Performance Measurement in the Intermodal Transport Chain

RFC Rhine-Alpine study

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1. Introduction

The intermodal transport sector is divided into a range of stakeholders with different business models contributing to the transport chain. Punctuality is a shared objective, but the way how punctuality is measured and managed differs between those firms and there is hardly any knowledge about each other's approaches. As these stakeholders together build a logistical chain, it is important to have an overview of the different perspectives and approaches in order to achieve an effective performance management system (measuring and managing the performance of the entire transport chain).

The purpose of this paper is to create more transparency on the performance measurement systems of different stakeholders. This paper is based on a bachelor thesis by Christoph Geiss, a former student intern of RFC Rhine-Alpine, regarding the comparison of performance measurement and management systems related to rail freight punctuality. Thanks to Christoph for carrying out this important work!

RFC Rhine-Alpine is initiator and stakeholder at the same time. The idea of the bachelor thesis originated in the context of performance discussions with the end customer Covestro and was developed thematically in cooperation between RFC Rhine-Alpine and Covestro.

Research for the bachelor thesis was done between August and November 2018. It was based on a questionnaire, which was sent via e-mail to all parties involved. Subsequently, at least one visit to the various companies followed, during which the results of the questionnaire could be discussed in detail with company representatives involved in the measurement and management of performance.

It was agreed that the thesis itself will not be published due to the fact that in some parts it contains commercially sensitive information. This paper is to share the essence of the thesis and is published after the approval of all stakeholders. In its comparison of the different performance measurement systems it focuses on the following topics:

- Performance definitions
- Performance thresholds
- KPIs
- Delay reasons
- Incentive systems
- IT tools and communication
- Data quality

2. Involved companies

The companies which are listed below participated in the bachelor thesis. Collectively, they represent the typical set up of an intermodal transport chain. However, it has to be noted that other organisations and contractual relationships in the intermodal transport chain are possible.

Name	Role
Covestro	Shipper
Bertschi	Logistics service provider
Hupac	Intermodal operator and terminal operator
Kombi-Terminal Ludwigshafen (KTL)	Terminal operator
SBB Cargo International (SBBCint)	Railway undertaking (RU)
RFC Rhine-Alpine	Association of infrastructure managers (IMs)

With the exception of the shipper (in this case Covestro), the above companies cover a different part of the intermodal transport chain, being connected by a series of bilateral contractual relationships.

Figure 1 below shows these relationships.

