

COMMON FRAMEWORK FOR A LIFE CYCLE BASED ASSET MANAGEMENT APPROACH FOR TRANSPORT INFRASTRUCTURE NETWORKS

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ABSTRACT

Achieving a well-integrated, optimal performing transport infrastructure network in Europe is a key element in the White Paper on Transport's overall ambition for a single European Transport Area in 2050. As such it complements and supports the pillars on efficient and sustainable transport means and operations.

The required integration and enhancement of the European transport infrastructure networks needs a shift towards next levels of governance capabilities that can adequately address the key societal challenges. In the framework of the AM4INFRA project on a life cycle based asset management approach for transport infrastructure networks, these challenges are related to:

- An unprecedented call for network capacity and performance
- An unprecedented call for transparent, coherent and consistent decision making on cost-performance

The (mostly public) financing of the transport infrastructure system has met with concrete fiscal limits. Already in many countries in the EU, this has led to a backlog in maintenance and replacement. Unless decisive actions are taken on network construction, maintenance and operations, this trend will result in mounting congestion losses in the economic powerhouses on the short term and to prohibitive obstructions in transport flows across the European transport network on the medium term. This calls for cross asset, cross modal and cross border decision making by the appropriate authorities, implying their close coordination and collaboration.

The paper describes the overall objective of the AM4INFRA project, its concept and the results of the framework architecture developed as one of the three cogwheel elements of the project i.e. the common language.

1. INTRODUCTION

Achieving a well-integrated, optimal performing transport infrastructure network in Europe is a key element in the White Paper on Transport's overall ambition for a single European Transport Area in 2050. As such it complements and supports the pillars on efficient and sustainable transport means and operations.

The required integration and enhancement of the European transport infrastructure networks needs a shift towards next levels of governance capabilities that can adequately address the key societal challenges. These challenges are related to:

- An unprecedented call for network capacity and performance.

Our society is in transition under the influence of a variety of trends, which alter the current ways of transport profoundly. Key elements in these trends are:

- the upkeep of existing, ageing infrastructure asset systems resulting in the demand for timely maintenance, rehabilitation and replacement, but minimising delays to transport network users with their safety as the top priority;
- the rapid increase in society's demand for the next level transport network capacity and performance levels, including the far-reaching transitions in energy and information provision and the urgent demand for protection and security;
- the mitigation of and adaptation to climate change effects in particular to provide network resilience and to prepare long term investment plans.

The governance challenge is to provide society with appropriate transport network capacity and performance levels, including the complementary energy and information provision as well as integral protection and security.

- An unprecedented call for transparent, coherent and consistent decision making on cost-performance.

The (mostly public) financing of the transport infrastructure system has met with concrete fiscal limits. Already in many countries in the European Union, this has led to a backlog in maintenance and replacement of the current system to the point that key sections in the European network experience limited access or even blockage.

Unless decisive actions are taken on network construction, maintenance and operations, this trend will result in mounting congestion losses in the economic powerhouses on the short term and to prohibitive obstructions in transport flows across the European transport network on the medium term.

This calls for cross asset, cross modal and cross border decision making by the appropriate authorities, implying their close coordination and collaboration. The precondition for this is transparency to each other as well as to policy and society. This requires them to share a common vision and objectives, in a common language and from a common information base.

The governance challenge is to provide the key stakeholders in the infrastructure governance with appropriate data, methods and tools in order to enable their decision making on cost-

performance to be transparent, coherent and consistent across the assets, across the modes, and across the borders.

- Towards the next level in governance.

The governments and the European Union have mandated the transport infrastructure authorities to address these challenges. This requires two major development steps that build on current practices and approaches and that yield quick practical wins: First, a further enhancement of current asset management practices is needed in order to enable effective and efficient decision making across the assets within the individual modes. The result from this step will serve as a consolidated basis for the second step: a strengthening of the asset management approach across modes and borders.

The foundation of these two steps is fostering coordination, cooperation and learning between the key stakeholders involved in infrastructure governance. From persistent and joint learning-by-doing actions, a common framework for life cycle based decision making will be built step by step.

AM4INFRA (Common Framework for a European Life Cycle based Asset Management Approach for transport infrastructure networks) is a European Union's Horizon 2020 funded project which aims to overcome the legacy of European transport networks under which they have been developed incrementally (and mostly fragmented) over time within the specific setting of mode and country under various policies and service levels. Building on ongoing bottom-up actions, best practices and contemporary experiences of four National Infrastructure Agencies (NIAs) that are considered frontrunners in the development and application of asset management in their networks governance, it will deliver the first ever common European asset management framework approach that enables consistent and coherent cross-asset, cross-modal and cross-border decision making in the context of the White Paper on Transport. This framework approach plays into the need for new financing models that are based on dependable added value estimates.

