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GRUPPO FERROVIE DELLO STATO ITALIANE

Extracting information from data for railway infrastructure maintenance decision support

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Rete Ferroviaria Italiana (RFI)
23 November 2016

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- The Asset Management
- Turning data into information
- Main user requirements
- Key aspects of implementation
- Main improvements

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- **The Asset Management**
- Turning data into information
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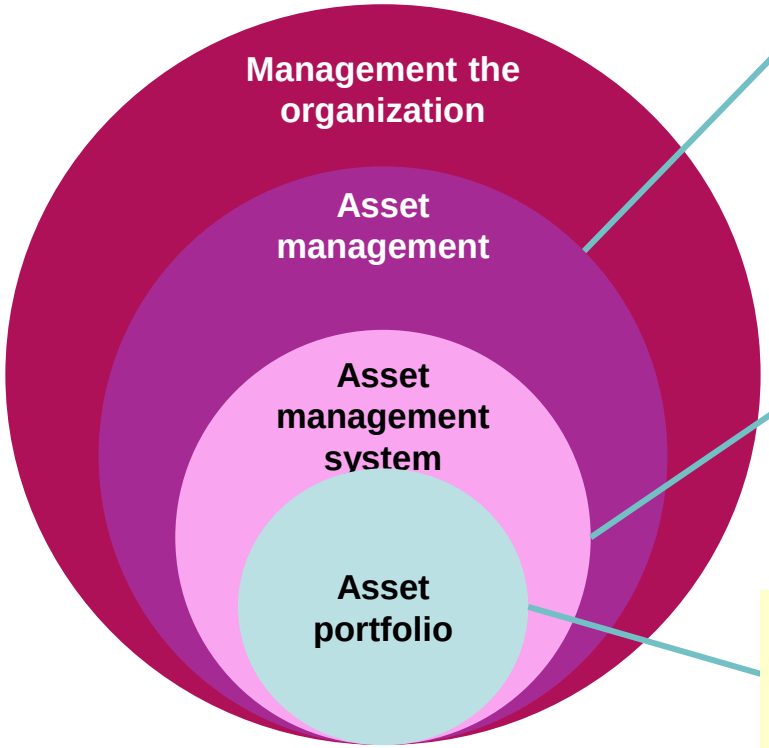
Asset Management (AM)



Coordinated activity of an organization to realize value from assets

Set of interrelated or interacting elements to establish asset management policy, asset management objectives and processes to achieve those objectives

Assets that are within the scope of the asset management system

ISO 55000: section 2

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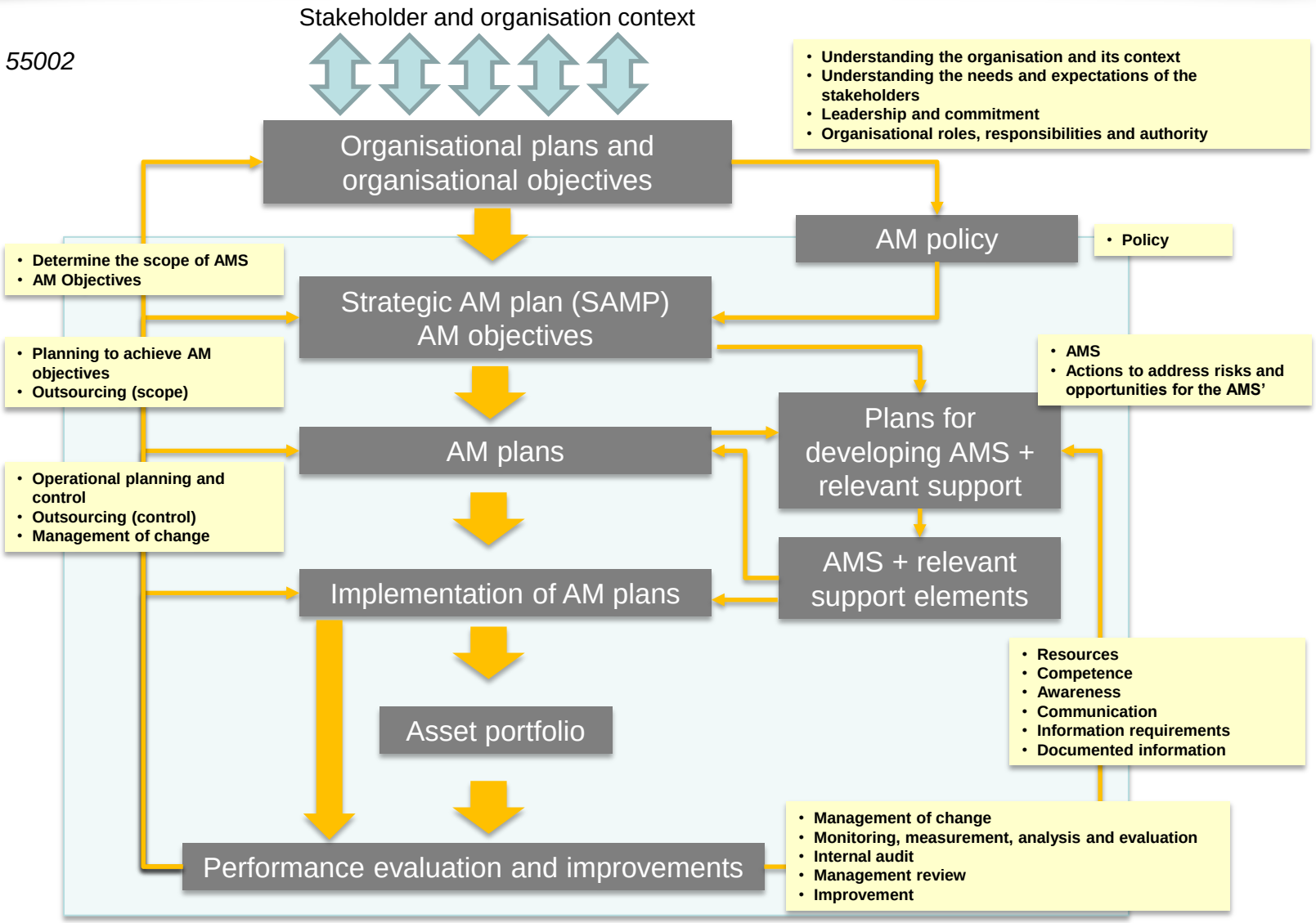
Relations between the key elements of an Asset Management System (AMS)

