Project no. TIP5-CT-2006-031415O

INNOTRACK

Integrated Project (IP)

Thematic Priority 6: Sustainable Development, Global Change and Ecosystems

D1.4.1 – Detailed Framework for Information and Data Collection

Due date of deliverable: M6 (February 2007)

Actual submission date: March 2007

Start date of project: 1 September 2006 Duration: 36 months

Organisation name of lead contractor for this deliverable: **University of Birmingham**

Revision F2

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Table of Contents

Glossary

IM	Infrastructure Manager
LCC	Life Cycle Costing
EC	European Commission
R+D	Research and Development
RAMS	Reliability, Availability, Maintenance and Security
SP	Sub-project
SP1	Sub-project 1
OBB	Oesterreichische Bundesbahnen – Infrastruktur Bau AG
CD	České Dráhy a.s
RFF	Reseau Ferre de France
DB	DB Netz AG
ADIF	Administrador de Infraestructuras
BV	Banverket
NR	Network Rail Infrastructure Limited
SQL	Structured Query Language

1. Executive Summary

Innotrack's goal is the development of innovative methods for the maintenance of European railway track, with the aim of reducing the life-cycle cost (LCC) for track by 30%.

The project is based on the following methodology:

- Identify the principal track maintenance problems that generate the highest costs for the railway;
- Gather vehicle and track information associated with these problems;
- Use the data to create 'virtual' track segments, which can be used to model the problems
- Use the virtual segment models to test new and innovative methods of track maintenance, and
- Establish the potential impact of these methods on track LCC

This report describes development of the detailed framework for collection, storage and analysis of the data required to support the methodology. The following requirements were identified for the framework:

- Flexibility to accommodate future changes;
- An initial focus on collection of track and vehicle data;
- The ability to store and process large volumes of data;
- The ability to collect and efficiently input large volumes of data;
- The ability to provide access to the data to Innotrack members who have limited knowledge of databases, and;
- A method of ensuring that data is provided according to a common understanding among Innotrack members of terminology.

A structured query language (SQL) database was selected for use on the project. This is powerful enough to deal with the large volume of data involved. It also has the facility to export data to Microsoft Access, which was considered to be more widely known and available, and therefore more accessible to Innotrack members.

The initial focus was on development of the system to collect, store and process data on track problems and their associated characteristics. The problems were identified in collaboration with infrastructure managers from each of the countries participating in Innotrack. Important vehicle data parameters were identified in collaboration with vehicle specialists in sub-project 1 (SP1). Based on knowledge of the data to be collected, an outline schema for the database was prepared and a test version of the database developed.

Efficient collection and inputting of data was arranged through the creation of a web-based questionnaire. The questionnaire was designed to take a 'top-down' approach, starting at the track component level and working through increasing levels of detail, to provide a description of the track problem and its associated characteristics. Pre-defined sets of answers were provided for each question to maintain consistency of terminology and maximise the searchability of the database.

The intention is that the data collected should be used to identify the virtual track segments. Innotrack members were invited to test the database, but the amount of data collected so far has been limited. Data collection remains an on-going process.

With regard to the future, some work has been done to investigate the feasibility of expanding the framework to accommodate extra, as yet unspecified, requirements from the project. A revised schema was developed showing that the existing database could be expanded to meet a range of new requirements.

2. Introduction

Innotrack's goal is the development of innovative methods for the maintenance of European railway track, with the aim of reducing the track's life-cycle cost (LCC) by 30%.

The project is based on the following methodology:

- Identify the principal track maintenance problems that generate the highest costs for the railway;
- Gather vehicle and track information associated with these problems;
- Use the data to create 'virtual' track segments, which can be used to model the problems
- Use the virtual segment models to test new and innovative methods of track maintenance, and establish their potential impact on track LCC

Achieving Innotrack's goal requires the collection, storage and analysis of a large amount of data. This report describes the work carried out by Work Package 1.4 (WP1.4) (part of Sub-project 1 (SP1) of Innotrack) to develop a framework for the collection, storage and analysis of the project data. It begins by providing some background to the Innotrack project. It then describes development of the framework/database requirements and discusses the methodology adopted in its construction. Finally, it describes the finished database and problems encountered in populating it with data.

3. Background

The track maintenance costs of European railways, which are the major cost component for infrastructure managers (IM), have not significantly decreased in the last 30 years. Over the same time period competing modes of transport have seen tremendous reductions in their LCC. Railway LCC must be reduced in a similar way if rail is to remain competitive. This issue can only be tackled by increased research and development (R+D) focused on standardisation at the European level.

The European Commission (EC) White Paper on Transport (September 2002) has set ambitious efficiency improvement targets for transport. The railways have responded by:

- Increasing speed and acceleration of trains,
- Increasing train axle loads and traction power, and;
- Introducing more rigid vehicles with greater stiffness.

