DELIVERABLE REPORT

DELIVERABLE NO:	D3.3
DISSEMINATION LEVEL:	PUBLIC
TITLE:	APPLICATION OF THE DESIGN MODEL FINAL REPORT

DATE:	12/07/2018
VERSION:	FINAL
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Grant Agreement Number:	713793
Project Type:	H2020-MG-8.4b-2015-smart governance, network resilience and streamlined delivery of infrastructure innovation
Project acronym:	AM4INFRA
Project title:	Common framework for a European life cycle based asset management approach for transport infrastructure networks
Project start date:	01/09/2016
Project website:	www.am4infra.eu
Technical coordination	Rijkswaterstaat (NL) (www.rijkswaterstaat.nl)
Project management	Uniresearch (NL) (www.uniresearch.nl)

H2020-MG-2015-713793— common framework for a European life cycle based asset management approach for transport infrastructure networks

Acknowledgement:

The author(s) would like to thank the partners in the project for their valuable comments on previous drafts and for performing the review.

Project partners:

1 - RWS – MINISTERIE VAN INFRASTRUCTUUR EN MILIEU – NL
2 - HE – HIGHWAYS ENGLAND COMPANY LTD – UK
3 - ANAS – ANAS SPA – IT
4 - FEHRL – FORUM DES LABORATOIRES NATIONAUX EUROPEENS DE RECHERCHE ROUTIERE – FR
5 - TII – NATIONAL ROADS AUTHORITY – IE
6 - UNR – UNIRESEARCH BV – NL
7 - CERTH – ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS- GR
8 - WI – WUPPERTAL INSTITUT FUR KLIMA, UMWELT, ENERGIE GMBH - DE

Disclaimer:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 713793. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the AM4INFRA consortium shall not be liable for any errors or omissions, however caused.

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Acronyms

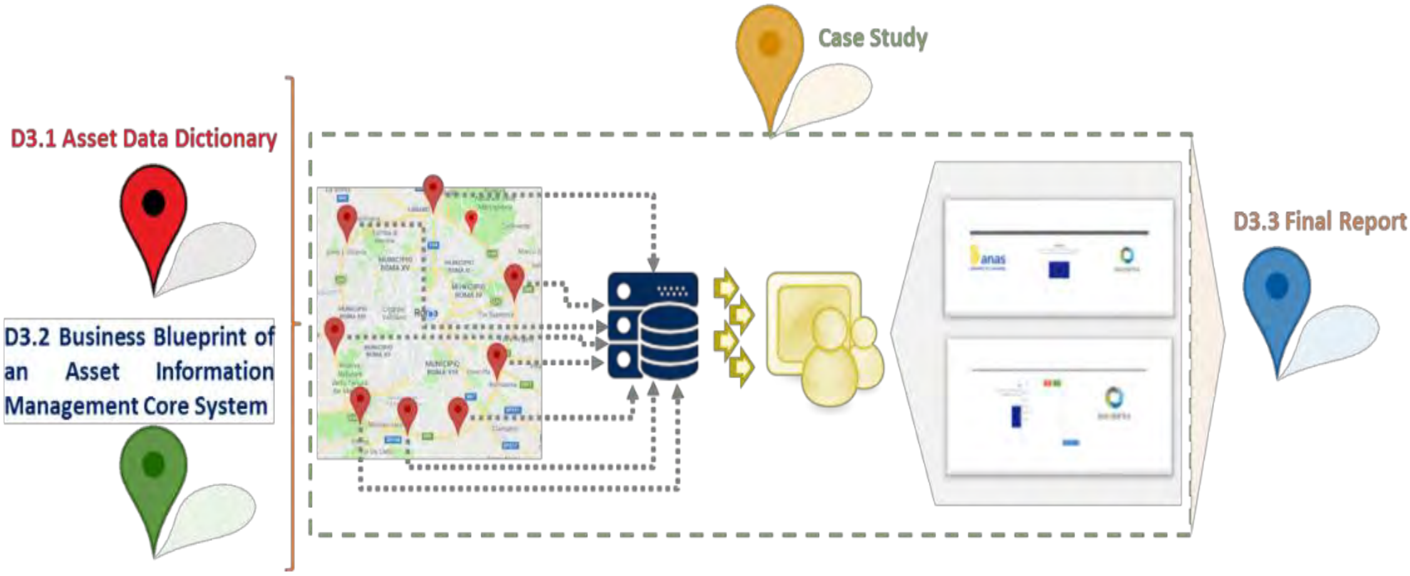
Table 1-1 List of Acronyms

Acronym	Definition
ADD	Asset Data Dictionary
AIMCS	Asset Information Management Core System
BBP	Business Blueprint
BI	Business Intelligence
E2E	End-to-end
KPI	Key Performance Indicator
IRI	International Roughness Index
NRA	National Road Agency
POC	Proof of Concept
RMT	Road Management Tool
TEN-T	Trans-European Networks
WP	Work Package

Publishable Executive Summary

The **third pillar** of Work Package 3 “Information and Data Management” is the verification of how the **information model** and **IT solutions** identified in D3.1 “*Asset Data Dictionary*” and in D3.2 “*Business blueprint of an asset information management core system*” would **fit in a real case scenario.**
This report “**Application of the Designed Model for Asset Management System on a Stretch of a TEN/T Itinerary”** summarizes the outcomes of the case study carried out during WP3 last task.

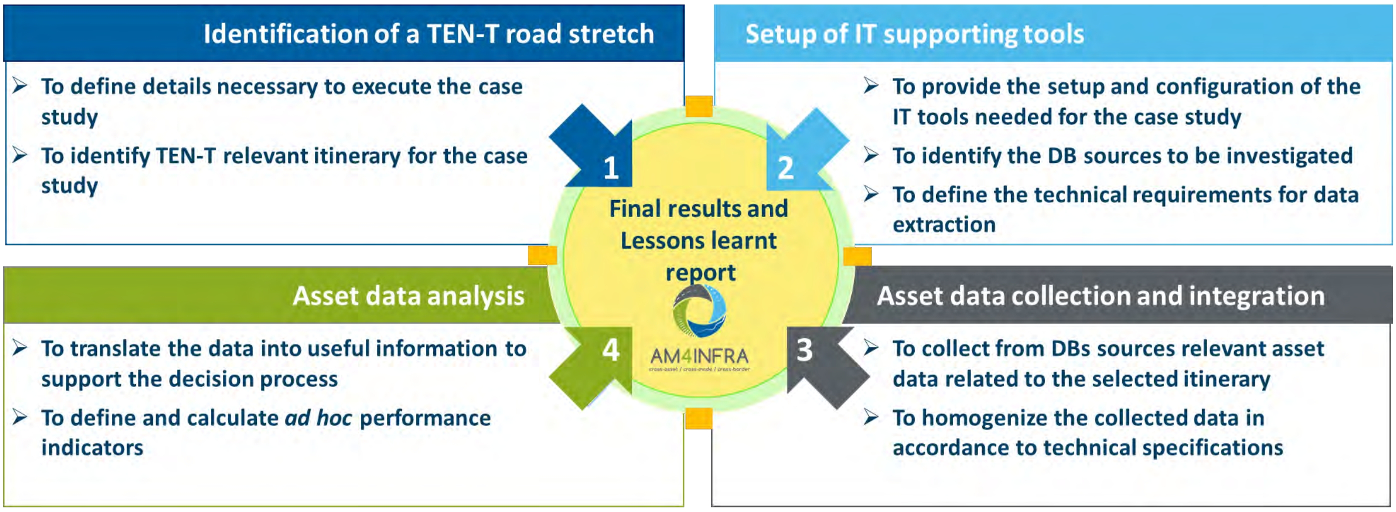
Figure 1-1 Description of D3.3



The approach taken for the task consists of **four steps**:

- **Step 1:** Formalization of a case study perimeter (scope, goals, and identification of technical specifications to gather data to perform the case study); the scope for the task has been limited to a specific road stretch along TEN-T in order to have a manageable amount of data.
- **Step 2:** Setup of IT Supporting Tools, through the investigation of asset data sources for the selected itinerary stretch and the identification of the tools to be adopted to collect and analyze the data;
- **Step 3**: Data collection, transformation and loading on a database designed according to Business Blueprint (BBP) model;
- **Step 4:** Data analysis and evaluation;

Figure 1-2 Task 3 approach



Regarding **Step 1**, within TEN-T itineraries, AM4INFRA project has identified **A90 Motorway** as the best choice to carry out the task. **A90 Motorway**, included in Scandinavian-Mediterranean Core Network Corridor of TEN-T, is the ring road of the City of Rome connecting the city center to: Leonardo Da Vinci international Airport through A91 Motorway, A1 (Milan – Naples) Motorway, A24 (Rome – Teramo) Motorway and other relevant national/regional roads.

A90 Motorway is a modern motorway with a length of sixty-eight kilometers, entirely managed by ANAS. The motorway is a strategic asset for the mobility of Rome area; with its round itinerary, it links the suburbs of Rome allowing people to move from one zone to another without crossing the city center, and therefore avoiding congestion.