Annex B - ISO 55002



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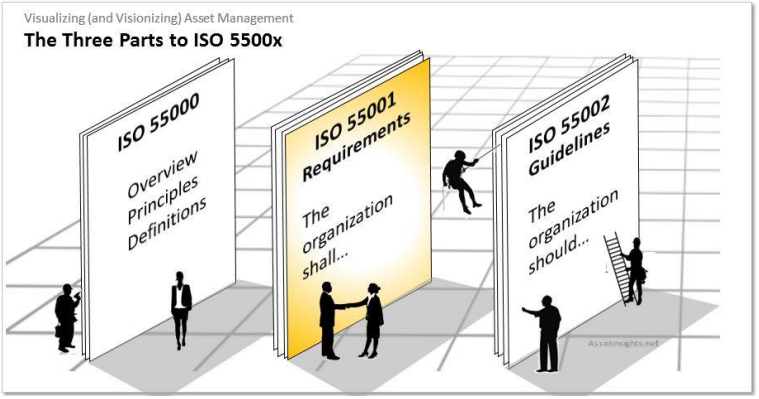
AM in RFI

Asset Management analyzes business process and it's focused on:

- **life cycle**, which involves a vision not only focused on the acquisition costs of the goods, but also on the effects of their management with respect to the business, optimizing the life of the plants;
- **systemic**, requiring the integration of the asset management processes with the functional management processes organization, such as finance, human resources, information systems and logistics;
- **risk**, which depends on good management based on finding the right balance between performance, cost and risk;
- **"asset centric" management** to ensure the orientation of business processes to the new way of seeing the Asset.



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AM - Decision Support System (DSS)

Number of information (In.Rete2000 objects)				
Type of object		Function	Partial	Total
Warnings	A1	Activity	25.025	
	A2	Inspection Visit 1	1.886	
	G1	Temporary Joint	617	
	I1	Failure	137.488	
	V1	Inspection Visit 2	86.750	
	V2	OHL Quality Index	6.506	
	V3	Track Quality Index	16.175	
	V4	Track geometry surveys	13.350	
	V5	Ultrasound	4.737	
	V6	OHL surveys	12.416	
				304.950
Work Orders	100-900	All policies		**851.435**
Measuring Doc	Surveys ..L94			**233.101**
Technical locations				**1.830.411**
Network		MS and Inv		**4.223**

There are a lot of necessary information to manage, so Asset Management needs a system for data analysis and for decision support

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The Diagnostic data and information extraction

Diagnostics gives the opportunity to easily provide a huge amount of data thus improving the information and decisions quality and this imposes the need to employ data safely.

The main risk is that an “excess of data” may lead to waste time and obscure information.

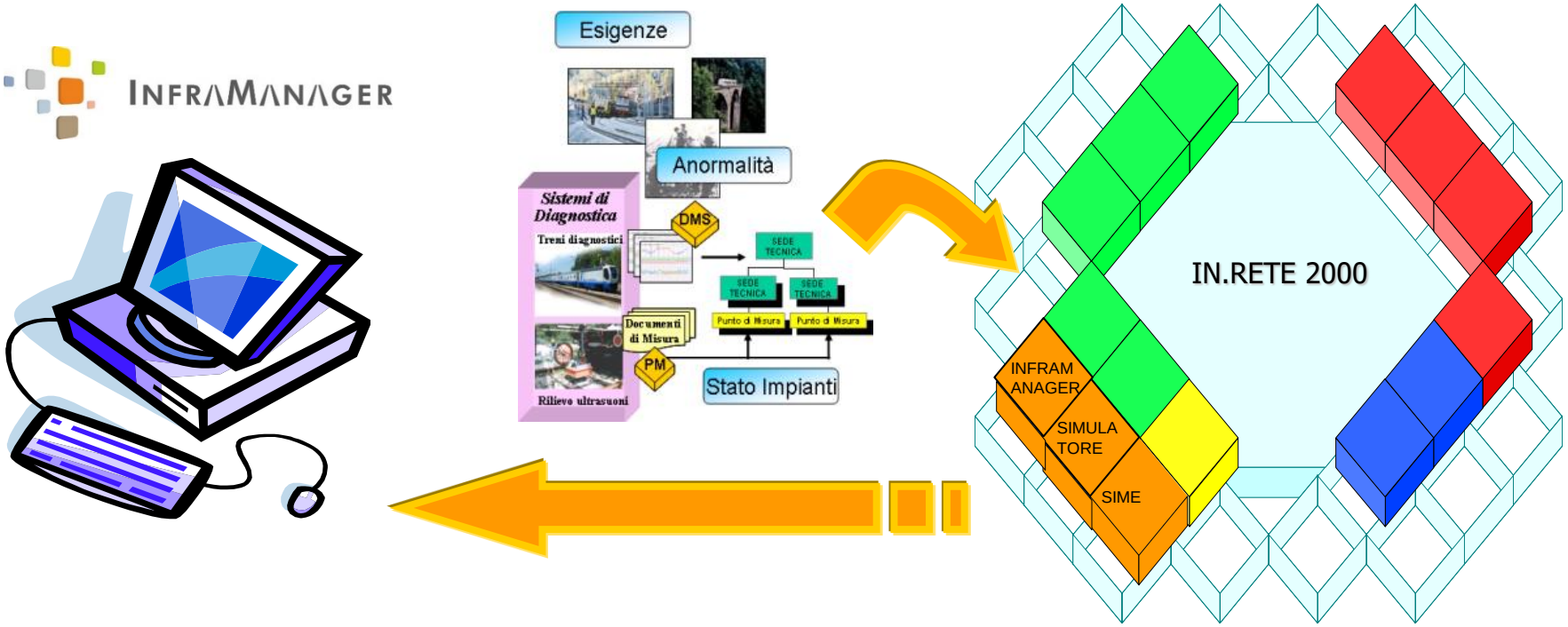
Data is important since it gives information, thus contributing to assess current asset conditions and predict their evolution in the future.