These innovations have a downside, however, in that they place greater demands on the track, causing more damage and greater maintenance costs.

In response to these problems, Innotrack's objectives are to reduce the LCC of railway track, while improving the reliability, availability, maintainability and safety (RAMS) characteristics of a conventional, mixed-traffic line. Investment alone will not be enough; significant innovation and technology transfer will be essential. This can only happen with very close co-operation between IMs and industry suppliers. Innotrack will therefore, bring these two groups together in a programme of research based on four key topics:

- Track support structure;
- Switches and crossings;
- Rails, and;
- Logistics for track maintenance and renewal.

Innotrack is a large project. To facilitate its management, it has been divided into the following seven sub-projects:

- SP1 (Requirements);
- SP2 (Track support – support structures below the level of the rail);
- SP3 (Switches and crossings);
- SP4 (Rails);
- SP5 (Logistics);
- SP6 (LCC assessment and RAMS), and;
- SP7 (Dissemination and training).

The principal objectives of SP1 are:

- To manage the collection of information in a standardised format relating to the types of vehicle and track that result in high cost for maintenance and renewal;
- To categorise the key degradation conditions chosen by the participating IMs, using the concept of 'track segments';
- To determine the root causes of these degradation conditions by modelling at an appropriate level;
- To provide technical data to enable the RAMS and LCC benefit of innovative solutions to be determined;
- To develop a relational database of information developed in the SPs, and;
- To verify that the technical solutions have successfully addressed the root causes within the railway system context, and are suitable for a wide range of present and future traffic conditions across Europe.

One of SP1's first key tasks in support of these objectives is delivery of a detailed framework for information and data collection. This will facilitate precise and efficient communication between project partners, through provision of a framework to support collection, storage and analysis of project data.

4. Framework Requirements

The following framework requirements were identified:

- The database is required to hold a wide variety of data; from SP1 there will be data on track and vehicle characteristics, from SP5 there will be data on maintenance logistics, and from SP6 there will be data on RAMS and LCC. There are likely to be additional storage requirements at later stages in the project, therefore the database structure must be flexible enough to accommodate the developing needs of the project;
- The development of virtual track segments is one of the earliest tasks on the project. Associated with that is the collection of track and vehicle data. Therefore, a requirement was identified to concentrate first on the development of these parts of the database;
- Very large volumes of data will be generated by the project. Not only does this have to be stored, but it must also be held in a way that is easy to access and analyse. This level of functionality was identified as a requirement;
- In view of the large volumes of data, a requirement was identified for an efficient way of gathering and inputting data;
- It was assumed that most members of the Innotrack project team would not be database experts and that in most cases, their experience of using databases would be restricted to commonly available software, such as Microsoft Access. Therefore, a requirement was identified to be able to transfer data from the main database to tools such as Microsoft Access, to allow team members to carry out their own data analysis;
- Data will be gathered from IMs and project team members from at least eight countries. For the data to be of maximum use, it must be based on a consistent use of terminology. Therefore, a requirement was identified to find a way of ensuring, as far as possible, that the terminology was consistent

5. Methodology

The first task was to select which database tool to use. Based on the availability of software at University of Birmingham, and the ability of that software to meet the framework requirements, the decision was made to use a structured query language (SQL) database. This is a powerful tool with the capability to handle and process large volumes of data. It can also export data to Microsoft Access, meeting the requirement for researchers who are not necessarily database experts, to carry out their own data analysis.

The next step was to decide how the database might be used to develop the virtual track segments. After consultation with SP1 colleagues, the database team arrived at the fault-centred approach shown in Figure 1 of Appendix A. This envisaged segments being developed for each of the principal track problems and their associated track and vehicle characteristics.

The principal track problems on which data would be required were identified in conjunction with the IMs. They were asked to participate in national IM workshops, at which the track problems they face were be discussed and prioritised. To provide some structure to the discussions, the IMs were given a pro-forma listing the main track components and asked to discuss each of the components in turn, noting any faults and suggesting underlying causes and possible solutions. A copy of the pro-forma is shown in Figure 2 of Appendix A. The results of the exercise are shown in Figure 3, which lists the most important track problems (referred to as faults), in descending order of importance.

Each of the faults has to be described in a structured way in terms of its own physical characteristics, as well as those of the railway vehicles that pass over them. The list of key parameters to be used in these descriptions was developed in conjunction with vehicle and track experts in SP1. A ‘top-down’ approach was adopted for the description of track problems and vehicle and track characteristics (see Figure 4 of Appendix A for an example relating to track), with the higher numbered levels associated with increasing levels of description detail.

