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IMPROVING THE NETWORK OF SECONDARY ROADS IN URBAN SETTLEMENTS: CASE STUDY ISTOČNO NOVO SARAJEVO

Abstract

The spatial development of the city and urban residential areas is inextricably linked with the spatial planning of transport networks. The concentration of population and residential facilities in a small area certainly creates traffic problems and affects the quality of life of individuals and the sustainability of urban settlements. The increase in population standard and the use of individual means of transport creates the need for huge spatial areas for the movement and rest of vehicles. This paper presents one possible way of modifying the planning document (regulatory plan) in the domain of the organization of traffic and free areas with the aim of increasing accessibility to end users, as well as improving the quality of life of individuals.

Keywords: traffic, urban road network, parking, urban planning, regulation plan

УНАПРЕЂЕЊЕ МРЕЖЕ СЕКУНДАРНИХ САОБРАЋАЈНИЦА У ГРАДСКИМ НАСЕЉИМА: СТУДИЈА СЛУЧАЈА ИСТОЧНО НОВО САРАЈЕВО

Сажетак

Просторни развој града и градских стамбених насеља је нераскидиво везан са просторним планирањем саобраћајних мрежа. Концентрација становништва и стамбених садржаја на малом простору свакако ствара саобраћајне проблеме и утиче на квалитет живота појединаца и одрживост градских насеља. Пораст стандарда становништва и коришћење индивидуалних средстава превоза ствара потребу за огромним просторним површинама за кретање и мировање возила. У овом раду је приказан један могући начин модификације планског документа (регулационог плана) у домену организације саобраћајних и слободних површина са циљем повећања приступачности крајњим корисницима, као и унапређења квалитета живота појединаца.

Кључне ријечи: саобраћај, градска путна мрежа, паркирање, урбанистичко планирање, регулациони план

1. INTRODUCTION

Cities experienced an exceptional growth rate at the beginning of this century, and the total world population exceeded 8 billion in 2023. More than 50% of the world's population lives in urban areas, and it is estimated that it will be over 70% by 2050. At the same time, this share in European cities is about 65%, and in the USA about 80% [1]. With a concentration of over 80% of the world's economic activities, cities offer millions of people social mobility and economic prosperity by bringing together creative, innovative, and educated individuals and organizations.

Turbulent past and present, as well as an uncertain future, demographic disturbances, and accelerated urbanization (consequently), move the surrounding settlements and villages closer to the city, while in the meantime they are becoming smaller cities (smaller urban environments) themselves. The big city has almost all the components of the natural environment: air, plants, land, relief, hydrographic network, ground water, bedrock, and climate. However, physical conditions in large cities are worse than those in small ones. As a result, the population of large cities is exposed to extremely large problems, despite the advantages and opportunities brought by urban facilities. Lack of apartments, schools, hospitals, green areas, difficulties in traffic, air and water pollution, high noise levels, chaotic street traffic, cause negative psycho-social consequences for city dwellers, and the traumatic consequences of high population density are increasing.

The successful functioning of today's life and work implies a combination of three elements - human activities, space, and transport. Activities comprise daily or occasional actions that the population performs during the day, i.e. during life. To carry out the activities, a certain space is needed, which will, through its concept, content and appropriate layout enable the most efficient performance. The activity that needs to be performed and the space that is adequate for its performance often have a physical separation that needs to be bridged by transport. This is how we arrive at the third element that enables the connection of people, spatial units, and the environment.

The performance of activities becomes difficult, sometimes even impossible, if good transport connections are not provided. Transport is also distinctive due to the opposite problem - generic connectivity, which is a frequent example in modern cities, where the auto-centric concept of traffic and transport planning and organization dominated through planning documentation (but also physical implementation) for decades. With such a radical adaptation of transport infrastructure to cars, other types of transport became neglected or even rejected as a potential mobility solution in urban areas. The consequences of this are reflected in numerous negative ecological, health and sociological aspects, whereby the negative consequences of industrialization and urbanization, as well as psychophysical stress, take on alarming dimensions in some societies. It must be admitted that traffic is not the only cause of these phenomena, but it is one of the factors that has the power to direct and motivate society to change.

