RAIL CDM DEVELOPMENT REQUIREMENTS & IMPLEMENTATION ROADMAP

Feasibility Study to Rail Collaborative Decision Making (Rail CDM)

Work Package 3 Report

Hacon Ingenieurgesellschaft mbH,
Hannover, Germany

To70 B.V,
The Hague, The Netherlands

Date: 06. July 2021

Table of Contents

1 Introduction

This document is the third deliverable in the project “Feasibility Study into Rail Collaborative Decision Making (CDM)” in contract 0072-10-20 for Rail Freight Corridor Rhine Alpine, which started 15 September 2020 (Reference 1), and was signed 23 October 2020. This contract is part of grant agreement by the European Union MOVE/C4/2020-62.

1.1 Purpose

This document describes the development requirements and implementation roadmap for Railway Collaborative Decision Making (Rail CDM) as an initial orientation to transform the Airport CDM concept from the aviation sector to the rail sector.

1.2 Related Documents

The project has provided an approach to Rail CDM in the first phase (WP1), and benefits and performance indicators description (WP2) in the previous phase. These project deliverables, Airport CDM background documents, and other relevant documents are listed in annex A

1.3 Audience

The prime recipient of this report is the Rail Freight Corridor Rhine-Alpine. The audience for this deliverable consists further of:

- Rail Freight Corridor Rhine Alpine Steering Board, Executive and Management Board, as well as the funding Directorate DG Move in the European Commission;
- Stakeholders who participated actively or passively in this project;
- Other Rail Freight Corridors and interested stakeholders;
- Other stakeholders and their associations;
- Non-freight rail stakeholders who see an interest in Rail CDM.

The document can be used by international as well as regional or local stakeholders for decision making on future programs, international projects, or small-scale projects in different regions or corridors.

1.4 Contents

This document describes

- Stakeholder processes for implementation decision making and setting up projects (chapter 2)
- Requirements for the development of international Rail CDM implementation (chapter 3)
- Roadmap of major development steps (chapter 4)
- Conclusions and Recommendations (chapter 5)

2 Process to Implementation & live operations

With the feasibility study completed, an outline for a Rail Collaborative Decision Making approach as described in reference 2) contains the basis for a Rail CDM implementation manual, after concluding the transferability and describing the analysis of rail processes inbound and outbound of a terminal.

With the Benefits description based on Performance Indicators in reference 3) stakeholders have a basis for decision making for regional or local implementation. A regional group of motivated stakeholders can set up an initial implementation program that delivers live operations. To achieve international harmonization and avoid risks on interoperability, international cooperation and coordination is required.

Once live operations are achieved, benefits can be collected, improvements implemented, which require an ongoing effort of improvement and steering on performance. This transition period is the path to changing of culture within organisations, change of reactive operations to pro-active more effective operations.

2.1 Challenges & Motivation

Rail stakeholders experience all kind of challenges in daily operations. These are discussed in the first deliverable in this project, Rail CDM Approach in reference 2). The main challenges were also applicable in aviation:

- Lack of situational awareness due to silo thinking
- Lack of common terminology, hence no level playing field for procedure adherence
- Planning uncertainties due lack of predictability, leading to reactive behaviour and no proactive thinking
- No transparency in capacity and resource assignment, leading to resource inefficiency
- Non-harmonised procedures, leading to confusion and misunderstandings
- No harmonised integration into the European Air Traffic Management Network

The consequences in aviation are delays, inefficiencies, poor information management, data inconsistencies, discrepancies and people no longer relying on information from other stakeholders. Trust is poor.

If these challenges are recognised by Rail stakeholders, they may consider the same motivation that aviation stakeholders have: implement Collaborative Decision Making in their own sector.

The stakeholders can learn from the aviation sector, though the same motivation factors apply also for Rail. CDM delivers, after implementation and live operations commence and multiple stakeholders working together and sharing information:

- Increase situational awareness by sharing a common dataset among all operational stakeholders
- Facilitate decision-making, based on high-quality data
- Increase predictability to:
    - Make operations more resilient
    - Make better use of infrastructure and resources
    - Increase capacity
    - Higher punctuality
- Improve operational processes based on stakeholder performance monitoring

- Move away from the ‘blame culture’ and a ‘first come, first served’ attitude, towards a ‘best planned, best served’ environment

Rail CDM will do what it does today in more than 40 airports in Europe, and 15 outside Europe:

> ***Provide the right information → at the right time → to the right people → for people to make the right decisions***

Airport CDM for aviation is a concept and a procedural framework for humans, facilitated by technology. It is not a software tool. Rail stakeholders should consider the same when they decide to investigate Rail CDM for their region and local stakeholders.

Moreover, Airport CDM has a track record delivering on the promise it made, though always more benefits are possible. With benefits documented for aviation in the Eurocontrol Impact Assessment (reference 8) and now globally endorsed by international authorities such as the International Civil Aviation Organization (ICAO), Airport Council International (ACI), International Air Transport Association (IATA), Civil Air Navigation Services Organization (CANSO) and European Air Traffic Management community represented in Eurocontrol, there is sufficient justification and motivation for Rail stakeholders to believe efficiency benefits can be obtained in their rail freight sector as well.

2.2 Decision process towards implementation

Stakeholders in rail who recognise the challenges in the sector today may find the new Rail CDM concept interesting to explore, but are uncertain whether it would provide benefits to their operations and business. The Cost Benefit Analysis (CBA) is required, which requires an assessment on the missing functionality and procedures to operate CDM. However, this analysis is not in the scope of this feasibility study.

Currently, the local stakeholder decision making process towards CDM implementation as well as starting figures for the CBA are missing, but lessons can be learned from aviation. Figure 1 shows the decision making process for local stakeholder management in aviation and how to proceed once interest for implementation is identified.

