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The ViWaS project: future-proof solutions for wagonload transport

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Abstract

Rail transports of single wagons or wagon groups are an indispensable part of the transport chain, such as for the forestry and the chemical industry. However, high production costs and low quality standards have led to a continuous decline in market shares in recent years. In order to counteract this tendency, ten European companies and research institutions, covering the areas of rail transport and logistics, have combined their forces in the scope of the research and development project ViWaS (Viable Wagonload Production Schemes). The goal: Innovative and simultaneously practical solutions for a sustainable wagonload transport. The applicability of these solutions and their effects have been proven with the aid of business cases in terms of field tests and pilot operations. The following main innovations have been achieved within the ViWaS project:
(1) Improved "last-mile" operating concepts incorporating hybrid locomotives and bi-modal shunting engines (by Bentheimer Eisenbahn, Fret SNCF and SBB Cargo supported by HaCon and NEWOPERA): The new production method for last-mile delivery is based on the idea of separating train movements and sidings shunting processes by deploying bimodal road-rail tractors. Processes within the sidings have been simplified; as a result costs for equipment and staff could be reduced considerably. Hybrid locomotives are fundamental in securing a seamless access to regional distribution rail networks. Potential cost advantages have been identified comparing different traction combinations of real-life transport chains.
(2) Modular wagon technologies for a flexible and efficient use of resources (by Wascosa and SBB Cargo): In detail, three components have been developed up to prototype status: Wascosa's Flex Freight Car is a light container wagon with an accessible floor and thereby applicable for various transport purposes. The Timber Cassette 2.0 is a new superstructure for log wood transport that features foldable stanchions and can be used in combination with a container wagon. In case the Timber Cassette is not loaded, it can be removed and stacked at the terminal or on a container wagon. Empty runs will be minimized generating efficiency improvements. Additionally, SBB Cargo has developed the so-called Container Loading Adapter, another add-on to a container

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wagon. It facilitates container loading and unloading in sidings. SBB Cargo will deploy this new component within the "Swiss Split" production system, combining intermodal with wagonload transport.
(3) Smart wagon telematics allowing improved tracking at reduced costs (by Eureka): A separate abstract "Smart Telematics Enabling Efficient Rail Transport" (Contribution ID 875) has been submitted for TRA 2016).
(4) A new simulation tool for planning and optimizing single wagonload networks (by ETH Zürich): WagonSIM is an agent-based simulation tool for rail freight networks to facilitate the optimization of SWL production schemes. It is based on the OpenSource software MatSIM. The tool models the routing of freight wagons according to the routes within the real SWL network. Therefore, the modelling of two network levels is required, the production network and the physical infrastructure.
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Keywords: Single wagonload transport; freight transport; wagon technologies; telematics, last mile

1. Background and objectives

In Europe today, the general framework of rail freight transport is exposed to significant changes. In 2005, single wagonload (SWL) transport accounted for 39 per cent of Europe's rail freight transport performance, but only five years later this number dropped to just 30 per cent. This is mainly due to low quality and unfavorable cost structures which led to the cutting of the least cost-effective tracks, yards and sidings as well as the general downscaling of SWL transport networks. The almost non-existent internal competitiveness, together with the strong competition through conventional block trains, intermodal transport and road transport services, built the background of a challenging future for this production scheme. In detail, the decrease of SWL market shares is supported by the following key factors:

- high fixed costs linked to infrastructure and operation of marshalling yards;
- insufficient SWL service profitability due to slow and expensive "last mile" operations and poor utilization rates of resources, e.g. trains and wagons;
- additional costs to be borne by the shippers to ensure wagon handling in their private sidings;
- insufficient SWL service quality and transport time compared to other transport modes, especially in competition with road (increasingly important in state-of the-art logistics);
- negligible competition in the SWL segment because of heavy fixed costs, complex operations and the need for a minimum critical mass of traffic;
- loss of profitable markets/transports from SWL rail operators to intramodal competitors and production systems (wagonload block trains/intermodal services) and
- increasingly limited possibilities to cross-subsidize SWL from the profitable full trainload (FTL) business.

