Infrastructure Corridor as Linear City

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1 ABSTRACT

This paper concisely reviews the evolution of linear urban form concept, from pioneer linear city proposal to contemporary infrastructure corridor. Urban settlements appear through building processes over long periods of time. Different urban forms, such as linear, radial, or grid, are outcome of urban functions and infrastructure development. Ordinary village along a road, known from ancient times, symbolizes the linear urban form. The road is the village backbone along which habitation, manufacture, storage and trade are located. Pioneer linear city proposal (Soria y Mata) motivated other authors (Garnier, Le Corbusier, Milytin, and others) to reconsider linear concept. The main feature of linear concept is rapid and efficient movement of people and goods. Analogous to linear city, infrastructure corridor is a spine for an elongated urban formation, which can expand without growing wider. Contemporary Trans-European Transport Corridors, among which are the Corridor VII (the Danube) and the Corridor X passing through Serbia, provide infrastructure, urbanization and economic development. The Euro-corridors development international practice may be useful guideline for the spatial and urban planning in Serbia.

Keywords: urbanism, linear city, infrastructure, corridor, Serbia

2 CITY FORM

History of cities is long and complex (Mumford, 1961). Old cities layout and functioning demonstrate inventive planning and design of ancient time builders. Cities are founded due to various reasons, frequently as centers of production, storage, and trade. Different urban forms, which have changed spectacularly through history, correspond to composite functions of the cities all the way through time (Maksimovic, 1972, 1976).

A city is not only “a fact in nature”, but also “a conscious work of art” (Mumford, 1938). The city *function* and *properties* are fundamental topics in urban studies. “The chief function of the city is to convert power into form, energy into culture, dead matter into the living symbols of art, biological reproduction into social creativity” (Mumford, 1961:571). “A city is the characteristic physical and social unit of civilization. It possesses size, density, grain, outline and pattern. The people who live in it shape these properties and are shaped by them” (Lynch, 1954:54).

Urban morphology investigates the *form* of different human settlements (village, town, and city) and considers the formation of urban areas (infrastructure, spaces, and buildings). Human settlements, with their infrastructure, plots, spaces and buildings, emerge through successive construction over long periods of time (Maksimovic, 1986). Founded in the last decade of the nineteenth century, urban morphology has developed during the twentieth century (Kostof, 1992). City spatial structure and physical form can be analyzed by urban patterns (streets, squares, buildings) (Kostof, 1991). *Typical forms* of the city are: linear, orthogonal, radial, circular, ring, and the rest (Djokic, 2004:125).

3 LINEAR CITY

3.1 Historical background

The concept of a linear city is old. *Linear form* of human settlements is widespread in history of urbanization. Ordinary village along a road, known from ancient times, symbolizes the linear urban form. The road is the village backbone along which habitation, manufacture, storage and trade are located. As well, a town beside a river frequently has linear form. Previous two examples (village, town) indicate that linear urban development is often a spontaneous response to local building conditions (road, river).

Linear city form has occurred in the *urban history* for a long time, before theoretical proposals of linear city planning started in modern urbanism. Spontaneous linear urban form realizations in the past pursue intentional theoretical linear city proposals in the modern times. Theoretical development of the linear city planning is profoundly studied elsewhere (Collins, 1965). The linear city pioneer proposal by Soria y Mata and a few succeeding ones are briefly presented in the following.

3.2 Pioneer proposal

Arturo *Soria y Mata* (1844–1920), Spanish urban planner, proposed *"La Ciudad Lineal"* ("The Linear City") (1882), for 30,000 inhabitants, as the urban concept applicable to Madrid (Maksimovic, 1976:172). The linear city concept is building along a line (strait or polygonal) infrastructure (roads, railways, etc.) and, after that, city elements. Soria y Mata's project "La Ciudad Lineal", envisaged a 55 km long open loop around the city of Madrid, but only a 5 km segment was built. This realized segment approves that Soria y Mata's proposal is not only one of urban utopias.

In a linear city, unlike a traditional city, not only a city centre and suburbs are merged, but also a city *expansion* is along a line without taking up more space than is necessary. „The growth of linear cities is simple", Soria y Mata noted, „because the line itself can go on to infinity and at any point a new community can shoot off like the branch of a tree, the tributaries of a river, the veins of the body" (Collins, 1965:205).

