Evaluation report on cutting-edge SWL solutions

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BE	Bentheimer Eisenbahn
CAPEX	Capital expense
CH	Switzerland
CT	Combined transport
DE	Germany
ft	feet
GLZ	Grafschafter Logistik Zentrum
ITSS	Industrieplattform Telematik und Sensorik im Schienengüterverkehr
KPI	Key Performance Indicator
m	metre
NL	Netherlands
OPEX	Operations expense
ROI	Return on investment
STVZO	Straßen-Verkehrs-Zulassungs-Ordnung
SWL	Single wagonload
TCCU	Telematics Communication Control Unit
tkm	tonne-kilometre

1 Introduction

The ViWaS project

Single wagonload (SWL) transport is still a major component in numerous European states transport systems and in the logistics of different economic sectors such as steel, chemical industry and automotive. However, changing framework conditions and increasingly demanding market requirements have led to dramatic market losses and even to complete shutdown of SWL business in some countries. As this business segment has been evaluated as important for specific transports in a European co-modal transport system also for the future, significant improvements are needed.

The ViWaS partners believe that for the success of SWL the following two issues might be crucial:

(1) A viable SWL system is highly dependent on the critical mass. Thereby all options have to be considered to secure a high utilisation of the trains operated on the trunk lines, including a combined production with intermodal loads.

(2) Only comprehensive and complementary measures are able to sustainably improve and preserve the European SWL systems in accordance with increasingly demanding market requirements.

The ViWaS project will follow such a comprehensive approach; therefore aiming at the development of

- Market driven business models and production systems to secure the critical mass needed for SWL operations,
- New ways for "Last-mile" infrastructure design and organisation to raise cost efficiency,
- Adapted SWL technologies to improve flexibility and equipment utilisation,
- Advanced SWL management procedures & ICT to raise quality, reliability and cost efficiency

The applicability of these solutions and their effects will be proved on the basis of pilot business cases (by demonstrations). Thereby important findings will be gained for a European wide implementation of developed solutions.

ViWaS stands for Viable Wagonload Production Schemes.

The ViWaS consortium includes railway operators (SBB Cargo, Fret SNCF, Bentheimer Eisenbahn), infrastructure providers (Interporto Bologna / IB Innovation) technology partners (Eureka, Wascosa) and consulting/ scientific partners (ETH Zürich, TU Berlin, HaCon, NEWOPERA).

Work package 11 is called "Evaluation, recommendations, implementation strategies". The methodology for this work package contains the following main steps:

(1) Firstly, the developed business cases are evaluated to detect strengths and weaknesses of the developed solutions as well as potential, recommendable modifications;

(2) Secondly, recommendations might also emerge from the above developed business cases with respect to their deployment in real operating environment;

(3) Thirdly, implementation of a European wide application, that need to consider the existing SWL production systems and infrastructures as well as future trends that are evaluated with a 2050 time horizon.

The corresponding "Evaluation report on cutting-edge SWL solutions (Deliverable D11.1)": provides an evaluation of the demonstrated business cases with respect to the previously defined success criteria (KPIs), applicability of developed solutions, further development needs and further potential application areas. Furthermore implementation strategies are described, facilitating a European wide application of the ViWaS developments.

The business cases and further test installations are a major component of the ViWaS concept that foresees testing and demonstration of the developed solutions under real-life operation conditions. Consequently, business cases have been defined already during the application phase and further modified and completed during the project lifetime.

Finally, the following business cases and test installations have been carried out and used for the structure of this evaluation report:

(1) **Swiss-Split 2** deals with the improvement of the current SWL distribution system to private sidings in Switzerland by renewing rolling stock and shunting locomotives, introducing a new loading platform to improve loading and unloading operations in sidings and therefore reducing costs and optimising time and effort.

Responsible ViWaS partners: SBB Cargo in collaboration with Wascosa and supported by ETH Zürich IVT;

(2) **Regional network of rail logistics centres** aims to improve "last-mile" services and to establish transhipment and rail logistics nodes for customers without own rail access points in a border region between Germany and the Netherlands. The business case is also used to evaluate the deployment of hybrid locomotives.

Responsible ViWaS partners: Bentheimer Eisenbahn supported by HaCon;

(3) **Last-mile service on French secondary lines** works on a new concept for the streamlining of "last-mile" and shunting operations based on active collaboration between RU and shippers. The RU distribution train stops in front of each siding and helps a bimodal vehicle driver in the shunting operations, (coupling, decoupling, switch...) which are performer by the shipper with its own traction unit. The neighbouring shippers organise themselves with a shared bimodal road-rail vehicle which replaces every shunting vehicles of each partner.

Responsible ViWaS partners: Fret SNCF supported by NEWOPERA;

(4) **Innovative Telematics and ICT services** seek to improve operation performance and on-time delivery by introducing telematics devices together with a telematics data distribution service. These telematics devices are managed and controlled remotely by the TCCU and inform the different partners involved in real time about position, speed, impacts, loading status etc., as well as wear related data like wheelset mileage. A further newly introduced aspect deals with sensors for wagon load measurements.

Responsible ViWaS partner: Eureka supported by HaCon;

(5) **Modular wagon components based on the Flex Freight System** deals with the improved capacity utilisation and flexibility of rail wagons by new and modular wagon components: One component is the Flex Freight Car, a light container wagon with a driveable grid floor that is also able to carry 45’ containers. The wagon is also part of the business case Swiss Split 2. The second component developed within ViWaS is the Timber Cassette 2.0. This advanced cassette is stackable for empty runs in order to provide more loading capacity for container transport on the standard rail container wagons and reduction of empty wagon transports by the enhanced flexibility (combination of containers and timber loads on one wagon).

Responsible ViWaS partner: Wascosa supported by TU Berlin.

2 "Swiss Split 2"

2.1 Business case at a glance

The traditional scope of SWL transports can be broadened by integrating intermodal solutions. The business case "Swiss Split 2" focusses on delivering maritime containers to sidings by using the encompassing Swiss SWL transport network. Thus the critical mass for a viable SWL system and its efficiency can and will be improved.

One part of the effort to attract more traffic to the Swiss Split operating system is improving the track layout, capacity and production systems used in terminals. Therefore – as outlined in the ViWaS proposal – improvements were being planned with the construction of the Basel Nord and Limmattal gateway terminals. In the meantime both projects have been the centre of a broad public discussion in Switzerland. As a result market experts and authorities agreed on improvements within the Swiss terminal landscape in general. The tri-modal terminal Basel Nord enjoys a broad support in the market; the work on the terminal will be progressed. The planning works for Limmattal gateway have been stopped. This change in the Swiss terminal strategy has no impact on the ViWaS project.

Instead, the project's development work within the tackled business case focusses on other aspects. To realise cost efficient transport solutions, specific rolling stock has to be developed to increase the quality of transports and meet the customer needs. One component is the introduction of new hybrid locomotives for shunting and short line traffic. The focus within ViWaS is the development of forward looking, cost efficient solutions that will replace end-of-cycle wagons with high maintenance costs currently used by SBB Cargo.

Figure 1: Wagon equipment developed for Swiss Split 2

Container Loading Adapter (left picture) and Flex Freight Car with iron grid inlay (right).

Source: SBB Cargo

Two innovative rolling stock solutions have been developed by the partners ETH Zurich, Wascosa and SBB Cargo (see Figure 1):

- As a first solution a new type of container wagon was engineered and tested in customers' sidings. This so called "Flex Freight Car" is based on a classical, but lighter container wagon. Its passable iron-grid floor allows for loading and unloading containers in sidings by driving with forklifts on the wagon.

- The second solution is based on three flexible 20ft platforms, which will simplify loading and unloading operations of containers in sidings. The so called container loading adapters guarantee a totally flat, passable surface on the wagon and it is mountable on standard Sgns-container wagons.

2.2 Evaluation of the demonstrated business case

2.2.1 Fulfilment of initially defined success criteria

The business case analysis is designed to evaluate the market potential for the Swiss Split 2 production process in the European SWL market. This is done by first estimating the concept's potential efficiency gains and customer benefits in Switzerland, and then extending the analysis for other European regions.

The goal of the Swiss Split 2 production concept is to increase the transport volume of SWL freight traffic. Achieving this goal requires developing an efficient and customer-oriented production system designed to create a sustainable shift of freight traffic from road to rail.

The key performance indicators (KPI) that can be used to evaluate this goal were developed as part of ViWaS work package 4 and are summarised in Table 1.

Table 1: Key Performance Indicators (KPIs) for Business case "Swiss Split 2"

	Criteria	KPI		Description	Unit of measurement
Operational KPIs	Cost efficiency	1	Transport volumes	No. of containers in Swiss Split	Loading unit per days
		2	Operation hybrid locomotive	Decrease in locomotive use	No. of rolling stock
	Service quality	3	Customer acceptance	Increased customer acceptance and satisfaction	Survey, customer acceptance and satisfaction
	Environ-ment	5	CO_2 reduction hybrid locomotive	Reduction of diesel by use of environmental friendly produced electricity	Operative hours of diesel locomotive

Source: HaCon based on SBB Cargo

Transport volumes in Swiss Split 2

During the project, SBB Cargo scaled up its efforts to increase transport volumes. On the one hand, the handling capacity in the existing terminals has been expanded, laying the foundations for further growth. Moreover, SBB Cargo is also prepared for the future challenges of increasing Swiss Split traffic. The creation of the bimodal gateway terminal Basel Nord, as starting point for a new tri-modal terminal, will enhance the efficiency of transportation processes and lead to an increased volume of sea containers shifted to rail.

On the other hand, activities were directed to develop and implement possible solutions concerning wagon equipment for Swiss Split 2 to further enhance the shift from road to rail. Within the project the necessary wagon equipment has been developed, constructed and tested during the project phase (As shown in Figure 2, the combined improvement activities led to raising transport volumes in Swiss Split, proven by the number of containers and wagons. The increase between 2012 and 2014 was 6% whereas overall increase of Swiss SWL was 2%.

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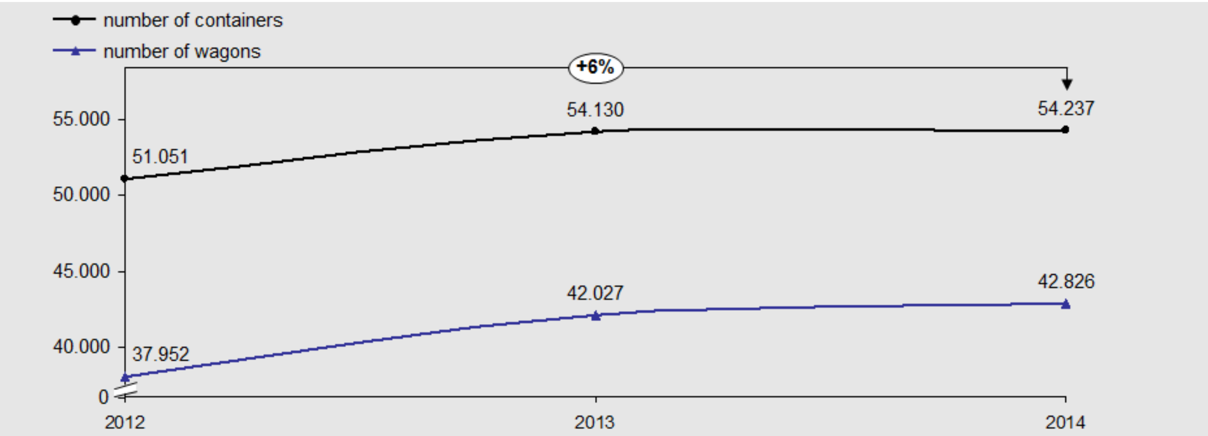
Figure 2: Increasing number of transported containers in Swiss Split



Source: SBB Cargo

Hybrid locomotive Eem 923 – cost efficiency benefits

Currently, the SBB Cargo locomotive fleet features a high number of different locomotive types. In connection to Swiss Split and single wagonload traffic, unfavourable conditions emerge especially from the following two operating situations. A large number of shunting locomotives are being used for last-mile distribution in private sidings. Meanwhile, heavy shunting locomotives are also being used for deliveries from the team stations. As a result, diesel locomotives are being used frequently - uneconomically - under existing contact lines. A use of electric shunting locomotives does not allow for shunting in private sidings.

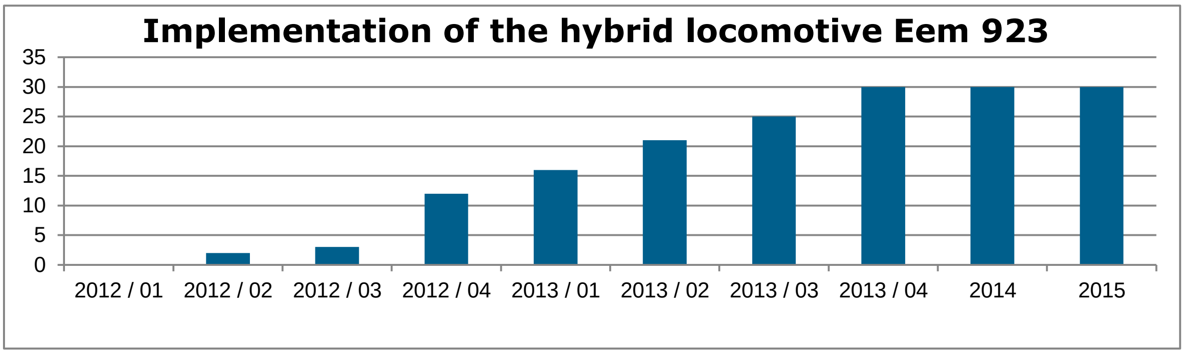
In order to eliminate these deficiencies, SBB Cargo initiated the construction and use of hybrid locomotives within the Swiss Split. In a public tendering procedure, the supplier Stadler Rail put forward the best service package with its shunting and main-line locomotive Eem 923 (see Figure 3).

Figure 3: Hybrid locomotive Eem 923

Source: SBB Cargo

A total of 30 hybrid locomotives were put into operation between 2012 and 2013. The locomotives were allocated to the regional teams and named after nearby mountains. Teams were permitted to choose the names themselves.

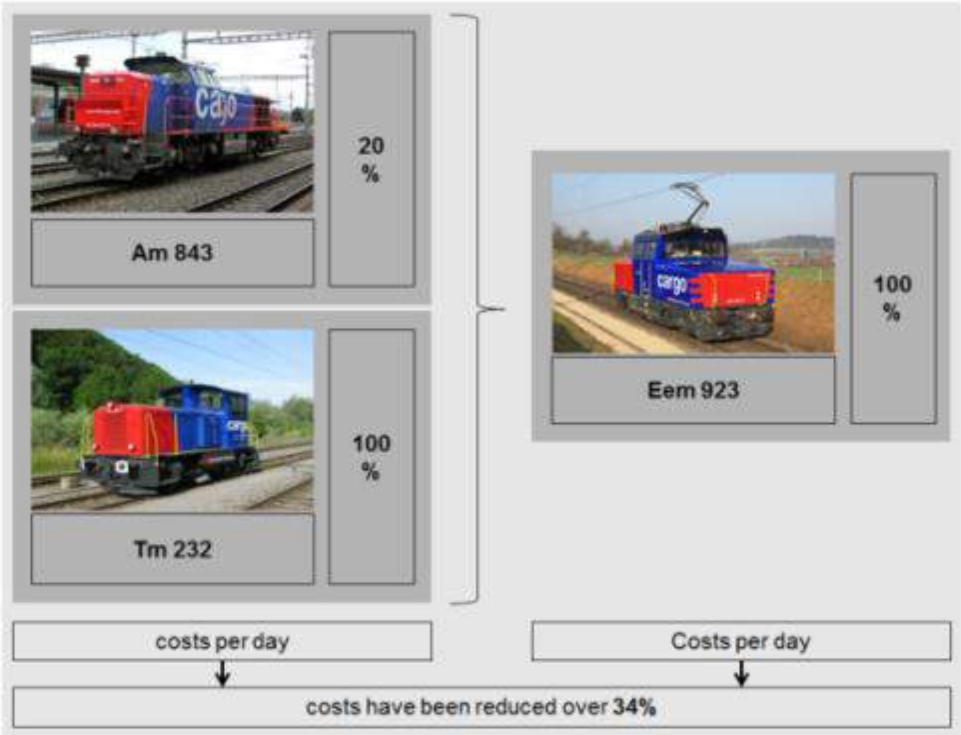
Figure 4: Implementation of the hybrid locomotive Eem 923



Source: SBB Cargo

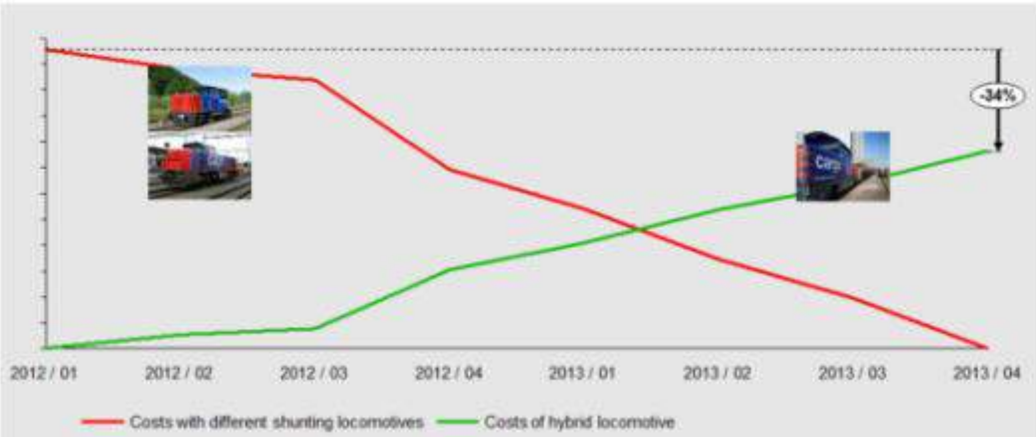
Due to the introduction of the Eem 923 hybrid locomotives it was possible to decommission 35 older shunting locomotives. In fact, 20% of the Am 843 locomotives as well as the entire TM 232 fleet (= 100%) have been replaced. As a result, a substantial reduction of the average daily operation costs per locomotive could be achieved (see Figure 5 - Figure 6). Through consistent exploitation of the savings potential, SBB Cargo has guaranteed constant prices for its customers despite rising train path costs.

Figure 5: Cost savings hybrid locomotive Eem 923



Source: SBB Cargo

Figure 6: High potential of cost savings



Red line represents the operation costs of the 35 shunting locomotives (type Am 843 and TM 232) that have been subsequently decommissioned (: all 35 considered shunting locomotives in operation (status: 2012/01) and decommissioned (status: 2013/04). Green line represents operation costs of hybrid locomotives Eem 923 in correspondence to the implementation timeline (2012/01-2013/04).

Source: SBB Cargo

Hybrid locomotive Eem 923 – environmental benefits

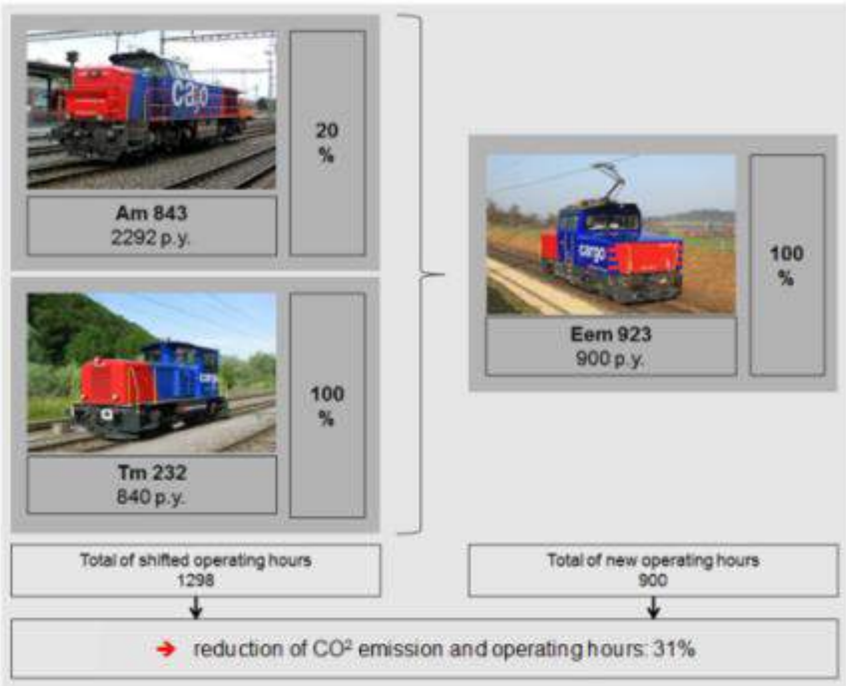
By using the hybrid locomotive with its efficient electric drive and eco-friendly diesel drive, SBB Cargo can offer the customers a "clean" solution that meets present-day requirements. Customers are pleased with SBB Cargo's commitment and support the use of environmentally friendly vehicles. At the same time SBB Cargo is significantly cutting noise emissions in the electric mode, taking a further step towards complying with noise protection legislation.

Using the hybrid locomotive means:

- a modern private sidings service for customers
- a reduction in noise pollution for people who live near the railway
- a clean and comfortable workplace for employees
- modern, low-noise shunting locomotives for more railway undertakings
- less CO2 in the environment

In addition to cutting costs, SBB Cargo has significantly reduced CO2 emissions through the use of hybrid locomotives. Consistent use of the electric drive in the overhead line sections has played a key role in this. The hybrid locomotive is designed so that the drive can be switched from electric to diesel mode (and vice versa) during the journey. This forms the basis for consistent use of the electric drive mode and for cutting the number of hours spent in diesel operation.

Figure 7: CO2 reduction with Eem 923



Source: SBB Cargo

The 31% reduction in operating hours fully translates into a reduction in CO_2, as 90% of the rail power generated in Switzerland comes from water power and 10% from nuclear energy. Therefore, no CO_2 is produced when generating power for the electric drive mode.

Customer acceptance 'Flex Freight Car' with iron grid inlays

The test phase of the 'Flex Freight Car' within Swiss Split was concentrated on bigger customers with several sidings, namely Migros and Ikea. Due to the involvement of only a limited number of customers it was possible to discuss the tests in detail and get a qualified feedback regarding the applicability and acceptance of the tested equipment as well as on potential requirements and improvements.

