



RAILWAY CORRIDORS IN CITIES AS A FACTOR OF URBAN DEVELOPMENT

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Abstract

The sustainability of urban development is related to the transport system in cities, including railway transport. Intra-city transport infrastructure, including railway, is one of the most important elements of the quality of the urban environment. In this paper, railway traffic corridors are observed through two basic components: the linear space of intra-city railway corridors and the surrounding area of railway stations. The paper presents the basic theoretical and practical principles of reconstruction of railway intra-city corridors and railway stations within cities. Railway corridors have the potential to stop being an obstacle to connecting parts of the city, while railway stations have the potential to become central places of city traffic, accompanying urban functions (commercial, service, public) and identity places of the city. Intra-city railway corridors in Croatian cities are important for the modernization and technical reconstruction of the railway as a transport system, but also as a factor in the urban renewal. The paper examines the reconstruction of the railway within the city of Zagreb, which was technically reconstructed but the urban reconstruction of the intra-city railway corridor was missing. The paper cites the city of Osijek as a positive example of the beginning of the urban renewal of the area around the Osijek railway station. In conclusion, it is pointed out that the reconstruction of the railway in the city should include the urban reconstruction of the area of the railway corridors, not only the technical and safety reconstruction of the transport system, and that the railway stations should once again become places of the city's *urbanity*.

Keywords: intra-city railway corridors, railway stations, sustainable urban renewal

1 Introduction

There is no sustainability of spatial development of cities without the sustainability of transport, including railway intra-city transport. In the 21st century, the approach to planning transport systems in cities is interdisciplinary with special care for environmental protection, resistance to climate change, safety and health. Intra-city railway corridors have their own specificities, and their reconstruction should include an interdisciplinary approach with many different stakeholders. The aim of this research is to investigate the specifics of the renovation of intra-city railway corridors and railway stations and present that the railway reconstruction in the city should be approached comprehensively and interdisciplinary, including several stakeholders (state, county and city administration, railway system management, associations, citizens). The article aims to analyse how the reconstruction of the railway within the city can become part of a wider process of urban renewal, whereby the role and spatial scope of intra-city railway corridors are particularly emphasized.

The railway outside the settlement passes mostly through undeveloped and uninhabited areas with little human activity. Within the settlement, the railway passes through settlement areas, primarily cities with a high concentration of residents and activities. For this reason, the issue of building new railways or reconstructing existing ones is completely different in urban areas, and includes the relationship to the urban structure of the city and the annulment of the railway as a barrier to connecting parts of the city. The issue of railways in Croatian cities follows the renaissance of railway transport in Europe and the world, and has been updated in recent years through the announcement of a significant reconstruction of the railway network in Croatia. The reconstruction of many railways has already begun, and numerous new projects have been announced in the next decade [1, 2].

The term “railway” in this paper refers to the railway infrastructure defined in the Railway Act, which consists of tracks, embankments and other building structures, crossings, stations, facilities, signalling and other buildings, facilities and equipment [3]. For the purposes of this paper, the term “intra-city railway corridor” is meant the land on which the railway is located as a transport infrastructure (tracks, stations, railway facilities) and the surrounding built or unbuilt space next to the railway line as presented in Fig. 1. Within the railway corridors, the potential of the railway stations stands out, which once again came to the fore as important city facilities with the renovation of the railway line.



Figure 1 Schematic presentation of intra-city railway corridor

The structure of this paper is as follows. The first part, introductory chapter, defines intra-city railway corridors, discusses the main problems of intra-city railway corridors, explains the need for an integrated approach to traffic planning in the city. In the second chapter, the available professional and scientific literature is investigated and the research methodology is determined. The central part of the paper discusses the problems and potentials of railway corridors and railway stations as factor of sustainable urban development and urban renewal. In a separate subchapter, examples from the city of Zagreb and Osijek are presented. This is followed by a chapter with a discussion of the research topic and finally a concluding chapter.