Fascinated with an idea of city development along the line, Soria y Mata stated: "A single street of 500 meters' width and of the length that may be necessary – such will be the city of the future, whose extremities could be Cadiz[1] and St Petersburg, or Peking and Brussels " (Collins, 1965:204). Soria y Mata's concept, reinforced by many proponents in the twentieth century, is again inspirational in recent times of corridors construction all over Europe.

The efficient *transport* planning is, according to Soria y Mata, solution for all the other urban problems. A passable line is a beneficial path between points. But if nodes and crossings number increases, linearity advantage decreases quickly. Soria y Mata, regrettably, underestimate crossings problem in his linear city planning. Without stations and crossings transport system planned cleverly, chief advantage of the linear city is far from the efficient one. Because of its inflexible transport solution, the linear city proposal had many opponents also.

3.3 Other proposals

In the 20th century, pioneer linear city proposal (Soria y Mata) motivated other authors (Garnier, Le Corbusier, Milytin, and others) to reconsider and to extend linear concept (Collins, 1965; Maksimovic, 1976; Djokic, 2004).

Tony *Garnier* (1869-1948), French architect and urban planner, proposed "*Une Cite Industrielle*" ("The Industrial City") (1918), as partly linear city for 35,000 inhabitants. Garnier divided spaces by function (transport, industry, work, recreation) through zoning (Maksimovic, 1976:178).

Le Corbusier (Charles-Édouard Jeanneret, 1887–1965), famous Swiss architect and urban planner, proposed *"La Ville Contemporaine"* ("The Contemporary City") (1922), for 3,000,000 inhabitants. The Contemporary City has a radial design with skyscrapers, green spaces and transport facilities. Later, under the influence of the Soviet urbanism, Le Corbusier extended La Ville Contemporaine ideas and proposed *"La Ville Radieuse"* ("The Radiant City") (1935) for 1,500,000 inhabitants. The Radiant City has a linear design and its base has a shape of human body (Curtis, 1996).

Nikolai A. *Milyutin* (1989-1941), Soviet architect, urban planner and influential politician, in his book *"Sotsgorod"* (on the planning of socialist towns) (1930), proposed linear plan of the industrial town "*Traktorstoi*" (for tractor manufacture), located beside the Volga River and Stalingrad. "Traktorstoi" functions are separated into parallel linear strips (railway, industry, motorway in green belt, residential zone, and park) (Collins, 1965:210).

An essential characteristic of a linear city form is a line. "The *LINE*", asserts Collins, is "a schema that allows for infinite and integrated expansion of both the core and the periphery of our communities

[1] Cadiz is the see port in Andalusia, Spain.

simultaneously" (Collins, 1965:204)." This expansion opportunity presents a chief advantage for the linear city proponents.

A *transport track* (railway, tram, motorway, or their combination) usually is the core line of linear city. Different city functions (industrial, commercial, residential, recreational) are organized in the region of this core line, which can be straight, polygonal, or sinuous. Sometimes city functions are grouped into strips parallel with the core line of transport track.

4 INFRASTRUCTURE CORRIDOR

4.1 Infrastructure

Infrastructure study is complex because many interrelated phenomena have to be analyzed. Infrastructural facilities follow spatial development and human civilization progress (Korica, 2008). The rise of infrastructural systems started with antique roads and canals for transport of people and goods. Modern infrastructure systems, besides transport of passengers and freights, also provide transport of energy and information (Korica and Furundzic, 2011:613).

Infrastructure systems of interest in urban planning are: *transport* systems (utilizing land, water, air), *water* systems (drinking water, sewage), *energy* systems (electricity, natural gas, crude oil), and *telecommunication* systems (Korica 2008:37). Transport systems, particularly these with roads or railroads infrastructure, are especially significant in space planning and urban design.

Transport represents an essential aspect of urban life. Mobility is fundamental to economic and social urban activities (Rodrigue et al., 2009). Each movement, independent of its nature, has an *origin*, perhaps intermediate *locations*, and a *destination*. Nowadays travelling is a part of everyday life.

Transport systems, composed of network and nodes, are coupled to distinct urban functions (Korica and Furundzic, 2011:614). Transport *network* is a spatial structure of transport infrastructures and stations. Transport *nodes* are locations, generally stations and terminals, for an access to a transport network. There is a connection between mobility and life quality. Good design and advanced materials can improve transportation systems and create more sustainable urban environment.