With regard to the 'Flex Freight Car', the following feedback was given:

- the large distance between the ramp and wagon was mentioned as a potential hazard for staff security in sidings
- The height difference is also an obstacle, as the angle of the drive-over plate is insufficient to accommodate modern forklift trucks.

The use of the wagon within Swiss Split is therefore depending to individual solutions in sidings.

Figure 8: Test of 'Flex Freight Car' with iron grid inlay at Migros siding in Neuendorf (CH)

Source: SBB Cargo

'Container Loading Adapter'

The 'Container Loading Adapter' has been developed for customers with standard loading and unloading requirements in sidings. All of the customers' safety and quality concerns – as stated in connection with the tests of the 'Flex Freight Car' – were taken on board and incorporated into the construction process. Since end of October 2015 six adapters are being tested in regular traffic. The tests will be progressing beyond the ViWaS lifetime. Initial feedback gathered from different customers concerning the unloading over the adapters were positive. However, a final evaluation will be only possible after the entire test series will have been concluded.

Figure 9: 'Container Loading Adapter' in Rothenburg (CH)

Source: SBB Cargo

In addition to the services currently offered, customers were also presented with further opportunities for wagon loading. A forward-looking mode of construction was chosen that will also enable 45' containers to be transported in future.

Due to the tests, SBB Cargo plans the introduction of approx. 140 wagons with Container Loading Adapters.

2.2.2 Applicability of developed solutions

Overall assessment

For container transports to customers' sidings SBB Cargo has been looking for a new cargo wagon. The Ks-wagon, a two axle wooden floor wagon currently in use, was originally determined to transport bulky goods, such as vehicles, spare parts for bigger machines or other goods that are less sensitive to environmental influences. Today SBB Cargo also uses these types of wagons to deliver sea containers from gateway terminals in Switzerland to customers' sidings. Although the wagons' dimensions suit the sidings perfectly, there is a number of disadvantages. Due to the fact that the Ks wagon is not equipped with receptive points for containers, they have to be secured manually by nailing wooden blocks into the floor on each side of the container. Over the years the floors got weakened, thus maintenance costs are high.

The traditional scope of SWL transports can be broadened by integrating intermodal solutions. The business case "Swiss Split 2" focusses on delivering maritime containers to sidings by using the encompassing Swiss SWL transport network. Thus the critical mass for a viable SWL system and its efficiency can and will be improved. To realise cost efficient transport solutions, specific rolling stock has to be developed to increase the quality of transports and meet the customer needs.

Two innovative rolling stock solutions have been developed by the partners ETH Zurich, Wascosa and SBB Cargo:

As a first solution, a new type of container wagon was engineered and tested in customers' sidings. This so called **'Flex Freight Car'** is based on a classic, but lighter container wagon. Its passable iron-grid floor allows for loading and unloading containers in sidings by driving with forklifts on the wagon. The grid is modular, meaning, that it is possible to remove the different parts of the grid as they are not permanently connected to the chassis. This results in a higher flexibility in wagon usability: The wagon can be used as a classic container wagon for terminal-terminal transports, where no floor is needed or – after a few modifications – it can be used to distribute sea containers into sidings.

As an alternative to the 'Flex Freight Car' with grid inlays, SBB Cargo developed a 60' platform, which can be put on every standard Sgns or Sgnss container wagon. This **'Container Loading Adapter'** guarantees a totally flat, passable surface on the wagon and it is mountable on standard Sgns-container wagons. In contrast to the 'Flex Freight Car' with grid inlays the design of the Container Loading Adapter offers some advantages in terms of width and height. With the platform the wagon is about 7cm higher than the test wagon and there is the possibility to build the platform wider than the wagons' width to reduce the gap between the loading dock and the wagon. The platform is heavier than the grid inlays, but it doesn't compromise the wagons' payload capacity. Normally payload in the Swiss Split never reaches its limits due to the fact that of 60 feet only 45 can be used for loading.

The results show that the implemented solutions may be applied differently. While the grid inlay solution for the Swiss Split wagon can be implemented for 70% of 18 measured sidings, the Container Loading Adapter solution can be used in 100% of cases.

Moreover, SBB Cargo is introducing a new series of **hybrid locomotives** that will eliminate the need for using full size locomotives in shunting service. The new locomotives will also allow SBB Cargo to retire older shunting locomotives that are not suitable for modern rail production systems.

Training needs 'Flex Freight Car' with iron grid inlays

The test involved the production of one test wagon and its disposition to sidings. First of all, appropriate sidings had to be defined to analyse the wagons abilities in different environments. The test scenarios have been selected only in sidings, where loading and unloading is done by forklifts or other floor conveyor vehicles.

During the test-preparations, all involved employees had to be trained in the new grid-covered wagons' handling. In addition, involved customers had to be informed about the changed loading- and unloading processes during the tests. Information letters were sent, workshops held.

Figure 10: 'Flex Freight Car' with iron grid inlays

Source: SBB Cargo

Training needs 'Container Loading Adapter'

The test of the Container Loading Adapter involved the production of six adapters (equipment for two wagons as three 20' platforms are needed for each wagon) and disposition of the newly equipped wagons to sidings. As in the first test, test scenarios for the Container Loading Adapter have been selected only in sidings, where loading and unloading is done by forklifts or other floor conveyor vehicles. The evaluation of the final test results is still in progress at the time of this reporting.

To test the Container Loading Adapters' abilities, numerous trainings were necessary, including information sessions and workshops for both customers and SBB Cargo employees. The Container Loading Adapter needs to be mounted to the wagons chassis. Therefore, employees in the service stations were trained by engineers.

Figure 11: 20' Container Loading Adapter

Source: SBB Cargo

Figure 12: 20' 'Container Loading Adapter', handling by reach stacker

Source: SBB Cargo

2.2.3 Requirements for further modifications

'Flex Freight Car' with iron grid inlays

To enable a widespread implementation of this solution for SWL end customers the challenges shown during the tests must be accomplished – such as the distance between the ramp and wagon, as well as the security aspects.

'Container Loading Adapter'

The support points on the Container Loading Adapter must be recalculated and adapted for all possible designs of the wagon type Sgnss for future production batches. If a wagon is only to be loaded with 20' and 40' containers, no support points are needed. For the potential expansion to 45' containers, however, the support points are necessary for stabilisation and to transmit force from the platform to the wagon. Further potential improvements are to be identified in the tests and implemented later in series production.

Hybrid locomotive Eem 923

New vehicles are to be fitted with the latest generation of ETCS before delivery. This allows them to be used without limitation for shunting and main-line services, as well as enabling the rail-side security apparatus to be adapted to the relevant infrastructure operator.

2.3 Deployment of developed solutions

The solutions described can be used in the European SWL and thus open up the possibility of re-establishing traffic in this segment. The potential should be considered from a project-based perspective and depends on a range of factors. Factors to be evaluated:

- Offer
- Infrastructure
- Profitability
- Partners
- Demand
- Interest of the supplier

2.3.1 Framework conditions: 'Flex Freight Car' and 'Container Loading Adapter'

Offer

Use of the Swiss Split product is currently restricted to the geographical zone of Switzerland. The development of the grid inlay and the Container Loading Adapter expands the possible area of use to the whole of the European standard-gauge region. Regardless of the additional solutions, the wagon can also be used for all conventional combined traffic. In addition, it offers the potential for new transport operations from the harbour to the customer via direct hinterland traffic or with an additional changeover from a terminal to the customer. The offer can be scaled up or down as needed and depends on the capacity of the loader's private sidings.

Figure 13: Flex Freight Car(left) and Container Loading Adapter (right)

Source: SBB Cargo

Infrastructure

SBB Cargo is currently using the existing infrastructure of the terminals and private siding owners without any additional adaptations. No further adaptations to the infrastructure will be necessary in future in order to implement the solutions envisaged by the project. The existing facilities on the customer's premises and in the terminal can be used. However, if it makes economic sense to further expand the traffic on account of the direct connection to the customer, the possibility of support during infrastructure construction needs to be investigated.

Profitability

The current offer has already proven its economic viability. The profitability of the new system should be assessed on a case-by-case basis, usually depending on the transport price. The customer will base their decision whether to switch from road to rail on the cost factor.

Partners

Customers can be brought on board as implementation partners directly or through the freight carrier tasked with the transport operations. This choice depends on each individual case. Existing knowledge gained from implementing the project within Switzerland can be used for new traffics or projects.

The project partners must be determined on a number of levels. At the start, the group consisting of operators, transporters and wagon manufacturers may be approached. It may then be possible to extend partnership to freight carriers, terminal operators and private siding owners directly affected by the project.

Demand

It is clear that there is demand for the system among the existing customer base of SBB Cargo, including for the European SWL. Initially, the SWL in the countries bordering Switzerland can also be supported. Further expansion of this offer is dependent on marketing by the relevant railway undertakings.

Interested parties typically include private siding users, recipients of transport loads, users of transportation services and those interested in increasing rail traffic.

Interest of the supplier

The interest of potential suppliers springs from two different background situations.

a) Owing to their age, the vehicles currently in use will have to be replaced with new ones. This may instigate steps towards investing in flexibility and the separation of substructures and superstructures.
b) There is potential for new traffic in private sidings and the vehicles needed are not yet in place. Here, the solutions envisaged by the project can be used and the expansion of the SWL implemented.

2.3.2 Framework conditions: Hybrid locomotive

Offer

The present range of standard-gauge vehicles is largely limited to the separate use of diesel and electric shunting locomotives. With its approval for use on all standard-gauge sections, the new hybrid vehicle can be used in electric operation with electrification of 15 KV and 16 2/3 Hz. In all other standard-gauge areas, it can be used in diesel mode without limitations. This offer therefore presents the possibility of deployment across Europe if the necessary approval procedures are completed.

Figure 14: Eem 923 in service

Source: SBB Cargo

Infrastructure

No separate infrastructure is required for use. Any maintenance work necessary can be conducted in the existing workshops.

Profitability

Converting the traction concept has been proven to increase profitability and will therefore secure a stronger future for the SWL. A switch to hybrid locomotives shall be considered in the forthcoming renewals of shunting locomotives for the SWL. It will also be possible to cut CO_2 emissions at the same time, which creates further potential for environmentally friendly transport capacity.

Partners

Possible implementation partners are manufacturers of railway vehicles. Cooperation with vehicle design offices is also possible.

Demand

Demand is currently limited to certain geographical zones with innovative traffic concepts. However, expansion in Europe is expected in the future and will strengthen the SWL.

Interest of the supplier

Existing suppliers are interested in large-scale marketing drives for hybrid vehicle technology. Marketing must be reinforced, as the benefits and advantages have not yet been recognised by the market segment as a whole.

2.3.3 Further application cases: 'Flex Freight Car' and 'Container Loading Adapter'

There is a potential interest at the European level on the 'Flex Freight Car' with iron grid inlays developed by Wascosa, and on the Container Loading Adapter developed by SBB. Both are adapted to the European standard-gauge and besides their SWL applications, they can also be used for all conventional combined traffic, as well as for shipments from sea and inland ports to customers. Therefore, these two innovations could potentially contribute to strengthen the rolling stock in a European level and increase the market strategy flexibility of freight operators.

In order to implement the usage of these rolling stock innovations, some infrastructure requirements are needed. Since the advantage offered by the 'Flex Freight Car' with iron grid inlays and Container Loading Adapter is a major, easier and safer operability for loading and unloading sea containers in customer's private sidings, customers need to be equipped with such private sidings. Historically, Europe has been closing some of those sidings, so fewer customers use them nowadays. Therefore, the customers who still are equipped with those sidings can already use these new technologies, and others should either reopen their sidings or build new ones. Administrations should evaluate if a mixed public-private budget for such infrastructures could be an opportunity for increasing rail freight last-mile and therefore reinforcing the European goal of "shift to rail".

Since the profitability of the business model has been proved, implementation in other European regions needs to be studied. Potential partners such as operators, transporters and wagon manufacturers, may be approached. Afterwards, partnership could be extended to freight carriers, terminal operators and private siding owners. Potential clients from bordering regions of Switzerland could be served by SBB Cargo. For other regions of Europe, other operators should be involved. Those operators might profit from new traffic in private sidings, and increasing the flexibility of their fleet when acquiring either the 'Flex Freight Car' with iron grid inlays or the Container Loading Adapter.

2.3.4 Further application cases: Hybrid locomotive

The usage of hybrid locomotive in SBB's SWL network has also been a success and within the next 2 years, 140 units will be ready to be used in Switzerland. The hybrid locomotive model Eem 923 is approved to be used in all electrified standard-gauge lines with 15KV and 16 2/3 Hz. In all other standard-gauge areas it can be used as well as thanks to its diesel engine. Moreover, no separate infrastructure is needed for its use. Therefore, this hybrid locomotive increases the range of standard-gauge shunting units available in Europe. Furthermore, it enables economies of scale for European operators, given that the same locomotive can be used in different standard-gauge lines, allowing to increase rolling stock investments productivity.

Hybrid locomotives play along the EU interests of reducing CO_2 emissions. When working as an electric vehicle, the hybrid locomotives transform the rail freight last-mile into an environmental friendly transport, which also saves costs to operators since 2 types of shunting locomotives (one electric and one with diesel engine) are no longer needed. Thus, operators and the EU Commission might be interested in investing on hybrid locomotives for shunting on the long run. One way to support this technology would be to support large-scale marketing, since the benefits and advantages have not yet been recognised by the market segment as a whole. Demand is currently limited to certain geographical zones with innovative traffic concepts.

3 "Regional Network of rail logistic centres"

3.1 Business case at a glance

Bentheimer Eisenbahn (BE) is one of the major regional railway companies in Germany. Main activities are passenger transport, rail freight, road haulage, warehousing and linked logistics services. With an own rail network of about 75 km, BE has a regional focus to Northwest Germany and the neighbouring Netherlands. Partners of BE in rail transport are in particular DB Schenker Rail, but also further private railway companies, which use BE services for last mile collecting and distribution of SWL and block train loads.

In the Rail Logistics Centre "Grafschafter Logistikzentrum (GLZ)" of Bentheimer Eisenbahn in Nordhorn, about 70 single wagons per month are loaded/unloaded, serving multiple customers. Last-mile services to these customers are carried out by truck. In correspondence to specific requirements of customers' logistics, freight is partly stored in the Rail Logistics Centre (RLC).

The business case "Regional network of rail logistics centres" of Bentheimer Eisenbahn (BE) deals with a better integration of truck distribution and long-distance transport by SWL rail transport. The goal is the optimisation of the transhipment between truck and train in order to shift additional transport volumes to SWL.

For this purpose Bentheimer Eisenbahn developed a methodology to analyse and optimise related transhipment processes and technologies. This methodology has been applied for specific SWL transports of Bentheimer Eisenbahn to identify the most efficient equipment (forklifts) and internal transport and handling processes with respect to these transports and the specific spatial conditions within the Rail Logistics Centre. For the optimisation of transhipment processes the following goods have been analysed: (1) steel panels, (2) intermediate bulk containers (IBC) and (3) big bags with salt products. The methodology and results of the developments are described in Deliverable 6.1, part 2 "Report on transhipment improved technologies for cost-optimised cargo collection / delivery".

Based on the results of the analyses, it was decided to buy a new, more powerful forklift Kalmar GCE70, that is deployed to optimise the internal transport and handling operations and thereby improve the cost-efficiency of the considered SWL traffic. Another element of the demonstration includes the 'Flexible usage of staff'. The improvement potential from the use of hybrid locomotives has been proven by theoretical comparisons of traction configurations.

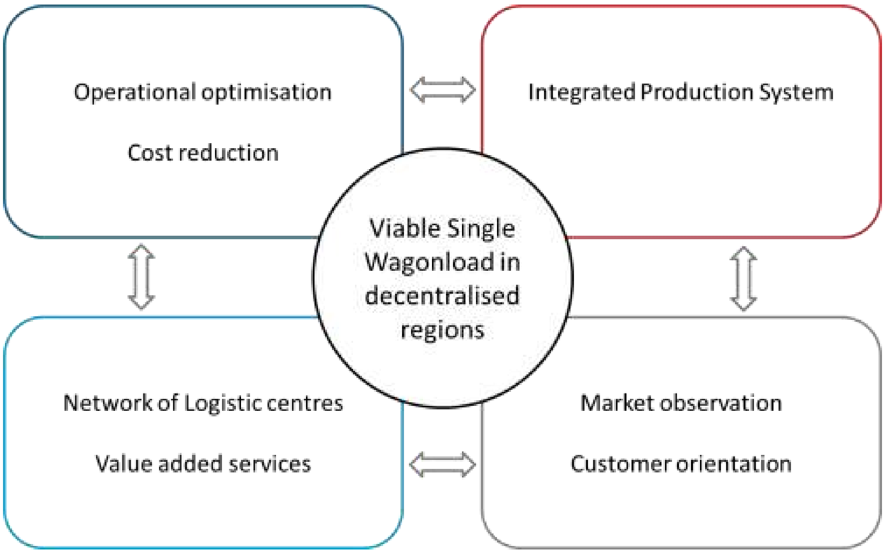
3.2 Evaluation of the demonstrated business case

General remarks

The provision of single wagonload services is an ambitious challenge, especially in decentralised areas. On the one hand the number of private sidings in Europe is steadily decreasing and on the other hand, truck service offers for customers are a simple, flexible and mostly attractively priced alternative to SWL-services. Bentheimer Eisenbahn AG as a local rail and logistics provider in north-western Germany is trying to act against this general trend. An evaluation of the profitableness of the SWL has shown that the production cost of a stand-alone SWL service especially in regional areas cannot be covered by transport price in competition to truck services. Therefore the integration of SWL services in a comprehensive and integrated regional logistic service concept including warehousing, intermodal services and at least also truck services in addition to wagonload services was fundamental to assure viable SWL services in the future. Doing so, SWL is an integral part of the full service offer and opens also the possibility to cost reductions in combination with other rail services like intermodal. This general approach was the basis of the contribution of Bentheimer Eisenbahn to the ViWaS project. The in ViWaS achieved innovations and findings were a remarkable step for the support of this general intention.

The further development of the regional oriented 'Railport' concept of Bentheimer Eisenbahn in the ViWaS project aims at tailor made and customised wagon load services at a reasonable price. The following Figure 15 gives an overview on the most important success factors for viable SWL, especially in decentralised regions.

Figure 15: Success factors for viable SWL in decentralised regions



Operational optimisation

ViWaS had a special focus on the further operational optimisation and cost reduction in single wagonload services and 'Railport' operation. Especially regarding the combination of warehousing services with the SWL, the efficiency of loading and unloading of wagons is crucial. For this business case, the deployment of a new forklift raised the handling capacity, reduced the transfer cost and time and thus solved a main bottleneck in the transhipment between rail and storage in the GLZ Nordhorn.

Another crucial fact is the efficient deployment of the staff, which can be reached through multifunctional personal. In this context, a program for the additional training of existing GLZ staff for the permission to perform also rail shunting operations was another major step to make SWL operations in the GLZ more flexible, avoid waiting times and increase productivity, which finally led to the possibility of increasing the frequency of services (cp. chapter 3.2.2).

The suitability of the used rolling stock in form of locomotives was also a point of concern during the project lifetime. AS shown in the SBB business cases new hybrid locomotives could also facilitate the operations of Bentheimer Eisenbahn, seamlessly changing between the use of catenary and diesel propulsion. This would contribute to eco-friendliness of rail services on one side and on the other side rail services like SWL will profit from clearly improved performance data (improved traction possibilities by lower energy consumption) compared to the older not state of the art locomotives currently in use.

Integrated production system

A major aim in this business case was the exploitation of synergies in the rail production in order to reduce costs as well as to improve services e.g. by extension of service frequencies for the customer. Bentheimer Eisenbahn is successfully operating various intermodal and block train services, which can be used to support single wagonload by combining all services in one concept. Therefore the existent rigid structure of the production systems (intermodal, block train and single wagonload) is replaced by a more flexible form in which the rail operations are merged according to the tasks:

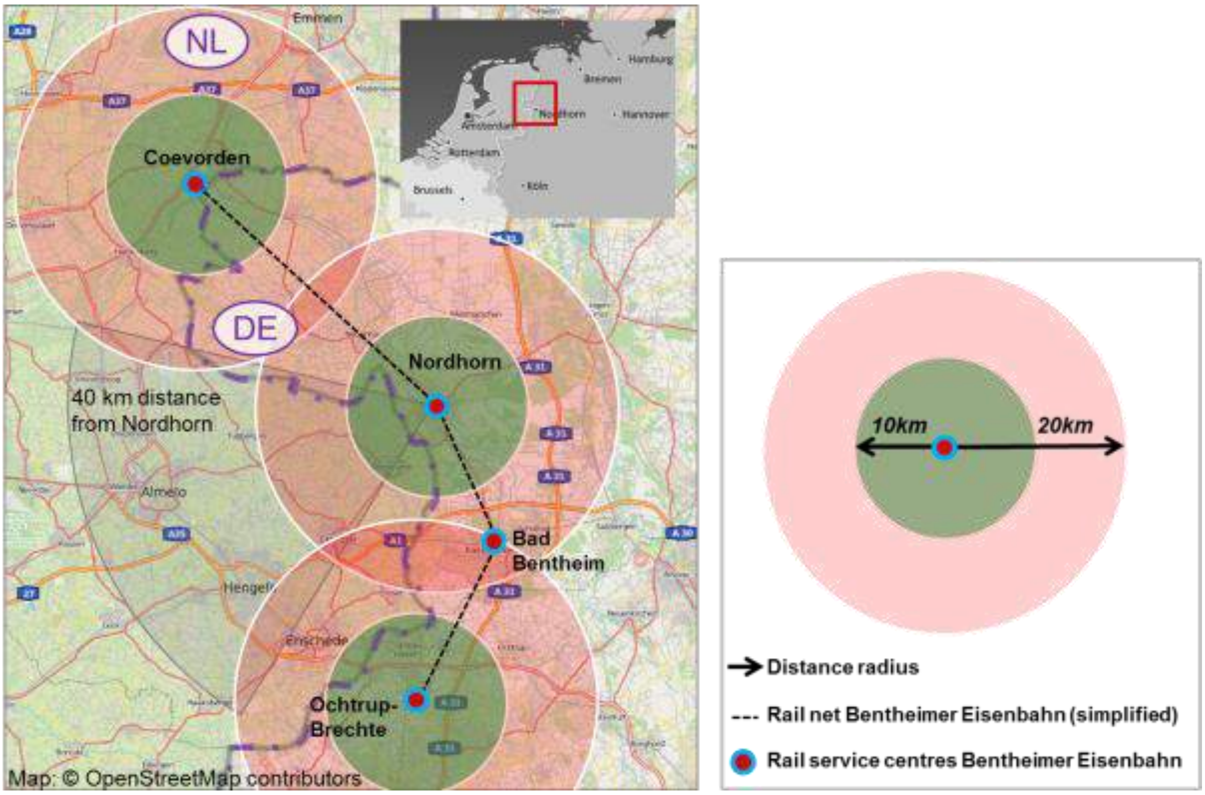
- General cost reduction of all rail operations with the specific task "making SWL profitable"
- Improved frequency of all rail services especially SWL
- Offering of an integrated rail service package to the customer in combination with warehousing and last-mile road services

Network of logistic centres / Value added services

The concept of a 'network of logistic centres' in combination with intermodal terminals as well as 'Railport' services of BE has several advantages. At first, it enables in general the use of synergies between all types of freight transport services including SWL and at second an almost comprehensive coverage of the area. Moreover, different locations open the possibility to give them different logistic focuses regarding the dedicated local demand for logistic services according to the structure of shipped/received goods. An example is the specialisation of the GLZ Nordhorn on logistic and freight transport offers for timber (cp. Chapter 3.2.1).