In that key, by overlapping the two functions of transport - physical and social - the meaning of the concept of the territory occupied by this infrastructure is also expanded. Therefore, the areas occupied by transport infrastructure are not only spatial facts, but also cultural, social, economic, and ecological. A wider observation, understanding and interpretation of these spatial elements is possible. With this procedure, sustainable design from "green" units, as the first association, moves towards social improvement in a much broader sense.

In addition to traffic and related infrastructure, modern city construction is characterized by massiveness and industrialization, and therefore designers and urban planners acquire a new role as designers of the living environment, i.e. places for work, housing, rest, and recreation. Often this process is marked (or branded) by the demands of high commercialization and enormous profits. In such conditions, and with the aspiration to reach the concept of sustainable development, the social aspects of city planning and design are gaining more and more importance. There is also more and more talk about sustainable planning and design, i.e. the tendency to harmonize design technology with the economic, environmental, and social functions of urban settlements.

This paper points to one of today's typical approaches to the planning of urban settlements with collective housing, which implies mass construction based on large demands for housing space in larger urban areas without significant analysis of requirements for traffic facilities and areas that improve the standard of living in an urban environment.

2. URBAN ROAD NETWORK

The role of urban traffic is to integrate city amenities, direct and synchronize activities and set the pace of urban life. In addition, urban roads limit the space for the development of physical structures

so that traffic is an inevitable factor in the spatial organization of the city. Therefore, the city and its traffic present unique planning and design complex with the same temporal and spatial dimensions [2].

The term “urban road network” represents a network system of structures and facilities that has multiple functions, starting with the movement and rest of vehicles. When using the word “vehicles”, it is understood as all vehicles participating in traffic. The functional classification of the urban road network is reflected in relation to two basic tasks. The first one refers to the connection of certain parts of the city by high-capacity urban arterials - the primary network. The second task is to serve locations and facilities immediately next to the road (i.e. access) - the secondary network. When both tasks are harmonized, a categorization of the urban road network is obtained, as well as the planning and design characteristics of a certain level of road in the urban environment.

Urban roads of higher order (primary) consist of roads intended for circulating traffic on which the basic transport work of all types of motorized surface traffic is carried out. On the other hand, lower-order urban roads (secondary) form a mix of streets and carriageways that serve to access certain destinations. For this level of the network, typical traffic parameters, such as flow and speed, lose their meaning since high vehicle movement speed and strong vehicle flows are, in essence, an unacceptable and unwanted phenomenon. The planning characteristics of the roads within the urban road network can be systematized according to functional classification and basic urban and technical-operational criteria (Table 1). It can be observed that the basic function of the urban road network has a dominant impact - traffic connection or access and servicing of the location and facility. Due to the different nature of tasks and functions, primary and secondary networks have different characteristics and spatial organization.

Table 1. Planning characteristics of urban road network [2, modified]

criteria	primary road network			secondary road networks	
	urban motorway	main urban artery	urban artery	collector street	access street
role in relation to the city	connects distant parts of cities	connects different urban contents	connects residential areas and the city center	serves urban units	serves individual locations
relation to the intercity network	direct connection to long-distance roads	introducing connecting roads in urban areas	introduction of collector roads in urban areas	-	-
relation to urban units	does not pass through urban areas			integral part of the road network of urban areas	
cargo traffic	transit in relation to the city	channeling of destination cargo flows	supply distribution	supply of urban areas	supply of individual locations
urban public transport	fast urban public transport	fast urban public transport	urban public transport	public transport terminals	terminals in the city center

3. URBAN ROAD NETWORK PLANNING

Rational organization of space to achieve its efficient use, as well as directing of construction and arrangement of populated areas, is done by means of spatial and urban planning which reconcile interests of different subjects in a certain area. Two groups of documents i.e. urban planning documentation, can be distinguished in relation to the documents necessary for planning and designing traffic infrastructure in the urban area depending on the size of the territory in question and contents of the plan:

- general urban planning documentation - general purpose plans solving wider problems of socio-economic and spatial development, including the long-term concept of arranging the urban space and transport (regional spatial plan, general urban plan);
- urban planning documentation - special purpose plans solving spatial relationship of the most important linear and network systems as well as regions and specific segments of the

urban area containing both important transport infrastructure (general urban plan, detailed regulation plans, and urban planning design).

