The 4th EPAM conference
Conclusions

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Road Infrastructure

The road system is a vital element in the infrastructure network for all societies. This is also one of the main investment every modern society must make. But it also pose significant impacts related to high material consumption, energy inputs, emissions and capital investments.

An elaborate and prudent asset management system (AMS) is therefore needed to enhance the sustainability of transportation infrastructure systems.
Sweden: Development of heavy traffic

Billions of metric tonnes kilometres

Conveyance of goods, road

Allowed maximum gross weight

Source: trafikanalys mfl. www.trafa.se
Traffic conjunctions – saturated road network
What is Asset Management of Road Infrastructure?

A systematic process of maintaining, upgrading and operating assets, combining engineering principles with sound business practice and economic rationale, and providing tools to facilitate a more organised and flexible approach to making the decisions necessary to achieve the public’s expectations.

Asset Management Systems (AMS) embraces all the processes, tools, data and policies necessary to achieve the goal of effectively managing assets.
Components of an Asset Management System

AMS consist of:

- Goals and policies of the administration
- Data
- Resources and budget details
- Performance models
- Project selection criteria
- Implementation programme
- A monitoring and feedback loop
Three main types of assets:
Bridges Asset Managements (BMA)
Pavement Asset Management (PMS)
Safety Asset Management (SAM)
Total measured length (lane km) with RST

Road surface condition monitoring during 1986 to 2010 in Sweden

The total length of the paved roads controlled by the Swedish transport administration
The Swedish LTPP database

The Swedish LTPP (Long Term Pavement Performance) database provides data on various pavement performance metrics for different locations, such as Rut, IRI, and Crack index. The graph shows the evolution of these metrics over time at the site Rv 31 Nässjö, indicating trends and changes in pavement condition.

LTPP = Long Term Pavement Performance
Major Components of a Project Level Pavement Design System

- Inputs
  - Models
  - Behavior
    - Distress
      - Performance
- Friction
  - Traffic
  - Costs
    - Decision Criteria
      - Ordered Set of Choices
        - Implementation
M-E performance calc.
Flow diagram

- Year \( y = 1 \ldots k \)
- Season \( p = 1 \ldots s \)
- Climate
- Traffic loading \( \Delta N_{pij} \)
- Response model
  - Stresses, strains and displacements
  - Performance model
    - Increment in permanent strain

\[ \Delta e_{pq} = \sum \Delta e_{pqij} \]

- Yes
  - \( i \leq n, j \leq m \)
- No
  - \( \Delta e_{pq} = \Delta e_{pq} + \varepsilon_{pl} \)

\[ \varepsilon_{pq} = \sum \Delta e_{pq} \]

- Yes
  - \( p \leq s \)
- No
  - \( \varepsilon_{pq} = \sum \Delta e_{pq} \)

- Yes
  - \( y \leq k \)
- No
  - End
Calibration & validation

Distance from the edge of the pavement [mm]
Permanent deformation [cm]
Load Repetitions
- 40000
- 120000
- 200000
- 300000
- 500000

Asphalt concrete

Pressure cell
Lateral asphalt strain gauge
Longitudinal asphalt strain gauge
Inductive coils (vertical strain)
The EPAM4 Conference

Summary:
Arranged by VTI under the auspice of the Swedish Transport Administration, FEHRL and the World Road Association

Participants: 165
Accepted technical papers: 85 (136)
Technical oral presentations: 70
Technical posters: 10
Two key-note sessions with four presentations
The EPAM4 Conference

Main sponsors: 2

Exhibitors: 10 + 2
## EPAM4 - The Conference Objectives

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<th>EPAM4 - OUR FUTURE</th>
<th>EPAM4 - MOTIVATION</th>
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<td>• Impact of climate change on asset management</td>
<td>• Management solutions for secondary networks</td>
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<td>• European harmonization and research activities</td>
<td>• New technologies for asset monitoring and data acquisition</td>
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<td>• Case studies and experiences from implementation</td>
<td>• Maintenance backlog versus funding</td>
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<td>• Decision tools and systems</td>
<td>• Innovative design and maintenance techniques</td>
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<td>• Performance prediction</td>
<td>• Long-life-pavements and engineering structures</td>
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<td>• Life-cycle-modeling (LCC, LCA, etc.)</td>
<td>• Sustainable maintenance strategies</td>
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<td>• User expectations on road condition</td>
<td>• Innovative asset management contracting (PPP, BOT, etc.)</td>
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<td>• Cross asset management (combining sub-assets)</td>
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EPAM4 Sessions

