CHALLENGES IN THE RAILWAY YARDS LAYOUT DESIGNING REGARDING THE IMPLEMENTATION OF INTERMODAL TECHNOLOGIES

Ivan Belošević [a*], Miloš Ivić [a], Milana Kosijer [a], Norbert Pavlović [a], Slaviša Aćimović [a]

[a] University of Belgrade, Faculty of Transport and Traffic Engineering, Serbia

Abstract: *This paper provides a survey on railway freight yard classification and presents the challenges in designing and planning of railway yards regarding the ongoing transformation and changes. Transport service in railways can be achieved through the conventional concept of wagonload transportation or within intermodal transport chain. In both concepts, railway yards are recognized as key factors for the smooth functioning of the freight transportation. At the same time, yards are facing problems relating to layout designing and operation planning. The railway yard under the study, Vršac railway yard, has a strategic position in the transportation network and for that reason is recognized as a potential location for establishing intermodal service. The paper proposes the layouts designed for the reconstruction of the existing classification yard and the construction of a new rail-road transshipment yard.*

Keywords: *railway freight yards, layout designing, intermodal transportation technology*

1. INTRODUCTION

The accomplished transport service in railways can be achieved through the conventional concept of wagonload transportation or within intermodal transport chain. In both concepts railway yards play a decisive role for improving the efficiency and quality of transport service. At the same time, yards have been faced with a whole array of problems relating to layout designing and operation planning.

Wagonload transportation, also called Single Wagon Load Service (SWL), consolidate loads composed of single wagons and wagon groups. These wagon loads are less than full train loads which are collected at different customer sidings and assembled in yards to full trains on the same routes throughout the railway network. Wagonload transportation is based on the system of marshalling yards which are comparable with hubs in the logistic Hub and Spoke System. In this way, marshalling yards obtain a certain degree of economies of scale benefits and reduce the wastages of the system. On the other hand, the overall operating efficiency is limited by the capacity of the yards and their utilization.

The intensification of railway yard efficiency can be achieved within intermodal ''door to door'' principle application. The essence of the technology of combined rail-road transport is in the combination of the advantages of the fast, cheap and safe railway transport of freight in long

* i.belosevic@sf.bg.ac.rs

distances and fast and efficient final distribution by trucks. This, as well, enables a sustainable modal share within transport chains. The sustainable modal share assumes the contribution to the whole transport system by shifting from one to another, more favorable transport mode. From the aspect of sustainable modal share, railways advantages are high capacities reserves, reliability and safety, reduction in specific energy consumption and pollution.

Railway yard management tries to reduce redundancy costs and to strengthen the role of yards in the transport chain by implementing the intermodal transport technologies. Only in that way, railways can increase its market share and reach the targets set by the White paper in the European transport area. Direct intermodal trains have the potential to be the basis of a novel railway freight transport service. They directly connect intermodal terminals while loading and unloading costs are allocated outside the railway service. Direct trains connect two terminals without intermediate stops in the most economical and fastest way. In addition to transport technology development, it is important to establish a more efficient freight handling and train operating in railway yards.

This paper presents the challenges in designing and planning of Vršac railway yard regarding the ongoing transformation and changes. The railway yard has a strategic position in Serbian railway network but due to years of lack of maintenance it is in an inadequate state to perform the service relating consolidation of wagonloads and to serve as interface in the novel intermodal transport technologies. The paper proposes layouts designed for the reconstruction of the existing classification yard and construction of the new rail-road transshipment yard.

2. RAILWAY FREIGHT YARDS: OVERVIEW AND CLASSIFICATION

Yards as nodes in networks have the key role for the smooth functioning of the freight transportation. Railway yards should be more used as transshipment points inside the railway system or between the railways and an alternative mode of transportation. Currently, railway yards mainly consolidate the movements of freight trains on the network. Railway yards concentrate resources, such as track sidings and various track installations, shunting locomotives and freight handling equipments in order to receive, operate and depart freight trains for the sake of provided service.