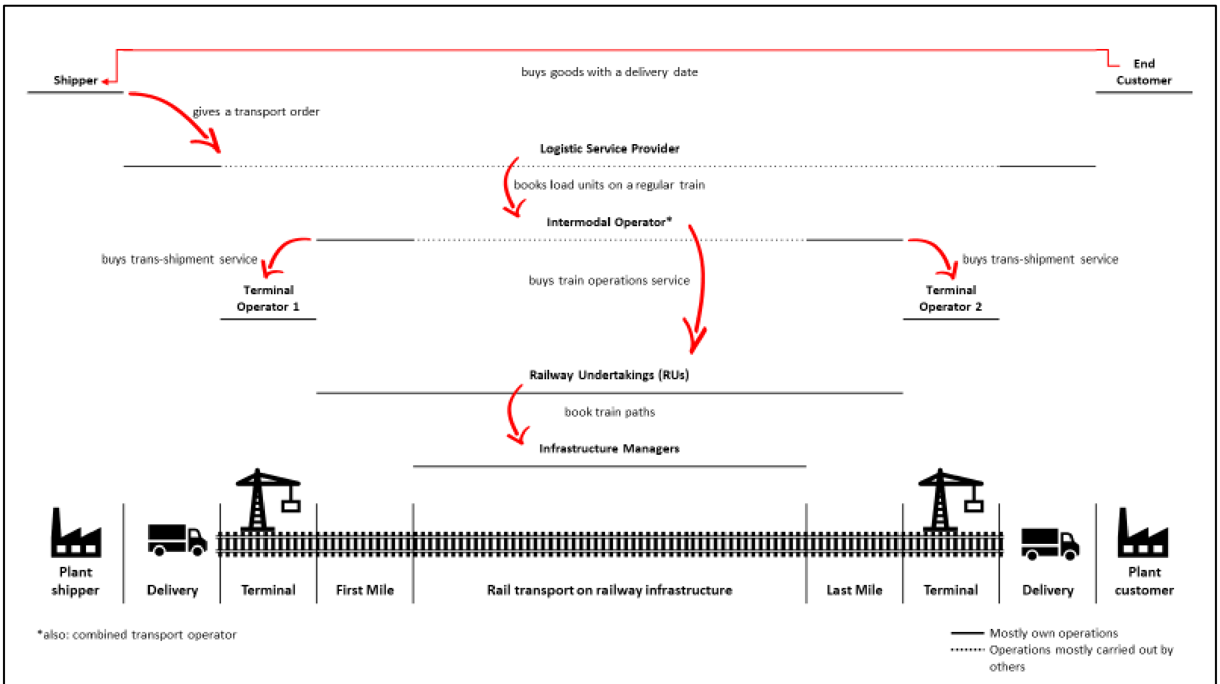

Figure 1: Relationships between stakeholders in a typical intermodal transport chain

Covestro, as producer and shipper of goods, is the party that is placing the transport order with a Logistics Service Providers, such as Bertschi, to pick up the goods at its production plant and deliver them, typically in a 20’ tank container, to its customer. The Logistics Service Provider books the loading unit with the goods (e.g. a tank container) on a regular train of an Intermodal Operator, including transshipment in Terminals. The Logistics Service Provider organises the pre- and end-carriage by road transport at the beginning and the end of the intermodal transport chain, using either with own trucking resources or via sub-contractors (the latter did not participate in this study). The Intermodal Operator typically owns the rail wagons for the regular train service and engages Railway Undertakings to perform the train run with their locomotives and train drivers. The Intermodal Operator also requests the train loading and unloading slots for its regular train services with the Terminal Operator. The Intermodal Operator which participated in the thesis has ownership over its strategically most important terminals. Railway Undertakings book train paths from the Railway Infrastructure Managers and manage the interface to Infrastructure Managers for train operations.

3. Comparison of performance measurement

3.1. Performance definitions

Figure 2 shows that each company defines punctuality with a different focus. Covestro and Bertschi view performance from an end customer perspective. Punctuality is defined as a match with end customers' requirements for the timely delivery of the goods. Hupac and KTL define punctuality based on loading units. SBB Cargo International measures the punctuality of the train with the transported loading units. Performance measurement of Infrastructure Managers in RFC Rhine-Alpine is focusing on timetable/train paths – information on loading units is not available. The differences reflect the stakeholders' services in the intermodal transport chain and their contractual relationships.

Company	Definition
Covestro	Punctual = delivery on the calendar date agreed as delivery date with the customers (planned delivery date), whereby delivery has to take place within the opening times of the customer (e.g. "delivery on dd.mm.yyyy by 15.00 hrs"). A delivery is completed on time (= punctual), if the delivery date and time match with delivery time window agreed with the end customer
Bertschi	Punctuality means fulfilment of the delivery time window agreed with the shipper of goods (see above), typically the delivery time and date agreed between the shipper and its customer, the receiver of goods.
Hupac	Loading units with less than 60 minutes delay under the crane are considered punctual.
KTL	Punctuality is the punctual supply of a loading unit, a train or a truck within the logistics chain.
SBBCint	Punctuality is defined in the delay of load units. Here SBBCint shows what was agreed according to the agreement with the customers.
RFC Rhine-Alpine	Strict adherence of the actual time in the timetable (train path).

Figure 2: Punctuality definitions

3.2. Punctuality threshold

Only Bertschi and Covestro do not have fixed thresholds due to their way of delivery to customers within defined timeframes. Bertschi and Covestro handle this topic in a similar way because they are direct partners in the transport chain (Bertschi organises the transport for Covestro). The four other stakeholders use thresholds between one and 120 minutes.