When dealing with a specific urban area, regulation plan particularly affects design of transportation facilities as it encompasses all facilities of primary and secondary network, and all main systems of infrastructure defined in the absolute coordinate system, thus becoming a skeleton of space organization and solid numerical basis for further action and developing necessary urban planning and technical documentation.

Processes of spatial planning and designing of transportation facilities are directly interconnected and conditioned. It should be emphasized that great difficulties may arise in the case that the planning process is performed separately from the designing of urban road network. It is of utmost importance to attune contents and period of designing of transportation facilities and planning of space - preliminary design of transportation facilities must represent a base for elaboration of regulation plan. In doing so, one must also consider the leading process depending on the functional level of the section of the urban road network [2]. When considering the primary network, the planning and design of urban road network will, due to the role of this network in the city's transport system, ensure the connection of individual units within the city area. On the other hand, urban planning and design dominates the secondary urban road network when the process is aligned with the requirements of local service of space and activities.

4. MAIN CHARACTERISTICS OF SETTLEMENTS IN THE WESTERN BALKANS

The intense demographic changes that the population of the Western Balkans began to go through in the second half of the 20th century manifested their greatest effect at the end of the last century and the beginning of this century. The process of demographic transition, which the population of the Western Balkans has been undergoing in recent decades, has taken place simultaneously and interacted with the process of urbanization.

Uncontrolled migration has particularly stimulated the intensified demographic and spatial expansion of urban and peri-urban zones (the process of unplanned and unorganized suburbanization) of cities, which has largely caused unplanned and informal construction. Such construction most often took place in an unclear urban matrix with insufficient and/or incomplete capacities of traffic and communal infrastructure, as well as other pronounced conflict phenomena that impede quality living and working conditions of the population.

The process of urbanization of the Western Balkans shows inconsistent characteristics [3]. Focal points of the development are larger urban settlements, dominated by larger centers (national, regional, and sub-regional). They exert influence and transform the environment by the power of their functions, and urbanized and deagrared zones are created around them. These are peri-urban rings - gravitational regions that form around stronger functional centers. The expansion of urban spatial-functional systems of cities was also followed by a change in the structure of population activity in settlements located not far from urban centers, which eventually merged with them and were subsequently administratively annexed to them. In this way, the urban tissue of all major cities (Banja Luka, Belgrade, Mostar, Niš, Novi Sad, Podgorica, Sarajevo, Skopje, Tetovo, Tirana, Tuzla, Zenica, etc.) was expanded, which by developing industrial zones, locating commercial objects, building residential areas, and increasing the capacity of infrastructure facilities and the supra-structural system were transforming the surrounding rural settlements.

The supply of traffic infrastructure, i.e. the road network in urban areas, is generally inherited and occasionally adapted to the growing demands. Some major links (primary urban roads), usually in large urban settlements have been developed and/or modernized in the last fifty years. The availability and capacity of access streets in the older urban areas remained largely unchanged. New urban settlements built according to the plans are exceptions where the primary traffic infrastructure is planned and designed according to modern principles of adaptation to the size and function of a particular settlement, i.e. urban area, but it often happens that the secondary network (access streets and parking) is missing or remains extremely deficient.

The lack of parking space for individual vehicles in large urban areas is especially visible. As a result, urban roads are often adapted to the increasing demands of stationary traffic by taking away space dedicated for regular traffic flow, even in primary urban roads with mobility function rather than access function. On-street parking is dominant, while organized surface parking lots and multi-story garages (underground or above ground) exist only in urban cores and plan-built parts of larger urban settlements/cities (although not sufficient). Smaller urban settlements, on the other hand, very

often do not have any capacity for stationary traffic other than space within private estates, and the vehicles are mostly parked on the part of the carriageway intended for moving vehicles (even on intercity and rural roads passing through those settlements) creating traffic jams and significantly affecting safety.