Having established in outline what the database should contain, work continued with the development of the initial schema (see Figure 5 of Appendix A). This is essentially a layout drawing showing the various data tables in the database and how they relate to one another.

Efficient data collection and inputting was dealt with by the development of a web-based questionnaire. It comprised a set of questions for IMs to answer, designed to gather data on track problems and their associated characteristics. To ensure that the data collected was a good description of reality, IMs were asked to base their data inputting on a stretch of their own track, that they regarded as typical with regard to the type and frequency of track problem, and the level of train service operating. The questions themselves were based on the top-down descriptions of track problems described above. In order to ensure the consistent use of terminology, and to maximise the database’s ‘searchability’, IMs were asked to select answers from pre-determined lists. In some cases, however, IMs were given the opportunity to provide ‘free-text’ answers. Figures 6 to 9 (inclusive) show screen shots from the questionnaire.

One of the framework requirements was that it should be able to expand in the future to accommodate the requirements of the other SPs. Figure 10 of Appendix A shows a draft schema with a possible arrangement for a much more comprehensive set of data tables. The tables in red signify those described in detail above. The other tables cover potential data from the SPs; for example LCC and RAMS data from SP6 and rail and switch data from SPs 3 and 4. Perhaps the key table from which everything else hangs is ‘case’, which could be visualised as representing a segment, or group of segments.

6. Results

The first version of the database was prepared according to the outline schema described above. A draft version of the web-based questionnaire was prepared and a representative from each of the Innotrack member countries was asked to test it. Unfortunately, the response has been very limited so far and only a small amount of data has been input.

7. Conclusions

A framework has been developed that has the potential to meet the data collection, storage and analysis requirements of Innotrack both now and in the future. A methodology for the efficient collection and inputting of data to the database has also been developed, but remains to be properly tested and assessed for its suitability.

