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CORRELATION BETWEEN LAND USE AND URBAN PUBLIC TRANSPORT: CASE STUDY OF ZAGREB

ABSTRACT

Investment in the transport system with the aim of fostering attractiveness and land use in urban structures is of great interest for planners and investors. Investment in urban public transport would especially contribute to revitalising distinct city areas. The samples of high population density and diversified area use are organised around accessible means of urban public transport.

The main objective of this case study was to find an adequate model for the solution of urban public transport on the location Novi Jelkovec in Zagreb after the construction of a new urban settlement, with the aim to revitalise the peripheral parts of the city.

The theoretical assumption on the influence of better organised transport on land use is hereby researched through the example of correction of timetables and reduction of travelling time between nodes on the line in the Novi Jelkovec settlement. In preparing this paper the following methods were used: analysis and synthesis, mathematical and statistical methods, methods of interviewing. The theory of correlation of land use and urban public transport is based on models that develop the "compact city".

The obtained research results confirm the significance of the correlation between urban land use and urban public transport. It can be concluded that this paper proves the influence of the correlation between land use and urban public transport on the concrete example of Novi Jelkovec. Its implementation could result in solving the concrete traffic problem and along with it a faster urbanisation of the new settlement.

KEY WORDS

urban public transport; timetable; accessibility context; land value; area attractiveness;

1. INTRODUCTION

The traffic system has a significant influence on stimulating urban space growth. The evolution of urban form is related to transport technology. Means of transportation and services have a great impact on land use.

The investment in urban public transport results in the revitalization of the core parts of the city, increased access to market of qualified labour and residential construction on cheaper land in more remote areas [1]. In developed countries, the investment into urban public transport advocates for the construction of a "compact city" with high density of variously used land with facilities located around the available means of urban public transport [2].

Investing in the transport system, with the aim to foster attractiveness and urban land use, is of great interest of the planners and investors. Investing in urban public transport would especially contribute to the revitalisation of distinct areas of the city. Samples of high population density and diversified usage of surfaces are organised around the accessible means of urban public transport.

The case study shows the research of the correlation between investments into urban public transport and land use. The main objective of this study is to find an adequate model for the solution of urban public transport on the location Novi Jelkovec in Zagreb after the construction of a new urban settlement, with the purpose of revitalising the peripheral parts of the city. The theoretical assumption is that better organised transport influences land use in the context of accessi-

bility. Solving the researched problem in this paper will be based on the example of correcting the timetable and reduction of travelling time between nodes on the line in the settlement of Novi Jelkovec.

Two dimensions are relevant for studying of the correlation between land use and transport: *context* and *dynamics*.

Context requires for samples of land use to be distinguished from the growth, i.e. that commercial development can appear in the form of an office building with a garden or in the form of a skyscraper. The investment location in transport is important, since potential rate of land use change is far lower in the developed areas than in the undeveloped ones [3].

The land use system is *dynamic* and represents the totality of relations of transport, accessibility, land use and sample of activity over a longer period of time.

2. THEORETICAL BASIS OF THE CORRELATION BETWEEN LAND USE PLANNING AND URBAN PUBLIC TRANSPORT

The theory of land use, in interaction with urban public transport tends to explain the effect of transport costs on the selection of residential locations. The accessibility is implicit in this theory, since the value of location is reflected through land price [4]. A unique solution is planned in which the total costs are minimized. The models that are based on this theory are generally statistical models of partial equilibrium. They are static since time has not been included, and the solution of the equilibrium is momentary [5].

The models of land use and transport are mainly models of partial equilibrium, with a subset kept constant. For instance, the standard theory of the selection of residential location treats the employment location constant even in the city centre [6].

The theory of location is usually focused on one part of the usage of residential land and transportation means (railway, bus, car).They are individually incomplete since they describe location determinants, and they were created in order to explain the basic structure of the cities, i.e. the land value and the samples of population density [7].

The selection of the settlement construction is expressed as a problem of maximisation of utilization in which the selection depends on the land value, costs of commuting, and costs of other facilities. The standard theory is based on the simplified assumptions [8].With the usual assumptions of rational behaviour, identical preferences, timely information the following assumptions have been made taking into consideration the simplest version of the theory:

- The total volume of employment is constant and located in the city centre;
- Every household has one employed member and only travelling to work is taken into consideration;
- Housing is the function of capital and land, and therefore the location and size of space are different factors;
- The unit transport cost includes the time and monetary costs, thus being constant and unique in all directions [9].