The most of railway freight yards execute classification procedures: disassembling and reassembling trains. It can generally be acknowledged that the most of classification freight yards are inefficient and that their layouts and disposition in networks does not satisfy contemporary needs. The most of the unproductive time railcars spend in the yards, approximately about two-thirds of their turnover system time. Petersen (1977) identified three types of classification freight yards: flat yards, hump yards and gravity yards. Flat yards are the yards where the railcars are pushed and pulled by a shunting locomotive which sorts them into the assigned track. These tracks lead into a flat shunting neck at one or both sides of the yard (for a detailed description of flat shunting yard operation and layout see Marinov and Viegas (2009)). Hump yards are the largest and most complex railway yards which feature the hump over which the railcars are pushed by the shunting locomotive. Early analytical queuing models (see e.g. Crane et al. (1955), Petersen (1977)) have been generally used in analyzing and evaluating the complex yard operations. Due to the dynamic and stochastic yard operation, the application of exact optimization methods is quite limited. The application of simulation tools enables the analysis of different yard layouts and operation strategies in real-time working conditions by varying different environmental parameters. The usage of simulations and their efficiency to estimate capacity requirements are pointed out in several papers (see e.g. Ivić et al. (2010) and Belošević et al. (2012)). Gravity yards, the third type of conventional railway yards, are designed with a continuous falling gradient and a distinct type of layout. Gravity yards have a very large capacity but with lots of the difficulties related to safety issues and for that reason only few remain in operation today. Typically, classification freight yards consist of:

- Arrival yard to receive freight trains in the railway yard system;
- Classification yard to disassemble received freight trains and to sort railcars;
- Departure yard to depart freight trains from the railway yard system and
- Maintenance yard and depot to serve railcars and locomotives.

On the other hand, the railway yards may serve as an interface between railways and other mode of transportation, mostly as rail-road transshipment yards. In such a system, trains perform only the long haulage while pre-haulage and end-haulage is performed by trucks. For this purpose, trains are not decomposed and only loading units are transshipped by means of handling equipment (gentry cranes, reach stackers or forklifts et.). The rail-road transshipment yards were in details analyzed considering layout planning and operational problems by e.g. Ballis and Golias (2002). To process freight trains and loading units, the rail-road transshipment yards are consisted of:

- Track sidings for train arrival/departure and inspection purpose;
- Transshipment tracks for the train loading/unloading operation;
- Loading and driving lines for the trucks ;
- Storage area for loading units and
- Handling equipment.

Besides the conventional rail-road transshipment yards fully automated rail-rail transshipment yards are designed to increase the exchange of loading units between trains. In order to ensure the rapid transshipment, the yards are designed without floor storage areas which are replaced with some of the automated systems for sorting. Although this novel transshipment technology is still under development some of these yards have already been constructed (see e.g. Boysen et al. (2013)).

3. CASE STADY: VRŠAC RAILWAY YARD

3.1 Motivation

The current role of Vršac flat yard is to rearrange freight trains passing through the yard and to classify railcars for further distribution over railway network in Serbia and border crossing to Romania. Furthermore, it is expected that Vršac yard obtains additional role in Serbian transportation network through the development of intermodal transportation. The establishment of the intermodal terminal and revitalization of railway infrastructure are defined as top priorities for further development of transport service in the Municipality of Vršac. In this sense, the existing railway yard in Vršac should be redesigned to fulfill the additional requirements for implementation of rail-road transshipment.

3.2 The current state

The flat-shunted yard Vršac is located in the industrial zone of Vršac and serves the following rail lines: Pančevo – Vršac – State border to Romania and Zrenjanin – Vršac – Bela Crkva. Vršac yard is open to entire passenger service and the service of part-load and wagon-load consignments. The yard is divided into the group of main tracks (the tracks for the arrival/departure of trains and the tracks for freight train classification) and a few groups of sidings. The yard has 28 tracks, 7 out of 28 tracks can be used for the arrival and departure of trains, while other tracks are handling, loading, depot and other sidings. The current layout of Vršac railway yard is outlined in Figure 1.