Despite the current situation of SWL transport, it still provides a vital service to industries wanting to shift freight below the block train segment level. In a bid to halt its deterioration, the 39-month Viable Wagonload Production Schemes (ViWaS) project has undertaken to breathe new life into the SWL market through improvements in cost efficiency, transport quality and sustainability. Ten European companies and research institutions from the areas of rail transport and logistics have joined forces in the frame of the Seventh Framework Programme (FP7) of the European Commission. The aim is to further develop SWL technologies and concepts, tested and proofed on the basis of real business cases, in order to

- streamline last-mile operations,
- improve flexibility and efficiency of equipment usage,
- raise transport quality and reliability,
- capture new markets.

In a final step all developed solutions will be evaluated with regard to impact, applicability in regular operations and their potential application in a wider European scale.

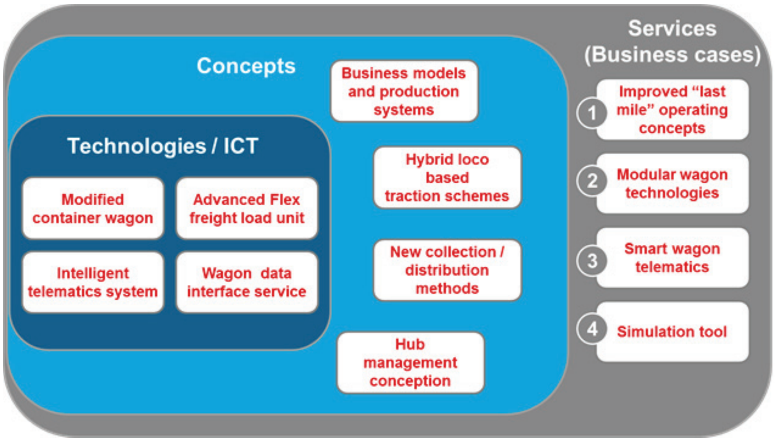

Fig. 1. Elements of the ViWaS project (Source: ViWaS).

Nomenclature

FTL: Full trainload
IBC: Intermediate bulk containers
RLC: Rail logistics center
RU: Railway undertaking
SWL: Single wagonload
ViWaS: **Vi**able **Wa**gonload production **S**chemes

2. ViWaS Innovations

This article describes the ViWaS developments that are related to one of the following four innovation areas:

(1) ”Last-mile“ improvements;
(2) Modular wagon technologies;
(3) Smart wagon telematics;
(4) SWL simulation.

(1)”Last-mile“ improvements

"Last-mile" operations are considered as an important cost driver in SWL rail transports. Process costs for local haulage, transshipment and shunting can easily amount to more than 50% of the overall transport costs, depending on the specific situation and transport distance. Therefore, an important success factor for SWL is the improvement of "last mile" services and the development of handling facilities for customers without own rail access. Capable rail infrastructure as well as efficient transport organization together with new technologies like hybrid locomotives and bi-modal shunting engines can enhance operation processes for the "last mile".

"Last-Mile" operation method

Generally, "last-mile" rail operations for the delivery and collection of rail wagons require a team of two people and a diesel locomotive that are mobilized from the concentration point (= marshalling yard) until the delivery point. These operations include (1) the train run on the main tracks of the National Railway Network, (2) the train run on the secondary line to reach the entrance(s) of the private siding(s) and (3) the delivery of wagons to the private siding by a backing movement, if necessary. The wagon movements inside the siding as well as cargo transshipment is organized by the private siding operator himself. All related “last-mile” processes together generally account for some 40-50% of the overall SWL transport costs.

To reduce this share in costs, Fret SNCF with the support of NEWOPERA have assessed possible improvements by a new “last-mile” operation method that is based on the idea of separating train movements and shunting actions. For this purpose, bi-modal road/rail tractors were deployed to enable wagon delivery/collection and shunting operations independently from the line locomotive. Three areas have been identified that may benefit from the new method: (1) Time savings for the line locomotive can be used to serve additional sidings per work period; (2) The road/rail tractor may be shared between two or three private sidings’ owners in the vicinity and enable reduced investment and maintenance costs and (3) the capability of the shunting tractor to run on road and rail tracks enables a simplified and cheaper track configuration.