The theory of residential location results in the urban form with the highest population density and the highest land value in the Zagreb city centre, and the gradients on the example of the settlement Novi Jelkovec (in the City of Zagreb) with this population density and the land value will fall with increase in the distance from the city centre.

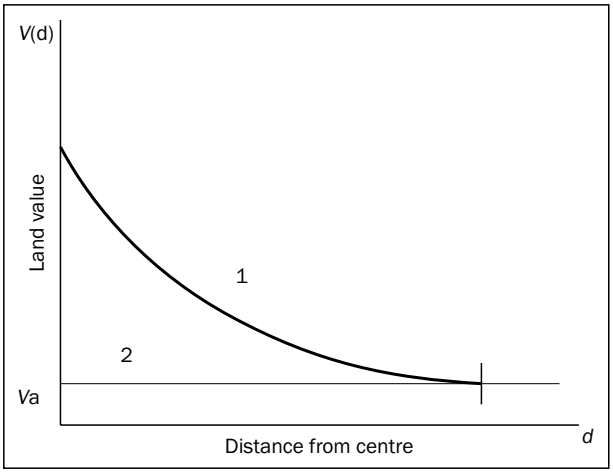

Figure 1 – Relation between the land value and location [10]

Figure 1 shows the curve of land value per land unit as a function of the distance from the city centre. According to the standard theory the curve of land value (Line no.1) is non-linear and falls constantly in absolute value with the distance from the city centre. Land value which is not urban, may be assumed to be constant, noting that it has different attributes regarding the differences in attractiveness (Line no.2).

The offer of available land in urban areas affects the theoretical expectations regarding its use for urban public transportation since it is reduced to the level at which the city administration can control and regulate the land market.

Land use is regulated by the jurisdiction of the local and regional self-government. The city administrations can have influence on the land use through restrictions and requests regarding the development and supply of infrastructure and services that contribute to the positive tax basis. The use which burdens the public cost should be discouraged [13].

Modernization and expansion of urban public transport services are justified means for the reduction of the use of passenger cars, air pollution, preservation

of energy and revitalization of the city centre. Better urban public transport would improve the accessibility of the city centre and stop the uncontrolled development of the cities. The potential investment means into the urban public transport are substantial which is justified since it contributes to better quality of air, energy effectiveness and more compact urban form.

The urban rail transport systems generate changes on land use only in the close vicinity of the railway line. The construction of this system would improve the accessibility along the railway line corridor and increase the land value. Modernization of urban public transport reduces the transportation costs, the passengers prefer to use some of the reduced costs in order to use more trips [14].

The Bay Area Rapid Transit (BART) uses new technological elements such as the automated system of fares and computerized train control and has found its implementation in some US cities. This system is considered to have low impact on land use and the urban development of the cities. The distance between the stops on the line is about 1.5 km which has resulted in an improvement of the travelling time in relation to passenger cars.

The city administrations can stimulate the preservation of suburban and rural parts of the country or cities and protect the ecological values. This can be achieved by political instruments such as taxes, growth restrictions, population density restrictions, land allocation and infrastructure requirements. On the other side, the range of the land development has increased over time. The planned residential construction on the example of the settlement Novi Jelkovec has resulted in poor accessibility of this area. Therefore it is necessary to make the decisions on transport and land use simultaneously.

3. THE CONTEXT OF ACCESSIBILITY – CASE STUDY OF ZAGREB – SETTLEMENT NOVI JELKOVEC

The context of accessibility in the wider sense refers to the ease of movement within the observed area, structure and capacity of the transport network including the concept of attractiveness of the origins and destinations. The ratio of investments in relation to the current system is also important because when one area is constructed, usually the changes in land use are secondary since the majority of buildings last for fifty or more years. The reconstruction costs in the built-up areas are usually high and often politically problematic [15].

A typical example of the context of accessibility in the City of Zagreb is the newly constructed settlement Novi Jelkovec with about 53 residential-commercial facilities and about 2,700 citizens, which is the base for the respective research. This is a unique project in Croatia since on an area of 39.47 ha a “compact city” has been constructed, planned with all the accompanying facilities and structures necessary for housing (*Figure 2*).

Regarding the transportation means, the traffic connection of the settlement Novi Jelkovec with the city centre is diverse. Regarding car transport, the settlement is very well connected since it is located about 200 m from the newly constructed intersection of Slavonska Avenue and the Street of Ljudevit Posavski near the motorway bypass (Ivanja Reka interchange – motorway towards Varaždin, Slavonski Brod and Lučko). A special problem lies in the poor traffic connection of the settlement Novi Jelkovec by urban public transport with the centre of the city which does not meet the requirements. It is precisely the poor infrastructure of the urban public transport that resulted in poor utilisation of the residential area which is about 60 percent.