5. CASE STUDY: ISTOČNO NOVO SARAJEVO

The Block 1 residential complex is located in Istočno Novo Sarajevo and is bounded by Dečanska street and streets 5.1 and 4.1 (names defined in the design documentation of the municipality of Istočno Novo Sarajevo). Dečanska street is a primary urban road whose cross section is composed of two traffic lanes, as well as bicycle and pedestrian paths separated from motorized traffic by a green belt. Streets 4.1 and 5.1 are secondary urban roads with a similar cross section as Dečanska Street, without established bicycle paths, but with a reserved area for them. In Figure 1, it is possible to observe the appearance of the block (red line) before occupation, i.e. the preparation of the planning document and the very beginning of construction through two stages - 2015 and 2019 - with noticeable changes of the surrounding in a relatively short period of time.



Figure 1. Residential settlement Block 1 in Istočno Novo Sarajevo before planning and construction [Google Earth]

The total area of Block 1 is 34,417 m², of which 7,332 m² is intended for the construction of buildings up to P+6+Pe. The analysis of the existing regulation plan (Figure 2) revealed certain shortcomings, primarily in terms of traffic connections, both for motorized traffic, and for pedestrian and cyclist traffic. Namely, the residential area is quite closed, with two traffic connections to Street 5.1 that

supply eight dead ends within the block with parking lots. All internal roads are 6 m wide, with longitudinal parking, while parking lots with a perpendicular scheme are planned between the residential buildings. In this way, 481 parking spaces are planned on an area of 11,945 m² of roads with parking lots. Pedestrian paths, 1.50, 2.00 or 3.00 m wide, occupy 3,347 m². The total length of the pedestrian paths is 1,439 m. A block park is not planned, and the green areas are composed in such a way that they only fulfill the form of existence, and not the essence of improving the residential environment. Bicycle traffic is not treated at all inside the block, although it is made possible by the existence of bicycle paths in the peripheral streets.