4.2 Corridor

In common English language, the word "*corridor*", (from Italian: *corridore* – gallery, passage), not only means: "passageway" or "route", but also signify: "a densely populated strip of land including two or more major cities" and/or "an area or stretch of land identified by a specific common characteristic or purpose" (Merriam-Webster, 2008). In spatial planning, urbanism and architecture, the term "corridor" denotes usually a belt of land between two areas, typically having a particular feature.

In view of the fact that the word corridor comes etiologically from Latin: *currere* – to run, the "corridor" can be somehow considered as "part of a building which runs", or "strip of a land which runs".

Transfer of people, goods and information is fundamental component of contemporary human society. Economic growth is dependent on transport systems. A corridor may be considered as a *broad band of land* that follows a general directional flow connecting major sources of trips that may contain a number of streets, motorways and transit route alignments (Rodrigue et al., 2009).

According to Whebell (1969), "corridor is a *linear system of urban places* together with the linking surface transport media". For example, corridors are some of the major types of urban systems in the USA. The corridor landscape can be described in five historical stages: initial occupancy, commercial agriculture, railway transport, motor transport, and metropolis. In each stage, innovations and economic progress appear first in corridors, and diffuse outwards (Whebell, 1969).

Corridors represent "*bundles of infrastructure* that link two or more urban areas" (Priemus and Zonneveld, 2003: 167). Traffic corridors (motorways, railways, canals, etc.) are the most important in spatial and urban planning. Occasionally, traffic corridors encompass pipes (drinking water, sewage, natural gas, crude oil) and lines (electricity, telecommunication). Corridors development depends of technological advances both in transport modes and in infrastructure construction.

5 EUROCORRIDORS

5.1 Trans-European Networks

An objective of the *Trans-European Networks* (TEN), outlined in the European Union (EU) by the Treaty of Rome (1957), is an internal market creation and economic and social cohesion reinforcement (CEMAT, 2010). Construction of the TEN is important both for economic growth and employment increase.

For the EU sectors of common interest (transport, energy and telecommunications), three types of network are defined: Trans-European *Transport* networks (TEN-T), Trans-European *Energy* Network (TEN-E), and Trans-European *Telecommunications* Network (eTEN) (CEMAT, 2010).

The *Trans-European Transport Networks* (TEN-T) are road, rail, air and water transport networks planned to serve the whole Europe. The TEN-T plans initiate improvements of roads, railways, airports, inland waterways and ports, seaports, and traffic management systems. An aim of the TEN-T is long-distance and high-speed integrated and inter-modal transportation of people and freight throughout Europe.

5.2 Euro-corridors

Inside Europe of disappearing national borders, "*Euro-corridor* is a category of space of linear nature connecting large agglomerations over various national borders" (CEMAT, 2007:13). Euro-corridors, as international areas of important and fast spatial development, provide transport infrastructure, urbanization, economic expansion and environmental sustainability.

Euro-corridor can be basically considered as *transport corridor*. Main transport nodes, such as motorway intersections, chief stations, freight terminals, airports, and inland ports, are significant particularly for regional and local spatial development. Integration of spatial and transport policies produces economic, social and environmental benefits.

An investment in the Euro-corridor, in addition to provision of transport infrastructure, give a powerful impact not only to regional finance, commerce, and business, but also to existing regional transport network improvement and environmental protection. Major transport project plans, programs and projects, particularly the concentration of roads, railways and waterways in a single corridor, must reduce negative and emphasize positive territorial effects (CEMAT, 2010:44).

The *Euro-corridors* can be divided into: the *Trans-European* Transport Corridors, and the *Pan-European* Transport Corridors. Likewise the Trans-European Transport Corridors in Western Europe, the Pan-European Transport Corridors are main transport routes in Central and Eastern Europe. There is a proposal to unite Trans-European and Pan-European Transport Corridors into an integral Euro-corridors System.

There are ten *Pan-European Transport Corridors*, denoted usually by Roman numerals from I to X. They differ one from another, as they can include road, rail and waterway routes. Two of Pan-European Transport Corridors are passing through Serbia: the *Corridor VII* (which is the *Danube River*), and the *Corridor X* (which links Salzburg in Austria and Thessaloniki in Greece).

