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LAND-USE AND TRANSPORT INTEGRATED PLANNING AND MODELLING IN CLUJ-NAPOCA, ROMANIA

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Abstract. The paper presents an example of successful reconversion of an industrial site located in the built-in area of Cluj-Napoca, Romania. This case study shows that land-use and transport integrated planning can be effectively implemented when a transport-oriented development (TOD) is designed for the redevelopment of an industrial site. Using TOD principles identified in the Romanian law and the technical criteria identified in the scientific literature, Sanex platform is analyzed to demonstrate it is a TOD. This would be the first documented TOD designed in Romania. A model is developed for TOD Sanex to estimate the impact that the redevelopment of the industrial platform into a multifunctional area will have on the local traffic. In this regard, two scenarios are analyzed – present scenario and future scenario after completion of the redevelopment. Two variants of the future scenario are discussed in connection to the Northern Mobility Corridor (CMN), the main project in implementation in the area, which is designed as a complete street. The results demonstrate that the induced traffic wouldn't have a considerable impact on the local traffic now or in the perspective of the redevelopment. It can be integrated by the street network, which could operate in appropriate conditions. Considering the need of revitalization of the urban and rural industrial sites at the national scale in Romania and the benefits of TOD, a methodological framework in four steps is proposed. This framework would be a helpful support in the sustainable urban reconversion process, especially to achieve the reduced impact over the built environment and urban mobility.

Keywords: *Brown field redevelopment, industrial site revitalization, Sanex platform, transit-oriented development, urban densification.*

Rezumat. Lucrarea prezintă un exemplu de reconversie reușită a unui sit industrial intravilan din Cluj-Napoca, România. Acest studiu de caz arată că planificarea integrată a utilizării terenurilor și a transportului poate fi implementată eficient atunci când o dezvoltare orientată către transport (TOD) este proiectată pentru reamenajarea unui sit industrial. Folosind principiile TOD identificate în legislația română și criteriile tehnice identificate în literatura științifică, platforma Sanex este analizată pentru a demonstra că este un TOD. Acesta ar fi primul TOD documentat, proiectat în România. Este dezvoltat un model pentru TOD Sanex pentru a estima impactul pe care reamenajarea platformei industriale într-o zonă multifuncțională îl va avea asupra traficului local. În acest sens, sunt analizate două scenarii – scenariul prezent și scenariul viitor după finalizarea reamenajării. Două variante ale scenariului viitor sunt discutate în legătură cu Coridorul de Mobilitate de Nord (CMN), principalul proiect în implementare în zonă, care este conceput ca o stradă completă. Rezultatele demonstrează că traficul indus nu ar avea un impact considerabil asupra traficului local, în prezent sau în perspectiva reamenajării. Poate fi integrat prin rețeaua stradală, care ar putea funcționa în condiții adecvate. Având în vedere nevoia de revitalizare a siturilor industriale urbane și rurale la scară națională din România și beneficiile TOD, se propune un cadru metodologic în patru pași. Acest cadru ar fi un sprijin util în procesul de reconversie urbană durabilă, în special pentru a obține un impact redus asupra mediului construit și a mobilității urbane.

Cuvinte cheie: *Reamenajare câmp brun, revitalizare sit industrial, platformă Sanex, dezvoltare orientată spre tranzit, densificare urbană.*

1. Introduction

The redevelopment of brown fields and old industrial sites in Cluj-Napoca represents one of the main goals of the local administration in the densification process of the city to reduce the urban sprawl phenomenon. During the last three decades the city has generated a very important urban sprawl effect in Cluj metropolitan area as documented in previous research [1-13]. The main actors that are addressing the issue of brownfield and industrial sites redevelopment [14-19] are joining their forces in supporting Public-Private-Partnership investments [20-22], to spotlight the opportunities for land reuse and urban regeneration [23-33].

However, land reuse, such as transforming the industrial platforms into multifunctional urban spaces generates additional trips in the transport system, both within the area of the development but also in connection with the city. Using integrated land-use and transport planning tools, such as transport-oriented development (TOD), proves to be a successful means to reduce the growing pressure on the transport system and to integrate additional trips [34].

Planners in different regions are successfully using TOD, considering elements such as physical design, transportation, environment, social, economy, collaborations, and accessibility in their urban regeneration projects [35-37]. TOD planning strategies support sustainable urban growth, based on some common general principles including PT efficiency, land use diversity and density, accessibility, connectivity, and sensitivity to property values [38,39].

The densification of the urban area implemented in neighborhoods surrounding specific transport hubs is at the core of TOD concept, promoting the compact and mixed land use well-integrated with mass transit [40]. The densification of mixed urban activities in the proximity of public transport facilities, between 400 - 800 m, supports two major main benefits. Creating a compact and dense urban form favors the reduction of the trips number and length shortening for the purposes served by the activities of the newly developed area while increasing the desirability of using public transport for out-of-area trips reduces the urge to use private cars [41,42]. In this regard, the location the development within a short walking distance of high-quality transit becomes the most important aspect. The ideal distance is 500 m of actual walking distance (about a 10-minute walk) or less, including all detours, from rapid, frequent, and well-connected public transport service. However, this should not be more than 1,000 m, about a 20-minute walk [43].

