RAIL

Reliability centred maintenance (RCM) Approach for Infrastructure and Logistics of Railway Operations

Funding: European (5th RTD Framework Programme)
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Status: Complete with results

Background & policy context:

Safety critical railway infrastructure components account for a large number of train delays. These delays occur despite the extensive, and very costly maintenance effort required under national safety regulations. One example is the weekly on-site visual inspections of points and track signalling required in several member state safety regulations. Furthermore, visual inspections in the field performed while normal train operation is maintained is one of the reasons for the large number of accidents involving maintenance personnel at work in the field.

A structured technique to come up with maintenance strategies based on the awareness of the nature and causes of malfunctions is called Reliability Centred Maintenance (RCM). The technique was developed for aircraft and nuclear industry maintenance. The application of the RCM to total railway infrastructure gives the project a total innovative approach.

Objectives:

The RAIL project developed, implemented and evaluated the RCM analysis on various types of track circuitry, axle counters, point machines, signals and interlocking devices.

The first goal is the development and use of a Reliability Centred Maintenance (RCM) approach for the railway infrastructure and logistics and the awareness of the nature and causes of malfunctions.

The second goal is to provide a methodology to study the reduction of costs and to develop a simple Life Cycle Cost (LCC) model to be applied in the economical evaluation of the railway equipment in general.

Methodology:

The research and development concentrated on developing a structured RCM approach to railway infrastructure. This area gives the greatest potential for improvement in safety and train delays. In particular, the RCM analysis was developed, implemented and evaluated on all various types of track circuitry, axle counters, point machines, the signals and interlocking devices, such as position of points, signals to clear, etc. The set of the above-mentioned equipment are called Safety Critical Railway Infrastructure components (SCRI components or SCRICs).

The methodology that was developed in order to study the SCRICs problems into the RAIL project included three models estimating the cost of maintenance operations:

- Corrective maintenance costs,
- Preventive maintenance costs,
- LCC (life cycle costs).

The Workpackage that covered an RCM analysis of the main machines of the railway signalling infrastructure also included a study of the first machines of the railway signalling infrastructure and was followed by transferring and applying the approach for the national railway company.

Furthermore, a preventive maintenance task supported by a database was developed. At the beginning, this database was developed as a first version and then it was completed with more data needed.
In order to discuss safety problems with railway security authorities, a set of standard performance indicators and steps to implement the RCM programme were developed. Analysing rail safety statistics and determining the effect of different maintenance policies on safety led to the analysis of safety aspects as a part of maintenance optimisation.

After evaluation and demonstration of cross-border traffic, the RCM inter operating system was modified.

**Parent Programmes:**
**FP5-GROWTH KA2 - Sustainable Mobility and Intermodality**

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**Partners:**  
Co-ordinator: ADEPA (France)  
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- Ireland: Iarnród Eireann (Irish Rail); Enterprise Ireland;  
- Germany: FIR - Forschungsinstitut fuer Rationalisierung; DB - Deutsche Bahn Netz A.G.;  
- Netherlands: NS - Nederlandse Spoorwegen (Dutch Railways); Baas & Root;  
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**Key Results:**  
The RAIL project provided a breakdown structure for the whole railway infrastructure, into:
- Sections (defined by its name, number and criticality - the latter being a numerical index of the severity of an effect combined with the probability or expected frequency of occurrence);  
- Components (called SCRiCs - Safety-Critical Rail Infrastructure Components, e.g. track, track circuits, wires, point machines, level crossings, signals, power supply, telecommunications, etc); and  
- Maintainable items (these are items whose failure could affect safety, or could be undetectable during operation, or could have significant operational/economic impacts).

The project produced a state-of-the-art report covering RCM (Reliability Centred Maintenance), safety, regulations and machines used in railway infrastructure in four European countries. It went on to propose a list of maintenance tasks through the RCM (Reliability Centred Maintenance) Task Selection, in order to simplify decision-making on the part of maintenance operators.

The criticality of railways sections and components was assessed in order to improve understanding of the part played by each component and potential weaknesses. Criticality of a railway section (in five classes, from non-critical section to highly critical section) was based on six criteria:
- Technological complexity of maintaining the section;  
- Economic revenue;  
- Traffic density;  
- Availability (including whether single/double track);  
- Exploitation (operational factors including train type mix);  
- Maintainability and costs (technical and process complexity).

FMECA (Failure Mode, Effects and Criticability Analysis) was used to identify functional failures, failure
modes, failure causes, failure effects and severity of failure consequences on SCRICs. When successfully applied, FMECA has been shown to reduce maintenance costs by up to 30%. Criticality of failure effects depends on the frequency of breakdown and the effect on safety, and can be classified as negligible, tolerable, undesirable and intolerable.

An RCM exercise was condu

**Technical Implications**

1. Successful application of RCM requires a good understanding of the equipment and structure, and the associated systems, subsystems and items of equipment, together with the possible failures and their consequences.
2. Pareto analysis (the so-called 80/20 rule) appears to apply to railway maintenance, i.e. around 80% of all failure causes occur on 20% of rail sections. Once necessary actions have been taken, there is a new range of 20% which represents 80% of the causes still to be dealt with.
3. Future developments should integrate better ways to optimise maintenance plans, including validation and deployment of such methods.
4. Use of the LCC (Life Cycle Cost) and the cost model, work with other departments is needed in order to ensure that cost figures used are accurate and all-encompassing.
5. Further improvements in the RAIL Toolbox are possible. These are:
   - Standardisation of the RCM R (RAIL) methodology (UIC - International Union of Railways);
   - Registration by an authoritative organisation of the maintenance subcontractors;
   - Requirements of RCM R to purchase new SCRI (Safety Critical Railway Infrastructure) components;
   - Interoperability and RCM R;
   - Simulation of the maintenance preventative actions and planning of preventative maintenance;
   - Development of a more complex LCC model;
   - Integration of the optimisation of the RAIL Toolbox;
   - Integration of the risk analysis into the RCM approach;
   - Development of a new version of the RAIL Toolbox including new functionalities (improved interface and technical functionalities).

**Policy implications**

1. The Toolbox should allow greater efficiency, cost savings and safety gains in the maintenance of railway infrastructure equipment.
2. The RAIL partners who are railway network operators agreed to deploy the RCM analysis in their respective organisations.

Documents:
- Complete Guide of RAIL Methodology (RAIL project Deliverable 16)

**STRIA Roadmaps:** Infrastructure

**Transport mode:** Rail transport

**Transport sectors:** Passenger transport, Freight transport

**Geo-spatial type:** Other