5.3 Corridor VII (Danube)

The *Pan-European Transport Corridor VII* (the *Danube*) refers to the Danube inland waterway, the Black Sea – Danube Canal, the Danube branches Kilia and Sulina, the inland waterway links between the Black Sea and the Danube, the Danube–Sava Canal, the Danube–Tisa Canal and the relevant port infrastructures situated on these inland waterways. Shipment facilities, necessary for combined transport developing, are also considered as the Corridor VII part. The Corridor VII length is approximately 2,845 km (CORRIDOR7, 2012).

The *Danube*, being after the Volga the longest river in Europe, represents the main inland waterway transport corridor linking Western to Eastern Europe through the *Rhine*, the *Main* and the *Rhine – Main – Danube Canal*. The Danube provides part of the link between the North Sea and the Black Sea. The inland waterway crosses 10 *countries*: Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Romania, Bulgaria, Moldova, and Ukraine. The Corridor VII chief *ports* are: Ulm, Regensburg, Linz, Vienna, Bratislava, Budapest, Novi Sad, Belgrade, Vidin, Rousse, Giurgiu, Braila, Galati, and Izmail.

The Corridor VII has links with the other Corridors (No. IV, V, IX, X) in some of the ports. The *Corridor VII* links are: with *Corridor IV* – in Budapest (Hungary) and Medgidia (Romania); with *Corridor V* – in

Bratislava (Slovakia) and in Budapest, Dunaujvaros, Mohacs (Hungary); with *Corridor IX* – in Oltenita, Giurgiu (Romania) and in Russe (Bulgaria); with *Corridor X* – in Budapest (Hungary) and in Belgrade, Novi Sad (Serbia). In addition, there is the seaport of Constanza which is at the mouth of the Danube – Black Sea Canal (CORRIDOR7, 2012).

The Danube has *strategic importance* because it is navigable in its course through 10 countries and it links the North Sea with the Black Sea though the Rhine – Main – Danube Canal system. The Danube is not only a multilateral waterway, but it is also the main water resource and important for living, culture and tourism. The use of the Danube has to be environmentally friendly and the fleets operating on the Danube must act according to the international legal regulations.

European multi-modal transport services expansion requests shifting cargo to inland waterway of the Danube. The Corridor VII development is a multilateral *venture* that includes maintenance, reconstruction, upgrading and new construction of main and supplementary infrastructure, including the relevant ports.

5.4 Corridor X

The *Pan-European Transport Corridor X*, having direction from North-West to South-East, is directly passing through 6 countries (Austria, Slovenia, Croatia, Serbia, Macedonia, Greece), and it has indirect links with 2 countries (Hungary, Bulgaria). The Corridor X includes two corridors, road and railway. *Road* Corridor X has length of 2,300 km and daily traffic of app. 20,000 vehicles (in 2010). *Railway* Corridor X has length of 2,528.2 km and a capacity for daily traffic of app. 100 trains (in 2010).

The Corridor X *main direction* is: Salzburg – Villach – Ljubljana – Zagreb – Beograd – Nis – Skopje – Veles – Thessaloniki. Also, the Corridor X has 4 branches: *Branch A* (Graz – Maribor – Zagreb), *Branch B* (Budapest – Novi Sad – Belgrade), *Branch C* (Nis – Sofia – Plovdiv – Dimitrovgrad – Istanbul / via Corridor IV), and *Branch D* (Veles – Prilep – Bitola – Florina – Igoumenitsa / via Egnatia) (Preradovic, 2005).

The Corridor X regional *strategic importance* is that it links Turkey and Greece with Austria via Bulgaria, Macedonia, Serbia, Croatia and Slovenia. The aim of the cooperation between the participating countries is the development of main and additional infrastructure of the Corridor X.

The development of the Corridor X should include reconstruction and new construction of main and additional infrastructure. Promotion of efficient and environmentally friendly transport modes is significant. Use of funds public and private and application of know-how are very important.

6 CORRIDOR VII & CORRIDOR X – IN SERBIA

6.1 Spatial plan of Serbia

Serbia belongs to the group of Balkan and Danube countries, which have a natural connection to the Black Sea (by the Danube River – being the Corridor VII), to the Aegean Sea (by the Corridor X), and to the Adriatic Sea (by the South Adriatic Corridor) (SPRS, 2010:38).

