

REDESIGNING THE NETWORK OF PEDESTRIAN SPACES IN THE FUNCTION OF REDUCTION OF CO₂ EMISSION. CASE STUDY: PANČEVO AND VRŠAC

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Research problem. *The research problem is the increase of GHG and CO₂ emissions in the transport sector, i.e. the intensification of urban transport activity in Serbia during the last 15 years. Focusing on redesigning of pedestrian networks as well as understanding the connections between urban design and pedestrian movement, the walkable environment could be achieved. In addition, as a direct result, a contribution would be made to a decrease of GHG and CO₂ emission.*

Methodology. *The following methods were used: analysis of the readability of open spaces, analysis of contents, rhythm and transparency on the ground floor of buildings and analysis of the intensity of use of open spaces using the Space Syntax method.*

Results. *The results show a proportional relation between characteristics on ground floors of buildings and the intensity of pedestrian movement. Also, they enable the establishing of general recommendations for designing the immediate pedestrian environment and upgrading the quality of open public spaces.*

Conclusion. *The improvement of the quality of pedestrian environment would have as its direct consequence greater use of open public spaces, and thus also increased intensity of pedestrian movement. In this manner, people would face a better quality and broader selection of contents and spaces.*

Key words: *Network of pedestrian spaces, Pedestrian movement, Sustainable transport, Central area, Serbia, Pančevo, Vršac.*

INTRODUCTION

After the signing of the Alborg Charter (1994), most European cities, signatories of this treaty, plead for upgrading sustainable mobility and favoring pedestrian and bicycle movement, with the goal to promote sustainable urban development. This is additionally based on the launching of numerous initiatives and activities throughout Europe which promote pedestrian movement (Galderisi and Ceudech, 2010). On the other hand, a lack of more radical solutions, in the sense of excluding transport from the historic city nucleus, can be noted.

Necessary pedestrian movement is most often independent, while movement resulting from the user's choice is influenced by numerous factors. Empiric research which monitored pedestrian movement showed that pedestrians

select the side they want to use (Weidmann, 1993). According to Helbing (1998) lines of pedestrian movement can be differentiated by their dynamics (direction of movement, speed, length), while the selection of the side most frequently matches the side used for the movement of vehicles in that city. If compared with the selection of the route for movement of vehicles, the selection of the path of pedestrian movement is influenced by several factors, and can very frequently be classified within the category of spontaneous movement. When moving, pedestrians usually have several goals during one "trip" and in numerous cases change the direction of movement.

According to De Certau (1984), pedestrians view strolling as an exceptionally intensive process, during which the pedestrian recedes into memories and imagination, constructs stories, thus intertwining concrete places with an imaginary world. In this manner, users of the city street temporarily gain control over the material

and the symbolic space. As opposed to the theory that a stroll is an inventive process, there are deterministic theories that claim that the urban space and the manner of its control influence the physical and the mental "shaping of the pedestrian" (Fyfe, 1998). We can claim that these relations by all means work in both directions: users of the public space influence the quality of the public city space, while it simultaneously "forms" its users.

Transit oriented development (TOD) is a major solution to serious and growing problems of peak oil and climate changes by creating dense, walkable communities that greatly

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reduce the need for driving and burning of fossil fuels (Dittmar and Ohland, 2004). TOD can decrease carbon emissions produced by development (Tiwari *et al.* 2011). Some of the components of transit oriented design are: walkable design with pedestrian as the highest priority, high density, high-quality development within 10-minute walk circle, urban design which includes easy use of bicycles, scooters, and rollerblades as daily support transportation systems and reduced and managed parking inside 10-minute walk circle around town center.

Having in mind these mentioned characteristics of pedestrian movement, and the growing need to opt for sustainable modes of transport and reduction of GHG and CO₂ emission, the following were set as basic research goals: establishing recommendations and guidelines for stimulating pedestrian movement in order to achieve more intensive use of open spaces and to form and expand the network of pedestrian spaces in the territory of the city area of medium sized cities. The main focus of this paper is reduction of concentration of GHG and CO₂ emissions from the transport sector as one of the anthropogenic drivers of climate change, which is one of the segments of the state of the environment. Small cities face difficulties in estimating their carbon emissions and planning future action plans (Kawakubo *et al.* 2010). However, the number of small and medium sized cities is larger than that of large cities in Serbia. In accordance with the mentioned goals the direction was toward establishing the relationship between the built environment, with a focus on the physical and functional framework, and the manner of using open spaces.

The polygons of the research were selected according to the following criteria:

- The NUTS categorization
- Population size and
- Size of the central area.

Research was carried out within the polygons of the central area of Pančevo and Vršac. The analyzed area was chosen within the boundaries defined by optimal pedestrian distance (500m from the focal points). Central city areas are usually similar in size (even in the cities and towns). As historically urban core the most of them were constituted during the 19th century in Serbia (Pušić, 1987). Just a few studies have addressed themselves to the description and measurement of local-to-global relationships, though such relationships constitute the potential to walk a substantial distance and duration (Brand Zook *et al.*,

2011: 3). This research is a small contribution to those studies which were focused on small scale intervention which have higher impact related to the city as a whole.

