enhancements, and so on) in order to obtain desired outcomes and benefits.

Within BBP, the following goals for an Asset Information Management Core System (AIMCS) has been identified:

- to integrate in one single repository the core data related to each NIA's assets;
- to improve asset data governance and control asset information publishing process;
- to standardize the dissemination of asset information towards stakeholders or across NIAs;

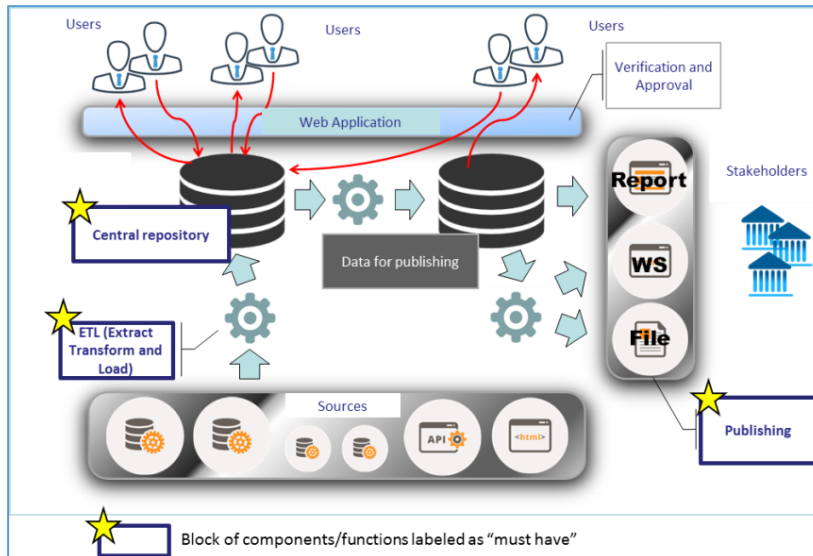
AIMCS has the following inputs/outputs:

- Inputs for AIMCS: data sources are NIA's IT system databases (Maintenance System, Asset Inventory System, Financial System, etc.), where asset data are usually scattered;
- Outputs of AIMCS: information (e.g. KPIs, reports, etc.), derived from loaded data, published to stakeholders;



- AIMCS main functionalities are summarized as follows:
 - to extract asset data present in several IT systems (data sources);
 - to aggregate and transform them according to a standard data model (derived from the ADD scheme) and to be compliant to publishing rules;
 - to assure data reliability, integrity and uniqueness;
 - to manage verification and approval processes through a web interface;
 - to publish information that could be shared within various asset stakeholders;

- to keep stored in a repository all past approved and published data;
- to allow profiling and accessibility to the front-end application.



The core block of components/functions labeled as "must have" are the following:

- Central repository: this is the AIMCS foundation and the starting point to build the system;
- ETL (Extract Transform and Load): in order to be able to get data from source systems (or from file) and produce the outputs;
- Publishing: ability to provide at least files containing the information for the stakeholders.

2.3.3 REAL CASE SCENARIO

- Third pillar for project model is the application in a real case scenario of the defined data and information framework. The task will be completed on **August '18** and aims at verifying how information models and IT solutions identified in "Asset Data Dictionary" and in "Business Blueprint of an Asset Information Management Core System" would fit in a real case.
- To achieve this verification, the task will design and deliver a proof of concept (POC) of the previous deliverables applied on a real road itinerary; as POC, we identify a demonstration, the purpose of which is to verify that certain concepts or theories have the potential for real-world application.

2.4 ASSESSING ORGANISATIONAL MATURITY

Key message 1: Assessing the organisational maturity provides helpful guidance in learning from each other's strength and practices. In particular when assessments differ by two or more points on a specific aspect, one would expect benefits from entering into a learning dialogue. From this assessment it appears that all participating organisations have at least one best-practise for the others to learn from:

- TII: LCC thinking
- ANAS: Connect and join IT systems to useful data for users
- RWS: Funding and performance-based contracting
- AWV: Stakeholder surveys and engagement
- SIA/ZAG: Line of sight from Strategy to Directives and Operational plan.

