

PRELIMINARY DESIGN OF BUS STATION IN RIJEKA

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ABSTRACT

Today's location of the bus station in Rijeka, whose main function is passenger and bus handling primarily in intercity passenger traffic, does not meet the basic conditions required of a bus station. The macro location of the bus station, namely, can be assessed positively (bus lines currently connect Rijeka with six regions including Istria, Slovenia, central Croatia, B&H, islands, Crikvenica, and Dalmatia), whereas its micro location is extremely unfavourable (it is located at one of the rare city squares in the very centre of the city), and from the traffic aspect quite poor. The technical-technological characteristics are extremely poor and do not offer comfort either to the passengers or to the staff employed at the terminal or to the drivers. The work studies the future role of the bus station in Rijeka, the traffic forecasts, dimensioning of the essential elements of the bus station and provides a preliminary solution at a new location connected with the railway station and the passenger seaport, so that these three terminals of long-distance passenger traffic in Rijeka would then form a single whole.

1 INTRODUCTION

Passenger terminals in Rijeka, in a wider sense, consist of bus stations, railway stations and passenger ports. They are located one next to the other on the coastline of the strict mid part of the city centre, so that it can be globally said that their distribution features a logical sequence and their accessibility for the citizens of Rijeka is also relatively good. However, the connections between the terminals are poor and cause problems, and this is especially true of the connection between the bus and railway stations.

The bus station is located on the Žabica Square, on a relatively narrow space, which is surrounded by the busy city roads and access roads to the cargo and passenger ports. Since it is located in the very centre of the city, and moreover, between the railway and maritime terminal, it may be said that it has an almost ideal macrolocation. However, the microlocation of the terminal in the centre of one of the rare city squares in the very centre of the city, from the traffic aspect is extremely poor.

Therefore, it has been concluded that it is necessary to find a new location, and traffic and technological solution for the bus station, which means its relocation and dimensioning according to the principles of advanced technology and the planned scope of work.

2 ANALYSIS OF THE CURRENT SITUATION

As already mentioned, the terminal of the intercity bus traffic in Rijeka is located on the busy city Square Žabica in the very centre of the town of Rijeka, between the railway and the maritime passenger terminals and has occupied an almost ideal location.

The traffic demand, and therefore also the supply offered by the terminal can be recognized through six outgoing – incoming directions from/into Rijeka, and these are Istria, Slovenia (towards western European destinations), Central (continental) Croatia, Bosnia and Herzegovina, Islands and Dalmatia.

The technical characteristics of the bus terminal Žabica regarding its location, as well as the equipment, are very modest and do not offer the personnel working there, drivers and especially the passengers the necessary comfort that such a terminal should provide.

The terminal features the main passenger platform, three narrow, island platforms and a regulation island which separates the platforms from the traffic area. It has 14 loading-unloading bus stands, but of insufficient dimensions, with two stands blocked by the first, that is, last bus. Four stands are used for waiting and parking of buses.

The current technology of traffic on the terminal Žabica consists of the bus flows that arrive to the terminal along certain routes of the urban traffic network. The terminal fulfils the function of the origin–destination and transit passenger traffic. Today's arrivals and departures of buses in communicating with the terminal are directed to the busiest traffic centre of the town of Rijeka.

In spite of the almost ideal macrolocation, the microlocation is extremely poor and the disadvantages can be recapitulated as follows:

- the location of the bus station on the city square, with no possibility of expansion, with a number of location and traffic conflicts between the terminals and the urban centre cannot be maintained,
- inadequacy of overloaded access roads with the orientation of a large number of bus lines to the road on which the throughput capacity is reduced by the passing train,
- insufficient space for the bus traffic operations,
- under-dimensioned traffic – spatial elements (platform width, bus turning radii, lounges, ticket offices, etc.),
- low level of passenger service (unsafe accesses to the platforms, narrow and inadequate loading or waiting areas, open-air platforms, etc.),
- unsolved passenger car parking problems at, that is, next to the bus station.

All this indicates that the bus terminal should be moved to a new location and dimensioned according to the principles of the advanced technology and the planned scope of operation.