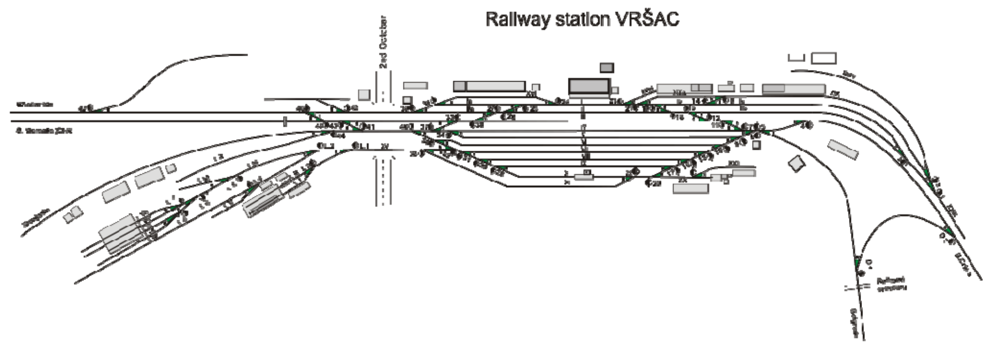

Figure 2. The current layout of Vršac railway yard

3.3 Reconstruction of Vršac railway yard

The initial framework for designing the intermodal terminal and its connection to the public railway network is based on the orientation to retain the existing location of the railway yard, which is proposed in the Master Plan of Vršac and in the Development Program of Serbian Railways. Under the current state, the railway yard in Vršac functions as a flat-shunted yard. Conducted current-state analysis has shown that the yard is able to serve trains with intermodal loading units. It has also noted the deficiencies of the sidings' conditions in the terms of the existence of the insufficient design of track ladders, unequal track lengths and poor superstructure.

Layout of the flat yard

Within the reconstruction (see Figure 2), the group of main tracks should be extended considering the requirements for serving intermodal trains with the maximum lengths of 600-650 m. This extension of main tracks requires the realignment of Belgrade railway line leading a yard and the complete reconstruction of the corresponding yard ladder. The expected intensification of the freight railway transport requires additional capacity, so the yard should be widened with two main tracks. Also, two shunting necks would be constructed to realize smooth and parallel disassembling and reassembling operations on the each side of the yard. Upon the reconstruction, the yard would deal with the 12 main tracks and two shunting necks. The first three tracks should be the platform tracks and the remaining nine should be used for freight service. The arrival group should be composed of 5 tracks, while the last 4 should be used for classification. The arrival group of tracks is intended for receiving the trains for complete or partial disassembling or other shunting operations (such as locomotive exchange, technical inspection or customs clearance). The arrival group of main tracks in the yard should be also used for receiving in-going/out-going trains for or from the intermodal terminal and the logistic center. All currently used handling sidings would be allocated from the yard and aligned over the logistic center and nearby industrial zone.

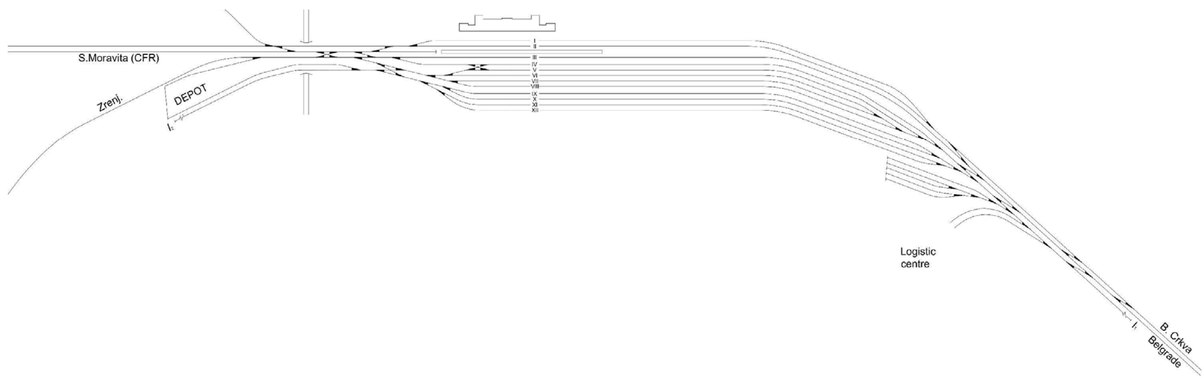

Figure 3. The reconstructed layout of Vršac railway yard

Layout of the rail-road transshipment yard

The construction of the intermodal terminal could be carried out independently of the reconstruction of Vršac yard. In the beginning, the intermodal terminal could be constructed and launched under the current state of the railway infrastructure in Vršac. Initially, the transshipment yard would be designed with three tracks in the area of the intermodal terminal (see Figure 3). Two tracks would be used as transshipment tracks for the train loading/unloading and one track would be used as a passing track for the run-around operation of shunting locomotives. The minimum usable length of handling tracks would amount 650 m in order to ensure the smooth reception of complete intermodal trains. For the purpose of accompanied transport, the RoLa loading ramp would be installed on track T1. Furthermore, after the establishment of logistic centre and initiation of intermodal transport it is possible to expand the capacity of the transshipment yard in terms of extending existing tracks or increasing the number of tracks.