1. User Expectations and Asset Management Contracting
2. Decision Tools and Systems I
3. Cross Asset Management and Maintenance Strategies
4. Decision Tools and System II
5. Climate Change – Secondary Network
6. Case Studies and Experiences from Implementation
7. Performance Prediction and Implementation
8. Structural Pavement Behaviour
9. Pavement Maintenance
10. Pavement Performance Modelling and Prediction I
11. Asset Monitoring and Data Acquisition
12. Pavement Performance Modelling and Prediction II
13. Pavement Condition Monitoring
14. Sustainable Pavements
The paper introduces a multi-attribute approach for computing costs, performance, and eco-efficiency. With this it includes environmental impacts into a Pavement Management System for enhancing the decision support systems and choose between several asset management alternatives.

M&R strategies generated according to their costs, performance, and environmental impacts over the life cycle.
The paper describes a new user cost model to be implemented in the Austrian PMS (VIAPMS_Austria). Example show clearly the conflict between agency’s and user’s interests. A solution for a procedure to avoid that structural aspects are neglected by focusing on user costs alone.

Taking road user aspects into consideration has a major effect on the maintenance strategies proposed within the pavement management system. This implementation leads to a minimum of disturbance and therefore to less replacement and more surface maintenance treatments.

Road User Interests as an Optimization Criterion for Austrian Motorway Maintenance by Brožek et al.
Objective to develop a framework for cross-asset management that can be used to objectively assign a budget to certain assets.

Comparing various maintenance scenarios to develop a system to estimate an optimum solution by using predictions concerning the number and costs of interventions as well as their consequences on so-called end user service levels.

Asset Service Conditions Assessment Methodology by Alten et al.
The session is addressing two challenges that Pavement and Asset Management Systems (PAMS) needs to face in the coming years:

- The impact of climate change on road maintenance management
- The extension of rational practices of road management from trunk road networks to so-called secondary road networks.
A road database has been established in Croatia storing available information about road inventory, pavement condition, traffic and historic data. The road agency is using this information for optimizing the management and rehabilitation procedures of the network.

The paper highlights the steps to be taken to implement a holistic, future oriented PMS and shows how the condition development as well as monetary and non-monetary effects of the selected maintenance strategies can easily be addressed.

**Croatia – On its way to a Holistic Pavement Management System** by Keller et al.
The objectives were to predict rutting, roughness, cracking and bearing capacity of flexible pavements at network level. The model is based on the HDM-4.

New Nordic Performance Model for better Maintenance Planning by Baltzer et al.
Large part of the German network is now about 30 to 50 years old, thus a systematic pavement and maintenance management is essential. The paper describes a method of calculating the pavement condition based on surface characteristics using a standardised procedure.
Due to climate change road authorities are currently faced with the challenge of reducing their carbon footprint. The paper describes a method that can compare the carbon footprint of different maintenance options. It is pointed out in the paper that treatment with the lowest cost do not allways have the lowest carbon footprint, which creates a problem in selecting an optimal treatment.
The paper deals with the important topic of estimating the remaining life of a pavement structures. Based on analysing lab testing of cores the fatigue life of pavement structures was predicted.
The paper deals with three relatively new technologies; laser scanner, thermal cameras and ground penetrating radar to do road diagnostic surveys.

A example of a thermal camera used to identify thermal cracks initiated during spring thaw.
Session 13
Pavement Condition Monitoring

The paper deals with a new Image processing method of surface pictures to assess and evaluate the condition of the pavement structure.
Development of new warm asphalt mixtures (temperature not exceeding 120°C). The objectives are to maximize, simultaneously, energy and natural raw materials savings in the manufacturing of warm mixes. By-products from three of the most important industrial activities established throughout Portugal are included in the mixes.
Summary

Lush number of interesting R&D activities within the PAM field going on in Europe.
Further Challenges

**Pavement Data Collecting**
- Needs and Cost Effectiveness
  - Type of data, Frequency of collection
- Collection Technologies
  - Precision required, Equipment reliability (calibration),
- Quality Assurance
  - Validity, Consistency, Accuracy, Management of data, Audits
- Storage and Integration

**Pavement Management**
- Structural design, LCCA
  - Input variables, Type of facility, Design methods
- Performance modelling
  - Prediction of rutting, Cracking, IRI etc, Reliability
- Treatment selection
  - Maintenance methods, Costs, Durability

**Climate Changes**
- Robustness, climate impact, Energy reduction,