Mentioned cities belong to the category of medium sized cities in Serbia, NUTS 4. Pančevo is one of 24 urban settlements above 100,000 citizens (Administrative city according the Law on Territorial Organization of the Republic of Serbia (2007)). On the other hand, Vršac is one of 59 urban settlements between 10,000 and 50,000 citizens. The following cities were chosen as representatives of mentioned groups of cities.

The research consisted of several phases, and was implemented at the Faculty of Architecture, University of Belgrade, in the period from 2009 to 2011:

- Part of the research was carried out for the needs of the doctorate dissertation of candidate Aleksandra Đukić, PhD² and Milena Vukmirović³;
- Part of the research was carried out in cooperation with the 3rd year students of Basic Academic Studies of Architecture, Elective Subject of Networks of Pedestrian Flows in the Function of Redesigning.⁴

The paper has four sections: (1) presentation of theoretical bases used to perform the research and to review the situation pertaining to GHG and CO₂ emission in Serbia; (2) presentation of the methodology and methods used for the research; (3) review of research results and their systematization in the form of conclusions, and (4) discussion of obtained results and conclusions in the form of recommendations and guidelines for future interventions.

THEORETIC BASIS FOR THE RESEARCH

Pedestrian movement has become a very current topic after the 1960's. Numerous authors were engaged in these issues with a goal to develop models for designing street furniture (Schubert, 1967; Whyte, 1988); developing models based on relations between the level of services and pedestrian movement (Fruin, 1971; Polus and Schofer, 1983), and forming a rulebook for urban planning

² Title of the doctorate dissertation: *Preserving the Identity of the Main Street of a City in Vojvodina in the Function of Urban Regeneration.*

³ Topic of the doctorate dissertation: *Significance and role of the network of pedestrian spaces in generating the competitive identity of the city.*

⁴ Elective Module 17.2 Elective subject: *Network of pedestrian routes in the function of redesigning.* Head of the subject: Doc.Dr. Aleksandra Đukić, Associate: Milena Vukmirović, Assistant, Faculty of Architecture, University of Belgrade.

(Crawford, 2002) and pedestrian behaviour (Brilon and Grosman, 1993; Kirsch, 1964). Methods used in this research mainly pertain to direct monitoring (field recognizance), as well as the use of photographs and films of concrete locations filmed during an extended period of time.

Numerous investigations have shown that it is possible to foresee the dynamics of pedestrian movement, that it is possible to influence pedestrian flows (via urban design), as well as that pedestrians can move relatively freely and independently only along short distances, while along longer paths movement is conditioned by other pedestrians, i.e. that following phenomena appear: "*self organization*" (collective behavior – also noted in flocks of birds) and "*automatism*" (based on actions performed automatically – users of public city spaces most frequently opt for the simplest solutions when choosing the direction and selecting routes of movement) (Helbing, 1998).

Research presented in this paper is based on a theoretical framework in the domain of urban design, pedestrian movement and quality of the pedestrian environment. Within the mentioned theoretical framework two works of the authors Hillier and Hanson (1989) and Gehl (2004) are exceptionally important, because they deal with the perception and orientation of users during their movement within the urban space, i.e. with reasons why people use a certain urban space and spend time within it.

Hillier and Hanson (1989) present the general theory of the relationship between people and space (Space Syntax) in populated regions and deliberates various aspects of space and the manner in which space functions. Space Syntax uses quantitative methods (counting pedestrians and vehicles), which enable easy establishing of relations between built space, the functions and vitality of open city spaces. In their research authors of the Space Syntax have reached two very important conclusions: that during the designing and reconstruction of open city spaces it is necessary to study the space first, and only then to engage in form, and second, that the importance of the subject space within the network of open spaces in the environment can be established based on the intensity of the network of pedestrian movement.

In his works, Gehl (2004) presents results of intensive field research on the topic of social use of public space and the experience of people in relation to an open public city space. In addition to the above, Gehl presents a method of valuation of city qualities, discusses

how the human apparatus of perception directs the use of public space, and gives recommendations in the form of designing techniques that could encourage active use of open public city space.

The trend for GHG and CO₂ emission in the transport sector in the last twenty years

Latest research shows that GHG (greenhouse gas) and CO₂ emissions have a global trend of growth. In addition to harmful emissions with an immediate effect, which are growing in intensity at the local level, these emissions have a postponed, long term negative effect in the form of global warming and climate change. Greenhouse gasses (GHG) retain electromagnetic radiation and thus lead to global warming of the Earth's surface. Concentrations of individual gasses within GHG emission are approximately: 83.3% carbon dioxide (CO₂), 9.7% methane, 4.7% nitrous oxide (N₂O) and 2.3% other gasses (U.S Environmental Protection Agency, 2012). Mentioned gasses are formed by fuel combustion in motor vehicles. Internal combustion motors used in motor vehicles or for other purposes are the main source of certain pollutants.