“It is necessary to turn data into information”

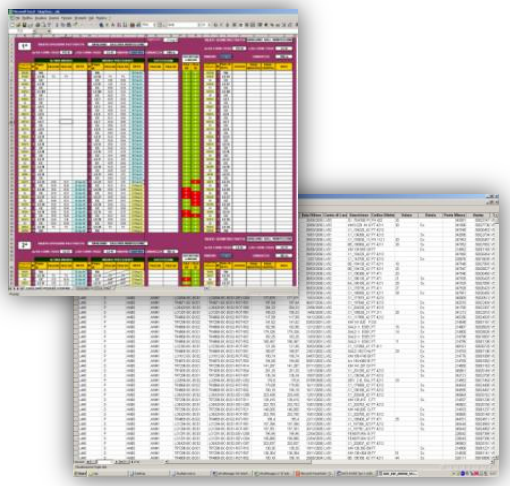
Business processes management: InRete and related systems

INFRAMANAGER is a DATA analysis and decision support system, transforming data into useful INFORMATION for work planning and control:

- It identifies and proposes the right works
- It identifies deterioration laws and priorities
- It optimizes interventions rationalizing resources

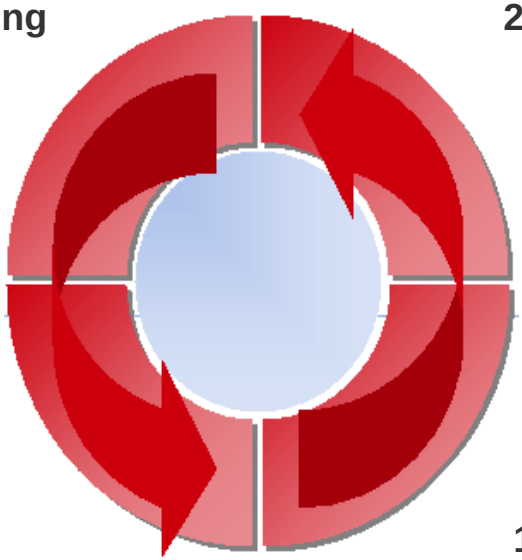


Predictive Maintenance (without InfraManager)



3. Planning

2. Data Analysis



4. Check

1. Data collection

Measuring systems

Measuring trains

Ultrasonic detection

- Non-structured and shared business rules
- Missing the analysis of the asset deterioration unless isolated cases
- Data collection in MS Excel and MS Access not integrated with In Rete 2000

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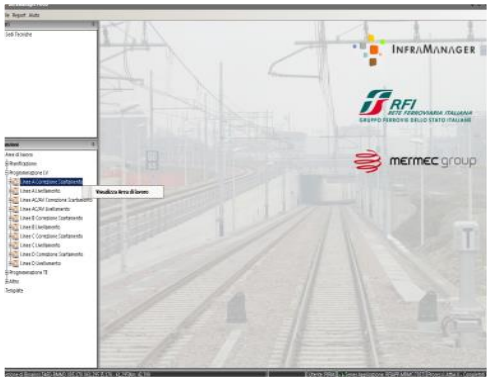
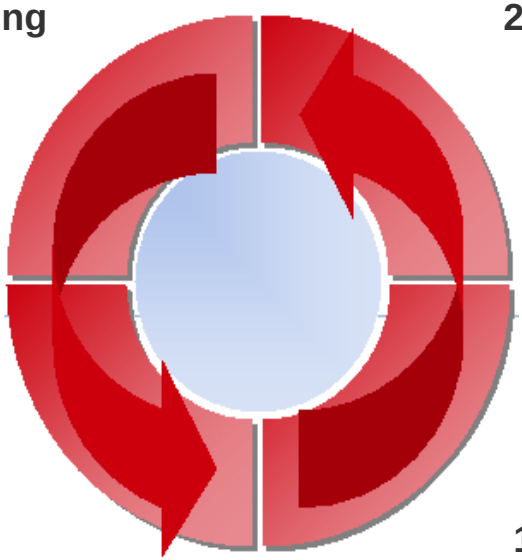
Predictive Maintenance (with InfraManager)