As mentioned before, the SWL service itself is not profitable in competition to road transport in most of the cases. For this reason, the operators, in this case Bentheimer Eisenbahn, have integrated SWL services in an extended logistic service offer with further value added services to gain supplemental revenues. This applies e.g. to the provision of (roofed) storage facilities that fit to different purposes (bulk, pallets, climate controlled, etc.). Another important aspect is the possible commissioning service with on demand and just in time last-mile road services. In this context BE succeeded in assuring SWL business as a remarkable part of the general rail service offer.

Figure 16: Network of logistic centres - Bentheimer Eisenbahn



Source: Bentheimer Eisenbahn

Market observation / Customer orientation

The challenging situation for SWL operation in general requires intense market observation as well as dedicated concepts for tailored acquisition based on the logistic needs of the customer. Therefore it is vital to carry out a regional concept for constant market observation in order to recognize actual logistic trends and to open up suitable business fields for rail freight services including SWL as soon as they occur. Last but not least, the response to individual customer wishes using the complete range of BE service possibilities as far as possible is necessary to land new orders.

General conclusions

The evaluation of the past has shown that regional SWL services as a stand-alone operation and offer in regional areas is more or less not profitable and therefore in this form not viable. Reasons for this fact can be seen in general trends like the more and more declining availability of private sidings in Europe and increasing competition through road services. Therefore, a viable SWL has to be integrated in a comprehensive regional logistic service offer in combination with intermodal services, warehousing and last-mile road service.

Based on the already high quality Bentheimer Eisenbahn provides in SWL services, the developed four pillars (see Figure 15) and their implementation in the framework of ViWaS have given a decisive contribution to the competitiveness of single wagonload services especially in decentralised regions. Through participation in the ViWaS project, it was possible to achieve complete cost-coverage (contribution margin IV, all costs excluding overhead), which transferred SWL services of the BE in a viable position for today and in the future.

3.2.1 Fulfilment of initially defined success criteria

The actual transport volumes and its development over the past years is the main KPI to evaluate this business case. Thereby, it has to be considered that the transport volume has to be seen in a wider context. Especially SWL affine goods like timber or fertiliser are affected by seasonal variations. Moreover developments like the closure of Railports in Italy, or the general economic trend can falsify the given picture.

The rail logistics centres in Coevorden (NL), Bad Bentheim (DE) and Nordhorn (DE) are relevant for the evaluation, the developments of their transport volumes are described in the following.

Nordhorn

In Nordhorn (see Figure 17), several goods are being transhipped:

- Potting soil: For a long time, potting soil had a significant share in the transports. Due to the closure of several railports in Italy (Agnani Railport, Castelguelfo Railport, Desio Railport, Torino Orbassano Railport), which were the main destinations, the transport volume dropped down considerably (2/3 less of the volume in the first quarter of 2015). Recipients in Switzerland (St. Prex and Martiqyx) are still served by rail. In this case, the dismantling of infrastructure lead to a shift to road, which was not possible to be reversed in the frame of ViWaS.
- Steel: Despite a recent drop in the volume due to the general economic development, the transhipment of steel is of high significance in Nordhorn. Steelworks have own sidings and thus are likely to use (single) wagonload services if it is beneficiary. In this case, it was possible to convince the customers that the use of SWL services can optimise their production. The warehouse with direct and roofed rail access (Figure 17) serves as interim storage and offers additional services like commissioning. The "last-mile" distribution is organised on demand by truck. This enables the steelworks to produce selected products in larger batches and thus optimise production as well as rail transport.
- Salt: Considerations about Salt transports from the Netherlands to Sweden organised by Bentheimer Eisenbahn have already been presented in work package 5, chapter 5.3.2. This business case is a good example to demonstrate the intention and logistic advantages of railports in combination with wagon load services in form of SWL as well as block trains. The private siding of a Dutch salt manufacturer was closed, but due to the nearby Railport in Nordhorn, it was possible to keep this transport on rail and avoid a modal shift to road. Although the start of this activity was promising, the high volume in the beginning of 2014 was reduced to a lower but stable level. The loss in volume is due to clearly cheaper transport possibilities by short sea transport.
- Plastic fibres: Until the end of 2012, plastic fibres which were first collected by truck and then transported to Romania by train (wagon groups) were a regular order. This activity had to be completely discontinued because Romanian road hauliers discovered this transport demand as possibility to reduce their empty back hauls and thus were able to make a very competitive offer (price), which cannot be beaten by rail.

- Animal food and hygiene: Nordhorn is the starting point for the transport of animal food and hygiene towards several destinations in Switzerland. Regional Suisse regulations limiting the total weight of trucks in some areas favour the transport by rail and ensure a high and stable level of the transport volume.

Figure 17: GLZ Nordhorn

Source: maps.bing.de

All in all, the development of the rail transport volumes in Nordhorn show in general a positive trend, which is also substantially based on the implemented measures and findings in the framework of the ViWaS project. The increased strong competition with road services due to e.g. fuel price reductions in combination with partly counterproductive decisions such as the closure of railports in Italy show how difficult the framework conditions for SWL services are. Against this background, it is remarkable that the total transport volume could be stabilised or even slightly increased with the opportunity of further development.

Bad Bentheim

Bad Bentheim is mainly dedicated to the transhipment of wood and fertiliser. For both goods, a stable development with high volumes could be observed and there is a trend for a positive long term expectation.

The figures also clearly indicate the seasonal variations as a temporarily drop in the third quarter of each year. The lumber of wood for example depends on the time in which it is permitted, possible storms, plans of the forestry industry and the general market development. For the future a reinforcement of the transport volume is expected, because the station Bad Bentheim Nord is officially listed as wood transhipment station (so is Coevorden), while other transhipment areas for this purpose are closed.

For fertilisers it is sometimes possible to operate Block trains, which means a more competitive price can be offered. The integrated regional production of SWL and block train services in one system enable the possibility to react flexible and thus use the most suitable and efficient option for both services.

Coevorden

The Rail logistic centre in Coevorden covers the transhipment of different container types (tanks, 20', 30', 40' and 45'-Containers). The overall picture shows a stable trend with a slightly increase of volume especially for the development of the 40' container units.

3.2.2 Applicability of developed solutions

The general success of this business case does not belong to one single innovation and measure. In fact, the quality level of regional single wagonload operators can be seen already as very high compared to the general European level. In order to keep the remaining SWL transport volumes and reopen the chance to realise future growth in suitable transport segments, it is vital to optimise the work flow in order to reduce costs and increase transport quality by integrating all rail service offers in one regional production system. It is the goal, to establish the offer of a comprehensive logistic service package which firstly generates value-added services and revenues (interim storage, commissioning) and secondly opens up the possibility for a flexible integration of SWL services in an overall logistic service package dedicated to the customers.

Both measures are the key to connect decentralised regions viable SWL services in the long term. Beside investments in infrastructure (e.g. logistic centres, railports) the soft measures are in our view more or less easy to apply, because they are not cost intensive changes in organisation, operation and the rail production can have a considerable effect as it is shown in the following example of staff deployment:

Young employees of the office and the transhipment hall are educated for the permission "driver for shunting". The training consists of an eight-week theoretical training course followed by a six-week practical deployment and a final exam.

The loading/unloading (including cargo securing) of a four axle wagon with up to 60 pallets requires about 60 minutes (30 minutes for a two axle wagon), considering the drive of the truck unloading. The length of the loading track enables the provision of up to three four axle wagons at once, afterwards, shunting is required. Before ViWaS, this shunting depended on the work assignments of the shunting operation staff. Due to the fact that a harmonisation between the different shunting tasks was not possible, considerable waiting times occurred in the GLZ Nordhorn. With the educated employees further staff is at hand to carry out these internal wagon movements. Consequently, wagons can be shunted immediately after the loading/unloading is finished. It was therefore possible to optimise the schedule for shunting and loading/unloading operations considerably. Thus, the efficiency was increased and nine wagons can be shunted in a regular eight hour shift (two workers for loading/unloading).

3.2.3 Requirements for further modifications

In the frame of ViWaS it became once more obvious that the main action fields for SWL are the competitiveness in terms of costs and the integration of rail services as far as possible in comprehensive logistic service packages.

For Bentheimer Eisenbahn, the next modification (development step) would be the implementation of a new traction concept. The theoretical analyses and comparisons between different traction configurations – involving the currently used locomotive, a new hybrid locomotive and a new diesel locomotive – indicated that it would be clearly beneficially to procure a new hybrid locomotive to optimise the rail operation.

Another modification is the expansion of storage facilities according to respective needs (in-/outdoor; as high rack or only for bulk material, etc.). The rail logistics centre in Coevorden needs to be expanded. A further specialisation as a hub for biomass is a foreseen project. The dedicated transhipment of timber in Coevorden and Bad Bentheim will be maintained and extended as the closure of other loading points promises a stable or even growing transport volume.

The flexible usage of staff has proven its success and the potential of additional application cases within Bentheimer Eisenbahn is monitored carefully in order to detect and use synergies.

3.3 Deployment of developed solutions

3.3.1 Framework conditions

Weight limitation for last-mile services by truck

Especially in decentralised regions, profitable single wagon load is hardly feasible. The small and declining number of private sidings reduces the accessibility of SWL. Due to this reason, and the more and more required integration of SWL in multimodal transport chains with an efficient last-mile road service the transfer from road to rail as well as the road operation have to be optimised as far as possible. Thus, the "last-mile" on road is very important and the conditions have to be favourable for SWL. In combined transport in Germany, trucks on the "last-mile" enjoy several advantages like the permission to operate on holidays and Sundays and a higher total weight (44t instead of 40t[1]). Especially the increased payload is a factor that would bring remarkable advantages and should therefore extended also to pre and onward carriage in the frame of SWL services.

In several cases, the disparity between the payload of the wagon and the truck leads to an increased number of truck journeys and finally increased costs for the SWL service compared to pure truck operation. Internal calculations of Bentheimer Eisenbahn show that 4t of additional payload on the truck in last-mile operation corresponds to a cost advantage of 16% can be the cornerstone for a profitable and competitive transport offer based on SWL for the long haul and road service for the last-mile.

Taking turf transport as an example (which actually occurred at Bentheimer Eisenbahn): The weight of a palette turf is about 1 tonne. The wagons used for the transport can handle 60 palettes. Currently, due to the restriction in road transport of maximum 40t, one truck cannot carry the technically possible amount of 30 palettes. This means that the filling of one wagon requires three trips per truck, of which the last trip only carries about 8 tonnes. With the same regulation as in combined transport, two truck trips would be sufficient, reducing the costs for the "last-mile" (in this very simple example) by one third.

Accordingly, a change in the German STVZO is duly recommendable in order not to disadvantage single wagonload services. In fact the intention of this exception for combined transport was to support the shift from road to rail and this is just what attractive last-mile services do when they supply railports. In general "combined transport" is a transport of which the majority of the trip is done on rail or by ship, just

[1] cp. §34 STVZO and 53. Ausnahmeverordnung

like in the case described before. Therefore, an adaption of this regulation for combined transport to multimodal SWL services will be hardly recommended.

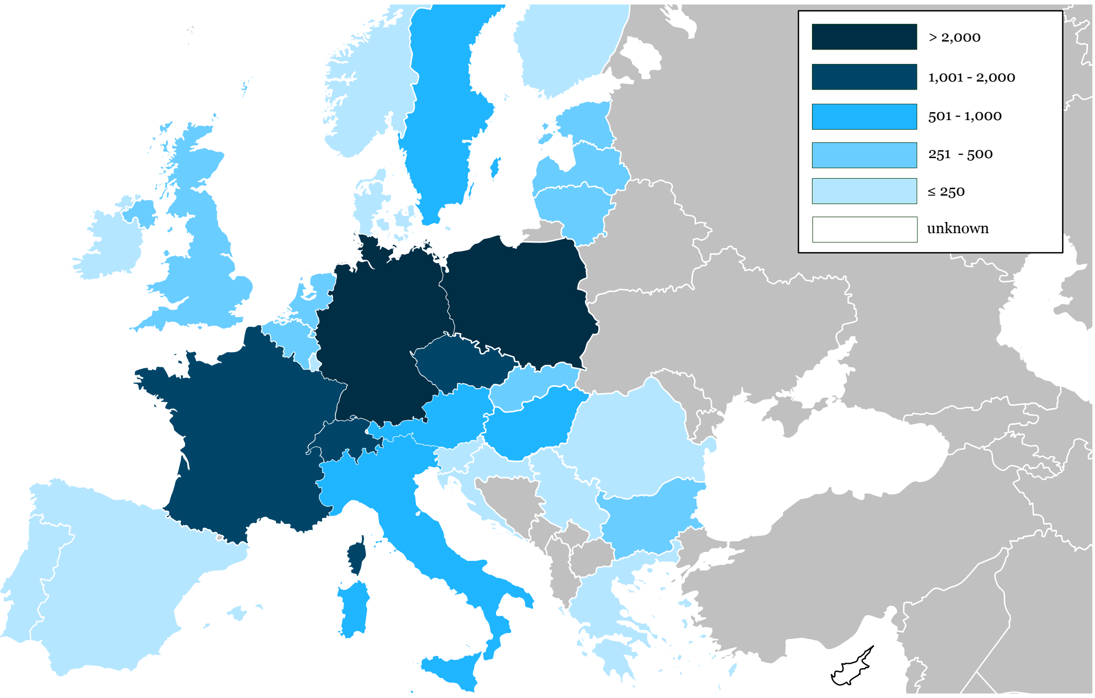
Coordinated and harmonised funding / support

In some countries like Germany, Switzerland and Austria, funding programmes for the building, extension and reactivation of private sidings exist. These programs help to keep a solid basis for Single Wagonload transport. Nevertheless, a successful shift is only possible when suitable access to rail is given on both ends of the transport chain (cp. 3.2.1; example with potting soil). For this reason a European-wide coordination and harmonisation of funding programmes is necessary to really generate a benefit.

3.3.2 Further application cases

The ViWaS developments of Bentheimer Eisenbahn are generally transferable to other transhipment points of single wagonload traffic. In the frame of another study on last-mile infrastructure in Europe (First progress report - Contract MOVE/B2/827-2013 "User-friendly access to information about last-mile infrastructure for rail freight") about 15,600 private sidings were identified in Europe, showing a clear focus in Germany, Poland, France and Czech Republic (Figure 18).

Figure 18: Private sidings - occurrence in Europe

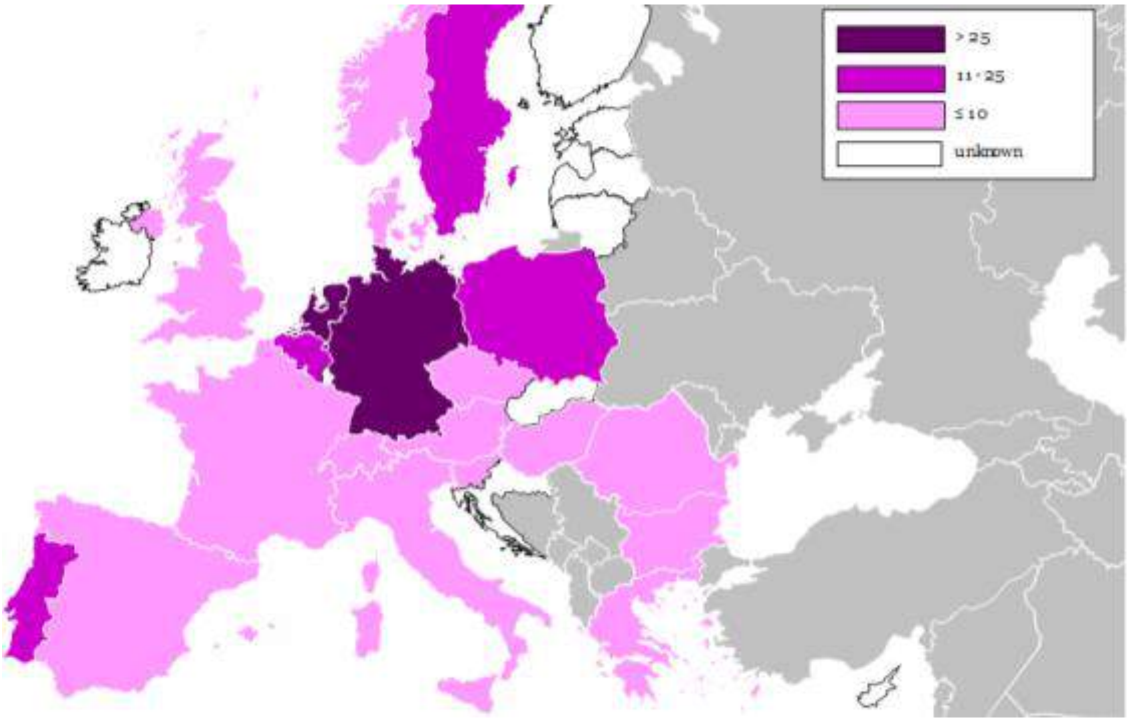


Source: HaCon based on Verkehr in Zahlen, Networkrail, SNCF, ÖBB Infra, SZ, SBB, network statements, own estimations

A considerable share of the transport volumes operated via private sidings is dedicated to block trains. The number of private sidings used for single wagonload has dropped down in recent years and is expected to continue decreasing.

Instead, it is expected that SWL activities will be more and more concentrated in bigger sidings and rail logistics centres or 'railports'. These sites gain increasing importance especially in those areas where private sidings have been disappeared. They are at the same time the ideal locations where the ViWaS developments of Bentheimer Eisenbahn could be applied. By integrating SWL in combination with other rail freight services in a comprehensive logistic service offer and establishing the 'railport' concept at other locations it will be possible to establish a capable European location network for the future SWL production systems. In the light of the small total number of 180 railports in Europe (Figure 19), there is a big potential for the development of the 'railport' landscape in Europe over the next years.

Figure 19: Railports/conventional rail-road terminals – occurrence in Europe



Source: HaCon based on CP Cargo, DB Schenker, RailScout, SZ

Basically, the elaborations of Bentheimer Eisenbahn within the ViWaS project can be useful for regional SWL operators in general and thus be one milestone to stabilise today and to enhance SWL services tomorrow in the European railway area. In order to spread the findings, it is recommendable to create a kind of catalogue with measures for the enhancement and optimisation of SWL services in connection with the development of railports to a European strategy for the revitalisation of SWL. Furthermore, 'railport' operators and railway undertakings should set up a European forum in which they can exchange their best practices. This would be an important step to spread approved strategies e.g. to generate cost savings and thus make SWL more attractive compared to pure road transport. But it is obvious, that in future, railports need to provide a discriminatory-free access to all rail operators. This model could be based on public funding for the development of the infrastructure, compared to proven models for the funding of intermodal terminals e.g. in Germany, Switzerland or Austria.

4 "Last-mile service on French secondary lines"

4.1 Initial situation

The last-mile operations represent a significant share of the cost of wagonload transport. It is the operation taking place from the last deconsolidation point of the trains up to the wagons delivery on the private siding. These operations are extremely different one from another. However there are several main sub-operations to achieve this service.

The first part is the train run on the main distribution line up to the point of local operation, then the operation to present the wagons at the entrance of the private siding on a lateral track of the National railway network either by a direct or a back move, then after unlocking the entrance, the operation continues with the delivery of the wagons at the entrance or in the private siding, the departure from the private siding with the remaining wagons and eventually with wagons to be extracted from the private siding.

The objective to be reached is the movements' optimization of the main distribution train by separating them from the final delivery movements to be operated by a Rail-Road Tractor. Moreover the mutualisation of the RR-Tractor between several sidings is expected to even improve the efficiency.

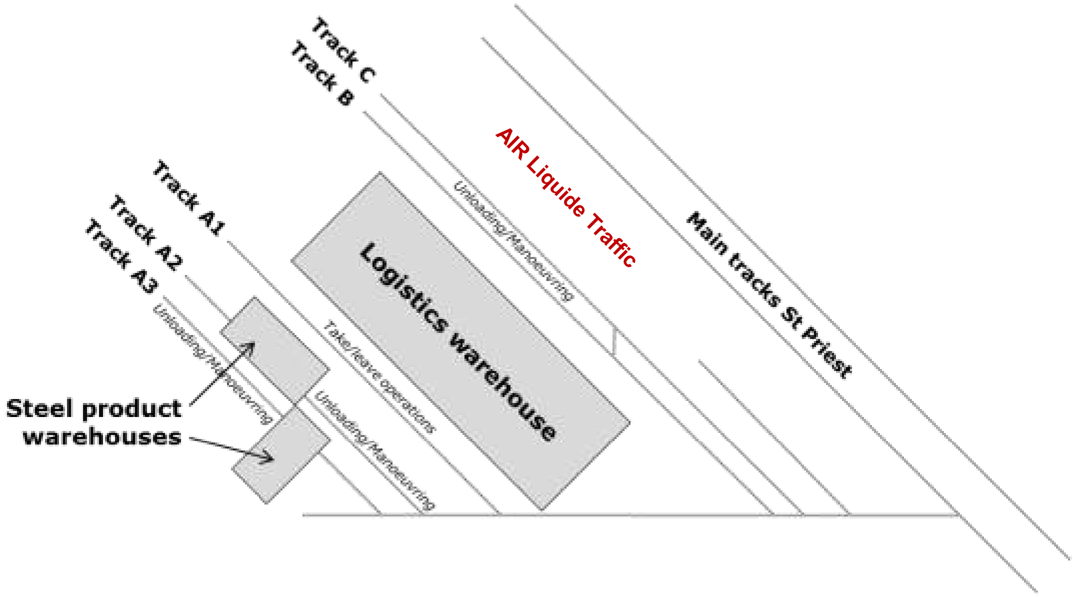
The search for adequate sites to demonstrate the solution is quite difficult as it is necessary to find a cluster of private sidings served by a unique distribution line, not far from each other and using the same distribution train. A favourable site was identified, but it appeared that the users of the private siding had already optimised their internal operations with their own rail means of traction and that they were not ready to upset their organizations for a temporary test. After checking several possibilities, SNCF Fret found a site operated by themselves, but composed of several sub-sites dedicated to different traffics in Saint Priest. The demonstration took place on that site for three months.