Figure 1-3 Rome Ring Road

As **Step 2** outcome, the project has identified the scope of ANAS IT systems involved for the task. ANAS is responsible for **all key asset management processes** (Asset Inventory Management, Road Enhancement and New construction, Preventive and Routine Maintenance and Road Operations) and has developed several IT systems to support them. The following scheme summarizes data sources selected within ANAS IT Systems:

Figure 1-4. ANAS Data sources identified for WP3 case study

During **Step 3** and **Step 4**, A90 asset data, collected from ANAS databases, have been mapped according to the datasets defined in D3.1 Asset Data Dictionary, and modelled according to information model defined in D3.2 Business Blueprint.
Asset data analysis has focused on:

- Evaluation of **coverage level** between ANAS asset data and the ones required by the asset data dictionary;
- Evaluation of **consistency** of relation links between ANAS datasets (information model);
- Evaluation of the **availability of core data** to perform calculation of strategic, tactical and operational KPIs;

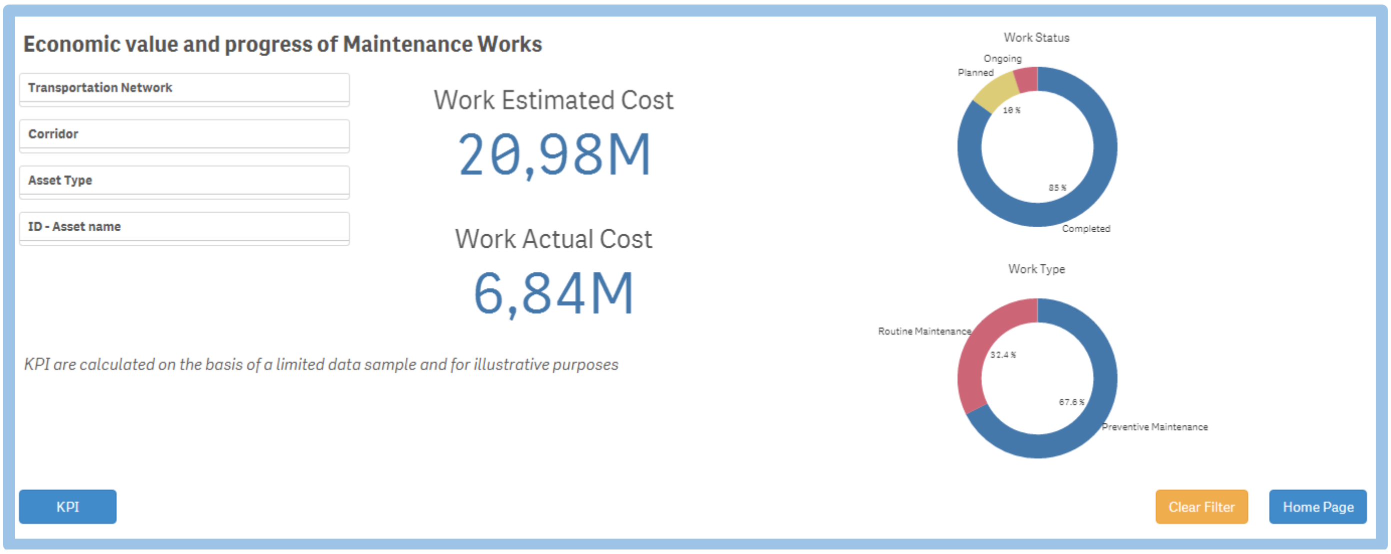
In order to have a more consistent analysis, during the task, a **Proof of Concept** (POC) has been developed, representing a "light" demo of the system described in D3.2, in which the information is stored according to "D3.1 Asset Data Dictionary" specifications. The Main **benefits** of a POC, as the one implemented for AM4INFRA project, are the following:

- To test the user experience related to the main system functionalities;
- To have a better understanding of system potentiality;
- To allow a clear visualization of the various links between asset datasets.

Figure 1-5 AM4INFRA POC screenshots [Illustrative]

Maintenance

Work ID	Asset ID	Asset Name	Corrid... ID	Work Start Date	Work End Date	Work Status	Work Type	Work Description
RM12F1B05005	20578	Ponte Monumentale sul Fiume Tevere - Mezzo Cammino	A90	22/06/2012	18/03/2014	Completed	Routine Maintenance	Joint Maintenance
RM13F1B05003	20578	Ponte Monumentale sul Fiume Tevere - Mezzo Cammino	A90	12/03/2013	28/02/2014	Completed	Routine Maintenance	Joint Maintenance
RMMS0608E2B1...	20578	Ponte Monumentale sul Fiume Tevere - Mezzo Cammino	A90	21/02/2008	30/05/2008	Completed	Preventive Maintenance	Joints reconstruction



Key results emerging from the task are:

- The verification of the application of WP3 deliverables in a real case scenario can be considered completed with **positive results**; in fact the task succeeded both in **filling datasets defined in asset data dictionary with real ANAS asset data** and **creating links** between them according to the **ontology map**;
- The KPIs, defined in the D3.2 BBP, have been successfully calculated on a sample of A90 data, and through **their graphic charts** has been possible to test also **the end user experience**;
- The project internal and external stakeholders have confirmed that the possibility **to browse**, through a web interface, several A90 **asset data** of different categories (technical, financial, operational) in **one single repository**, represents a **key success factor** to improve asset information sharing.
- The availability of a **unique repository of asset data** facilitates more control on the assets, to identify **more correlation among asset data**, and to support effectively asset management decisions;

1. Purpose of the document

1.1 DOCUMENT STRUCTURE

Document structure is the following:

- Description of the criteria adopted for the selection for TEN-T road stretch;
- An overview on IT supporting tools, used to perform asset data collection, integration and analysis;
- A description of activities carried out and related outcomes from the case study;
- An overview of the Proof of Concept;
- A presentation of final results and lessons learnt.

1.2 DEVIATIONS FROM ORIGINAL DESCRIPTION IN THE GRANT AGREEMENT ANNEX 1 PART A

1.2.1 DESCRIPTION OF WORK RELATED TO DELIVERABLE IN GA ANNEX 1 – PART A

The task objectives are:

- To identify a specific road stretch of a TEN-T itinerary in order to perform an on-field application for the designed asset management information system model
- To perform on the selected itinerary a case study regarding the application of asset information management system
- To collect results and lesson learnt from case study outcomes
- To identify possible additional user and functional requirements to update the asset information management system BBP
- To collect any possible input from the players on the living lab

To get to the application of the designed model, the following activities will be conducted:

- **Identification of a TEN-T road stretch:** the sub-task will define all the details necessary to execute the case study in terms of relevant TEN-T itinerary identification;
- **Setup of IT supporting tools:** the activity will provide the setup and configuration of the IT tools needed for the case study. The database sources will be identified, and subsequently technical requirements for data extraction will be defined;
- **Asset data collection and integration:** the activity, supported by IT tools, will perform the collection from database sources of the relevant asset data related to selected itinerary. Subsequently the collected data will be homogenized, according to technical specifications, in order to have a set of comparable data that will represent a source for dissemination of information to stakeholders;
- **Asset data analysis:** the activity, starting from the shared data of the assets in scope, aims at translating the data into information useful to support decision processes made by asset managers and asset owners. The analysis will focus in particular to put in correlation and compare asset technical data with asset economic data (e.g. asset maintenance costs) along the selected itinerary, identifying and calculating asset performance indicators;
- **Final results and Lessons learnt report:** the activity will formalize main evidences arisen during the whole case study through the delivery of a final report that will be made available in the living lab summarizing activities carried out, key results and lessons learnt.

1.2.2 TIME DEVIATIONS FROM ORIGINAL PLANNING IN GA ANNEX 1 – PART A

No time deviations have occurred during the task.

1.2.3 CONTENT DEVIATIONS FROM ORIGINAL PLANNING IN GA ANNEX 1 – PART A

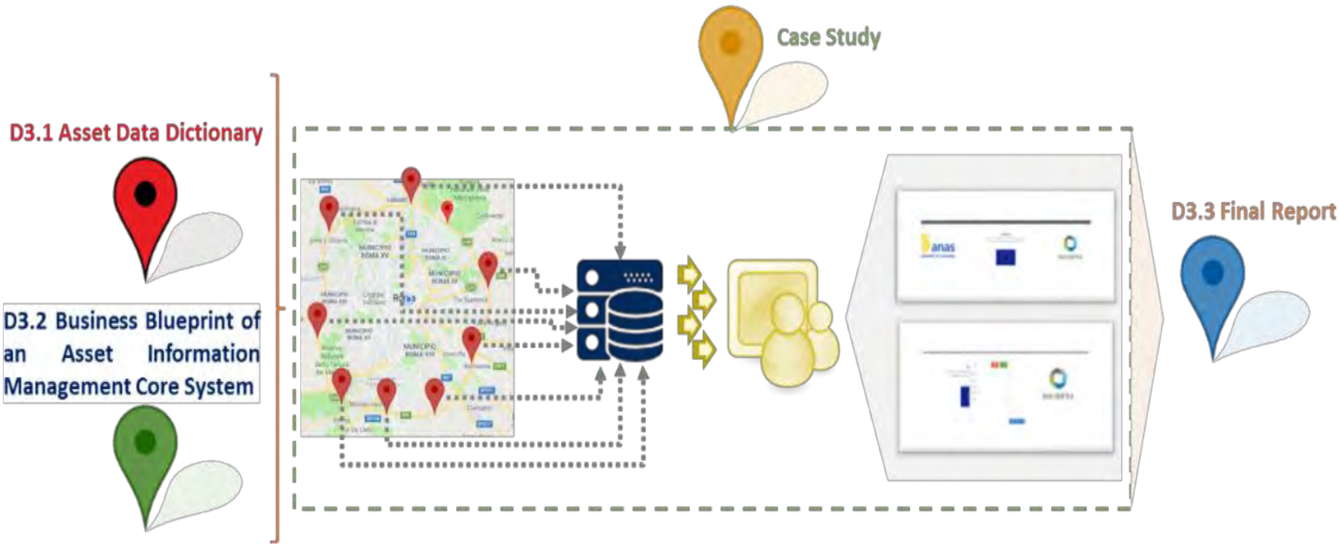
No content deviations have occurred during the task.

2. Introduction

The final task of Work Package "Information and Data Management" - **Application of the designed model for asset management system on a stretch of a TEN-T Itinerary -** aims at verifying how information models and IT solutions identified in **D3.1 "Asset Data Dictionary"** and in **D3.2 "Business Blueprint of an Asset Information Management Core System"** could be verified in a real case scenario.

To achieve this verification, the task will design and deliver also a **proof of concept** (POC) of the previous deliverables under WP3 applied on a real road itinerary. Using a POC, we identify a demonstration, the purpose of which is to verify that certain concepts or theories have the potential for real-world application.