Based on an analysis of GHG emission by sectors, it was concluded that transport ranks third, with a

14% share of total GHG emission. As can be concluded from data relevant to GHG emission, transport is not the dominant source of emission. However, as opposed to most sectors which show a downward trend in the 1990 – 2005 periods, transport had a considerable increase in emission of these gasses.

When data pertaining to CO₂ emission, as the most dominant emission in GHG was analyzed from the aspect of sectors, it was noted that transport is ranked third, with a share of 19.2% (Figure 1).

Compared to global trends manifested in connection with GHG and CO₂ emissions, the situation in Serbia is somewhat different, having in mind the specificities of transition linked to the last twenty years. The only existing data about GHG and CO₂ emissions cover the national level while there is no valid data on the local level (town, city, region, etc.). However, available data about GHG and CO₂ emissions in Serbia could be applied to particular cities (the level of traffic increase during the last decade is proportional to the population). According to the Networking action to involve Local Governments in the EU (van Staden, 2011) and international energy and climate debate it is important to act on the local level rather than on national. Some governments, especially in Europe, have launched ambitious plans to reduce GHGs by

implementing the strategies on national level which focused on the changes in lifestyle. As it is political decision and connected with voters, they consider that the local level is more suitable for that kind of strategies and interventions.

Since 1989 Serbia is in the process of transition from socialism to capitalism. Researches indicate that Serbia belongs to areas highly vulnerable to climate change (Lazarević Bajec, 2011). The mentioned period lasts somewhat over two decades and is characterized by two intervals in which certain specificities have been noted: the period from 1990 to 2000, with its basic characteristics of war with neighboring countries, economic sanctions and an unstable political situation, and the period from 2000 to date, characterized by a sort of stabilization and economic progress (Anon., n.d.). A thus established timeframe can also serve as the basis for viewing the situation in the domain of ecology, i.e. in connection with emissions of CO₂ and of other greenhouse gasses (GHG).

Data from previous periods shows a trend of growth of CO₂ emission. A research by the World Recourse Institute registered that in 1950 Yugoslavia had one half per capita CO₂ emission compared to the global level. In the next 25 years, more precisely in 1975, per capita CO₂ emission showed a trend of growth. In this period the research shows that total CO₂ emission in Yugoslavia had a value similar to overall global per capita CO₂ emission.

The same source indicates that in 1998 recorded per capita CO₂ emission in Serbia and Montenegro was higher than global emission, but lower than per capita CO₂ emission in Europe. In the period from 1990 do 2008, registered trends for CO₂ emission from fuel combustion (in Mt) differed depending on the approach by sectors. The variable situation is reflected also in the sector of transport, as shown by research carried out by the International Transport Forum, as of 2008. The ITF report states that CO₂ emission in the transport sector in 1990 was 7.8% of total CO₂ emission in Serbia. Since then a downward trend is noted lasting until 2000 (1995: 6.4%; 2000: 5.6%). After this period a trend of growth is registered, amounting to 13.4% as of 2008 (International Transport Forum, 2007).

The period from 1990 to 2000 is characterized by a dire economic situation and instability in the country. The most important events featured in this period were war with neighbouring countries, economic sanctions, and a complex political situation. In

Annual Greenhouse Gas Emissions by Sector

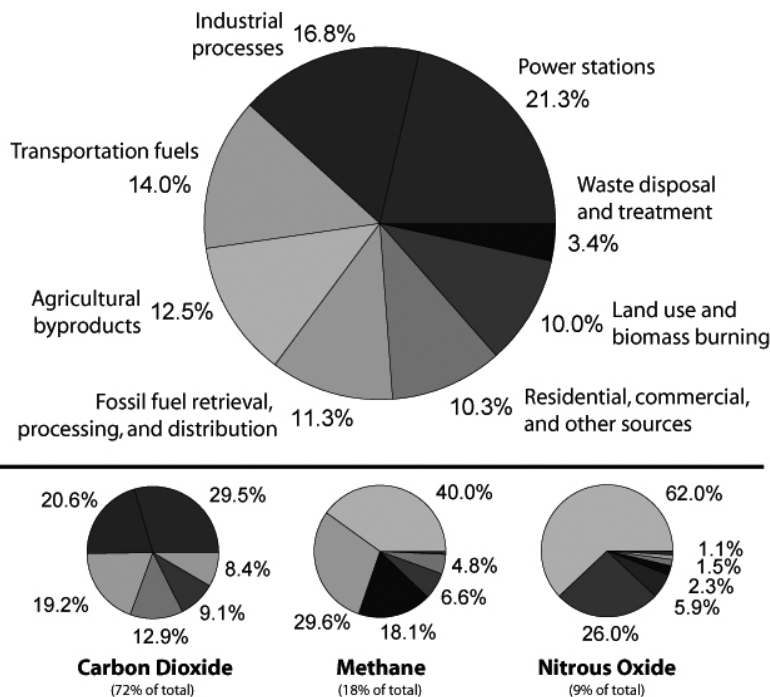


Figure 1: Annual Greenhouse Gas Emission by Sector. EDGAR 3.2 Fast Track 2000 dataset. Source: PLB Netherlands Environmental Assessment Agency (2010)