Company	Threshold	Comment
Covestro	No	Calendar date; any shipment not delivered on the agreed calendar date within the agreed timeframe is counted as late.
Bertschi	No	No fixed threshold. See punctuality definition above. If delivery is on-schedule and matches customer's needs it is punctual. If not, it is a delay.
Hupac	60' (under the crane)	Under the crane = MAD (Mise à disposition)
KTL	1' (timetable)	
SBBCint	60' or 120' (under the crane)	Under the crane = MAD; threshold time varies on contract
RFC Rhine-Alpine	30' (timetable)	General agreement among RFCs to measure RFC punctuality within 30 min. Internally, IM apply other thresholds.

Figure 3: Punctuality thresholds

3.3. Focus of performance measurement and KPIs

Each company measures performance in different parts of the logistics chain – thus reflecting its scope and tasks. This includes the scope of KPIs. The crucial overriding supply chain KPIs for Covestro is OTIF (on-time in-full) and OTDC (on-time delivery reliability carrier). These KPIs focus on arrival at the end customer. Bertschi as logistics service provider for Covestro is bound to the same KPIs and covers the road pick-up/delivery part with its own resources or with subcontractors – and further stakeholders in the logistics chain (not included in this analysis). Hupac as an intermodal operator focuses with its performance management on arrival/departure of loading units at terminals ("ready for pick-up under the crane"). The terminals are partly owned by Hupac, partly by other terminal operators. KTL's performance management focuses on the punctuality in the terminal. SBBCint, as an RU, only measures performance on the railway infrastructure which, depending on the specific transport order, can include first and last mile to reach terminals. The Infrastructure Managers in RFC Rhine-Alpine can only address a part of the railway network in their performance management: the networks of the national infrastructure managers which is mostly excluding first and last mile to terminals. All KPIs in the RFC performance reports cover the own IM/RFC network. Figure 4 compares the participating companies, mirroring the contractual relationships shown in figure 1.