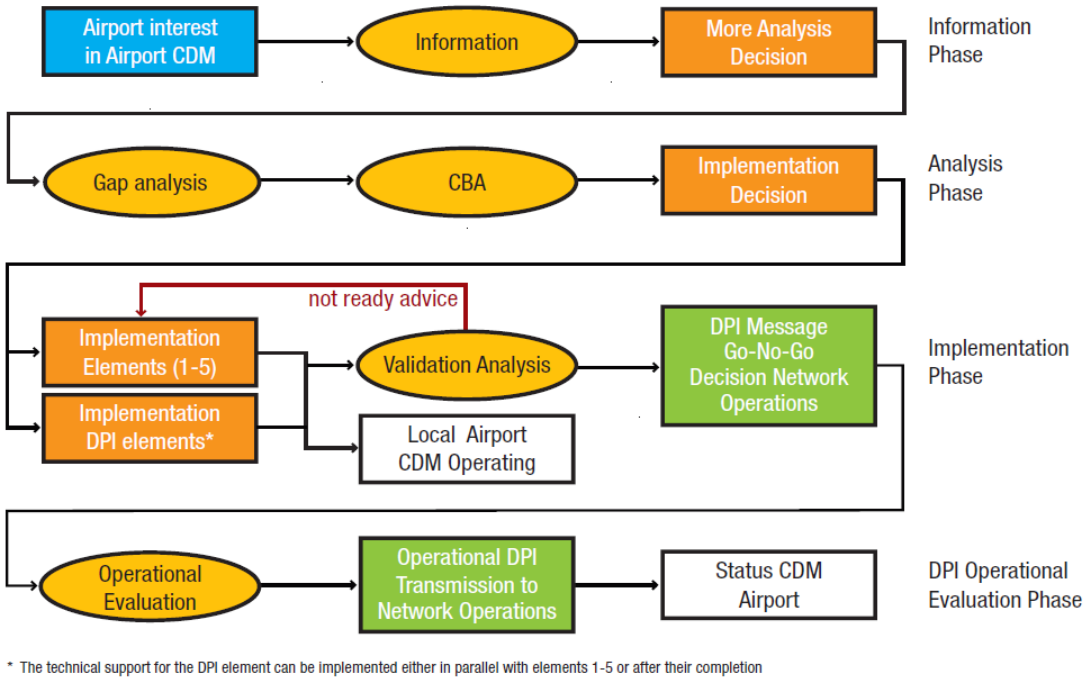

Figure 1 Airport CDM generic decision process for airport stakeholders (source: Eurocontrol)

This process describes how initial information from literature and third party experiences can trigger the decision for more analysis on site. A technical and procedural Gap analysis would identify needs for improvements, whilst a Cost Benefit Analysis would determine the potential benefit to cost ration as well as return on investment.

Implementation efforts including integration to other regions, nations, or international networks require validation prior to decisions for entering live CDM operations. In aviation a third party validation is created by Eurocontrol Network Management Operations Centre (NMOC) to assess the quality of performance data from the local airports. A similar external validation could be applicable for Rail CDM, when international cooperation and harmonization of is applicable.

After live operations are achieved after positive validation and decisions, evaluations need to continue into a transition period where the implementation period evolves into permanent Rail CDM operations.

2.3 Setting up Implementation Program

Once a decision for local implementation is made, based on positive analysis phase the commitment by all stakeholders should result in an actual implementation by a collaborative program team, supervised by a collaborative yet local steering board. First step would be to apply the international Rail CDM Implementation Manual, if this already exists (see 2.4). Figure 2 demonstrates an organisation structure for a local Airport CDM program.

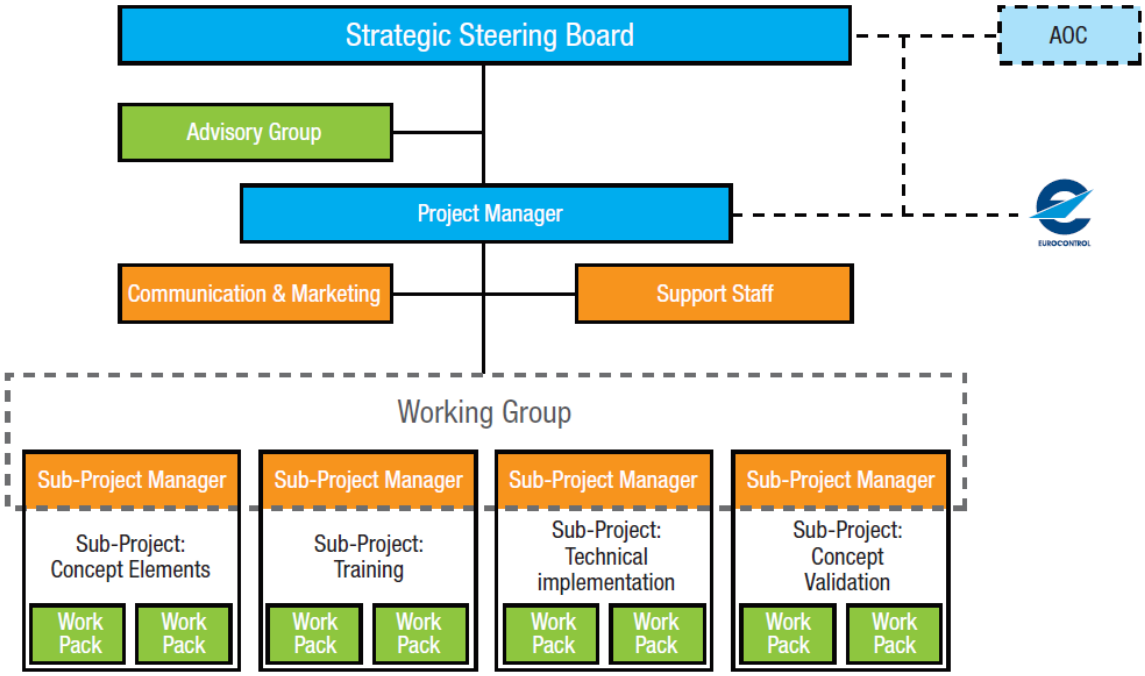

Figure 2 Generic organisation for a local airport program (source: Eurocontrol)

The Implementation Program consists of a core implementation team, supervised by a project leader, and structured in subgroups for various activities. Essential activities of such implementation team are (not limited to):

- Developing local concept of operation
- Determining the system integration and interfacing between stakeholder systems
- Training the stakeholders operational experts with the new concept and procedures
- Testing the chain of systems and validating operational scenarios with stakeholder operational experts
- Organising live trials
- Transition to live Rail CDM operations

In parallel performance monitoring is set-up locally to feed analysis to implementation team and reports to the steering board, identifying areas of improvement and enabling local steering on performance targets.