3 TRAFFIC FORECASTS

Based on the analysis of the most significant factors that affect the traffic forecasts, and these are population, social and economic development and ownership of motor vehicles, in the Primorsko-goranska County, the following may be concluded: the number of inhabitants features the tendency of decline, the number of employees is slightly increasing and is almost stagnating, the number of tourists is permanently growing, the average incomes as well as the GDP are growing, and the total number of motor as well as passenger vehicles is also increasing.

The number of passengers on the Rijeka Bus Station is not registered regularly, nor is it determined by occasional recordings, and it can be estimated on the basis of analysis of the number of sold tickets at the Rijeka Bus Station and the performed counts according to the structure of passengers and surveys carried out by the Institute of Transport and Communications 2004.

The increase in the number of passengers at the Rijeka Bus Station is estimated for the periods 2005 – 2010, 2011 – 2020 and 2021 – 2030 according to certain rates, depending on the version, i.e. for an optimistic rate version these amount to 2%, 1% and 0.5%, realistic (mean) 1.5%, 0.5% and 0.5%, and for the pessimistic version 0% for all the periods. Thus, the following number of passengers, expressed in millions, is to be expected:

Year	Number of passengers [mil.]		
	optimistic version	realistic version	pessimistic version
2010	2.15	2.09	1.91
2020	2.37	2.19	1.91
2030	2.49	2.19	1.91

4 DIMENSIONING OF THE BASIC BUS TERMINAL STRUCTURE

Specification of the bus terminal area

The entire analysed spatial, plan and design documentation has focused on the area of the today's railway warehouses 31 and 32 (western Žabica) as the best traffic, technological and spatial solution of the bus station. The space at the new location of the bus terminal can be specified to the following facilities: station part, passenger part, traffic part, internal communications, accompanying traffic facilities, accompanying catering facilities, accompanying services, accompanying commercial facilities and external communications.

Entries and exits for buses

The plan includes from the new road extended Riva from the western side of the station, because this eliminates the intersecting of the bus flows to and from the stands with the passenger flows to and from the platforms, allowing at-grade movement of buses to the stands and passengers to the platforms (stands), and allowing bus movement within the bus station only in one direction.

Stands, platforms and internal station roads

Based on the forecast number of passengers at the bus station according to the optimistic version and the remaining estimated parameters, as well as estimations according to various methods, the following number of stands is obtained:

Type of stand	2010	2020	2030
unloading (arrival)	3	3	4
loading (departure) - transit	9	10	10
excursion – tourist	2	3	3
link to air traffic terminal	1	1	1
Total:	15	17	18

Based on research in the conditions of new bus station location, the most acceptable is the saw-like type of stands in relation to the platform (Figure 1). This type of stand is a through type, i.e. the bus enters and exits forwards, thus insuring high level of safety both for the passengers and for the buses.

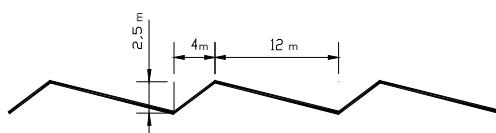


Figure 1: Shape and dimension of stands for the buses of standard length

Since the today's structure of buses regarding length, of the most represented carrier, means three types of buses with the 12 m long buses being the most represented ones with 84 percent, it is estimated that in the future also the standard buses will be 12 m long, and that

the number of buses longer than 12m in the total structure at the Bus Station will not exceed 15%.

The planned width of the traffic lane in the bus station directly connected to the stands is 4 m, and directly along it there will be the so-called "transit" traffic lane for buses 4 m wide.

Parking space for buses – spare areas for balancing the timetable

Bus parking is mainly intended for minor balancing of the timetable, i.e. bus stays of 30 minutes to about one hour and a half. For this type of bus parking the Bus Station should provide 6 to 7 parking spaces in the peak period, and in other periods, apart from these, the less occupied stands may be also used. Any longer stays of the buses, as well as all the longer parking of non-scheduled i.e. excursion - tourist buses should be solved at another location (Škurinje, Cernik, etc.).

Taxi stands

A minimum of 6 to 8 stands for taxi vehicles is planned. The most favourable location is directly next to the arrival bus stands, but a certain number of stands should also be insured at other accesses to the bus station, i.e. in Krešimirova Street next to the warehouse 33 and in the Riva Street east of the Žabica Square.