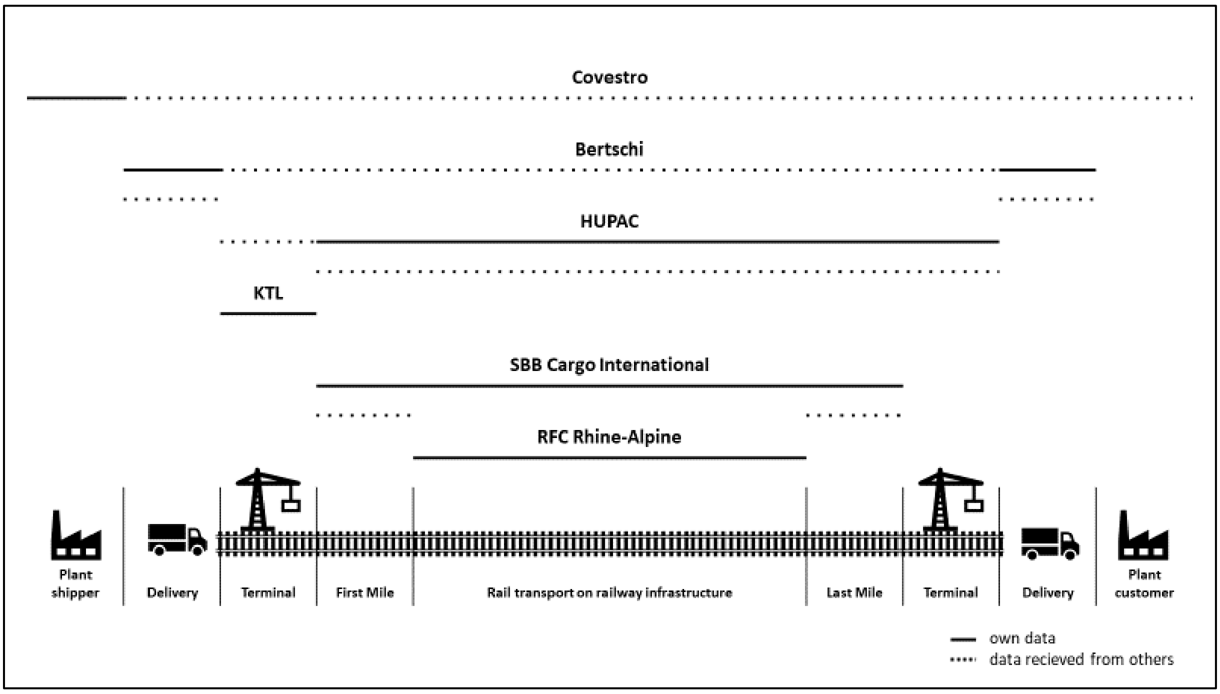

Figure 4: Focus of performance measurement

3.4. Delay reasons

Delay reasons vary significantly between stakeholders. Each stakeholder has a detailed record of delay reasons in his own area of responsibility, but usually has little knowledge about delay reasons and statistics on delay reasons of the other stakeholders in the intermodal transport chain.

The comparison between delay reasons recorded at Covestro as shipper and at RFC Rhine-Alpine partners as IMs illustrates this perfectly. Covestro only has one category for "rail delay" (see figures 6 and 7). There is no further differentiation, e.g. whether the delay is related to a RU or an IM, or whether it is for example malfunction of signaling or switch. So far Covestro has not planned to obtain more detailed information on rail delays, because the is a limit to the number of of reason codes that can be maintained and expected to be used by the logistics service providers. As such one could say that rail is viewed as a "black box".

In contrast to that, all reasons of RFC Rhine-Alpine are very detailed for rail delay caused by IMs and RUs. The IMs of RFC Rhine-Alpine (and all IMs in Europe) use detailed delay codes which have been agreed via the international railway organisation UIC. A drawback in this delay coding is that the delay reasons on last mile infrastructure, in terminals, in the road delivery or at the shipper are not known at all to the IMs. The dispatchers at the IMs can only identify the late departure of an RU, not knowing if this was maybe caused by any other stakeholder in the transport chain. Thus, all delays stemming from other stakeholders in the transport chain which lead to the late departure of a train are attributed to RUs in the performance statistics of the IMs.

This shows how complicated it is to find a single uniform system for delay reasons that enables good performance management in the intermodal transport chain.

Figure 5 below illustrates the reason code framework of Covestro and shows how this extends beyond transport to other stakeholders (such as production or reasons within the spheres of the customer, the receiver of goods).

Covestro delay reason code desriptions			
Carrier	**Customer**	**Production**	**Force Majeure**
Carrier rejects transport order / no capacity	Change of delivery date on customer request	Product not ready / not available	Traffic disruption due to strike action
Delay at prior (un)loading point	Insufficient storage capacity / customer unable to accept delivery	Congested loading point / excessive waiting time	Act of nature (e.g. traffic disturbance due to unpredicable weather condition, rock fall, avalange, etc.)
Delay at transshipment hub	Delay during customs clearance (customer responsibilty)	Excessive loading time	
Delay in pre-carriage / traffic	Refusal to take delivery	Problems with load securing material	
Equipment damage / malfunction		Missing documentation	Disruption caused by unexpected delays or conduct of public authorities (customs, traffic police, etc)
Late handover to forwarding carrier			
Late pick up by carrier			
Missing documentation			
Packaging damaged / product off-spec			
Predictable weather condition			
Problems at cleaning station			
Product temperature deviation			
Rail delay			
Road traffic congestion			

Figure 5: Delay reasons of Covestro

In comparison, Figure 6 shows the rail operations centered delay codes as defined by UIC and used for the punctuality statistics on RFC Rhine-Alpine. Further UIC delay codes are for example related to external reasons (weather etc.) and to delays building up from other delayed trains.