Figure 2-1. Task 3.3 Overall Scheme

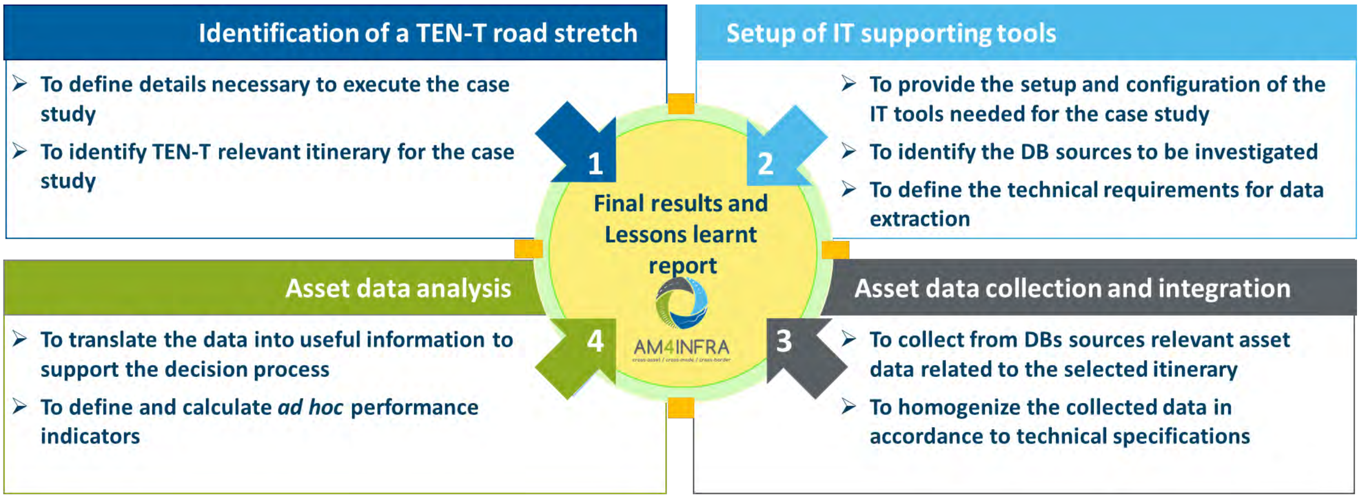


The approach for the task, shown in the following scheme, consists of **four steps**:

- **Step 1:** Formalization of case study perimeter (scope, goals, and identification of technical specifications to gather data to perform the case study; the scope for the task has been limited to a specific road stretch along TEN-T in order to have a manageable amount of data.
- **Step 2:** Setup of IT Supporting Tool, through the investigation of asset data sources for the selected itinerary stretch and the identification of the tools to be adopted to collect and analyze the data;
- **Step 3**: Data collection, transformation and loading on a database designed according to BBP model;
- **Step 4:** Data analysis and evaluation.

This report collects all the outcomes coming from the activities carried out during the task, and then summarizes final results and lessons learnt of the case study.

Figure 2-2. Task 3.3 approach



3. Assumptions

The task, dealing with asset data related to ANAS road network, has some privacy issues related to presenting ANAS actual values (e.g. asset defects or economics).

Therefore, within report contents, for privacy and security reasons, the following actions have been taken:

- Some of real data have been replaced with illustrative ones;
- Only a sample of real data has been used.

However, this replacement does not affect the outcomes of WP3 tasks, as the task goal is to verify the IT model to support asset information management designed in the previous tasks, and not to perform a critical analysis on ANAS data values.

In other terms, from AM4INFRA project perspective, this task investigates the possibility of building a system with specific datasets linked according to a specific information model, but it does not focus on analyzing the outcomes deriving from the data values.

4. Step 1 - Identification of a TEN-T Road Stretch

In order to perform and test the application of designed model, the first step has been the identification of the road stretch itinerary. Asset data related to this itinerary will be assessed against the information model defined in the previous WP3 tasks. Considering the scope and goals of the project, the itinerary had to comply with the following main requirements:

- Included within TEN-T Core Network Corridors;
- Near or linked to important transport hubs;
- Relevant for both urban and no urban mobility;
- Several actors with responsibility of mobility should be involved on itinerary area;

Within this scenario, ANAS has identified the A90 Motorway as the itinerary on which the case study shall be performed.

The A90 Motorway complies with all the requirements set for the case study. A90, included in Scandinavian-Mediterranean Core Network Corridor of TEN-T, is the ring road of the City of Rome connecting the city center to:

- Leonardo Da Vinci international Airport through A91 Motorway;
- A1 (Milan – Naples) Motorway, Italian major Motorway;
- A24 (Rome – Teramo) Motorway;
- Other relevant national/regional roads;

Several institutions/companies are involved every day in the A90 area providing services to road users:

Table 4-1 List of A90 Stakeholders

Company	Role in A90 Area
anas	**ANAS:** public concessionaire company responsible for designing, building and operating the road and motorway network, as of national interest (26.000 km throughout Italy). ANAS is also responsible of A90 management.
autostrade per l'italia	**Autostrade per l'Italia**: private concessionaire company responsible for the operation and management of A1 Motorway. 760 km of toll motorway (connecting Milan to Naples)
strada dei PARCHI spa A24 autostrade A25	**Strada dei Parchi**: private concessionaire company responsible for the operation and management of 281 km of toll motorway, including the Eastern road section getting to Rome downtown
ASTRAL AZIENDA STRADE LAZIO SPA	**ASTRAL**: public operator of the non-tolled roads and motorways belonging to the Lazio Region
ROMA CAPITALE	**Municipality of Rome:** responsible for overall mobility within the City of Rome.

1.3 A90 KEY INFORMATION

The A90 Motorway, also known as Ring Road of Rome, is a modern motorway with a length of sixty-eight kilometres, entirely managed by ANAS.

The motorway is a strategic asset for the mobility of Rome area; with its radial itinerary, it links the suburbs of Rome allowing people to move from one zone to another without crossing the city centre, and therefore avoiding congestion.

The Motorway has three lanes for both travel directions and thirty-three numbered exits. In the more heavily traffic sections, more than 150 thousand vehicles per day transit are registered.

Figure 4-1. TEN-T Network Map & A90 Motorway Map

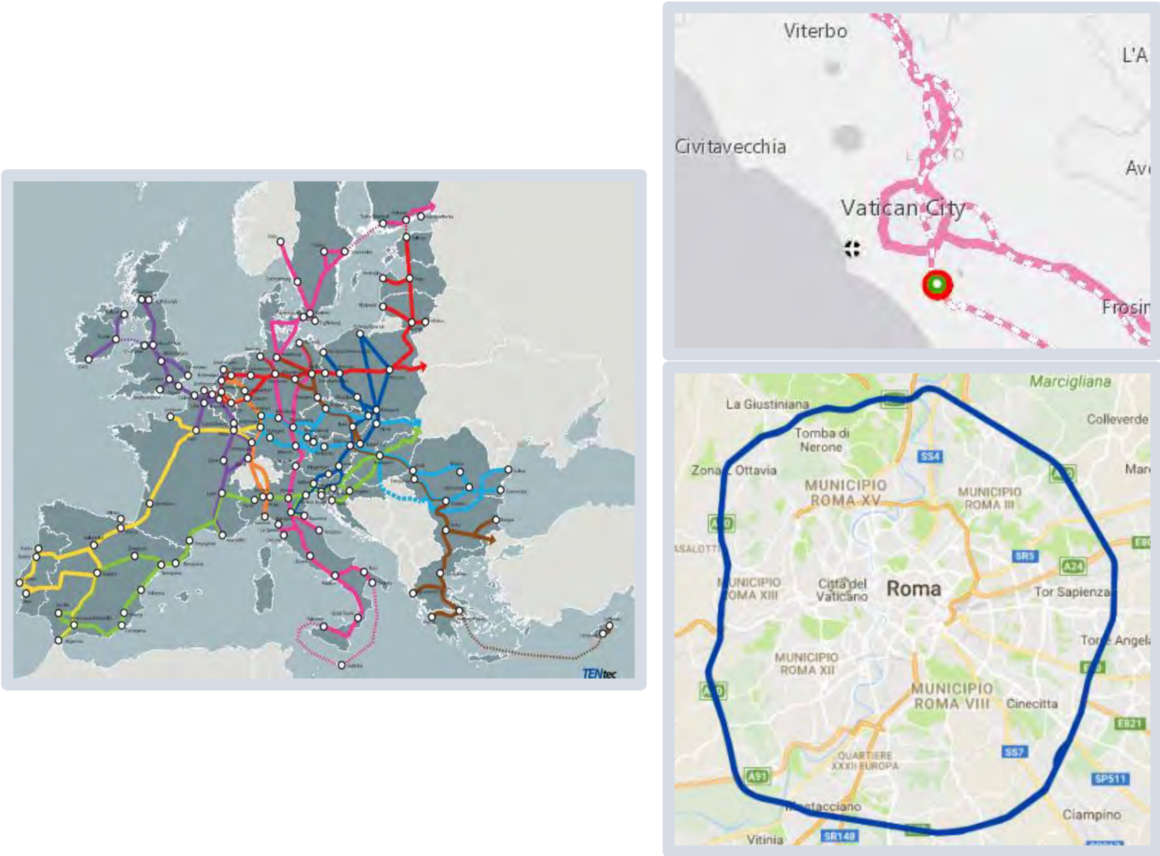
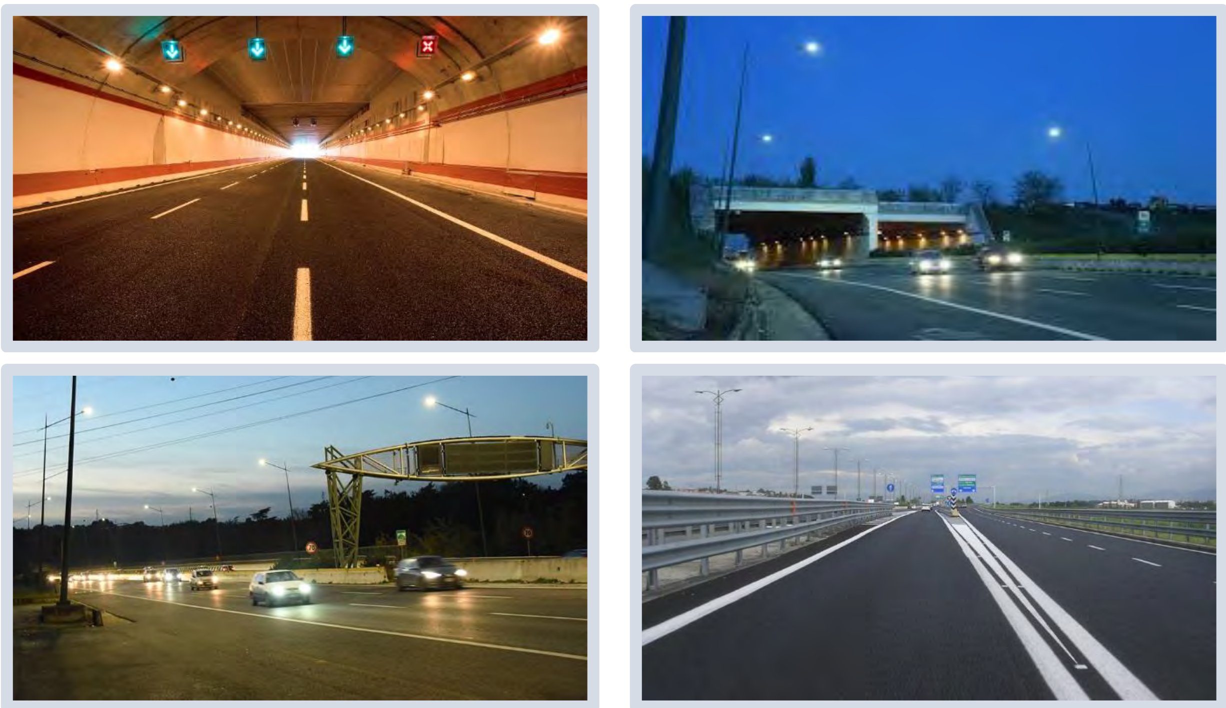