4.2 Evaluation of the demonstrated Business case

4.2.1 Fulfilment of initially defined success criteria

The demonstration in Saint Priest took place on the below displayed site (Figure 20) for a period of three months.

Figure 20: Demonstration site in Saint Priest



Source: HaCon based on NEWOPERA/Fret SNCF

Instead of the conventional light motor tractor which usually is in charge of the operations, a Road/Rail tractor MOL 2444 (Figure 21) was used during the ViWaS tests.

Figure 21: Road/Rail tractor MOL2444

Source: Fret SNCF

On this site the operations were the following: SNCF was bringing a full the train at the gate of the private siding and the user was positioning ½ train of CO_2 on the unloading track; exchanging after unloading it with other ½ train; finally bringing them globally back to entrance, SNCF taking it in charge towards the national network. This operation was comparable to a double siding operation with a single distribution train. This was even made more complex by the fact, that a second service was delivering some sets of wagons of steel coils, handled by small groups of wagons in the other shed of the siding.

The introduction of the RR tractor in place of the classical light rail motor tractor able to move easily from one track to another one at an embedded track point was greatly simplifying the operations enhancing the efficiency.

The objective of the project was to increase the efficiency of this last-mile operation by 10% at least.

For that purpose a very detailed analysis of the operation and comparison with the classical process has been performed by SNCF on 52 items concerning the equipment, its maintenance and the operation capabilities. The table can be found in the Appendix 3 and shows that a large majority of the important criteria favour the RR Tractor in comparison with the classical light rail motor tractor. Among them the improved safety, the speed of raising the pressure in the brake pipe, the manoeuvrability, the accuracy and the softness of the movements, an increased traction power and a reduction in energy consumption are important positive factor. Its' easy remote control enable to pilot it alone with extreme accuracy.

The economic analysis performed in D6.2 shows that the project target of 10% is largely overtaken on the St Priest experiment (34%) and further benefits can be expected if an agreement is set up with a neighbouring siding (car depot) which is served every day in a block train backward movement. This operation is today very costly, not having any other logistics movement during such operations.

The best proof of the validity of the results is that SNCF has launched a tender for a long term rental of an adequate RR Tractor for that site. The main results are summarised in the table below.

Table 2: KPIs improvements

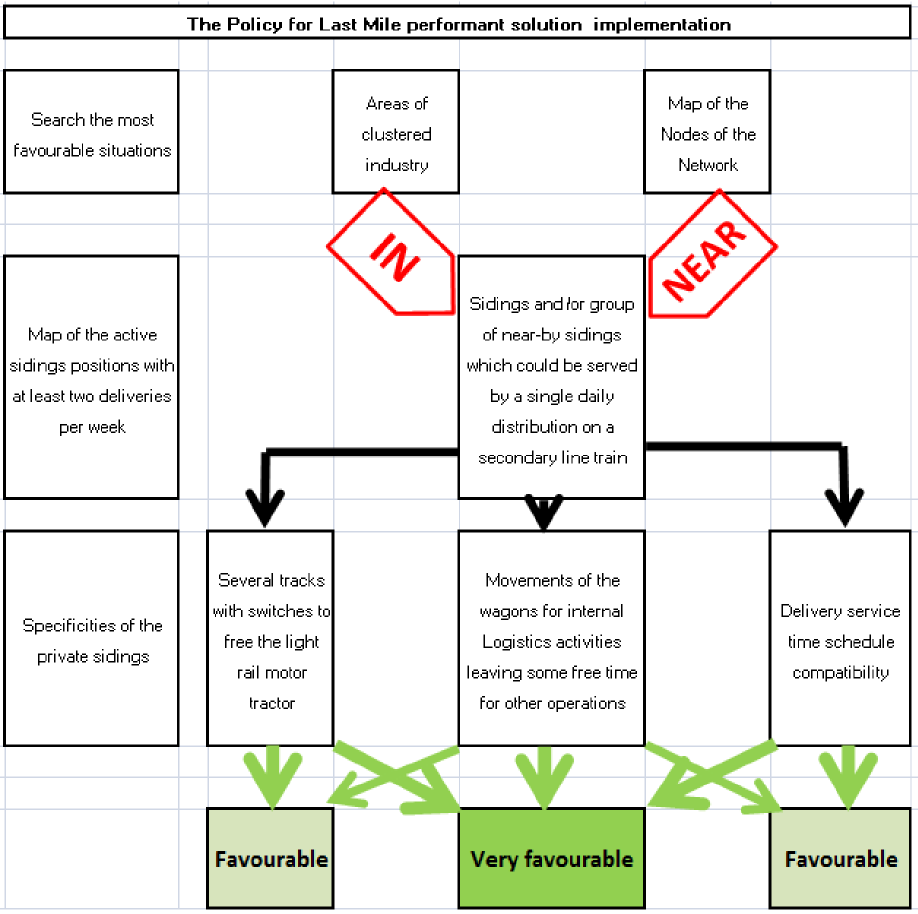
	Criteria	KPI	Description	Unit of measurement
Operational KPIs	Cost efficiency	1	Costs for investment and maintenance	Costs per siding (€/m) 70€/delivery for 300m
		2	Delivery of a given number of wagons	Costs per delivery 16% < ECONOMIES< 34%
	Service quality	3	Time gained per roundtrip of the train	Hours per delivery haul 25% < Spare Time < 50%

4.2.2 Applicability of developed solutions

The solution has shown its applicability in many sites where mutualisation of internal operations with the last-mile delivery service is possible even if it is a dedicated service for a single siding. This type of equipment being largely more flexible than the pure rail shunting locomotives will have many other fields of developments reducing significantly the cost of wagon manoeuvres. The use of such equipment on ports will also create high efficiencies if certain areas have to be served by small group of wagons.

The approach of the problem is summarised here under (see Figure 22).

Figure 22: The Policy for Last-mile performant solution implementation

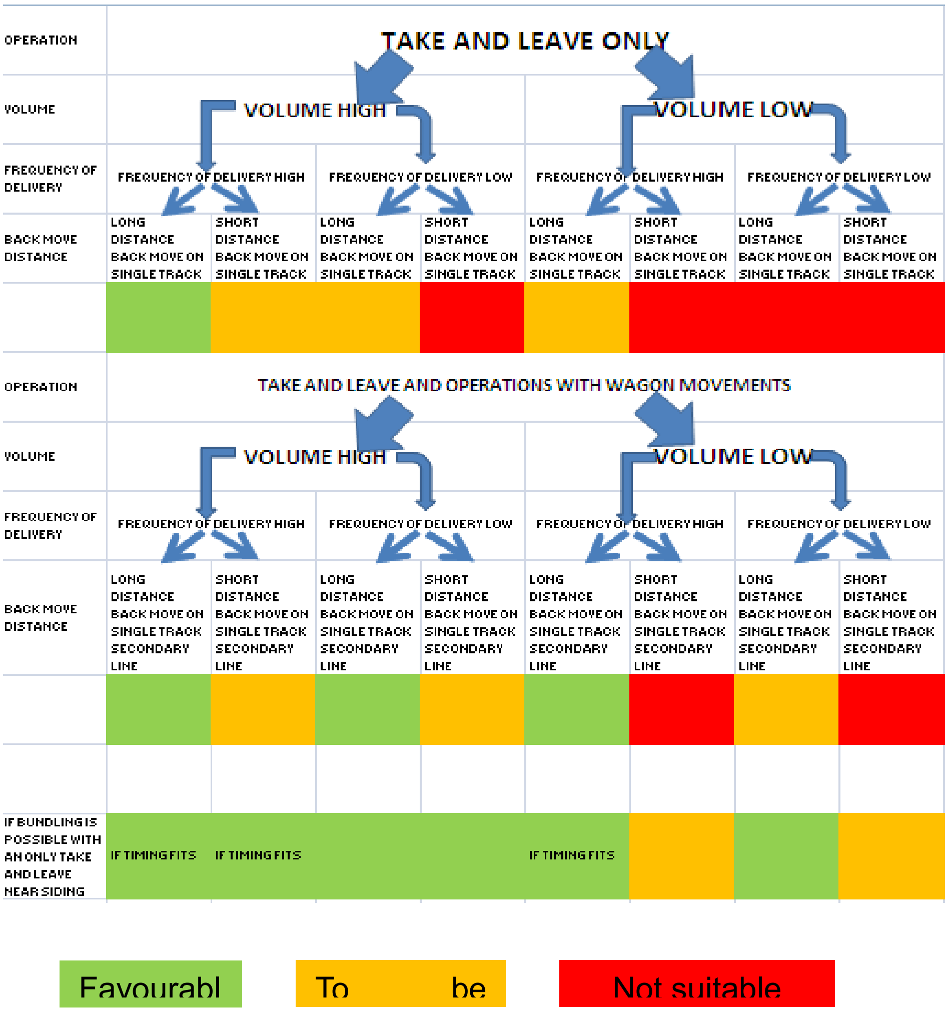


Source: NEWOPERA

The solution tested in St Priest is directly applicable on complex sidings where multiple logistics operations are performed with several deliveries by the main railway undertaking.

The step by step detailed approach is described in the decision tree hereunder.

Figure 23: Decision tree for the deployment of the RR Tractor operation scheme



Source: NEWOPERA

The important development of the technology in use in certain sidings for internal movements of wagons is to exit from the private siding to fetch the wagons as far as needed to avoid any back move of the main train. The homologation of such a RR tractor has to take into account the safety equipment of the national railway network. Specific analyses have to be made in the various countries to solve the arising problems:

- For instance in France the risk of switch closure detectors implies a close monitoring of the tyre wear and tear and some vulcanisation that could be done easily.
- For instance in Germany the discussion for its homologation has to take into account the "Indusi" detectors and therefore the possible solution is to reduce the width of the tyres to solve the problems. The study is being undertaken by one of the providers today, showing that there is a demand in the market place.

4.2.3 Requirements for further modifications

The solution has already been studied on other sites as it offers important potentialities as soon as the objections for its penetration on the National railway network will be overcome. A very simple measure could be introduced to overcome the constraint of refilling with rubber (vulcanization) the grove appearing on the tyre for the friction on the rail due to a deeper depth than the tolerable limit. This may create a risk for certain infrastructure safety equipment detecting the closure of the switches.

Adapting the remote control of the RR Tractor for a single hand operation would immediately allow for a one–man back-move of the RR Tractor pushing a train.

Ultimately when this RR Tractor will be certified on certain parts of the National Railway Network it could take the train directly from the nearest marshalling yard connected to secondary lines.

4.3 Deployment of developed solutions

The developed solutions can be applied in a European wide scale subject to the analysis of specific conditions impacting safety devices. The idea to progress rapidly would be to extend the private sidings up to the point where the main distribution train may easily transfer its wagons to the RR tractor in a convenient way excluding backward movements of the train.

4.3.1 Framework conditions

The recommendations to develop such a solution at European level are the following:

- Define the minimum requirements to authorise such RR Tractor on a public track: capacity of braking coherent with the set of wagons authorised and with the profile of the lines where it should run; speed limit, radio connections with control centre, capacity of track electric shunting.
- Define the controls on the driver capacity, and on the status of the equipment.
- Define the type of lines where such RR Tractors can be authorised in the first step.

4.3.2 Further application cases

This solution is also providing significant benefit in terminals where the tracks end on a buffer as the RR Tractor can haul the wagons in a direct move and exit easily on an embedded part at the end.

All these cases of applicability will multiply largely the opportunity to develop this efficient solution without all the constraints of the initial system. This solution is also efficient when internal movements of semi-trailers are required as certain RR tractors are also able to drag semi-trailers.

4.4 Implementation Strategies for an European wide application

4.4.1 Perspectives of the future development of the European freight transport market

In Annex 2, some maps are provided. These maps represent the hubs situation in various countries. In order to implement the ViWaS project recommendations in these sidings, it is necessary to apply the identified best practices described hereto. One has to look at the future and not at the past. A list of terminal ranking is provided (Annex 3) reproducing the terminals situation projected at 2050. These terminals in the middle of the traffic attraction zones have the right characteristic to deal both with the intermodal traffic as well as SWL traffic. In fact the new industries in the research of the zero mile cost objective must gravitate around these hubs which are becoming logistics clusters. Only by giving a modern interpretation to the SWL making it integrated into the rail freight mobility concept of a multi facets service industry, the SWL can prosper and develop. It is reasonable to assume that the new logistic clusters of the future are likely to develop around these core nodes. Therefore the old and new private sidings will have to converge into these nodes for traffic bundling, supply chain logistics and traffic industrialisation capable of delivering services at competitive costs.

4.4.2 Positioning of SWL in the future market

SWL or rather wagonload transport will continue to be necessary in the future rail freight transport sector in parallel with the other type of rail services such as block trains or combined transport. The SWL traffic is vital for market segments such as basic metals, fertilizers, chemical and metal products, secondary raw materials, steel, construction, cereals, and transport equipment among others, but its rejuvenation implies its incorporation in complex supply chains with reliability and competitiveness.

4.4.3 Implementation strategies and role of actors

In order to reach the goal of rejuvenating SWL, a multiple strategy has to be developed with coherent efforts of all actors:

- The infrastructure managers must not transform essential facilities like marshalling yards, conventional or combined terminals and other available spaces dedicated to rail freight into areas designed for real estate developments for the simple reason that these spaces are likely to be located in urban environment. They have also to maintain the capillary network giving access to private sidings in correct conditions or delegate to interested parties the responsibility of refurbishing the tracks at the right level even by extracting those tracks from the national railway Network when necessary.
- The authorities, both local and central must adapt the standards applicable on those secondary tracks to the real level required by the traffic. They must also preserve the availability of necessary land for future development. They have to develop policies in favour of innovations and clear the way for allowing a fast implementation of such innovations. Finally they must set up a specific policy to develop cluster of industries around freight villages with incentives in order to facilitate the formation of logistic services at disposal of such industries.
- The private actors must develop collaboration policies to bundle and consolidate the traffic into critical mass in order to allow the rail freight transport to become competitive and efficient through traffic industrialisation between hubs and logistic clusters.
- The potential market of the private sidings show that the field of application is important but that it will need a detailed analysis according to the methodology developed in. If the case is favourable the cost reduction of the overall operations, (logistics and operational,) may reach 50 %.

5 "Intelligent wagon telematics and ICT services"

5.1 Initial situation

Modern telematics and their comprehensive use are standard in road transport services already for several years. Today, trucks are more or less generally equipped with GPS and several other sensors that monitor every aspect of the trip. The telematics are used to optimise the utilisation rate of the fleet and thus increase efficiency of road based services. Some of the systems are also redundant; smartphone apps extend the functions of the driver's mobile phone.

In contrast to that, the situation in rail freight is far away from a comprehensive use of telematics. Only a small part of the more than 600.000 rail freight wagons in Europe is equipped with telematics devices – based on expert estimations the equipment rate in Europe is below 10% in the range of 5-8 %. Especially for those wagons (about 150.000-180.000) that are used in national and international SWL services, an equipment of the complete fleet could generate added values. Due to the production system the SWL trains are frequently separated and reconfigured. Therefore the tracking or locating of wagons is not trivial and requires manual records of train consistent lists which are often error afflicted. In view of an efficient maintenance service concept the knowledge of the objective travelled mileage of the wagon is an important fact. A correct documentation of travelled mileage in context with the maintenance records ensures optimal safety.

Today the equipment costs for telematics between road and rail are very differing. The high quantity of telematics units for trucks realises comparatively cheaper costs per unit. For rail, due to much lower quantities in context with different framework conditions (e.g. energy supply, protection against theft) the costs are clearly higher. Therefore the reduction of unit costs is one of the main goals in the frame of ViWaS.

5.2 Evaluation of the demonstrated Business case

5.2.1 Fulfilment of initially defined success criteria

The fulfilment of the aimed at development goals and success criteria has been proven for the following items:

- Telematics costs
- Information flow
- New Data Business Model
- Load Sensor

KPI – Telematics costs

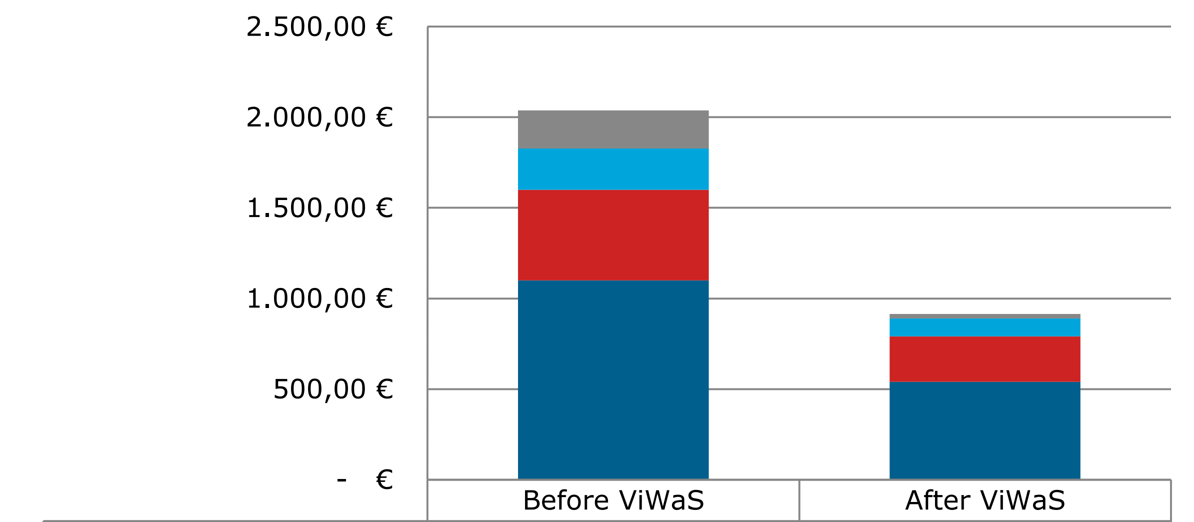
In the frame of ViWaS, Eureka has developed an improved concept for the equipment of the wagons and the operation of the system. The new generation for rail freight in contrast to the existent "NavMaster" is shown in Figure 24. Due to reduced cost for the Hardware, installation as well as operation (Data transfer and tracking portal) – see Figure 25- the initially defined success criteria of 50% cost reduction could be exceeded.

For six years, the four cost factors sum up to 3,628.00 € before and 1,534.00 € after the ViWaS innovations. Thereby, the capital expenses (CAPEX) and operation expenses (OPEX) were successfully reduced by 58%. This reduction was possible due to a new and optimised telematics unit with optimised manufacturability. Moreover, the installation of the modern generation is much easier than before because no dedicated workshop stop is needed, everything can be realised on site by a mobile installation team. Optimisation of software and (data) tariffs for the data transfer shortened operation expenses. So the targets in terms of telematics costs were clearly achieved (Table 3).

Figure 24: New generation of Eureka telematics for rail freight

Source: Eureka

Figure 25: Telematics cost - ViWaS achievement



	Before ViWaS	After ViWaS
GSM/GPRS (per year)	210,00 €	24,00 €
Tracking Portal (per year)	228,00 €	100,00 €
Installation	500,00 €	250,00 €
Telematics Unit	1.100,00 €	540,00 €

Source: Eureka

Table 3: Overview KPI Telematics costs

Definition	**Measure** **(compared to initial situation)** **Reference: CREAM Telematics**	**Target**
Change in Hardware Components and new HW-production schemes and communication cost	Cost of new ViWaS telematics CAPEX and OPEX	Overall 50% cost cut ✓
New installation schemes to cut costs of installation	Cost for telematics installation including material, wagon transport cost, wagon down time, labour cost	

KPI – Information flow

The daily frequency, quality and quantity of information are the main performance indicators for such a telematics system. Based on this fact the following table summarises the relevant KPIs in the field of Information flow and shows the reached success in this area due to the developed new technology (see table 2).