Examples for delay reasons registered by IMs/RFC Rhine-Alpine

10 to 19 - Operational planning,Management	
10	Timetable compilation
11	Formation of train if managed by Infrastructure Manager
12	Mistakes in Operational procedures
13	Wrong application of Priority rules
18	Staff
19	Other causes
20 to 29 - Infrastructure installations	
20	Signalling installations
21	Signalling installations at level crossings
22	Telecommunication installations
23	Power supply equipment
24	Track
25	Structures
28	Staff
29	Other causes
30 to 39 - Civil engineering causes	
30	Planned construction work
31	Irregularities in execution of construction work
32	Speed restriction due to defective track
39	Other causes

40 to 49 - Causes of other IM	
40	Delay caused by next IM
41	Delay caused by previous IM
50 to 59 - Commercial causes	
50	Exceeding the stop time
51	Request of the RU
52	Loading operations
53	Loading irregularities
54	Commercial preparation of train
58	Staff
59	Other causes
60 to 69 - Rolling stock	
60	Roster planning / re-rostering
61	Formation of trains by Railway undertaking
62	Problems affecting coaches (Passenger transport)
63	Problems affecting wagons (Freight transport)
64	Problems affecting power cars, locomotives and railcars
68	Staff
69	Other causes
70 to 79 - Causes of other RU	
70	Delay caused by next RU
71	Delay caused by previous RU

Figure 6: UIC delay codes related to IMs and RUs

3.5. Incentive systems

Only two of the interviewed stakeholders are using a financial incentive system. It is included in the contract between the Intermodal Operator Hupac and the Railway Undertaking SBB Cargo International. The contract also defines punctuality targets.

The other four stakeholders do not use financial incentive systems but almost all stakeholders underline that there are indirect incentives because punctuality is probably the most important quality criteria in rail business. For instance, Bertschi argues that the number of new transport contracts with shippers is depending on quality criteria like punctuality. KTL argues in the same way. Covestro does not have an incentive system, but awards transport contracts on the basis of safety, reliability and competitiveness. At RFC Rhine-Alpine some IMs are using incentive systems in their service contracts with RUs but there is no overall incentive system for the whole corridor.

The aim of incentive systems in this area is to foster punctuality. Financial penalties or bonuses shall motivate stakeholders to punctuality-oriented railway operations. The disadvantage of incentive systems is the administrational effort to agree on delay causes and a possible lack of transparency to avoid penalty payments. A good incentive system needs to find a balance between these negative impacts and actual quality improvement. Due to the high complexity of the intermodal transport chain and generally low degree of transparency on delay causes of all stakeholders, the usefulness of incentive systems in the intermodal transport sector is unclear to the authors.

Figure 7 gives an overview about the different approaches.

Company	Financial incentive system implemented?	Comments
Covestro	No	Only in an exceptional limited number of cases, involving dedicated block train operations, linking Covestro production plants.
Bertschi	No	Indirect incentive because allocation of new transport contracts by shippers depends on punctuality figures
Hupac	Yes	Included in contracts with RUs and depending on the agreed quality level in the contracts with customers (shippers/logistics service providers)
KTL	No	Indirect incentive because punctuality is the essential quality criteria
SBBCint	Yes	Depending on the agreed quality level in the contracts with customers (intermodal operators)
RFC Rhine-Alpine	In responsibility of partner IMs	ProRail and RFI are using incentive systems for rail freight

Figure 7: Incentive systems

3.6. IT-systems and communication

All stakeholders are using IT-systems to support performance management. These systems have different functions, data sources and interfaces. Figure 8 compares these IT-systems.

The systems of Covestro and Bertschi cover a broad range of functions and are fully integrated into all company divisions. These systems are so called Enterprise Resource Planning (ERP) systems. Covestro currently uses TM3 as add-on to SAP as a transport management system. And is planning to with to SAP-TM, the transport management solution of SAP. Logistics service providers are linked via EDI and report delivery dates and reason codes, in case of delays, electronically back to Covestro. Systems of the other stakeholders are more related to the rail freight sector. For these systems the most important data is timetable and real-time information. Data is often obtained from external partners. Hupac gets data from systems of different RUs and Bertschi from several different partners. As a result, they only have an indirect influence regarding e.g. improvement in the field of data quality (see chapter data quality). Therefore, Bertschi and Hupac are trying to generate their own data by using GPS transmitters on wagons and containers. This helps to gain more independence from external data sources. KTL generates own data on movements in the terminal and uses the train information system LeiDis of DB Netz for consultation (no direct interface).