Unloading – loading stands for passenger cars

For faster unloading of passengers according to the "kiss&ride" system, several stands need to be planned along with the arrival-departure bus station platforms, and then in the Krešimirova Street next to the warehouse 33 and the Riva Street from the Žabica Square.

Garage parking facility

Along with the bus terminal, a certain number of parking spaces for passenger cars with time-limited parking and a certain number without time limitation should be provided, as well as a number of places for the so-called long-term – several days parking.

Directly above the bus terminal itself, an above-ground garage structure can be constructed thus meeting the parking needs related not only to the terminal, but also to a certain extent for the railway station and the passenger port.

Regarding the needs, the capacity of the garage parking facility should be very large, but actually it should amount to 600 places, since this is the capacity that can be efficiently adjusted to the capacity of the arrivals and departures, as well as the capacity of the access road and the Žabica Square. Higher capacity, which would be technically feasible, in the peak period would result in queues and would only disturb the traffic.

For entries into and exits from the facility the need should be respected that these should be outside the main traffic flows and not in collision with the entry (exit) to the bus terminal.

An important issue is also good pedestrian connection between the garage within the facility itself and the terminal (by elevators, etc.) and the external connection of the garage to the pedestrian traffic flows towards the downtown area and towards the planned maritime and railway terminals.

Passengers and passenger-reserved areas

Passengers arrive to the bus station on foot, by public transport, by taxi and by passenger cars. It is estimated that in the future, the number of passengers arriving on foot and public transport vehicles will exceed 70 percent. Therefore, a logical solution would be to select the main entrance and exit for pedestrians to the bus station from the Žabica Square, and therefore adequate station pre-area should be provided there.

Inside the bus station sufficient reception area, information centre, ticket offices, left-luggage office, restrooms, areas for shorter stays of passengers, minor catering services at the level of the bus station i.e. directly to the platforms need to be provided.

Major accompanying catering facilities, services, retail facilities, official premises are necessary at a bus station, but do not have to be at the same level as the platforms, if this is impossible to achieve because of the space.

Luggage

Transport of luggage is planned only by personal bringing of these to the platform (bus) and the luggage is loaded into the bus at the same time as passengers embark. In order to facilitate such transport of luggage, luggage is planned to be distributed by terminal trolleys that have to have the possibility for moving not only within the terminal area, but also to the railway and port terminals. For vertical hoisting and lowering, elevators should be planned.

5 PRELIMINARY DESIGN OF THE BUS TERMINAL

The preliminary design of the bus terminal (Figure 2) is based on the defined role and function it has to play in the future, selected technology of access and movement of passengers and buses within the terminal and on the determined capacities regarding the expected volume of traffic. It has been defined respecting the spatial limitations and fully recognizing the function and capacity.

The planned new preliminary design of the bus station would be located at the current warehouses 31 and 32, which means that its location would be bordered on the west by the railway passenger station, to the south by the Port, railway line to Brajdica and road extended Riva, to the north by the Krešimirova Street and on the east by the protected railway buildings, which are west from the Žabica Square. The space required for the bus terminal according to the preliminary design of the Study of the Terminal for Passenger Long-distance Traffic in Rijeka, IPV, 2004 amounts to 11,906 m². This area should be supplemented by the area for entries and exits to the bus station, i.e. to the garage – parking facility which covers 2,127 m², so that the total area would cover 14,033 m².