Table 4: Overview KPI Information flow

Definition	**Measure** **(compared to initial situation)** **Reference: CREAM Telematics**	**Target**
Information quantity in terms of information frequency and number of different information types	Information data transmission frequency at a defined battery life time (e.g. 6 years)	Increase data transmission frequency by 50 % ✓
Information Quality, ensure a higher position availability	Percentage of data transmissions with missing position due to bad GPS coverage	Increase percentage of position availability ≥ 95 % ✓
Information quantity in terms of information frequency and number of different information types	Number of different information types (e.g. movement/standstill status, Shock x, Y, Z, mileage ...)	Increase number of information types ✓

The set goals have been fully reached:

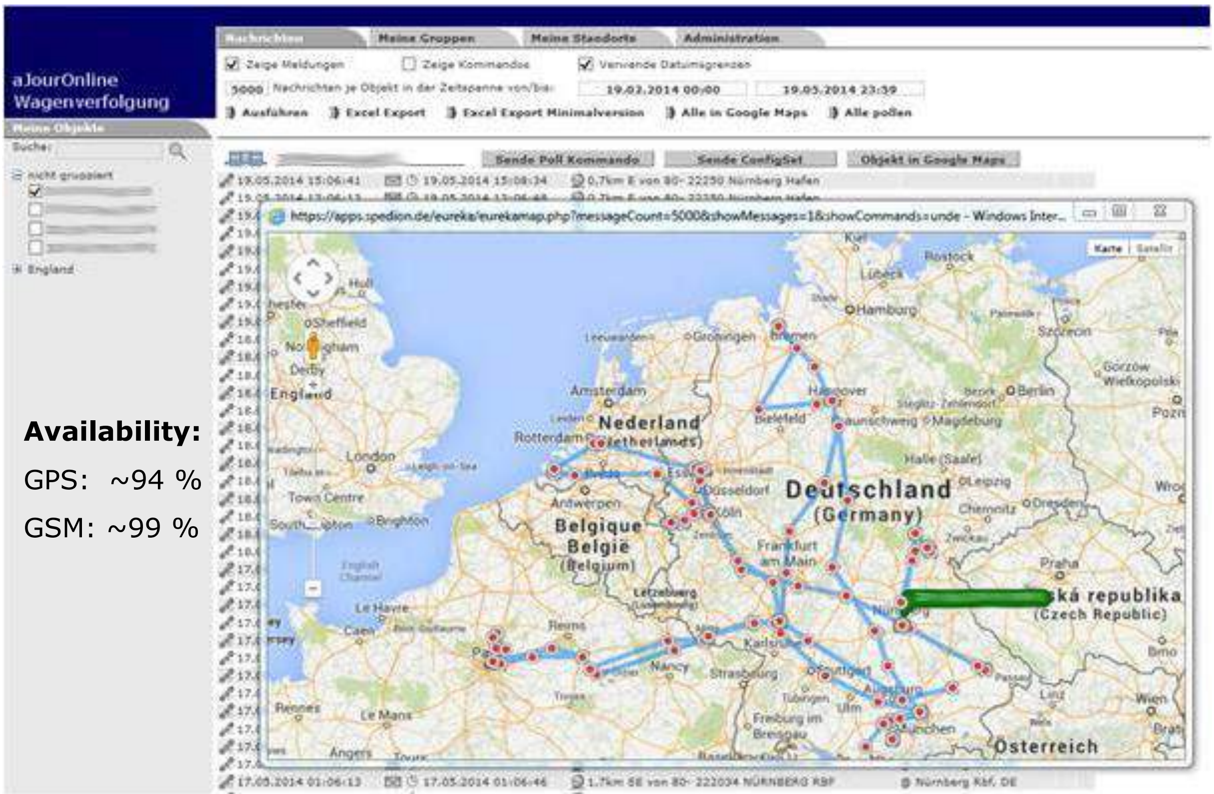
- Increase data transmission frequency by 50 %:

  The missing electric energy supply on existent freight wagons leads to the fact that the telematics devices have to be supplied by battery. Thereby it is an important requirement of the involved stakeholders, that the battery life covers at least a period of 6 years. The standard NavMaster before ViWaS realised a transmission of maximum four positions per day in this required time period. Afterwards the change of the battery was very complex. The new ViWaS generation of "aJour"-Telematics offers clearly improved attributes. Although the capacity of the battery was only slightly increased (+10 %) the device can send 24 positions per day over 6 years (+600 %). This was made possible by new sensors, more energy efficient hardware electronics and a new operation mode which sends positions only when the wagon is moved. During longer standstill, the telematics device is in standby modus and thus saves energy.

- <u>Increase percentage of position availability ≥95 %:</u>

  The former generation used only GPS (with max. 8 satellites) for the location of the wagon. The "aJour" Telematics is equipped with GPS, Glonass and prepared for Galileo, using up to 56 satellites for the location. Thereby the position availability was clearly improved, even under unfavourable conditions. In addition, the Telematics Communication Control Unit (TCCU) enables the location (approximately) via GSM navigation, so that a location is also possible when no satellites are available (e.g. if the wagon is in warehouses or roofed storage areas). All in all, the position availability was increased to at least 97 % in contrast to 80% - 85% before ViWaS. This was proved by a 3-month field test – see Figure 26.

Figure 26: Position availability of 3 month of wagon operation



Source: Eureka

- <u>Increase number of information types:</u>

  In the frame of ViWaS, several important information types were added to the system, which can contribute considerably to the increase of the provided transport quality and the efficiency of SWL services in competition to road based services. The table below gives an overview over the information types provided by the previous NavMaster system versus the new developed aJour TCCU.

Table 5: Information types before/after ViWaS

NavMaster (before ViWaS)	aJour TCCU (after ViWaS)
Position, Speed (GPS)	Position, Speed, **Heading** (GPS)
Next UIC Station, direction, distance to station	Next UIC Station, direction, distance to station
Temperature	Temperature, **Humidity**
Shock X	Shock X, **Y, Z**
Dig input e.g. switch (max 4)	Dig input e.g. switch (max 4)
Analog input 0 – 32 VDC (max 2)	Analog input 0 – 32 VDC (max 2)
Analog output (max 2)	Analog output (max 2)
	Motion + duration, Standstill + duration
	Start time, Stop time
	Loading status (unloaded/loaded)
	Load weight in kg
	GSM cell ID, GSM country
	Wagon/wheelset total km
	Wagon/wheelset daily km

Source: Eureka

Especially the new information types enable enhanced possibilities for the use of rail freight. The knowledge of the Humidity for example helps to prove the transport conditions, which is an important topic for crude steel products. The monitoring of the load weight helps to increase the utilisation while at the same time prevents overloading, which is a crucial issue and could generate additional time and money consuming handling operations if first noticed by starting transport operation or extremely during transport operation. Exact knowledge about the mileage of the wagon avoids unnecessary early or risky late workshop stops.

KPI – New Data Business Model

Besides the data collection, the flexible preparation as well as the customized access or retrieval of data is a decisive factor for the usability. Comprehensive and versatile possibilities manifold and disseminate the benefits of the telematics due to the fact that valuable information are available and customized for different stakeholders. These requirements as well as their set targets in the frame of ViWaS are summarised in Table 6.

Table 6: Overview KPI New Data Business Model

Definition	**Measure** **(compared to initial situation) Reference: CREAM Telematics**	**Target**
TCCU shall give more flexibility to distribute telematics data to the users: - More than 1 data receiver - Different formats XML, CSV, Excel - Different channels FTP, Mail	Number of possible telematics information receivers	Increase the possible number of information receivers ✓
	Number of possible telematics data formats and channels	Increase no. of data formats and channels ✓

Several points of criticism were addressed towards the former system:

- **Access rights:**

  The data can be made available for several people/organisations. However, it is not possible to differentiate between the users. This means that all of them see the same information although they have different backgrounds and interests. Railway Undertakers want and need to know where the wagon is, for wagon owners this information is not of any concern. Either users don't get all information they need (and could get) or users see more information than they are allowed to.

- **Raw data:**

  The data is displayed as it is without further processing and customizing. Evaluations require high manual efforts and are also limited by the data format.

- **Insufficient data export possibilities:**

  Manual data export is possible via the telematics portal. The only export option is Excel, which is in most of the cases sufficient, but dedicated applications require other formats such as XML or CSV.

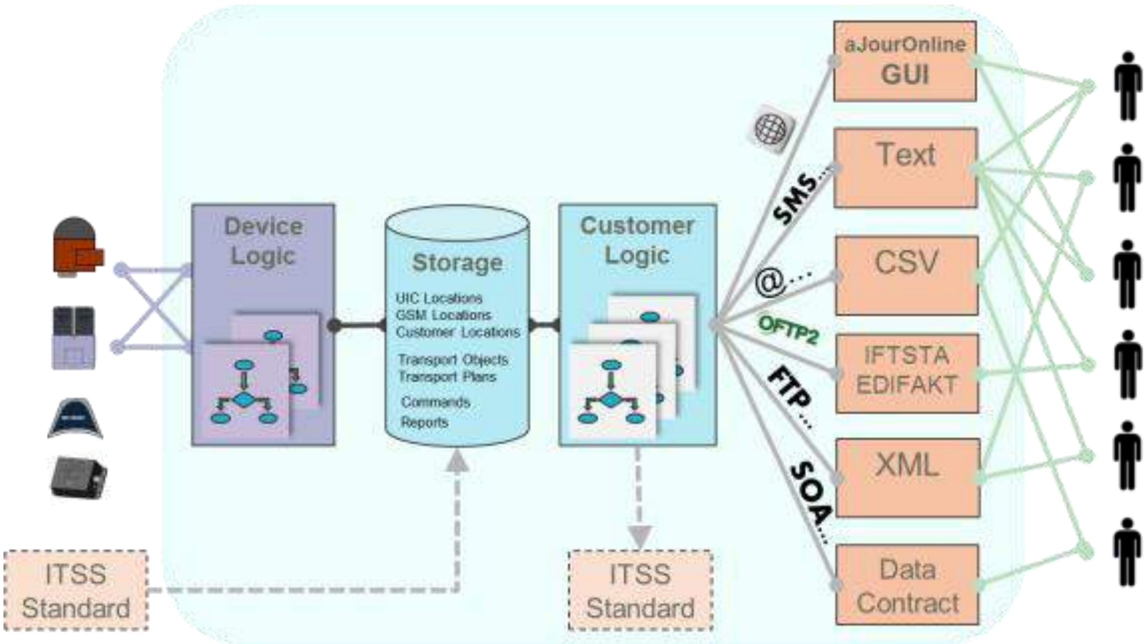
The new generation was thoroughly revised and improved in order to address former criticism. Multi–client and multi-user architecture now enables customers to have several users and sub-users and serve them with dedicated rights and selected information. For this reason, all stakeholders profit from a tailored service. Customer specific logic of data processing as well as the visualisation of data and aggregated information enable dedicated reporting services and thus provide an ideal preparation for efficient processing and evaluation of data.

The number of different data receivers is unlimited, also due to the multi-client capability. The variety of data formats (for export) was also widened, enabling Excel, CSV, various XML and EDIFACT formats.

Eureka and the main suppliers have founded a practise group ITSS (Industrieplattform Telematik und Sensorik im Schienengüterverkehr) for the standardization of telematics messages to the ERP system and a standardized sensor interface. The practise group has now worked out a first draft standard between and is in discussion with possible railway undertakers about a first reference installation of the telematics message interface. This will ensure an open and regulated system, accessible for all actors and hinders the development of isolated applications which is a key for comprehensive implementation.

In all, the usability of the system was clearly enhanced; comprehensive data exchange is possible, while the multi-client architecture distributes the information according to demand and authority (Figure 27). The goals of the New Data Business Model were clearly achieved.

Figure 27: TCCU - Interface architecture



KPI – Load Sensor

The development of the Load Sensor is one of the few but important technological innovations in single wagonload. In intermodal transport, the containers and swap bodies are loaded/unloaded by modern cranes or reach-stackers that are often equipped with a weighing system and thus document the weight of the wagons and the whole train. Such a general detection does not take place in single wagonload although the varying load (or load weight e.g. for dry and wet log wood) would require this action. Moreover, exact knowledge of the wagon weight is an important safety aspect and basis for optimal (in terms of efficiency) loading which is a key for cost optimisation – a major target in SWL. Against this background, the KPI Load sensor was defined as follows:

Table 7: Overview KPI Load sensor

Definition	Measure (compared to initial situation) Reference: CREAM Telematics	Target
Quantity of sensors required for: - Weighing - Loaded/empty detection	Number of Load sensors to be required for an Y25 4 axle wagon.	Weighing: max. 4 sensors Load detection: max. 2 sensors ✓
Information Quality; measure weight accuracy of the load sensor.	Measure sensor results with different calibration weights. Calculate typical and max. weight deviation of sensor.	Max. +/- 3.5 % for wagon overweight detection. Max. +/- 1%for weighing with official verification.

The tests of the Load Sensor are ongoing. The first target of maximum 4/2 sensors per wagon for weighing and load detection is achieved.

5.2.2 Applicability of developed solutions

The production system single wagonload is under high pressure. The decreasing number of private sidings and the competitive pressure through the cheaper trucks are constantly impairing the market share of SWL. In order to keep the current level and possibly increase the volume in some fields it is of vital importance that the available innovations like telematics are spread comprehensively. Possible application fields for the telematics are manifold, at the same time the installation is simple and the benefits are high. The following major aspects underline the positive effects:

Monitoring of transport and increase of transport quality

The sensors, especially the GPS sensor with its detection of position, speed, heading and movement/standstill make constant transport monitoring possible. The theoretical transport plan can be compared with the actual transport which gives the possibility to intervene in case of need.

Emerging deviations with negative impacts (e.g. delays at borders, delays due to changed routing) can lead to claims against a third party. Telematics document these deviations and help to identify responsible organisations.

Secondly, transported goods in SWL often require certain conditions. This applies e.g. to crude steel products, which can be impaired by high humidity or chemical products that have to be transported very safely without vibrations or shocks. As before, the sensors detect and document these parameters and thus help to ensure a high transport quality or to assert compensation claims in case of insufficient quality.

Increase of efficiency

Telematics also help to increase the efficiency of the wagons. This is especially due to two reasons. Exact knowledge about the mileage of the wagons enables workshop stops at the optimum time. Too early stops, which don't exploit the full optimum mileage and thus cost money due to the replacement of still suitable material, are avoided. At the same time the risk of too late stops, which might impair the high safety standards (and in case of an accident lead to unmanageable damage claims) is more or less eliminated.

Without a suitable track balance or on board weighing, loaders tend to load less than possible in order to stay on the "safe side". The risk of overloading is high and a wagon which runs with overload (so called dynamic overload) has to be intensively checked immediately. The problem gets even worse, in case an overloaded wagon is involved in an accident, leading to reduced insurance cover or further damage claims. On the other hand, underweight leads to higher transport costs per tonne than possible, which is dramatic in the light of the competitive situation of SWL.

For the weighing of wagons, special track balances exist, which are quite rare due to their complexity and costs. Only correspondingly large sidings (e.g. of steelworks) have own track balances. Wagons that start in small private sidings often have to take detours with up to 200 km on top to reach the next track balance. At this point, the load sensor eliminates several disadvantages and optimises the full exploitation of payload. A very good example is the transport of log wood. While a wagon might be capable of 80 dry logs, the maximum payload might be reached with 65 logs when they are soaked wet. Experienced wagon keepers know about this and they also have "an eye" for the weight of a loaded wagon, but this "measurement" is always afflicted with inaccuracies.

Improved applicability through proper return of investment

It is at first important that both, the investors (wagon owner) as well as the renting companies (e.g. the wagon keeper) have a proper return on investment for the equipment of their wagons with telematics in relationship with the wagon user, who is in charge to generate the dedicated advantages due to the added value of the telematics. Therefore the costs for the equipment are reflected in a slightly increased rental fee. Over 6 years, the costs for the equipment and operation of a wagon with telematics costs 1,534.00 € (see Figure 25), which is equivalent to 0.70 € per calendar day [1534.00 € : 6 * 365 days per year].

The average rental for a wagon used for SWL freight services is typically about 25.00 € (based on internal knowledge and expert interviews). For wagons with telematics, the additional amount is calculated of about 1 € including about 0.30 € interest rate for the investor.

Based on the experience of the usage of freight wagons in SWL, the turnaround time of the wagon to the next reloading is about one week in national transport (collection, loading, main trip, unloading, return). This results in about 50 transports per year (52 weeks, two weeks loss) and costs the provision of the wagon of 182.50 € per transport. Existing wagon fleets equipped with telematics, demonstrate an increased efficiency of about 10% due to reduced turnaround times and therefore to an increased utilisation rate of about 55 paid transport circulations per year. Thus, the costs for the provision of a wagon are reduced from 182.50€ by 10 € to 172.55 € per circulation. For 55 transport circulations, this results in annual savings of 550.00€ per wagon and year. Thereby the equipment of wagons with telematics pay off already three years after the investment (under this general conditions). This means, that even under unfavourable conditions (e.g. a reduced efficiency increase of 5%) the investment in telematics pay off, including the interest rate for the wagon owner. Recent experiences of Eureka based on current tenders document increased demand for the equipment of wagons with telematics and thus prove that all stakeholders are more or less convinced by the benefits.

Table 8: Cost example

	Before ViWaS	After ViWaS
Telematics costs per day	-	0.70 €
Wagon rental per day	25.00 €	26.00 €
Transport circulations per year	50	55
Costs per transport circulation	182.50 €	172.55 €
	~ 10 € savings per transport circulation	
Cost savings per year (55 circulations)		**550.00 €**

5.2.3 Requirements for further modifications

Although great advances have been realised during the past two years of ViWaS, several requirements for further modifications have been identified which are already addressed now or will be addressed in the years to come:

Official recognition of the Load sensor measurements

So far, the load sensor provides internal and unofficial information about the weight of the wagon or its load. An officially recognised result would facilitate controls of the transport authorities and the load sensor could also be used for commercial invoices of transported goods, e.g. transport of scrap metal and billing per tonne. This would save an additional manual weighing of the transported good. For the official recognition, the accuracy and reliability of the load sensor need further refinement. Afterwards the extensive tests are carried out under various conditions to prove the quality of the measurements.

ITSS (Industrieplattform Telematik und Sensorik im Schienengüterverkehr)

For comprehensive implementation of telematics in European SWL services, it is of vital importance that the products of different manufacturers are compatible in terms of their data interfaces. The definition of a common standard among all manufacturers, which is already ongoing, has to be further advanced so that isolated solutions do not develop and thus do not reduce the potential of the telematics in rail freight.

5.3 Deployment of developed solutions

Framework conditions

In order to facilitate the breakthrough of telematics in rail freight, suitable framework conditions have to be provided, which means that the topics funding and (voluntary) commitment have to be addressed:

Funding

According to expert estimates of Eureka, between five and ten percent of the (SWL) wagons in Europe are equipped with telematics. For noticeably improvements in SWL on European level, an installation rate of 70 to 80 % would be necessary. Without additional incentives, the deployment will increase very slowly, although existing customers are satisfied with the telematics and its benefits. Two examples show, that the equipment of wagons with telematics is a typical case where national or European wide funding is recommendable:

- German "De-minimis" program[2]

  Germany supports the equipment of trucks with telematics that increase efficiency, with up to 2,500.00 €. As indicated above, the total costs over six years for wagons telematics are only about 1,550.00 € and an efficiency increase is given, too. Moreover, the support of rail telematics is even more sustainable since it contributes to the modal shift and the rail equipment is used much longer than truck equipment.

- Conversion to low noise brakes[3]

  The costs for the conversion to low noise LL soles sum up to about 1,700.00 € (quite similar to the equipment with telematics), of which 50% are given as support by the German state.

This shows that a possible future support of the rail freight telematics corresponds to the size and intention of other support programmes.

(Voluntary) commitment to increase safety standards:

In general, rail transport is the safest transport option, especially for dangerous goods, provided that infrastructure and vehicles are well maintained. Information about freight wagons operating in SWL services are mainly gathered by manual methods (evaluation of transport circulation plans etc.). This procedure is very error prone and time consuming. However, the exact knowledge about the mileage of the wagon is important, otherwise wagons might run significant more kilometres between their workshop stops than allowed. With the increasing mileage, the risk of failures and material fatigue goes up and severe accidents might occur.

In 2009, such an accident took place in the Italian city Viareggio when a freight train of 14 tank wagons derailed and exploded. 32 people were killed, 27 injured and immense property damages took place. A possible reason is that a defect in one of the axles occurred which then caused the derailment. This shows that the maintenance of wagons has to be a top priority and supporting measures such as the mileage counter have to be used wherever possible to increase safety, especially if these possibilities are cheap and promise further advantages. Against this background, a (voluntary) commitment for the use of mileage counters seems duly recommendable in order to have a major contribution to rail safety.

[2] http://www.bag.bund.de/DE/Navigation/Foerderprogramme/Deminimis/Deminimis_2015/demin15_node.html#doc1035468bodyText1

[3] https://www.vdv.de/vdv-vpi-positionspapier-laermminderung-schienengueterverkehr.pdf

6 Modular wagon technologies based on the Flex Freight System

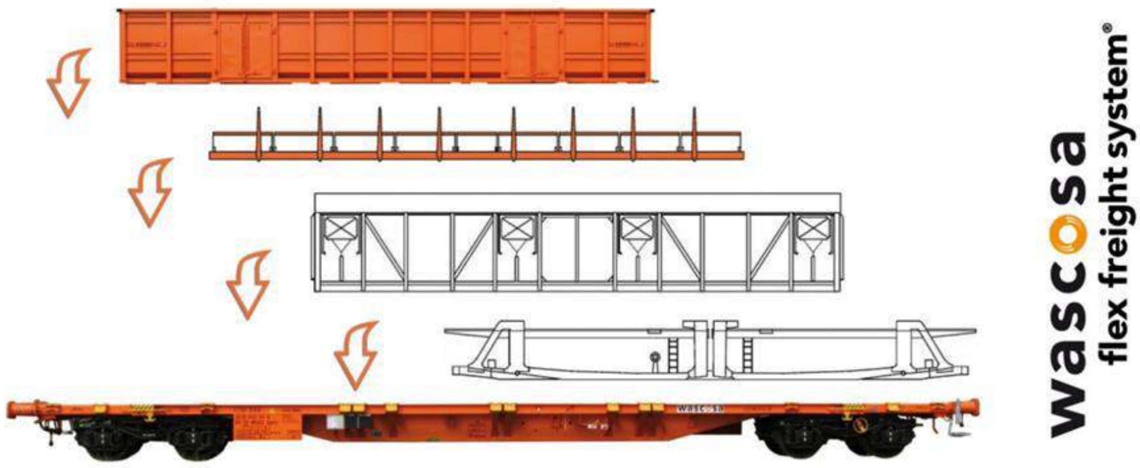
6.1 Business case(s) at a glance

Efficiency of single wagon load freight traffic is directly connected to the mileage with payload: High mileage with payload equals low costs per tonne-km. To reduce the amount of empty wagon transport the single wagon has to become more flexible. The wagon has to able to carry different types of cargo.

Flex Freight System

The flex freight system© of Wascosa strives for the modularisation of the freight wagons by separating the running part, this is wagon frame and bogies, from the actual logistic part of the wagons, which is the attachment adapted for any transportation and logistics need.

Figure 28: Wascosa flex freight system ©



Source: Wascosa

By this it is possible to introduce a degree of freedom when an operator is addressing different markets with a standardized type of wagon.

The framework conditions for this kind of product are very similar to those that have propitiated the breakthrough of the container transportation, or the containerisation.

The containerisation is a consequence of the standardization of the transportation units for an efficient and compatible handling at ports, vessels trains and trucks. In the case of the maritime container this standardization was not really adopted as a result of a consensus between many parts, neither companies nor countries, but more as a "trend following" and adoption of an existing standard that proved to be efficient for a certain use. A prove of that is that maritime containers are not so good for inland transportation in Europe because the pallets dimensions used here are not coherent with the internal dimensions of containers. For these reasons pallet-wide containers are used, among them the 45 feet containers.

ViWaS approach

The Flex Freight System of Wascosa has been further developed within the ViWaS project. The newly developed components (Flex Freight Car, Flex Freight Car 45’, Timber Cassette 2.0) have been designed for specific use cases and partially tested in real life situations. The following sections provide an overview on the relevant use cases.