However, experience shows that many other points of learning are likely to arise during the dialogue when touching on the specific topics.

Key message 2: The quick scan method applied in the AM4INFRA project –following the method recommended by former CEDR TG N2- proved itself to be efficient and easy to use. The procedure was a quick self-assessment followed by a teleconference with the coordinators/consultants in order to verify/validate the results from the self-assessment. Repeating this exercise periodically would help to mark developments in maturity at little cost.

Key message 3: The five organisations assessed, delivered comparable scores. This could imply they are facing the same opportunities and barriers in implementing Asset Management in their organisations.

Maturity measurements can support organisations in identifying their strengths and weaknesses in relation to their intended goals. This enables organisations 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 Institute of Asset Management and the Global Forum on Maintenance & Asset Management (GFMAM), the CEDR N2 Task Group developed a maturity scale and has established four generic maturity levels as described in the following table:

Table - CEDR Task Group Generic Asset Management Maturity Scale

| | Maturity Level | Description | <i>Equivalence to IAM</i> |
|---|------------------------|--|---------------------------|
| 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. | <i>Levels 0 & 1</i> |
| 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. | <i>Level 2</i> |
| 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. | <i>Level 3</i> |
| 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. | <i>Level 4 & 5</i> |

The CEDR Asset management maturity matrix is based upon the self-assessment tool from the Institute of Asset Management to measure the maturity of an organisation compared to the ISO 55000 standard and other available maturity measurement tools. In order to better suit the sector specifics of the CEDR members the final tool has been adapted by CEDR.

The tool is composed of five themes which combined cover the majority (but not whole) spectrum of asset management. These five themes are:

- Asset Knowledge and Information
- Strategy & Planning
- People and Organisation
- Stakeholders
- Risk Management

For a more detailed description of the sources used and the road towards the CEDR maturity matrix please consult the Asset Management TG Final Report 2017 [CEDR TR 2017-06].

The following authorities participated in this comparison: ANAS – Italy; AWV – Flanders (Belgium); RWS – The Netherlands; SIA – Slovenia; TII – Ireland.

Annex I provides the spider diagrams for each of the five themes.

A key aspect of the project is the replication potential for the common approach. The AM4INFRA team considered that assessment of such potential would be underpinned by an organizational maturity assessment. However, this would only be the case if the assessment outcomes were

perceived as relative i.e. by comparison and were to be used in guiding a conversation in learning from each other by indicatively marking extreme differences in scores between the organisations.

The use of the method recommended by TG N2 was found to be effective and instrumental to inter-organizational learning.

2.5 DEMONSTRATING AND VERIFICATION.

Key message 1: Use of living labs proved to be a valuable, energetic work format as it linked concepts to context specific problems and challenges.

Key message 2: The three living laboratories in the project will be sustained as learning environments under the project legacy (proposed CEDR Working Group on Network Governance).

Key message 3: One common denominator was that it all starts with getting acquainted with one another, with colleagues at the neighbouring network agency, and finding common ground to make further steps. In this way the living labs provided fruitful ground in making these first steps. The Living Labs provided stakeholders the opportunity to understand each other's needs and paradigms and get acquainted with their counterparts in neighbouring agencies.

Key message 4: The living labs showed that this "learning by doing" approach provides a viable and energetic path forward for the wide variety of agencies involved in optimizing our European transport networks

Learning by doing has been a key principle of the AM4INFRA project. For this reason, the project not only delivered a framework approach, tools and guidelines for asset management, but also demonstrated and verified these in practice through three living laboratories. These 'living labs' provide a learning environment against the backdrop of practical situations on the TEN-T network.