accordance with this, as opposed to other countries of Eastern Europe, little attention was being devoted to the aspect of ecology. However, this period registered a decrease of total CO₂ emission. This state of affairs is not characterized by raising awareness about negative effects of CO₂. The bad economic situation and instability in the country resulted in the decrease of industrial production, a decrease in the use of motor vehicles, and decrease in construction work.

The mentioned situation was also reflected in the transport sector. In the observed period a downward trend was noted until 1996. In 1996, increase of CO₂ emission was noted in the transport sector, reaching its maximum in 1997. After this period, the trend is again decreasing, reaching its lowest level in 2000 (Figure 2). In this period the highest CO₂ emission in Mt was registered in the domain of motor (passenger) transport. In 1990 this was 4.42Mt, in 1995 – 2.7Mt, and in 2000 – 2.3Mt.

The period after 2000 can roughly be characterized as a period of stabilization. This is reflected in the orientation toward democratic and European values, the end of conflicts and war activities in the country and

its surroundings, stabilization of the political situation, etc. As the table shows, the general situation pertaining to the ecological aspect and CO₂ emission is variable. However, in relation to the transport sector, a trend of growth, with a linear character, was noted. This is already visible in 2001, when it amounts to 8.5% of total CO₂ emission, which is 2.9% higher than the share of transport in 2000. The growth trend continues until 2008, when it reaches 13.4%. According to research by International Transport Forum (Figure 3) in 2008, the transport sector climbed to third place among all sectors (energy, production, transport and other). In 2008 per capita CO₂ emission amounted to 6.6Mt.

In addition to general trends mentioned, both global, and in Serbia, the level of emission of harmful substances in the sector of transport can be viewed from three aspects:

- characteristics of the transport network – the structure of the network determines the spatial distribution of emission of harmful substances. Thus, we can differentiate a centralized network characterized by concentrated transport and emission and lower energy consumption, and disperse network with higher energy

consumption, and lower concentration of emission.

- transport intensity – proportionate to the degree of emission of harmful substances, and
- transport type/mode – which defines the nature of emission. Different modes of transport use different types of energy, and therefore emit (or do not emit) different pollutants.

For this research, the third aspect pertaining to types/modes of transport is particularly important. In relation to the mentioned aspect of review, and having in mind that different modes of transport use different sources, i.e. quantities of energy for their movement, we can divide them into sustainable and unsustainable. By analyzing energy consumption per person for covering a certain distance, a green hierarchy was established for participants (modes) of transport. The green hierarchy represents (Figure 4) the basic concept forming the basis for the reform of the transport system in cities around the world. The most significant positions in the green hierarchy go to pedestrian and bicycle transport, owing to low costs, spatial efficacy and nonexistent negative effects on the environment (zero environmental impact). Third place is held by public city transport. These mentioned types of transport, regarded as sustainable, are followed by service vehicles, with the list ending with private vehicles.

Having in mind the harmful effects of increased GHG and CO₂ emissions, and viewed in relation to the sector of transport, sustainable modes of transport should be considerably upgraded. In accordance with characteristics of medium sized cities (Stupar and Đukić, 2007), depending primarily on the size of the city and the lifestyle of its inhabitants, pedestrian transport is of special interest. In accordance with the basic goals pertaining to upgrading transport and reduction of GHG and CO₂ emissions, the goal of the research was to establish measures that would stimulate pedestrian movement in the central nucleus of medium sized cities in Serbia.

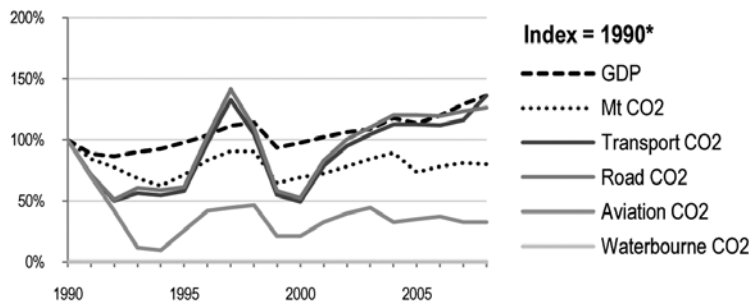


Figure 2: Percentage of decrease in/growth of CO₂ emission in the period from 1990 do 2008. Source: International Transport Forum

