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INNOTRACK

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Thematic Priority 6: Sustainable Development, Global Change and Ecosystems

D5.3.2 Final Report on Logistics & Support

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Table of Contents

Glossary

IM	Infrastructure Manager
LCC	Life Cycle Cost
SP	Sub Project
WP	Work Package

1. Executive Summary

The present deliverable is the final report on the logistics of track support structure considering developments derived in subproject SP2 –"Substructure" of INNOTRACK.

It can to be seen as an attempt to put SP2 output in the context of the relation between Infrastructure Managers and Contractors.

The analysis developed is based on one hand on the output of work package WP5.1 and on the other hand on the output of SP2.

The work achieved in WP5.1 has showed that the logistic aspects have to be considered in the development of innovative solutions especially when LCC arguments are taken into account. The research in WP5.1 have identified seven areas which are critical to success, and these are: Market strategy; Long-term funding, Planning and contracting; Work programming; Project management and logistics; Contracting strategies; Rules and regulations; Plant.

They are mostly linked to management issues, but some of them may have also a direct technical repercussion which effects could be influence worksites. These are: Work programming; Project management and logistics; Rules and regulations; Plant.

In the present analysis, only these latter have been kept, along with a benchmark of logistics constraints.

With these elements in hands, the logistics views on SP2 new products can be established. In other words, the conclusions and recommendations of WP5.1 provide a reading grid, which is helpful for the current analysis of the logistic aspects.

SP2 has carried out many investigation and innovative developments on the assessment, monitoring and reinforcement of track sub-grade as well as on the evaluation and test of superstructure innovations.

The implementation of the innovative solutions developed by SP2 will involve some logistics and possibly new processes, which may bring about changes compared to the current way of working. For example new equipment or tools, which are not commonly used at the moment on trackwork sites may be required. Planning of the work and possession may have to be more anticipated, traffic disruption is not required or no speed restriction are necessary at handover to operation, etc.

The proposed study will be limited to some selected output of SP2 related to:

- sub-grade improvement by inclined Lime/Cement columns from trackside
- new ballast-less trackform consisting of embedded slab track developed by Balfour Beatty, and of Corus steel–slab track.

2. Introduction

Following the review of existing methods and the analysis of the relation between Infrastructure Managers and Contractors, which was achieved during the development of the WP5.1, the current WP5.3 study could be presented as an application of WP5.1 results and conclusions to the logistic of SP2 output. Alternatively it could be presented as a logistics assessment of SP2 output analysed through the grid of the results and conclusions of WP5.1.

WP5.1 was aiming at identifying best practices and making proposals for promoting good management and logistic practices in track maintenance and renewal work. The development of the work, implemented through interviews and analysis, demonstrated that there is large potential for savings through the improvement of the overall process of track maintenance and renewal. Figures of savings between 10 to 30 % were set forth.

These figures are matching the INNOTRACK overall objective of 30% reduction in LCC and are showing that logistics aspects have to be considered in the development of innovative solutions. The other side of the coin is that a 30% gain in LCC provided by a technical solution could be wasted through bad logistics solutions.

It is thus vital to carry out a logistics assessment of the SP2 output. Those elements of WP5.1 with immediate application on site have to be first identified and then crossed with the logistics requirement of the SP2 innovations.

As an example, either Infrastructure Managers or Contractors, predominantly requested a better track possession policy, a better planning enabling for example the implementation of high output methods, the industrialisation of processes, common rules & regulations, and an optimised utilisation of the fleet.

- Elements of conclusions and recommendations from WP5.1 that can have a direct application for the development of WP5.3 are detailed below:
    - Contracting strategies of infrastructure managers e.g. long term planning, dependability, economies of scope and scale, output orientation (innovation, LCC-aspects), terms of employment/build-up and continuity of skills
    - Track possession policy: vast potential for process-innovation to make better use of operational windows
    - Industrial engineering of processes and worksites (good-practice knowledge management)
    - Rules and regulations, particularly in safety and logistics (worksite protection and material supply) have a massive impact on productivity and LCC.
    - Fleet utilisation for heavy equipment is often too low. This results in the fleet size of some very expensive machinery to often be far above real needs. The consequence is a high capital cost and an immediate consequence for initial direct costs of track maintenance and renewal. However, this situation is sometimes justified by few and short disposal times on high-density lines.