2 Materials and methods

The research method is based on a relevant literature review and analyzing the most important conclusions from the literature. Field researches were carried out on the example of Zagreb and Osijek. The researched data were compared, critically reviewed, and the final researches were formed using the method of generalization. The basic hypothesis of the article is that intra-city railway corridors or the revitalization of the area next to the railway station can be a factor in sustainable urban development of cities in the 21st century. Historically, at the time of construction, the railway was placed far from the borders of the then growing cities and outgrew the railway which remained etched into the fabric of the city, creating boundaries and barriers to connecting parts of the city. The renaissance of railway traffic in

the last ten to fifteen years in Europe and the world raises the question of the existing railway routes in the city structure. In cities, the railway is mostly an inherited transport structure, difficult and expensive to adapt to spatial and traffic changes. Today, the question is how to use the renaissance of rail transport and investment in the railway system so that it is no longer a border and barrier.

Many scholars have researched the potential of railway reconstruction in cities on the example of larger and smaller cities or countries [4-8]. Based on a critique of the situation in Spain, there are few suggestions how to integrate the railway into city. Along with the opinion that the railway within the city should be buried or raised on viaducts (“heavy-duty” method), there are opinions that instead of these expensive operations it is necessary to have interdisciplinary soft approach (“soft” method) which implies “soft” technical interventions and rehabilitation of the areas in railway corridors [9].

Development of intra-city railway transport system and bringing the idea of urban sustainable mobility into life, are perceived as two of the most effective ways of shaping sustainable urban transportation. It is also important to discuss mutual relations between operation of a newly built railway line and a spatial changes taking place in its closest vicinity, i.e. railway corridors, which determine the accessibility to it [10]. Railway transportation system affects the process of spatial and functional urban structure shaping, and vice versa. The transport system cannot be viewed separately from the total activities of the surrounding area, since the transport system results from the needs of meeting these activities, but also affects them in return [11], the railway as a transport system cannot be viewed separately from the state and economic structure that conditions its transport and economic development [5]. In the post-socialist states the system transition towards the free market capitalism (after 1989) covered both railway transportation system and city management [10]. Accession to the European Union enabled many of them to use the Structural Funds for the development and modernization of railway infrastructure.

A specific problem arises in China, which in the 21st century is increasing mobility with the intensive construction of high-speed railways, which results in the abandonment of normal speed railways. The reuse of abandoned normal speed railways provides a way to rebuild urban public transport based on traditional tracks, and is also a way of transform towards urban regeneration of the surrounding neighbourhood, i.e. railway corridors. The abandoned railways are often located in city centres, they impact land development, traffic flow, the ecological environment and quality of life in general [12]. There are hundreds of abandoned railway lines in China, which covers about 20.000 km of abandoned tracks [13].

The Spatial Development Strategy of the Republic of Croatia from 2017 emphasizes that rail transport is insufficiently developed and used for public transport [14]. The Strategy emphasizes the redirection of traffic from road to rail, and establishes as a priority “the resolution of spatial conflicts caused by the routes of railway lines within urban agglomerations”. It is estimated that a comprehensive reconstruction of railway corridors is necessary in those cities where the railway restricts the expansion of the city or the connection of parts of the city. This is a chance for the railway to once again be a symbol of technology, progress, and sustainable development. The Transport Development Strategy of the Republic of Croatia from 2017 partly distinguishes the specificities of transport within cities from non-urban transport, and establishes the need for better integration of the railway system into local transport systems and the need for better use of the railway system in larger Croatian agglomerations (Zagreb, Rijeka, Split, Varaždin, Osijek) [15]. We can conclude that both strategic state documents recognize the need, at least in basic indications, for different treatment of railway corridors inside and outside the city.

Some scholars have researched the potential of railway reconstruction in cities on the example of Croatian cities: Zagreb [16, 17] and Osijek [5]. In both research the conclusion is the same: a new role for the railway in the city is possible, the intra-city railway corridors

have the potential to turn from a traffic and spatial barrier into an integrative factor of urban transformations, while at the same time increasing the quality of life along the railway, and thus life in the city.