Figure 4-2. A90 Sample Pictures

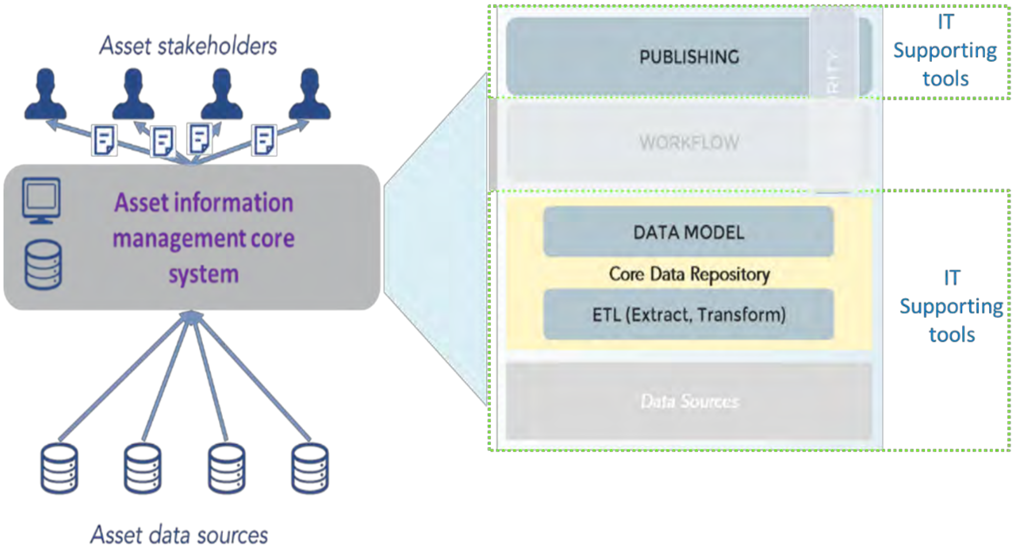


5. Step 2 - Setup of IT Supporting Tools

The setup of IT Supporting Tools represents the second step to develop the case study on A90 motorway, in order to identify data sources of A90 assets, how to collect their data and where to store them.

Referring to Asset Information Management Core System (AIMCS) Scheme, IT supporting tools adopted for the case study cover the bottom layers of the system architecture and the publishing layer, as represented in the following picture:

Figure 5-1. AIMCS Scheme and IT Supporting Tool (ref. D3.2)



5.1 A90 DATA SOURCES

On the A90, ANAS perform all key asset management processes including:

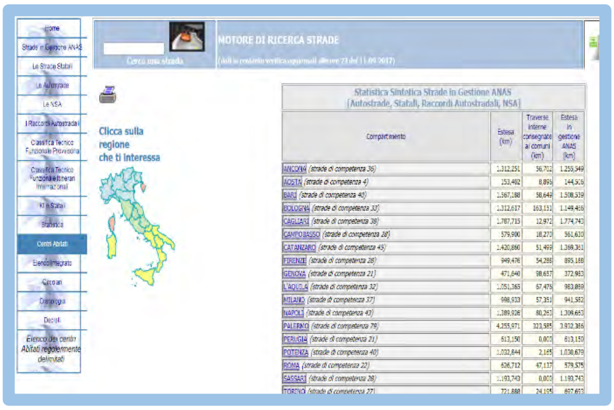
- Asset Inventory Management;
- Road Enhancement and New construction;
- Preventive and Routine Maintenance;
- Road Operations (e.g. Traffic Management, Event Management, Emergency Response, etc.);

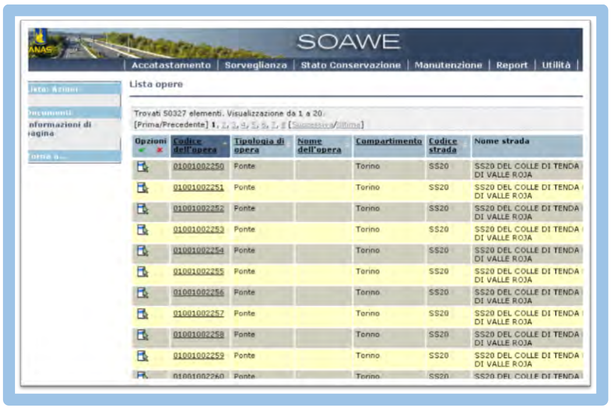
Specific IT systems and applications that are currently in use, support ANAS asset management processes above; for the case study, they have been identified as data sources to collect asset data and grouped into "Asset inventory", "Road maintenance works and costs accounting", "Traffic management and road operations" and "Asset economical and financial data" categories as can be seen from figure below.

Figure 5-2. ANAS Data sources identified for WP3 case study

Applications for managing asset inventory include Archivio Strade, SOAWE and GeoANAS Aria.

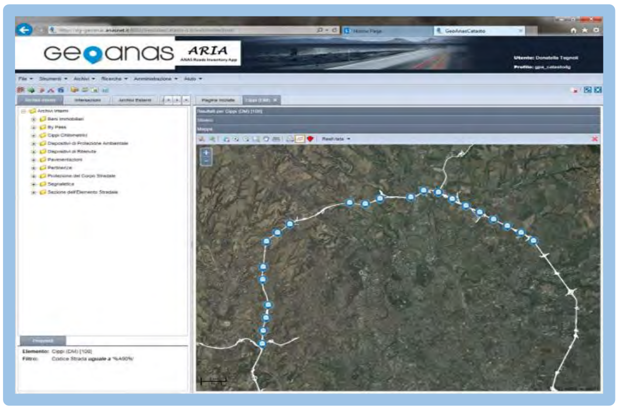
Archivio Strade is the official ANAS **Roads Inventory**.
It contains data of roads operated by ANAS, technical and administrative data and the link to the corresponding road maps.



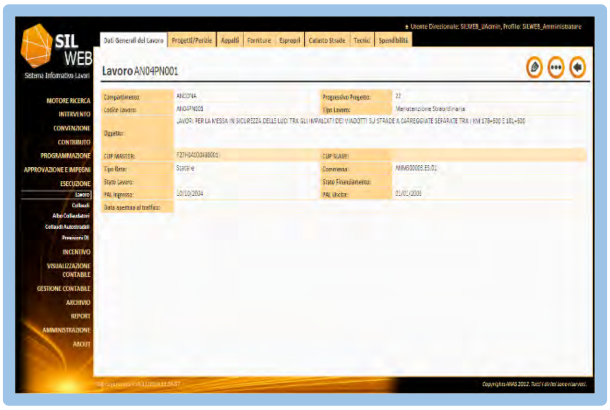


SOAWE is the central *master database* for **Infrastructural Road Assets** *(e.g. Bridges, Tunnels, Viaducts, Retaining Walls, etc.)* and related **Inspections**.
A mathematical model allows to estimate a *Global Status Index* for the main assets, this KPI indicates the degradation index of the asset.

GEOANAS ARIA is the central master database for ANAS Road Network Graph and for the Other Road Assets. Users can access data through a **Google Earth Enterprise map** and they can visualize road asset items over the map and consequently access related data and pictures

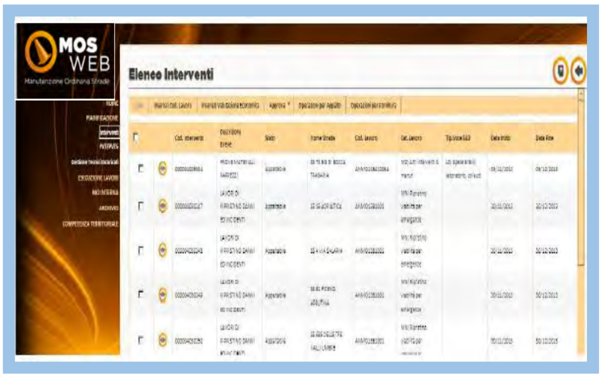


SIL WEB and MOS WEB are applications used for managing maintenance works and for costs accounting.



SIL WEB is the **Preventive Maintenance Works supporting system**, **integrated** with the **Asset Inventory Systems** in order to have a **unique registry** regarding overall road infrastructure subject to maintenance. The system covers **road maintenance work end-to-end (E2E) life cycle** in terms of**:**

- *Planning:* tracing planned interventions and maintenance needs
- *Execution:* recording maintenance work data & progress
- *Accounting:* recording current expenditures to specific road asset items
- *Closing:* performing intervention closure at completion and keeping historical data



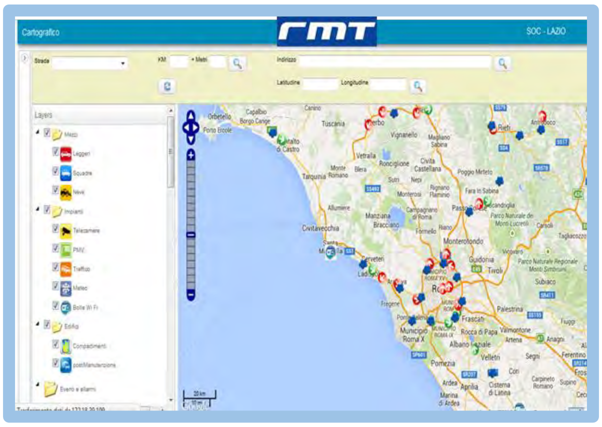
MOS WEB is the **Routine Maintenance Works supporting system**. Like SIL Web it is **integrated** with the **Asset Inventory Systems** and covers **road maintenance work E2E life cycle,** in particular from works planning to their closure.

Traffic management and road operations are followed and managed with RMT tool and MOS Mobile.