The living labs were designed to cover three major themes of the project, namely cross-asset, cross-network, cross-border optimization in terms of performance, risk and cost. These three themes correspond with the three work packages, where Work Package 1 covers cross border issues, Work Package 2 the cross-network issues in terms of life cycle management and risk-based approaches, and Work Package 3 the cross asset issues. In practical terms the responsible institutions for each of the work packages managed the set-up and organization of the respective Labs:

| Living Lab | Focus | Cross Asset | Cross Mode | Cross Border |
|---------------------------------|-------|-------------|-------------------------------|--|
| E34 (Antwerp-Venlo) | WP 1 | No | Yes (road, rail, waterway) | Yes (Belgium/Flanders-Netherlands) |
| M4-M25 (London-Heathrow) | WP 2 | Yes | Yes (Road-Metropolitan) | Yes (public-private; national-metropolitan) |
| A90 (Rome Ringway) | WP 3 | Yes | No | Yes (public-private; national-metropolitan) |

In each of these living laboratories, the common framework was used to promote dialogue with the local managers and stakeholders, and to learn how the framework would support and enhance their current practices of managing the infrastructure assets (annex II).

The Rome and Eindhoven living labs were both held as one-day events. The London living lab was a two-day event. The London living lab was scheduled back-to-back with the Executive Board of the CEDR which allowed many executives to join this living lab. As this was the third living lab in the series, it also provided the opportunity to share the results of the previous labs (Rome and Eindhoven) with the board members of CEDR and other participants. This formal engagement with the CEDR EB through the London living lab contributed to the leverage, impact and dissemination of the project results in AM4INFRA Work Package 4.

In the Eindhoven Living Lab, the guidelines for the use of framework architecture for smart governance of transportation networks were validated showing many elements of the applied procedures and it also stimulated the conversation at a cross border level. In the London Living Lab, where Life Cycle Management across the networks was a central theme, dialogues were held bridging the gaps in understanding and approaches by the variety of agencies present. Finally, in Rome Living Lab, a comprehensive debate and approval of the asset data ontology map, delivered fertile ground for further cross-asset network optimization.

In total around 100 participants joined these living labs, representing over 20 infrastructure agencies or affiliate organizations.

The three living laboratories mentioned will be sustained as learning environments under the project legacy (proposed CEDR Working Group on Network Governance). As implementation of the common framework inevitably will have to support and sustain the specific organisational setting of the infrastructure manager(s) involved it is envisaged that over the years to come, more living labs will be initiated driving a growing number of communities of practice across Europe. By expanding the scale of application of living labs the legacy of AM4INFRA will be leveraged, and more importantly the learning curve to optimize EU networks will be steepened in a broader sense.

The use of living labs proved to be an inspiring work format as it linked abstract concepts to context specific problems and challenges. As the format involved lively dialogues, the results did at the time cover a wider array of topics than initially conceived. In general, however, valuable feedback was gained from the interaction with and between participants. The Living Labs provided stakeholders the opportunity to understand each other's needs and paradigms and getting acquainted with their counterparts in neighbouring agencies.

Overall the application of living labs provided a mechanism for strengthening the cooperation between infrastructure agencies and building a converging growing path. They provided inspiration, stimulated mutual learning and paved the way to a common language.

3 REFERENCES AND HYPERLINKS

3.1 WP 1 DELIVERABLES (STAKEHOLDERS INTERESTS AND OBJECTIVES)

D1.1 Framework architecture for Smart Governance of Transportation Networks

http://www.cedr.eu/download/other_public_files/am4infra_public_files/AM4INFRA-D1.1-Framework-architecture-for-smart-governance-of-Transportation-Networks.pdf

D1.2 Guideline for the use of the framework architecture;

http://www.cedr.eu/download/other_public_files/am4infra_public_files/AM4INFRA-D1.2-Guideline-for-the-use-of-the-framework-architecture-FINAL-October-2017.pdf

D1.3 Living lab for three real life situations (cross-asset, cross-network, cross-border)

http://www.cedr.eu/download/other_public_files/am4infra_public_files/AM4INFRA-D1.3-Living-Labs-FINAL-resized.pdf