According to the Romanian law on sustainable urban mobility [44], a final version which is under debate, TOD is described as "the design and realization of urban spaces to integrate communities, activities, buildings and public space, with the provision of easy connections through walking and cycling, as well as the provision of efficient public transport services to the rest of the city" [44].

The document of the law also defines TOD principles. They include the design of dynamic public spaces, ensuring inclusive mobility, adequate and safe infrastructure for pedestrians and cyclists, as well as of public transport that can compete with the private car, to the densification of activities around public transport stations in a mix that allows access to quality public transport and the reduction of the number of trips, as well as the reduction of travel times through the proximity of workplaces, educational offer near homes[44]. TOD principles are listed in the following section.

The paper aims to demonstrate that the redevelopment of the Sanex platform follows the principles of a TOD, on one hand and to estimate its impact on the local traffic, on the other. The location of the site in proximity to mass-transit and the integrated planning of the platform serve the purpose to best accommodate additional trips and to ease the burden on the transport system. Furthermore, the Public-Private-Partnership investments prove their capabilities to support sustainable urban regeneration.

Section 2 of the paper presents data collection and the methodological framework in four steps. Section 3 of the paper presents the practical results and elaborates the discussion based on the results. Section 4 synthesizes the conclusions.

2. Data collection and methodological framework

TOD characteristics of the Sanex platform are presented and verified based on the principles highlighted in the Romanian law in Figure 1 [44], which considers the needs of all users of the transport system. Spatial analyses are conducted using ArcGIS.

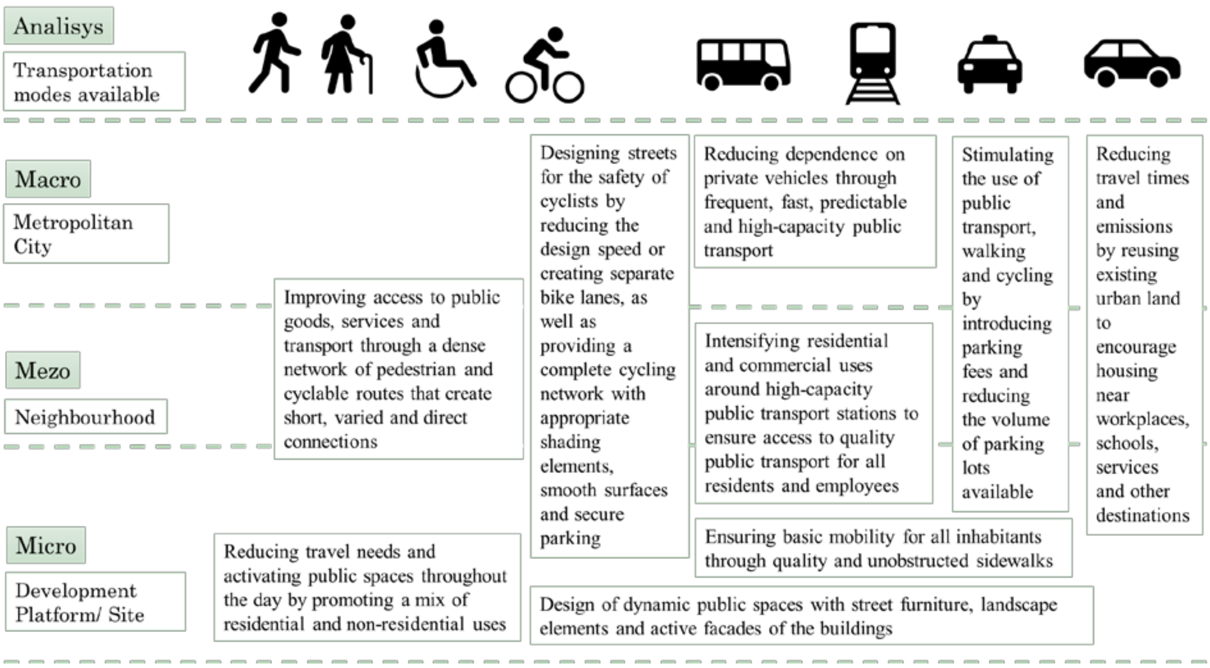


Figure 1. TOD principles according to Romanian law [44].

Furthermore, the impact of Sanex development on the local traffic was estimated following the four steps presented in Figure 2: traffic analysis, trip generation analysis, model development and analysis for the estimation of TOD Sanex impact on the local traffic.