‘Flex Freight Car’

The use of the Flex Freight Car for the loading and unloading of maritime containers in railway sidings has been tested extensively within the ViWaS business case “Swiss Split 2” (see chapter 2).

Another use case deals with the transport of 45’ cooled containers from Antwerp and Bremerhaven to Switzerland. In fact this transport will be also organised within the Swiss Split system. For the loading and unloading operations of the container in the railway siding it is necessary to provide a certain forklift operation area on the wagon. This would be not possible if the 45’ container would be positioned in the middle of the wagon as it is the normal case for the transport of 45’ containers with 60’ wagons. Consequently, a second prototype of the Flex Freight Car has been developed that enables the transport of 45’ containers at the wagon end. The 45’ Flex Freight Car will be delivered in December 2015. Therefore test operations are scheduled after the end of ViWaS period.

‘Timber cassette 2.0’ - functionalities and usage instructions

In 2010, Wascosa has presented the first flex freight unit for timber transports that is a major market for SWL. Within ViWaS, the so-called timber cassette has been further developed according following design goals. It should be

- compatible for intermodal handling equipment
- foldable and stackable on standardised twist lock positions

Three units of the prototype ‘timber cassette 2.0’ were delivered in August 2014. The main characteristics of the delivered cassettes are as follows:

- Base of the module is a 20’ frame to be placed on a standard 20’ position with container spigots.
- The module can be handled by both fork lift and reach stacker.
- The empty modules can be stapled on each other.

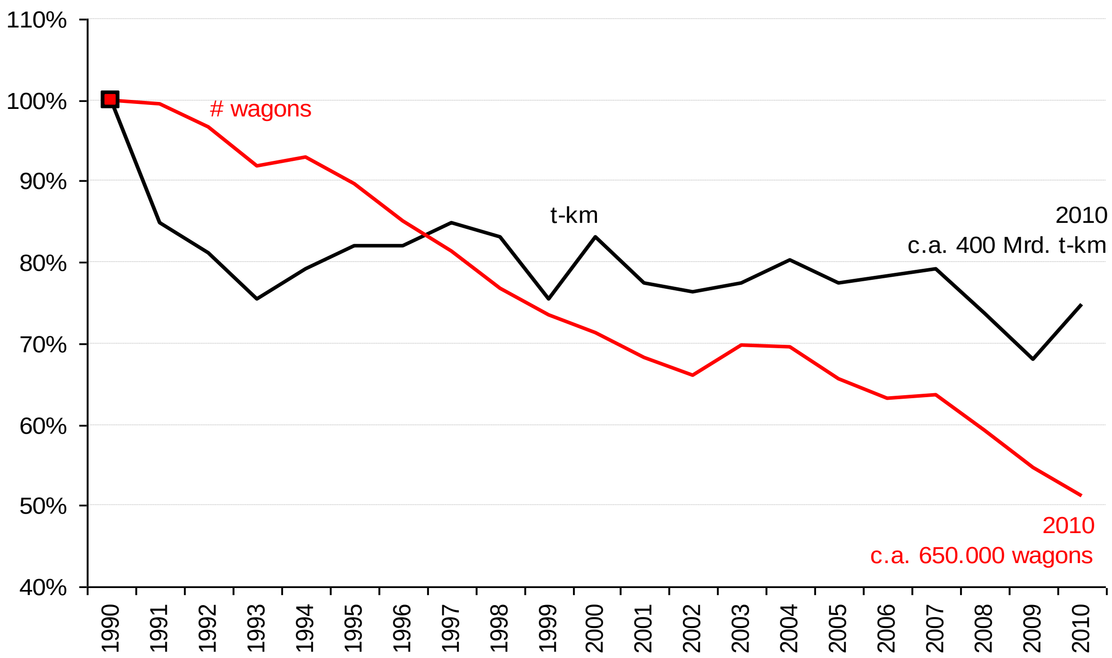
Core data e.g. regarding technical details and owner are displayed by the inscriptions on the cassette (cp. chapter 6.4.2).

6.2 Background

6.2.1 The market types of railway wagons

In European rail freight transportation the total amount of freight wagons has been gradually decreasing at an approximate rate of 3% per year until reaching approximately 650.000 units in the year 2010, on the other hand the offered tkm has been stagnating or slightly decreasing to reach around 400 milliard tkm in 2010 (UIC stats and Eurostat 2011) – compare .

Figure 29: Amount of wagons vs. rail freight performance



Source: Phd. Armando Carrillo Zanuy TU Berlin 2012, Data Source: Eurostat And UIC 2011

This mirrors the actual trend of utilising more efficiently the available wagon fleet, which is achieved by increasing the amount of productive km (loaded km) the wagons make per year.

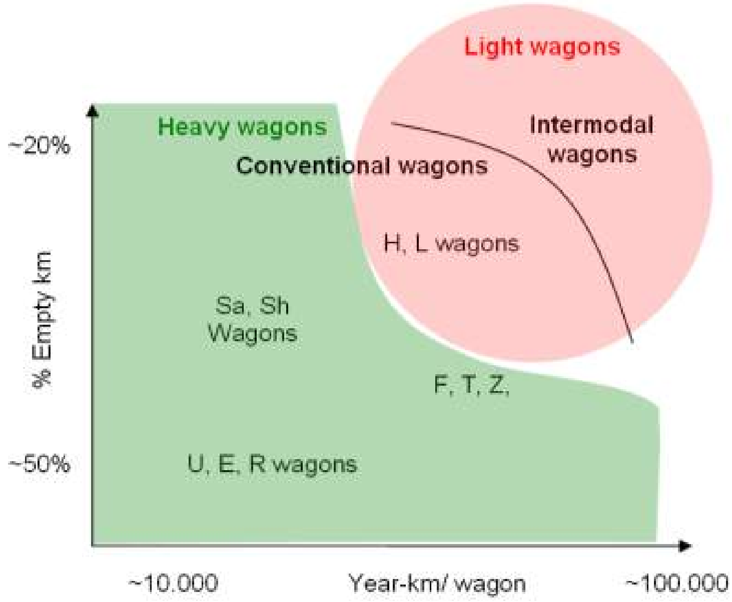
An important part of this overall wagon efficiency can be attributable to the exhaustive utilisation of intermodal wagons, which have found a good place to perform in the globalised market of containerisation.

Intermodal wagons usually carry lighter cargoes that have high value, typically, the higher the value of the cargo the lighter it is and the more exigent in respect to quality standards, especially concerning security and safety.

Conventional wagons have the optimal physical and technical characteristics to transport some specific kinds of commodities – usually with lower value per ton – and fail in being versatile for other transports. There are exceptions as the H and L wagons that address general (palletised) cargo which have high value too.

The production system in which wagons are utilised has as well an important effect on the productivity. Then so, intermodal and company-dedicated wagons tend to run in point-to-point direct configurations with short turn-over times, while other conventional wagons may make use of the single wagon load system where they can be re-marshalled many times, reducing by this their total yearly mileage. A compromised solution has to be found to increase mileage while being flexible ().

Figure 30: European wagon productivity



Source: PhD. Armando Carrillo Zanuy TU Berlin 2012 data source: Eurostat, UIC 2010, [DB Wettbewerbsbericht 2010] and internal knowledge

The graph shows that the light wagons do much more loaded kilometres per year than the heavy wagons and that he intermodal wagons, a sub-group of light wagons, are the most efficiently employed overall.

The flex freight system of Wascosa intends to increase the amount of productive km of the wagons by introducing a modular system.

6.2.2 Examples of multipurpose applications with intermodal wagons

Examples of multipurpose applications involving intermodal unit carrying capability are shown in the figures below:

Figure 31: Inter Ferry Boats/B-Cargo Eaos gondola loaded with containers

Source: André Schachtschabel, 2005

Originally built to carry a variety of commodities such as coal, logs and scrap metal. Doors removed.

Flat wagons with a complete floor are frequently adapted to container loading by installing container guides or pedestals, while retaining their suitability to traditional flat wagon loads, such as vehicles, lumber and steel mill products.

Figure 32: PKP Cargo Kgns wagon with folding sides, side stakes and container pedestals for multiple commodities

Source: André Schachtschabel, 2007

Figure 33: B-Cargo Res/Regs wagon for containers and multiple commodities such as steel shapes and plates

Source: Denis Verheyden, 2005

Wooden floor, hinged stakes. On Regs, lateral guides are installed to align containers.

Figure 34: FS Rgs wagon for containers and multiple commodities such as steel shapes and plates

Source: Antonio Scalzo, 2007

Wooden floor and hinged stakes.

In Scandinavia container and log carrying capability has been combined in dual-purpose Sgs wagons since the 1970s.

Figure 35: Green Cargo Sgs wagon designed for dual commodities: containers and logs

Source: Anders Karlsson, 2011

End bulkheads, side stakes and cross beams. No floor to avoid bark and snow accumulation.

Figure 36: Sgns with stanchions

Source: BJ, ~2010

Large numbers of standard Sgns(s) container wagons are fitted with ExTe log bunks and in many cases end bulkheads. The larger log bunks (SR 12) must be removed if containers are to be loaded, due to the large corner radius inside the log bunks (to limit stress concentration). No floor to avoid bark and snow accumulation.

Figure 37: Ahaus Alstätter Eisenbahn Sgns container wagon for multiple commodities: containers, packaged lumber and logs.

Source: ExTe, 2010

ExTe log bunks (side stakes and cross member) type SR 8 with small corner radius, cross beams to protect the underframe from damage by log grapples, and foldable container pedestals. No floor to avoid bark and snow accumulation.

Figure 38: Loading of woodchip container onto Ahaus Alstätter Eisenbahn Sgns container wagon with ExTe SR 8 log bunks

Source: ExTe, 2010

Figure 39: Installation of ExTe SR 8 log bunks and cross beams on Ahaus Alstätter Eisenbahn Sgns container wagon

Source: ExTe, 2010

Figure 40: Insulated superstructure "Maxi-Låda". Fitted onto Lgjs container wagon

Source: BJ

Figure 41: Insulated superstructure "Maxi-Låda" with cooling unit fitted onto Lgjs container wagon

Source: Green Cargo

The Maxi-Låda ("Maxi-Box", Capacity 33 Euro pallets. Inside dimensions: 13.544 m x 2.545 m x 2.700 m. Designed to be lifted empty only.) Insulated superstructures on Lgjs container wagons in Sweden, which were not capable of being lifted in loaded condition, have been phased out and replaced by "Jumbo-Containers" which are capable of being lifted laden.

In North America the same wagons have often been used for both containers and semitrailers, 89 ft (27 m) flat wagons fitted with container pedestals and trailer hitches. Since the 1980s container handling has shifted to double-stack container wagons and has increased dramatically and attracted new traffic off the road, whereas trailer handling has declined.

Occasionally containers have also been handled by mill gondolas, i.e. open-top wagons with fixed side and end walls, primarily used for steel mill products.

6.3 Framework conditions for ViWaS business cases

In ViWaS, two particular cases of the flex freight system have been addressed, namely:

- Timber cassette 2.0, an intermodal detachable cassette for the transportation of forestry products, round wood and timber
- Flex freight system 45 feet solution, new spigots for permitting to place the 45 feet containers at the edge of the flat wagons (now only possible at the centre)

A brief analysis of the framework conditions for these cases is depicted as follows.

6.3.1 Flex freight system for timber and forestry products

The developed solution covers a particular case of transportation which is very much dependent on the existence of a demand and a supply of forestry raw products. In this way, the European forestry industry consumed about 390 million m^3 of industrial round wood in 2014, being the major producers Finland, France, Germany, Poland and Sweden. It is a market with an average stabilized growth of 3% (2010 to 2014). For this reason it is possible to assume a favourable market framework for these kinds of transportations in which the timber cassette may gain applications.

Another framework condition for these kinds of transports is a weather-dependent one, being this the case of unpredictable storms that may tear down important areas of forest, imposing by this an obligation to collect the wood to avoid getting it lost and/or perished.

The project team of ViWaS identified very well the intrinsic unbalanced condition of the transportation of round wood, which in almost every case secures a full loaded transportation on one sense (forest to mill) but an empty demand in the contrary.

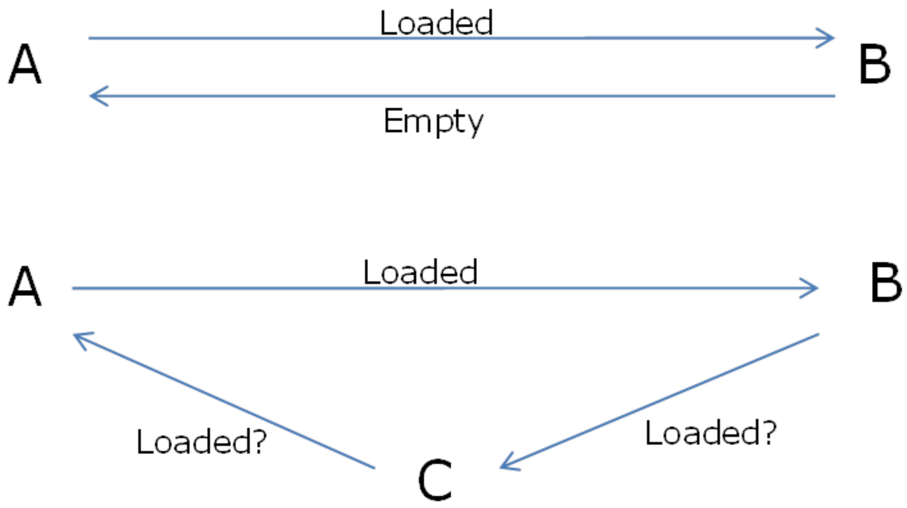
The framework conditions of the Wascosa timber cassette 2.0 also refer to the supply side, being this aspect referring to the production systems that railway transportation utilizes for achieving the actual transportation of round wood.

In many of the cases of wood transportation (raw timber, round wood, cut and clean timber) the preferred production system is the full train. In this case, a complete train with one client, one operator and one consignment runs from origin to destination back and forth.

The railway operator becomes a payment from the client for the transportation of wood in one direction and it is responsible of having again an empty train at the origin for being loaded again.

If the operator is performing this transportation with specialized wagons that only can transport one kind of good, round wood, then the operator is almost obligated to run empty towards the origin without the possibility of doing a "C" circulation for finding backloads.

Figure 42: Direct circulation vs. "C" circulation



The Wascosa timber cassette 2.0 adds flexibility into the system because it is detachable and this enables to apply other production systems that may increase the logistics possibilities for the wagons and the cassettes.

Furthermore the project team has produced a timber cassette that is able to be stacked, to reduce the space it occupies when it is stored and more importantly it can be transported in less space when the trains are running empty.

The other typical production systems of the railways, namely: single wagon load and combined transportation also represent important frame conditions for the application of the timber cassette.

In the case of the combined transportation the advantage is clear as the cassette employs the same kind of wagons employed for the transportation of containers, swap bodies and semitrailers. Provided that the combined transportation usually employs the "shuttle" production system, the important advantage is the possibility to detach the cassettes and handle them as if they were containers. This opens the complete logistics systems of combined transportation in order to find alternative routes and alternative destinations which do not necessarily have to have a railway access. Furthermore the cassettes may be delivered to origin for load by road (if necessary) and repositioned by road if this mode is more convenient.

Figure 43: Wascosa timber cassette 2.0 as intermodal unit

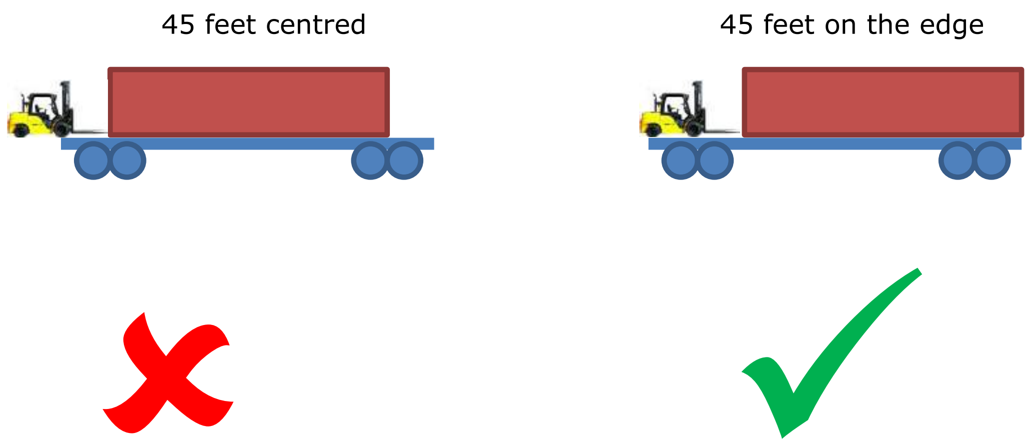
The production system of the single wagon load offers even a more flexible situation in which the timber cassette can be employed at its most logistics capacities. The possibility to detach the cassette, even with the wood loaded, provides a number of possibilities in which the single wagon load could be very profitable. In so doing, the wagon employed for the delivery of the woods can be rapidly put into circulation for other uses – even for intermodal- while the woods are being received at the destination. It is not necessary to assume that this wagon will be used to reposition the empty cassettes as this can be done by another wagon which will take a stacked amount of them.

Furthermore, the single wagon load can deliver some wagons with enough stacked cassettes that can be loaded at the origin without being necessary to have a train waiting the whole time.

6.3.2 Flex freight system for 45 feet container (new position)

The basic idea is to provide a new position for the 45 feet containers in 60 feet wagons so that a forklift can drive comfortably onto the wagon and unload the goods from the container without needing to handle it with a crane ().

Figure 44: Flex freight system for 45' containers on the edge



As a consequence it is necessary to adapt the 60 feet wagon with extra spigots to be able to allocate the 45 feet container in the edge position, so the forklift can operate comfortably.

Furthermore it is necessary to provide a floor; this is done with an iron grid that covers the gaps of the wagon surface.

Figure 45: Flex freight system with iron grid inlays

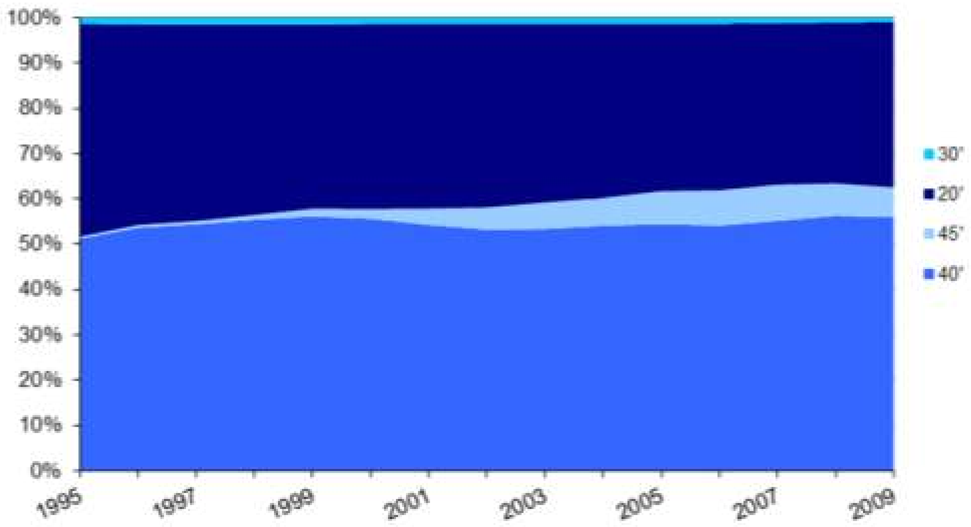
Source: Wascosa

Market of 45 feet containers

The 45 feet container has not really made it through the overseas transportation, understanding by this the routes of the big ocean carriers that for example bring containers from China using the long distance maritime routes. The 45 feet containers are used mostly in European internal markets and if transported by sea they are mostly present in routes with Northern Europe and the UK.

Nevertheless, the market for 45 feet containers is growing at a constant pace and it may become during the next decade very important in the European ports.

Figure 46: Container lengths at Rotterdam Port

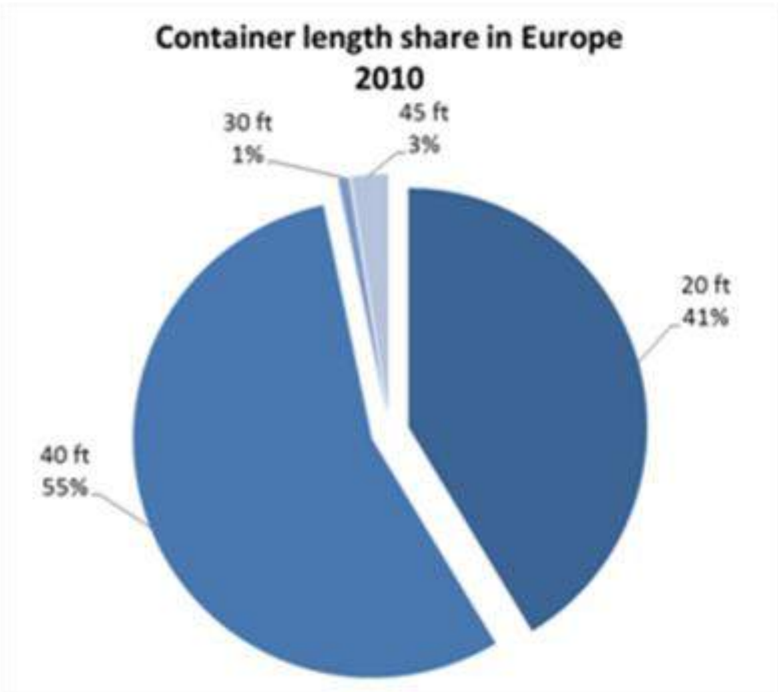


Source: PhD. Armando Carrillo Zanuy TU Berlin 2012

This trend is comprehensible as the 45 ft containers do fit much better the pallets of the European market; they fit 33 euro-pallets, and do make use of the whole loading length of the European trucks, which is about 13.6 m.

In 2010 the share of 45 feet containers in the European market was of only 3% but with a clear ascending trend ().