Company	**Name of IT system**	**Functions**	**Data sources**	**Interfaces**
Covestro	TM3 (Add-on on SAP)	Comprehensive ERP-based transport management system	Electronic feedback of forwarder (reason codes), e-mail, SAP Business Warehouse	EDI via Elemica
Bertschi	Galaxy 11	Comprehensive ERP-system for all company divisions	TruckTracer application, GPS transmitter of containers, e-mail	Booking platforms
Hupac	Goal (will be substituted by *Wolf*)	Scheduling system	GPS transmitter of wagons (partly), Automatic and manual data transmission from systems of RUs and terminals	Ediges (XML)
KTL	Terminal Operating System	Integrated terminal management	Focus on information generated in the terminal; LeiDis of DB Netz for consultation (no direct interface), telephone contact if data in LeiDis missing	Ediges
SBBCint	Zedas	Scheduling system integrated into all company divisions	TIS	UIC 407-1/TAF-TSI
RFC Rhine-Alpine	TIS (RNE system)	International train management	National train information systems of IMs	UIC 407-1/TAF-TSI

Figure 8: IT-systems used in performance management

The fundamental idea of Supply Chain Management (SCM) is to optimize the whole supply chain. This includes company-wide data flows or, as in this study, data flows with all stakeholders within the intermodal transport chain. Interfaces play an important role for data exchange. Hupac and KTL use Ediges as their defined data exchange format related to load units. The IMs of RFC Rhine-Alpine and SBB Cargo International use a standardized interface related to train run information (TAF-TSI) for data exchange. The train run information recorded by the IMs is consolidated by RNE in the TIS system, a European-wide system. As of today, TIS is used by IMs, RUs and few terminals. Only in very few European countries the national train run information is completely public – not on RFC Rhine-Alpine.

An automatic exchange of data between the stakeholders and connection of IT systems is usually only established between organisations with direct contractual relationships SBB Cargo International and Hupac for example have established an automatic data exchange - the RU is providing all train/load unit information including delay reasons and ETA via an interface into the Hupac system. In the Hupac system this information is combined with the own GPS-generated data which is available for a large part of the wagons. SBB Cargo International also offers a direct access to this information via a web-based tool and is enabling the access via a smartphone application in 2019.

Hupac is strongly developing and improving the information exchange for its intermodal train services with all RUs. However, a direct access to the TIS system or to national train information systems of the IMs does hardly exist.

In general Stakeholders in the intermodal transport chain still often use e-mail and telephone for communication processes. This is generally not negative but manual communication can cause information delays. An example for Covestro shows the impact of the manual communication chain. Specific information about rail delays is only shared via e-mail. This communication is illustrated in Figure 9 which also shows the number of involved parties. It can take a long time until the information in the e-mail chain reaches the right person with Covestro customer service, which is responsible for informing the customer. Due to the fact that logistics service providers are either not sufficiently early informed about rail delays, or do not pass this information on in sufficient time, Covestro is currently often not in a position to proactively inform its customers about a rail delay and thus later arrival of goods than agreed with its customers. Hence this is preventing customers from being able to make timely contingency plans in their production processes (slowing down or changing production schedules or replenishing inventories with a last-minute rush order, frequently performed by road).