3.2 WP 2 DELIVERABLES (WHOLE LIFE CYCLE AND RISK MANAGEMENT)

D2.1 Whole Life Cost and Risk Based models for Road Asset Management

http://www.cedr.eu/download/other_public_files/am4infra_public_files/AM4INFRA-D2.1-Whole-Life-Cost-and-Risk-Based-models-for-Road-Asset-Management-.pdf

D2.2 Case Examples Of Good Practice For Applying Whole Life Cost And Risk Based Approaches At Strategic, Tactical And Operational Levels

http://www.cedr.eu/download/other_public_files/am4infra_public_files/AM4INFRA-D2.2-Case-Examples-of-good-practice-for-applying-whole-life-cost-and-risk-based-approaches-at-strategic-tactical-and-operational-levels.pdf

D2.3 Framework for Adopting Whole Life And Risk-Based Approach In Europe

http://www.cedr.eu/download/other_public_files/am4infra_public_files/AM4INFRA-D2.3-Framework-for-adopting-whole-life-and-risk-based-approach-in-Europe.pdf

3.3 WP 3 DELIVERABLES (DATA/INFORMATION MANAGEMENT):

D3.1 Asset Data Dictionary

http://www.cedr.eu/download/other_public_files/am4infra_public_files/AM4INFRA-D3.1-Asset_Data_Dictionary.pdf

D3.2 Business Blueprint Of An Asset Information Management Core System

http://www.cedr.eu/download/other_public_files/am4infra_public_files/AM4INFRA-D3.2-Business-Blue-Print-of-an-asset-information-management-core-system.pdf

D3.3 Application of The Design Model

http://www.cedr.eu/download/other_public_files/am4infra_public_files/AM4INFRA-D3.3-Application-of-the-design-model-final-report.pdf

3.4 WP 4 DELIVERABLES (COMMUNICATION, DISSEMINATION AND KNOWLEDGE TRANSFER):

D4.4 Series of Stakeholder Engagement Visits and Tech Transfer Visits

http://www.cedr.eu/download/other_public_files/am4infra_public_files/AM4INFRA-D4.4-Series-of-stakeholders-engagement-visits-and-tech-transfer-visits.pdf

D4.5 Replication Assessments for each Stakeholder

http://www.cedr.eu/download/other_public_files/am4infra_public_files/AM4INFRA-D4.5-Replication-Assessments-for-each-Stakeholder.pdf

D4.7 Mission statement of the PCS, organisational structure and the nature of the PCS, governance structure

http://www.cedr.eu/download/other_public_files/am4infra_public_files/AMINFRA-D4.7-Mission-statement-of-the-PCS-organizational-structure-and-nature-of-the-PCS-governance-structure.pdf

3.5 REFERENCES

[CEDR TR 2017-06] Asset Management TG (N2) Final Report 2017:

http://www.cedr.eu/download/Publications/2017/CEDR_TR2017-06-Asset-Management.pdf

[CEDR AP 2017] CEDR Rolling Action Plan 2017-2020

<http://www.cedr.eu/strategic-plan-tasks/action-plan-2018-2020/am4infra/>

Shortly after each living lab a webinar was held to share, consolidate and disseminate the gained insights. Recordings of the webinars:

<http://www.am4infra.eu/living-lab-a90-rome/>

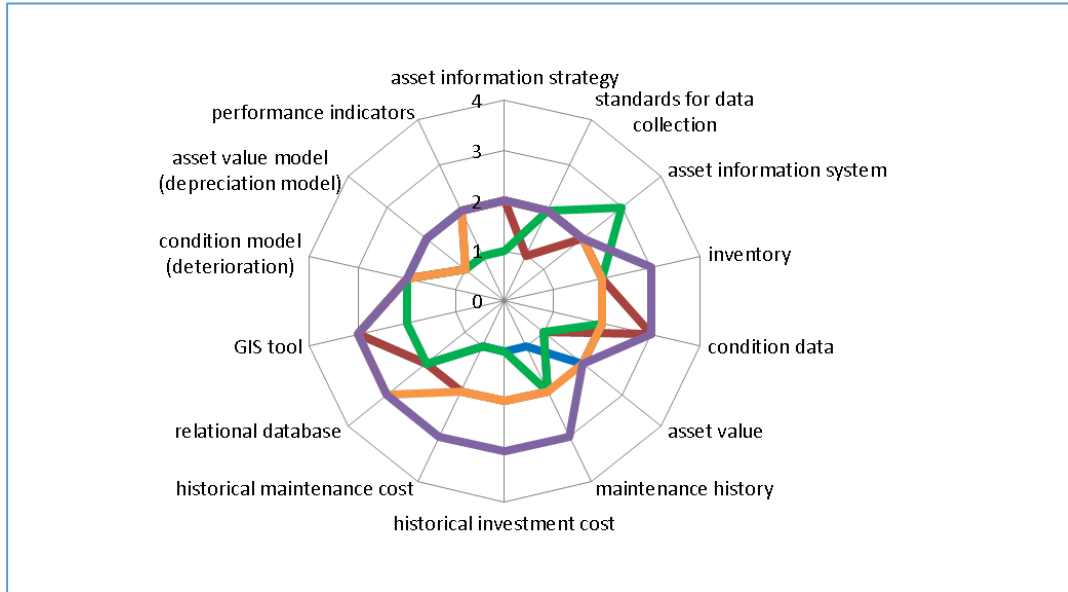
<http://www.am4infra.eu/living-lab-e34-eindhoven/>

<http://www.am4infra.eu/living-lab-m4-london/>

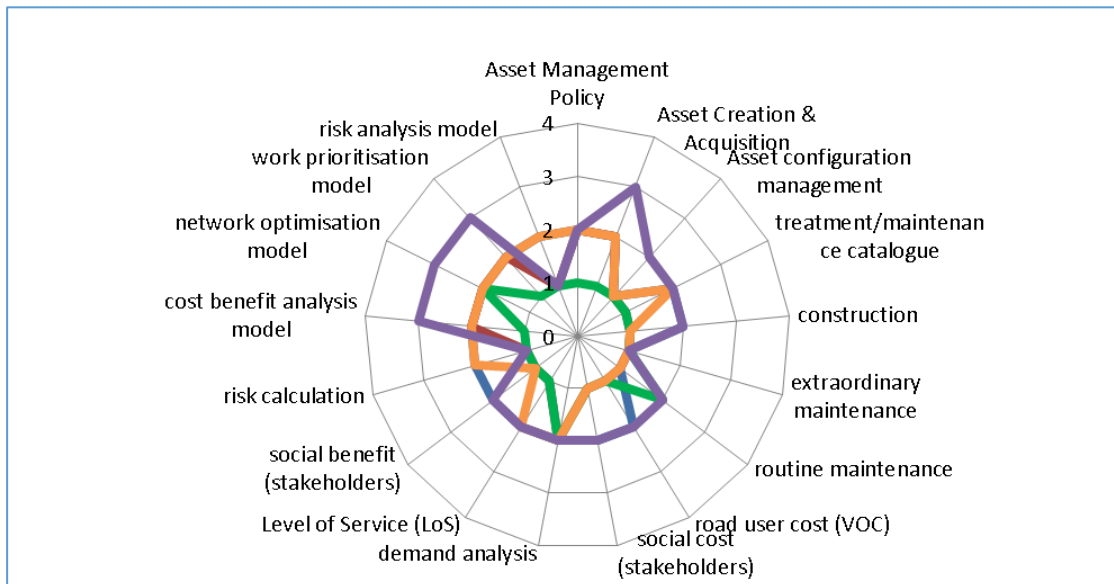
ANNEX I – MATURITY ASSESSMENT

The following authorities participated in this comparison: ANAS – Italy; AWV – Flanders (Belgium); RWS – The Netherlands; SIA – Slovenia; TII – Ireland.