INFRAMANAGER

3. Planning

2. Data Analysis



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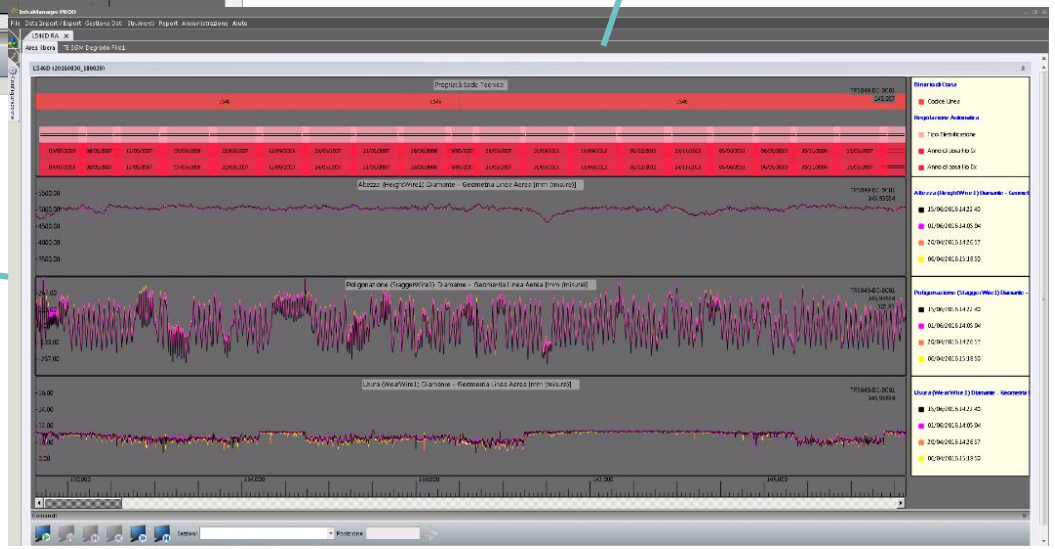
Linear Visualization of both condition and asset data

Correlation of Track and Catenary Defects

Track and Catenary Asset Data



Track and Catenary Parameters

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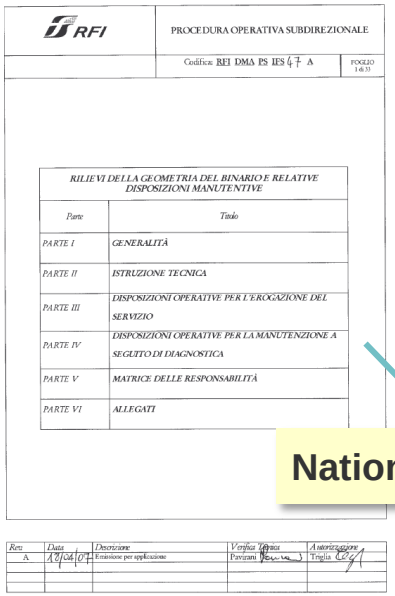
Open to new algorithms compliant to norms


RFI

PROCEDURA OPERATIVA SUBDIREZIONALE

Codifica: RFI DMA PS IES 47 A

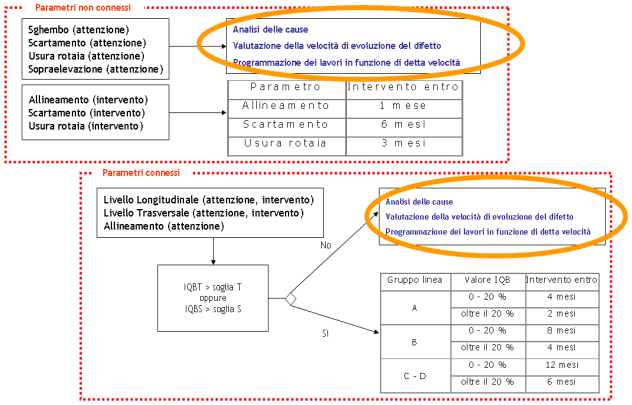
RILIEVI DELLA GEOMETRIA DEL BINARIO E RELATIVE DISPOSIZIONI MANUTENTIVE

Parte	Titolo
PARTE I	GENERALITÀ
PARTE II	ISTRUZIONE TECNICA
PARTE III	DISPOSIZIONI OPERATIVE PER L'EROGAZIONE DEL SERVIZIO
PARTE IV	DISPOSIZIONI OPERATIVE PER LA MANUTENZIONE A SEGUITO DI DIAGNOSTICA
PARTE V	MATRICE DELLE RESPONSABILITÀ
PARTE VI	ALLEGATI

Rev.	Data	Descrizione	Verifica tecnica	Autorizzazione
A	12/04/07	Emissione per applicazione	Pavirani	Trigila

National Norms

IF there is at least a defect in warning (L1,XL1,A1,SG91,DH1)
AND
IF the track deterioration speed (which can be calculated as the worst of trends of track quality indexes) is superior than a limit value
THEN
introduce such activity


Parametri non connessi

Sghembo (attenzione)
Scartamento (attenzione)
Usura rotaia (attenzione)
Sopraelevazione (attenzione)

Allineamento (intervento)
Scartamento (intervento)
Usura rotaia (intervento)

Analisi delle cause
Valutazione della velocità di evoluzione del difetto
Programmazione dei lavori in funzione di detta velocità

Parametro	Intervento entro
Allineamento	1 mese
Scartamento	6 mesi
Usura rotaia	3 mesi

Parametri connessi

Livello Longitudinale (attenzione, intervento)
Livello Trasversale (attenzione, intervento)
Allineamento (attenzione)