Based on the researched literature, it can be concluded that sustainable urban mobility has a key place in the context of sustainable development of cities. Ecological public transport stimulates urban development, economic development, social progress, all with the aim of sustainable, healthy and more pleasant living in the city. In this sustainable context, the railway in the city and railway stations in the city have one of the most important roles and the greatest spatial and technical potential.

3 The intra-city railway corridors in the context of sustainable urban renewal

Urban renewal is a multidisciplinary process that includes the processes of reconstruction, revitalization, regeneration and restoration of the city [18]. The goal of urban renewal is to stop the process of urban degradation and the degradation of conditions and quality of life. Urban renewal is a prepared and planned activity that has an established program, funding sources and implementation. A strategy and a political decision at the state and city level are needed for urban renewal processes that would include the renovation of intra-city railway corridors [19].

We can distinguish between two points of view: the point of view of the railway system operator (state) and the point of view of the local administration (city administration). From the state point of view, it is important to technically and safely reconstruct the railway, while from the city point of view, it is important to reconstruct, restore, revitalize the areas along the railway, achieve that the railway is no longer a barrier to connecting parts of the city, i.e. build underpasses, overpasses, that is, when renovating the railway, raise it on pillars or bury. It can be concluded that the processes of railway reconstruction, which would cover a wider area, that is, the transformation of the surrounding area, should be initiated by the local administration (city administration).

The urban renewal of intra-city railway corridors in cities is a chance for the creation of new urban spatial values and integration of the city structure. If we accept the three pillars of the sustainability of cities: economic efficiency, social well-being and ecological sustainability [20] it can be concluded that the reconstruction of intra-city railway corridors is a contribution to a sustainable city:

- city's transport infrastructure is one of the most important elements of the quality of the urban environment and urban life
- railway is a fast, safe, economical and environmentally friendly public transport system
- railway has a large capacity and does not depend on weather conditions
- along with the railway there is an intensive use of land
- renewal of the city according to the principles of energy and ecological sustainability.

The specific goals of the transformation of intra-city railway corridors in the context of urban renewal are [5, 6]:

- ensuring the permeability of all types of traffic through railway corridors – the railway ceases to be a barrier to connecting parts of the city
- the area of the railway corridor becomes the development corridor of the city - in the spatial and economic sense
- reducing the number of conflict points in city traffic
- railway stations are becoming new places of urbanity
- preservation of railway industrial heritage
- preserving the memory of the railway in space.

Since urban renewal implies that an individual intervention is part of a broader, more complex plan of renewal, it can be concluded that the interventions of reconstruction, revitalization or regeneration of intra-city railway corridors are suitable interventions for systematic urban renewal. Interventions within intra-city railway corridors can be of a smaller or larger scale, they can be point, linear or territorial, they can be time-adaptable, staged, but it is important that they are part of a wider, more complex urban renewal plan.

3.1 Railway corridors

Corridors are spaces where transport, economic and demographic processes are linearly articulated and include infrastructure, urbanization and economic development [21]. Corridors can be of different scales, can have different degrees of influence and importance, and integrate infrastructure, urbanization and economic development [22, 23]. The intra-city railway corridors have their own spatial, traffic and social specificities, which we recognize as advantages [5, 6]:

- they pass radially (from the centre to the edges) through the central city areas
- have a linear extension that is suitable for intra-city traffic
- improve sustainable urban mobility
- railway stations can become new urban centres or sub-centres of cities
- changes along the railway, even on a smaller scale, are visible and affect the image of the city
- the historical architectural and technological heritage of the railway is part of the industrial heritage with a pronounced memory of place in space.