The success of the program is defined as the commencement and sustainment of live Rail CDM operations, reporting of performance, collection of benefits and adherence to procedures by all stakeholders.

2.4 Transition to permanent live operations

After all the work is done, concept of operations agreed, systems developed or procured, testing and trialling is successful and staff are well trained, the moment comes when it is transformed into live CDM operations. Systems and procedures are activated, performance monitoring generates continues data streams and live as well as post-operation analysis conducted.

This is also the phase where the program should be transformed in permanent maintenance of knowledge on CDM operations. A major pitfall for management is to assume that expertise can be let-go and the operation will be sustained on itself. Such pitfall would omit considering the human habits

of falling back to old methods of working. Changing the culture in organisations and operation takes years, continued training, and requires a long-term effort of stakeholder managers to sustain knowledge to be available.

The new operations require a permanent local steering on performance and continuous evaluation of achieved benefits and accountability on non-compliance. For that purpose it is recommended to organise permanent collaborative management boards replacing the steering board, where monitoring and steering is organised. Such organisation outlives the program and is presented in chapter 2 of the WP2 deliverable on Benefits and Performance Indicators, reference 3).

2.5 International Coordination Support Function

The success of local programs, projects, and benefits collection depend on one common approach in the network of international and national operations. When local initiatives are not supported with similar programs or harmonisation of local initiatives, the risk occurs that non-optimal benefits will not deliver on the promise.

For this purpose, the success of Rail CDM would benefit from international cooperation and initiatives providing resources and leading to efforts of development of documentation, harmonization, and regulations. This international cooperation could be organised in an International Coordination Support Function.

Such International Coordination Support Function shall work with existing Rail Freight Corridors (RFCs), national regulators and rail freight stakeholders, as well as local stakeholders where implementations are decided and executed to improve local operational performance. Figure 3 shows these layers of cooperation, where activities are visualised.

In the aviation sector, this function is carried out by the airport division in Eurocontrol Headquarters, with operational coordination and performance monitoring in the Network Manager Operations Centre (NMOC), established under the European Union in Brussels.

Local stakeholders are a group of interested operators and terminals, including the national Infrastructure Manager who decide to implement Rail CDM. The International Coordination Support Function, together perhaps with existing Rail Freight Corridors and/or international institutions facilitate and fund local projects. In the longer term, regulations and mandates can be made applicable, in order for implementations to adhere.

National organisations and governments often have a supervising function and make sure national interests are reflected in regulations. They can also play a role in national enforcement of mandates, when international regulations require local enforcement.

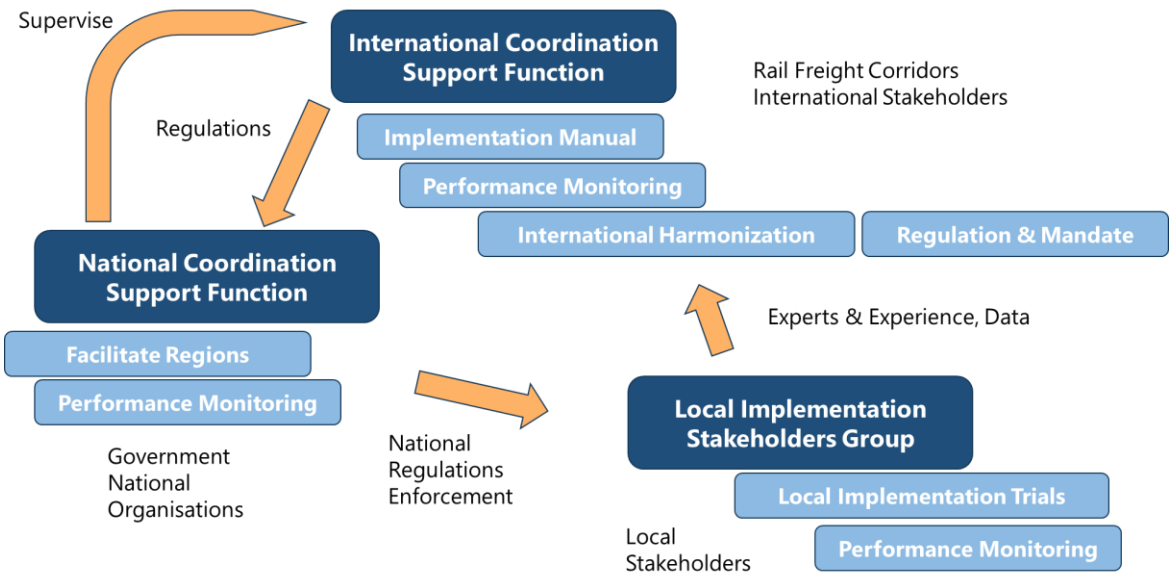

Figure 3 International, National and Local high-level activities

The next chapters introduce the requirements (chapter 3) and roadmap (chapter 4) towards an international collaboration to develop a common Implementation Manual, Cost Benefit Analysis, and harmonised performance monitoring to ensure local initiatives are worthwhile and create synergies rather than suboptimal results.

3 Requirements for Development and Implementation

This chapter describes requirements for Rail CDM development and implementation. These requirements enable international decision makers and local stakeholders to decide on steps towards development and implementation. The topics are listed in sequence of relevance, as one enables the next.

For the purpose of lessons learned, references are made to the aviation sector where experiences are gained since nearly twenty years. From such lesson, a requirement for the railway sector is derived. RFC RALP along with all other rail freight corridors could play a prominent role in supporting the implementation of the requirements.

3.1 Culture of Equality and Collaboration

Fundamental to a more constructive and productive way of working is to create the culture where results can be obtained and sustained as all stakeholders join the effort and buy-in to the long term commitment. For such culture to exist and prosper, all stakeholders need to feel equally relevant and represented.