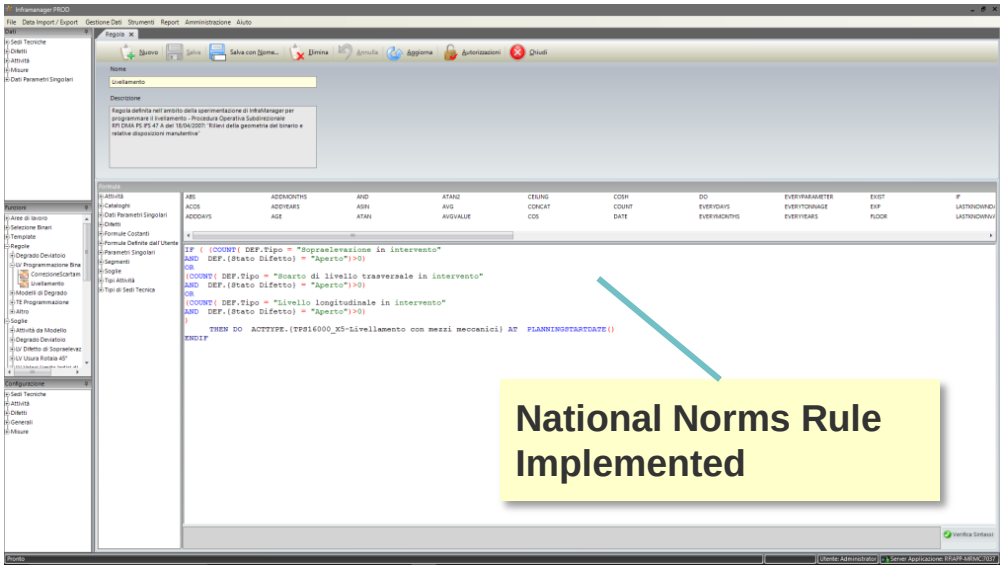
No

Analisi delle cause
Valutazione della velocità di evoluzione del difetto
Programmazione dei lavori in funzione di detta velocità

IQBT > soglia T
oppure
IQBS > soglia S

SI

Gruppo linea	Valore IQB	Intervento entro
A	0 - 20 %	4 mesi
	oltre il 20 %	2 mesi
B	0 - 20 %	8 mesi
	oltre il 20 %	4 mesi
C - D	0 - 20 %	12 mesi
	oltre il 20 %	6 mesi



National Norms Rule Implemented

Capability to easily configure new algorithms via a business rule editor

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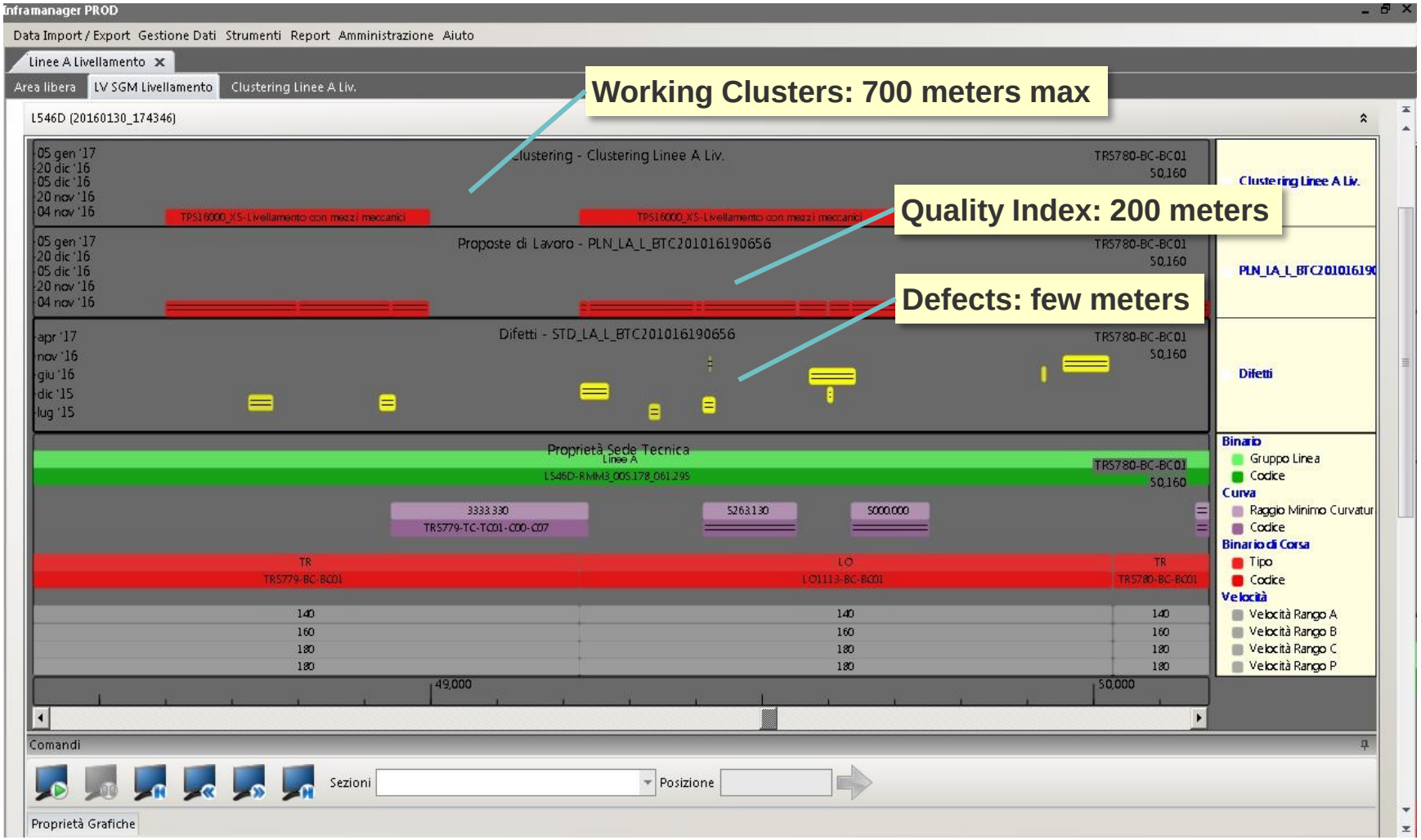
Generation of optimized maintenance work plans