The intra-city railway corridors have their own specificities, which we recognize as shortcomings that can be eliminated by reconstruction and revitalisation:

- the railway in the city creates multiple (traffic, spatial, mental, social) barriers to connecting parts of the city
- stations and railway facilities are located in central parts of cities and occupy significant areas
- each railway corridor is unique in terms of its spatial location, its uses, the ratio of built-up and unbuilt surrounding space.

The criteria for evaluating the transformational potential of railway corridors in cities can be determined [5]:

- integral interdisciplinary approach to solving the spatial and traffic problems of the railway in the city
- cost-benefit ratio
- the possibility of phased implementation
- the possibility of solving ownership relations
- improving technology and traffic safety.

The goal of this approach is to emphasize that the problem of solving the railway in the city cannot be approached only from a transport and technical point of view, but also spatially, interdisciplinary and comprehensively, whereby the role of local administration (cities) is crucial.

3.2 Railway stations

Historically, railway stations were an integral part of the city's urbanity, important city buildings, buildings next to which other city functions were built, they were also link of the city to the world [24]. Industrial plants, warehouses, office buildings, as well as hotels, lodgings, and inns were built next to the railway stations, near the tracks. Stations were places of public life, exchange of cultures (on the example of Croatian cities: Osijek, Slavonski Brod, Vinkovci, Rijeka). After the Second World War, the wave of motorization has swept the whole world, "rail society", "rail culture" was replaced by "car society", "car culture" and railway stations became partly abandoned buildings, oversized for railway traffic and lost their place in the urbanity of the city [25, 26]. Stations are places where public and private traffic, public and private mobility meet. Viewed spatially, the railway stations are both a node of networks and physical urban spaces, so it is necessary to take account of this dual character. It is necessary to achieve a good balance of these factors in according to achieve stations' role as living spaces and focal points for a new sustainable urbanity, while improving the city's urban and socioeconomic quality [25, 27]. Railway stations occupy an unique positions in urban structure, very often in city centres, as schematically presented in Fig. 2.

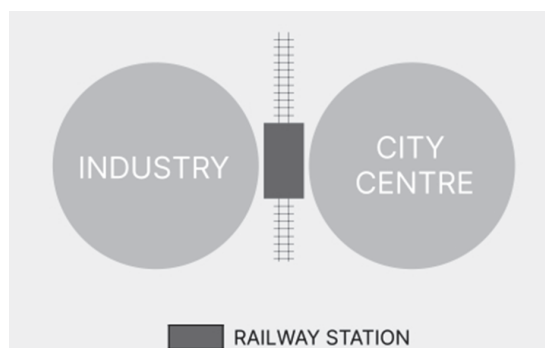


Figure 2 Schematic presentation of historical location of railway station within the city

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Transit Oriented Development, as a sustainable spatial planning concept, was developed at the beginning of the 90s of the 20th century. TOD, once again, puts in the focus the railway stations as new centres of urbanity around which the facilities that the residents need in their daily life are located: trade, recreation, business and service facilities. TOD implies the existence of intensive intra-city and inter-city public railway traffic [28, 29]. Benefits of TOD are reduction of automobile traffic, reduction of carbon footprint, revitalization of the urban environment, enabling residents to meet their needs in one narrow area - walking and cycling distance from home [28, 29].

Nowadays, the increase in transport entity and transport routes, economic convenience, and higher environmental awareness, are leading to higher consideration of the use of railways. In this framework, railway stations represent complex objects requiring significant material flows, which make up their ecological footprint. In this sense, a railway station is the last industrial plant to be accepted in contemporary cities [30]. Today, railway stations have the potential to become places of sustainable urbanity, because people, goods and cargo pass through them every day. They are potential hubs of traffic, they have potential for the formation of micro-centres, new places of centrality in the city [31, 32].

For this reason, they should provide more different services to users: commercial, public and cultural buildings. Railway stations can become the focal point of the new urbanity as schematically presented in Fig. 3 [5].

