



MODERNISATION OF LJUBLJANA RAILWAY JUNCTION

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Abstract

The Ljubljana Railway Junction, as an intersection of 5th and 10th European Railway corridor, has a special importance not only for the city of Ljubljana and for development of Slovenian railway infrastructure but also for the European railway network. While in the last decades only minor modernisations were realised, the railway junction needs to be adapted to the current and future task of the junction within national and international framework to cover the requirements of a modern traffic system.

Beside the technical point of view and beside substantial financial resources which are needed, the modernisation of this junction is a sizable challenge for the development of railway infrastructure and for the city development. Since railways were first introduced, urban development has been, to the high degree defined by the tracks, that still today, present serious obstacles for the development of city space.

Keywords: railway junction, modernisation, railway deepening

1 Background

The discussion on the Ljubljana railway junction has been dragging on for decades. An important milestone in discussion on the development of the railway junction was the decision for the so-called A-54 variant envisaging leaving the railway at the current height level. That decision resulted in subsequent construction of road underpasses on Celovška, Dunajska, Erjavčeva, Drenikova and Kajuhova cesta and pedestrian underpasses on Cankarjeva and Puharjeva that have in the long term defined the present image of the city and its development. The consensus with the railway at the city level was short lived and proposals of putting railway underground in the city centre or with by-pass line around the city centre for freight trains (in this case existing lines in city centre would be used only for passenger traffic).

The Slovenian state tendered in 2007 a detailed study to find the best solution for the future railway junction whereas the main development objectives were the following:

- Relocation of railway cargo transport from the current route through the city by constructing a new bypass around the city or under it and connecting the line from Rakovnik directly towards Zalog via a new Vodmat arc.
- Discharge of the existing railway lines in the city area from freight traffic with the aim of their exclusive use for passenger, notably commuter intercity transport with appropriate stations in the city area.
- Rearrangement of existing Ljubljana main station into pure passenger station.
- Providing for adequate rail capacity at the future Ljubljana Passenger Station considering the construction of the new high-speed passenger line, introduction of cycle time table, upgrading of existing single-track into double-track lines and reactivation of the Vrhnika line.

- Improving traffic safety and fluidity at the railway junction by introducing state-of-the-art signaling & safety devices, reducing crossings of lines, constructing off-grade intersections with roads and off-grade access to platforms.

Feasibility of railway deepening or new by-pass line was examined and elaborated in study *Študija variant za razvoj javne železniške infrastrukture na ljubljanskem železniškem vozlišču*. In this study, operational concepts, design of railway infrastructure, costs, urban and environmental impact assessment and evaluation, financial and economic indicators and evaluations of four variants were examined and will be presented in this paper.

Above mentioned study is the result of Slovenian and German experts knowledge (joint venture of companies Verkehrsbau Projekt GmbH (Vepro), Ingenieurbüro Vössing, DDC svetovanje inženiring d.o.o. and Univerza v Ljubljani - Fakulteta za gradbeništvo in geodezijo).

2 Existing situation at Ljubljana railway junction

The Ljubljana Railway Junction is the most important junction in Slovenia. International corridors v and x meet in Ljubljana. Additionally, there are two regional lines starting and ending in Ljubljana. These lines are Ljubljana – Kamnik to the north and Ljubljana – Novo mesto to the south. The corridor v runs along the track sections Sežana – Ljubljana Main Station – Zidani Most at the Ljubljana junction. The track sections Jesenice – Ljubljana Main Station – Zidani Most represent the corridor x at the Ljubljana junction. Nearly all lines are used for mixed traffic of freight and passengers. All international transit trains (passenger and freight) pass the Ljubljana Railway Junction.

Following basic data shall give an overview of the network characteristic:

- total length of lines 1226km
- share of double track lines 26,9%
- share of single track lines 73,1%
- share of electrified lines 41,0%

Zalog station is Slovenia's central marshalling yard where most of the national and international freight trains get dispatched and handled. Furthermore, the container terminal in Moste plays a role in handling of freight in the Ljubljana junction. Freight trains are mainly operating in the relation from the port in Koper via the marshalling station Zalog or via the container terminal in Moste to the northwest of Europe via Austria. Due to missing functionality in the junction, all trains coming from Novo mesto must turn in the Ljubljana main station to reach Zalog or Moste. The same problem exists for the trains coming from Koper and Sežana. A lot of them must turn in Ljubljana main station to go towards Jesenice and Austria.