3.1.1 Aviation Reference

In early 2000, multiple stakeholders from four major airports in Europe initiated ground delay trials to reduce delays. Together with Eurocontrol Head Quarters Airport Throughput Division, the process of development of the Implementation Manual was initiated. From the start, interests and inputs of all stakeholders were recognised in various working groups and documentation, though the dependency on ground handlers' data become more relevant when more airports became fully implemented.

This dependency on ground handlers was not immediately recognised by other stakeholders, yet much in the prediction of the next flight depends on their progress and readiness predictions. Airport CDM traffic demand predictions, take-off time and pushback times depend on the progress of handling aircraft and preparing for departure. The data needed for predictions of the next flight mostly comes from the turnaround phase, where the arrival aircraft is turned around for departure, passengers and cargo are offloaded, cleaning, fuelling and catering takes place, and new (transit) passengers and freight come in. The ground handlers operate most of these turnaround phase activities.

Though a freight train is different from a passenger aircraft, the process of handling an arrival and preparing for a departure is very similar. Resource availability and improved (pro-active) management of resources is also for rail a key factor. Hence, representation from terminal and shunting operators is vital for understanding for example the turnaround processes and to predict the next journey of a train.

3.1.2 Requirement to Rail

Working together, developing documentation in working groups, requires all stakeholders operating in the chain of rail freight to be included with equal seats and influence in the developments, making sure that final endorsements of deliverables are aiming to represent all stakeholders' interests, not just those of a selected or better-resourced group.

Collaborating successfully can only be accomplished by recognising all stakeholders in the chain of operation, understanding their concerns and reflecting their needs.

3.2 Transparency

Equally fundamental to a more constructive and productive way of working is to create an open and secure method of sharing data between stakeholders, while protecting commercial interests. When

conferencing, stakeholders are often willing to share from own experiences, yet with exchange of data the sharing is less optimal, as fears and need-to-know methods run the daily operations.

Yet working on minimal sharing of information will lead to uninformed decisions locally, nationally, and internationally. Lessons learned and experiences are not applied elsewhere and sub-optimal decision making is ongoing, leading to sub-optimal commercial results for all.

3.2.1 Aviation Reference

Though the Airport CDM implementation manual in an early stage described the needs for performance monitoring, reporting never came to full deployment or sharing on an international scale. Currently, the Network Manager Operations Centre (NMOC) in Eurocontrol receives live data feeds on all departing flights from more than 40 airports, yet no results on departure flight predictions in the monthly reporting is organised.

This is a missed opportunity by the aviation sector to not only speak about results in conferences, yet publish predictability performance indicators in a similar way punctuality and delays are reported for airports and airspace sectors.

3.2.2 Requirement to Rail

Stakeholders should organise sharing of operational data as well as frequent performance reporting, for the purpose of optimal learning curve and decision making. For that, an organised culture of transparency is key to be set from the beginning.

Initiative for cultural aspects could come from international collaboration, which will lead by example and set the culture for transparency and information sharing for rail stakeholders.

3.2.3 Risk

Not sharing information amongst regional, national or international stakeholders will sustain sub-optimal decision making and reduced pace of developments.

3.3 One International Implementation Standard

When an approach needs to be defined and implemented, this needs to occur on a common platform to ensure that the implementation can be standardised on all participating entities.

3.3.1 Aviation Reference

For aviation, the platform was Eurocontrol together with SES (Single European Sky) regulating under European Commission mandate. The format of standardisation was done through an implementation manual defined by the leading stakeholders, driving the concept early and including their local partners. For aviation, these were air traffic control, airlines and airport. Facilitated and supported by Eurocontrol Head Quarters, the leading airports in Europe together developed the first version of the Airport CDM Implementation Manual in 2006 (Reference 4).

EUROCONTROL Airport CDM Implementation Manual

For this implementation manual (first draft 2005), detailed concept elements, functional requirements, operational procedures and automation processes were discussed by operational stakeholders of several airports, including ground handlers, main airlines, air traffic control and airport operator from multiple nations. Eurocontrol provided knowledge and resources from the Network Manager Operations

Centre (NMOC), formerly known as Central Flow Management Unit (CFMU), as stakeholder in need to balance capacity and demand in the airspace of European Civil Aviation Conference (ECAC).

Find more aviation references in Annex A 2 on Airport CDM documentation.

3.3.2 Requirement to Rail

Rail Collaborative Decision Making should be developed by leading and driving stakeholders, representing Terminal Operators, Railway Undertakings, Shunting Operators, Intermodal Operators and Infrastructure Managers under the guidance of an International Coordination Support Function facilitating the equal consideration of all stakeholder needs.

An Implementation Manual shall be developed which contains the concept and implementation steps that the stakeholders can apply in their effort toward a Rail CDM implementation. This includes all involved stakeholders including local terminals or region of terminals.

3.3.3 Risk

Not developing an implementation manual risks appearing deviating approaches and competing definitions of CDM to result in an unclear operational environment, especially for rail undertakings traveling through multiple nations and regions.

3.4 Harmonised Interface for Systems Integration

The risk of having several implementation initiatives is that multiple formats of Rail CDM are being developed and harmonisation is not taken care of.

3.4.1 Aviation Reference

In aviation, the need for harmonisation was identified after multiple initiatives led to local deviations in European nations, despite agreed high-level functional requirements. Flight crews learned that operational procedures deviated from airport to airport, causing confusion with increasing airports each defining their own variant. The room for local deviations was purposely left open, to reflect European differences of national cultures and methods.

The consequence of not mitigating this risk from the start of defining the implementation manual is that national differences are difficult to reverse or harmonise. Though this does not impact safety, local differences may frustrate and lead to confusion for foreign crews, resulting in non-optimised efficiency and punctuality.

Find aviation references in Annex A 2 on Airport CDM interfacing and regulations:

I. **EUROCAE Working Group 69**
   This EUROCAE standard (Reference 5) Airport CDM technical and interface specification in Europe 2008 resulted in three reports based on the EUROCONTROL Airport CDM Implementation Manual version 2005:
   - ED-141: Minimum technical specifications.
   - ED-145: Interface specifications.
   - ED-146: Guidelines for test and validation.

II. **ETSI Community Specification for European Commission 2010**
   This ETSI specification (Reference 6) is based on the EUROCAE WG69 reports and serves as intermediate specification prior to implementation regulation.