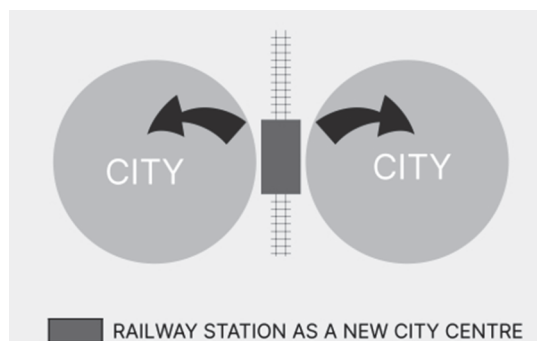


Figure 3 Schematic presentation of new role of railway station as new city centre

It is necessary to achieve a good balance of these factors in according to achieve stations' role as living spaces. The sociological aspect is also important, which takes into account the integration of the station into the life of the city community and the cultural heritage of the railway [5, 6]. and focal points for a new sustainable urbanity, while improving the respective city's urban and socio-economic quality [27].

3.3 Zagreb

Research on the example of Zagreb showed that “the general attitude of Zagreb residents towards the railway is negatively clichéd: the areas next to the railway are unpleasant, untidy, dangerous and noisy. This premise should be taken into account in the effort to integrate railway lines into the city: physically, traffic-wise, mentally” [16, 17]. It can be concluded that the perception of the space next to the railways is negative.

The renovation of the railway from the direction of Sesvete to Savski Marof in the part that passes through the central part of Zagreb included the complete renovation of the upper and lower track structure, the renovation of tracks, switches, the construction of landscaped areas for passenger access, work on signal-safety and telecommunication devices, as well as the renovation and replacement of the contact network [1]. Thus, it included the traffic-technical part, but it did not simultaneously include the construction of elements of urbanity, connections of the city fabric, such as overpasses or underpasses (pedestrian or vehicular), the enrichment of railway stations with additional facilities or the construction of completely new stations with different purposes. The railway's potential for urban renewal was not implemented, although the transformational potentials described in Section 3.1 can be clearly identified on the example of the Sesvete - Savski Marof railway:

- the railway passes through the central city areas of Zagreb
- have a linear extension through the city
- along the railway are many railway stations which have the potential to become new city sub-centres
- the historical architectural and technological heritage of the railway is presented.

Regardless of this potential, along the railway there was no encroachment into the surrounding space, railway stations did not become new centres of urbanity or city functions, and not a single overpass or underpass was built in Zagreb. The reconstruction of the railway from Sesvete to Savski Marof was based only on technical and safety parameters, the relationship

between the railway and the city and the relationship with other transport systems in the city was not considered. It can be concluded that in the case of the reconstruction of the railway line through Zagreb, an exclusively sectorial (traffic) approach was applied. During the reconstruction of railways in the Zagreb an interdisciplinary approach was missing.

3.4 Osijek

Unlike Zagreb, new buildings were first built around the Osijek railway station, then the station building itself was renovated, but the railway tracks was not reconstructed. During the year 2007, a glass pedestrian crossing was built and the square in front of the railway station was landscaped, as presented in Fig. 4.



Figure 4 Square in front of Osijek main railway station and new glass pedestrian crossing

During the year 2009, the construction of a new bus station was completed in the immediate vicinity. In 2023, a modern office building was built near the station, as presented in Figure 5. In 2024, works on the renovation of the existing historical station building were completed, as presented in Figure 6.



Figure 5 New office building near the Osijek railway station, 2024.



Figure 6 Osijek railway station after the reconstruction, 2024.

The renovation of Osijek railway stations and the construction of a bridge or the formation of a traffic hub are a catalysts for the reconstruction of the surrounding area. The railway's potential for urban renewal was partly implemented, but the transformational potentials described in Section 3.1 can be clearly identified on the example of Osijek intra-city railway corridor:

- the railway passes through the central city areas of Osijek
- have a linear extension through the city
- main railway stations can become new urban sub-centre of Osijek
- changes along the railway, even on a smaller scale, are visible and affect the image of the city
- the historical architectural and technological heritage of the railway is presented.