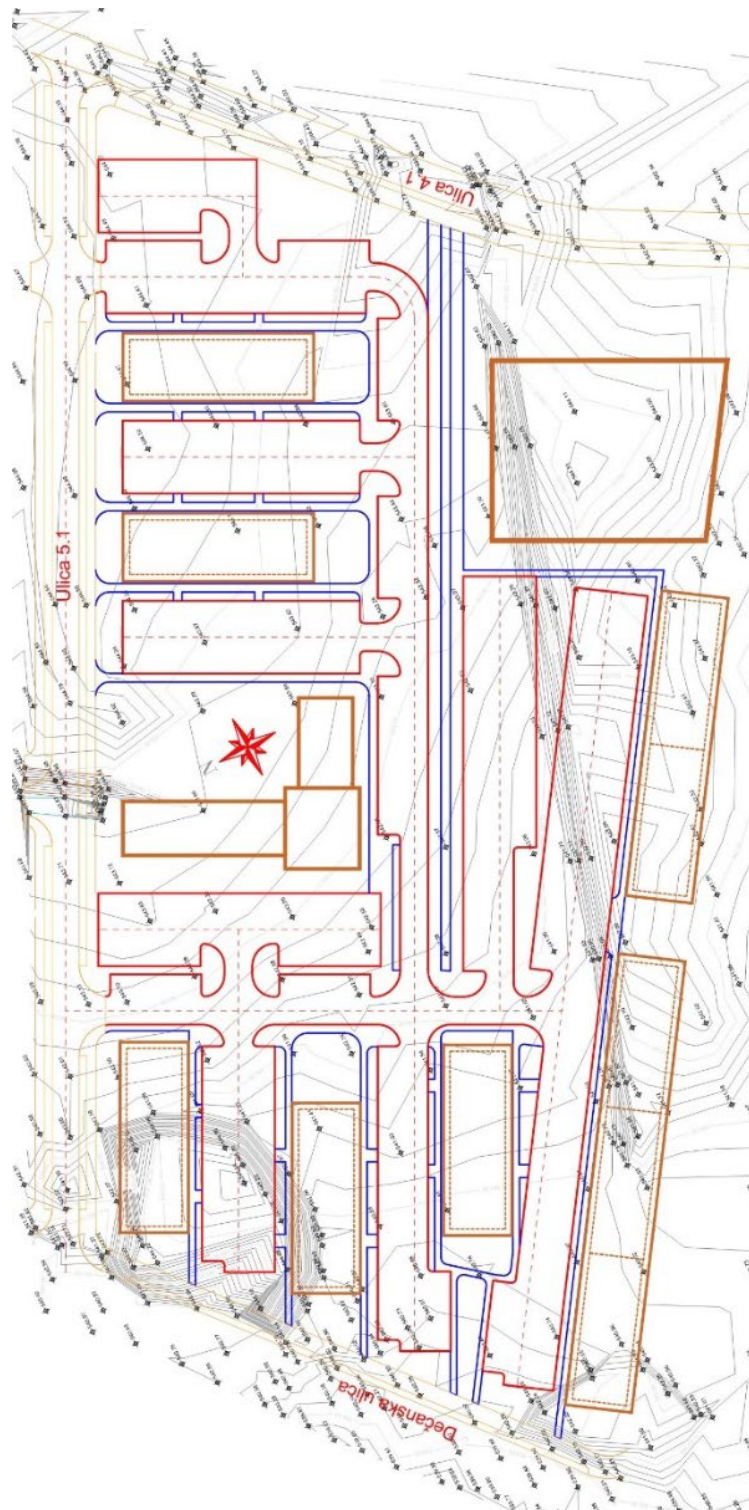


Figure 2. Excerpt from the regulation plan of Block 1 [4]

In the event of possible traffic congestion on Street 5.1, the residential area becomes absolutely non-functional for motor vehicle traffic, thereby jeopardizing the safety and functionality of the space for all users, primarily residents and users of planned business facilities. Additionally, internal congestion will easily transfer to Street 5.1. In relation to the identified shortcomings, and the requirements of regulations, standards for planning and designing stationary traffic, as well as program conditions and spatial possibilities, it was observed that traffic facilities within the residential area must and can be reorganized.