III. Commission Implementing Regulation (EU) Regulation

Commission Implementing Regulation (EU) No 716/2014 of 27 June 2014 (Reference 7) on the establishment of the Pilot Common Project supporting the implementation of the European Air Traffic Management Master Plan Text with EEA relevance.

This regulation specifies Single European Sky, Airport CDM and other Air Traffic Management Implementing Regulations.

3.4.2 Requirement to Rail

Harmonisation should be developed and maintained in early stage for stakeholders to acknowledge difficulties for international rail operations, and the need for common procedures and rules for exchange of information or request of clearance.

3.4.3 Risk

The rail sector is still step-by-step solving the interoperability challenges from the past decades. If no international coordinated approach is followed from the beginning, the risk is that lacking harmonisation efforts will impact on benefits and slow down support later.

3.5 Performance Monitoring

Prior to implementation, the potential benefits of Rail CDM need to be understood by the stakeholders. For that purpose, benchmark performance indicators need to be identified, assessed, agreed and reported. This should also apply for national and international corridors, sectors or network, in order to understand the current level of performance and the indicators where improvements are expected.

3.5.1 Aviation Reference

Performance monitoring was recommended through the Implementation Manual but not organised on international level. This resulted in fragmented approach in leading nations, causing different indicators and reporting, with little incentive to share on international platform. Learning from aviation, this negative effect should be avoided in rail.

Airport CDM Impact Assessment

This report (Reference 8) provides and overview on common benefits from 17 large European airports.

3.5.2 Requirement to Rail

European harmonised performance monitoring, reporting, and transparent sharing should be organised early on by international coordination and collaboration. Formatting of reporting and key performance indicator analysis suitable for all stakeholders will demonstrate early benefits and lessons learned from the better and lesser performing.

3.5.3 Risk

Not organising performance reporting on international platform will risk local fragmentations and little effort to share, causing a slowdown of learning lessons and effectiveness.

3.6 Cost Benefit Analysis

Management decision making depends on identifying the incentive to proceed. A positive return on investments or operational benefits such as reduction of workload and needed resources could drive the need for a cost benefit analysis for various use cases on international, local or regional scale.

To reach international solutions is of high importance, since more and more freight traffic crosses borders and is in need of efficiency and punctuality to remain effective.

3.6.1 Aviation Reference

Eurocontrol Head Quarters provided a Cost Benefit Analysis for Airport CDM in 2005 and update it several years later (Reference 9). This CBA remains the most relevant document for stakeholders to enter long implementation programs and convinces stakeholder why the program was created even long after its start.

Airport CDM Cost Benefit Analysis (2008)

This report outlines the methodology and results for Airport CDM Cost Benefit Analysis, including results for multiple airports.

3.6.2 Requirement to Rail

Methodology for internationally harmonised Cost Benefit Analysis should be determined and recommended as guideline for regional or local analysis to be conducted as driver for implementation decision making. In addition to clearly identifiable and monetarised benefits to a dedicated stakeholder, Rail CDM will lead to operational improvements and non-economic benefits. To identify economical as well as non-economic benefits, a methodology has to be defined which takes into account direct and indirect benefits. Acknowledging that there are several stakeholder interactions and dependencies in rail which lead to a very complex situation for taking decisions, clear rules have to be identified and implemented in a neutral methodology and tool(s), to ensure that direct or indirect benefits can be achieved for every involved stakeholder and will be proportionally shared.

3.6.3 Risk

Not developing a commonly agreed methodology risks local initiatives to deviate from international guidelines causing potentially underinformed stakeholder to enter implementation projects without founded answer on the question why to proceed.

3.7 Safety Assessment

Eurocontrol Head Quarters provided together with the European Union an assessment on the safety impact of Airport CDM (Reference 10).

3.7.1 Aviation Reference

Thought aviation has a culture of safety first in the development of new concepts, Airport CDM was conducted much later when the first airports were already implementing Airport CDM. Since more experiences concluded that, perhaps enhanced predictability and efficiency could be beneficial for safety and to complete the requirement from authorities, a safety assessment was repeated in 2016 by Eurocontrol together with the European Union.

Safety Assessment on Airport CDM

The report provides assessment on the concept elements, flight phases and data flows, documenting impacts, hazards and possible mitigations. This generic safety assessment concludes that Airport CDM will lead to no adverse safety impacts with the mitigations identified in this report.

3.7.2 Requirement to Rail

A safety assessment will contribute to the confidence of stakeholders how CDM impacts on safety. It is recommended to conduct an international safety assessment on impact for rail. This assessment should be conducted after at least several regions have successfully and completely implemented CDM, since that provides the experience to learn from.

3.7.3 Risk

Not conducting a safety assessment may result in continuous questions from stakeholders and government authorities whether safety hazards exist. This may delay implementation project starts or continue to cause doubts by decision makers.

4 Roadmap

This chapter lists the most relevant activities to be conducted by international decision makers. RFC RALP along with all other rail freight corridors could strongly support this process.

Two main phases need to be defined:

1. Development Phase – a period where stakeholder try and learn with purpose to develop a mature implementation manual and prepare for international interfacing standards and regulations aimed to maintain harmonised progress. This period typically lasts probably multiple years.
2. Implementation and Operations Phase – a period where the first stakeholders are operating Rail CDM, share data and provide performance reports. Others are preparing for implementation using the latest lessons learned and methods. This period will probably last more than ten years.