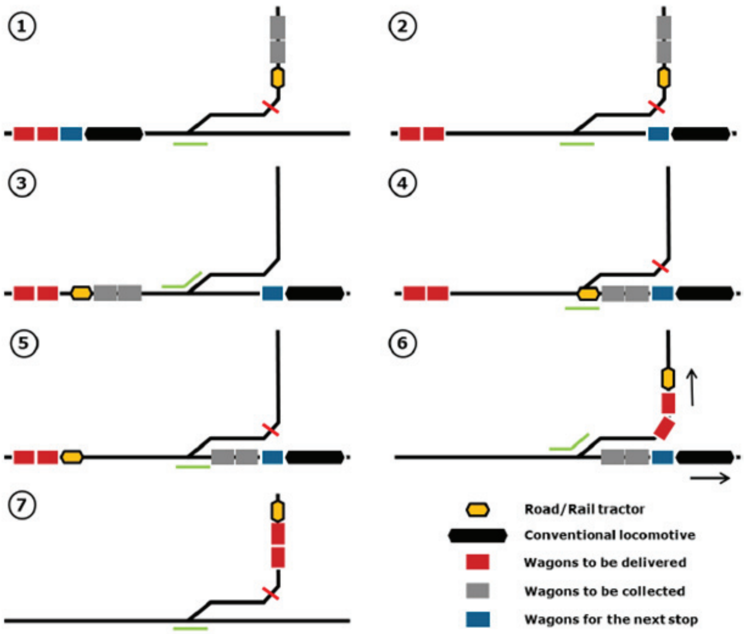

Fig. 2. Take and leave operations with direct entrance (Source: ViWaS).

How does the new operation method work? Operational schemes are numerous according to the commercial need (take and leave wagons) to link the private siding and the main distribution line that may be single or double track, classified as main or secondary line. Variations refer also to the exact location of the siding’s entrance and the signaling system in place. Within the project two process chains have been looked at in more detail: one with direct entrance in the private siding (cp. Figure 2) the other with a reverse entrance. In each case the operation scheme is that the RU distribution train stops in front of each siding but does not shunt wagons, whereas the shipper’s road-rail shunting vehicle detaches the loaded wagons from the train that is stopped on the line, and attaches the empty ones (or vice versa). The driver of the RU train helps the bimodal vehicle driver to shunt (coupling, decoupling, switch...). When the shipper’s delivery is complete, the RU train moves towards the next siding by rail and the bimodal moves by road.The theoretical economic analysis took into account the various elements impacting the efficiency: distance on which the distribution train is doing backing movements, the frequency of deliveries, the volume of traffic, the layout of the private siding and the nature of the logistics operations on the private siding as well as the existence of other sidings for a joint use of the road/rail tractor. Of course, the use of the road/rail tractor reduces the number of tracks, necessary switches and their maintenance. It has to be noted that, for existing sidings only, the maintenance savings have to be taken into account while investment savings should also be considered for new sidings. However, taking into account the main possibilities, a methodology of analysis has been proposed to see where the solution could be effective. It appears that if the authorization to go out for a simple exchange of wagons on the National Railway Network is granted and if the use with one hand of the remote control is done the global economies (for the distribution train service and the private siding operation) could be at the level of 10% for a single delivery, to 22% for a double delivery. Regarding the French application case, the economic analysis shows an increased efficiency in the inside operations leading to overall economies of 35%. After the positive cost-benefit evaluation, a trial in real-life conditions proofed the capabilities and advantages of the new method and the bi-modal shunting engines.

Regional network of rail logistics centers

Whereas the number of small rail sidings is continuously decreasing it becomes more and more important to develop capable rail freight bundling points that also serve rail freight customers without own rail siding. ViWaS partner and German regional railway operator Bentheimer Eisenbahn supported by HaCon has taken up this challenge with the further development of the “Railport” concept. The envisaged network of multifunctional rail logistics centers (RLC) facilitates the transshipment of a wide range of products (e.g. palletized, oversized and heavy goods, liquid and bulk goods, containerized goods). Additionally, the centers provide for further logistics services such as warehousing, pre- and end-haulage by truck or commissioning of goods.

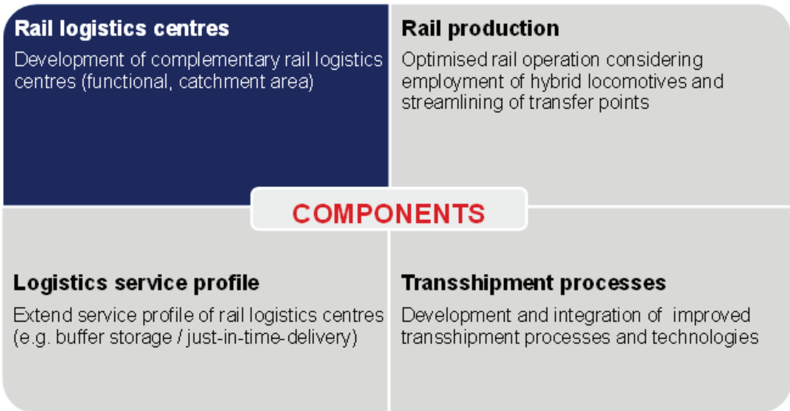

Fig. 3. Complementary rail logistics centers – improvement components (Source: HaCon based on Bentheimer Eisenbahn).