Capital work priority (planning criteria)

General Data

Asset Registry Data
(technical characteristic; age, etc)

Environment conditions
(sea-mountain, north – south, etc)

Presence of singular points
(landslide, flooding, etc)

Line Category
(commercial segmentation of network)

Line gradient

Contact wire gradient
(plano-altimetric profile)

Impact on operations
(effects on circulation)

Management data

Technical and economical data (work order, etc.)
Annual average failure rate
Trend of failure rate related to previous years
Average duration of failures
Trend of contact line quality index
Trend of track quality index
Corrective maintenance annual costs
Trend corrective maintenance annual costs (previous years)
Preventive maintenance annual costs
Trend preventive maintenance annual costs (previous years)
Extent of civil structure indicators
Minutes of train delay
Existence of serious failures
Obsolescence
Number of wire joints / spans

Data to set / Guidelines / Technological adjustment

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Work Priority/Score Calculation

```
IF (EXIST ( Binario))
THEN
IF  (Binario.(Gruppo Linea) = "LINEE A")
THEN 1
ELSE
IF  (Binario.(Gruppo Linea) = "LINEE B")
THEN 0.75
ELSE
IF  (Binario.(Gruppo Linea) = "LINEE C")
THEN 0.50
ELSE
IF  (Binario.(Gruppo Linea) = "LINEE D")
THEN 0.25
ENDIF
ENDIF
ENDIF
ENDIF
ENDIF
```

Using data to calculate an "objective" priority based on a set of standard criteria!

Priority=Higher the value, the more urgent is the work

Binario.Gruppo	Binario.Nome	Km Inizio	Km Fine	Binario di corsa.N	REPPriorità
LINEE A	L550D	6,331	8,923	TR5854-BC-BC01	0,999
LINEE B	L448D	169,484	176,708	TR4867-BC-BC01	0,987
LINEE B	L448D	144,874	156,332	TR4865-BC-BC01	0,936
LINEE A	L546D	139,004	152,955	TR5849-BC-BC01	0,715
LINEE A	L546D	180,847	187,841	TR6316-BC-BC01	0,204
LINEE B	L543U	123,383	123,845	LO1440-BC-BC01	0,000
LINEE B	L543U	123,905	133,641	TR8704-BC-BC01	0,000
LINEE B	L543U	133,641	134,233	LO0577-BC-BC01	0,000
LINEE B	L543U	134,233	140,319	TR5101-BC-BC01	0,000
LINEE B	L543U	140,319	141,144	LO2776-BC-BC01	0,000
LINEE B	L448D	122,080	124,966	TR4861-BC-BC01	0,000
LINEE A	L550D	179,146	182,110	TR5856-BC-BC01	0,000
LINEE A	L550D	184,748	188,198	TR5858-BC-BC01	0,000

Priority = 0 indicates that data is not valid!!!

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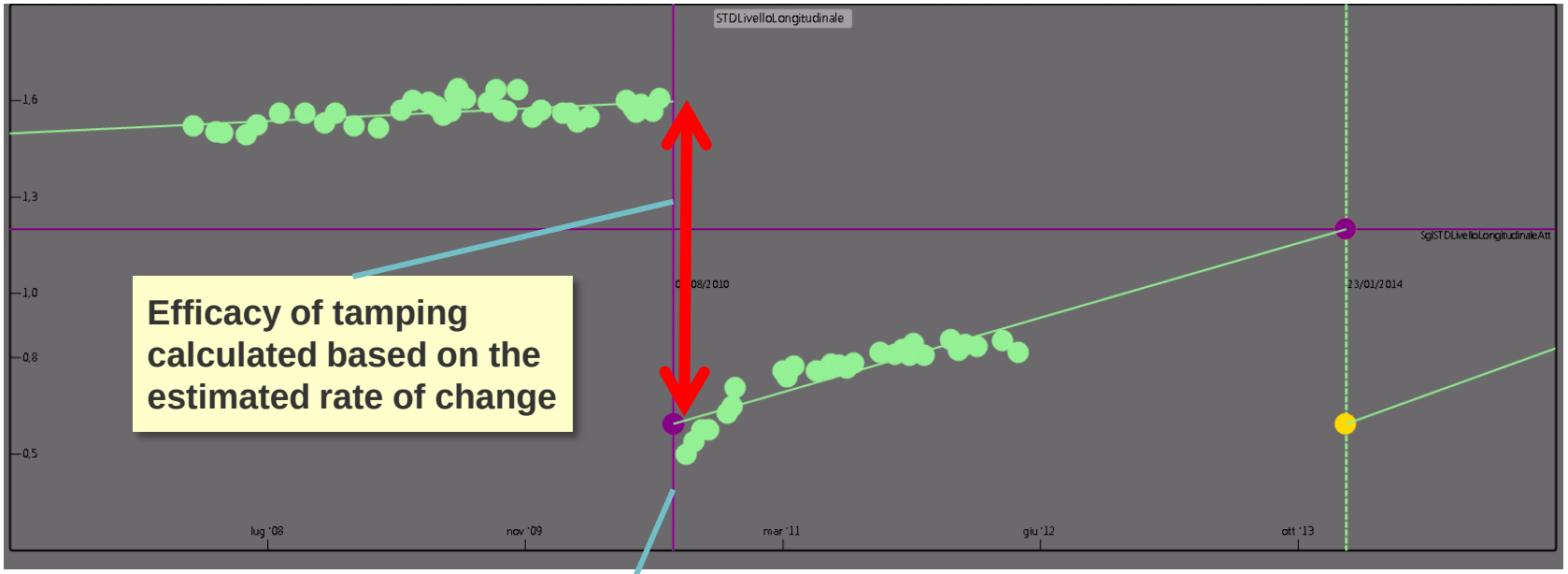
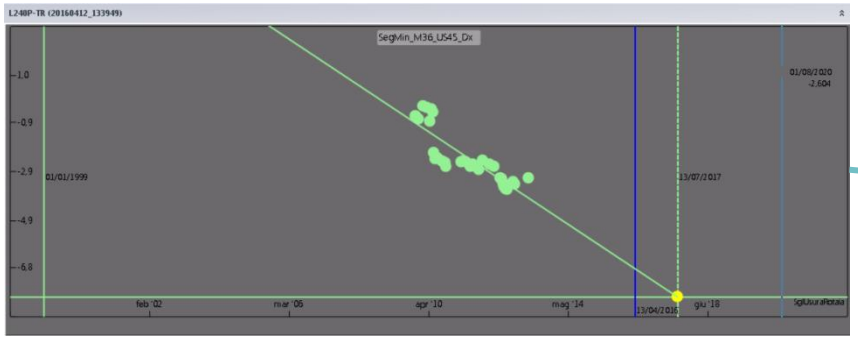
Calculate work efficiency and efficacy