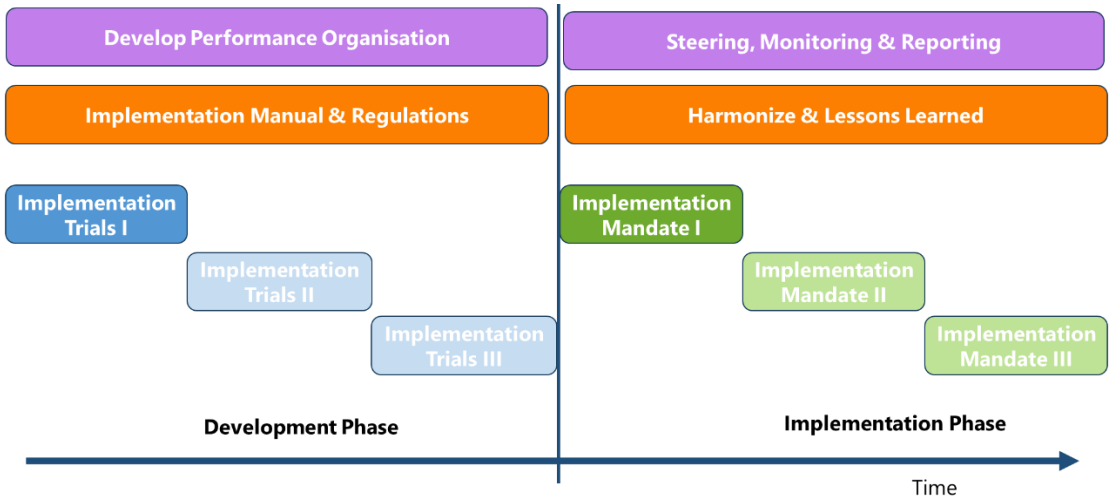

Figure 4 Development and Implementation and operations phases.

Most relevant activities to be set-up on an international level are described in the sections below:

- Develop the Implementation Manual
- Set-up Proof of concept implementation trials by local or regional stakeholders
- Set-up Performance Monitoring Organisation
- Develop Cost Benefit Analysis Methodology
- Set-up Development and harmonisation working Groups
- Steer, Monitor, Report on operational performance

To facilitate and lead international collaboration on a longer term and wider scale, an International Coordination Support Function is needed as described in section 2.5.

4.1 Develop Implementation Manual

The Rail CDM Implementation Manual is the common international standard, which should guide any group of stakeholders in their implementation efforts.

4.1.1 Who

Multiple representative stakeholders should contribute with their knowledge and share their interests and ideas. The regional stakeholders should represent at least one railway undertaking, intermodal operator, shunting operator, terminal operator and infrastructure manager. Ideally, representative stakeholders from multiple regions contribute, however only those who are capable to provide sufficient resources for the development period. Multiple nations and multiple corridors should be represented to enable the implementation manual to be endorsed by a broad range of stakeholders.

The International Coordination Support Function provides chairmanship, lead writing team and enables progress and compromise where stakeholders (groups) may not find consensus themselves.

The process of developing the Implementation Manual is a complex mixture of a high number of plenary working meetings with all stakeholders for the assessment, coordination and negotiation of elements to find consensus, supported by collaborative discussions between the writing team and the stakeholders to resolve issues or objections. It needs full support of all management levels including governmental bodies if necessary and should not be owned by one stakeholder group to ensure equity.

4.1.2 What

The Implementation Manual should describe:

- Why to implement Rail CDM
- How to measure success
- How to set up an implementation project
- Detailed concept elements to implement, based on the initial Rail CDM approach (Feasibility Study 2020-2021, Reference 2).
- A comprehensive set of performance indicators, grouped by business drivers and strategic objectives Predictability, Efficiency, Capacity, Punctuality.
- Project Risks and Mitigation, learning lessons from Aviation
- Transition to post-operation phase
- Organisational steps to consider for stakeholders initiating local implementation
- Relevant platforms for collaboration and high level terms of reference
- Sample documents with lessons learned from aviation and other similar connected improvement projects
- Frequently Asked Questions

4.1.3 When

An initial version of the Implementation Manual should meet the criteria set by the stakeholders, enabling at least a minimal set of benefits to be collected by each stakeholder.

The update of the Implementation Manual should be organised with a new version every 2-3 years. Ownership of the update should be discussed and agreed by leading stakeholders led by the International Coordination Support Function who is responsible for the writing and progress.

4.2 Set-up Performance Monitoring Organisation

A performance monitoring organisation needs to be set up in order to monitor operations, set performance targets, and facilitate frequent reporting based on agreed performance indicators. With more stakeholders over time providing more data, regions and reported performance indicators can be expanded.

4.2.1 Who

Multiple representative stakeholders together with local, regional, national and international platforms should organise performance monitoring and report frequently on commonly agreed performance indicators. The International Coordination Support Function should facilitate efforts and international reporting. Determine a team of analysts supported by stakeholder senior representatives who prepare reporting for stakeholders' management and analysis support to implementation teams.

4.2.2 What

The terms of reference for the organization, the governance of steering by international indicators should reflect the interests of all stakeholders and be structured in accordance with the methodology documented in the performance indicators (Reference 3).

4.2.3 When

While the concept elements are being discussed and agreed upon, the interests of stakeholders and the need for predictability to enhance efficiency become better understood by all. This is also the phase when performance indicators can be evaluated, discussed, documented, and the methodology for monitoring can be adopted.

4.3 Initiate Proof-of-Concept Trials

To gain experience with implementations and benefits, trials enable collection of valuable lessons learned and inputs for the implementation manual.

4.3.1 Who

Regional stakeholders with a drive to implement Rail CDM should be enabled to organise initial trials, obtain lessons learned and monitor collection of benefits as soon as possible. International Coordination Support Function should facilitate with funding and collection of reports to include into the development of new documentation.

4.3.2 What

Using the approach provided by this project in reference 2), as well as references in aviation in reference 4) or early agreed outline drafts of the Rail CDM Implementation Manual, an initial gap analysis may be created by interviewing all stakeholders and determining what data exchange is needed, what

systems and interfaces would be required, and what processes to exchange need to be agreed. With a clear and agreed overview of needs, stakeholder can move to a local cost benefit analysis and agreement to commit effort, funds and organise implementation.

Operational concept and scenarios can be determined by a set of participating and pioneering stakeholders who want to demonstrate that enhanced predictions for last mile and/or terminal operations show benefits. Trials can be done on partial concepts yet in line with the common international needs.

International requirements enable financial support and consistency on lessons learnt from the trials, enabling further development of the implementation manual.

Based on the results after live operations commenced, improvements could be recommended and implemented in sequence of an agreed prioritisation. This phase is a transition to mature operations where benefits are secured.

Sustainment of the operations needs to be monitored through collaborative management where steering on performance is established, and the required collaborate platforms managed.

4.3.3 When

Using initial versions of the Rail CDM Implementation Manual a first trial may be set-up.

