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## THE DEVELOPMENT OF TOWNS' RAILWAY COMPLEXES

### ROZWÓJ DWORCOWYCH KOMPLEKSÓW KOLEJOWYCH MAŁYCH MIAST

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#### ABSTRACT

The architectural and urban development factors of the towns' railway complexes are considered. The study boundaries are defined by the category of cities with a population up to 50 thousand inhabitants. It is shown that railway complex for such cities is one of the most important cities' forming object and a nodal element of the transport and communication network for various hierarchical levels of town-planning space. Thus, it is confirmed that urban development factors have a hierarchical structure. The analysis of these factors allowed to formulate the basic principles of the development of towns' railway complexes, outline the parameters of their development by the degree of spatial consolidation within the limits of the complex's influence.

Key words: railway complexes, habitat areas system, transport and communication framework, communication potential, town-planning potential, towns.

#### STRESZCZENIE

W artykule rozpatrzono architektoniczno-urbanistyczne czynniki rozwoju dworcowych kompleksów kolejowych małych miast (liczbą ludności poniżej 50 tys. Mieszkańców). Pokazano, że dworcowe kompleksy kolejowe dla takich miast są jednym z najważniejszych elementów kształtujących miasto oraz węzłowym elementem sieci transportowej różnych hierarchicznych poziomów przestrzeni urbanistycznej. W związku z tym urbanistyczne czynniki wpływu na kształtowanie dworcowych kompleksów kolejowych mają strukturę hierarchiczną. Analiza tych czynników pozwoliła sformułować główne zasady architektoniczno-urbanistycznej organizacji takich kompleksów, zarysować przestrzenne parametry ich rozwoju.

Słowa kluczowe: architektoniczno-urbanistyczna organizacja, dworcowy kompleks kolejowy, system terenów mieszkaniowych, rama komunikacyjna, potencjał komunikacyjny, potencjał urbanistyczny, małe miasta.

## 1. INTRODUCTION

Nowadays there is a growing need to improve urbanized areas' planning and their functional organization in the condition of their modern development. The program of urban planning documentation development provides the solution of such problematic issues as the city's development and town-planning formation of its individual elements. The architectural and urban organization of public transport complexes, including railway complexes, required special attention during solving the problem of towns' urban spaces improving (towns with the population of up to 50 thousand inhabitants according to the classification of DBN 360-92 \*\* [7] are being studied).

Railway complex is a kind of multifunctional public transport complex. It is the city territory where external railways and internal city transport connect. It is full of public transport and service functions within a radius of walking distance from the railways, stations and stopping points, within 500 meters' boundaries for towns [9].

The development of railway complexes as the transport infrastructure elements of Ukraine is stipulated by the promising processes of joining it to European and international transport systems. Expansion of Ukraine's transport links with the European Union provides the opportunity to use the geopolitical potential of the country.

Scientists emphasize that railway complexes, not only provide external connections of the city, but also stimulate its economic development [6,9]. Thus, the railway complexes are city forming elements. On the other hand, they are the nodal elements of the transport and communication network of various hierarchical levels, namely: city, system of habitat areas, and the region. The functional-spatial combination of elements of two networks – transport-communication (railway and city) and public services (urban and interurban) – led to the formation of completely new urban development system – the railway complexes [9]. Their development is stimulated and determined by the needs of the society (fig.1,2).

The relevance of the research is consistent with the issues that are being announced and discussed in global programs, in particular at the United Nations Sustainable Development Summit 2015 (September 25-27, 2015) in New York [16], and secured in 17 Sustainable Development Goals for the period 2016-2030 [17]. In particular, national programs for the towns and rural areas development are being developed in cooperation with UN-Habitat, UNDP, UNIDO, the Ukrainian Government, the Polish Ministry of Finance, the United States Agency for International Development and local authorities [19]. The research correlates with the programs of the Ukrainian Ministry of Regional Development, which is gradually implementing the decentralization reform of territorial communities. But unfortunately, the specificity of small settlements is not taken into consideration during the working out of state bills, orders, plans, etc. Although the national culture is being formed in these settlements, and in future, towns can become the development foundation and guaranty of the state stability. Therefore, currently tasks for urban development science are the elaboration and provision of recommendations for the further development of the habitat areas of this category, their urban development complexes, with the involvement of local authorities and active discussions with the communities. The purpose of the study is to develop and make recommendations for the further development of small towns' railway complexes, as the key element of their long-term development.

