

presents the selection of rational set of the facilities management services applying the weighted cost-effectiveness analysis together with the fuzzy multi-criteria decision making method ARAS. Such an analysis supports objective decision making: options considered in an objective way provide support for the final decision.

3 - Quality Management Improvement in Road and Highway Engineering

Jerzy Paslawski, Tomasz Rudnicki

Quality assurance is a critical problem in road and highway engineering. A new approach implemented in the last time is presented. An open market, a new network of quality laboratory and a ranking list of contractors are key elements of this conception. A value management and six sigma are discussed as steps for the future. Some case studies (acoustic screens, park & ride parking, quality ranking list) for illustration of implementation procedures are presented.

4 - Markov Switching Applied to the Evolution of GDP of Argentina, Brasil, Colombia and Mexico, 1950 to 2004

Alfredo Russo, Hernan Ferrari, Carlos Martinez, Juan Ledesma

Using the annual GDP series for Latin America countries (1950-2008) in constant dollars of year 2000, we have calculated the transition probabilities for each Hidden Markov matrix and the respective mean times for each regime since 1950 to 2008. Inter annual percent variations of GDP's for each country are used to simplify calculations. Parameters have been calculated using the Maximum Likelihood method. A first calculation has encompassed the whole period of 54 years and a second one encompassed periods of 10 years to verify time dependency of transition probabilities.

Tuesday, 16:00-17:30

■ TE-01

Tuesday, 16:00-17:30 - Room 118

Robustness and Maintenance of Vehicles and Infra

Stream: Railway and Metro Transportation

Invited session

Chair: *Ángel Marín*

1 - Long-Term Planning of Railway Track Maintenance

François Ramond, Bathilde Vasselle

For security reasons, maintenance has to be performed on railway tracks, making some portions of them unavailable during operations. For a given number of maintenance operations, maximum track availability is achieved by combining operations into single "track possessions". We consider the associated scheduling problem where operational constraints have to be taken into account to minimize the number of required possessions as well as the distance travel by maintenance machines on the network. We present some results showing that significant gains can be achieved by optimization techniques.

2 - Interactive Rolling-Horizon Scheduling of Depot Visits and Condition based Maintenance Tasks

Bob Huisman, Cees Witteveen

The majority of train maintenance tasks is condition based. When needed, vehicles have to visit maintenance depots within predetermined time windows. We propose schedules for depot visits and maintenance tasks taking into account the availability of routing options while respecting job deadlines. The method proposed solves the problem to optimality in polynomial time and offers real-time interaction with human planners. When used in a rolling horizon scenario with a dynamic environment it enables the user to control economic optimality versus plan stability in a time-efficient way.

3 - Optimal Scheduling of Aircrafts' Engines Repair Process

Isabel Cristina Lopes, Eliana Costa e Silva, J. Orestes Cerdeira

We address a real world scheduling problem concerning the repair process of aircrafts' engines by TAP Maintenance and Engineering (TAP-ME), which is the maintenance, repair and overhaul organization of the Portuguese leading airline. A MILP model, based on the flexible job shop scheduling, to determine the optimal sequencing of tasks within workstations, minimizing the total weighted tardiness, is presented. The model was tested on a real instance provided by TAP-ME from a regular working week and also on benchmarking instances available in literature.

4 - Scheduling of the train operation by a double track railroad while segments are closed.

Nail Khusnullin, Alexander Lazarev

We consider a problem, namely, the optimal scheduling of the train operation by a double-track railroad when one of the segments is under repair works. It is necessary for the set of trains available at the stations to determine time-scheduling and destination routing by railways in order to minimize one of the regular objective function. We suggest an exact algorithm. The idea suggested may be used for choosing the time period when the closing segments are economically profitable.

■ TE-02

Tuesday, 16:00-17:30 - Room 111

Vehicle Routing Applications

Stream: Vehicle Routing

Invited session

Chair: *Refail Kasimbeyli*