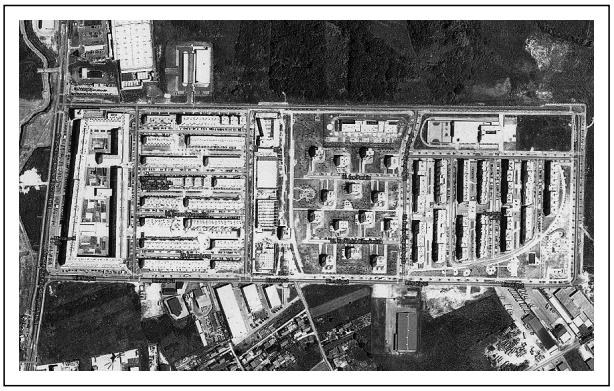

Figure 2 – Local network of the settlement Novi Jelkovec

Generally, the structure and capacity of the transportation network affect the accessibility level within the given area, i.e. travelling is usually done with the aim of engaging in some other activity such as work or shopping. Before the very usage of land with the aim of constructing the residential settlement it is necessary to study and offer traffic solutions both by passenger cars and the vehicles of urban public transport.

Figure 3 shows the shortest way by passenger car between the settlement Novi Jelkovec – Sesvete (railway station) in the length of 3.1 km with the drive taking 4 minutes (line 1) and the pedestrian path which is 2.2 km and takes 27 minutes (line 2). The air-line distance is 1.36 km (line 3).

The correlation between the urban space and public transport has been analysed from the aspect of the bus line timetable. Potential improvements have been noted. By shortening the bus sequence from 30 minutes to 15 minutes the waiting time would be shortened which would improve the quality of urban public transport service. For the citizens of the settlement Novi Jelkovec the travelling time from the place of living to the desired destination would be shortened.

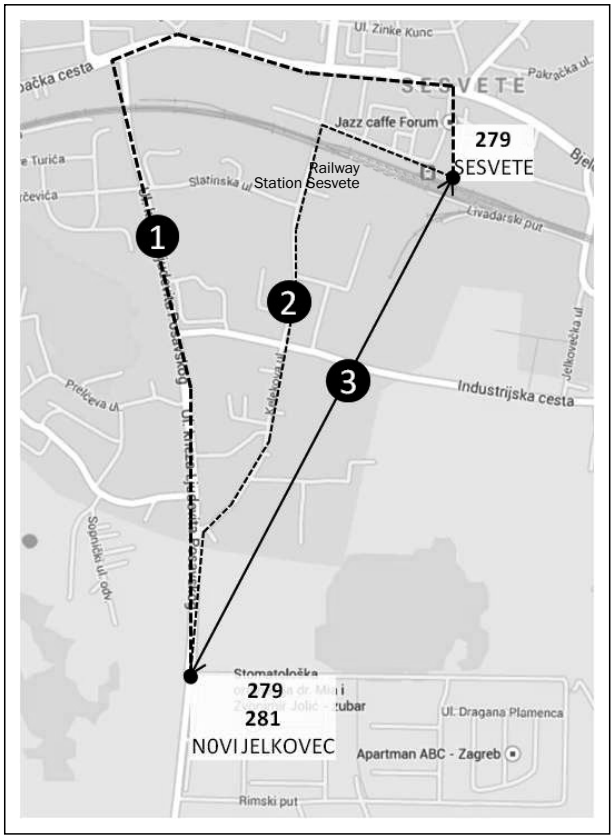

Figure 3 –Route Novi Jelkovec – Sesvete (railway station)

Figure 4 shows the route of line 279 Dubec–Sesvete – Novi Jelkovec and the route of new line 281 Novi Jelkovec – Žitnjak.

Further improvements of public urban services are possible by increasing the accessibility between the nodes on the bus lines route.

Each node represents a possible origin/destination, and the numbers near each connection represent the travelling time (*Figure 5*). The comparison of networks shows that the network improvement not only improves the accessibility between nodes Novi Jelkovec – Sesvete and Novi Jelkovec – Dubec, but also results in advantages for the entire network. By higher traffic accessibility, there is more interaction, since more flats will be used and a greater number of activities will be located into Novi Jelkovec.