- Infrastructure Managers identified the following constraints affecting logistics:
    - Fluctuating levels of funding from governments, adversely affecting the ability to plan long-term

- The loss of skilled staff through retirement and a shortage of suitable new people willing to come to the industry
- The variability of track condition resulting in relatively small and inefficient packages of work unsuitable for high-output methods of working
- A limited number of component suppliers resulting in resource shortages and poor competition

The output of SP2 that have been considered for the current study concern:

- sub-grade improvement by implementing inclined Lime/Cement columns from trackside
- new ballast less trackform consisting of embedded slab track developed by Balfour Beatty, and of Corus steel slab track.

The study should be seen as an attempt to put SP2 output in the context of the relation between Infrastructure Managers and Contractors.

3. Logistics analysis

3.1 Input and Benchmark from WP5.1

Different approaches have been followed to encompass the existing methods that have been developed throughout Europe: on one hand face-to-face interviews were carried out and on the other hand an online questionnaire was filled in.

Two aims of these investigations were: primarily to collect quantitative data with the help of questionnaires and interviews and secondly to collect qualitative information during face-to-face interviews. Quantitative information collection was about procedures relating to: rail; sleepers; ballast; switches and crossings; machinery; and maintenance and renewal planning.

Two deliverables summarise the studies:

- D5.1.5 “Final Report on Existing States-of-the-Art for Construction, Maintenance and Renewal Activities and Assessment of Logistic Constraints”
- D5.1.6 “Final Report on conduct of interfaces between contractors and infrastructure managers"

The logistics & support analyses in this report will be guided by these two reference documents.

From the conclusions and recommendations of WP5.1, two ways forward have emerged:

- one is focusing on the management and strategic level. It was taken over by the Infrastructure managers, members of EIM and CER and EFRTC contractors which are the most suited bodies to carry out this work;
- the second approach is focusing on the technical level and is developed inside INNOTRACK.

Figure 1 below shows the split of the work between the management and technical levels. This report deals with the technical level.

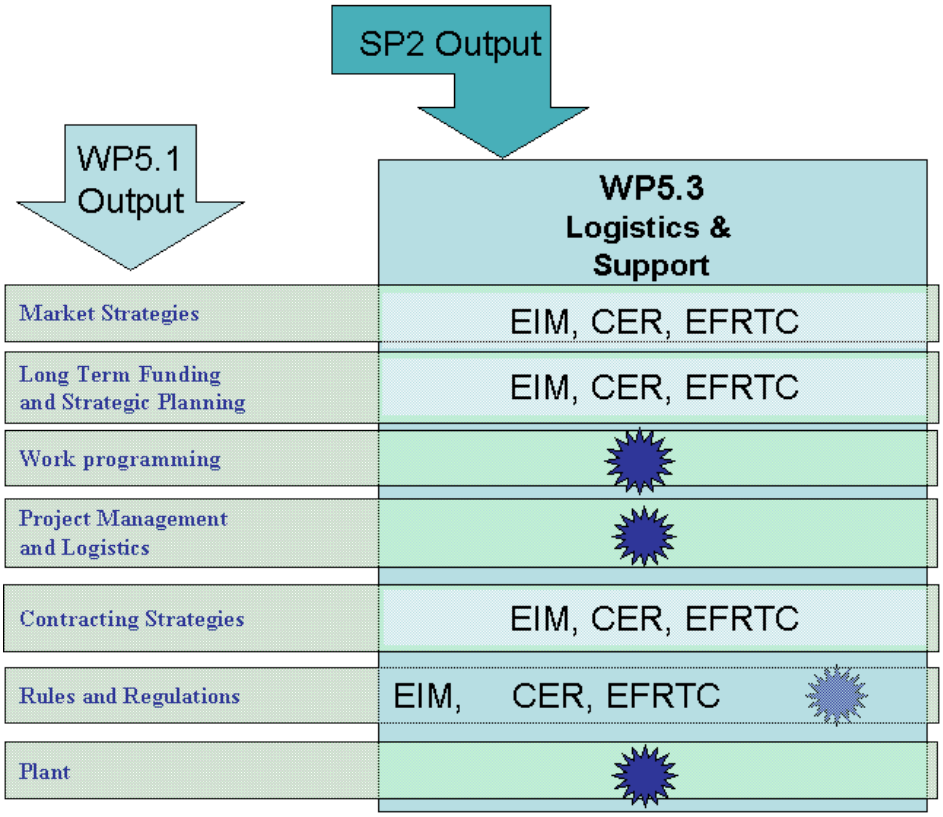

Figure 1: Split of logistics priorities between technical and management levels

Further, D5.1.6 has classified the key findings of WP5.1 pertaining to the conduct of interface between Infrastructure Managers and contractors into seven clusters detailed below:

A – Market strategy

B – Long-term funding, planning and contracting

C – Work programming

D – Project management and logistics

E – Contracting strategies

F – Rules and regulations

G – Plant

Among these areas those that have a direct application on logistics at a worksite level include:

- Work programming
- Project management and logistics
- Rules and regulations
- Plant

These areas thus have a direct application to the logistics of support.

Work programming

From a logistics point of view the fundamental building blocks for good economics of resource deployment with a substantial impact on unit cost are:

- plant and staff deployment during track possessions
- well programmed project pipeline and sequencing of plant and staff deployment (logistics from work-site to work-site)
- minimum disturbance strategies and procedures for assessing the overall costs of the intervention into the track

Work Programming to ensure the proper planning and programming is at the heart of all efficiency of contractors works and should include:

- consistent sequencing of all work over time and geographically
- coordination of activities, bundling
- a “clockwork” approach to worksite logistics and work execution (mutual programme management)
- a well programmed pipeline of major projects leading to such a “clockwork” approach to worksite logistics and work execution
- avoiding large programme changes resulting in increase of costs both for supply-side and regarding the execution of work
- careful attention to all details in the planning process and work programming

The infrastructure managers’ approach in this regard is a key to create a cost efficient framework, for the execution of works by contractors primarily by

- mid-term planning and work programming
- consistent sequencing of work
- logistics and execution dependability
- an even distribution of workload over the year

Project management and logistics

Multiple interfaces on site between IM, and the IM’s suppliers and contractors introduce cost and undermine responsibility to deliver efficiency. Maintenance and renewal works are often carried out by various parties (e.g. staff of the infrastructure manager for worksite protection, contractor's staff for work execution). This increases the number of the interfaces and the effort required for coordinating the work (elimination of synergies, process perturbations, etc.). There is also often a great variability in working time per possession – output can be improved by step change both in processes and technology. Substantial gains can be made (double digit %) if good-practice at the supply-interface is ensured.

Due to the fragmentation of work without clearly defined responsibilities for project management, the contractors cannot sufficiently influence the overall efficiency of the project. Moreover, they often have to take the risk for delay in the execution of the work and thus cost due to the disturbances in the logistics, which are beyond their potential intervention. It is therefore vital that project management is clearly defined and assured by a body/person authorised by client and agreed with contractor. The logistic process also has to be carefully designed in the overall programming of the work jointly with contractors at a very early stage. All changes in project management and logistics have to be agreed with contractors and risk properly allocated.

Rules and regulation

The differing rules and regulations are a key barrier to entry into national markets. This includes border issues: "it takes months sometimes to transfer equipment to another country". It also

concerns cross-country acceptance of certifications for machinery (technical and process) and for innovations. Such an acceptance would enhance competition and ensure that efficiency gains are rolled-out more easily. In general, a more open market would result in lower prices, more efficient sizing of capacity and better utilisation.

Sometimes very rigid rules for worksite protection and logistics can have a very substantial impact on productivity and costs. They can be also onerous in proportion to benefits. So there is a need for harmonisation based on good practices. This includes a certification process that encourages innovation rather than obstructing it

Plant

The cost for moving equipment (logistics) is often very high; it consumes considerable time, often as a consequence of improper planning Coordination between infrastructure managers and contractors in purchasing and specifications of heavy equipment is essential for "avoidance of over-sized, over-specified fleets".

Plant utilisation (e.g. measured by productive shifts per year) varies between less than 50% in some countries and up to 90% in others

Benchmark of logistics constraints

From the quantitative inquiry reported in D5.1.5, it is interesting to notice the benchmark of logistics constraints identified by the Infrastructure Managers (abstract of D5.1.5 hereafter).

Infrastructure Managers identified the following constraints affecting logistics:

- Fluctuating levels of funding from governments, adversely affecting the ability to plan long-term
- The loss of skilled staff through retirement and a shortage of suitable new people willing to come into the industry
- The variability of track condition resulting in relatively small and inefficient packages of work unsuitable for high-output methods of working
- A limited number of component suppliers resulting in resource shortages and poor competition

The input and benchmark that can be drawn from WP5.1 as presented above constitutes a helpful reading grid that will be the basis for the analysis of the logistic aspects and for the taking account of suggested ways of improvement.