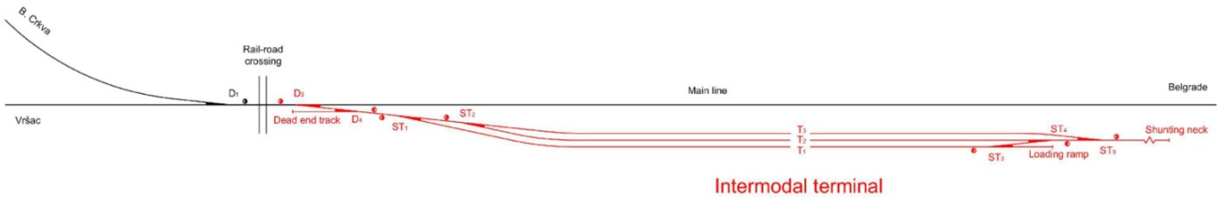

Figure 4. The layout of the rail-road transshipment yard

Layout of the rail-road transshipment yard connection with the flat yard

To ensure the full and effective operation of the intermodal terminal it is necessary to enable its connection with the public railway infrastructure (see Figure 4). The connection to the rail network would be carried out indirectly using Vršac railway yard. Connecting Vršac yard to the transshipment yard could be implemented in phases, which would be in line with the reconstruction of Vršac yard.

Under the current state, the transshipment yard could be connected from the main passing track in the railway yard. For the reason of increasing safety on the main line, the terminal connection would be designed with the short dead-end track (see Figure 4a).

a) Before the reconstruction of the railway yard *b) After the reconstruction of the railway yard*

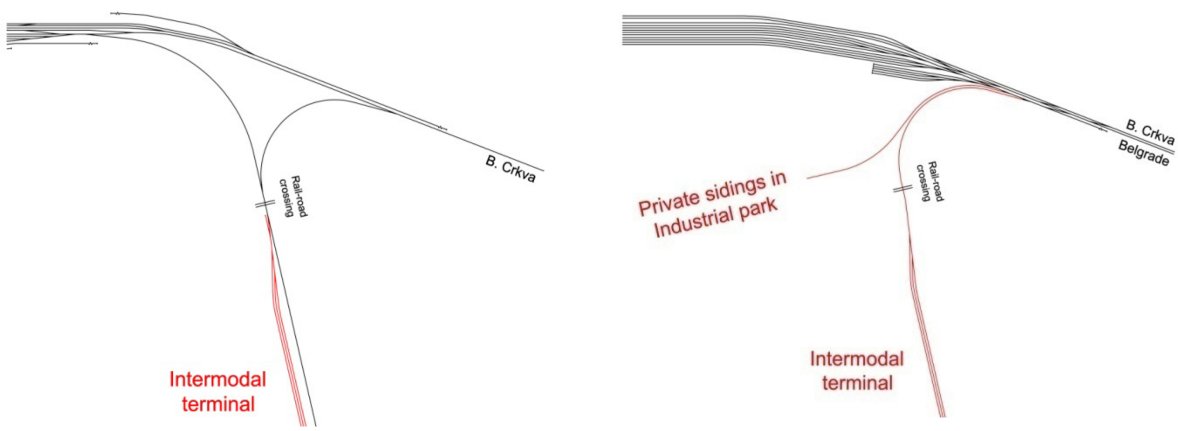

Figure 5. The rail-road transshipment yard connection with the flat yard

The allocation of the entrance of the railroad from Belgrade (in the final phase of Vršac yard reconstruction) revokes the allocation of the previous connection to the main passing track in the yard, (see Figure 4b). The connection of the terminal to the arrival group of the yard would be performed independently (using the track of existing triangle). This connection results in an indirect arrival and dispatch of the compositions to and from the terminal. Parallel to this connecting track it is possible to align another connecting track and to spread the network of private sidings within the industrial park.

4. CONCLUSION

This paper provides a survey on railway freight yard classification and presents the challenges in designing layouts of railway yards regarding the establishment of novel intermodal technologies. Railway yards are recognized as key factors for the smooth functioning of the freight transportation. The most of railway freight yards execute only the classification of railcars which do not satisfy contemporary needs. Therefore modern railway yards should be more oriented on the transshipment procedure either inside the railway system or between the railways and alternative modes. In the shape of case study we analyzed the railway yard in Vršac which mainly performs the conventional rearrangement of freight trains over railway network in Serbia and border crossing to Romania. In addition, it is expected that Vršac yard obtains more significant role in Serbian transportation network through the development of intermodal transportation. The catchment area of the potential Vršac intermodal terminal widely exceeds borders of the South Banat District because of its favorable position in Serbian transportation network, near Corridors X, IV and VII. In this paper we propose the layouts designed for the reconstruction of the existing rail classification yard and the construction of the new rail-road transshipment yard.

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