8. Appendix A

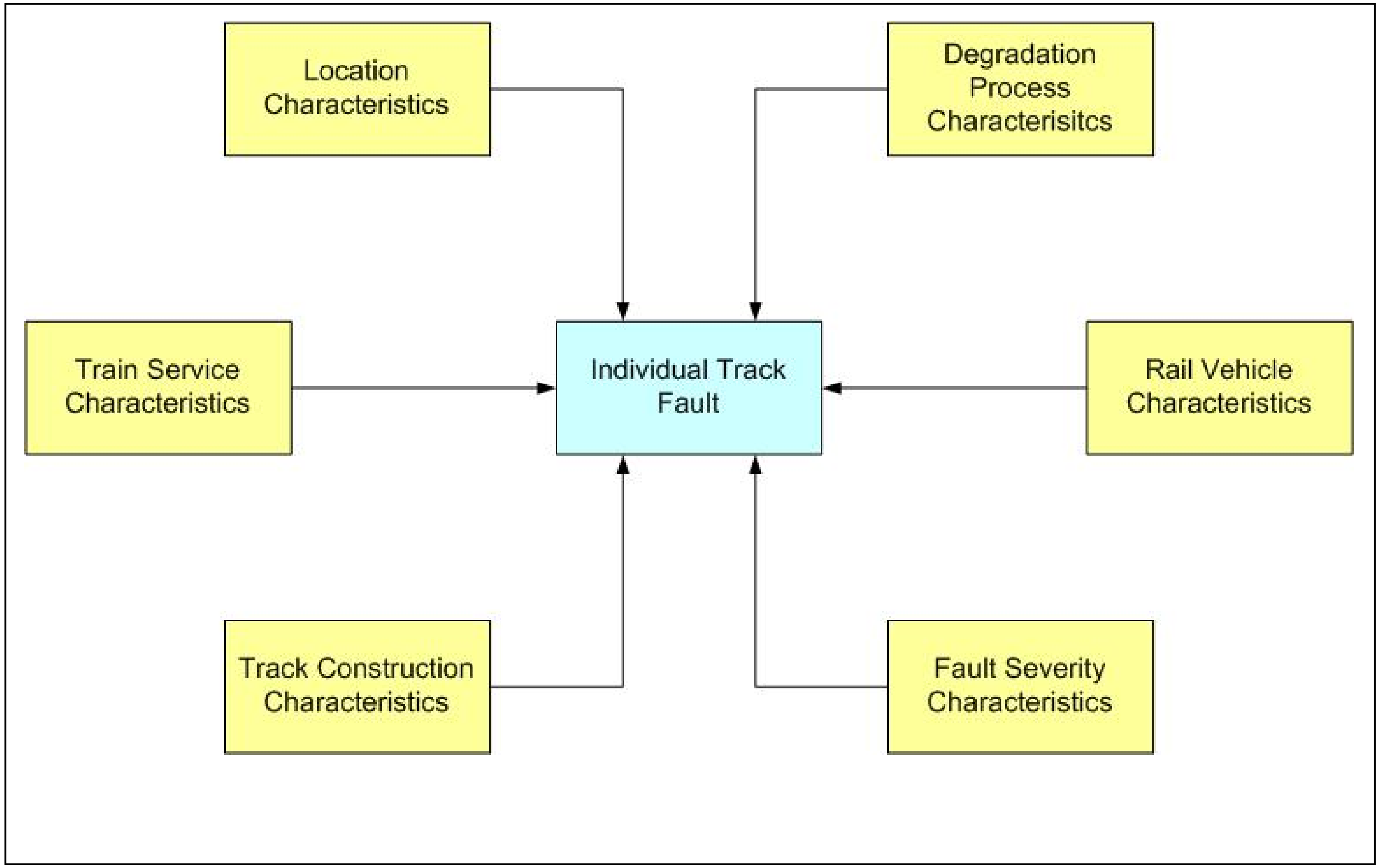


Figure 1: Diagram Showing the Characteristics used to Describe an Individual Track Fault

Components	Problems	Causes	Possible Solutions	Evaluation Methods
S+C				
Track				
Rail				
Substructure				
Ballast				
Sleepers				
Fasteners				
Drainage				
Joints				

Figure 2: Table Used in the Infrastructure Manager Workshops to Promote Structured Discussion of the Main European Track Faults, their Underlying Causes, Possible Solutions and Evaluation Methods