The main improvement idea within ViWaS is to develop several rail logistics centers in close neighborhood to each other so to enlarge the number of potential rail freight customers that can be reached in a distance of max 20-30 km (from a rail logistics center and to bundle rail volumes from the different locations. As illustrated in Figure 3 complementary improvement components are related to three areas:

Efficient rail production schemes for long haul and “last mile” transport. In order to optimize the “last mile” by rail, the use of hybrid locomotives has been evaluated. Bentheimer Eisenbahn compared different transport chains to find out the best traction configurations. The calculations show that the TRAXX F140 AC with last-mile functionality has a great cost advantage on mainly or fully electrified railway relations. In view of the specific framework conditions at Bentheimer Eisenbahn like route profile and speed limits, the last-mile locomotive shows the best efficiency in comparison with other traction configurations, analyzed.

Extended logistics service profile of rail logistics centers widen the range of potential customers. A very important issue is the introduction of SWL services into just-in-time or just-in-sequence supply chains. Bentheimer Eisenbahn developed corresponding logistics concepts for three product groups: (1) steel panels, (2) intermediate bulk containers (IBC) and (3) big bags with salt products.

The previously listed logistics chains have been also used to *improve transshipment processes and technologies* within the rail logistics center. Optimization options include a better organization of road-rail transshipment sequences (e.g. increasing share of direct transshipment between road and rail) or introduction of improved transshipment technologies (like fork lift trucks with high load capacity allowing “twin lifts”). Within ViWaS, Bentheimer Eisenbahn developed a methodology to analyze and optimize related transshipment processes and technologies and derive decisions for necessary improvement actions: Notably a purchase decision was taken for a more forklift truck with higher productivity (higher payload), storage areas have been re-organized and extended. Additionally, Bentheimer Eisenbahn has introduced a concept that allows the flexible and multifunctional deployment of staff, originally only involved in handling processes. With a special training a dedicated team achieved the permission to perform shunting operations and thereby put another development idea into practice to make operations more flexible, free waiting times and increase productivity, which finally led to the possibility of increasing the frequency of services.

Altogether, the developments can serve as a blueprint for bundling points of conventional rail freight transport that need to be developed in a wide range to enable the viability of less-than trainload services in the long-term.

(2) Modular wagon technologies

The increase of flexibility and the utilization rate was the top-priority for the development of the three modular wagon technologies:

- Wascosa Flex Freight Car
- Timber Cassette 2.0
- Container Loading Adapter (deployed in Swiss Split 2)

Flex Freight Car

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 platforms perfectly, there are some disadvantages. Due to the fact that the Ks wagons are not equipped with receptive points for containers, these have to be secured manually by nailing wooden blocks into the floor on each side of the container. Over the years the floors get weakened, thus maintenance costs are high.

Together with Wascosa and ETH Zurich, a solution for a new type of wagon that meets the requirements for loading and unloading containers in sidings was developed. The wagon called "Flex Freight Car" is based on a classic container wagon (code Sgnss). Compared to standard KS wagons the wagons' floor is filled in with iron grids. The grid is modular which means 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 of the 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. To test the wagon under realistic conditions SBB Cargo deployed the wagon in defined sidings. Therefore, it has been integrated into the SBB Cargo wagon pool.

Fig. 4. Wascosa Flex Freight Car (Source: Wascosa/ViWaS).

Timber Cassette 2.0

Conventional rail transports are generally operated with special wagons for specific types of cargo. Transport flows are often done in one direction only. Consequently, the share of empty wagon transports is comparably high and reduces its cost efficiency.

Wascosa has therefore developed the flex freight system® to enable a multi-functional usage of container wagons. The system is based on two elements: a light 60ft container wagon and removable swap bodies for a wide variety of cargo.