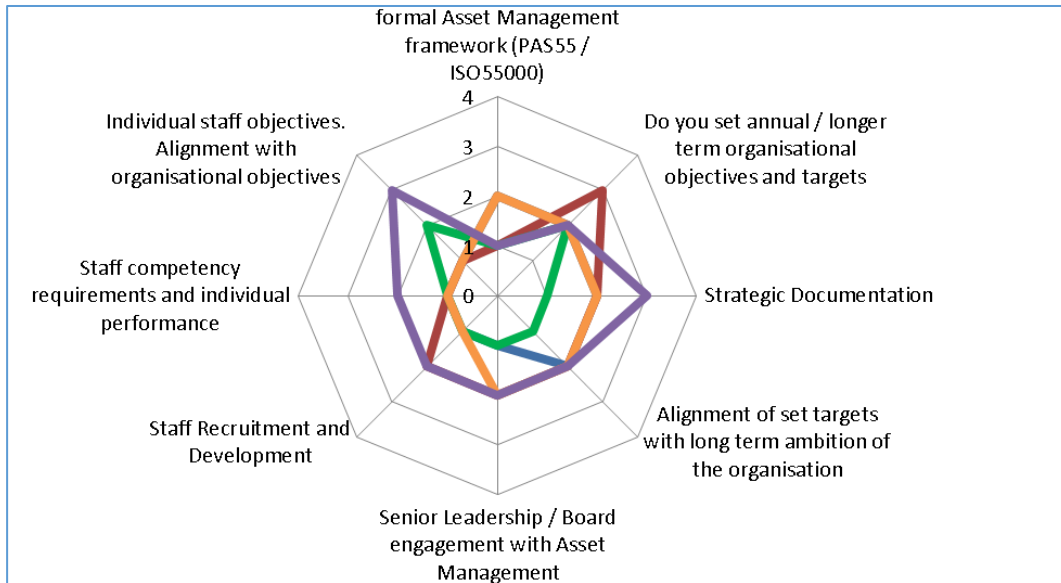
ASSET KNOWLEDGE AND INFORMATION



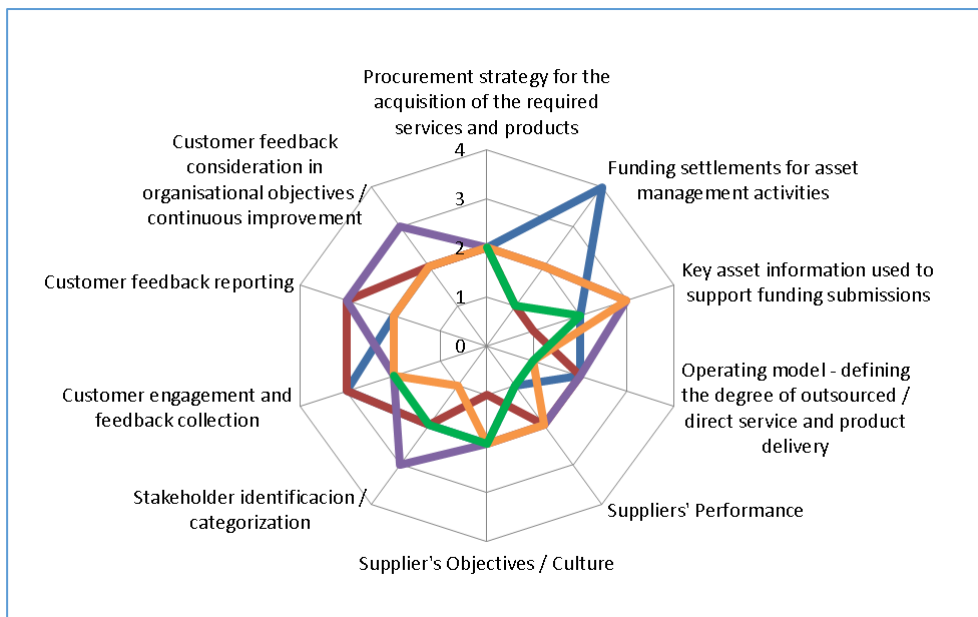
STRATEGY AND PLANNING



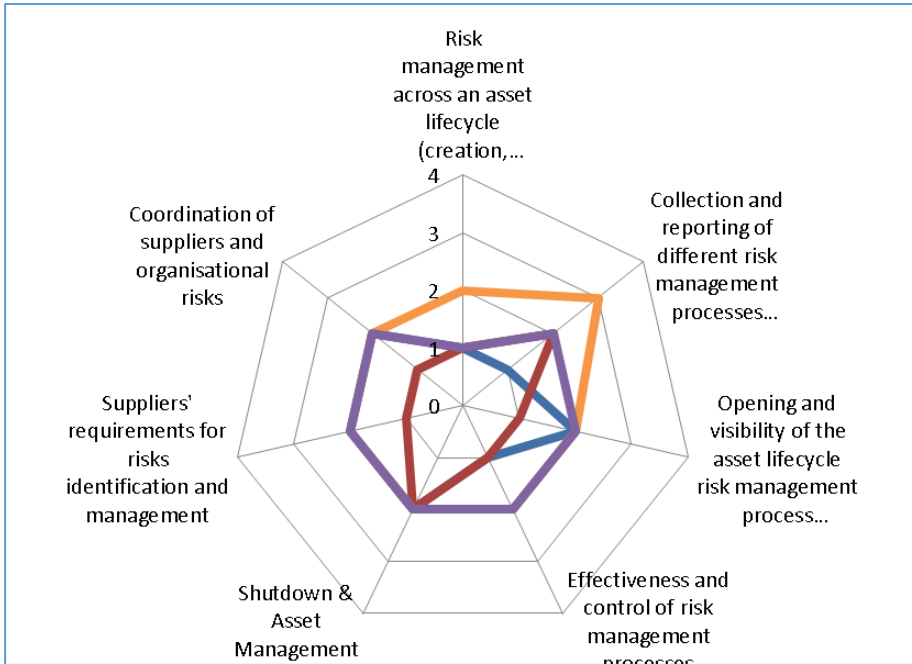
PEOPLE AND ORGANISATION



STAKEHOLDERS



RISK MANAGEMENT



ANNEX II – LIVING LABS

PHOTO IMPRESSION LIVING LAB EINDHOVEN



AM4INFRA



PHOTO IMPRESSION LIVING LAB LONDON



PHOTO IMPRESSION LIVING LAB ROME





NEWSLETTER AM4INFRA OUTCOME LIVING LABS

May 2018

Issue 3



AM4INFRA builds a common framework for a European life-cycle based asset management approach for transport infrastructure

HORIZON 2020 Project

AM4INFRA has received funding from the European Union's Horizon 2020 research and innovation programme under grant 713793.



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Outcomes of the three Living Labs: Rome, Eindhoven and London

The “**Living Lab**” is a concept which aims to provide the opportunity to embed and verify elements of the AM4INFRA (Asset Management for Infrastructure) framework approach into real life scenarios and practices. This is a dynamic process where continuous learning is assimilated as the project evolves and provides a platform for key stakeholders to engage in and collaborate on the long-term management and coordination of transport infrastructure planning, investment and communication.

In the context of the **AM4INFRA project**, three living labs have been held: (i) the Rome Living Lab, (ii) the Eindhoven Living Lab and (iii) the London Living Lab. These living labs cover the three central themes of the project: (i) cross asset optimisation (the **Rome** Living Lab), (ii) cross border optimization (the **Eindhoven** Living Lab) and (iii) cross network optimisation through an examination of asset life

<http://www.am4infra.eu/>

PROJECT PARTNERS



cycle management and risk-based approaches (the **London Living Lab**). In total, around 100 participants joined these living labs, representing over 20 infrastructure agencies or affiliate organisations.