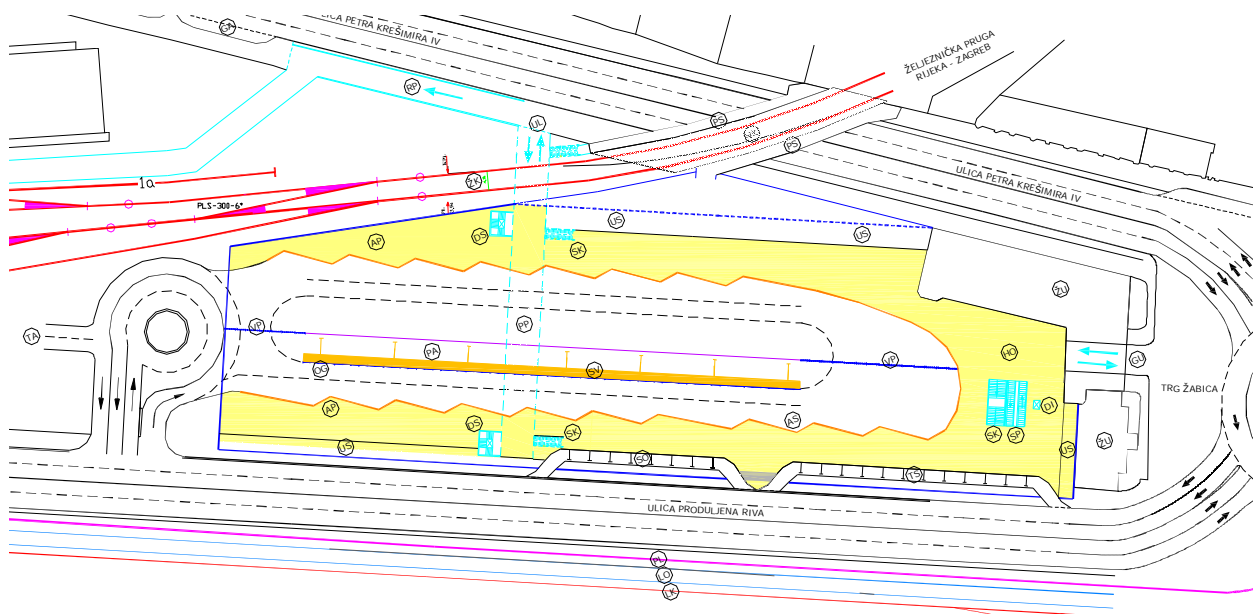


Figure 2: Preliminary design of the bus terminal

The ground level of the bus terminal with platforms, stands and other facilities is planned at the level of the ground level of the existing warehouses 31 and 32 (elevation + 4.50 m). Two longitudinal side platforms are planned and they are connected on the east side and together with the hall of the building form a shape of a "horse-shoe".

Ten stands for the buses are planned on the southern platform, out of which eight are of the length for standard buses and two are for the buses of up to 18 m long. Minimal width of this southern platform is 7 m. On the northern platform, eight stands are planned, out of which seven are of standard bus length and one stand is for the buses of up to 18 m long. The northern platform has a minimal width of up to 8 m, except for the last stands on the western part, where the width is reduced due to the limited space because of the railway.

In the central and western part of the north platform there is a space 4 to 14 m wide that can be used for the information office, ticket office, kiosks, offices, restrooms and the similar.

On the south part of the south platform, stands are planned for taxis and “kiss&ride” passenger cars (short stays).

On the outer side of the south and north platforms an area is planned for the construction of columns, that is, the supporting wall of the bus station building and the garage parking facility, and if it should prove necessary, columns can be also set in the central part next to the drivers’ path.

Furthermore, on the south side, directly next to the bus terminal, a four-lane two-way road is planned, extension of Riva Street, and more to the south reconstructed light rail system tracks connecting Brajdica via Riva.

The entry of buses to the bus station is planned from the road of the extended Riva Street, from the western side of the bus station through a roundabout around the entry – exit “spiral” ramp for the garage parking facility.

The necessary space for bus turning on the eastern side of the planned bus station as well as for the bus flow lanes has conditioned a significant separation of platforms. This gap is used for the bus flow lanes, especially the lane connected to stands along one and the other platform, and between them a space for shorter bus parking that wait only in order to balance the timetable. All the longer stays of the buses will be solved in a different manner, i.e. outside the station zone (Škurinje, Cernik, etc.).

Next to the parking lot for buses on the south side a drivers’ path has been planned.

For greater passenger safety, a protective fence is planned, which would prevent passage of passengers from one platform to another, crossing and intersecting with the bus flows and parking spaces for shorter bus stays.

The main entry into and exit from the bus station for the pedestrians is planned from the Žabica Square through the today’s arch-passage of the protected railway building. Also important is the entry and exit of pedestrians through the underpass from the Krešimirova Street.