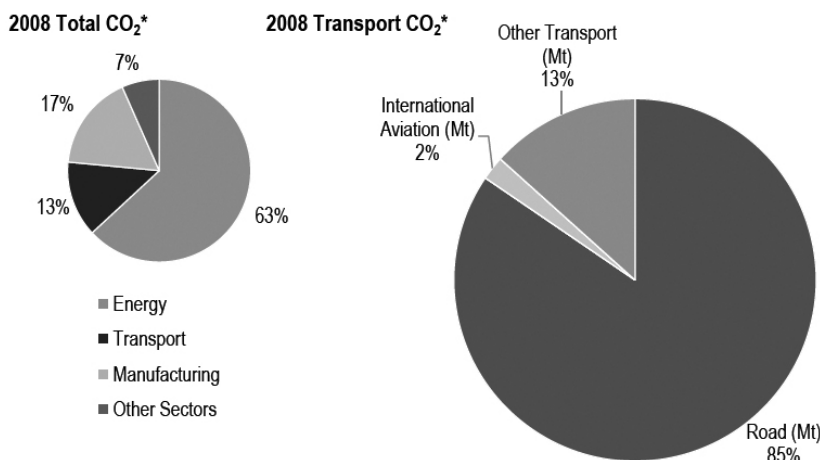


Figure 3: The share of transport in total emission and the distribution of this share according to the type of transport in Serbia. Source: International Transport Forum



Figure 4: The green hierarchy of participants in transport. Transport Alternatives, Spring 2001, p. 9

According to the General Urban Plans of Pančevo⁵ (Direkcija za izgradnju i uređenje Pančeva, 2011) and Vršac (Zavod za urbanizam Vojvodine, 2007) the main objectives of traffic sector are:

- Decrease in vehicular transport in central area by stimulating the development and use of sustainable modes of transport (walking, cycling and public transport)
- Implementation of the policy which will intensify walking and cycling in the central city area.

METHODOLOGY

Implemented research methodology is based on the presented theoretical framework, and encompasses following elements:

Analysis of readability of open space centered upon establishing dominants, markers, benchmarks and vistas on the subject polygon of the cities of Vršac and Pančevo. By considering the distribution of markers at the level of the city matrix, an attempt was made to establish the key elements of urban structure and their mutual connections. According to research by Lynch (1981), distance between dominants should be between 200 and 300m. This means that the entire territory of the city should be covered by a grid of maximum 300m with markers placed in the centers (Lynch, 1981).

Hegemann *et al.* (1996) emphasize that the distance between main buildings – markers along the direction of movement of users, should not be large. The angle between the coronets of these buildings and the eye of the beholder-passer by should not be over 18 degrees (Hegemann *et al.*, 1996). Otherwise, the "images" of these structures in the eye of the beholder would become silhouettes and would blend into the environment, i.e. would lose their dominant role in space.

Analysis of content units number in ground floors of buildings and establishing the rhythm of repetition. The function of buildings along the street front conditions the character of the viewed path or space, the manner of use and the density of users. For a space to have vitality, it is indispensable to secure a density of user frequency and a density of diversity. As the most important factor of vitality of open public space, Alexander *et al.* (1977) emphasizes the number of users per square meter, i.e. the area of open space per user, while for Hillier and Hansons's

(1989) method of Space Syntax the important issue is the number of users in a certain direction per time unit.

Both authors recognize the significance of user concentration within certain zones. While Alexander *et al.* (1977) only research the cause for users to gather in certain zones of city space and their position (concentration to rest and realize social contacts, along the edges and in corners of squares, and in niches and indented sections of city fronts), Hillier and Hanson (1989) offer methods and techniques for changing the concentration, based on a study of ground floors of buildings. These contents directly influence user density, and as opposed to higher floors, ground floors are the most subject to pressures for change.

The analysis was implemented in ground floors of buildings via categorization and mapping of parts of street fronts into (Gehl, 2004): Category A street front (small units – 15 to 20 buildings on 100m; diversity of contents; with no closed/passive facades; with much depth and relief of facades, and a high quality and materialization); Category B street front (relatively small units – 10 to 14 per 100m; moderate diversity of functions; a few closed or passive facades; moderate relief and depth of facades, and good quality materials and facade elaboration); Category C street front (combination of smaller and larger units – 6 to 10 units per 100m; moderate diversity of functions; a few closed or passive facades; predominantly unattractive facades and few or no details); Category D street front (larger units with several entrances – 2 to 5 units per 100m; few or absent diverse contents; several closed or passive facades; unattractive facades and few or absent details), Category E street front (large units, with few or without entrances; no visible content variation; closed/passive facades; unattractive facades and nonexistent details).

