Urban water infrastructure asset management: a structured approach in four Portuguese water utilities

M. A. Cardoso*, M. Santos Silva*, S. T. Coelho*, M. C. Almeida*, D.I.C Covas**

Laboratório Nacional de Engenharia Civil, Av. do Brasil 101, Portugal
** Instituto Superior Técnico, Av. Rovisco Pais, Portugal

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» Scope & objective
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Water services are fundamental to:

- Public health protection
- Population well-being
- Sustainable development of the community
- Environmental protection

Usually these services are taken for granted!

Essential to be rationally and efficiently managed!
AWARE approach

A structured and comprehensive procedure for IAM

- Strategic level
- Tactical level
- Operational level
- Information
- Engineering
- Management

Assessment dimensions:
- Performance
- Risk
- Cost

Planning decisional levels

Knowledge / people
Scope & objective

This procedure has been applied by four Portuguese water utilities.

Paper presents an appraisal of the implementation of the referred procedure in these utilities:

- describing characteristics of the different water utilities
- identifying the major benefits and outcomes of each developed plan
- identifying the main difficulties that arose from this implementation.
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## Case studies

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<thead>
<tr>
<th>End-user partner</th>
<th>Type of utility</th>
<th>Systems</th>
<th>Pilot study</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td><strong>AGS</strong>, S.A.</td>
<td><strong>private holding</strong></td>
<td>“Aguas do Marco” serving 55,000 p</td>
</tr>
<tr>
<td></td>
<td></td>
<td>municipal concessions from pop. 7,000 to 200,000</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td><strong>AdP Serviço, S.A.</strong></td>
<td>part of <strong>AdP Group</strong></td>
<td>large bulk WWS (700,000 p.) and an industrial WSS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>multi-municipal systems</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td><strong>SMAS Oeiras e Amadora</strong></td>
<td>independent <strong>public utility</strong></td>
<td>pop. 350,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Municipalities of Oeiras and Amadora</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td><strong>Veolia Águas de Mafra</strong></td>
<td><strong>private operator</strong></td>
<td>Pop. 76,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Municipality of Mafra</td>
<td></td>
</tr>
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# Strategic level results

## OBJECTIVES
(Using ISO 24500:2007; EN 752 standards; ERSAR quality of service assessment system)

### ASSESSMENT CRITERIA

| Compliance of all legal requirements concerning public safety and quality for human consumption | A; D |
| Service supply failures | D |
| Adequacy of the water quantity | D |
| Financial sustainability | B; D | A; C | A |
| Environmental management systems certification | A; B |
| Occupational health protection and safety management certification | A |
## SWOT analysis

<table>
<thead>
<tr>
<th>STRENGTHS</th>
<th>WEAKNESSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Good information systems on WSI</td>
<td>- Insufficient information systems on WWI (gaps, inaccuracies)</td>
</tr>
<tr>
<td>- Sufficient information to assess the water supply systems condition and performance</td>
<td>- Financial restrictions</td>
</tr>
<tr>
<td>- <strong>Strong competence</strong> of human resources</td>
<td>- Inadequate tariffs</td>
</tr>
<tr>
<td>- Relation between information systems and work orders</td>
<td>- Poor structural condition</td>
</tr>
<tr>
<td></td>
<td>- Poor functional performance</td>
</tr>
<tr>
<td></td>
<td>- Insufficient historical records</td>
</tr>
<tr>
<td></td>
<td>- Inadequate data</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPPORTUNITIES</th>
<th>THREATS</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Equipment and technologies available</td>
<td>- <strong>Portuguese legislation and regulation</strong> (costs)</td>
</tr>
<tr>
<td>- <strong>Portuguese regulation and legislation</strong> (improve Qual.Service)</td>
<td>- Political uncertainties</td>
</tr>
<tr>
<td>- Incentives for sustainable use of energy</td>
<td>- Economic crisis and financial restrictions</td>
</tr>
<tr>
<td></td>
<td>- Demographic development uncertainties</td>
</tr>
<tr>
<td></td>
<td>- Illegal cross connections in wastewater systems</td>
</tr>
</tbody>
</table>
Strategic level results

Main problems identified

Water Supply

- Low system reliability
- Insufficient historical records
- Water losses
- Mains’ failures
- Insufficient service accessibility

Wastewater

- Insufficient / inadequate data
- Insufficient historical records
- Flooding
- Collapses
- Cross connections and high infiltration and inflows
- Insufficient service accessibility and coverage
Strategic level results