Figure 47: Container length share in Europe (total containers)



Source: PhD. Armando Carrillo Zanuy TU Berlin 2012

The trends on container length use are visualized in the following table:

Table 9: Trends in container use

Container type	Length (m)	Width (m)	Height (m)	Tare (kg)	Max. gross weight (kg)	% of total dry containers	Averaged gross weight loaded (kg) 2010
20 ft dry standard	6,096	2,438	2,591	2.230	30.480	41% (trend ⇘)	19.500
40 ft dry standard	12,192	2,438	2,591	3.700	32.500	23% (trend ⇩)	22.500
40 ft dry high cube	12,192	2,438	2,896	3.830	32.500	33% (trend ⇧)	22.500
45 ft dry high cube	13,716	2,438	2,896	4.000	32.500	3% (trend ⇗)	23.000

Source: PhD. Armando Carrillo Zanuy TU Berlin 2012

There is a manifest increasing trend on the use of 45' containers (Eurostat 2011); it is envisaged a further growth of this unit length in European ports (short sea shipping and deep ocean shipping), railway terminals (continental and hinterland) and European road transportation, as it matches with the maximum allowed semitrailer dimensions in Europe.

6.4 Business cases timber cassette 2.0

6.4.1 Fulfilment of initially defined success criteria

The main KPI of single wagonload transport on rail are the empty mileage costs. Thus the KPIs of timber transport on rail with cassettes are both

- empty mileage costs of the wagon and
- empty mileage costs of the cassettes.

In order to improve these KPIs (and thus making timber transport in single wagonload more efficient) both availability and usage of wagon and cassettes have to be increased.

To increase wagon availability the cassettes have to be stackable when empty (cp. Figure 50). The stanchions have to become foldable.

To increase cassette availability already the first non-stackable cassettes were designed for usage on both road and rail.

Figure 48: Non-stackable timber cassettes on Wascosa flex freight system ©

Source: Wascosa

Therefore the main characteristics of the new timber cassette 2.0 are

- Base of the module is a 20’ frame to be placed on a standard 20’ position with container spigots.
- The module can be handled by both fork lift and reach stacker.
- The empty modules can be stapled on each other.

When not needed for transport, the cassettes will be stapled and therefore only use a few 20’ positions on the train. The remaining load positions of the train can e.g. be used for containers, swap bodies instead of running empty.

6.4.2 Applicability of developed solutions

The new timber cassette 2.0 was developed as a 20’ cassette for intermodal transport.

The cassette has been designed to be handled both, empty and loaded by fork lift. If not handled loaded, the payload of the cassette is even 12t higher.

The distances between the stanchions of the cassette enable transport of 2, 3, 4, 5 and 6 meter long timber, which are the normal European length.

The loading area of the timber cassette 2.0 is due to the intermodal use which restricts the maximum width and the international rail gauge G1 to 5 m2.

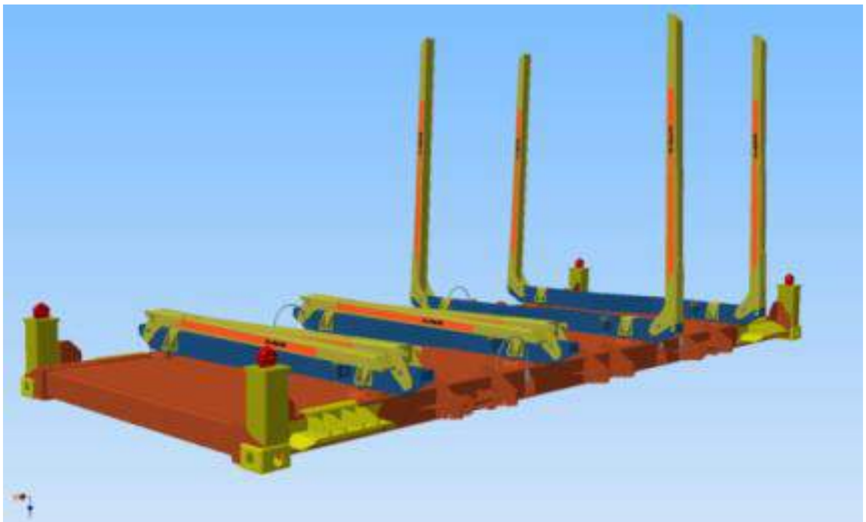
- Timber cassette 20'

- Cassettes / 60' container car 3
- Tare per cassette 2,13 t
- Tare per wagon 23,80 t
- Max. pay load per cassette
    - Handle loaded cassette with fork lift 17,87 t
    - No handling of loaded cassette 29,87 t

- Pay load per 60' unit
    - Handle loaded cassette with fork lift 53,61 t
    - No handling of loaded cassette 66,20 t
- Loading lengths 2, 3, 4, 5 and 6 metres
- Loading area (G1) 5,00 m^2

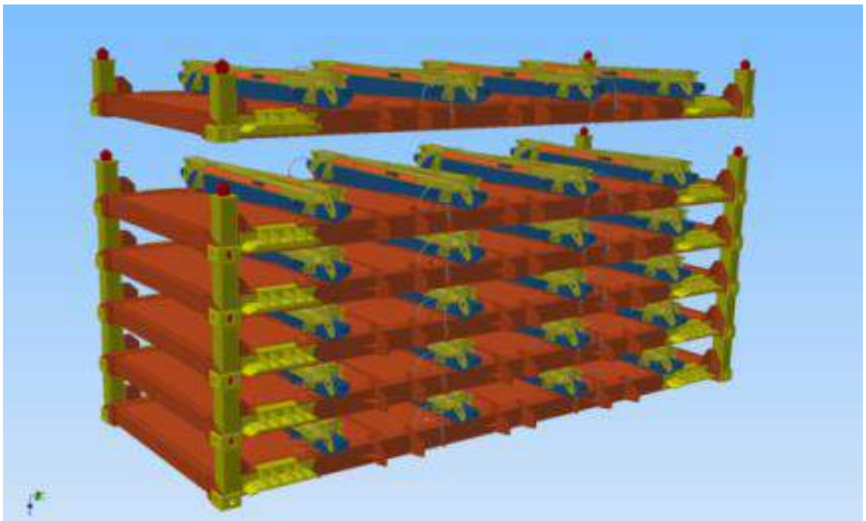
During the design phase the idea was to staple six empty cassettes on each other. Due to stability and gauge restriction this was impossible to achieve. When empty the stanchions of the cassette have to be folded down for security reasons (too much vibrations when the wagon running). Maximum four of the empty cassettes can be stapled on each other. The figures below give some impressions from the timber cassette.

Figure 49: Design study of the stackable timber cassette



Source: Wascosa

Figure 50: Timber cassettes stacked



Source: Wascosa

6.4.3 Requirements for further modifications

Today the three main types of rail freight cars for timber transport in Europe are

- Roos-t
- Snps and
- Sps

Figure 51: Roos-t, Snps and Sps wagons

Source: Wascosa

Roos-t wagons are designed for transport of long, heavy goods, especially for needle, beech and oak logs as well as for lumber. The Roos-t wagons are equipped with permanently installed binding devices and stanchions which can be installed according to the length of the timber/lumber, the three existing types are all only 80t gross load wagons. Thus the maximum payload is only 52 to 55 t.

Snps wagons are designed for transport of tubes and logs as well as sectional and flat-bar steel. Characteristics of Snps wagons are high payload capacity and optimised devices for securing the cargo. In order to protect the cargo, the stanchions of Snps wagons are equipped with plywood bracket and plastic heads. The wagons are equipped with 8 especially broad and strong stanchions on each side which are permanently connected to the wagon structure. For securing the cargo each pair of stanchions is equipped with a binding device which can be handle be one single person. Snps wagons are 90 t gross load wagons and can carry payloads up to 63 t.

Sps wagons are designed for transport of tubes and logs as well as sectional and flat-bar steel, but only for a payload of maximum 53 t (80 t gross load). Because of the location of the stanchions, the minimum length of the cargo on a Sps wagon has to be 3 meters.

The prototype cassettes were running in SBB trains carrying timber from the South of Switzerland to a customer close to Lucerne. According to current freight charges of SBB, the customer has to pay a minimum tonnage depending on the type of wagon and the type of timber. For the prototype wagon, the charges for Snps wagons were applied, which is 50 to 55 t for the different types of timber.

Because of the requirement for intermodal usage the loading gauge of the timber cassette 2.0 is so small, that this tonnage cannot be used completely.

- In 45 train runs the prototype wagon did carry an average pay load of only 40 tonnes.
- Snps wagons SNPS do carry a pay load of 52 – 53 tonnes.

So the customer had to pay for 50 to 55 tonnes pay load (depending on the type of timber), whereas only 40 tonnes on average have been carried. Of course also the standard wagons sometimes carry less than the maximum because of bad timber quality. But this does not happen regular, whereas the intermodal timber cassette 2.0 nearly never uses the maximum payload.

So the next generation of timber cassette should be optimised for rail only, using the complete G1 gauge. This issue is also displayed in the table below:

Figure 52: Capacities of different versions of the timber cassette

	Rail and road (bi-modal)		Timber cassette optimised for rail
	Timber cassette	Stackable timber cassette	
Loading gauge (G1)	5.0m²	5.0m²	5.5 m²
Payload per wagon (3x20' cassettes)	66.4t (no handling of the loaded cassettes) 53.79t (handling of the loaded cassettes)	66.2t (no handling of the loaded cassettes) 53.61t (handling of the loaded cassettes)	67.8t

Source: Wascosa

Further application cases

In this section some of the applications in which the Wascosa timber cassette 2.0 could be employed are discussed:

Stackability

The simple calculation below provides an idea, the advantage of stackability brings for further applications:

- Train composition: 24 Sgns wagons
- Amount of cassettes: 24*3= 72 WTC2 (Wascosa Timber Cassette 2.0)
- Loaded circulation from origin to destination
- Amount of stackable cassettes: 4
- Necessary wagons to reposition the cassettes: 72/4/3= 6 wagons
- Available wagons for other circulations while being repositioned: 18
- Gain of available capacity 18/(24+24)= 38%

However the advantage requires a further logistic organisation of the operating company who should find the back loads for the empty wagons. In this way, a successful finding of loads may lead to revenues.

On the other hand, the cassettes need to be folded and stacked, which requires extra personal costs and crane movements.

The project team of ViWaS recommends a further project on definition and investigation of the logistic properties of stackable containers and modular attachments to the standard wagons.

Detachability

The utilisation of the detachable cassette enables that the train does not necessarily have to be present at the destination or origin while the wood is being loaded or unloaded. This leads to a more flexible utilisation of the wagons and frees the logistic restraint of having the cassette (or cassettes) joint rigidly to a particular wagon. In this case the increase of the availability of the wagons is of 100%, which means that these wagons can be utilized for other purposes while the loading and unloading operations take place.

Again the project team of ViWaS recommends a further study of the logistic implications of detachable units when introduced in the railway production systems.

Storage ability

Another very interesting application would be storage capacity that the cassettes are offering. In some markets of the transportation of petroleum products and other chemicals the companies employ the tank wagons -cisterns- and/or the tank containers to storage the products they may need during an unpredictable and unstable demand situation.

The same concept can be here applied to the timber market, which can be also conveniently and cleanly stored. This enables a fast adaption to an unpredictable demand.

Introduction in the intermodal network

The detachability of the cassette converts it in an intermodal unit, for this reason the application and use of it in intermodal markets results evident.

On the other hand it should be possible to deliver (and to gather again) racks of stacked cassettes where they are needed, being in this case the rack treated also as an intermodal unit and therefore following the same paths. It has to be mentioned that the cassettes can be also delivered by road and therefore they enable a proper intermodal transportation.

The ViWaS team recommends to further study the intermodal possibility and applications of the timber cassette.

Vehicle cassette

As an example for many other single wagon load freight systems with expensive empty wagon transports the ViWaS project aimed to develop a solution for the company LION Spezialtransport GmbH, a rail freight forwarder located in eastern Germany.

LION was running trains with containers and tractors from Bremerhaven to Medyka at the border between Poland and Ukraine. On the way back they want to ship lumber. The Ukrainian sawmill is located about 60 km away from the border. Transport from sawmill to the border station was planned to go on road. In Medyka LION wanted to put the lumber on the same train, which has been carrying the containers and tractors.

The North American tractors are shipped on 2axle 40’ short coupled platform wagons with integrated wheel chocks from Bremerhaven to Medyka. One train consists of 8 short coupled 2 x 40’ units plus several 6axle 80’ container flats. It carries up to 32 tractors plus several containers (components, spare parts …). On the way back to Bremerhaven the wagons run empty, as lumber can be carried neither on a platform wagon without stanchions nor in containers.

Unfortunately the Lion traffic with tractor had to stop because of the war in Ukraine so the vehicle cassette was not developed.

The figure below gives an impression of a possible vehicle cassette.

Figure 53: Design study of a vehicle cassette

Source: Wascosa

6.5 Business case Flex Freight Car 45'

6.5.1 Fulfilment of initially defined success criteria

On today standard 60' container wagons 45' containers are always placed in the middle of the wagon. With this position there is not enough space to move the fork lift in front of the container to charge or discharge the container in a siding.

The main KPI of this concept is CO2 reduction. Switzerlands biggest retailer Migros gets its Banana deliveries in 45' cooled containers from Antwerp and Bremerhaven. The containers change from road to rail in Swiss terminals. For the ripening, the bananas are put into Migros own storages in Gossau or Ebikon.

In Gossau Migros places a special ramp onto the wagon. This ramp enables them to drive onto the wagon with a forklift and take out the banana palettes and put them into the storage for the riping process.

Figure 54: Loading ramp at a Migros storage

Source: Wascosa

The biggest storage for ripening of bananas Migros is running in Ebikon. But at that location there is not enough room to put a special ramp onto the wagon like in Gossau. Because of that the bananas are not delivered by rail but by road to Ebikon. This goes against the cooperate strategy of Migros which is to reduce CO_2 as much as possible.

The solution to this problem is the 'Flex Freight Car' with integrated platform equipped with additional container spigots which enable transport of the 45' containers at the wagon end. With this solution Migros can change the banana transport to Ebikon from road to rail and use the same concept of discharging the container like in Gossau.

So in this business case road transport is moved to rail in the Swiss Split System.

6.5.2 Applicability of developed solutions

The WASCOSA flex freight system® needs to be equipped with

- a fully accessible floor and
- additional container spigots to load 45' containers at the wagon end (on standard 60' wagon only in the middle of the wagon).

With this equipment 45' containers can be charged/discharged with a fork lift driving on the wagon. When the 45' container is sitting in the middle of the wagon (standard 60' wagon) there is not enough space to move the fork lift in front of the container on the wagon floor.

Transport with the prototype wagon will start in January 2016. The applicability of the development has been tested with the Swiss Split prototype wagon with integrated platform. Both, Gossau and Ebikon have platform heights that do fit to the wagon thus no additional platform is needed to increase the wagon height.

6.5.3 Requirements for further modifications

After switching from road to rail transport with the new wagon with 45' Position at the wagon end Migros plans to take the second step, to improve a second KPI: noise reduction.

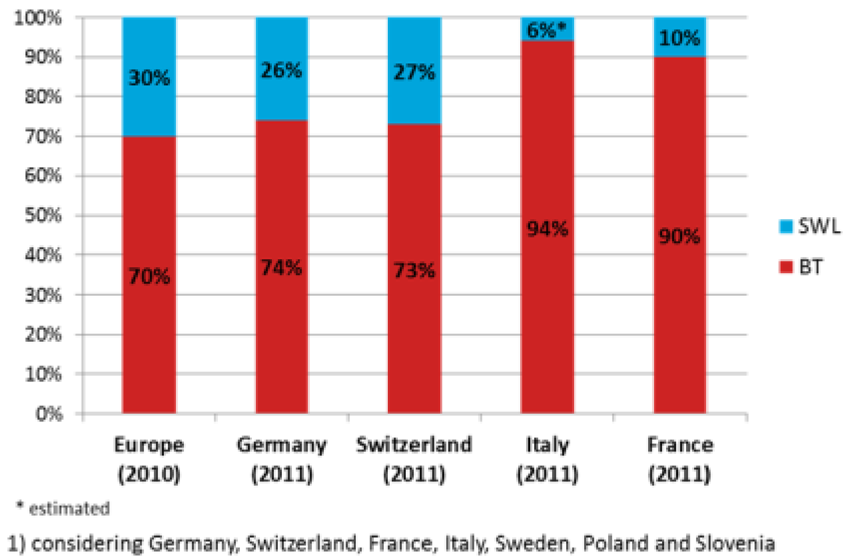
The wagon will be equipped with an electric line and a converter to use the electricity from the locomotive for cooling of the transported reefer. With that the noise from the diesel generator used for the cooling during transport on rail will be eliminated.

7 Summary and conclusions

The analysis of the overall development of the rail freight market in Europe and in particular in the ViWaS partner countries focussed on SWL business – summarised in deliverable D4.1 - have shown the following main results:

(1) SWL is still a major component in numerous European states' rail transport systems. This applies in particular for Germany and Switzerland. In Italy (in 2009) and France (in 2010), the "classic" production systems have been abandoned due to economic reasons. This led to significant losses of SWL transport volumes in these countries.

Figure 55: Market shares of SWL on total rail freight volumes based on tonne kilometres



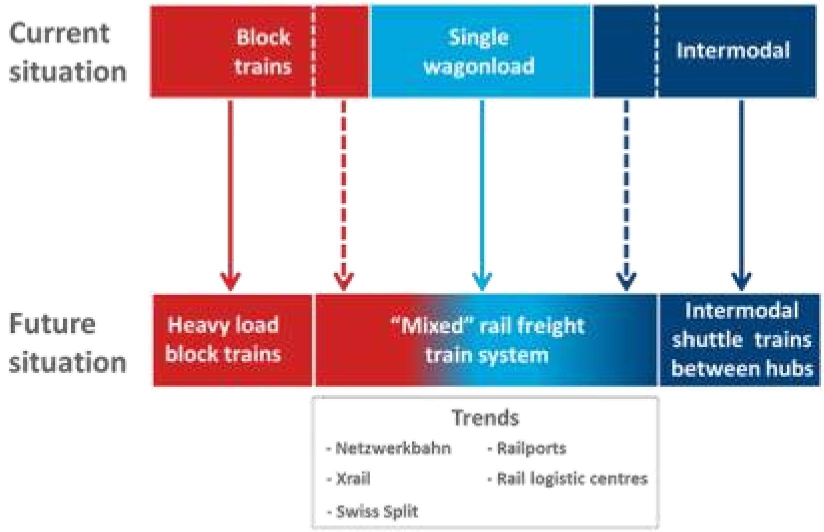
Source: ViWaS

(2) Specific industries and market segments (e.g. chemical industry, steel industry, automotive industry) still demand rail freight services below the block train segment (single wagons, wagon groups) for domestic and international transports. Due to the hard competition to road transport, SWL operation has to be optimised with respect to cost efficiency and transport quality.

(3) The existing and future market demand for SWL services has been realised by (many) European railway operators. Especially in France and - partly - in Italy, RUs are entering the market with new offers based on alternative production systems and improved quality standards supported by ICT / telematics systems. The formation of the Xrail alliance is exemplary for the trend to improve quality and transport performance.

(4) Existing "borderlines" between the "classic" rail production systems will be narrowed in order to raise capacity utilisation and competiveness of the entire rail freight system. Netzwerkbahn in Germany and Swiss Split in Switzerland are examples for the trend towards mixed rail freight production forms.

Figure 56: Rail production systems and trends



Source: ViWaS

(5) An important success factor for SWL is the improvement of last mile services and the provision of transhipment nodes for customers which do not have own access point. The use of hybrid technology for the propulsion of locomotives and bi-modal shunting vehicles can enhance operation processes within the last mile. The implementation of railports and rail logistics centres will support the access to SWL services for a bigger group of potential clients. At the same time such rail logistics nodes facilitate an efficient "feeding" of SWL and the future "mixed" rail freight system (securing the critical mass).

(6) The analyses and findings, documented in this report, show that the planned ViWaS developments correspond to the most urgent challenges and market needs. The aimed at solutions are therefore considered as important components in the evolution process to future rail freight systems that are able to compete in a more and more challenging transport market. In detail the ViWaS developments tackle the following action fields (work packages):

- Market driven business models and production systems, considering opportunities for bundling different types of traffic to secure the critical mass needed for SWL operations;
- New ways for 'last mile' operational methods;
- Adapted SWL technologies to improve flexibility and equipment utilisation;
- Advanced SWL management procedures & ICT to raise quality, reliability and cost efficiency.

(7) The ViWaS developments are done on the basis of real business cases. The success of the aimed at improvements is evaluated on the basis of all demonstrated business cases.

The ViWaS activities are directed to the idea of establishing realistic solutions to reach a real impact in securing the viability of single wagonload transport. Therefore almost all developed solutions have been tested or demonstrated on the basis of real business cases. This deliverable D11.1 provides the evaluation results of all demonstrated business cases:

(1) Swiss-Split 2 deals with the improvement of the current SWL distribution system of ISO containers to private sidings in Switzerland. Main ViWaS activities are connected with the introduction of a new loading platform ('Container Loading Adapter') and the deployment of newly developed hybrid locomotives (Eem 923). Additionally, operation data from this business case has been used to develop a simulation tool (WagonSim) for the planning and optimisation of SWL production schemes.

(2) Regional network of rail logistics centres aims to improve "last-mile" services and to establish transhipment and rail logistics nodes for customers without own rail access points in a border region between Germany and the Netherlands. The business case is also used to evaluate the deployment of hybrid locomotives. All in all the business case promotes the 'Railport' concept

(3) Last-mile service on French secondary lines works on a new concept for the streamlining of "last-mile" and shunting operations based on active collaboration between RU and shippers and the deployment of a bimodal Road/Rail tractor.

(4) Innovative Telematics and ICT services seek to improve operation performance and on-time delivery by introducing telematics devices together with a telematics data distribution service. Different transport chain actors are informed in real time about position, speed, impacts, loading status etc., as well as wear related data like wheelset mileage. A further aspect deals with sensors for wagon load measurements.