2. OBJECTIVES

The overall objective of AM4INFRA is to launch a life cycle and risk based Asset Management framework approach enabling effective governance of transport infrastructure networks across Europe. The framework approach will be supported by data management tools that ensure transparency and compatibility of optimization and collaboration actions of the infrastructure authorities within the modes, across the modes and across Europe.

In line with the overall objective, the targeted long-term impacts of the project are to support NIAs with:

- a good understanding of the benefits a life cycle and risk based asset management. Therefore, the framework approach will build on:
 - their understanding of the strategic stakeholders' needs and risks;
 - their ability to define a clear 'line of sight' for their networks, i.e. the relationship between strategic policy goals and asset performance levels;
 - the availability of a common life cycle costing (LCC) approach that incorporates master planning, design, construct, maintenance and renewal, and that relates to traffic management strategies and measures;

- the availability of flexible standards as well as a risk based approach towards implementing these;
- the availability of procurement plans and dynamic contract management models;
- the availability of an information management framework, such as a design of an IT solution for a common core system for Asset Management or a Building Information Modelling (BIM).
- a good overview of effective and practicable tools, and flexible standards to support effective allocation of funds based on required network performance levels while managing and controlling risks.
- a good understanding of how Asset Management practices add measurable economic value to different levels of the economy
- an effective and sustained community of practice (CoP) to support the application of the framework approach as well as to further enhance the Asset Management framework approach.

The specific objectives of AM4INFRA, under the overall objective and the targeted long-term impacts, are:

- ✓ Development of a common language and reference to bring forward in cross-modal and cross-border optimization of transport networks.
- Building on common principles and methodologies to enable decision-making and prioritization of infrastructure investments and actions, across political, institutional and network borders. These common principles and methodologies aim to optimize collective welfare under constraints of limited resources.
- Translating these principles and methodologies into actionable strategies for Infrastructure Authorities. These actionable strategies include guidance to determine strategic policy goals, network service level agreements and asset performance levels.
- ✓ Determination of the whole life and risk based Asset Management framework approach on network level, comprising of:
 - Meaningful, practicable criteria for performance, risk and life cycle cost
 - Practicable methodologies to balance life cycle performance, risk and cost on an asset level as well as on a network level
 - Practicable methodologies for managing complex systems under changing demands and requirements
 - ✓ Determination of the procedures and standards for information management for life cycle and risk based Asset Management, comprising of:
 - Identification of meaningful and practicable standards for cross-European information management (e.g. which data to use, how to use it, and how to translate it into the required information)
 - Identification of adequate frameworks for a European information management model that enables asset owners, asset managers, and service providers to effectively and efficiently carry out their tasks; interoperable across modes and borders.

The common framework will pave the way towards an integrated agenda such that it allows smooth functioning of the European transport networks, providing outstanding value for stakeholders and customers.

3. OVERALL CONCEPT

The overall concept, its major conceptual elements and the targeted results are depicted in Figure 1. The envisioned common framework comprises three major elements: common language, common data and data management, and common approach represented as three separate cogwheels. These three cogwheel elements need to be aligned and in place to make the framework operational and to enable the roll out to network owners and asset managers in Europe.