**Strategies** (similar for WS and WW)

- **S1** - *Protect public health* regarding WS quality
- **S2** - *Control water losses*
- **S3** - *Protect public health* from untreated WW discharges
- **S4** - *Reduce cross connections and infiltration*
- **S6** - *Improve infrastructures information systems*
- **S7** - *Increase system reliability*
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## Tactical level results

<table>
<thead>
<tr>
<th>Type</th>
<th>System reference</th>
<th>Features (physical charactics and population)</th>
<th>Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water Supply</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| A-WS1             | Rural/ peri-urban| 478 customers; 39 km pipe length; 278 service connections | - High water **losses**  
- High non-revenue water  
- **Inadequate pressure**  
- Occurrence of pipe failures |
| A-WS2             | Rural/ peri-urban| 220 customers; 3 km pipe length; 114 service connections | - Insufficient **storage** capacity  
- High water **losses**  
- High non-revenue water  
- Inadequate pressure  
- Occurrence of pipe failures |
| B-WS              | Industrial       | service started 1980; supplied by one 10 km water main; 17 km pipe length; $10^7$ m$^3$/year | - Water **losses**  
- **Corrosion** in metallic components  
- Future increase of supply needs  
- Need for system redundancy |
| C-WS              | Urban            | 4388 customers; 12.5 km pipe length; 40% of asbestos cement | - High water **losses**  
- **Pressure** problems  
- **Velocity** problems  
- Pipe failures, mainly in asbestos cement  
- Service interruptions |
| **Waste water**   |                  |                                               |                                                               |
| A-WW              | Rural/ peri-urban| 1.1 km$^2$ catchment area; separate domestic system; 9.5 km sewer length; 280 manholes; 85 customers; 128 723 m$^3$/year | - **Insufficient** inventory data  
- Insufficient monitoring data  
- High inflow/infiltration flows |
| B-WW              | Domestic         | interceptor system; close to coastal bathing waters; 220 km$^2$ contributing area; 140 km sewer length; 798 000 p.e.; 155 000 m$^3$/day of collected wastewater; 11 pumping stations; | - **Poor structural condition** of particular sewers  
- High inflow/infiltration flows (mainly received from upstream municipal sewers) |
| C-WW              | Urban            | separate system (domestic + storm water); 3.4 km domestic sewer length; 3.5 km stormwater sewer length | - Root **intrusion**  
- High inflow/infiltration flows  
- **Poor structural condition** of some sewers |
| D-WW              | Rural/ peri-urban| separate domestic system; 360 km sewer length | - Insufficient service physical **accessibility**  
- Insufficient service **coverage** |
Tactical level results

Commonalities and differences of case studies

- Scenarios of evolution *(relevant changes in the external context)*
  - demand evolution (all)
  - changes in the regulatory system (all)
  - physical access to downstream interception WW services (one)

- Infrastructural contexts
  - mature infrastructures (all), requiring rehab to assure reliable service M&L term
  - some systems in densely populated areas whereas others in peri-urban or countryside areas
  - excessive inflows from stormwater
  - insufficient capacity
  - no redundancy
Tactical level results

- Commonalities and differences of case studies
  - Drivers
    - scenarios
    - infrastructural contexts
  - Types of decisions required
    - prioritizing among subsystems for concerted actions
    - detail analysis of parts of the systems
    - application of the whole process

These differences led to distinct paths!
Tactical level results

» System assessment and selection of priority areas
  » tactical objectives, assessment criteria and metrics were defined in alignment with the outcomes of the strategic plan
  » these were applied to each system

» Analysis horizons
  » Most operators considered 20 years
    » except those with concession >> the last year of concession

» Tactical planning horizons
  » 2 to 5 years
Tactical level results

» Detailed diagnosis based on:

» available data:
  » GIS
  » billing systems
  » complaints & work order records
  » systems telemetry
  » hydraulic models
  » performance indicators
  » accounting data