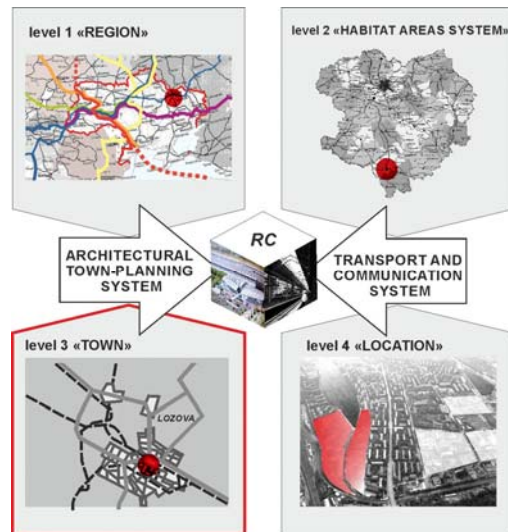


Fig. 1. Railway Complex (RC) as a nodal element of town-planning and transport systems. Source: developed by Lyudmila M. Shvets

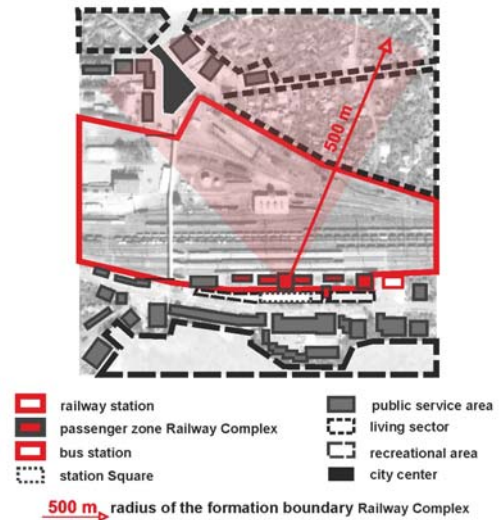


Fig. 2. Railway Complex as a city-forming element. Structural and functional scheme of the Lyubotin Railway Complex (Ukraine). Source: developed by Lyudmila M. Shvets

## 2. RESEARCH METHODS

The work is based on the general provisions of the system approach, which allows considering urban space as a hierarchical system, formed with the help of mutually related elements. General scientific empirical methods (as observation, measurement, comparison, analysis and synthesis), as well as cartographic and morphological methods were used during the research.

## 3. THE BACKGROUND OF THE PROBLEM

This work is based on modern scientific researches on the development of railway complexes carried out in various aspects: social, economic, technological, architectural and planning, ecological, land use, etc. [1,4,14,18]. The main provisions of the research confirm that railway complexes are dynamic objects, which acquire continuous transformations associated with the development of society. Thus, they are always in a state of constant simulation of optimal development of its structure.

In addition, the scientific works on the development of urban space and its elements in various hierarchical levels, made by such authors as M. Demin, M. Garbel, Y. Bilokonia are important for this research. [3,5,8]. The main provisions of the modern urban development paradigm are revealed in these works. According to this paradigm the urbanized space is considered as a complicated integral dynamic system. Its transport subsystem serves as a kind of "framework" that unites all the elements. The nodal elements of the frame have particular importance. At the city level, these are public transport complexes. They include two main components: transport and communications and public services.

The study of the town planning aspects of towns' functioning and development was conducted by E. Markov, V. Lotukhin, and others. [11,12]. Scientists emphasize that the specific feature of towns is the presence and development of one or two urban core centers. Separate works are devoted to the study of the city center formation laws and other public transport complexes. However, the peculiarity of this study is the use

of a single model, where railway complex (as a public transport complex) and the public center of the city are considered as elements of a coherent system. This approach is due to the general goals of functioning of this territory with a high level of social activity, namely, the servicing of passengers and the population of the city.

The peculiarities of the passengers' traffic formation were analyzed for formulating the unified model of railway complex construction - G. Goltsom [6], the technological features of the station complexes work were studied by N. Pravdin and other authors [16]. The development of modern railway station complexes has been studied by such specialists as Z. Azarenkova, I. Dreval, K. Kherceg and others [2,9,10].

The author's conclusions which are important for this study:

- the geometry of the railway complexes' space depends on the location of their localization in the city structure;
- the structural and functional organization of the railway complex is influenced by the spatial relationship with the city center/

These main provisions of scientific resources were used during the study.

#### **4. STUDY MATERIALS. FACTORS, PRINCIPLES, PARAMETERS OF THE TOWNS' RAILWAY COMPLEXES DEVELOPMENT**

In 2016, there are 348 small cities in Ukraine, which is 80% of the general number of the cities. 90% of them have a railway connection. The length of the railway lines of Ukraine occupies the fourth place in Europe after Germany, Poland and France and is 20951.8 km (without taking into account the temporarily occupied territory). The nature and peculiarities of passenger transportation passing through the railway stations of small cities, largely determine the possibilities for their further development. As of January 1, 2017, in Ukraine, 28043.4 million pass. Km of passenger traffic was recorded. It was carried out by railway, accounting more than 28% of the total passenger traffic in a year [15]. This indicates the high potential of railway passenger transportation on the basis of developed infrastructure. Thus, the relevance of the study of the development of railway complexes as nodal elements of the transport network and important objects of small cities is expedient at present. During the study about 95 railway complexes of small cities of Ukraine (Kharkiv, Lviv, Kiev and other regions of Ukraine and about 15 foreign, mostly Polish cities) were investigated.