From the hall (vestibule) which connects the north and the south platform the first level of the bus station can be reached by regular stairs and escalators and elevator. Major catering facilities, services, retail facilities, bank, post office, various official premises as well as other business, commercial and office facilities are planned on the first level.

Apart from connection of the south and north platforms from the east side across the hall (vestibule), the plan includes also the connection of the platforms by the underpass from Krešimirova Street, where the pedestrian path leads across the first platform of the railway station, which practically in pedestrian traffic connects the railway and bus station. Over time this path can be closed down and a walkway installed.

Due to full grade separation, since Krešimirova Street will be lowered beneath the double-track railway line, during grade separation the pedestrian passage across the lowered Krešimirova Street should be constructed directly from the western and eastern side of the railway line.

The entry into the bus station underpass is in close vicinity of the bus stop on the south side of the Krešimirova Street next to the warehouse 33.

The entry to the bus station underpass from Krešimirova Street is planned by sloping ramps, rather than classical stairs, both from the pavement of the Krešimirova Street, and from the path across the first railway station platform, and also possibly from the path across the Krešimirova Street which is planned from the western side of the railway line.

The exit from the underpass to the north and south platforms of the bus station is planned to the eastern side by classical stairs, and to the western side by narrow classical stairs and elevators which will connect the bus station and all the levels of the garage-parking facility. On longer paths intended for passengers – pedestrians, walkways can be installed in the future, as e.g. on the first platform, if this proves justified regarding the passenger volume. If there is investment interest, business premises, i.e. areas for service and other activities can be constructed on both sides of the bus underpass.

Garage – parking facility

Garage –parking facility is located above the bus terminal, covering an area of 11,906 m² per level, which in the first phase has two levels and will possibly eventually have one more.

The first two levels feature together 664 parking spaces, and for the second phase 332 parking spaces more are planned. Apart from the planned number of parking spaces, a spare area is planned for the construction elements (columns, walls, etc.) then pedestrian paths, etc.

The entry, that is, the exit of cars from the garage-parking facility is planned by a two-way “spiral” ramp from the western side of the bus station.

In the garage-parking facility “Bus terminal” parking is to be charged automatically by means of ticket vending machine at the entrance, detached automatic cash-kiosks with vertical communication in the object and automatic ticket scanner at the exit from single levels of the building.

The plan also includes the accompanying facilities necessary for the functioning of the garage-parking facility (restrooms, storage, and vertical communications, elevators, stairs that connect all the levels of the garage –parking facility and enable connection with the first level and the ground level as well as with other facilities in the terminal and the wider area.

Žabica Square

In the new conditions, when the existing bus station is removed from the Žabica Square, then this square will be used as the road intersection between the streets: Krešimirova, Trpimirova, Riva, port road and the extended Riva Street, and it will also be intended for the entry and exit of passengers into and from the Bus station.

6 FUNCTIONING OF THE BUS TERMINAL

Movement and parking of buses

According to the new preliminary design, all the buses that arrive to Rijeka from the west, north and east (the by-pass road) will enter the Bus Station by the extended Riva from the west side, i.e. exit in the opposite direction, and from the east along Trpimirova Street, across the Žabica Square and the extended Riva from the east. The technological scheme of the bus flows at the Bus Station is presented in Figure 3.

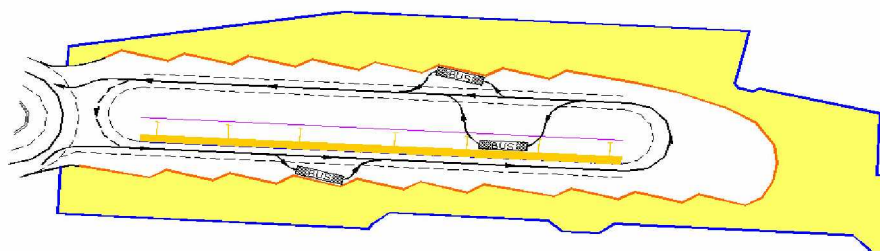


Figure 3: Technological scheme of bus flows at the Bus Station

Stands and platforms

Fifteen bus stands are for the standard length buses, and three are for buses of up to 18 m. The stands are marked by numbers 1 to 18, and their purpose according to the basic structure of passengers is the following:

- arrival platforms from 1 to 4,
- departure – transit and departure from 5 to 15,
- connection with the air traffic terminal on the island Krk, stand No. 16,
- excursion – tourist, 17 and 18.