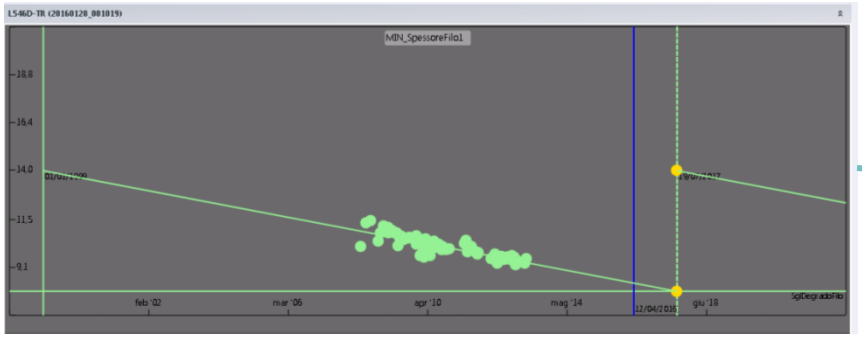
Efficacy of tamping calculated based on the estimated rate of change

Work Activity from the database

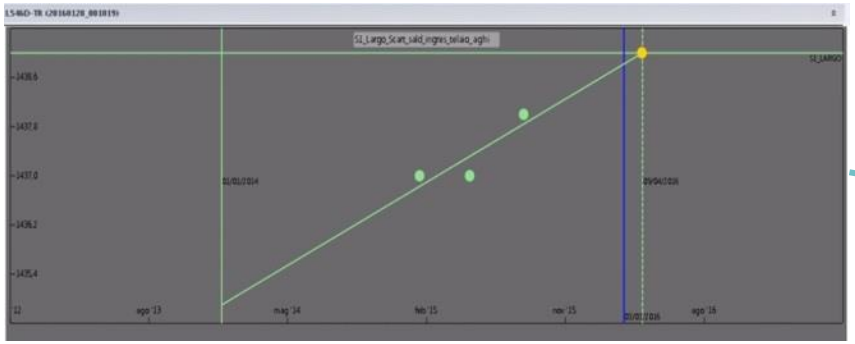
Generate deterioration models for different assets



Rail Wear Deterioration



Wire Thickness Deterioration



Switch Deterioration

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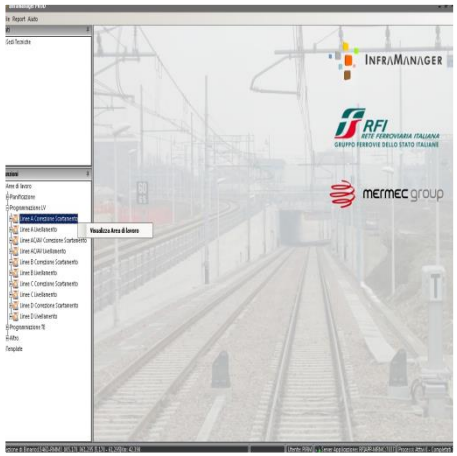
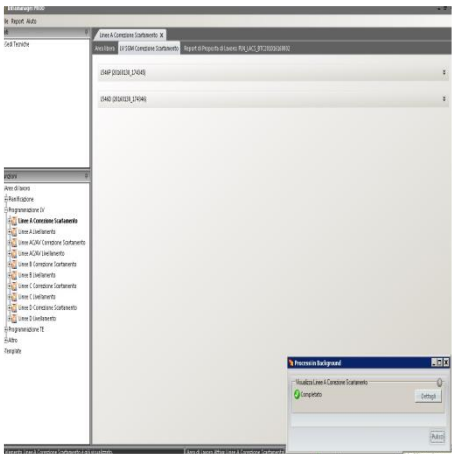
Accessing to the work plans with one click