The project and scientific experience study of the towns' railway stations development in Ukraine and other countries has proved that its features are determined by three major urban development factors.

The first factor is the place and role of the railway station in the structure of the transport network, system of habitat areas, region. This factor determines the potential number of passengers which arrive in the city. Characteristics of passenger traffic affect the functional organization of a railway station. External transport in the city structure is known as a "supplier" of passenger traffic [6]. Quantitative and qualitative characteristics of the passenger traffic are due to the features of the city's connection with the "outside world". The role of the railway station in the structure of the transport and communication frame of the system of habitat areas, region, country determines its communication potential (CP). So, the railway stations which serve the long distance, including international ones have the largest CP. For example, Railway complex Chop Zakarpatska region, Zhmerinka, Vinnitsa region (fig. 3). The railway complexes which formed on the basis of node stations as Lozova, Kupyansk in Kharkiv region, or tourism (resort) basis as Kolomyia, Yaremche, Ivano-frankivsk region have medium-communication potential. The ordinary railway stations located in the peripheral zone of habitat area system have the smallest CP.

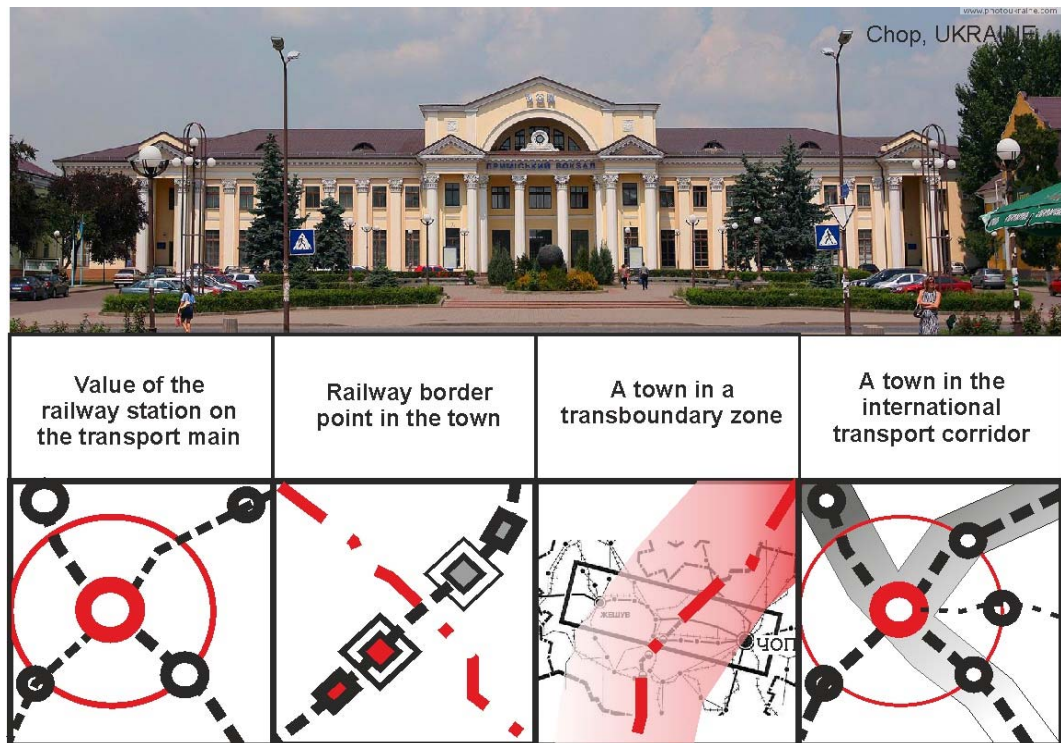


Fig. 3. The role of the railway station in the structure of the transport and communication framework of the country. Chop (Ukraine) is located in a cross-border area, has customs control and has significant communication potential. Source: developed by Lyudmila M. Shvets

The second factor is the town-planning potential of the city namely the location of the railway complex, which is determined by the role of the city in the habitat areas system, the region. This factor characterizes the attractiveness of the city and also affects on the qualitative and quantitative characteristics of the railway complex passenger traffic. Also, the town-planning potential of the city is determined by the development of functions, historical-cultural, environmental, natural-climatic features. Moreover, the observations showed that the town-planning potential of the city determines the possibilities of utilizing the communication potential of the railway complex for its further development. For example, the growth of the town-planning potential of the city with the help of tourism development (examples) contributes the functional and spatial development of the railway complex (Truskavets in Iviv region) (fig. 4).