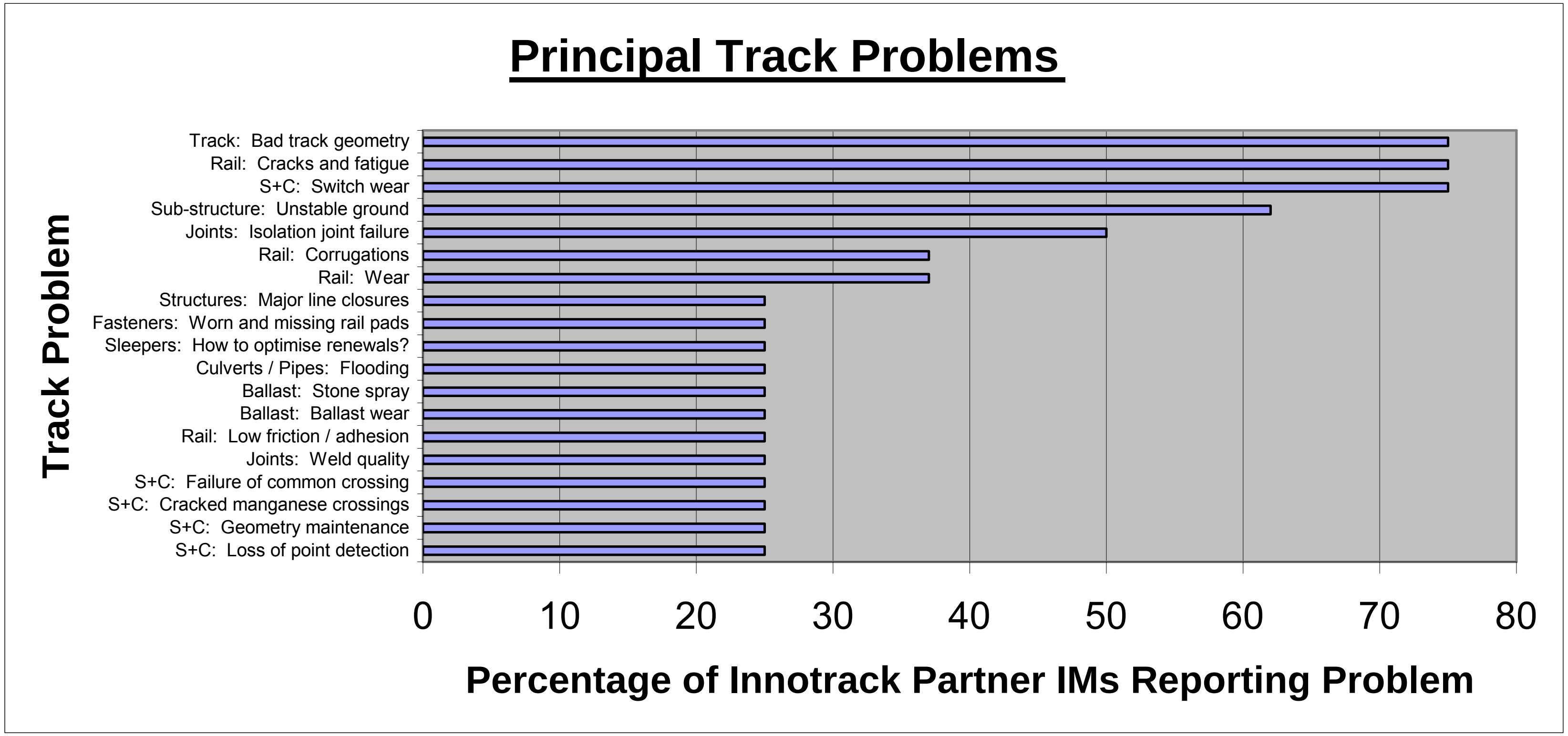


Figure 3: SP1 Ranking of Track Faults Based on the Output of the IM Workshops

Level 1	Level 2	Level 3	Level 4	Component Description	Fault	Fault Description	Underlying cause
Track	Track	Plain line	Rail	EN standard	RCF Squats Fracture Corrugation Geometry Gall		
			Fastening	From standards	Broken Loose Missing		
			Pads	From standards	Worn Split Disintegrated		
			Sleepers	Concrete	Bending failure Shear failure Bearing failure Attrition Reinforcement corrosuion		
				Steel	Bending failure Shear failure Bearing failure Attrition		
			Ballast	From standards	Loss of stability Reduced drainage capability		
			Slab	Slab type	Bending failure Shear failure Bearing failure Reinforcement corrosion		
			Subgrade	Design CBR	Loss of bearing capacity Settlement		

Figure 3: SP1 Ranking of Track Faults Based on the Output of the IM Workshops

Figure 4: Table Showing the Top-down Approach Adopted to Describing Rail Problems (Faults) - Typical