3.2 Output from SP2 “Substructure”

SP2 has carried out many investigation and innovative developments on the assessment, monitoring and reinforcement of track sub-grade as well as evaluation and test of superstructure innovations.

The implementation of the innovative solutions developed by SP2 will involve some logistics and possibly new processes, which may bring about changes compared to the current way of working. For example new equipment or tools, which are not commonly used at the moment on trackwork sites, may be required. Planning of the work and possession may have to improve, etc.

Below, each “critical-to-success” area identified in section 3.1 will be considered and checked towards the logistics demands introduced by the SP2 innovations. A reference for comparison will be defined.

In this section logistics related to sub-grade improvements using inclined columns and related to superstructure improvements will be the analysed. This covers track work activities from the construction of a new track to maintenance and renewal.

The analysis will be developed following the framework below:

Field of implementation and reference

Is the solution applicable to maintenance, renewal or new track construction.

Reference to the traditional technique the innovation is aiming at replacing.

Work programming

Plant and staff deployment during track possessions.

Sequencing of work over time and geographically.

Coordination of activities: interfaces with other activities.

Logistics and execution dependability.

In case of maintenance or renewal: is traffic disruption, re-routing or other measure required .

Project management and logistics

Interfaces with other parties on site.

Possession and access to the track:

- worksite area required by the innovative solution, time from reception of worksite until handing-over for operation including preparation of worksite, convey of equipment & tools, etc.
- does the solution requires rail or road access (large or small; reinforced or not), which make not applicable in some configurations;

Rules and regulation

Are the equipment & tools used able to overcome borders hindrance?

Is there any certification required.

Plant

Description of equipment & tools required :

- does the innovative solution requires heavy or light equipment,
- with high or low output rate

Taking account of the logistics constraints

Does the installation of the innovative solution require skilled labour or not.

Are the track conditions suitable for high-output methods of working?

Does it require new components? How is the supply situation?

3.2.1 Sub grade improvement: inclined columns

Field of implementation and reference

This solution is essentially applicable to the maintenance of ballasted track when the reinforcement of the sub grade is required to avoid significant settlements. It is suitable when the track is laid on soft soils.

It is to be compared with a more classical solution, which would consist in removing the track, reinforcing the sub grade and reinstall the track.

Work programming

Plant and staff deployment during track possessions:

- A special machine for injection of lime/cement columns has to be brought on site with associated staff to operate it.

Coordination of activities: interfaces with others:

- No specific interface with other activities.

Logistics and execution dependability:

- Site has to be prepared for columns injection i.e. removal of stones if they are present.

Traffic:

- Work can be done without traffic interruption.

Project management and logistics

Possession and access to the track

- The worksite area is of a limited length: it is a punctual site, at the moment not foreseen to be implemented lengthwise over larger distances.
- Preparation of the worksite: stones have to be removed.
- Access to the track: access from side, which is able to support the load and dimension of heavy equipment.

Rules and regulation

Equipment & tools machine used, able to overcome borders hindrance:

- The type of equipment used should have no particular problems in crossing borders.

Required certification:

- A QA system for contractors is required.

Plant

- Heavy equipment is required (crane, specific cement columns machine).
- The total schedule is decreased by 30% with subsequent consequence on output rate. It can be increased by increasing the number of equipment.

Logistics constraints

- Skilled labour is required for operating the lime/cement columns injection.
- The market for lime/cement columns is functioning with good competition between competent contractors.

3.2.2 Superstructure innovations: steel–concrete–steel trackform

Field of implementation and reference

This solution is applicable to new track installation or renewal.

It should preferably be implemented in case of the renewal of a switch and crossing.

The reference for comparison is the classic ballasted track.

Work programming

Plant and staff deployment during track possessions:

- Heavy cranes have to be brought on the worksite to handle steel beams.
- Workers are required for mounting the steel structure and concreting.

Sequencing all works over time and geographically:

- It is similar to a classical ballasted track.

Coordination of activities: interfaces with others:

- In case of new track construction, interface with others is the same as with ballasted track construction.
- In case of renewal, there is an interface with the catenary system

Logistics and execution dependability

- Whether this innovative solution is implemented in renewal or new track construction, there is no specific dependability compared with ballasted track.