The third important factor which influence the peculiarities of the railway complex formation is the location of the complex in the zonal structure of the city, namely the central, middle or peripheral zones. The biggest town-planning potential has railway complexes with the great number of functions and communications within its structure, and those that have a strong connection with the central part of the city. This factor affects the structural and planning organization of the railway complex (Yaremche, Ivano-frankivsk region). Moreover, this location offers wide opportunities for satisfying the needs of all types of passengers (suburban and long-distance migrants with labor, cultural, domestic, tourist, recreational and other purposes) (fig. 5).



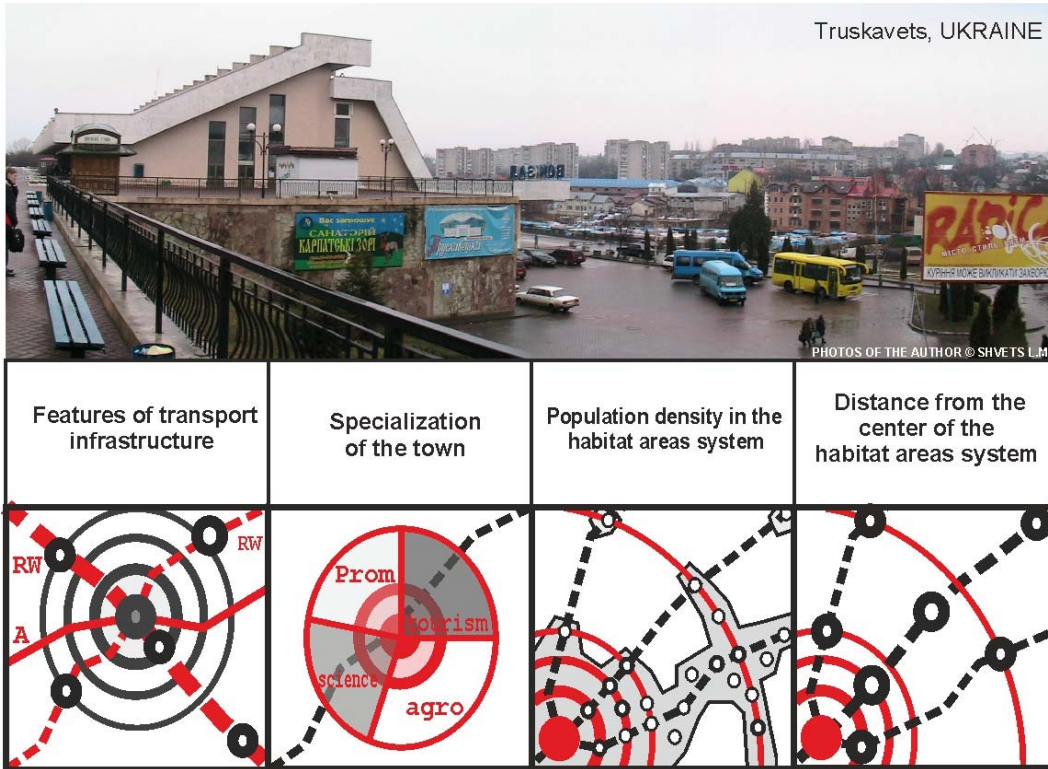


Fig. 4. The value of the city in the habitat areas system. The city of Truskavets (Ukraine) is specialized in tourism, located in the middle zone of the habitat areas system, has significant development potential. Source: developed by Lyudmila M. Shvets