» C-R-P assessments using established metrics
## Tactical level results

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water supply</strong></td>
<td><strong>Status quo</strong></td>
</tr>
<tr>
<td>- <strong>Current situation</strong> (e.g. consumption)</td>
<td>- Pressure reduction on the network</td>
</tr>
<tr>
<td>- <strong>Domestic consumption changes</strong> based on expected population evolution</td>
<td>- Improvement of operation practices</td>
</tr>
<tr>
<td>- Consumption defined in the concession contract</td>
<td>- Pipes with higher failure rates replacement</td>
</tr>
<tr>
<td>- Consumption considering commercial development</td>
<td>- Construction of new pipes to ensure systems reliability</td>
</tr>
<tr>
<td>- <strong>Industrial consumption changes</strong></td>
<td>- Optimal design in term of cost and energy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wastewater</th>
<th><strong>Status quo</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- <strong>Current situation</strong> (e.g. rejection, infiltration)</td>
<td>- Pipes replacement.</td>
</tr>
<tr>
<td>- <strong>Rejection evolution</strong> based on expected population evolution</td>
<td>- Pipes renovation.</td>
</tr>
<tr>
<td>- Reduction of illegal cross connections and infiltration / inflow</td>
<td>- Reduction of a number of cross-connections in separate systems.</td>
</tr>
<tr>
<td>- Completion, during the next years, of treatment and interceptor works that are the responsibility of another operator, but affects the coverage and availability of the service provided</td>
<td>- Improvement of operation and maintenance practice</td>
</tr>
<tr>
<td>- Construction of alternative solutions for treatment and connections to the interceptor system where it is available.</td>
<td></td>
</tr>
</tbody>
</table>
Tactical level results

Assessments and multicriteria analysis:

- the balance between the assessments P, C, R

- not all assessments were used
  - in A-WS1 and A-WS2, the main assessments were P+C
  - in B-WS and D-WW cases, the main assessments were C+R

- the cost is always relevant for all operators

- evaluation and ranking of alternatives
  - See Marques et al. (2011)’s presentation
  - See Carriço et al. (2011)’s presentation
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## Benefits of IAM implementation

### SWOT analysis

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<tr>
<th><strong>STRENGTHS</strong></th>
<th><strong>WEAKNESSES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- AWARE-P project partnership</td>
<td>- Insufficient integration between different organizational levels (e.g. decision, technical, operational)</td>
</tr>
<tr>
<td>- Development of an IAM plan</td>
<td></td>
</tr>
<tr>
<td>- Availability and experience on information systems</td>
<td></td>
</tr>
<tr>
<td>- <strong>Knowledge improvement on IAM by participating on the project</strong></td>
<td><strong>Poor availability of data</strong> specially in wastewater systems which affects C-P-R assessments</td>
</tr>
<tr>
<td>- Results and opinion sharing with other utilities</td>
<td></td>
</tr>
<tr>
<td>- Promotion of internal procedures changes</td>
<td></td>
</tr>
<tr>
<td>- Improvement of infrastructures knowledge (e.g. inventory data collection)</td>
<td></td>
</tr>
<tr>
<td>- Improvement of infrastructures condition and functional information (e.g. infrastructure condition, monitoring)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>OPPORTUNITIES</strong></th>
<th><strong>THREATS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The new Portuguese legislation</strong> (DL 194/2009) and regulation (made by ERSAR)**</td>
<td>- Lack of specification, in the Portuguese legislation, on what is IAM</td>
</tr>
<tr>
<td>- Availability of new developments in IAM planning</td>
<td></td>
</tr>
<tr>
<td>- Availability of new developments and technologies</td>
<td><strong>Significant effort and human resources were required</strong> for the implementation of IAM planning methodology</td>
</tr>
<tr>
<td>- Existence of a concession contract</td>
<td>- Investment restriction of concession contracts (low investment flexibility)</td>
</tr>
<tr>
<td>- Higher requirements of customers on the service provided</td>
<td>- Financial restrictions, Political uncertainties, Economic crisis</td>
</tr>
<tr>
<td>- Need to improve infrastructure data and information</td>
<td></td>
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Conclusions

Application of the AWARE-P IAM methodology

End-users

- represent a significant variety of institutional /organizational formats, priorities, drivers

Good evidence

- that the methodology provides a standardised and flexible IAM planning framework
Conclusions

» **Strategic management level**
  » the need to revise stated objectives and strategies
  » the importance of carrying out a systematic and organised diagnosis

» **Tactical management level**
  » the most critical step is in generating meaningful and comprehensive alternatives
  » the need to integrate performance, risk and cost assessments
Conclusions

» Recently changed Portuguese regulatory framework in terms of IAM is an opportunity to improve data and knowledge.

» Despite the considerable effort and resources needed to apply the AWARE approach, utilities have now the knowledge and new tools to develop their own plans!