4.4 Develop Cost Benefit Analysis

“A methodology has to be developed for the international assessment of cost and benefits needed for the justification of international and local implementations.

4.4.1 Who

Multiple representative stakeholders together with local stakeholders together with economic advisors or business experts determine what defines success of implementation. Together they then determine what is needed.

4.4.2 What

Success can be defined by more than economical or monetary benefits. Operational benefits, workload reduction or enhanced safety levels are all factors that could be determined by a methodology set-up by the leading implementation stakeholders. Such methodology should be facilitating future implementation projects and international stakeholders aiming at or considering for implementation.

4.4.3 When

As soon as trial reports or experiences from aviation are valued, the development of a CBA method for Rail CDM can be started.

4.5 Set-up Development and harmonisation Groups

Setting up infrastructure for coordination and harmonisation is essential to maintain and sustain one definition of Rail CDM in the development and operation phases.

4.5.1 Who

An International Coordination Support Function, representing all stakeholders, reporting to the European Commission can lead writing development documentation, award and fund projects to stakeholders’ trials and efforts. Stakeholders from all nations should join and support the efforts.

4.5.2 What

This International Coordination Support Function should develop the organisation to determine and adopt formal documentation and take actions for future deliverables or initiatives. It will determine terms of reference for various working groups that develop and adopt procedures, documents, programs, regulations, and where needed recommends to the highest decision making platform.

4.5.3 When

As soon as decisions are made to continue with development of Rail CDM in Europe.

4.6 Steering, Monitoring, Reporting

Over the longer term, with more and more regions applying Rail CDM, more data is collected and operational performance can be monitored, analysed, reported and steered.

4.6.1 Who

The International Coordination Support Function develops the performance-monitoring organisation responsible for post-operation analysis reporting of performance. For this reason, data needs to be collected from operations, on which also live monitoring and coordination can be applied.

4.6.2 What

Collecting and monitoring of operational data, coordination where needed, and post operations analysis and international reporting. A performance management board on international level shall steer target values for international operations, such as setting predictability targets in accordance with strategic objectives as documented in 3).

4.6.3 When

After live operations are taking place in Europe, more and more data becomes available to report. At least several regional or local stakeholder groups should share.

4.7 Relationship between Activities

The International Coordination Support Function leads developing, monitoring and harmonization efforts, supported by local stakeholders and national authorities. All the activities described in this section need to feed each other with input and need iteration to reflect experience in new versions and new trials. By definition, the early trials pioneer on experience and require support and incentive to do so.

There are dependencies, which should be considered. Figure 5 shows these dependencies and provides a sequence of events feeding one-other.

Most relevant are the parallel initiatives of developing an internationally adopted Implementation Manual and starting local stakeholder trials to prove segmented concepts. These activities interact and trialling stakeholders should be directly involved in development of the manual.

Setting up an international Performance Monitoring Organisation with Reporting function enables the setting up of Cost Benefit Analysis methodology to be applied to local implementations. These activities should follow each other and be repeated after trials provided new insights and performance indicators or lessons learned.

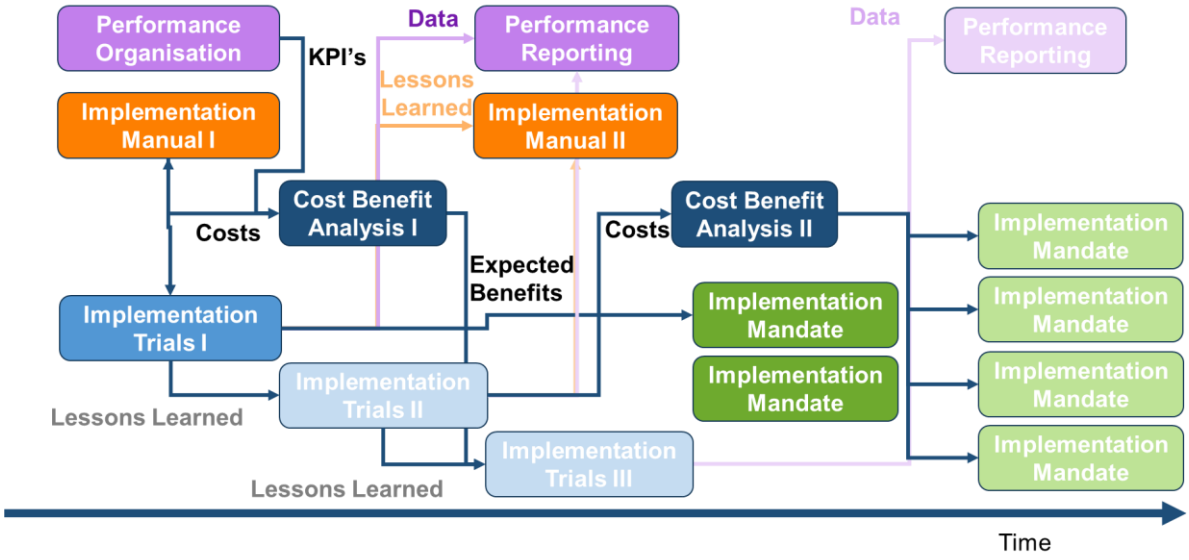

Figure 5 Sequence of activities that feed follow up activities. After a development phase follows an implementation mandate phase.

5 Conclusions and Recommendations

This chapter describes the conclusions of the feasibility study, as well as recommendations for the path forward.

5.1 Conclusions

Based on the findings and reports in this feasibility study, the following conclusions are achieved:

- Airport CDM is transferrable to the rail freight sector to a significant extend due to the similarity of transport characteristics including the stakeholder landscape, scarcity of resources and infrastructure capacity, and consequential need for punctuality to be competitive by operators.
- Performance Monitoring can apply similar performance indicators as in aviation, since the need for optimal use of resources and capacity requires the same need for efficiency and predictability indicators.
- Stakeholders, in their understanding of the Rail CDM approach as documented in this project have in broad range taken notice on the content and impact and agreed that such program may contribute to resolve of multiple challenges existing in rail sector today.
- International Stakeholders recognise that important challenges today could be resolved with more efficiency, exchange of information between stakeholders, predictions, pro-active detection of potential conflicts and integration of systems. Hence, they see the potential for a positive cost benefit analysis.
- Rail CDM enables efficient national and international rail freight operations and can be further defined, developed and implemented throughout rail freight handling and operating stakeholders.
- Rail Collaborative Decision Making for international freight operations requires detailed predictions and conflict detection, as well as real-time conflict solving based on live management systems with decision support functions, and for sure international coordination, exchange of operation planning and prediction information.