In 2010, Wascosa has presented the first flex freight unit for timber transports which is a major market for SWL services. The main disadvantage of the already existing timber cassettes was the fact that they had to be transported back empty for reloading, claiming the whole rail wagon capacity. To reach improved capacity utilization, a new timber cassette was designed and prototypes were constructed in the frame of the ViWaS project. This advanced cassette - so-called “the Timber Cassette 2.0” (Figure 5) - is stackable (up to 6 empty cassettes) for empty runs in order to provide more loading capacity for container transport on the standard rail container wagon. Moreover, it has a reduced height of 2.5 m - compared to 2.8 m of the previous version – and is therefore applicable for transport on trucks as it fully complies with the limits of maximum allowed overall height of 4m for road transport in Europe. The cassettes are used in domestic transports in Switzerland to gather first operational experiences. Afterwards, it is planned to increase the number of units and to extend the operations to international transports.

Fig. 5. Timber Cassette 2.0 (Source: Wascosa/ViWaS).

Container Loading Adapter

As an alternative to the Flex Freight Car with grid inlays, SBB Cargo developed a 60ft platform: The so-called “Container Loading Adapter” consists of three separate 20ft modules, which together can be put on every standard Sgns or Sgnss container wagon. This platform guarantees also a stable surface to load and unload the containers with forklifts, as shown in Figure 6.

In comparison to the Flex Freight Car, the design of the platform offers some advantages in terms of width and height. To increase usability the platform was designed with the standard floor dimensions of a 20-foot container. The platform is mounted on the wagon in the import/export terminal together with the SWL container. In addition to securing the SWL container to the wagon, the platform helps overcome the difference in height between ramp and wagon as well as ramp and container at the end of the customer’s siding. This means that customers do not need to invest in costly ramp reconstructions. The platform guarantees a totally flat, passable surface on the wagon and is mountable on standard Sgns-container wagons.

Although the platform is heavier than the grid inlays, it does not compromise the wagons’ payload capacity. Normally, payload in the Swiss Split never reaches its limits due to the fact that of 60ft only 45ft can be used for loading.

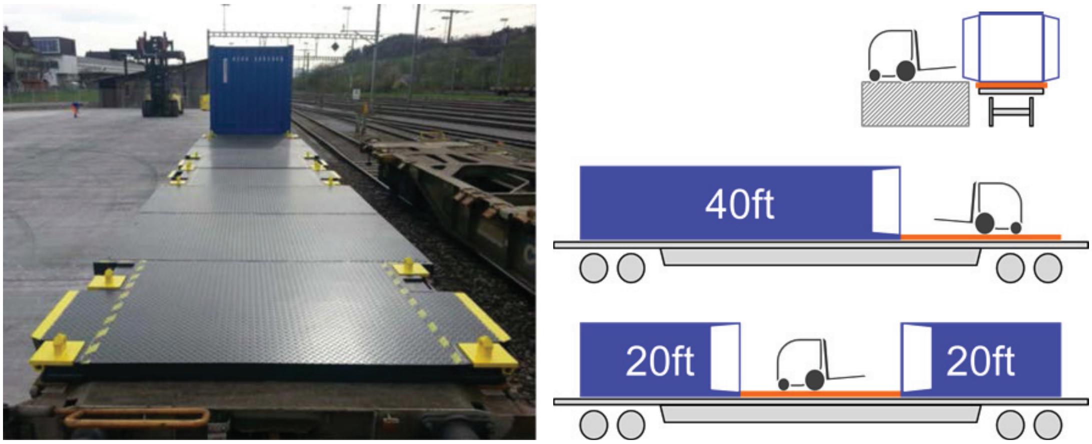

Fig. 6. Container Loading Adapter.

The Container Loading Adapter as well as the Flex Freight Car are used by SBB Cargo within the “Swiss Split 2” business case which aims at the broadening of the traditional scope of SWL transports by integrating intermodal solutions. “Swiss Split 2” focusses on the delivery of maritime containers to sidings with the aid of the encompassing Swiss SWL transport network. The critical mass for a viable SWL system and its efficiency were improved. The new equipment helps considerably to realize cost efficient transport solutions and meet the customers’ needs.

(3) Smart wagon telematics

In the scope of the ViWaS project, the general need for single wagon monitoring and specific requirements for data visualization to the stakeholders of railway transports has been specified. As a result of the project work the aJourOnline telematics IT platform concept has been developed by project partner Eureka Navigation Solutions AG.

