Asset management and maintenance planning
an example in the road sector

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1st Open Workshop
AGENDA

01 INFRAESTRUTURAS DE PORTUGAL

02 ASSETS UNDER IP’s JURISDICTION

03 PAVEMENT MANAGEMENT SYSTEM

04 SUPPORT TO DECISION-MAKING

05 FINAL REMARKS AND OPEN CHALLENGES

Profile

Company
National Road Network General Concessionaire
Long-term Concession Contract of 75 years (until 2082)
Shareholder Base: Portuguese State (100%)

Mission
Financing, operation and development of the road network integrating the National Road Plan (except the network under private concession);
The design, construction, financing, maintenance, operation and development of the future road network.

Responsibilities
Fulfilment of performance indicators: Level of Service, Road Safety and Environmental Sustainability
Road sector model

IP CONCESSION CONTRACT -> PORTUGUESE STATE -> TOLLED ROADS CONCESSION CONTRACTS

PORTUGUESE STATE

CONCESSIONAIRES

ROAD USERS

ROAD AVAILABILITY AND SERVICE PROVIDED

SUB-CONCESSIONAIRES

CONCESSIONAIRES

SUB-CONCESSION CONTRACTS

FUEL TAX

TOLLS
Road network extent

- **NATIONAL ROAD NETWORK**: 17,765 km
  - **IP CONCESSION**: 15,144 km
    - **DIRECT MANAGEMENT**
      - **MOTORWAYS**: 196 km
    - **SUB-CONCESSIONS**
      - **MOTORWAYS**: 321 km
  - **OTHER CONCESSIONS**: 2,621 km
    - **MOTORWAYS**: 196 km
    - **OTHER ROADS**: 1,235 km

- **OTHER ROADS**
  - **DIRECT MANAGEMENT**: 13,588 km
  - **SUB-CONCESSIONS**: 1,556 km
    - **MOTORWAYS**: 321 km
    - **OTHER ROADS**: 1,235 km
Road assets under IP jurisdiction

Classified Roads (9,774 km)
- Principal Itineraries (443 km)
- Complementary Itineraries (1,579 km)
- National Roads (4,465 km)
- Regional Roads (3,287 km)

Declassified Roads (3,814 km)
Road assets under IP jurisdiction

Bridges and similar structures (5 211)
  • Water ducts prevail over other types of structures (40%)

Earth Retaining Structures (23 551)

Other types of road furniture
  • Signalling, drainage, lighting, safety barriers, etc. (complete inventory)
IP Asset Management Systems

SGPav
Pavement Management System
Pavement Management System overview

- Annual condition surveys
  Pavement quality data

- Pavements database
  Pavement description and historic record

- Performance model
  Pavement quality prediction

- Design and construction

- Strategies evaluation
  Multi-annual intervention plans

2003 | Project start
2007 | Production start
Database structure

**Node**
Object defining start and end points of each section, placed on junctions, district limits, change in road classification or change in cross section type.

**Section**
Basic road network object, serving as minimum unit for a network stretch and used for survey and analysis purposes.
Database contents

- **Road network features**
  
  section id, location data, geometric data *(per section)*

- **Traffic data**
  
  AADT, heavy vehicle rate, growth rate, axle aggressiveness *(per section)*

- **Pavement condition data** (global and parametric)
  
  Quality Index (global) *(per section/1000 m/100 m per year)*

  Condition parameters (longitudinal unevenness, transverse unevenness, area with cracking, macrotexture, friction) *(per section/1000 m/100 m/10 m per year)*

- **Pavement subgrade bearing capacity** *(per section)*

- **Historic record of all pavement interventions**, allowing the assessment of the structural capacity *(start and end km, materials, layer thicknesses, etc.)*

- **Front and rear images** *(per 10 m per year)*
### Survey methods and annual coverage

<table>
<thead>
<tr>
<th>Visual inspection</th>
<th>Laser RST</th>
<th>SCRIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIZIROAD equipment (visual surface defects identification with linear and GPS referencing)</td>
<td>Laser vehicle collecting unevenness (longitudinal and transverse), macrotexture, geometry and front and rear images</td>
<td>SCRIM vehicle collecting wet skid resistance and macrotexture</td>
</tr>
</tbody>
</table>

- **Used for project level surveys**
- **Used for network surveys** *(over 90% per year)* since 2011
- **Used for network surveys** *(partial extent)* since 2012
Besides each individual condition parameter, a global quality index is used:

**PAVEMENT QUALITY INDEX**

IQ = f (longitudinal unevenness, transverse unevenness and cracking)

\[
IQ_t = 5 \times e^{-0.0002030 \times IRI_t} - 0.002139 \times R_t^2 - 0.03 \times (C_t)^{0.5}
\]

**PAVEMENT QUALITY RANK**

- **Good**: IQ > 3.5
- **Fair**: 2.5 < IQ < 3.5
- **Poor**: 1.5 < IQ < 2.5
- **Bad**: IQ < 1.5

Besides each individual condition parameter, a global quality index is used:

**PAVEMENT QUALITY INDEX**

**automatic evaluation**

IQ = f (longitudinal unevenness, transverse unevenness and cracking)

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IQ_t = 5 \times e^{-0.0002030 \times IRI_t} - 0.002139 \times R_t^2 - 0.03 \times (C_t)^{0.5}
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**NON-STRUCTURAL MAINTENANCE** → **STRUCTURAL MAINTENANCE**
Pavement quality

2015 data

average quality = 2.9

IQ RANK

GOOD
FAIR
POOR
BAD

68%
16%
12%
4%
DATA VISUALISATION

Section general information

Global quality overview
Data visualisation

Condition parameters visualisation

Front and rear image visualisation (clickable location or per km selection)

Dynamic segmentation according to visualisation scale (section, 1000 m, 100 m and 10 m for all parameters)
Data visualisation and web apps

Linear visualisation for condition parameters

Statistical analysis for condition parameters

Cross section visualisation for each 10 m

Information automatically provided by SGPavGraf web app (per section per year)
Support to decision-making

Aid to routine maintenance planning by identifying sites needing actions

high longitudinal unevenness

area with alligator cracking
Pavement performance modelling allowing the early identification of future maintenance needs

Support to decision-making

Network-wide future pavement condition evaluation

Performance assessment of different maintenance alternatives
Support to decision-making

Budget **optimisation** and **prioritisation** of maintenance interventions

- Heuristic method to rank interventions and assign them to each analysis year according to the expected budget.
- Ranking is made based on two criteria: investment/traffic demand ratio (35%) and the road condition deterioration rate (65%).
- The result is a 5-year maintenance plan, designed to meet strategic quality targets.
The recent IP SGPav developments contributed decisively to its consolidation

- by **eliminating the subjectivity** in the collection of condition parameters
- by the **extent of the information available** (annual network coverage over 90%)

It resulted in a wider SGPav **recognition**, not only from its everyday users, but also from **top management**
Open challenges

Given the **heterogeneity of the IP network** (hierarchy, traffic demand and attributes), several challenges arise

- **Forecasting** road condition efficiently
- **Performance indicators** enhancement
- **Decision-support** improvement

Common **asset management framework** for both road and rail