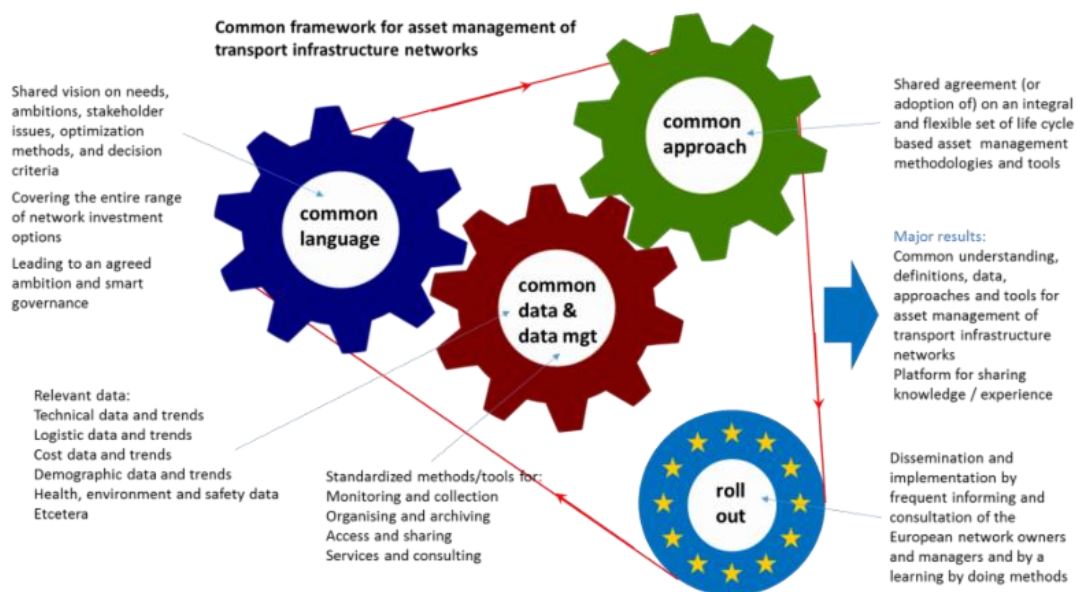


FIGURE 1 Overall concept, major conceptual elements and targeted project results

- **Common language**
Stakeholders (owners, managers and service providers) will be provided with a common set of principles, definitions and key performance indicators (e.g. on reliability, availability, maintainability and safety) in order to support them in their efforts to optimize their transport networks. 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 approach**
Stakeholders (owners, managers and service providers) will be provided with meaningful criteria 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.

- Common data and data management

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.

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

The results shown in this paper are focused on the framework architecture developed in one of the three cogwheel elements, the common language.

4. FRAMEWORK ARCHITECTURE FOR SMART GOVERNANCE OF TRANSPORTATION NETWORKS

The objective here is to develop a common framework architecture for smart governance networks in order to push forward in cross-modal and cross-border optimisation of transport networks.

4.1 Why Do We Need A Framework?

Developing and managing infrastructure to serve the transportation needs of society is a challenging task. Infrastructure serving transportation comes in a variety forms (road, rail, waterways and more), spans large time frames (sometimes up to 100 years), is capital intensive (single projects can easily exceed € 100 mln), is both physically inert and part of relatively inert institutions (ministries, agencies, long term contracts), is widely linked (cross-modal, central-regional- local networks, cross border, regional context), is rich in externalities affecting many stakeholders, and is extremely resource intensive (natural resources in infrastructures). Transport and transport infrastructures play a central role in many policy fields beyond transportation, e.g. environmental and climate policy, social policy, cohesion, innovation policy, economic and industry policy and has to respond to respective demands. Decisions about these networks will inevitably have a variety of effects, short- and long-term, and will in their turn influence the use of these networks. The design of infrastructure influences choices of transportation modes and thus is closely linked to social issues such as availability and affordability of mobility, to environmental aspects such as greenhouse gas emissions, emissions of nitrogen oxide, or nature protection, or to health issues.

For mentioned reasons infrastructure networks can be considered as complex. From a societal perspective, all stakeholders need to be involved (a participatory approach), aiming at satisfying the wide set of interests with minimum consumption of resources. Due to the high number of parameters in play and uncertainties about current state or future situation, this is a challenging task. Practice, however, has delivered a variety of tools and methods to face this challenge. These tools and methods can optimise current networks according to specific aspects and optimize the value proposition for new infrastructure investments. Such optimisation needs to be placed in a wider context of policy ambitions covering a wider set of issues including concepts like resilience and sustainability.

To avoid a high degree of ‘muddling through’ and ensure effective and efficient use of resources, a framework could be instrumental. Such a framework could help balancing efforts, avoid losses by network incompatibilities and push symbiotic functioning of networks. In this paper, the most elemental set of building blocks is described in order to create a common basis for European NRAs, NIAs and alike. The focal point here is building a common core to facilitate communication and alignment between agencies.

4.2 Major Elements of a Framework Architecture

The fundamental elements for valued infrastructure networks are mentioned here.

Transport networks need to address four key elements in order to suit contemporary needs. First, the networks in place need to deliver an optimised service to the users in terms of balancing performance, costs and risk. Second, all investments in new infrastructure need to consider the broad context in which these investments take place, and need to achieve maximum returns on the resources employed. These returns benefit not only a single asset owner, but a variety of owners, users and affected stakeholders in a broad sense. Thirdly, disruptions of all sorts can take place in these networks, exceeding anticipated design conditions. To cope with the nature of these events, and reduce risk for people and first and second order economic damage, resilience is to be enhanced. Especially as climate change might be an additional stressor. Fourth, sustainability is vital for durable solutions and the prosperity of generations to come. In all activities taking place at and around transport infrastructure, these concepts need to be taken into account.