This aJourOnline platform is an interface service that ensures a direct data supply to railway lead contractors, railway sub-contractors, service departments and shippers. Eureka used the experiences gathered during the ViWaS project to adapt the aJourOnline platform for the needs of DB Schenker Rail and its customers. The individual adaption leads to an optimized visualization of location and status data of DB Schenker’s freight wagon fleet.

The data quality and availability was also significantly enhanced, thanks to a new generation of telematics devices. Improved sensors and optimized design led to a cost cut of more than 50% in the capital and operations expenses, while at the same time the variety of information types and the frequency of data transmission was increased. According to field tests precise information on the location of a wagon can be given in more than 97% of all cases, even in situations where no GPS is available (GSM data). With the aid of the new developed loading sensor with weighing function, a full exploitation of payload is possible, while at the same time the risk of overloading (with far reaching consequences) is eliminated. Together with the mileage counter a decisive contribution to rail safety is made. Detailed information is provided in another paper submitted for TRA 2016 regarding “Smart Telematics Enabling Efficient Rail Transport“ (Behrends, V. et al.).

(4) A new simulation tool for planning and optimising SWL networks

Single wagonload (SWL) traffic in Switzerland has to deal with a rapidly growing passenger traffic which is prioritized in the access to the rail network. Thus, the number of available train paths for SWL is limited. Especially during the peak hour of passenger transport, a lack of train paths for SWL is observed. Even under these restricted conditions, SWL has to cover all national relations in Switzerland with an overnight service to remain competitive with road transport. Consequently, the production schemes have to be continuously improved to meet these requirements.

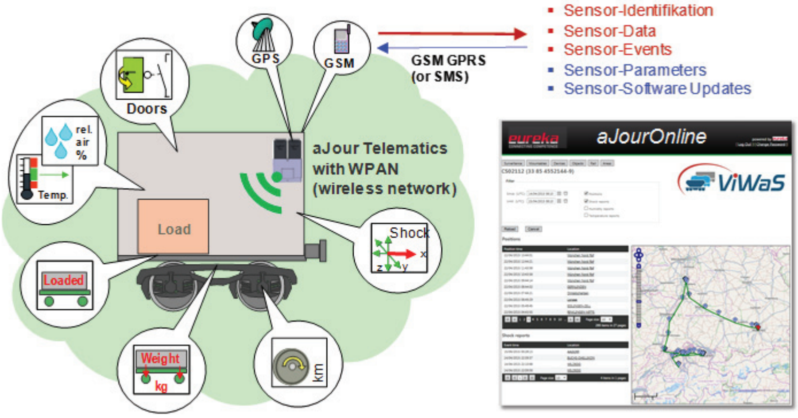

Fig. 7. aJour wagon telematics (Source: Eureka/ViWaS).

Within the ViWaS project, the Institut für Verkehrsplanung und Transportsysteme (IVT) at ETH Zurich has developed WagonSIM, an agent-based simulation tool for SWL transport. It is based on the OpenSource software MatSIM. The tool models the routing of freight wagons according to the routes within the real SWL network.

Therefore, the modelling of two network levels is required. The first level is the production network. This stage comprises the assignment of the access points (sidings) to regional shunting points and shunting yards, including the specific timetables for the trains between these points. The second level is the physical infrastructure with its capacity limitations. The simulation tool enables the development of improved SWL networks and production schemes which are based on eight performance parameters (see Figure 8).

WagonSIM analysis parameters

Total number of wagons	Stuck wagons	Wagon hours	Train kilometres
Transported wagons	Wagon kilometres	Train hours	Tonne kilometres

Fig. 8. WagonSIM analysis parameters (Source: ETH Zurich IVT)

3. Conclusions

A wide range of improvements of SWL was created in the scope of ViWaS. These improvements emerge from the system itself and thus really pave the way for a sustainable recovery and stabilization of the generated transport volumes. Although these applications were related to specific situations, strong emphasis was given to the question of European-wide applicability. Main components, especially with regard to operational schemes, such as the use of hybrid locomotives or the “Railport” concept are gaining importance, not only in SWL “home countries” like Germany, Austria and Switzerland but in the entire European transport markets. Technical developments that enable a better modularity of wagons and the comprehensive use of telematics do not only favor SWL services. Higher flexibility as well as continuous monitoring of transports are topics that also apply to state of the art intermodal and block train services. The market maturity and the positive consequences of almost all project developments were proofed within ViWaS. The operative partners were able to resist the omnipresent negative trend of SWL. Especially due to higher cost efficiency, it was possible to stabilize transport volumes and even realize gains in specific market fields.