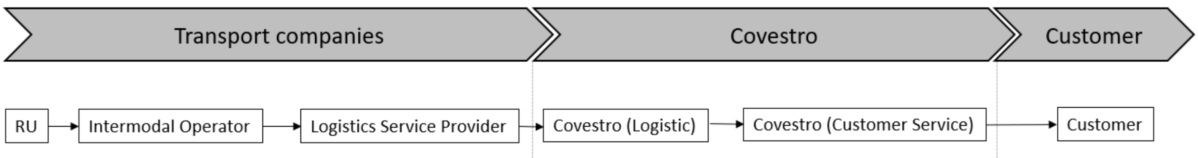

Figure 9: Typical e-mail communication process for information on rail delays at Covestro

3.7. Data quality

All stakeholders are somehow affected by data quality issues in their performance measurement and management. Tracking & tracing information is sometimes not recorded in a fully automated way at the individual stakeholders. Also, automatic real time exchange of information with other stakeholders inside the intermodal transport chain usually does not exist. Manual input e.g. on delay causes might not always be correct. This leads to incomplete or even wrong performance measurement information which complicates performance management/improvements. The effort to achieve missing information and to agree on delay causes can be high.

Performance information for RFC Rhine-Alpine which is based on train run information in the TIS system might miss on international trains. They can only be identified by the system if they have an international train number. But international trains also sometimes run with national train numbers which are changing at the border. The “link-up-trains” function in TIS which was created by RNE upon request from the RUs to be able to identify those trains in the system is still not used often enough.

Another framework condition on RFC Rhine-Alpine which makes performance measurement and comparison between stakeholders difficult is the so called “load shift”. If a train running from Germany to Switzerland is delayed, its train path and train number may be used in Switzerland for another train. By doing that, train path and train number run punctual, whereas the load is shifted to a later path. The system of the IMs/RFC Rhine-Alpine cannot identify this, but still analyses the punctuality for the planned train number. Also, a direct comparison between information on loading unit punctuality of the RUs and train path punctuality measured by IMs can therefore be difficult.

4. Conclusion

The main purpose of this paper is to shed light on the different punctuality measurement approaches which are the basis for performance management/improvements at the different stakeholders in the intermodal transport chain. The initiators of the bachelor thesis, RFC Rhine-Alpine and Covestro, had no detailed understanding about these approaches, but the general understanding that performance can only be improved in a joint effort by all stakeholders of the intermodal transport chain.

Multiple delays occur along the entire intermodal transport chain. They are not limited to individual stakeholders and do not stop at system borders. Performance is therefore strongly interconnected and improvement of the punctuality of intermodal transport chains is highly dependent on the collective effectiveness of currently stand-alone quality management systems of the multiple stakeholders. Therefore, even though every company is only responsible for a part of the logistics chain, in an ideal world, the information available to individual stakeholders would be visible throughout the entire intermodal transport chain, ideally managed by one party. However, this is not the case today. Information is usually only shared between stakeholders that have a direct contractual relationship. Because of this division of labor and fragmentation of responsibilities it can take a long time until information about train delays, or delays in terminals, is reaching shippers and ultimately the end customer and receiver of goods. Currently, no single stakeholder has a complete overview of the intermodal transport chain and its performance. And it is therefore currently impossible to manage the overall performance holistically.

Each stakeholder is currently maintaining its own system within legal, commercial and operational boundaries. However, to improve individual performance measurement and management systems and provide vital information to the end-customers of intermodal transport, it is crucial to establish an overarching link to these individual and only partially connected systems, for the benefit of all. This analysis aims to serve as an impulse for further development of both individual and overarching punctuality measurement and management frameworks in the intermodal transport sector.

Main challenges for an overarching link and connections of the individual performance measurement systems are:

- Only bilateral contractual relationships in the intermodal transport chain – no organization with an overall responsibility and contractual relationships with all stakeholders.
- Different focus of performance measurement on goods, load units or train paths.
- No comprehensive approach to delay causes for the overall intermodal transport chain, but different approaches at the stakeholders.
- Individual IT systems for performance measurement with a low degree of automatic interfaces, thus reflecting the above points.

The intermodal transport community should think about a future concept for a holistic quality management. Perhaps a place to start this debate is the network that has been established through the ELETA-Project, one of the eleven Sector Priorities. Quality Circles involving all relevant stakeholders for specific traffic could also be a good step towards holistic performance management. Quality Circles could serve as a platform to share insights into the causes of delays encountered in intermodal transport chains and allow the community of stakeholders to define preventive measures based on end-to-end transparency on delay reasons.