Low capacity of the Ljubljana junction (missing connection curves, single track lines, operational procedures in the Ljubljana main station), low entry speed in the Ljubljana main station (only 30km/h) due to lacking infrastructure, obsolete railway signaling system and poor safety situation for railway-road crossings (mainly level-crossings) and spatial aspect (removal of railway tracks from ground level) results in a requirement for new railway settlement in the area of the Ljubljana railway junction.

As an important extension, it is planned to realise a separate line for high speed trains between Trieste and Budapest, which will be bundled with the existing line in corridor v, so future infrastructure must cover these additional demands. Introduction of envisaged variants The comparison and selection relates to three variants prepared on the basis of rough concept designs which have proven to be the most suitable and feasible in the past research and documents on the long-term development of the City of Ljubljana and the public railway infrastructure in the Ljubljana region and the additional fourth variant which was defined by the consultant during study work.

All four variants envisage upgrading the existing single-track railway lines in the Ljubljana region to double-track lines suitable for introduction of commuter railway transport, reacti-

vation of the abandoned Vrhnika-Brezovica-Ljubljana line and eliminating freight transport from city centre. The study discusses the following four variants:

2.1 Variant 1

The variant 1 envisages putting the existing railway lines to the level -1 in the city centre and putting the existing railway station to the level -1, construction of freight line at the level -2 below the city and construction of high-speed passenger line by a tunnel through Šišenski hrib.

2.2 Variant 2

The variant 2 envisages preserving the existing railway lines at the present level and preserving of the existing railway station at its present level, construction of freight bypass line to the west at the level -1 and north to the city at the level 0 and construction of high-speed passenger line by tunnel through Šišenski hrib.

2.3 Variant 3

The variant 3 envisages preserving the existing railway lines at the present level and preserving of the existing railway station at its present level, construction of freight bypass line between Vižmarje and Dolgi most at the level -1 and under the city at the level -2 and construction of high-speed passenger line by a tunnel through Šišenski hrib.

2.4 Variant 4

An essential change comparing to the other variants is to give up the bypass for freight and high speed traffic as the main reason of the enormous investment costs and additional conflicts in environment and usage of private ground. All lines should remain in the existing corridors, while freight traffic will be lowered down in city area to the -2 level.

The main goal of this study was to determine the optimal variant for the proposed development of Ljubljana railway junction. The railway traffic forecast was adjusted to the needs of this study, so it is focused mainly on passenger and freight flows converging in the junction from all directions. Railway traffic volume forecast was based on extrapolation of trends in the years between 2000 and 2007, considering "Strategic plan of Slovenian Railways to 2015", future investments into public railway infrastructure and the estimations of the long term traffic growth anticipated in the existing relevant international studies and prognoses. In the passenger traffic, implementation of a cycle time table and renewal of the railway line to Vrhnika were anticipated. The passenger and freight forecast in the number of passengers, pkm, tons, gross tons, number of trains was made in form of three scenarios; optimistic, realistic and pessimistic (high, low, medium) for the period up to 2045.

To verify that the designed infrastructure of the Ljubljana Railway Junction is sufficient for the forecasted traffic in 2045 an operational analysis with a railway simulation has been compiled for each of the four variants. An operational simulation with considered infrastructure data for the four variants, vehicle data, signaling data, etc. and timetable for one exemplary peak hour for each component of the Ljubljana Railway Junction was analysed.

The results are given on Figure 5 as occupation diagrams for the Ljubljana Main Station and as train graphs for the track sections.

To fulfill all operational needs during the construction phase furthermore the railway operation during the construction phase was analysed.