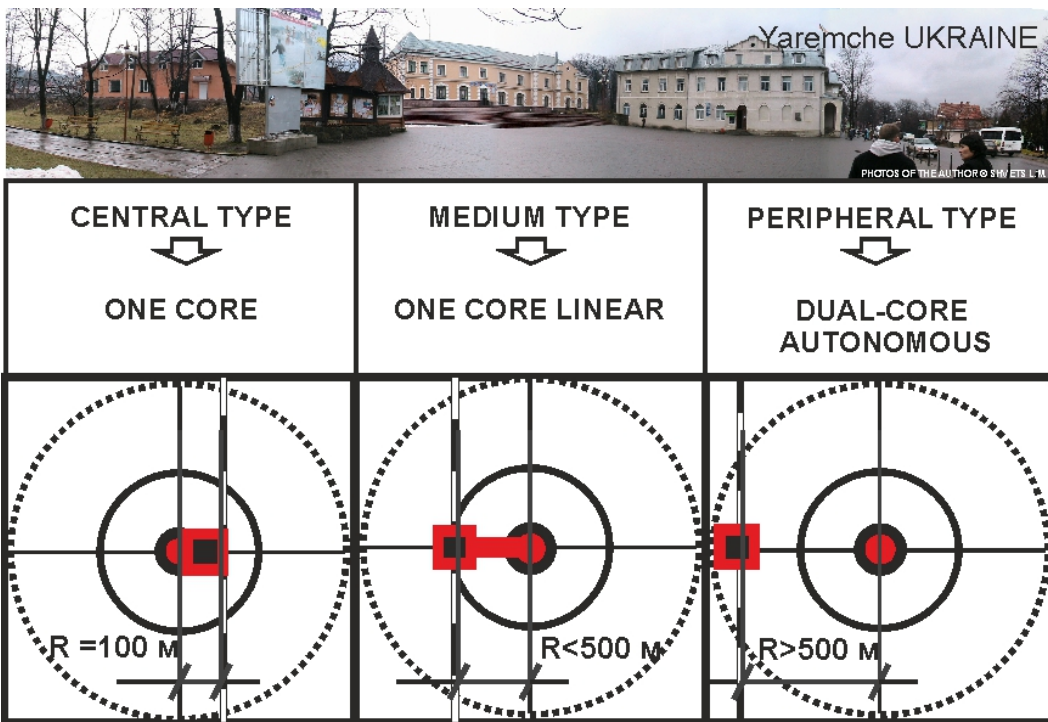
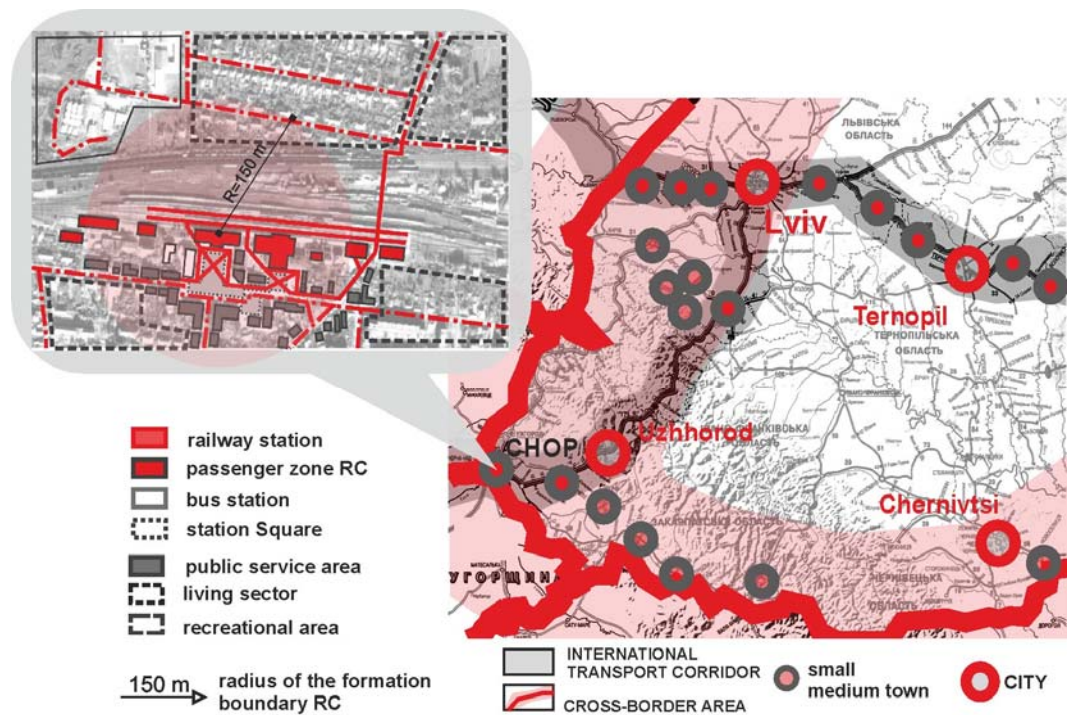


Fig. 5. Place of the railway station complex's localization in the zone structure of the city. The city of Yaremche (Ukraine), Railway Complex is located in the immediate vicinity to the center, within 100m. Source: developed by Lyudmila M. Shvets

The analysis of town-planning development factors which influence on the towns' railway complexes development allowed to formulate the basic principles of the railway complexes formation.

Thus, the main town-planning principle of the towns' railway complexes formation is the principle of the correspondence of its functional and planning structure to the parameters of the town-planning space, two hierarchical levels that correspond to its town-planning potential (fig. 6).