5.2 Recommendations

The following recommendations are made to the audience, especially European Commission decision makers, as funders for this project:

- Organise the development of Rail CDM with a coalition of the willing stakeholders who wish to drive this concept forward and implement at their local stakeholder terminals, in cooperation with railway undertakings, intermodal operators, shunting operators and infrastructure manager. Rail Freight Corridors could support this process as facilitators and by providing test environments.
- Define an International Coordination Support Function responsible for preparing harmonised rules, procedures and IT-systems and support national traffic management decision makers in operations.
- The coordination of the trials and the joint development steps should be jointly financed by all involved stakeholders or by a neutral governmental body to ensure the equity between the stakeholder group’s needs.

- Set-up a project for development of the Rail CDM Implementation Manual. This project shall be based on the initial findings of this feasibility study in coordination with ongoing initiatives.
- Set-up various projects for trials. Further work is needed to analyse and assess the last miles processes, which similar to aviation where taxi and runway congestions are often a bottleneck, can lead to currently unpredictable delays for outbound trains entering the main line. In addition, the influence of main line conflicts and delays on the performance of local operation needs to be further elaborated.
- Set-up a project for development of a generic Cost Benefit Analysis that applies to multiple stakeholders, indicating a generic return of investment period and benefits to cost ratio.
- Set-up a project for implementation trials at one or multiple terminals, including all stakeholders: Railway undertakings, shunting operators, terminal operators, infrastructure manager, intermodal operators.
- Set-up a project for the organisation of performance monitoring harmonisation and reporting group, which facilitates performance reporting harmonisation through the locations implementing Rail CDM. A working group can present annual reporting in meetings and monthly performance reporting in combined punctuality and delay reporting, using the new predictability performance indicators.
- All of these projects which in any case need to be properly coordinated and integrated with sector ongoing initiatives of the same nature should be partly locally financed and governed to ensure the equity between the stakeholder group's needs. Subsidies from international and national organisations or government could contribute as well to facilitate and demand harmonisation and preparing for future mandates.

A References

This list of reference documents is used to develop this report.

A 1 Project References

1) RFC Rhine Alpine EEIG Contract HACON-To70, Frankfurt, September 2020.
2) Feasibility Study WP1, Rail CDM Approach, HACON-To70, Hanover, January 2021
3) Feasibility Study WP2, Rail CDM Performance Organisation & Expected Benefits, HACON-To70, Hanover, June 2021

A 2 Aviation References

4) EUROCONTROL Airport CDM Implementation Manual 2017
5) Airport CDM EUROCAE Working Group 69 Airport CDM Standard to Guide Implementation in Europe 2008
6) ETSI Community Specification for European Commission 2010
7) Commission Implementing Regulation (EU) Regulation No 716/2014 of 27 June 2014
8) Airport CDM Impact Assessment, Eurocontrol 2016
9) Airport CDM Cost Benefit Analysis, version 1.4, Eurocontrol 2008
10) Safety Assessment on Airport CDM, version 2.0, EU/Eurocontrol 2016

B RCDM Data Element Acronyms

This annex provides a list of acronyms relevant to understand detailed metrics and abbreviations in the document.

Acronym	Meaning	Ownership & Source
AEMT	Actual Enter Mainline Time	IM
AEFT	Actual Enter Final IM Time	IM
ALMT	Actual Leave Mainline Time	IM
ALHT	Actual Leave Handoverstation Time	RU/SO
ALCT	Actual Leave Connection line Time	To
ASUT	Actual Start Unloading Time	TO
AEUT	Actual End Unloading Time	TO
ASDT	Actual Start Decomposition Time	TO
AEDT	Actual End Decomposition Time	TO
ASCT	Actual Start Composition Time	TO
AECT	Actual End Composition Time	TO
AEIT	Actual Empty Inspection Time	TO
ASLT	Actual Start Loading Time	TO
AELT	Actual End Loading Time	TO
ASBT	Actual Start Braketest Time	TO
AEBT	Actual End Braketest Time	TO
ARST	Actual Ready for Shunting Time	TO/SO
ASST	Actual Start Shunting Time	TO/SO
AEHT	Actual Enter Handover station Time	SO
ARMT	Actual Ready for Mainline Time	RU

AMAT	Actual Mainline Approval Time	IM
AEMT	Actual Enter Mainline Time	IM
TRST	Target Ready for Shunting Time	RU
TRMT	Target Ready for Mainline Time	RU
TMAT	Target Mainline Approval Time	IM

C Other Abbreviations

Acronym	Description
Airport CDM	Airport Collaborative Decision Making
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
B2B	Business-to-Business
BLU (= product name)	(Betriebsleitsystem für Umschlagebahnhöfe) Operating management system for transfer stations and terminals
C#1 – C#5	Transferability Criteria
CE#1 – CE#6	Concept Elements
DAC	Digital Automatic Coupling
ELETA	Electronic Exchange of ETA information
ETA	Estimated time of arrival
KPI	Key Performance Indicator
LeiDis (= product name)	(Leitsystem zur Netzdisposition) Network scheduling control system
LU	Loading Unit
NMOC	Network Manager Operations Centre
OCR	Optical Character Recognition
OTP	On-Time Performance
P#1 – P#14	(Railway) Processes
PROMI	Process Optimisation through ETA-Management in Inter-modal Transport
RAG	Railway Undertaking Advisory Group
Rail CDM	Rail Collaborative Decision Making
RFC RALP	Rail Freight Corridor Rhine-Alpine

RNE	Rail Net Europe
TAF/TAP TSI	Technical Specification for Interoperability relating to Telematics Applications for Freight/Passenger Services
(RNE) TIS	(RNE) Train Information System
TSI OPE	Technical Specification for Interoperability relating to Operations