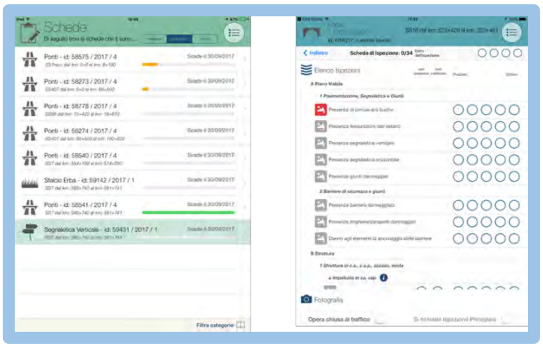
Road Management Tool (ANAS RMT), introduced by ANAS for road network management, has been specifically developed to meet ANAS road managers' needs, such as:

- controlling all operations and activities on the road network by one single system;
- monitoring current events on the network and promptly managing road operations;
- integrating information coming from different sources and visualizing them on maps;

ANAS RMT has introduced a unique operational tool that through its feature enables the standardization of the



overall management within the road network operations at ANAS.



MOS MOBILE + IDEA MOBILE

MOS Mobile and IDEA Mobile, the apps for ANAS workforce management, represent innovative applications and a new way of utilizing Information Technology, which promotes new tools for **remote operations**, **offering speed and simplicity of use**, removing geographical and timing constraints.

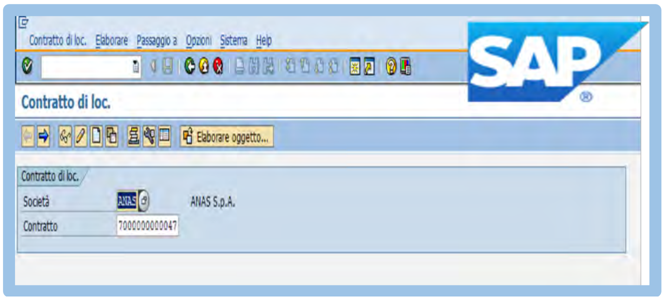
MOS Mobile allows the scheduling and definition of routine maintenance activities, sends intervention requests, integrating information with ANAS IT and cartographic systems.

With MOS Mobile, it is possible to:

- *plan, assign and send activities to road teams on real time basis;*
- *take charge of the activities, reporting progress status with photos and videos;*
- *account information for single road km, section and activity performed;*

IDEA Mobile allows to track and monitor performance condition for some ANAS asset types (e.g. bridges, signs) in order also to report the results to Asset owner.

Finally, **SAP Financial Operations** is the ANAS ERP supporting several processes related to asset management (financial management, accounting management, investment management, etc.



5.2 TECHNICAL REQUIREMENTS FOR DATA EXTRACTION

Once the data sources for the case study have been identified, the following step have been taken to find out the requirements for data extraction in terms of:

- Selection of **data type** for each data sources *(e.g. only financial data from source 1, technical data from source 2, etc.);*
- Selection of the **data perimeter** *(e.g. only data referred to A90 motorway);*
- Definition of **type of outputs needed from data extraction** *(*e.g. csv files, xls files, etc.)

Regarding **data perimeter,** the task has focused only on the following subset of asset type:

- Pavement,
- Bridge,

- Tunnel,
- Barrier.

The following table shows the links between data sources, data types and data perimeter:

Table 5-1 ANAS Data source, data type and data perimeter

Data Source	Data Type	Data Perimeter
ARCHIVIO STRADE	Road network general data	*A90 Motorway*
SOAWE	Asset inventory data	*A90 Bridges* *A90 Tunnels* *A90 Barriers*
GEOANAS ARIA	Asset inventory data	*A90 Pavements*
MOS WEB	Routine Maintenance Work data	*A90 Works*
SIL WEB	Preventive Maintenance Work data	*A90 Works*
ROAD MANAGEMENT TOOL	Traffic and Event Data	*A90 Events*
MOS/IDEA MOBILE	Asset condition/status Asset inspection Asset performance	*A90 Bridges* *A90 Tunnels* *A90 Pavements*
SAP	Financial and economic data	*A90 Investments* *Maintenance Works related to A90* *Maintenance Works Funds*

5.3 DATA REPOSITORY, ANALYSIS AND PUBLISHING TOOL

In addition to the identified data sources, specific business intelligence (BI) software has been used during the case study to:

- Store a sample of A90 asset data, simulating AIMCS data model and repository;
- Perform the browsing of A90 asset data, simulating the front-end application designed in D3.2 and some of its use cases;
- Allow to represent and publish KPIs, as the ones defined in D3.2.

BI software is a type of application software designed to retrieve, analyze, transform and report data for business intelligence. The applications generally read data that have been previously stored in a data warehouse or data mart. Common functions of business intelligence technologies include reporting, analytics, data mining, process mining, complex event processing, business performance management, benchmarking, text mining, predictive analytics and prescriptive analytics. BI technologies can handle large amounts of structured and/or unstructured data to help identify, develop and otherwise create new strategic business opportunities. They aim to allow for the easy interpretation of these big data. Identifying new opportunities and implementing an effective strategy based on insights can provide businesses with a competitive market advantage and long-term stability.

Source: Enterprise Analytics, Thomas Davenport, 2013

Furthermore, this type of software allows to create dashboards for the reporting that can be easily navigated, in fact different pages are linked together to create a sort of organization. For AM4INFRA context, this allows to generate a good visual representation of core elements of the system design in D3.2.

6. Steps 3 and 4 - Asset Data Collection, Integration and Analysis

Once the setup of the case study environment has been completed, the core activities related to the application of the designed model have begun.

6.1 ASSET DATA COLLECTION AND INTEGRATION

To achieve data collection and integration, the following activities have been performed:

- **Collection of A90 asset data** from ANAS databases in form of reports, excel files or specific views on system databases;
- **Mapping of A90 collected data** to the datasets defined in D3.1 Asset Data Dictionary;
- **Mapping of A90 data** according to information model defined in D3.2 Business Blueprint;

The mapping activity has required effort to identify or integrate several ANAS datasets with the ones defined during the project.

The following table shows the links between AM4INFRA datasets and ANAS data sources:

Table 6-1 AM4INFRA datasets and related ANAS data sources

Asset Data Dictionary – AM4INFRA D3.1			anas Data Source
Data Group	**Dataset**	**Dataset description**	
Asset Inventory	*Pavement*	The portion of a road placed above the design subgrade level for the support of vehicular traffic, and upon which the pavement surface (wearing course) is applied	▪ GEOANAS ARIA
	Tunnel	A tunnel is an underground way, dug through the surrounding soil and enclosed except for the entrance and exit	▪ SOAWE
	Bridge	A structure designed to provide passage for road users over an obstacle by spanning it.	▪ SOAWE
	Barrier	A structure that provides protection from errant vehicles/ road users for safety or other purposes (e.g. noise reduction)	▪ GEOANAS ARIA ▪ SOAWE
Construction	*Asset Construction /Installation*	This data group aims at identifying data related to the process either of building an asset (e.g. bridge) or of installing a new asset (e.g. traffic camera) within the transportation network.	▪ SOAWE ▪ GEOANAS ARIA
Condition & Performance	*Asset Lifecycle*	Data to record life history of the asset;	▪ SOAWE
	Asset Performance	Data to describe asset technical levels of service;	-
	Asset Condition	Data to describe the state of an asset at a particular instance in time. This data is usually capture by inspection, survey or monitoring.	▪ IDEA MOBILE
	Asset Inspection	Data to track the activity related to asset condition monitoring, that provides inputs to evaluate asset condition	▪ IDEA MOBILE ▪ SOAWE

Asset Data Dictionary – AM4INFRA D3.1			anas Data Source
Data Group	**Dataset**	**Dataset description**	
Risk & Safety	*Asset Risk*	Data to describe risks occurring on the asset like risk likelihood, impact, action to be implemented, etc.;	▪ SOAWE
	Asset Defect	Data to record defects occurring on the asset, and their updates during time (e.g. detection date of the defect, defect closing date, asset defect rate, etc.).	▪ SOAWE
Maintenance	*Maintenance Work*	Data to record either the future intervention works and the history of what has been done to an asset	▪ SIL Web ▪ MOS Web
Financial & Accounting	*Asset Valuation*	Data referred to asset valuation process	-
	Asset Expenditures	Data referred to accounting process in order to have an overall monitoring of asset expenditures;	▪ SAP FinOpe ▪ SIL Web ▪ MOS Web
	Asset Funds	Data to describe funding model for asset management	▪ SAP FinOpe
Operational	*Asset Event*	Data to describe any relevant event occurring during network operations (e.g. car accidents, damaged assets, presence of obstacles, etc.) that can provide input for other asset management practices (e.g. asset maintenance, asset performance improvement, etc.);	▪ Road Management Tool

6.2 ASSET DATA ANALYSIS

Asset data analysis has focused on:

- Evaluation of **coverage level** between ANAS asset data and the ones required by the asset data dictionary;
- Evaluation of **consistency** of relation links between ANAS datasets (information model);
- Evaluation of the **availability of core data** to perform calculation of strategic, tactical and operational KPIs;

Regarding coverage level, the main outcome is that ANAS databases store the majority of the datasets required. In fact, as shown in table 6-1, it's possible to identify an ANAS IT system's source for the ADD datasets; there are only few exceptions such as:

- *Performance* dataset: this dataset refers to the technical performance specifications that an asset or part of it must achieve; from the analysis of ANAS context, currently the measurement of this data from M&O Department is not recorded in a specific database.
- *Valuation* dataset: this dataset refers to asset valuation process; ANAS currently performs valuation (historical cost) at corridor level as whole, therefore there isn't the possibility to have a more detailed information regarding each single asset value;
- *Lifecycle* dataset: data to record life history of the asset; ANAS doesn't collect lifecycle data for all asset types and lifecycle information are not assessed through a structured process;

Regarding the **consistency of links between the datasets**, the **level of overlapping** between the D3.2 Ontology Map and A90 asset data can be considered at a good level.
As demonstrated in Ch 6.2.1, with the realization of a proof of concept, it has been possible to create **a physical data model** with **ANAS asset data** and allow to browse through them according to ontology map.

Regarding **the availability of core data**, ANAS has availability of both technical and economic data thereby facilitating the calculation of several KPIs, as described with more details in 6.2.1.2.
The **KPIs identified** represent an effective source of information to support decision processes for different organization departments, allowing correlating operational, maintenance and financial data.

6.2.1 PROOF OF CONCEPT

The **Proof of Concept** (POC) represents a demo of the system described in D3.2, in which the information is stored according to "D3.1 Asset Data Dictionary" specifications. The main **benefits** of a POC are the following:

- To test the user experience related to the main system functionalities;
- To have a better understanding of system potentiality;
- To allow a clear visualization of the various links between asset datasets.