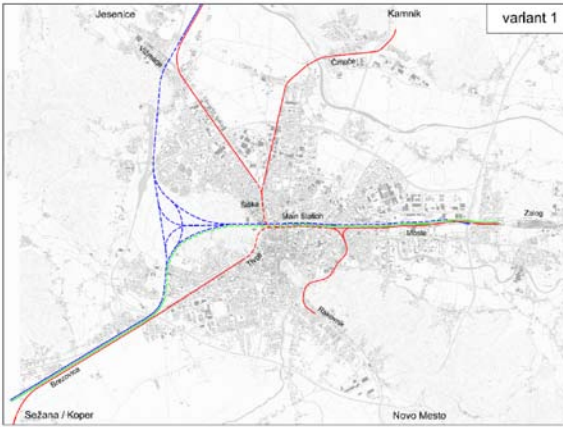


Figure 1 Variant 1.

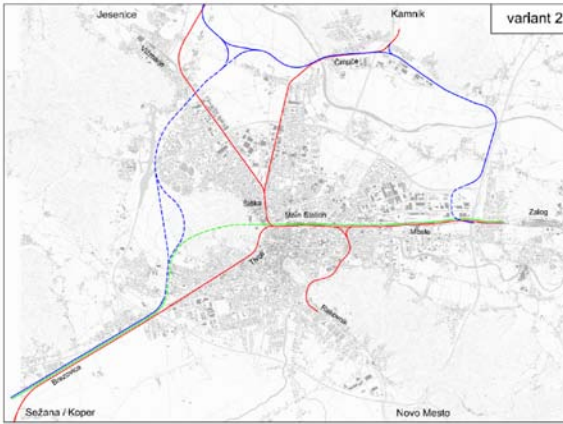


Figure 2 Variant 2.

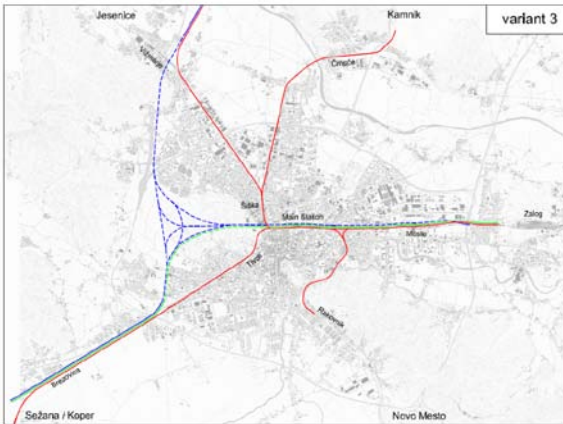


Figure 3 Variant 3.

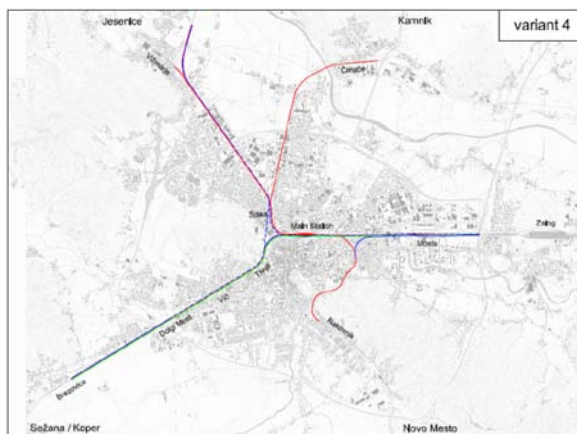


Figure 4 Variant 4.

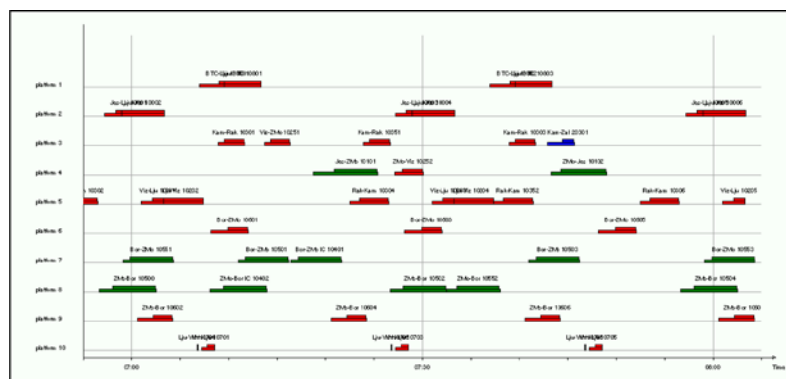


Figure 5 Occupation diagram for the Ljubljana main station, peak hour in 2045, variant 4.