Nevertheless, the analyses have also shown that the general framework conditions do not sufficiently support the development of rail freight services in the less than trainload segment. Current policies are more in favor of intermodal transport or even road services. A good example in this respect is the limited weight of "last-mile" services on road. Intermodal services profit from an exception which allows them to carry four tonnes additional payload. SWL services do not have this advantage although they follow the same aim – shift from road to rail. Furthermore, the harmonization and streamlining of support strategies and funding schemes is recommendable. State support for private siding in one country cannot be effective when sidings or railports are closed in another country at the same time.

Within the 39 months of project lifetime, the ViWaS consortium partners addressed several challenges of European Single Wagonload traffic. The achieved developments have been applied and proofed their applicability in several dedicated case studies. The ViWaS developments may serve as blueprints and as a starting point for the revitalization of European wagonload transport systems.

References

Balmer, M., Meister, K., Rieser, M., Nagel K., Axhausen, K.W., 2008. Agent- based simulation of travel demand: Structure and computational performance of MATSim-T. 2nd TRB Conference on Innovations in Travel Modeling, Portland.

Behrends, V., D., Haunschild, M., Galonske, N., 2015. Smart Telematics Enabling Efficient Rail Transport, Paper submitted for TRA 2016 in Warsaw

Boysen, N., Fliedner, M., Jaehn, F., Pesch, E., 2012. Shunting yard operations: Theoretical aspects and applications. European Journal of Operational Research, 220, 1, 1-14.

Bruckmann, D., C.E. Jackson, M. Ballmer and U. Weidmann, 2014. Agent based simulation of a Single Wagonload network, Second International Conference on Railway Technology, paper 137, Ajaccio, April 2014.

Bruckmann, D., C.E. Jackson, M. Ballmer and U. Weidmann, 2014. Optimization of SWL production schemes using an agent based simulation, Presentation, EURO – ZEL 2014, 22nd International Symposium, Žilina,

Bruckmann, D., Dober, P., Galonske, N., Saabel, I., Weidmann, U., 2015. Improving the container distribution by rail into Swiss sidings, Paper submitted for TRA 2016 in Warsaw

Bruckmann, D., Mancera, A., Galonske, N., Weidmann, U., 2015. Optimization of Swiss single wagonload production schemes optimization using an agent-based simulation, Paper submitted for TRA 2016 in Warsaw

DESTATIS Verkehr Eisenbahnverkehr, 2010. Fachserie 8, Reihe 2, Statistisches Bundesamt, Wiesbaden

DESTATIS, 2007. Prognose der deutschlandweiten Verkehrsverflechtungen 2025, Abschlussbericht – Langfassung, München/Freiburg 2007

Fret SNCF, 2013. Brochure Fret SNCF's single wagonload offer in Europe, Direction de la Communication Fret SNCF

Hagenlocher, S. et.al., 2013. Ableitung effizienter Organisationsformen im Schweizer Schienengüterverkehr in der Fläche, Abschlussbericht,

Infras, BAKBASEL, ETH Zürich IVT (Ickert, L. et.al.), 2012. Marktanalyse und Marktprognose Schienengüterverkehr 2030, Gesamtbericht, Bern, 29 Oktober 2012

Karlsruhe, 4. Februar 2013

Oliver Wyman, 2011. Developments and trends in single wagonload rail traffic in Europe, prepared for the 6th International VDV Railway Congress 2011, Frankfurt am Main

Réseau Ferré de France (RFF), 2013. Network statement of the national rail network "2014 timetable", Version 3 of 26 April 2013

Rieser, M., 2010. Adding Transit to an Agent-Based Transportation Simulation, concepts and implementation, PhD-Thesis, Berlin.

Schroeder, S., Zilske, M., Liedtke, G., Nagel, K., 2012. A Computational Framework for a Multi-Agent Simulation of Freight Transport Activities. Annual Meeting Preprint 12-4152.

Vogt, A., 2011. Renaissance des Einzelwagenverkehrs nach Liberalisierung des Schienengüterverkehrs in Deutschland?, Freiburg im Breisgau, Germany: Verlag MetaGIS Fachbuch