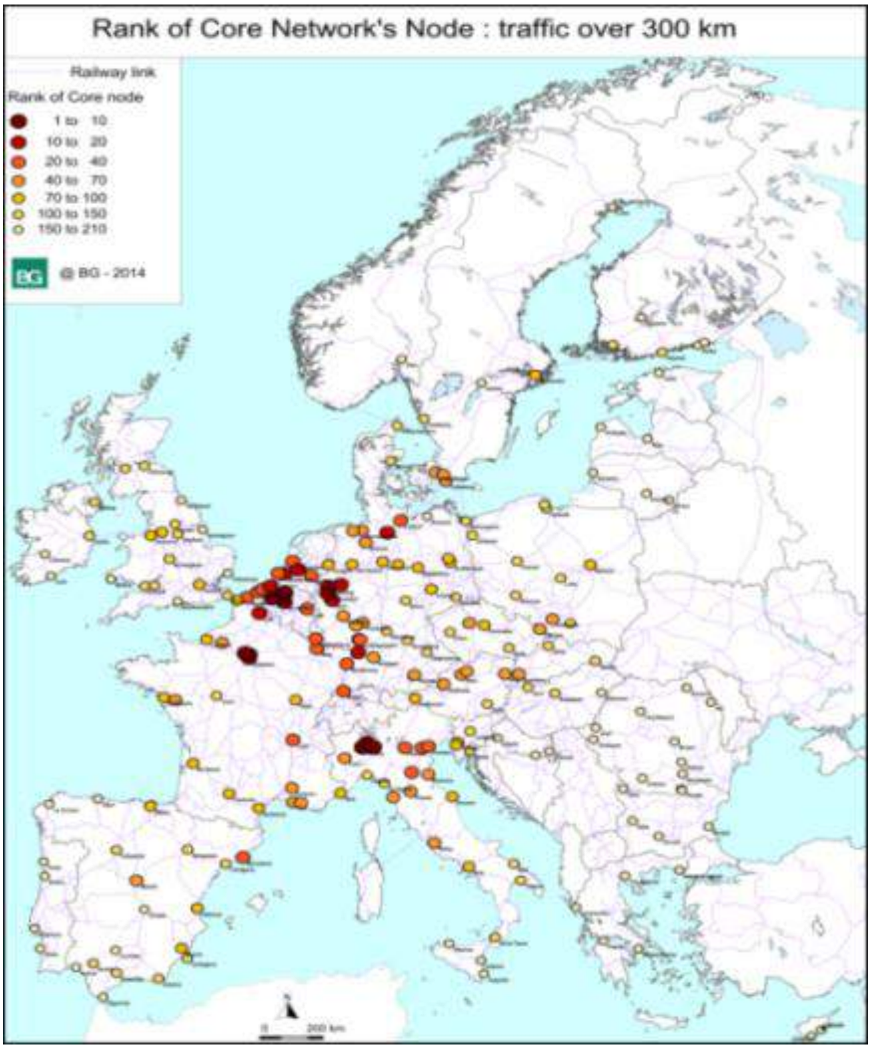
(5) Modular wagon components based on the Flex Freight System deals with the improved capacity utilisation and flexibility of rail wagons by new and modular wagon components: One component is the Flex Freight Car, a light container wagon with a driveable grid floor that is also able to carry 45' containers. The wagon is also part of the business case Swiss Split 2. The second component developed within ViWaS is the Timber Cassette 2.0. This advanced cassette is stackable for empty runs in order to provide more loading capacity for container transport on the standard rail container wagons and reduction of empty wagon transports by the enhanced flexibility (combination of containers and timber loads on one wagon).

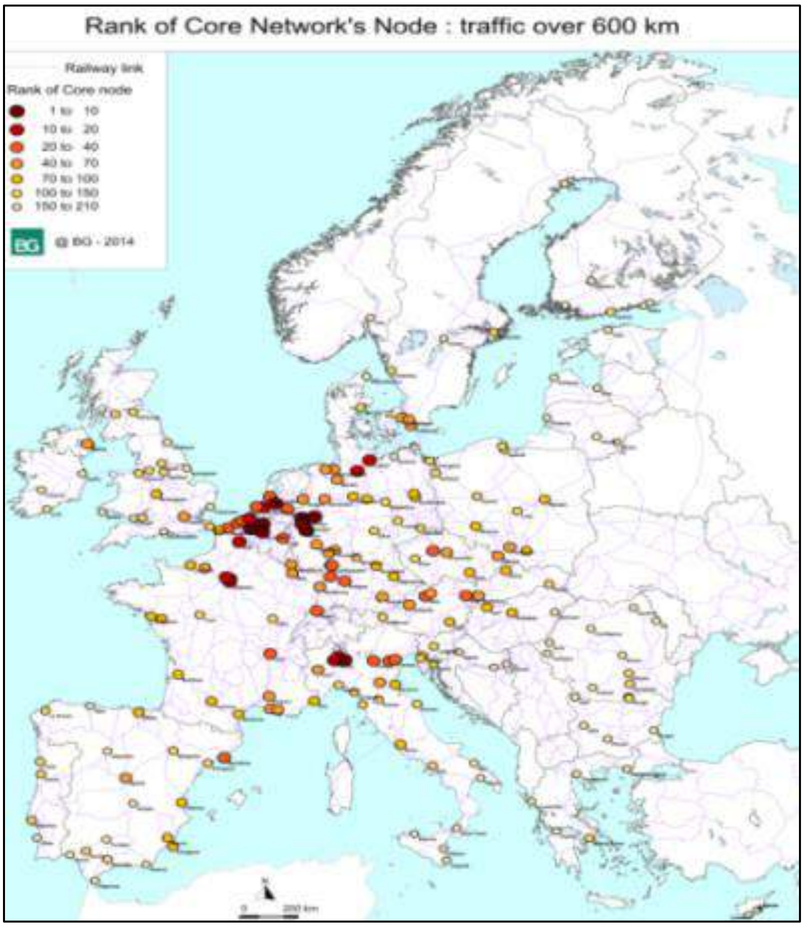
The business cases provide promising show cases for the improvement of dedicated SWL processes or technologies. It has become clear that the long-term viability of SWL needs further support. Framework conditions need to be improved. This concerns regulation (e.g. possibility to enter French national network with bimodal Road/Rail tractors; application of 44 tonnes rule also for trucks that serve conventional co-modal transport solutions) as well as sufficient funding possibilities e.g. for establishing a European network of Railports or implementing telematics in a wider scale. Of cause it is also necessary to continuously re-evaluate the developed solutions with the estimated developments of future "less-than-trainload" production schemes and further developing logistics requirements. It is up to the respective development partners to conduct arising developments in the future, but also provide the appropriate business strategies to bring the developments to the markets.

Appendices

The main Nodes represented in the maps here under are potential freight villages in the future where wagon transfer from a conventional terminal to a combined terminal must be done at low cost. They constitute an important potential market for the technology.

Appendix 1: Rank of Core Network's Node: Traffic over 300km and over 600km




Rank of Core Network's Node : traffic over 600 km
Railway link
Rank of Core node
1 to 10
10 to 20
20 to 40
40 to 70
70 to 100
100 to 150
150 to 210
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Appendix 2: Appendix 3a: Rank (1 to 100) of potential traffic (national and international) by core Node

Buffer 75 km (traffic & population in millions)		2010			2030			2050			RANK 2050 NAT & Internat		
Nom pays	Code node	All distance	Over 300 km	Over 600 km	All distance	Over 300 km	Over 600 km	All distance	Over 300 km	Over 600 km	All distance	Over 300 km	Over 600 km
Belgique	Gent	425.7	68.6	35.4	504.6	86.6	45.9	618.9	111.2	59.9	2	1	1
Allemagne	Dusseldorf	550.1	74.1	44.6	580.9	85.4	52.3	607.7	95.6	58.9	3	6	2
Belgique	Antwerpen	440.6	65.5	33.8	520.0	82.4	43.5	631.5	104.5	56.2	1	2	3
Allemagne	Koln	498.3	67.0	40.5	525.6	77.2	47.5	548.2	86.5	53.5	7	11	4
Belgique	Bruxelles	386.7	59.6	30.0	471.2	77.0	39.9	591.8	100.2	52.9	4	4	5
Allemagne	Duisburg	516.8	67.1	40.1	545.4	77.2	46.9	570.0	86.3	52.7	6	12	6
Allemagne	Dortmund	476.9	58.4	34.7	501.5	67.1	40.4	520.5	74.6	45.1	8	13	7
Italie	Milano	365.9	62.7	24.2	409.5	77.6	30.3	490.7	102.4	39.2	12	3	8
Pays-Bas	Utrecht	477.0	48.3	27.8	517.8	55.9	32.9	570.2	64.6	38.7	5	17	9
Pays-Bas	Vlissingen	291.3	45.6	23.6	343.0	57.0	30.1	416.2	72.2	38.7	18	14	10
Pays-Bas	Rotterdam	413.0	46.4	26.5	451.4	53.9	31.4	501.6	62.9	37.2	9	18	11
Italie	Busto	339.2	59.4	22.5	378.9	73.3	28.1	453.2	96.7	36.3	15	5	12
France	Dourges-Lille	264.3	44.5	22.3	294.1	54.4	27.9	340.8	69.2	36.0	25	15	13
Italie	Novara	314.9	56.1	21.2	351.8	69.0	26.4	421.1	90.9	34.0	17	8	14
France	Argenteuil	298.6	56.7	19.8	326.4	71.1	25.0	371.7	93.1	32.6	20	7	15
France	Noisy-le-Sec	290.1	55.1	19.4	317.2	69.2	24.6	361.3	90.7	32.0	22	9	16
Allemagne	Hambourg	197.9	41.6	19.8	221.9	51.7	25.6	243.8	61.5	31.6	39	19	17
Allemagne	Lubeck	197.8	41.6	20.0	220.4	51.5	25.7	241.3	61.2	31.6	40	21	18
France	Valenton	278.8	53.9	18.8	305.1	67.7	23.9	347.3	88.9	31.2	24	10	19
Belgique	Ostend	211.1	35.9	19.0	241.0	44.1	23.8	286.0	56.0	30.6	29	25	20
Suisse	Basel	192.9	36.3	19.5	208.7	45.0	24.4	230.1	56.0	30.3	42	24	21
Pays-Bas	Amsterdam	350.4	35.5	21.1	382.3	41.1	24.9	422.8	47.8	29.4	16	35	22
Pays-Bas	Rotterdam Maasvlakte	298.8	35.7	20.6	324.4	40.8	24.0	357.7	46.7	27.9	23	36	23
Espagne	Barcelone	189.3	25.2	15.4	201.1	35.4	21.0	216.1	48.1	27.7	46	34	24
Belgique	Zeebrugge	189.9	31.3	16.9	220.7	38.7	21.3	266.3	48.9	27.3	34	32	25
France	Dunkerque	185.5	32.9	16.8	207.2	40.3	21.1	240.8	51.4	27.2	41	29	26
Allemagne	Karlsruhe	283.3	47.6	18.9	303.4	56.2	22.5	320.8	65.6	26.0	27	16	27
Pays-Bas	Nijmegen	319.9	34.5	18.8	344.4	40.0	22.3	374.7	45.9	26.0	19	37	28
Belgique	Liege	187.8	29.2	15.8	219.2	36.4	20.0	263.4	45.8	25.5	35	38	29
Italie	Padova	221.2	38.2	14.6	252.2	46.8	18.0	310.3	61.3	22.7	28	20	30
Italie	Venezia	198.6	37.5	13.6	226.2	45.8	16.7	277.9	59.8	21.0	30	22	31
Republique-Tcheque	Prague	112.4	19.6	12.2	127.8	26.6	16.5	143.4	33.4	20.9	72	56	32
Italie	Verona	197.9	28.3	12.9	225.8	34.9	16.0	277.8	45.5	20.4	31	39	33
Autriche	Wien	131.3	22.2	13.0	151.5	28.0	16.4	175.5	34.1	20.1	56	53	34
Allemagne	Mannheim	246.5	39.0	14.4	264.4	45.7	17.1	277.5	52.1	19.5	32	27	35
Allemagne	Stuttgart	233.0	30.6	14.9	247.4	35.6	17.4	257.1	39.9	19.5	38	45	36
Allemagne	Ludwigshafen	242.8	38.7	14.2	260.5	45.4	16.9	273.6	51.8	19.3	33	28	37
Autriche	Wels	113.3	24.4	13.8	123.8	29.0	16.4	136.5	34.3	19.3	78	52	38
France	Lyon	163.2	33.4	11.4	175.9	42.8	14.6	195.3	57.0	19.3	50	23	39
Slovaquie	Bratislava	123.0	21.8	12.6	142.2	27.9	16.0	161.8	33.3	19.2	63	57	40
France	Strasbourg	161.0	34.4	13.1	172.7	41.1	15.8	187.0	50.0	18.9	51	30	41
Luxembourg	Luxembourg-Bettembourg	134.8	33.0	12.4	148.9	40.1	15.3	167.1	49.1	18.6	61	31	42
France	Metz	148.9	36.3	12.4	161.7	43.5	15.2	179.8	53.3	18.4	54	26	43
Allemagne	Bremen	150.5	24.5	12.9	163.6	28.8	15.7	174.5	32.7	18.3	57	58	44
Allemagne	Munich	156.2	22.9	12.0	171.4	29.1	15.3	184.4	35.1	18.3	52	49	45
Republique-Tcheque	Pardubice	103.6	16.3	10.7	116.8	22.1	14.4	130.1	27.6	18.2	81	70	46
Autriche	Linz	104.0	22.2	12.7	113.9	26.5	15.1	126.1	31.4	17.8	84	62	47
Allemagne	Bremerhaven	138.3	23.5	12.5	150.6	27.7	15.2	160.8	31.4	17.6	64	61	48
France	Marseille	119.3	21.5	10.5	127.8	27.7	13.4	140.3	36.8	17.6	74	47	49
France	Fos	116.2	20.7	10.3	125.5	26.9	13.3	139.1	36.0	17.6	76	48	50

Source: BG Group for NEWOPERA

Buffer 75 km (traffic & population in millions)		2010			2030			2050			RANK 2050 NAT & Internat		
Nom pays	Code node	All distance	Over 300 km	Over 600 km	All distance	Over 300 km	Over 600 km	All distance	Over 300 km	Over 600 km	All distance	Over 300 km	Over 600 km
Pologne	Katowice	193.2	24.9	13.4	221.1	31.6	16.3	225.7	33.6	17.5	44	55	51
Allemagne	Wilhelmshaven	137.4	22.8	11.9	149.5	27.0	14.6	159.6	30.8	17.0	66	64	52
Italie	Bologna	177.6	29.5	9.9	204.5	36.3	12.4	257.2	48.7	16.3	37	33	53
Danemark	Copenhagen	100.7	30.5	9.6	107.6	35.6	12.5	116.3	41.9	16.0	91	41	54
Suede	Malmo	96.7	29.2	9.4	103.9	34.4	12.2	112.7	40.8	15.7	95	43	55
Republique-Tcheque	Ostrava	149.0	21.5	11.6	168.3	27.0	14.0	173.3	29.1	15.4	58	68	56
Allemagne	Mainz	235.4	32.0	11.3	250.0	37.1	13.3	260.2	41.9	15.1	36	42	57
France	Avignon	94.7	17.1	8.6	103.1	22.4	11.2	115.4	30.0	15.0	92	66	58
Italie	Turin	123.4	26.1	9.8	137.2	31.1	11.8	165.3	40.4	14.9	62	44	59
Allemagne	Koblenz	180.6	22.8	11.0	190.5	26.5	13.0	198.1	29.9	14.7	49	67	60
Royaume-Uni	Belfast	53.8	10.1	8.3	57.8	13.2	10.8	63.1	17.2	13.8	139	105	61
Autriche	Salzburg	94.3	19.0	9.4	103.0	23.1	11.5	112.8	27.6	13.6	94	69	62
Pays-Bas	Hengelo	189.7	18.6	9.5	202.9	21.8	11.3	217.8	25.2	13.1	45	75	63
Allemagne	Osnabruck	195.7	18.2	9.8	205.8	21.0	11.5	213.9	23.6	12.9	47	80	64
Espagne	Madrid	141.4	16.8	7.3	157.3	23.3	9.9	178.1	31.3	12.9	55	63	65
Suede	Trelleborg	76.8	23.3	7.5	82.4	27.4	9.9	89.3	32.6	12.7	110	60	66
Allemagne	Frankfurt	207.4	26.8	9.3	219.7	31.0	10.9	228.2	34.9	12.4	43	50	67
Royaume-Uni	London	309.6	11.1	6.4	392.7	15.0	8.7	490.8	19.8	11.6	11	97	68
France	Rouen	127.0	22.0	7.3	137.8	26.8	9.0	156.2	34.5	11.5	68	51	69
France	Nantes	123.3	19.4	6.4	133.9	25.3	8.5	150.0	34.1	11.4	70	54	70
Italie	Ravenna	118.2	27.4	6.8	136.4	33.7	8.6	172.0	45.5	11.3	59	40	71
France	Calais	84.9	14.2	7.0	94.7	17.3	8.7	108.7	22.0	11.1	98	82	72
Espagne	Valencia	100.8	11.7	5.5	109.2	17.5	8.0	120.3	25.2	11.1	89	74	73
France	Bordeaux	80.3	14.6	6.4	86.6	18.7	8.2	96.1	24.8	10.7	108	77	74
Espagne	Murcia	77.4	10.4	5.0	87.2	15.8	7.4	100.4	23.0	10.5	105	81	75
Allemagne	Berlin-Wustermark	127.6	16.1	7.8	134.8	18.7	9.1	139.1	20.7	10.3	75	89	76
Allemagne	Berlin-Großbeeren	126.3	16.2	7.7	133.5	18.8	8.9	137.7	20.8	10.1	77	88	77
France	Nice	63.6	15.7	6.0	68.9	19.8	7.6	77.8	26.2	10.0	122	73	78
France	St-Nazaire	102.5	15.7	5.6	110.9	20.3	7.4	123.8	27.4	9.9	85	71	79
Allemagne	Hannover	143.3	16.4	7.0	151.3	18.6	8.2	157.6	20.6	9.3	67	92	80
Pologne	Krakow	125.8	13.8	6.9	147.6	18.2	8.6	151.1	19.4	9.2	69	100	81
Pologne	Warsaw	97.1	13.0	5.9	115.9	18.2	7.8	120.8	20.1	8.9	87	96	82
France	Toulouse	72.9	11.9	5.0	79.5	15.8	6.6	88.9	21.4	8.8	111	84	83
Allemagne	Regensburg	92.5	11.8	6.2	100.3	14.2	7.5	106.4	16.5	8.7	101	110	84
France	Le Havre	105.7	17.1	5.6	114.4	20.8	6.8	129.2	26.9	8.7	83	72	85
Slovaquie	Zilina	71.8	11.4	6.2	80.3	14.8	7.8	84.1	16.5	8.7	117	109	86
France	Narbonne	47.7	11.5	4.7	53.5	15.4	6.3	61.9	21.1	8.7	140	86	87
Autriche	Graz	74.1	10.5	6.4	78.5	12.3	7.4	84.3	14.3	8.5	116	121	88
Pologne	Wroclaw	70.8	12.4	6.3	82.8	16.1	7.9	84.4	16.9	8.5	115	106	89
Espagne	Bilbao	92.7	12.2	5.2	98.7	15.4	6.6	106.5	19.6	8.3	100	99	90
Italie	Roma	122.6	20.4	5.2	135.5	24.7	6.4	160.7	32.7	8.3	65	59	91
Hongrie	Gyor	60.2	12.0	6.0	66.7	14.7	7.3	70.9	16.4	8.2	124	111	92
Allemagne	Brunswick	128.8	17.3	6.1	135.9	19.6	7.1	141.3	21.5	8.1	73	83	93
Allemagne	Nuremberg	110.6	12.7	5.9	117.3	14.8	7.0	121.6	16.6	7.9	86	108	94
Republique-Tcheque	Brno	69.2	9.0	5.4	75.0	11.0	6.5	80.2	12.9	7.7	120	128	95
Royaume-Uni	Birmingham	300.9	8.6	4.5	369.4	11.4	5.9	455.7	15.0	7.7	14	119	96
Hongrie	Budapest	86.9	9.8	5.7	89.9	11.5	6.7	93.2	13.1	7.6	109	126	97
Italie	Trieste	56.9	13.9	5.2	62.7	16.5	6.1	73.4	20.7	7.4	123	90	98
Espagne	Cartagena	52.9	7.2	3.4	60.1	11.1	5.1	69.8	16.2	7.4	126	114	99
Italie	Firenze	103.4	23.7	4.7	117.4	28.5	5.7	145.5	37.8	7.4	71	46	100

Source: BG Group for NEWOPERA

Appendix 3: SNCF, NEWO Last mile table

	PROJET		EXPERIMENTATION ENGIN RAIL ROUTE		COMPARATIF Y.8294 VS RR MOL.2444 ([illegible])	
			[illegible]		[illegible]	
	n°	Items	Locotracteur Y.8294	RR MOL.2444	Observations	Appréciations
DONNEES GENERALES	1	Diplômes ou certifications pour conduite sur rail	[illegible]	[illegible]	[illegible]	RAS
	2	Carburant	GNR	GNR	[illegible]	RAS
	3	Rayon de courbure minimum franchissable	100 mètres	100 mètres	[illegible]	RAS
	4	Diplômes ou certifications pour conduite route	[illegible]	[illegible]	[illegible]	RAS
	5	Dimensions	[illegible]	[illegible]	[illegible]	[illegible]
	6	Poids	[illegible]	[illegible]	[illegible]	[illegible]
	7	Capacités du réservoir	[illegible]	[illegible]	[illegible]	[illegible]
	8	Année de construction	[illegible]	2012	[illegible]	RR plus récent
SECURITE	9	Ceinture de sécurité	[illegible]	[illegible]	[illegible]	[illegible]
	10	VACMA	Non	Oui	[illegible]	[illegible]
	11	Rétroviseurs	[illegible]	[illegible]	[illegible]	[illegible]
	12	Klaxon	[illegible]	[illegible]		[illegible]
	13	Marches pieds : dimensions de passage du corps	[illegible]	[illegible]	[illegible]	[illegible]
	14	Marches pieds : éclairage	Non	Oui		[illegible]
	15	Bouton d'urgence	[illegible]	[illegible]		[illegible]
	16	Action de refoulement	[illegible]	[illegible]	[illegible]	[illegible]
	17	Visibilité	[illegible]	[illegible]		[illegible]
CONFORT ERGONOMIE QVT	18	Gestion de la température intérieure du poste de pilotage	Chauffage	Climatisation possible	[illegible]	[illegible]
	19	Volume sonore extérieur	[illegible]	[illegible]	[illegible]	[illegible]
	20	Volume sonore intérieur	[illegible]	[illegible]	[illegible]	[illegible]
	21	Prise en main	assez facile	très facile		[illegible]
	22	Accès aux coffres divers lors de la PS	[illegible]	[illegible]		[illegible]
	23	Evolution du conducteur à l'intérieur de la cabine	[illegible]	[illegible]		[illegible]
	24	Confort fauteuils	[illegible]	[illegible]		[illegible]