These three living labs produced a **number of conclusions** from both a technical and soft skills perspective. Generally, the application of these living labs succeeded in **strengthening the cooperation** between infrastructure agencies and building a converging growing path, as well as providing inspiration, stimulating mutual learning and paving the way to a **common language**.

Living lab Rome – A90

The first AM4INFRA Living Lab was held on 31st January 2018 at the Sala Situazioni Nazionale, ANAS Headquarters in Rome, Italy. This Living Lab was concentrated on a 70 km stretch of the Rome Ringway A90.



Motorway A90 in Rome.

The main scope:

- Demonstration and validation of the applicability and practicality of the asset data management approach;
- Recommendations for further improvement of asset data dictionary and Business Blueprint;
- Dissemination and outreach of the AM4Infra initiative.

Results:

1. **WP3 approach and methodology:**
 - Some 2-3 specific suggestions related to the ontology map that has been included in the final report:
 - **Ontology Map:** “Risk” concept to be connected to Maintenance Works and LoS, introducing a double view for risk (asset-oriented and road user-oriented).
 - **Asset Data Dictionary:** new datasets to be introduced in the asset inventory data group, considering elements related to telecommunication and ITS systems installed on the network.
2. **The road itinerary based on a common AM-LCC approach:**
 - The agreement on the corridor and criteria of the case study.

- A first identification of constraints/threats with respect to the common approach.

Living Lab — Eindhoven E34.

The second Eindhoven Living Lab took place on 21st February in Antwerp, Belgium. The focal point of the Eindhoven Living Lab was cross-border optimisation. This motorway is a major artery connecting Antwerp and wider Flanders with the Netherlands and Germany further to the west.



Motorway E34 along Eindhoven

The main scope:

To demonstrate and verify the applicability and practicality of the guidelines and establish if any further improvements are needed.

Results:

1. Need for cross-border alignment for:
 - Planning of renovation works
 - Future functionality
 - Lorry parking facilities
2. Joint opportunity (and issues) map
3. Get cross-border acquainted
4. Shortlist of priorities and required participants for follow-up Living Labs

General conclusions:

- Cross-border issues are not isolated elements (not in time, type of work, institutional players)
- Cross-border issues easily propagate deep into national networks (alternative routes/cross-modal solutions/parking facilities)
- Be aware of institutional asymmetry (mandate, responsibility, work culture etc)
- Language is important (meaning and terminology)

Living Lab – London M4.

The third London Living Lab took place in Old Windsor, close to London's Heathrow airport on 8-9th March 2018. This living lab was



Motorway M4 in London

concentrated on the M4 (London - Wales) motorway - the main strategic route between London, the west of England and Wales.

The main scope:

To verify and demonstrate the common framework of the life cycle and risk-based management element.

Results:

1. **A good opportunity** to discuss detailed topics and learn from each other
2. **Helped understanding of the practical links** between the six building blocks (data, systems/tools, organisations and WLC and managing risk)
3. **Management level/strategic systems are important** influence on the effectiveness of asset management, not just operational and tactical levels



Life cycle management and risk-based approach framework – Six Building Blocks

The results of the Living Labs were given at the AM4INFRA Final Conference on Wednesday 18th April at the Transport Research Arena (TRA) 2018 event in Vienna, Austria. More details to be given in the near future in the next issue of this newsletter.

For more details on AM4INFRA, see <http://www.am4infra.eu>, watch the [first AM4INFRA video](#) and the [second AM4INFRA video](#) or contact the Dissemination and Communication leader [Adewole Adesiyun](#).

Ref: CEDR Technical report 2018-02 – Common framework for a European Life Cycle based Asset Management approach for transport infrastructure networks: Final report of AM4INFRA project

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