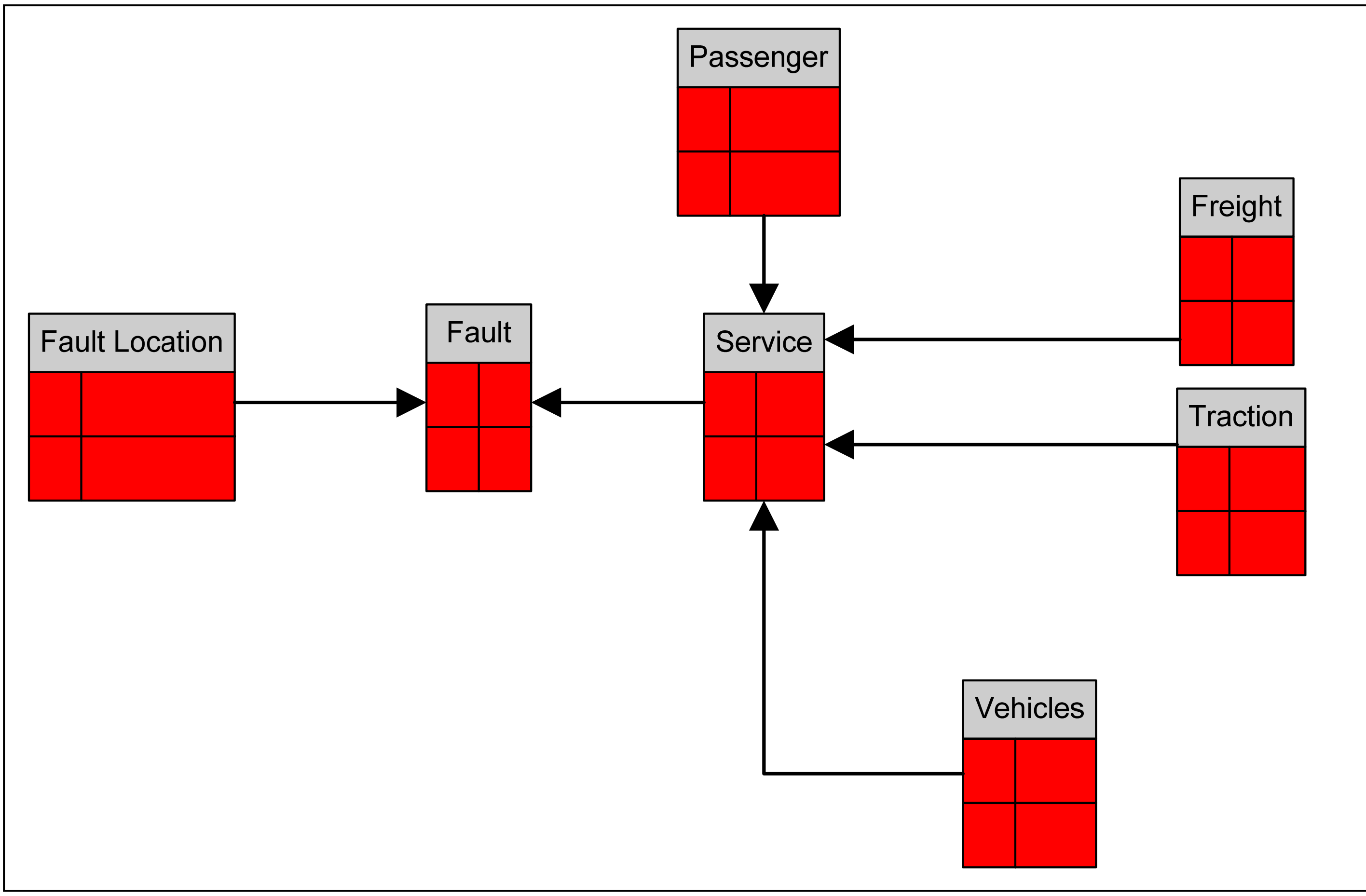


Figure 5: Diagram Showing Initial Arrangement of Data Tables in the Database

Innotrack Questionnaire
SP1 / WP 1.4

Gathering of Track Fault Data

This questionnaire is collecting data about track faults that cause the most problems in Europe. As well as data about faults it also collects data about the type of track, the type of rolling stock and the train service involved as well as the severity of the problem.
Please choose a section of track (up to 20 kilometres long) that you know about and use the questionnaire to describe its track faults.

Begin by clicking on 'Describe track fault' below and follow the instructions.

Describe track fault

Describe a vehicle using this track

Describe train service using this track

View track faults in database

Figure 6: Draft Web-based Questionnaire – Screen Shot of 'Front Page' of Questionnaire

Innotrack Questionnaire
SP1 / WP 1.4

Gathering of Track Fault Data

Please describe the track fault by answering the questions below. Please fill in a separate questionnaire for each fault even if some of the faults are the same or similar. When each questionnaire is complete click 'Add this entry' to send the information to the database, then click 'Return to Menu'. Select 'Describe track fault' to add another fault, or click 'Describe a vehicle using this track' to add details about the rolling stock.

Enter the starting station

Enter the end station

Enter the distance of the fault from the start station (0.000km)

Any other comments e.g. up line / down line

Please select the location characteristics from the lists below:

Location Level 1	Location Level 2	Percentage
Not Chosen		

Fault Description Level 1 — Nothing Selected

Fault Description Level 2

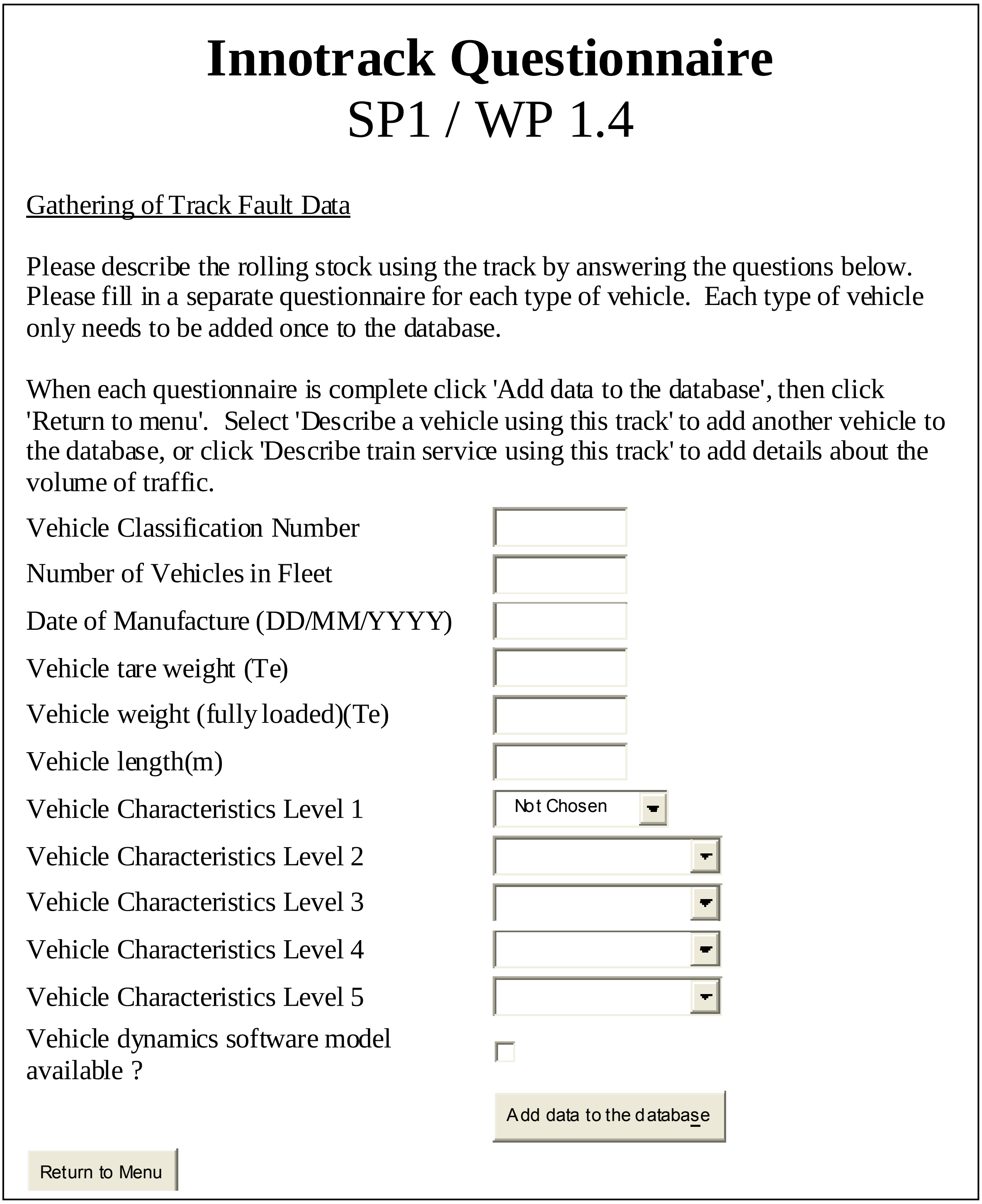
Fault Description Level 3

Fault Description Level 4

Fault Description Level 5

Enter a description of the fault:

Figure 7: Draft Web-based Questionnaire – Screen Shot of Part of the 'Individual Fault' Data Collection Page



Innotrack Questionnaire
SP1 / WP 1.4

Gathering of Track Fault Data

Please describe the rolling stock using the track by answering the questions below. Please fill in a separate questionnaire for each type of vehicle. Each type of vehicle only needs to be added once to the database.

When each questionnaire is complete click 'Add data to the database', then click 'Return to menu'. Select 'Describe a vehicle using this track' to add another vehicle to the database, or click 'Describe train service using this track' to add details about the volume of traffic.

Vehicle Classification Number
Number of Vehicles in Fleet
Date of Manufacture (DD/MM/YYYY)
Vehicle tare weight (Te)
Vehicle weight (fully loaded)(Te)
Vehicle length(m)
Vehicle Characteristics Level 1 — Not Chosen
Vehicle Characteristics Level 2
Vehicle Characteristics Level 3
Vehicle Characteristics Level 4
Vehicle Characteristics Level 5
Vehicle dynamics software model available ?

Add data to the database

Return to Menu

Figure 8: Draft Web-based Questionnaire – Screen Shot of Part of the Vehicle Data Collection Page

Innotrack Questionnaire
SP1 / WP 1.4

Gathering of Track Fault Data

For each fault please describe the train service using the track by answering the questions below. Start by clicking on the fault at the top of the page to select it and then answering the questions. When the questionnaire is complete click 'Add details to database' and then click 'Return to menu'.

The data gathering process should now be complete for the section of track you selected.

Thank you for your help

Track:Track:Plain Line:Subgrade:10km from Exeter towards Bristol Temple Meads. Notes:up
Structures:Bridge - Arch:Two Pin:Masonry:20km from Crewe towards Preston. Notes:down goods

Gross Annual Tonnage [ ]

Proceed >>

Total Passenger Tonnage [ ]

Passenger Service Type	tonnage at category		maximum speed band
High-speed	% < 11te axle weight	[ ]	Not Chosen
High-speed	% >= 11te axle weight	[ ]	Not Chosen
Long distance intercity	% < 11te axle weight	[ ]	Not Chosen
Long distance intercity	% >= 11te axle weight	[ ]	Not Chosen
Regional	% < 11te axle weight	[ ]	Not Chosen
Regional	% >= 11te axle weight	[ ]	Not Chosen
Suburban	% < 11te axle weight	[ ]	Not Chosen
Suburban	% >= 11te axle weight	[ ]	Not Chosen

Proceed >>

Total Freight Tonnage [ ]

Figure 9 Draft Web-based Questionnaire – Screen Shot of Train Service Data Collection Page