Analysis of the level of transparency in the buildings' ground floor. The phenomenon of transparency in architecture and urbanistic designing can be interpreted also as the utilization of glass "transparent" facades and the linking of the external and the internal space (exterior and interior). The text "Close encounters between buildings" by Gehl (2004), takes into account the characteristics of the human apparatus for observation, defining frameworks of the direct experience of space and elements of the built environment viewed during pedestrian movement, i.e. when moving at 5km/h. In relation to the thus established context, Gehl notes the framework of viewing (experience) – the urban scene –

within which he notes key elements, transparency among them.

Analysis of the intensity of use in open spaces (Space Syntax method). The Space Syntax method is a set of techniques which describe and analyze the relationship between the configuration of space, and socio-economic relations. These techniques investigate relations between the user movement and the content in ground floors of buildings along the paths of movement. Networks of pedestrian flows are presented in the form of a hierarchy, while the model of change (future transformations) most frequently implies changes of contents in buildings and the activation of a broader network of pedestrian movement (Hillier and Hansen, 1989).

The mentioned methodology was applied to polygons of city nuclei of Pančevo and Vršac, with the goal to establish current situations pertaining to the manner and intensity of space use from the aspect of pedestrian movement, and define issues that would contribute to their more equal and intensive utilization, thus increasing pedestrian movement as a mode of transport.

RESULTS

Implementing the structure of research presented in the previous chapter, results of research on polygons of the cities of Vršac and Pančevo will be presented.

Vršac

Vršac is among medium sized cities. It is located in the north of the Republic of Serbia, i.e. in the south-east of the province of Vojvodina. It has a population of 36,000.

Results pertaining to readability

By placing a grid of 200m i.e. 300m, it can be concluded that the Vršac of the streets has a satisfactory distribution of dominants in the city nucleus. Dominants are concentrated on the main city square and its contact zone, and as the distance from the square grows, they appear sporadically. It is difficult to note the beginning and the end of the outline due to the abrupt change of the level of urbanity while moving away from the main city square and its more immediate contact zone.

Results pertaining to contents, rhythm and transparency

The horizontal rhythm of the fronts possesses characteristics of alternation of widths of street fronts (facades), making it dynamic and

⁵ General plan of Pančevo includes the results and conclusion form Traffic Study of Pančevo Central Zone (Institut za puteve, 2004).

relatively uniform (Figure 5). The presence of tools for avoiding monotony – built/unbuilt (at the site of the Orthodox temple and the Bishop's residence, pulled back from the regulatin line), opposition between light and shadow, additionally emphasized by changes of the number of floors, and the orientation of street fronts; the existence of vertical accents in the pronounced horizontality of the composition; an opposition between the prophane and the sacral, can be noted. The uneven terrain enables the inclusion of buildings located in the second plan in the image of the front, i.e. ambiguous space.

Contents in the central zone were analyzed using street front categorizations. The general conclusion is that, except in the zone predominantly dominated by service and commercial contents, placed in Category A, the remaining space has a character corresponding to street front Categories B, C and D.

There is no continuity of transparent barriers (shop windows, glass partitions, doors) on ground floors, which would provide an intertwining of the public and the semi-public

space and enable an insight into the interiors of buildings from the street. Interiors of blocks are not used for public purposes, i.e. there are no passages (since there is no need to additionally expand ground floor contents – the public space of the main city square has taken over numerous types of contents).

In the historic nucleus of Vršac permeation between public and private space is present only in the zone of the main city square and its contact zone. Most contents in ground floors of buildings are not transparent, and as the main square is left behind, the predominant function in the ground floor of buildings becomes housing. There is no pronounced difference in the use of public city space in different seasons. Even though in the past the main city street served for trade, after the reconstruction of the main city square and with the lack of possibility to turn it into a pedestrian zone, this function of the main street was taken over by the square, while the main street retains the transport function as dominant, i.e. it is fully subordinated to the vehicle transport.

Results of analyses using the Space Syntax method

The lack of diverse service contents in buildings along the streets of the historic nucleus in Vršac conditions the reduced intensity of its use, except in the main city square. Based on the research using the Space Syntax method in the period of May–October 2011 it can be concluded that the highest concentration of users can be found in the main city square, especially in its part exiting toward the main city street, and in contact zones between the main city street and the square, as well as on the intersection itself (Figure 6).

The main city square is placed at a tangent in relation to the direction of the main city street, enabling the flow of users exactly to the beginning of the main city street. The position of other significant open spaces in the historic city nucleus is on a line with the main city square, and perpendicular to the main city street. The main point of crossing of more important flows of movement is at the beginning of the route, which is also the main



Figure 5: Vršac – The contents of ground floors (left) and distribution of dominants (right). Source: Aleksandra Đukić, Milena Vukmirović



Figure 6: Vršac – Results of analyses using the Space Syntax method. Source: Aleksandra Đukić, Milena Vukmirović

access for users. User densities are highest on the main square and on secondary squares, and considerably lower in side access streets. Commercial contents are located on the first floor of the main city street toward the square, as well as on the main city square itself. Selection of the paths of movement depends on: cohesion of contents – the continuity of "active" ground floor levels and the concentration of users on specific paths (dominant directions of movement always connect points with maximum user concentrations).