From **POC homepage**, the user can access the following **sections**:
- **Section 1 - Asset Data,** where it is possible to select a specific asset and browse its key data.
- **Section 2 - Key Performance Indicators,** where it is possible to navigate all the KPIs referred to a specific corridor/asset.

Figure 6-1 POC home page

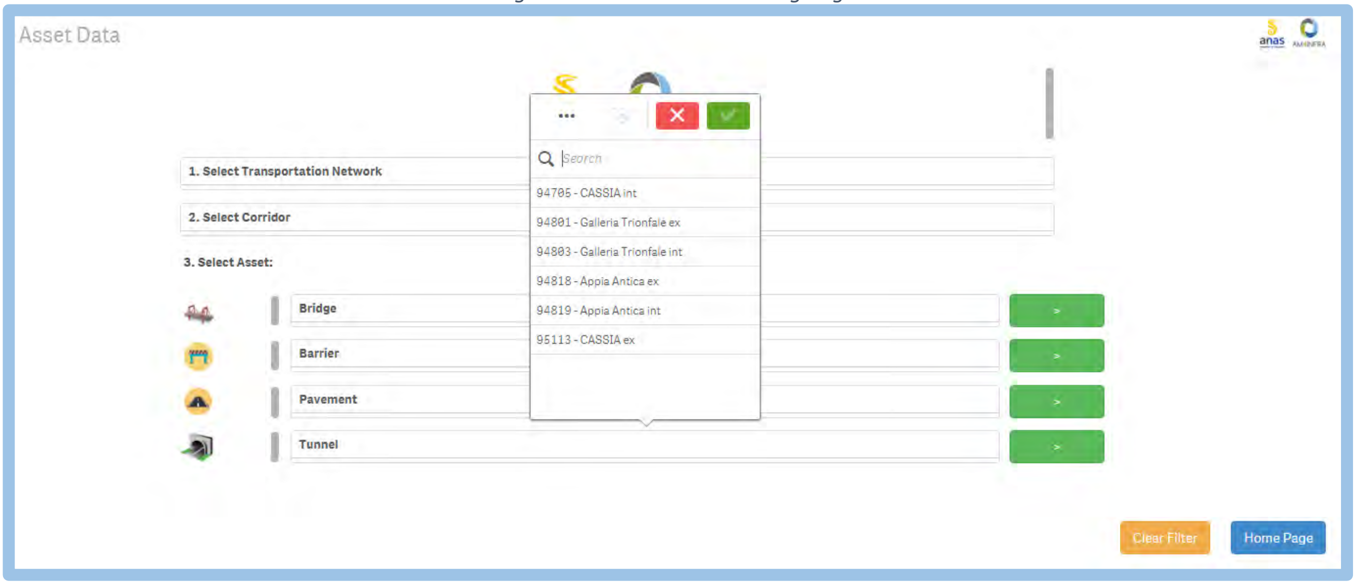
6.2.1.1 SECTION 1 – ASSET DATA

Asset Data section allows performing a selection of a **Transportation network** (Motorway, Railway, or Road), **Corridor,** or an **Asset,** and then browsing the related key asset data.
In the POC, four types of asset have been included:
- Bridge
- Barrier
- Pavement

- Tunnel

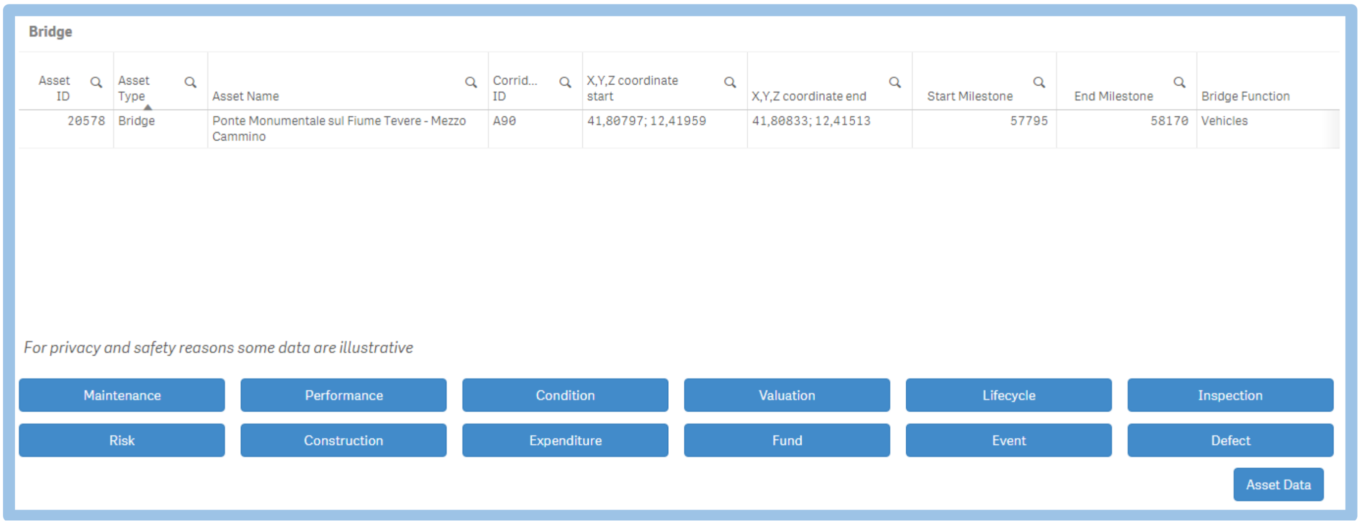
Selecting **an asset category**, the system shows the list of the assets present on the corridor.

Figure 6-2 Asset Data Browsing Page



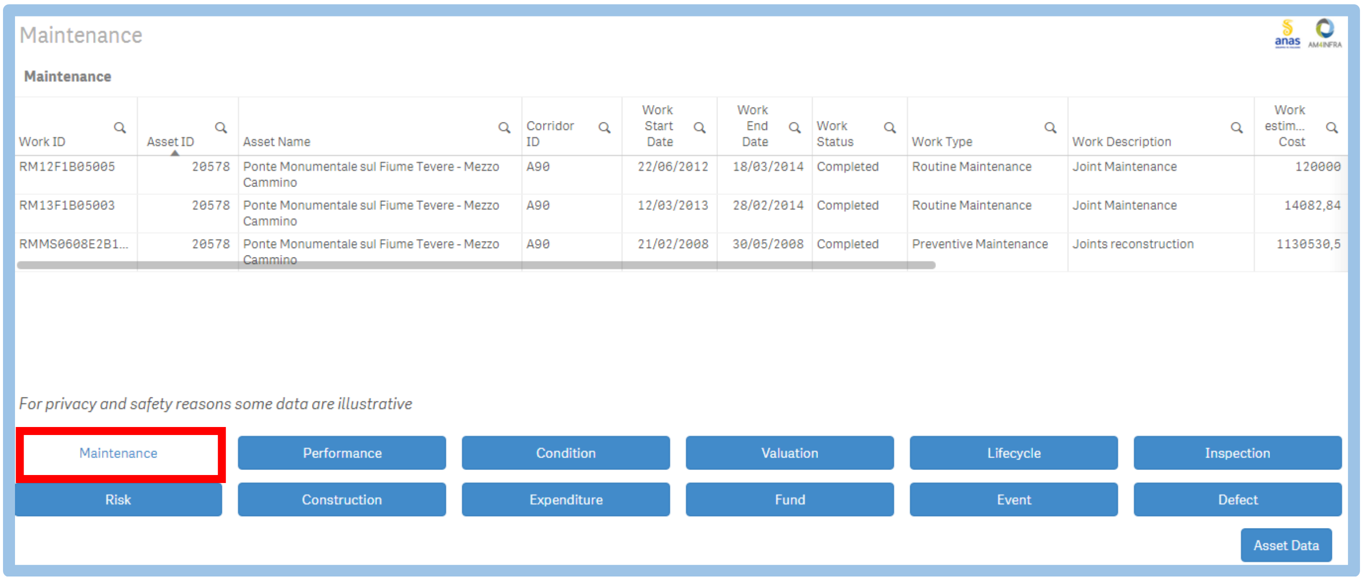
Once the user has selected a specific asset, she/he will be redirected to a subsection, where she/he will be able to view the general asset data (Asset Inventory dataset). In the same page, the user is able to choose and view the other datasets related to the asset.

Figure 6-3 Asset Inventory (Illustrative)



Asset information is organized according to the datasets described in D3.1 "*Asset Data Dictionary*".

Figure 6-4 Example of navigation in Asset Data Browsing: Maintenance (Illustrative)



6.2.1.2 KEY PERFORMANCE INDICATORS SECTION

The Key Performance Indicators section allows the user to view a set of KPIs referred to a specific corridor (for the case study it is represented by A90) or asset.

As reported in D3.2 "Business blueprint of an asset information management core system", three main categories of KPIs have been identified.

- **Strategic KPIs:** to track "performance metrics" against high-level objectives; as a result, these KPIs tend to summarize performance over the past month, quarter, or year; target audience are asset owners, asset managers and other external stakeholders;
- **Tactical KPIs**: to monitor the processes that support the organization's strategic initiatives. Tactical KPIs help the decision-making process; target audience are asset managers;
- **Operational KPIs**: to monitor and analyzing NIA's processes related to core activities; target audience are both service providers and asset managers;

In the following paragraph, examples of each category are shown.

Figure 6-5 KPIs Page (Illustrative)

6.2.1.3 STRATEGIC KPI'S

The Strategic KPI's, represented in the POC, are the following:

- Service quality (Comfort) - Ride & Surface quality
- Service Quality (mobility and speed) – Average Travel speed
- Economic Return – Asset Value

Service quality (Comfort) - Ride & Surface quality

Ride and surface quality is represented by **I_{PAV}** KPI that is a **weighted average** (see table below) of the two following KPIs:

- **International Roughness Index (IRI)** obtained from measured longitudinal road profiles. It is calculated using a quarter-car vehicle math model, whose response is accumulated to yield a roughness index with units of slope (in/mi, m/km, etc.).
- **Coefficient of Transverse Friction (CAT)** represents the adherence of the road surface and it is expressed as a formula function of friction coefficient in determined situation.