5.2. PROPOSAL OF SOLUTION

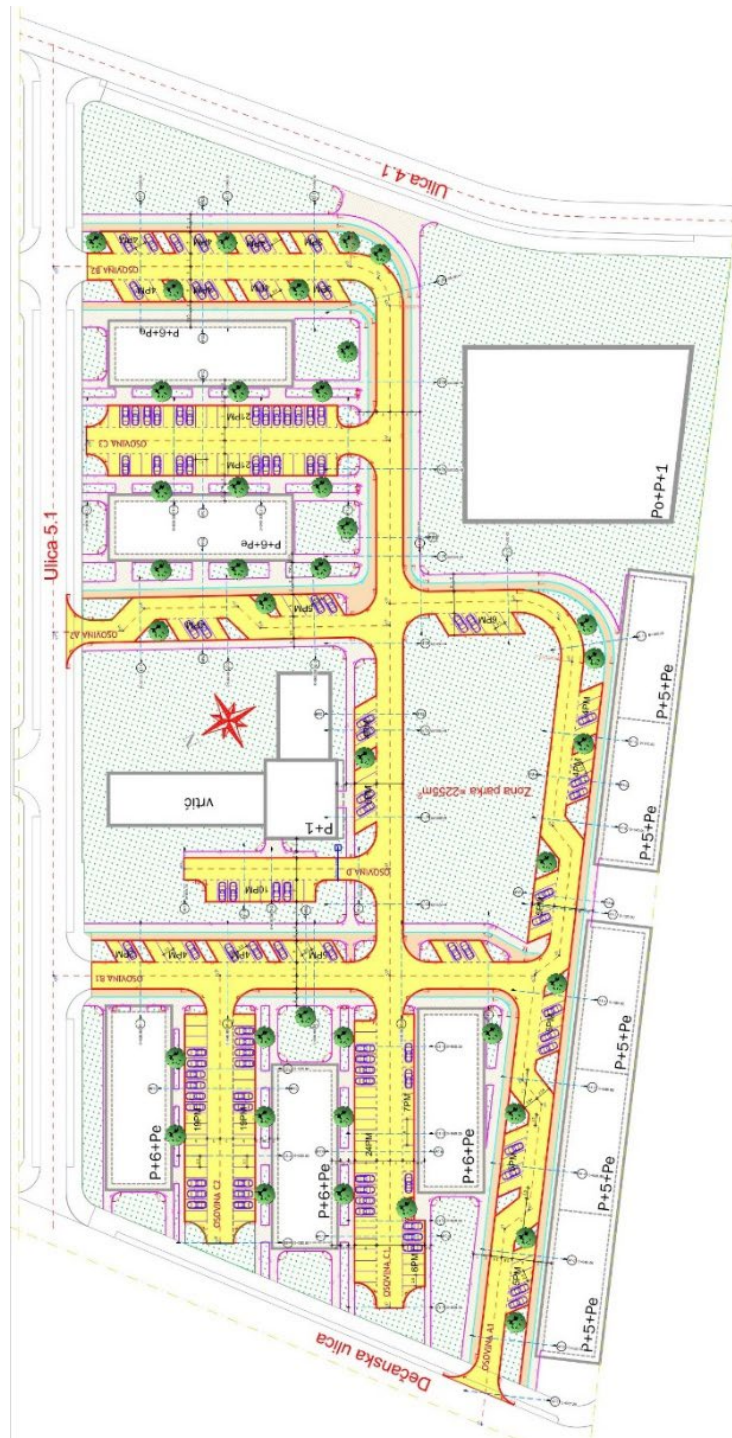


Figure 3. Layout of traffic facilities in Block 1 according to the proposed solution [5]

By creating a solution proposal [5], certain deficiencies identified in the regulation plan (Figure 3) were eliminated. In addition to the two planned access streets for the residential block, two more were designed, opening the block to the west (toward Dečanska Street) and the north (connection to Street 5.1). The connection to Dečanska Street increases the accessibility of the contents inside Block 1 for utility and commercial vehicles, as well as for end users, which reduces the load on the planned streets from the regulation plan. To avoid the use of these streets for through traffic, they are designed in such a way that traffic lanes and parking areas are alternated in the cross section of the streets, which forces motorists to drive more cautiously and calmly. Also, all parking spaces within the streets connected to the peripheral streets are designed at an angle in relation to the axis of the street, which ensures simpler and faster maneuvering when entering and exiting the parking space. Designed streets fit into the leveling of the existing streets and do not require additional work. Along all the streets that connect to the peripheral streets, 2 m wide bicycle paths have been designed, with a total length of 818 m, which brings this type of movement closer to users, encourages active mobility and creates the potential for reducing air pollution from motor traffic. In the central zone of the residential area, near the kindergarten, an area of 2,255 m² has been reserved for a block park, and white ash trees are planned to be planted along all streets. Thus, the residential area becomes enriched with green areas and rows of trees and completes the pleasant ambience of the residential block.

Table 2 provides an overview of the areas within Block 1 and a comparison with the planned areas from the regulation plan. As can be seen, the areas for the movement of pedestrians and cyclists, as well as the green areas, have been increased at the expense of the reduction of the areas intended for the movement and rest of motor vehicles. The total length of the footpaths has been increased by about 400 m, and conditions have been created for the development of bicycle traffic, unlike the solution adopted through the regulation plan, as already emphasized. By deviating from the regulation plan, the number of parking spaces on the surface parking lots along the streets in the settlement has been reduced (219 spaces). Therefore, it is necessary to carry out a correction of the number of floors in buildings to add basement (and/or ground) floors that would serve as garages for users of residential buildings, whereby such garages would be included in the mandatory equipment of the apartment, and not sold commercially on the market. Adding floors is not the only solution, bearing in mind that some of the lower floors can be converted into garages or, for instance, the purpose of the entire residential building might be changed into a parking garage (an unprofitable solution in the short term from the investor's point of view, but with a greater potential to create a more humane environment that would be less burdened by motor traffic and population density).