Paths of movement along the route vary in intensity, and are most intensive in the contact zone with the square. We can conclude that active sections of the street are those in the immediate vicinity of the square, i.e. activity has been transferred to the space of the square.

Pančevo

Pančevo is a medium sized city. It is located in the north of the Republic of Serbia, i.e. the southern part of the province of Vojvodina. The city has 76.000 inhabitants.

Results pertaining to readability

By placing a grid of 200m i.e. 300m, it can be concluded that the framework of the historic city nucleus in Pančevo has a satisfactory distribution of dominants. The main city street has a double altitudinal dominant (a building with GF+11), three dominants of local significance (the court building and two buildings with towers at the block corners), the main city square contains one more altitudinal dominant of city significance (municipal building) and local significance (museum building), and Dimitrija Tucovića street contains a double dominant of the church tower.

Results pertaining to contents, rhythm and transparency

Monotony in the central part of Pančevo is avoided by using contrast and practically all tools available. There is the contrast of built–unbuilt (houses built after World War II are withdrawn from the regulation line, while some are placed aggressively, at an angle in relation to the regulation line, also representing a contrast in relation to building on the line in other blocks along main street); the opposition between shadow and light, additionally emphasized by the change of width of the street front, change of the number of floors, roofs and street orientation; the existence of vertical accents in the emphasized horizontality of the composition. Blockades/barriers are visible and provide the desired level of

dynamics when moving, as buildings standing out in the forefront due to the curvature of the route or greenery which forms a visual barrier.

An analysis of contents in ground floors of buildings established the categorization and mapping of sections of street fronts (Figure 7). It was noted that along Vojvode Petra Bojovića Street, Radomira Putnika Street and Njegoševa Street, Category A street fronts (predominantly dominating) and Category B are present.

However, as opposed to them, along Braće Jovanovića street and Karađorđeva Street, there are mostly Category C and D street fronts, and in some sections of Braće Jovanovića street there are also Category E street fronts.

Based on this analysis, as well as on individual observations of rhythm, the alteration of street front widths is dynamically uneven.

Transparent barriers (shop windows, glass

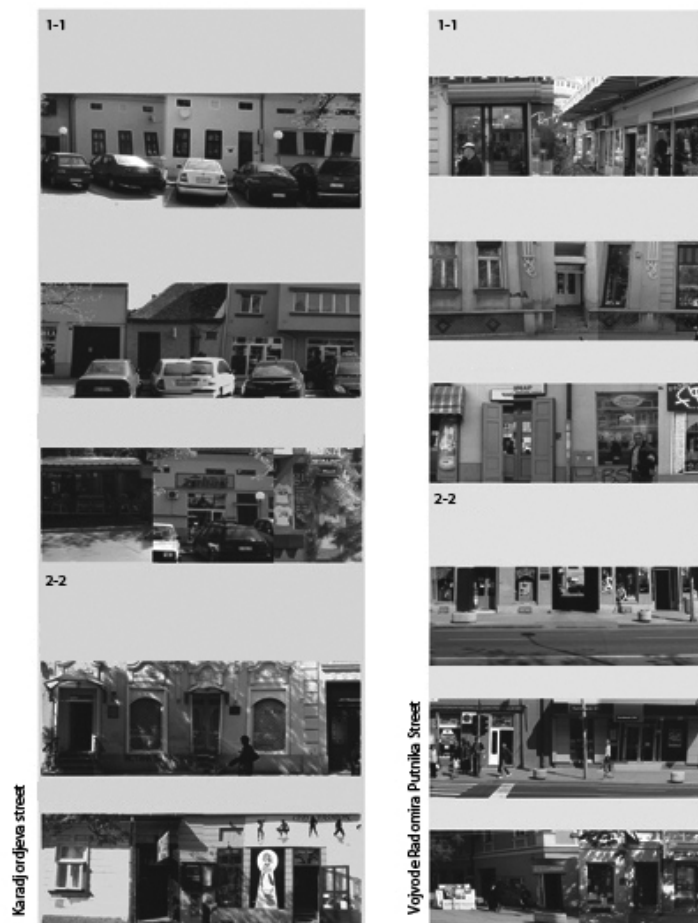
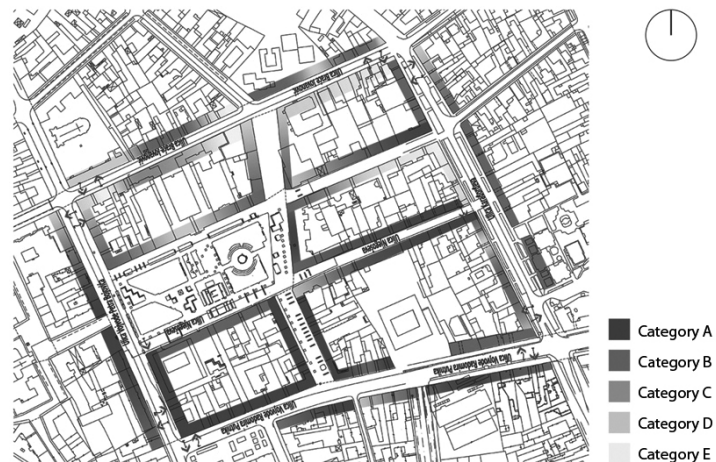


Figure 7: Pančevo – Intensity of activity in ground floors of buildings grouped in Categories A, B, C, D and E.