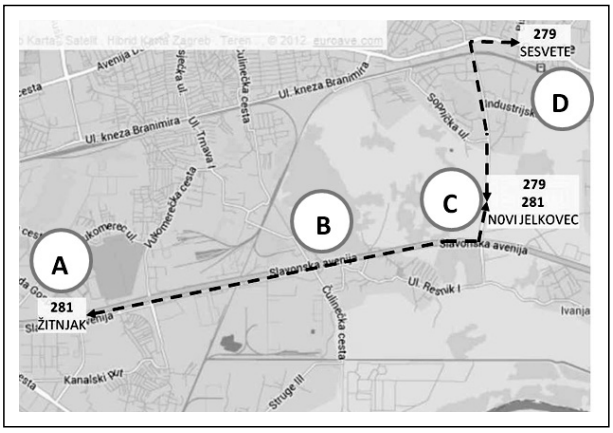

Figure 4 – Bus lines route

Each node represents the possible origin/destination, and the numbers near each connection represent the travelling time. By shortening the travel time by half between nodes B and C an improvement on network P has been achieved. The network accessibility can be calculated by calculating the travel time from each node to each other node (*Table 1*). Each row in the matrix corresponds to times of travelling from one to every other node. The sums of rows represent the accessibility measure for every node. Smaller numbers mean greater accessibility. By comparing the sums of rows of two networks the advantages for the entire network are obtained [4].

In this example, nodes A, B and C profit because of these improvements and it may be expected that there will be greater changes in land use in these nodes. As the number of citizens and employment are growing, their relative location will be affected by the organization of the transport system.

The costs of daily commuting include the travelling time and costs of fuel price or public transport fare. The reduction of travelling time has higher influence on the population with higher income, since the time value is the function of income [12].

Figure 6 shows the relation between the land use and the location of residence. Curve 1 is the gradient of land value prior to transportation improvement, and curve 2 shows the gradient of land value after transportation improvement.

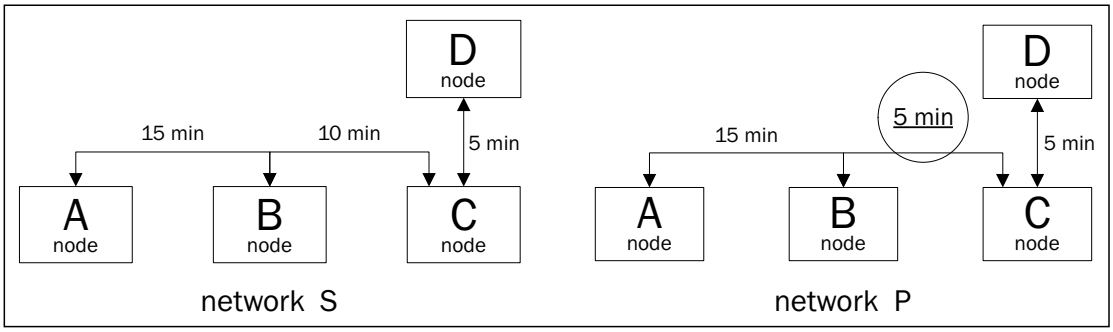

Figure 5 – Accessibility in the network by introducing the new line B - C

Table 1 – Accessibility matrix of travelling time for traffic network Novi Jelkovec – Centre

NETWORK S						NETWORK P						changes (in %)
from/to	A	B	C	D	∑	from/to	A	B	C	D	∑	
A	0	15	25	30	70	A	0	15	20	25	60	-14.3
B	15	0	10	15	40	B	15	0	5	10	30	-25.0
C	25	10	0	5	40	C	20	5	0	5	30	-25.0
D	30	15	5	0	50	D	25	10	5	0	40	-20.0

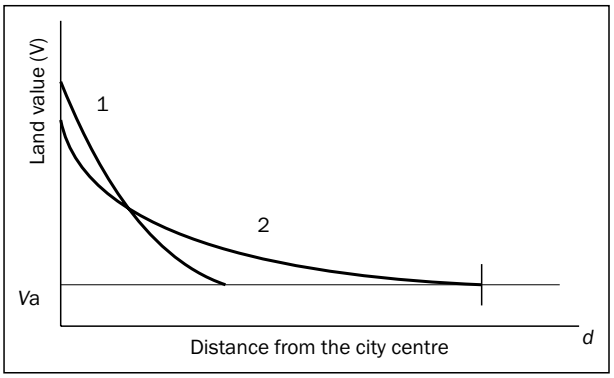

Figure 6 – Correlation between the land value and location in the function of urban public transport development