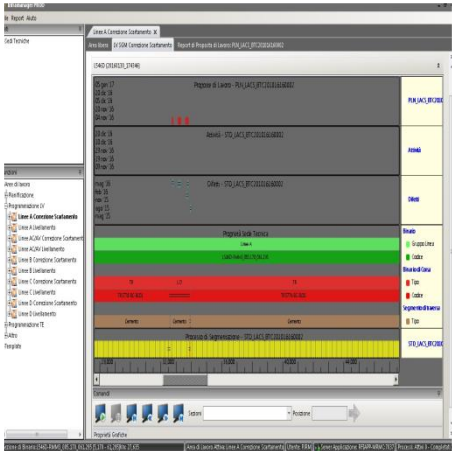
Field users required a simplified Graphical User Interface (GUI) where they can open with a SINGLE CLICK of mouse the planned works for a specific line category and type of work.



Selection of work area



Plan Download



Visualisation & Reporting

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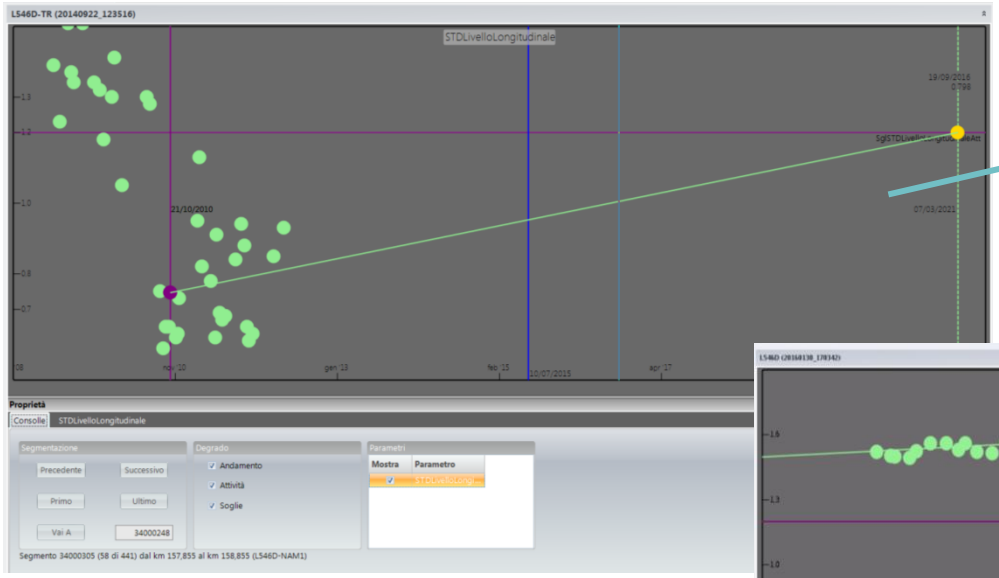
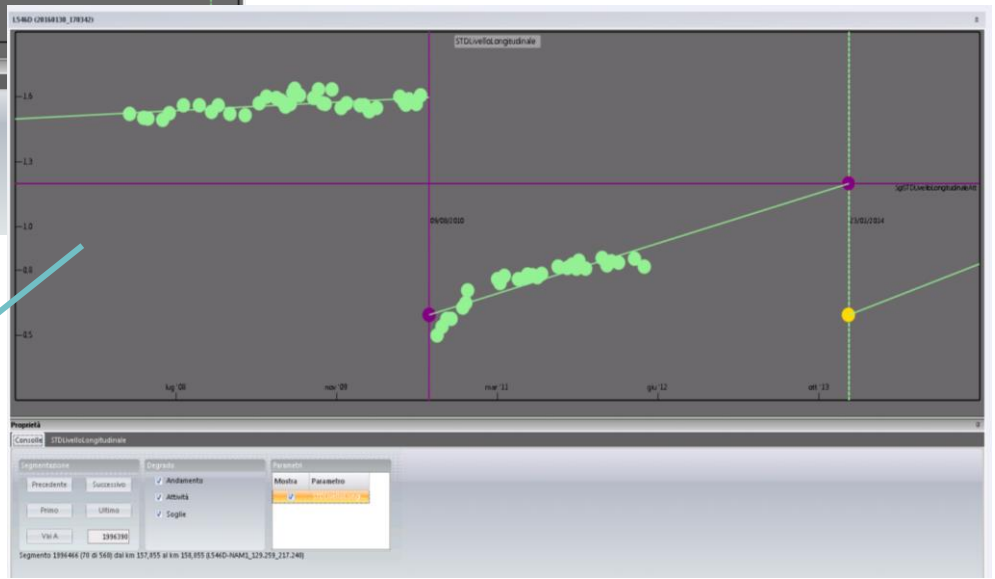
Deterioration modelling without and with data validation

Data may contain errors of various types (e.g. localisation, calibration, etc.) so it is fundamental that condition and asset data must be validated before to be used for predictive analytics.



Invalid data used for trending Track Quality on a selected track segment

Update of the trend after data validation for the same track segment



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Main Improvements introduced by Inframanager

- **Immediate visualisation** of many maintenance data using graphical **linear mode**
- Visualization of the required information in a single and **common user interface** without the need to adopt custom tools or paper
- **Enhanced understanding** of defect occurrence and causes
- Clustering of defects for **better targeting maintenance works**
- Monitoring quality deterioration and improvements in time with **predictive rules/models for better maintenance planning and control** (saving up to the 30%)

Thanks for your attention