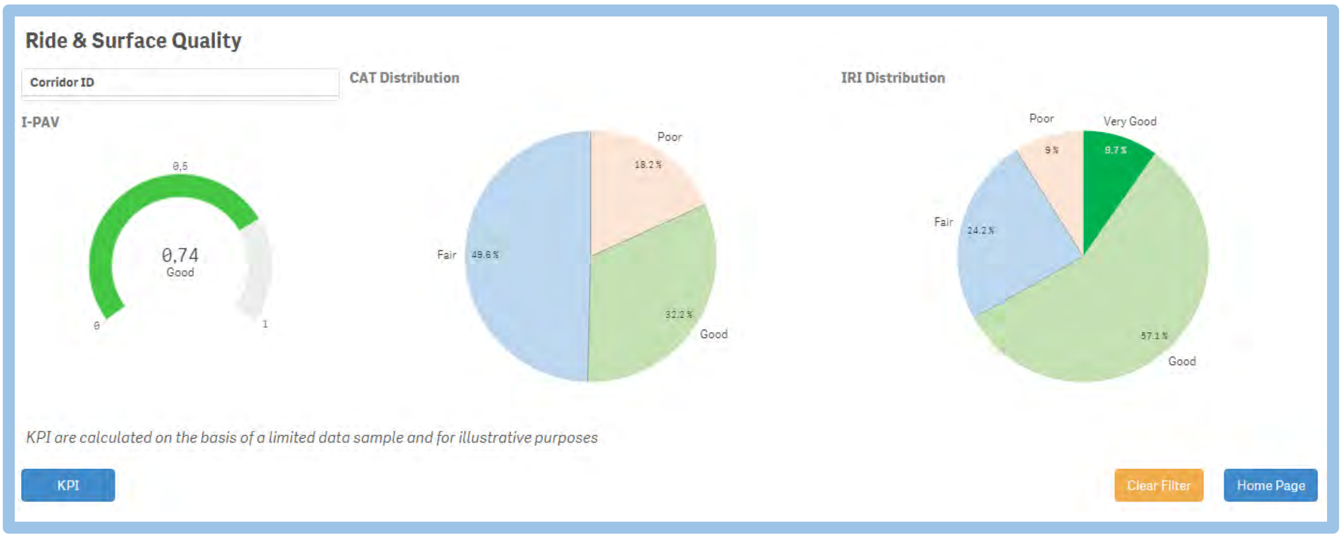
Table 6-2 **I_{PAV}** KPI details

I_{PAV}
$\boldsymbol{I_{PAV} = 0,6 * I_{CAT} + 0,4 * I_{IRI}}$ where: $\boldsymbol{I_{CAT}} = 1 * L_A + 0,75 * L_B + 0,50 * L_C + 0,25 * L_D$ $\boldsymbol{I_{IRI}} = 1 * L_A + 0,75 * L_B + 0,50 * L_C + 0,25 * L_D$ L_x indicates the percentage of the length of road belonging to a specific class (A, B, C, or D) of CAT or IRI. Specific classes are defined, in qualitative form, as it follows: A - **Very good,** B – **Good,** C – **Fair,** D – **Poor** **Classes of I_{PAV} are defined as below:** A: I_{PAV} >= 0,8 B: 0,7 < I_{PAV} <= 0,8 C: 0,5 < I_{PAV} <= ,7 D: I_{PAV} <= 0,5

In the related POC's page, for the selected corridor, the following data are shown:

- **% Distribution of CAT value** along the corridor (A - Very good, B – Good, C – Fair, D – Poor);
- **% Distribution of IRI value** along the corridor (A - Very good, B – Good, C – Fair, D – Poor);
- **I_{PAV} total value**.

Figure 6-6 Ride & Surface Quality (Illustrative)



Service Quality (mobility and speed) – Average Travel speed

This KPI represents the level of traffic calculated as **average speed** on a specific stretch of road and in a specific time slot. The KPI is represented as a **histogram that can vary following the application of filters**.

It is possible to **filter:**

- Corridor,
- Range of mileage,
- Time slot,
- Day type (day before holiday, public holiday, weekday),
- Month.

Figure 6-7 Average Travel Speed (Illustrative)

Economic Return – Asset Value

This is a KPI that indicates the entire value of the assets, ANAS calculates this KPI through the **historical cost**.

Historical cost represents the original nominal monetary value of an economic item, in this case it is the sum of all the investments (that can be new construction, installation of new device or item on the road, securing, etc …) related to a given corridor.

Figure 6-8 Asset Value - Historical Cost (Illustrative)

6.2.1.4 TACTICAL KPI'S

The Tactical KPI's represented in the POC, are the following:

- Maintenance Works – Economic value and progress
- Safety - Number of accidents, fatalities and injuries
- Utilization & Traffic – Network availability (closure)

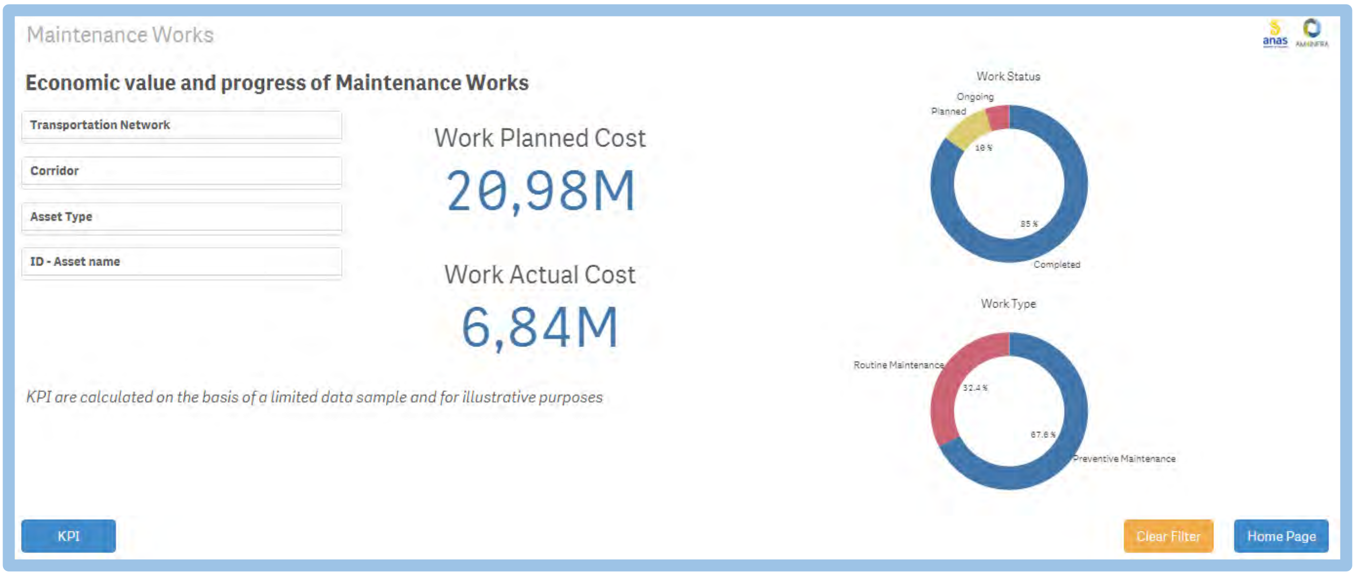
Maintenance Works – Economic value and progress

KPIs representing **aggregated values** of the maintenance works, in terms of:

- **Planned value** of maintenance works;
- **Current expenditures** for maintenance works;
- **% Distribution of Maintenance Works Status** (e.g. ongoing, planned, completed);
- **% Distribution of Work Type** (e.g. routine maintenance and preventive maintenance).

Furthermore, it is possible to filter: transportation network, asset Type, asset ID.

Figure 6-9 Economic value and progress of Maintenance Works (Illustrative)



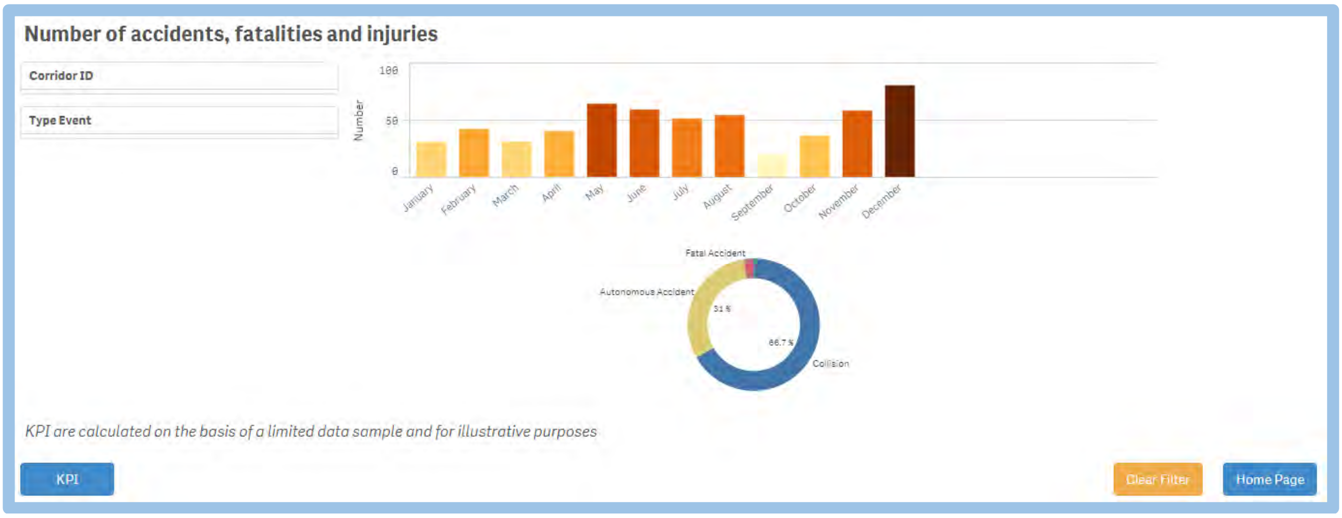
<u>Safety - Number of accidents, fatalities and injuries</u>

KPI shows monthly:

- The number of events happened;
- % Distribution of events' type: types can be autonomous accident (where a unique car is involved in the accident), fatal accident, or collision (an accident between two or more cars without fatalities).

Furthermore, it is possible to filter the Corridor ID and thus view information for single corridors defined in the system.