4.3 Framework Architecture

The elements described above have been structured in a framework (Figure 2). The logic of the framework are as follows:

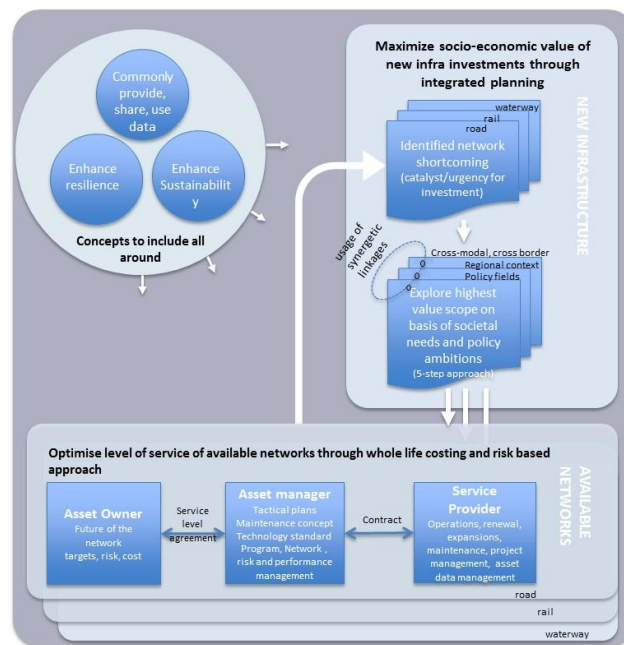


FIGURE 2 Framework architecture

- Asset management is the foundation of the system. By balancing performance, costs and risk the aim is to optimise the service to the public given the available resources. By defining an asset owner, an asset manager and service provider role, responsibilities and tasks are clear. At some point, the owner, the asset manager or the service provider may encounter a situation that requires new investment. Preliminary studies, cost benefit analysis and other commonly used methods can determine a rational background; politicians could be following a path parallel to this rationality.
- When, according to (national) regulations, it is determined that the problem needs to be tackled, the scoping of the project will take place. This is a crucial step in the process, where the scope determines to what extent elements of the problem, the entire problem, or the wider context of a problematic region, are addressed. Here lies the opportunity to determine the best value proposition for the agency and for society in a broader sense, ensure mobility and transport is efficiently and effectively accommodated, (negative) externalities are minimised and effective institutional arrangements are selected.
- Common concepts like use of data, resilience and sustainability will have to be taken into account in all steps of network management, network enhancement and network expansion.

In a more generic way the framework can be seen as: there needs to be a problem to initiate action, integrated planning taking into account synergies delivers value, and sectoral (by road, waterway of railroad agencies) implementation and operation (for each individual sector) spurs effectiveness and efficiency.

5. CONCLUSIONS

The framework architecture for smart governance of infrastructure networks can be considered as a generic canvas that enables agencies to find common ground. The National Infrastructure Agencies have to deal with political dynamics and policy ambitions related to new infrastructure, which is a different action arena than provision of service and maintenance and operation of available networks.

Secondly, although some infrastructure agencies have multiple modalities in their portfolio, many agencies manage and assign responsibilities for different modes in isolation. a sectoral assignment. National or international institutional frameworks do not currently optimise the entire system of networks holistically. The provided framework architecture does recognise the interlinkages and provides an entry to take synergetic behaviour of networks into consideration.

Thirdly, contemporary infrastructure ambitions include a variety of concepts that need to be incorporated. These concepts, like commonly shared data, network resilience and sustainability, have wide implications. These are not restricted to a single activity or physical element. These concepts need to be embedded in systems and processes and are therefore shown in the framework architecture to include all around.

The framework architecture, as shown, offers a way to see all these interconnected elements and concepts in a coherent way. It connects new investments to available networks, it includes cross border and cross-modal considerations and it relates to policy ambitions and generic concepts to be pursued. The framework architecture provides a very generic overview of the coherence of decision making and optimisation of networks in order to provide best value. Such a generic overview is useful to support a common dialogue and common learning processes. This

framework will be followed by specific guidelines that are far more detailed and will be more diversified towards specific challenges or network issues.

Along with the guidelines, the framework architecture will be tested and validated in living labs. These living labs will focus on regional contexts where a variety of interlined network problems play out and where investments, maintenance and operation play a role for different modalities.

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