



# Scheduling preventive railway maintenance activities with resource constraints

Rita Macedo <sup>a,1</sup> Rachid Benmansour <sup>b,2</sup> Abdelhakim Artiba <sup>b,3</sup>  
Nenad Mladenović <sup>b,4</sup> Dragan Urošević <sup>c,5</sup>

<sup>a</sup> *Univ. Lille, CNRS, UMR 9221 - LEM Lille Économie Management, F-59000 Lille, France*

<sup>b</sup> *University of Valenciennes and Hainaut Cambrésis, France*

<sup>c</sup> *Mathematical Institute, Serbian Academy of Science and Arts, Belgrade, Serbia*

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## Abstract

In this paper, we focus on the scheduling of preventive railway maintenance activities. The objective is to keep the railway infrastructure in good operating conditions at low costs, also taking into account the limited available resources in what concerns crew members. Equipments degrade with usage and age and a good preventive maintenance program can greatly reduce their unreliability in the sense that expectable failures can be anticipated. We propose a mixed integer programming formulation for the problem of scheduling preventive railway maintenance activities and a Variable Neighborhood Search (VNS) algorithm to solve large instances of the problem.

*Keywords:* Variable neighborhood search, scheduling, maintenance, railway.

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<sup>1</sup> Email: [rita.macedo@univ-lille3.fr](mailto:rita.macedo@univ-lille3.fr)

<sup>2</sup> Email: [rachid.benmansour@univ-valenciennes.fr](mailto:rachid.benmansour@univ-valenciennes.fr)

<sup>3</sup> Email: [abdelhakim.artiba@univ-valenciennes.fr](mailto:abdelhakim.artiba@univ-valenciennes.fr)

<sup>4</sup> Email: [nenad.mladenovic@univ-valenciennes.fr](mailto:nenad.mladenovic@univ-valenciennes.fr)

<sup>5</sup> Email: [draganu@turing.mi.sanu.ac.rs](mailto:draganu@turing.mi.sanu.ac.rs)

## 1 Introduction

Rail transport is one of the safest and most environmentally friendly means of conveyance of passengers and goods. By making regions and markets more accessible, it plays a main role in the development of countries due not only to its impact on the economy but also to its social role. In order to support the increase of traffic due to globalization and personal interchanges, many efforts have to be done to keep rail transport safe, efficient and competitive. This can be achieved through technical elements like supervision, maintenance, and standardization.

In this paper, we focus on the scheduling of preventive railway maintenance activities. The objective is to keep the railway infrastructure in good operating conditions at low costs, also taking into account the limited available resources in what concerns crew members.

Equipments degrade with usage and age and a good preventive maintenance program can greatly reduce their unreliability in the sense that expectable failures can be anticipated. Although this represents additional costs, these are typically much less important than the ones caused by the failure of an equipment, which can cause the failure of a complete system, added of a subsequent corrective maintenance. In sum, to prevent that stochastic failures occur frequently on the railway infrastructure, it is important to perform preventive maintenance on a regular basis. This helps to reduce the probability of the occurrence of a failure on the components of the railway infrastructure and maximizes the operational benefits [5,1]. The main goal of preventive maintenance is to prevent possible failures before they actually happen, reducing costs and increasing reliability of equipments and services.

We propose a mixed integer programming formulation for the problem of scheduling preventive railway maintenance activities and a Variable Neighborhood Search (VNS) algorithm to solve large instances of the problem.

## 2 Problem description

There is a set of maintenance activities to perform during a planning horizon composed of  $|T|$  periods. As pointed out by [3], maintenance activities in railways can be divided into two categories: small and large routine works. Therefore, we consider two different kinds of maintenance activities: routine works with smaller durations and projects with larger durations. Routine works, such as inspections, cleaning operations and small repairs, are conducted on a periodic basis, whereas projects are considered to be conducted

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