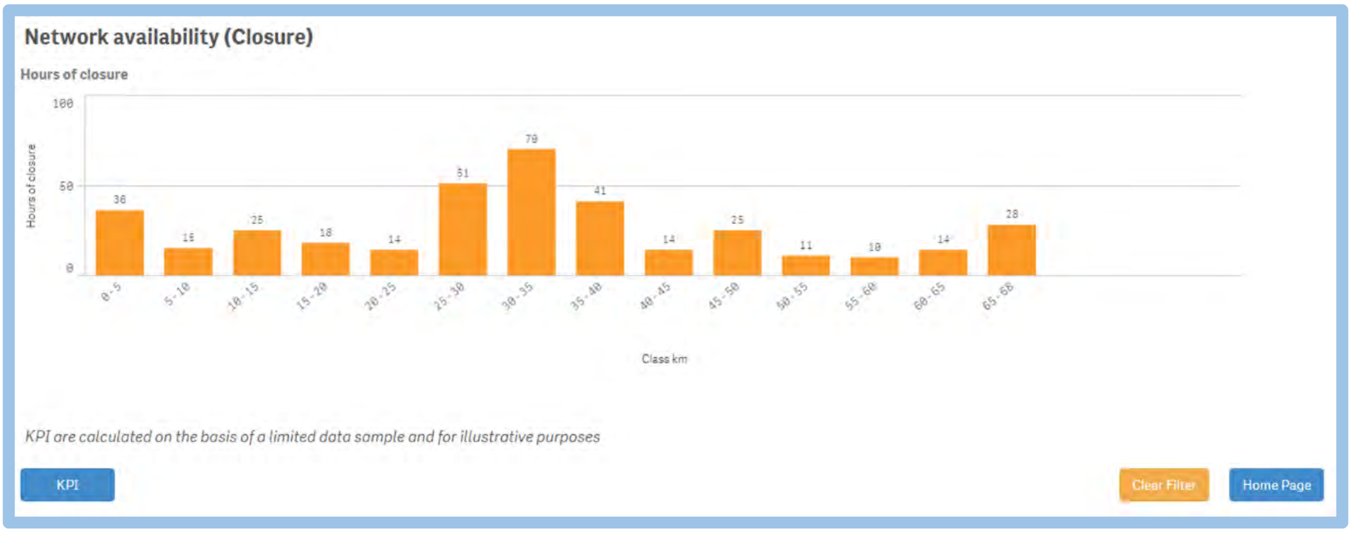
Figure 6-10 Number of accidents, fatalities and injuries (Illustrative)



<u>Utilization & Traffic – Network availability (closure)</u>

This KPI shows, through a histogram, the number of hours, divided by range of KMs, in which a road or a carriageway has been closed after events (e.g. obstacle presence along the carriageway, broken down vehicle, car accidents, etc.).

Figure 6-11 Network yearly availability (Illustrative)



6.2.1.5 OPERATIONAL KPI'S

The Operational KPI's, represented in the POC, are the following:

- Bridge – Bridge Condition
- Operational Effectiveness – Incident Response Time

<u>Bridge – Bridge Condition</u>

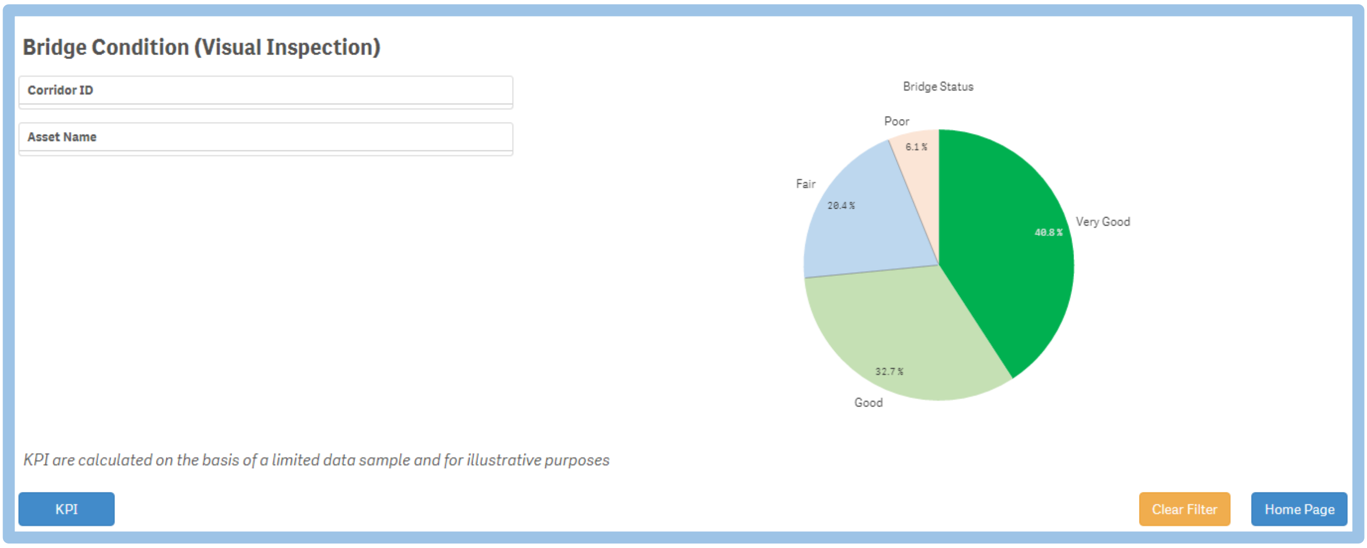
Through a regular visual inspection, bridges managed by ANAS are checked, and the inspector assigns the bridge a qualitative mark that can be:

- Very good – Long term maintenance required;
- Good – Medium term maintenance required;
- Fair – Short/medium term maintenance required;
- Poor – Short term maintenance required.

This mark is used to understand the requirements of maintenance for every bridge and possible needs of further checks.

The KPI represents therefore the % distribution of bridges condition over the network or the current condition of a specific bridge.

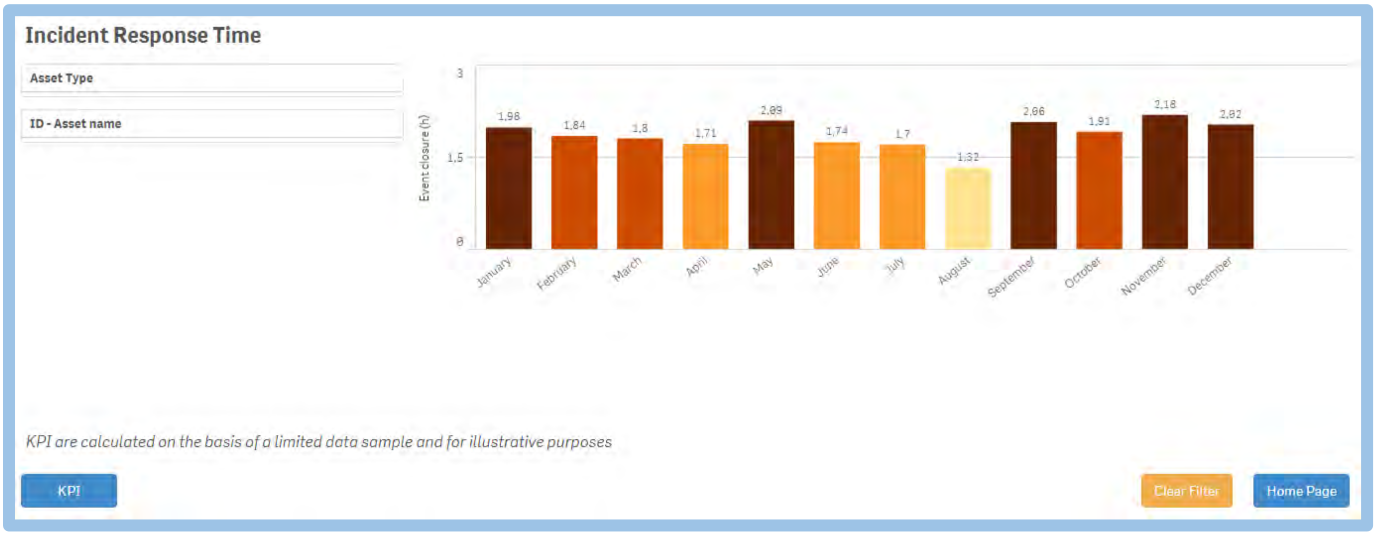
Figure 6-12 Bridge Condition (Illustrative)



Operational Effectiveness – Incident Response Time

This KPI measures the average duration time of an event occurring along a corridor or an asset (e.g. obstacle presence along the carriageway, broken down vehicle, car accidents, etc.).

Figure 6-13 Incident Response Time (Illustrative)



7. Final results and Lesson Learnt

Key results coming from the activities carried out during this task of AM4IINFRA Work Package "Information and Data Management" are the following:

- The verification of the application of WP3 deliverables in a real case scenario can be considered completed with **positive results**; in fact, the task succeeded both in **filling datasets defined in asset data dictionary with real ANAS asset data** and **creating links** between them according to the **ontology map**;
- The KPIs, defined in the D3.2 BBP, have been successfully calculated on a sample of A90 data, and through **their graphic charts** has been possible to test also **the end user experience**;
- The project internal and external stakeholders have confirmed that the possibility **to browse**, through a web interface, several A90 **asset data** of different categories (technical, financial, operational) in **one single repository**, represents a **key success factor** to improve asset information sharing.
- The availability of a **unique repository of asset data** facilitates more control on the assets, to identify **more correlation among asset data**, and to support effectively asset management decisions.

Lesson Learnt

- Within the ANAS context, some asset datasets requested by the model are not recorded yet (e.g. lifecycle, valuation); it could be useful to define **a priority among datasets of D3.1 asset data dictionary**, in order to allow NIAs, during implementation phase, to identify which issues must be addressed first;
- Regarding **key performance indicators**, the availability of a unique repository for asset data facilitates the development of an increasing number of KPIs and to **identify more correlation** among asset data in order to support asset management decisions;
- In the **Asset data section,** for each data item, it could be useful to have the possibility to retrieve the information regarding its source system name;
- From the Proof of concept (**POC) execution**, it emerged that a **further major improvement** could be to implement a system based on a **Big Data architecture**, creating a **Data Lake** containing all asset data.

8. Conclusion

To support improvement of asset data management across transportation network stakeholders (owners, managers and operators), AM4INFRA Work Package 3 “Data and Information Management” has delivered an Asset Data Dictionary and a Business Blueprint of an Asset Information Management System.

This framework has been successfully verified and tested both during Rome Living Lab and during this task, where it has been applied on a sample of actual asset data related to a TEN-T Itinerary (A90 Ring Road).

In order to exploit the benefits coming from more robust data and information management among NIAs, further to this deliverable it is possible to foresee the following next steps:

- Definition of a standard roadmap for the implementation of data and information management element of the framework (activities, time and responsibilities);
- Involvement of other NRAs for the application of the data and information management element of the framework in pilot projects.

9. References

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