4. DISCUSSION

The analysis undertaken for the purpose of this study, supported by empirical evidence, imposes that population density declines with the distance from the city centre, and the studies of time sequences prove that housing density declines together with the improvement of the transport system. By fostering the urbanisation of the border areas of the city, attempt was made to raise the quality of housing in the new settlement Novi Jelkovec, all with the aim of raising the quality of life of young people and socially sensitive groups including all other citizens of Zagreb travelling on that relation. Given the significant correlation between the duration of the travel to the city for work and the contribution to the quality of life, the improvement in the urban transport model for connecting Novi Jelkovec with the City of Zagreb, this paper tries to present the adequate model for revitalising the settlement which subsequently contributes to the wider development of the city of Zagreb.

The unit housing cost has to fall proportionally to distance from the city centre, since the transportation costs grow with the distance through daily commuting. The theory forecasts samples of daily commuting since the average length of everyday commuting corresponds to the average distance of the total population from the centre [5].

The best location for a household is the point in which the savings of a household correspond to the transportation cost. Consequently, the households with lower income would use less residential space and would be located nearer to the city centre, and households with higher income would use more residential space and would be located further from the city centre.

The fall of transportation costs reduces the land value in the city centre. The citizens use the benefit of reduced travelling costs travelling daily over greater distances. As result, the total volume of used land increases, and the city borders expand. The standard theory understands the following: if the transport cost is increased, the effect is opposite – with the intention of reducing the travelling costs, the population will move to the centre of the city into a smaller residential area, as confirmed by the empirical evidence.

If one assumes that the transportation improvement by the construction of the railway system increases the price of urban transport and reduces the travelling time, then the increase in fares can neutralize the travelling time value. The advantage of this investment would grow unproportionally with the increase in the number of households with higher income.

5. CONCLUSION

Empirical evidence about the impact of urban public transport on the land use has resulted in the knowledge that the investments in transport have no consistent and foreseeable impact. It shows that land use will result from the investments into transport and that favourable public policy can promote railway development. One can accept the fact that urban public transport plays a crucial role in the land use policy, particularly when the development of new railway systems drastically reduces the costs of everyday commuting.

The example of the settlement Novi Jelkovec has proven that by correcting the timetable the travelling time and costs would be reduced, which would result in better utilisation of the residential area.

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SAŽETAK

MEĐUSOBNA POVEZANOST KORIŠTENJA URBANOG PROSTORA I JAVNOG GRADSKOG PRIJEVOZA: STUDIJA SLUČAJA - ZAGREB

Cilj ovog rada bio je pronaći adekvatan model rješenja javnog urbanog prometa na lokaciji Novi Jelkovec u Zagrebu nakon izgradnje novog urbanog naselja, u svrhu revitalizacije perifernih dijelova grada.

Ulaganje u prijevozni sustav s ciljem poticanja atraktivnosti i korištenja zemljišta u urbanim strukturama, od velikog je interesa za planere i investitore. Posebna ulaganja u javni gradski prijevoz pridonijela bi revitalizaciji pojedinih područja grada. Uzorci velike gustoće naseljenosti i raznolikog korištenja površina, organizirani su oko dostupnih sredstava javnog gradskog prijevoza. Teorijska pretpostavka utjecaja bolje organizacije prijevoza na korištenje zemljišta u kontekstu dostupnosti, istraživana je na primjeru korekcije voznog reda i smanjivanjem vremena putovanja između čvorova na liniji u naselju Novi Jelkovec. Pri izradi ovog rada korištene su metode analize i sinteze, matematičke i statističke metode te metode intervjuiranja. Teorija korelacije korištenja zemljišta i javnog gradskog prijevoza bazira se na modelima koji razvijaju ''kompaktni grad''.

Dobiveni rezultati istraživanja potvrđuju značaj korelacije korištenja urbanog prostora i javnog gradskog prijevoza. Logično je zaključiti kako je ovim radom dokazan utjecaj korelacije korištenja zemljišta i javnog gradskog prijevoza na konkretnom modelu Novi Jelkovec, a čija implementacija bi mogla rezultirati rješavanjem konkretnog prometnog problema, a time i bržom urbanizacijom novog naselja.

KLJUČNE RIJEČI

javni gradski prijevoz; vozni red; kontekst dostupnosti; vrijednosti zemljišta; atraktivnost područja;

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