Passengers and passenger-reserved areas

The passengers arrive to the Bus Station from the Žabica Square through the today's arch-protected railway building and through the underpass from the Krešimirova Street. Entering from the Žabica Square the passengers enter directly the hall, which is at the same time the front of the platforms and connects the north and the south platforms which can be also directly reached, and across them to all the stands of both platforms.

The passengers arriving from Krešimirova Street through the underpass, arrive to the north and south platforms to which they exit from the eastern side by classical stairs, and from the west by elevator around which there are also narrow stairs. The elevator and the stairs around it connect the underpass with the bus station level, and then to the first level and with all the levels of the garage-parking facility.

From the south pavement of Krešimirova Street and the pedestrian path which represents an extension of the platform I of the railway station, the movement of passengers to the bus station underpass is planned by sloping ramps. The plan also includes the pedestrian paths from the western and the eastern side of the double-track railway line across Krešimirova Street. On the western side the path should be connected with the bus station underpass, preferably by a sloping ramp, and should there be problems regarding space, then by stairs. The pedestrian path from the eastern side of the railway line should lead directly to the bus station, since all this is at the same level.

Northwards from the north platform at the bus station, an area for ticket offices, information centre, kiosks, restrooms, traffic office and the similar is planned. Some of these facilities can be, apart from this section, situated also in the south-eastern part of the hall.

In the hall, classical stairs, escalators and elevator to the first floor are planned, and the elevator and the stairs around it will connect all the levels of the garage-parking facility from the first floor of the bus station.

Bus station offices, various commercial facilities, bank, post office and other business commercial and office facilities, as well as the major service and catering facilities are planned on the first level.

Functioning of the garage – parking facility

The entry and exit of passenger cars to and from the garage levels will proceed across spiral ramp. The access road to the garage-parking facility is the extended Riva.

The technological scheme of passenger cars flows at every level of the garage-parking facility is given in Figure 4. At the very entry into, that is, exit from the level, the entry – exit control is planned.

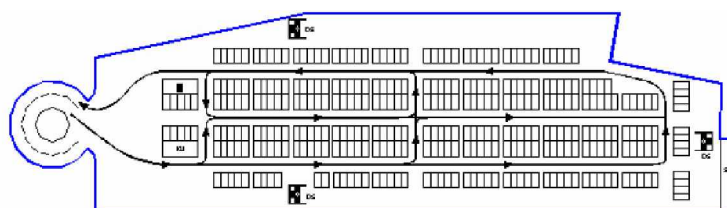


Figure 4: Technological scheme of passenger car flows

7 CONNECTION OF THE TERMINAL WITH OTHER TERMINALS IN THE CITY

Transfer of passengers between the bus and railway terminals

The bus station at the new location of western Žabica is by 200 to 250 m closer to the railway station, so that the distance between them would now amount to about 350 m.

It will be possible to carry out the transfer of passengers between the bus and railway stations by urban public transport, light rail system, taxi and on foot.

Due to the relatively small distance between the bus and the railway station (only about 350 m) and high traffic intensity and frequent standstills in the Krešimirova Street, it is to be expected that for the passenger transfer between these two stations mostly walking will be used, which can be done along the first platform of the railway station, and in the future, if this proves justified, the walkways will be installed on the pedestrian connection between these two terminals, in order to facilitate and simplify the movement of passengers and luggage.

Exceptionally it is possible to organize also occasional shuttle bus between the bus and railway stations, should the need for that arise (larger organized groups of passengers, etc.).

Transfer of passengers between the bus and maritime terminals

The passenger transfer between the bus and maritime terminals can in principle be organized by light rail system (along Riva), public urban bus transport, although the bus stop in Trpimirova Street is quite far away from the location of the port at the root of the present Rijeka quay, about 600 m, by taxi and on foot.