The next town-planning principle of the structure formation of the towns' railway complexes is the principle of phased deployment of its structure. The communication component of the railway complex is the least stable but predictable indicator of the transport system. Therefore, during the formation of a railway complex as a nodal element of the transport and communication framework (TCF), the possible dynamics of passenger traffic as an intra-system (its accumulation or transit) and long-distance communication must be taken into consideration. This principle is realized in the techniques of phased development of the adjacent territory of the railway station. The increase of passenger service functional blocks derives according to the type of station by the dominant passenger traffic. The territory in the operation zone of the railway complex is being reserved taking into account its CP and functional type of the complex. In case of functional transformation, the functional composition of the railway complex is changing (fig.7). The structural and planning development of the railway complex should be "flexible" in accordance to the changes in the communication and functional component of the complex. Its spatial development can be one-level, two-level, coastal (on one side of the station) or disjuncted (on both sides of the station) types.



**THE RAILWAY COMPLEX AND THE CENTER OF THE TOWN - CREATE ONE CORE, ITS «CENTRAL TYPE»**

Fig. 6 Principle of the functional and planning structure correspondence of the railway complex to the parameters of its urban space and the principle of the railway complex and the city center interconnected development. Structural-functional scheme of the rail-way complex formation in Chop (Ukraine). Source: developed by Lyudmila M. Shvets

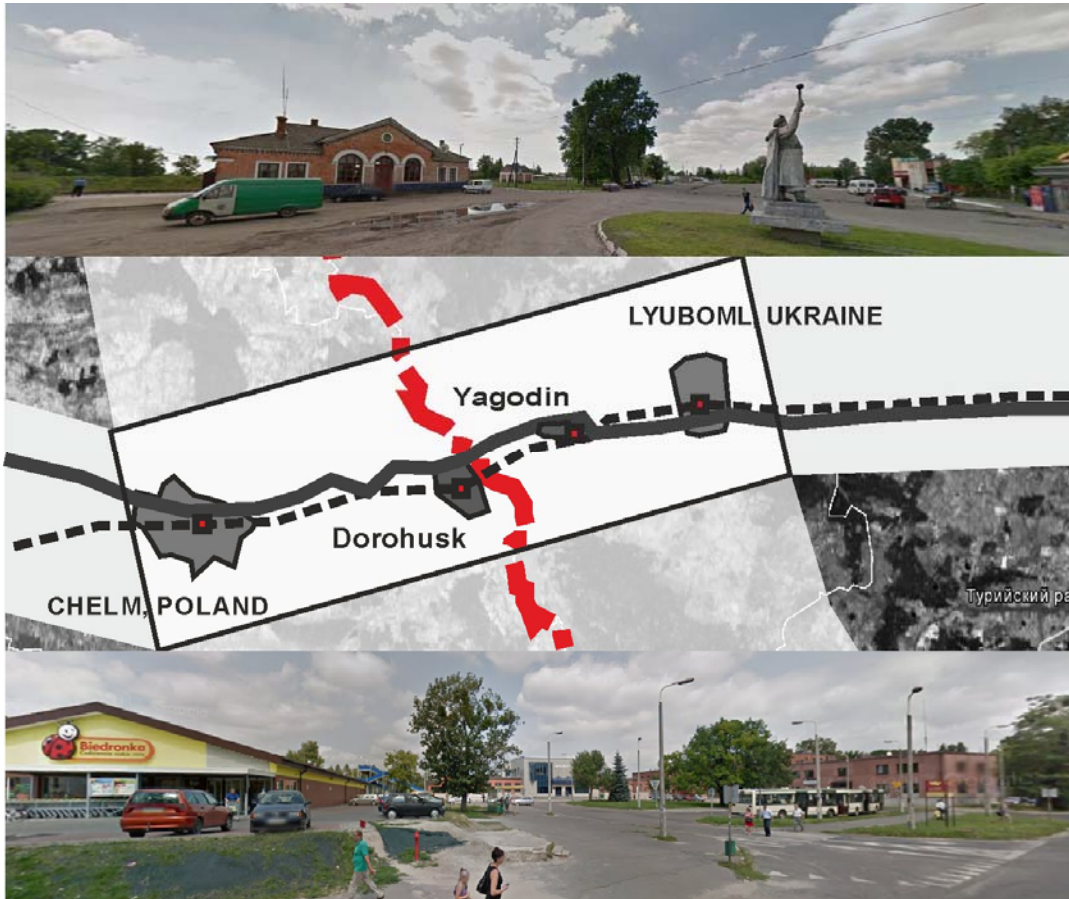


Fig. 7 Principle of phased deployment of the towns' railway complex structure. Taking into account the long-term growth of communication potential of railway complex. Helm (Poland) and Lyuboml (Ukraine) in the structure of the cross-border territory. Source: developed by Lyudmila M. Shvets

As practice shows, the railway complexes are public service objects (target and associated) which serve not only different types of passengers, but also significant part of the city's population. At the "city" level the perspectives of railway complexes' town-planning development, its integration into the city structure and the connection of it with the city center can be evaluated. Therefore, one or two cores model of the center development is possible. One-core model of the center is formed when the public center coincides with the location of the external transport nodes: road and rail transport. The two cores model of the center is formed if the location of the public city center and the external transport nodes do not coincide, and the distance between them is more than 500 meters.