3 Design of the technical infrastructure

The results of traffic analysis, traffic forecast, operational concept and tender documentation of the study, defined the objects and requirements to the infrastructure. The design includes not only the track-ways and structures but also all railway specific systems like traction power, signalling and telecommunication.

Beside the definition of the final situation of each variant it was focused also on the construction phasing which is very complex but not less important in such an eminent infrastructure project within a grown city where the complete construction process must be realised under operation.

The study contains report on environmental impact of variants of railway infrastructure in the area of the Ljubljana railway junction and was made by appropriately taking into account the project task and applicable regulations. Potential spatial conflicts and restrictions which in accordance with experience appear in particular in areas with special protection regimes (protected areas of nature, cultural heritage and protection areas of underground water) and in populated areas due to noise emissions and land use were recorded. Preliminary report on environmental impact includes an overview of lanned variants in space and the potential impact assessment is based on publicly available data. The comparison of variants from the

environmental aspect is based on evaluation and comparison of the following segments: cultural heritage, nature conservation, land use, impact on health of people (noise pollution) and impact on water resources.

4 Evaluation

Evaluation of the Ljubljana Railway Junction was performed on basis of determination and calculation of monetarised and non-monetarised effects. For calculation of monetarised effects (economic evaluation) the Cost Benefit Analysis method has been used. Non-monetarised effects (environmental and urban planning ones) are given descriptively. In the final evaluation the results of CBA and non-monetarised effects were weighted in their importance and the results were proofed by a sensitivity analysis regarding the used weighting. Economic evaluation/aspect

Within the economic evaluation costs were calculated for the status “without investment” and the status “with investment”, for each individual variant. The difference between the costs “without investment” and the costs “with investment” represents benefits from the investment. Under economic assessment, there were the following types of costs calculated and compared: investment costs, maintenance costs, traffic management costs, direct users’ costs (time costs, consumption costs) and external costs.

With regard to the economic justification the Variant 4 was proposed as the most economic; it is followed by the Variant 2, Variant 3 and Variant 1.

4.1 Urban planning aspect

The appraisal of variants has been prepared on the basis of existing planning documents as well as on the documents under preparation (SPN MOL). Variants were evaluated regarding the impacts on: long-term urban development, spatial transitivity accessibility to urban areas, renewal and revitalisation, quality of the residential environment, economic potentials and legibility of space. As the (comparatively) more suitable solution from urban planning aspect the Variant 1 was proposed. The variant 4 was appraised as suitable. Variants 2 and 3 have been evaluated as “conditionally appropriate” due to the course of the High Speed Line between Cekinov grad and the main station.

5 Conclusion

It is evident from the common evaluation that the Variant 4 has the best overall result, so it is proposed as the best among the studied variants. The result is very clear and sensitivity analyses show high independence on the subjectively selected proportions (weights) among segments and multi-criteria analysis on one hand and on changes of costs and revenues on the other hand. Based on technical design, financial and economical evaluations and comparisons, we may conclude, that all variants are very complex and financially demanding so they require disproportionately large investment compared to the financial and economic effects. We would like to emphasize, that from the aspect of organisation, stage development and budget such a project cannot be designed and managed within the existing institutional framework. For such a big investment, with so wide range of effects, not only within the framework of Slovenia, one has to find a new model of financing.

The proposed optimal Variant 4 was elaborated in the way, which included a condition of comparison with the other three variants. In case the abovementioned comparison is not taken into consideration, the proposed variant enables substantially better solution, without essentially disabling, through changes, the main set objectives of the project.