It can be concluded that in a period of about 15 years, the revitalization and reconstruction of that part of the city began in the area around the railway station in Osijek, with the construction of a pedestrian bridge, the arrangement of the Square in front of the railway station, the construction of a bus station, an office building, and several new ones were opened nearby (two restaurants and a game room). Electro-mobility was introduced through the use of electric scooters. There was no reconstruction of the railway tracks, which would have been followed by the introduction of more intercity lines.

4 Findings and discussion

Comprehensive reconstruction of railway corridors is necessary in those cities where the railway restricts the expansion of the city or the connection of built parts of the city. This is a chance for the railway to be, once again, at the forefront of technical and technological changes in the urban life of the city, a symbol of new sustainable technology and progress in fight against the climate change (reduce dependence on driving) and higher quality of life for citizens. The renovation of railway corridors within cities can take place in stages or poly-centrally, interventions within railway corridors can be of a smaller or larger scale. Since it is an expensive and long-term process that involves many stakeholders, smaller measures are proposed for implementation that are realistically feasible in terms of time and money (levelling of intersections, construction of pedestrian overpasses or underpasses, construction of commercial and office buildings and other public facilities next to railway stations). The peculiarity of the role in this process is played by railway transport, including its nodal elements - railway station complexes. World experience shows that these areas and adjacent areas of urban space are objects of significant changes in terms of their functional, structural planning, and compositional aspects. Transit oriented development (TOD) is a positive approach how to achieve greater sustainable mobility, with railway station as new city sub-centre with different functions. Despite the fact that the main strategic documents outline the specifics of railway renewal in cities (intra-city railway corridors), it is not implemented in practice (the example of Zagreb) or only partially implemented (the example of Osijek). In Croatian cities, railway reconstruction includes only the technical-technological and safety aspect, the reconstruction of the entire area of the railway corridor and holistic interdisciplinary approach are missing. Major historical railway stations in Croatia have been renovated (Zagreb, Rijeka), but only their physical structure, including conservation protection is being renovated, without considering the area around the station. Exception is Osijek railway station where reconstruction and revitalisation of surrounding area include new buildings (bus station, office building) and pedestrian overpass.

5 Conclusion

The economic forces that shape the city today are based on energy, ecology and IT technology that is transforming urban life. The European Union established a common transport policy focused on the use of rail systems, on the revival of rail transport. Historically, railways have generated the growth and development of cities - in the expected renaissance of railway transport, they have this potential again, which in the 21st century also implies sustainable development of cities.

It is estimated that a comprehensive reconstruction of intra-city railway corridors is necessary in those cities where the railway restricts the expansion of the city or is a barrier the connection of parts of the city. It is a chance for the railway to once again be a symbol of technology, progress, and sustainable development. The renovation of railway corridors can take place in stages or poly-centrally, it involves many stakeholders, it is a financially and time-consuming and long-term process.

Both Croatian strategic state documents recognize the need, at least in basic indications, for different treatment of railway corridors inside and outside the city but in implementation, this approach is missing (Zagreb, Rijeka) or partially implemented (Osijek). The basic hypothesis of the article is that intra-city railway corridors or the revitalization of the area next to the railway station can be a factor in sustainable urban development of cities in the 21st century, which is confirmed by the example of the city of Osijek.

For the planning of railway corridors within cities, an integral spatial-traffic approach is proposed, which was developed in the 1960s in the USA and Great Britain, i.e. that the transport system cannot be planned separately from the purpose of its surrounding space. The continuation of this approach is the TOD, which emphasizes the role of railway stations and the surrounding area, where the purposes that the residents need should be located, all with the aim of increasing the use of the railway as the most environmentally friendly means of transport. During the reconstruction of the railway in the city, it is crucial to look at the new role of railway stations as a place where private and public transport, mobility and micro-mobility meet, as well as the potential for planning and other city functions.

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