Traffic

- In case of renewal, traffic disruption is required on the concerned track. Work has to be done during night or a re-routing has to be implemented to minimize delay. Work programming in advance is then a major issue. However, the disruption will be less than for the traditional solution.
- When the track is handed over to operation no speed restriction is applied.

Project management and logistics

Interfaces with others on site

Possession and access to the track:

- road access which is able to support the load and dimension of heavy equipment
- possible rail access
- low track possession which could be justified by the modular aspect of the design and the use .of steel beams as structural support.

Rules and regulation

Equipment & tools machine used, able to overcome borders hindrance:

- the required equipment & tools consist of cranes and concreting truck which can easily cross borders.

Required certification:

- no specific certification

Plant

- Heavy equipment may be required in order to handle steel beams.
- Specific installation equipment could be developed in the view of a mechanised installation, which would increase the output rate.

Logistics constraints

- No skilled labour is required for the installation of this innovative solution.
- This innovative solution is developed by Corus.

3.2.3 Superstructure innovations: Embedded Rail Slab Track

Field of implementation and reference

- This solution is applicable to new track installation or renewal.
- The reference for comparison is the classic ballasted track.

Work programming

Plant and staff deployment during track possessions:

- A slipform paver has to be brought on site including a competent operator.
- Topographer for implementing the guiding of the slipform paver.
- Workers for the installation of the steel reinforcement, the rails, etc.

Sequencing all works over time and geographically:

- This type of installation method requires a significant length per day to be efficient.
- The formation has to be prepared and the guiding of the slipform paver has to be implemented.

Coordination of activities: interfaces with others:

- Whether it is a new track construction or a renewal, interface with others is the same as with ballasted track construction.

Logistics and execution dependability:

- The formation has to be prepared over a significant length
- Concrete supply has to be ensured to feed the slipform paver.

Traffic

- In case of renewal, traffic disruption is required on the concerned track. A re-routing has to be implemented to minimize delay.
- Work programming in advance is then a major issue.
- On handover to operation, a speed restriction has to be applied.

Project management and logistics

Possession and access to the track:

Depending on the type of installation the possession time will vary: it will decrease when using slip-form process and increase when using pre-cast elements and cast in-situ method.

The access to the track has to be adapted to the chosen installation method. Access of heavy equipment has to be considered when implementing pre-cast elements installation or slip-form process

Rules and regulation

Equipment & tools machine used able to overcome borders hindrance:

- the required equipment & tools, especially the slipform paver and the concreting truck should have no particular problem in crossing borders.

Required certification:

- no specific certifications

Plant

It is possible to use a slip-form paving machine, which will provide a high output rate and a good quality. Then a minimum length handed over from the civil works is required so that high output level can be reached.

Alternative solutions are :

- installation of pre-cast elements: requires heavy cranes
- cast in-situ installation: lower output rate.

Taking account of the logistics constraints

- The installation of this innovative solution requires a quite skilled labour for the operation and guiding of the machine.
- The track conditions and the use of a slipform paver can be suitable for high-output methods of working
- This innovative solution is developed by Balfour Beatty.

4. Conclusions

The main idea of WP5.3 could be presented as an application of WP5.1 to the logistic of the innovative solutions of SP2.

The conclusions and recommendations from WP5.1 were taken as input and benchmark to WP5.3. The suggested ways of improvement were considered and cross-examined with the logistics involved by the implementation on site of the innovative solutions resulting from SP2.

Four areas identified as “critical to success” in WP5.1 were guiding the current study of Logistics and Support: Work programming, Project management and logistics, Rules and regulation, and Plant.

Three innovative solutions output of SP2 were selected and these are related to sub-grade improvement and superstructure innovations.

Finally it is an additional asset to consider the relation between Infrastructure Managers and Contractors in the development of innovative track solutions.

5. Bibliography

INNOTRACK deliverable D2.3.2 – Optimised design of steel-concrete-steel trackform

INNOTRACK deliverable D2.3.3 – Design and Manufacture of Embedded Rail Slab Track Components

INNOTRACK deliverable D5.1.5 – Final Report on Existing States-of-the-Art for Construction, Maintenance and Renewal Activities and Assessment of Logistic Constraints

INNOTRACK deliverable D5.1.6 – Final Report on conduct of interfaces between contractors and infrastructure managers