Therefore, an important town-planning principle for towns is the principle of interconnected development of the railway complex and the city center in the functional and planning aspects. It is implemented in the ways of railway complexes' functional and planning formation. Three main types of railway complexes can be distinguished according to this criterion. 1. The central type of the complex is formed in the immediate vicinity (up to 100 m) from the public center of the city. 2. The linear type of the railway complex is formed within the planning connections with the city center within the walking distance (up to 500 m). 3. The autonomous type of the railway complex is formed at



a distance from the city center outside the walking distance (more than 500 m). This type of complex may be with a developed functional structure or not. In the first case, the railway complex may form a separate additional city center with a significant town-planning development potential (Fig. 8). In the second case, the railway complex is not the center of developed communications. There are some cases when the city center was transferred to the railway station complex, as in this space the most active connections are taking place (Lyubotin, Kharkiv region, Yagotin, Kyiv region) (Fig. 9).

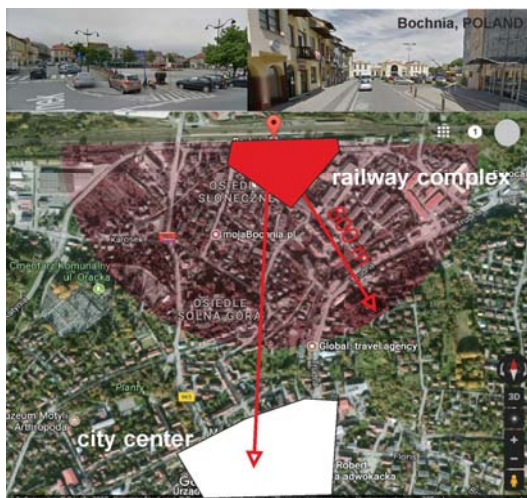


Fig. 8. Formation of the additional city center on the railway complex's basis. Bochnia city (Poland). Source: developed by Lyudmila M. Shvets



Fig. 9 The trend of transferring the functions of the city center to the structure of the railway complex. Lubotin city (Ukraine). Source: developed by Lyudmila M. Shvets

Two groups of elements that differ in their degree of spatial fixation - "carcass" and "tissue" – were found in the railway complexes' structure. (Fig. 10). The "carcass" of the railway complex defines its structure, which is due to the town-planning conditions of the railway complex's site, namely the scheduling features of the railway station, the planning of the street network adjacent to the complex, the configuration of the railway station area, etc. It was revealed that the most stable elements of the railway complex's "skeleton" are the railway station and the peculiarities of the planning adjoining of the city highways to the complex, which form the "core" of the complex. Also, the structure of the railway complex's "core" include the station square, pedestrian communications, transport entrances. Parameters of the "hard core" of the towns'/medium cities' railway station are determined by the type of station and can reach more than 200 m (railway platform) in length and 25 m in depth. In addition, the main types of the railway stations were determined. They are island, coast and deadlock]. The features of the city highways adjoining determine the most likely configuration of the entire railway system (linear, compact or splitted). Planning features of the adjoining of the railway station area (deadlock or transit) directly depend on the method of adjoining highways. [16,18]. Pedestrian communications are characterized by the communication radius of the railway complexes: the intensity of pedestrian connections (significant in the case of high communication potential of the railway complex).