In the future when one part of the passenger port will be located on the De Franceschi quay, which is in close vicinity of the bus station, the main transfer of passengers will proceed by walking.

Transfer of passengers between the bus and the air terminals

There is no such bus line today which would connect the bus and the air traffic terminal, i.e. with Rijeka airport on the island of Krk, nor does any of the existing bus lines visit the Airport.

It is estimated that in the future there will be the need to establish a scheduled bus line that will connect the bus, and also the railway and port terminals with the Airport on Krk. Depending on the estimated volume of passengers the bus carrier will select an adequate vehicle.

Apart from the public line transport of passengers, the passenger transfer can also be done by taxi and rent-a-car vehicles.

Connection of the terminal with the public urban transport

The bus terminal is directly connected via bus stops in Krešimirova and Trpimirova Streets and the Žabica Square itself, with the public urban bus lines (Figure 5).

There are plans for the Riva Street to become a two-way street reserved only for the passenger car traffic, which means that no buses would be driving that way, whereas Trpimirova, Adamićeva and Scarpina Streets would be reserved only for two-way public bus transport. Also, a significant lengthening of the lanes reserved for public transport in the downtown streets is planned.

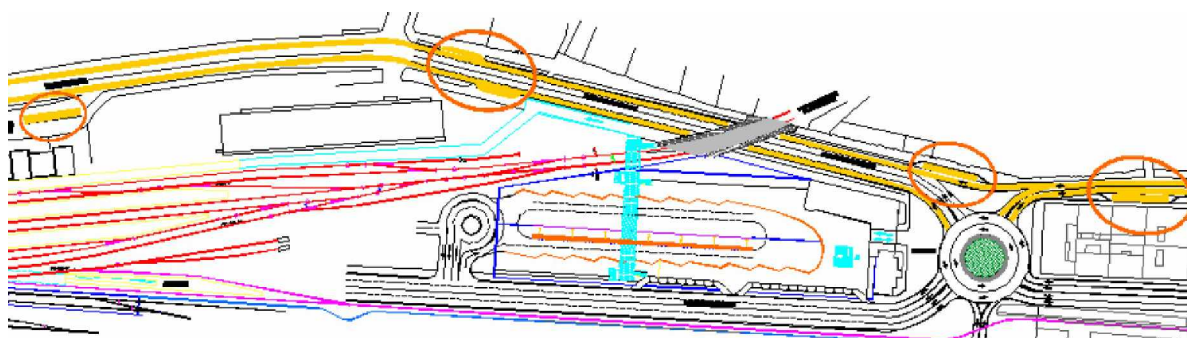


Figure 5: Connection of the terminal with public urban transport

8 CONCLUSION

Regarding the micro location of the today's bus station, its technical and technological characteristics and services offered to its customers, there is a clear need for defining a new preliminary solution which would, among other things, include its relocation.

The new preliminary design of the bus station that can satisfy the needs for a period until 2030, has been based on the following conceptual assumptions:

- the bus terminal is purposefully well designed and thus forms a single technical and technological whole with the clearly defined technological functions,
- it is simply and efficiently connected with other passenger terminals (railway, maritime), which particularly refers to the pedestrian traffic, which must be safe and rational,
- the facilities within the terminal are functionally laid out according to a logical principle, so that they provide rational usage of stable capacities and transport means,
- traffic safety is maximal, both in case of material goods and particularly in case of the safety of passengers and all the other traffic participants,
- accessibility of terminals in relation to the global concept of the regional, state and international traffic routes is simple, feasible and efficiently interactively designed,
- accessibility of terminals compared to the current and future urban and suburban traffic, as well as the passenger cars is also functionally designed so that all the main traffic flows shall be integrally solved,
- separation between single groups of passengers has been purposefully well solved, so that the conflicts of single passenger structures within the terminal or in communication between different terminals is maximally avoided,
- since the space in Rijeka is really limited, the basic guideline of the new conceptual solution of the passenger terminal is rational usage of the space, maximally retaining the already existing objects and traffic infrastructure.

In the future, the bus station will play a similar role that it has today, but with technical and technological features and the quality of services at a much higher level.

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