Source: Aleksandra Đukić, Milena Vukmirović

partitions, doors) on ground floors, which provide an intertwining of the public and the semi-public space and enable an insight into the interiors of buildings from the street, are partially present in streets in the historic nucleus in Pančevo. Transparency of the street front is connected to functions in buildings along the route and to the manner and dynamics of using the open public space, but having in mind that there is no continuity of functions on ground floors, there is also an apparent discontinuity of transparency. Passages – which also enable certain street transparency are sporadically present in main street and in Njegoševa street.

Results of analyses using the Space Syntax method

Based on the research implemented using the Space Syntax method in the historic city nucleus in Pančevo in the period of May - October 2011 it can be concluded that the highest concentration of users is not in main street, but in Njegoševa street (first parallel street toward the main city square) (Figure 8). User concentration is also higher in the street linking the main city street with the main city square, as well as on the square itself. Along the main city street, the number of users is higher on the side closer to the main city square, as well as in the section of the street with a higher concentration of service contents. Directions of user movement, i.e. selection of paths of movement are therefore conditioned by a continuity of "active" ground floor levels, indirectly depending also on the concentration of users on specific paths (dominant directions of movement always connect points with maximum user concentrations)

The quality of the main street in the functional sense is also substantially influenced by the level of accessibility. The possibility to access

the main city street from various directions is also present in the case of the main city street in Pančevo. Access is possible from side streets, while the intensity of movement of users from the direction of the main city square toward the main route is the highest. Surrounding streets leading to the square have a higher level of vitality than the main city street itself, due to a higher concentration of potential stopping points. (Figure 8). Paths of movement with the same or similar intensities are relatively equally distributed.

The main city street in Pančevo is in the immediate vicinity of the park, thus the number of users in shaded places is evident during the summer months (side streets leading to the park-square). The street has an alley of trees, but no benches or fountains, therefore in summer months users stay for shorter periods of time.

Discussion

The analysis of results for central area of selected cities of Pančevo and Vršac, as examples of medium sized cities in Serbia, in general shows that there is no uniformity in the use of these spaces by pedestrians. Zones of intensive use coinciding with presented characteristics of street space in the form of diverse contents, attractive appearance, high level of transparency and rhythm, can clearly be seen. We note certain types of proportionality in this relationship, and conclusions, such as recommendations and guidelines for future interventions in space can be drawn, both relevant to distribution of contents, and on the issue of arranging facades of buildings in the ground floor zone. Having in mind the point of view of Jan Gehl (2004) that the quality of open public city spaces is proportional to the number of users (who spend time in open city space), the open

public city space and its immediate pedestrian surroundings should have following characteristics:

- uniformly placed spatial dominants, markers and vistas corresponding to a grid of 200 to 300 metres
- distribution of contents on ground floors corresponding to Categories A and B in the more immediate central zone (city nucleus, gathering point), i.e. Categories B and C in the broader central zone
- suggested distribution of contents corresponding to mentioned categories would contribute to establishing the adequate rhythm, transparency and attractiveness of facades on ground floors of buildings
- distribution of contents with longer working hours during the day, in order to achieve a more uniform use of space in different time intervals
- establishing legal measures in the form of rulebooks that would contribute to upgrading and achieving above mentioned recommendations.

The given situation would directly lead to greater use of open public city space, and thus also to the increase in the intensity of pedestrian movement. In this manner, people would face a better quality and a broader choice of contents and space, and thus also a higher probability to opt for walking as a sustainable mode of transport in medium sized cities in Serbia. Furthermore, decrease in vehicle traffic in the central city areas would limit the concentration of carbon dioxide and GHGs in the atmosphere. The transportation sector is not the only challenge that will be faced by the future cities according to the climate change. Several other sectors like construction, energy and agriculture are also important considering greenhouse gases



Figure 8: Pančevo. Results of analyses using the Space Syntax method. Source: Aleksandra Đukić, Milena Vukmirović

emissions. But every improvement, even on the local level (small scale) could provide positive results in the field of climate change.

Further research could be carried out with the goal to establish the affinity of the very users of space and pedestrians. Placing them in the role of "experts" would offer an even more precise review of future interventions that would need to be implemented in space, in order to satisfy most aspects of the quality of open space and the direct pedestrian environment.

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