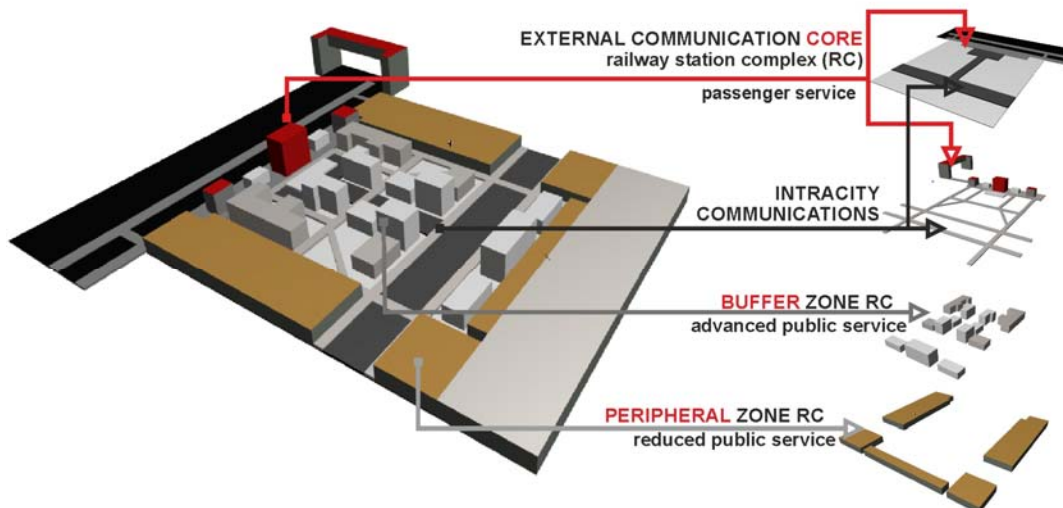


Fig. 10. Town-planning model of towns' railway complex's formation. Source: developed by Lyudmila M. Shvets

The tissue of the railway complex includes such elements as the associated functional units of public service (recreation, trade, cultural and household services, and others). Parameters of the complex can be defined starting from its "core": 25 m in depth, which corresponds to the minimum limits of railroad tracks [7]. Next, a "buffer zone" is placed, which mitigates the influence of the railway on the adjoining city territory. Its depth ranges from 25 to 200 m (sanitary protection zone of railway tracks), and the "peripheral zone" of the complex is from 200 m and more, which corresponds to the depth of penetration of pedestrian connections (up to 500 m for towns). The depth of penetration of direct pedestrian connections (average communication radius) depends on the location of the functional zones of the city in relation to the railway complex and their saturation with the public services. The formation of short pedestrian communications determines the planning "boundaries" for the associated service localization in the buffer zone of the railway complex. The directions of the main pedestrian connections outline the planning frames for the railway complex's peripheral zone. Pedestrian communications are the "flexible" elements of the railway complex's "skeleton". They provide the planning relationship between the transport core and the other functional blocks of the complex. Zone of their localization is the railway station area. Deadlock square before the railway station forms a compact planning type of the railway complex, transit square forms linear or splitted type. The quantitative characteristics of pedestrian connections in the zone of the railway complex's influence depend on the intensity, depth of penetration and the extent of the railway complex's connections with the other areas of the city. The most intense short connections with the strict rules of boarding – diplaning – transfer of passengers (up to 25 m) are localized in the zone of the complex's "core". The pedestrian connections, which are also intense, but with relatively free regulations of the passenger movement and the penetration from 25 to 200 meters deep into urban tissue are situated in the "buffer" zone. The less intensive pedestrian connections, with unregulated passenger movement is located at 200 and more m in the "peripheral" zone of the railway complex.

## 5. CONCLUSIONS AND IMPLEMENTATION

Thus, defining the town-planning features of the railway complex's development as a city forming element, it is necessary to determine its communication and town-planning potential, the functional type of the complex and its possible perspective development, the degree of its' integration with the city center, planning and compositional features of the site.

The provisions of this research are implemented in the framework of main objectives realization of "The Kharkiv region development strategy for the period 2015-2017" for further improvement of urban areas, structural and functional organization of the zones of its influence. Also, the research data are being implemented in the updated territorial schemes of planning the administrative-territorial units in the influence zones of Kharkiv, Izyum, Lozova and Kupyansk. Involvement of the functional and planning organization principles of towns' and medium-sized cities' railway complexes allowed to plan a number of territories' planning events, expedient placement of functional objects, and identify the boundaries of their further territorial expansion. Implementation of certain town-planning techniques for the towns' development provides the opportunity to create integrated projects by overcoming the departmental disunity of local authorities and railways management.

An orderly architectural environment enhances its comfort and attractiveness. This allows getting a social effect - increasing the number of complex visitors by improving its aesthetic and functional characteristics: improve image properties of the city; obtain an economic effect in the form of increased financial deductions from the profit. Thus, the provisions obtained during the study allow the introduction of a multiplicative, systematic approach, to define clear boundaries of functional specialization and the principles of coordinated management of the development of urban areas. Formation of integrated urban development complexes with the inclusion of external transport nodes, will enhance the communicative qualities of the entire urban space. The consideration of the railway complex and the center of a small city as a single system with a common goal of functioning is an innovative approach in the study of the development of the railway complex of small cities. The study examines railway complexes of small towns in Ukraine, but the findings can be used for other similar cities.

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