Landlocked Serbia (44 00 N, 21 00 E), due to its *geographical position*, controls one of the major land routes from Western and Central Europe to South-Eastern Europe and the Near East. Therefore, the development of all transport modes in Serbia has the high priority. This task is not easy, because of the extremely varied terrain (plains, hills, basins, mountains), as well as the budget deficit.

The *Spatial Plan for the Republic of Serbia* (SPRS) defines strategically territorial development of Serbia from 2010 to 2020 and contributes to horizontal and vertical coordination of planning (SPRS, 2010). The SPRS promotes sustainable transport and development of road network and facilities, railway network and facilities, air transport system, inland waterways, inter-modal transport and logistic centers.

The *road* network and facilities are below European standards in Serbia. There are many traffic accidents, which cause economic expenses, injuries, and sometimes deaths. The development of the Serbian road network and facilities enables sustainable mobility, integration with the regional network and competitiveness on the market. The *railway* network and facilities are outdated. Infrastructure repairing and rolling stock modernization will improve rail transport quality and speed. Better railways become more competitive in relation to the road transport. The *air* transport system renovation, inland *waterways* ports construction, and *inter-modal* transport expansion will provide more efficient and better quality services.

The Pan-European Transport Corridors VII and X, which are passing through Serbia, meet the requirements of modern transport, which implies optimal combination of different modes of transport. These two Corridors have strong positive impact on the transit market and they are vital for fast development of the region.

The SPRS recognizes importance and potentials of Serbia as a *transit* country. As the key priority task, the SPRS proposes the rapid development of *Corridor VII* (the *Danube*) and *Corridor X* in Serbia. With these two corridors, due to its favorable geographical position, Serbia can become a central transit link between Western Europe and South-Eastern Europe.

These days construction of the Corridor X brings new jobs to building companies. In future, the Corridor X will bring road taxes, facilitate sustainable economic development, improve transport of people and goods, cause business opportunities for gas stations, restaurants, shops, motels, and tourism growth.

6.2 Corridor VII (Danube) in Serbia

The Danube is navigable throughout its course within Serbia in the length of 588 km, which makes up 25% of its total length. The Corridor VII reconstruction and upgrading give an impact to economic development of Serbia and the entire region.

Besides the Danube, Serbia's inland waterways include the Danube tributary rivers, navigable throughout its course: the Sava River – 207 km in length, the Tisa River – 164 km in length, and the navigable part of the Danube–Tisa–Danube (DTD) Canal which has to be used to its full potential.

6.3 Corridor X in Serbia

The Road Corridor X passes through Serbia with *main direction* (Serbian/Croatian border – Belgrade – Nis – Serbian/Macedonian border) in length 493 km, with *Branch B* (Serbian/Hungarian border – Subotica – Novi Sad – Belgrade) in length 179 km, and with *Branch C* (Nis – Dimitrovgrad – Serbian/Bulgarian border) in length 108 km.

The *Railway* Corridor X passes through Serbia with *main direction* (Serbian/Croatian border – Sid – Belgrade – Nis – Presevo – Serbian/Macedonian border) in length 527 km, with *Branch B* (Serbian/Hungarian border– Subotica – Novi Sad – Belgrade) in length 149 km, and with *Branch C* (Nis – Dimitrovgrad – Serbian/Bulgarian border) in length 104 km.

7 CONCLUSION

Linear urban form, well known in urban history, was founded theoretically by the end of the nineteenth century, the time when modern urbanism has appeared as the art and science. The linear city – pioneer proposal by Soria y Mata, had many proponents and opponents during the twentieth century. Modern infrastructure corridors revive attention for linear concept in this century.

The essential characteristic of a linear city and a corridor is: a line. Regardless of linear form strict conditions and certain contradictions, linear concept demonstrates adaptability. The chief characteristic of linear concept is rapid and efficient movement of people and goods.

Linear city represents important concept in urbanism and spatial planning. The idea of linearity, being utopian and without significant realizations in the past, become promising and applicable to modern infrastructure corridors. Analogous to linear city, infrastructure corridor is a spine of elongated urban formation – which can expand without growing wider.

Contemporary Trans-European Transport Corridors, such as the Corridor VII (the Danube) and the Corridor X passing through Serbia, provide infrastructure, urbanization and economic development. The Euro-corridors development international practice may be useful guideline for the spatial and urban planning in Serbia.

Linear city and infrastructural corridor are presented together in this paper, because the authors assume that "old wine" (linear city) is "in new bottle" (infrastructure corridor).

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