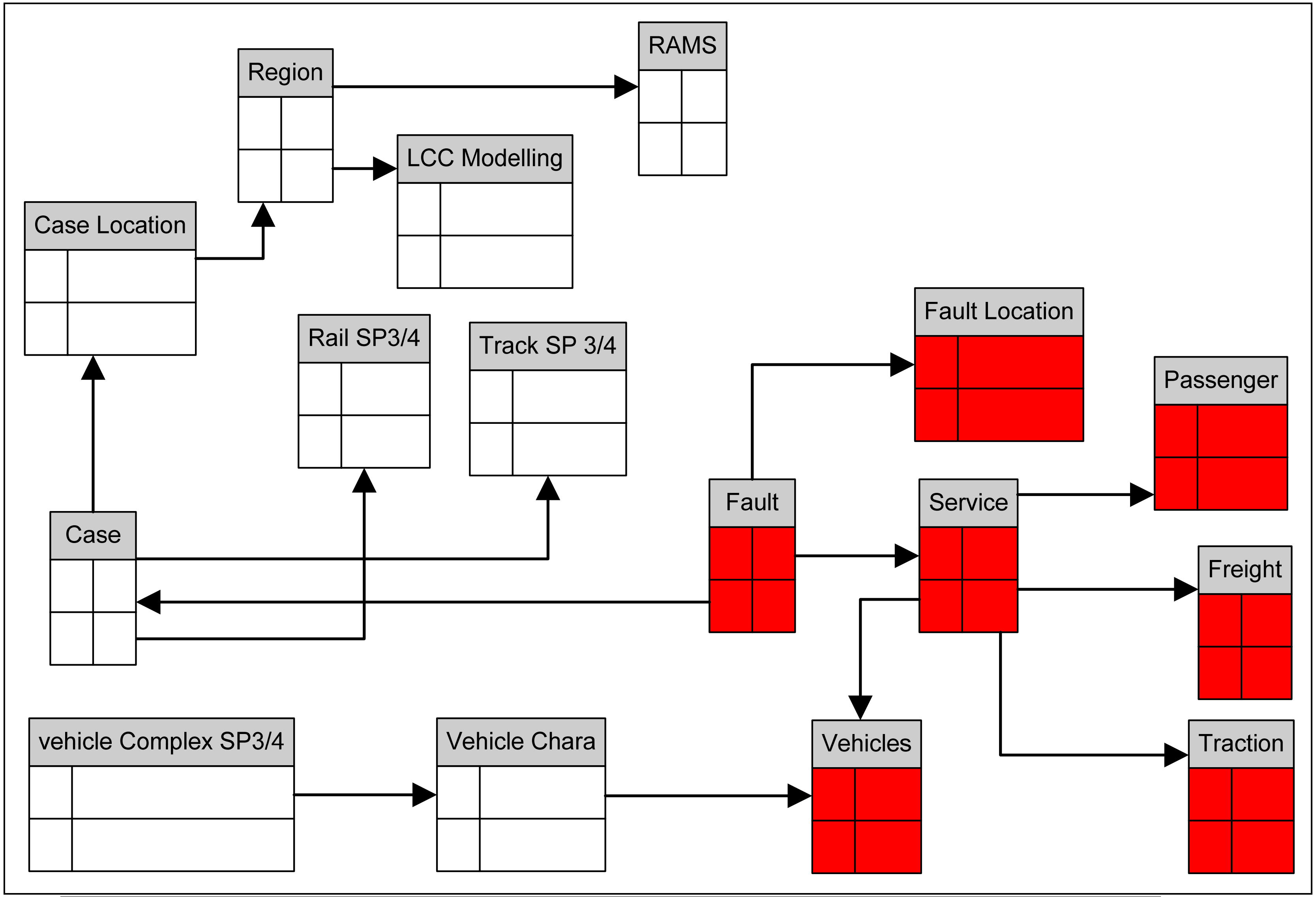


Figure 10: Diagram Showing Potential Future Expansion of Database (Red boxes Indicate Initial Development)

Level of confidentiality and dissemination

By default, each document created within INNOTRACK is © INNOTRACK Consortium Members and should be considered confidential. Corresponding legal mentions are included in the document templates and should not be removed, unless a more restricted copyright applies (e.g. at subproject level, organisation level etc.).

In the INNOTRACK Description of Work (DoW), and in the future yearly updates of the 18-months implementation plan, all deliverables listed in section 8.5 have a specific dissemination level. This dissemination level shall be mentioned in the document (a specific section for this is included in the template, both on the cover page and in the footer of each page).

The dissemination level can be defined for each document using one of the following codes:

PU = Public

PP = Restricted to other programme participants (including the EC services);

RE = Restricted to a group specified by the Consortium (including the EC services);

CO = Confidential, only for members of the Consortium (including the EC services).

INT = Internal, only for members of the Consortium (excluding the EC services).
This level typically applies to internal working documents, meeting minutes etc., and cannot be used for contractual project deliverables.

It is possible to create later a public version of (part of) a restricted document, under the condition that the owners of the restricted document agree collectively in writing to release this public version. In this case, a new document code should be given so as to distinguish between the different versions.