Table 1. Overview of areas within Block 1 [4]

Functional area	Regulation plan		Preliminary design	
	area [m ²]	share [%]	area [m ²]	share [%]
Structures	7,332	24.2	7,332	24.2
Motorized traffic facilities	11,954	39.5	8,230	27.2
Pedestrian paths	3,347	11.1	4,125	13.6
Bicycle paths	0	0	1,483	5
Green areas	7,610	26.2	9,073	30
Total	30,243	100	30,243	100

It is quite clear that with such a proposed solution, the arrangement of the block in relation to the planning document would be abandoned. However, the fact is that the internal arrangement of the block has been improved and the space is closer to the users. Also, as in all cities that put the well-being of the residents first, the movement of motor vehicles along the roads is calmed down, and stationary traffic is removed from the surface. The forgotten practice of equipping residential and commercial buildings with internal parking spaces can be returned to the domain of planning and designing secondary urban roads, without the need to satisfy investors by reducing obligations and endlessly increasing the amount of commercial square footage (regardless of whether it is residential or commercial space). On the contrary, investors must commit themselves to providing useful residential and/or business space and the appropriate amount of parking spaces for users, and not to transfer the entire arrangement practically to the public sector and municipal budgets.

5.3. THE CURRENT ARRANGEMENT

Figure 4 shows the current state of arrangement of Block 1, which largely followed the adopted regulation plan. However, it is also noticeable that there was a deviation from the same since one new building was built in relation to the ones defined in the plan, while the shape of the other one was changed. Since only a small part of the traffic facilities have been built, there is still the possibility of correcting them and adapting them to the proposed solution. This certainly requires a change in the regulation plan, but much more important is the desire and willingness at the competent services. However, it seems that the opportunity to provide parking spaces within the buildings has been lost. As in most cases in the last thirty years, the quick profit of housing investors prevailed.



(August 2022)

Figure 4. Residential settlement Block 1 in East Novi Sarajevo in its current condition [Google Earth]

6. CONCLUSION

Thoughtful use of space and thoughtfulness of transport systems are not only a matter of infrastructure and organization, technique and technology, zones and plots, capacities, and resources. Thoughtfulness rests above all on one important activity - planning. Planning is an activity that equally involves creativity and engineering knowledge. Planning is equally an empirical and research process. Many previous experiences can be incorporated into future quality elements. But that is not enough. Planning requires a systematic approach, collection of numerous data, research work, testing of hypotheses, development of solutions.

Planning and designing the traffic infrastructure in cities is a very complex task that comprises of different levels, starting from the planning considerations of urban development, as a whole, to the separate technical solutions of the individual elements of the traffic structure.

City streets should be shaped in accordance with the cultural environment and the way of life of the specific city. Their design must provide a response to a number of important limiting factors and required services. Streets should be made more efficient not only by means of expansion, but also by positioning of individual elements - maximum utilization to obtain maximum performance during operation.

This paper observes a whole complex within the urban tissue that should provide the highest standards for the development and life of people, as well as for a better business environment. Wide streets with sufficient capacity for pedestrian and bicycle traffic, as well as for parking of vehicles (garage facilities supported by surface parking facilities), are something to strive for in the development of new urban settlements. In addition to fulfilling the requirements of motor traffic, new settlements must also provide conditions for sustainable forms of urban mobility, while taking the uncompromised approach in respect to the unlimited hunger for commercialization and profit.

LITERATURE

- [1] *Pathways to Urban Sustainability: Challenges and Opportunities for the United States*, Washington, D.C.: National Academies of Sciences, Engineering, and Medicine, 2016.
- [2] M. Maletin, *Planiranje i projektovanje saobraćajnica u gradovima*, Belgrade: Orion art, 2019.
- [3] I. Jokanović, M. Maksin and V. Ristić, “Saobraćaj i saobraćajna infrastruktura kao elementi strategije urbanog razvoja” in Proc. 10th Bosnia and Herzegovina Congress on Transport Infrastructure and Transport, Sarajevo, 2019, electronic proceedings, pp. 93-104, Book of Abstracts, pp. 18.
- [4] *Regulacioni plan „Centar 1“ opštine Istočno Novo Sarajevo*, 2013.
- [5] Z. Spajić, *Idejno rešenje sekundarne ulične mreže stambenog naselja u Istočnom Sarajevu*, graduation work at bachelor studies, Faculty of Civil Engineering, University of Novi Sad, Subotica, 2022.