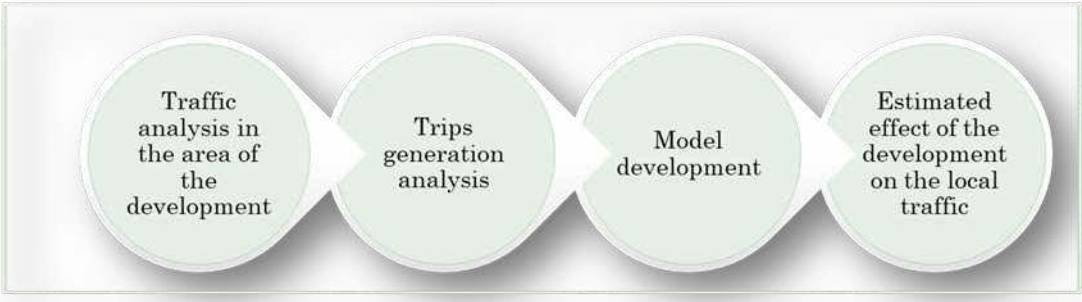


Figure 2. Estimation of the impact of TOD Sanex development on the local traffic.

The analyses are based on extensive traffic measurements conducted in 20 representative intersections and on 13 street links which were established by the municipality, Figure 3. Automatic data collection was conducted during May - June 2022 (05.23.2022 - 06.06.2022), within a period considered representative in the municipality during the school and academic semester.

Traffic flows were determined using video recording with MioVision Scouts and video processing for 12 hours between 7:00-19:00 on each of the 20 intersections. 20 O-D matrices were obtained on each category of vehicles. Traffic data on each link were determined in volumes of passenger car units (PCU).

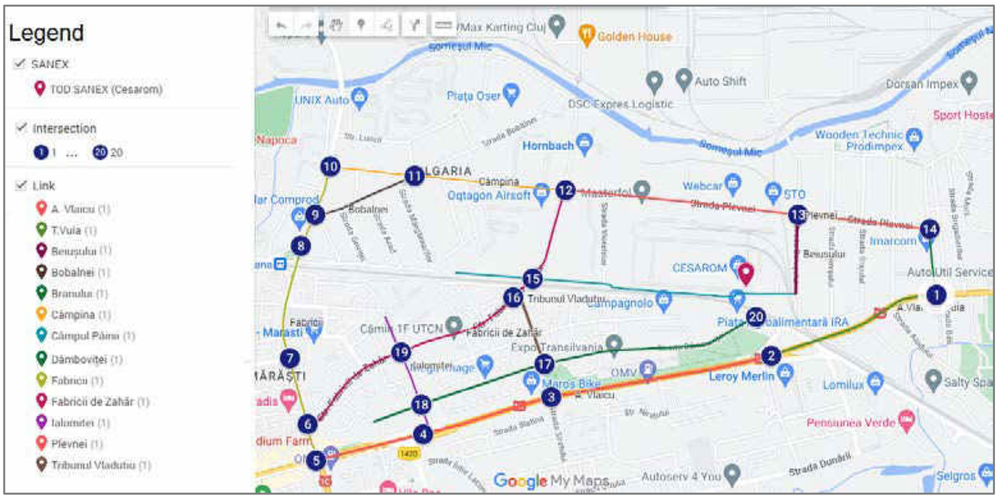


Figure 3. Intersections and links for traffic counting established by the local administration in the proximity of the redevelopment site (Basemap: Google Maps).

Figure 4 presents an example of an analyzed intersection, I13, with the traffic movements (Figure 4a) and traffic flows (Figure 4b).

There is only one access point for the Sanex platform at the moment, through the Intersection 13 (I13) from Plevnei Street, through the streets Beiușului and Câmpul Pâinii.

Arcady/picady was used to evaluate the level of service of each intersection and the delays. Traffic volumes on each link were obtained from O-D matrices. The traffic capacity on each link was evaluated with the aid of the Romanian standard [45]. The volume/capacity ratio (V/C ratio) of the links was used to compare the results obtained for different scenarios.

Both intersections and links were analyzed in two scenarios - the existing situation and the perspective in which the investment would be completed. Two variants of the future scenario are discussed in connection to the Northern Mobility Corridor (CMN), the main project in implementation in the area, which is designed as a four-lane complete street.

a) b)

Figure 4. Intersection I13 movements: a) with the traffic movements; b) with traffic flows.

The traffic analysis in the development area was followed by the trip generation analysis. The calculation of the hourly traffic flows generated / attracted by the new development was based on the ITE Trip Generation Manual [46], 11th Edition.

Peak hour volumes are calculated by multiplying the number of parking lots by the hourly distribution of entering and exiting vehicle trips by land use. On the site there are parking spaces, which generate/attract traffic and which can be found in the traffic counts which were carried out.

The results were used to develop the traffic model for a 12-hour period. It was used for the traffic capacity verification of the links and the intersections, at the peak hour resulting from the model. The last step was to estimate the impact of TOD Sanex development on the local traffic using the attracted/generated traffic in both scenarios and variants.

3. Results and discussion

The reconversion of the Sanex platform was analyzed as a case study of TOD, a land-use transport integrated planning tool. The planning process considered the connection to the transport system as well as the reconversion of the activities on the platform. Therefore, the characteristics of the redevelopment were checked according to TOD principles. Furthermore, the impact of TOD on the local traffic was estimated.

3.1. Sanex platform connections to the transport system

Sanex platform is located north of the railway corridor in Cluj-Napoca. This urban area is in a massive process of redevelopment by restructuring the industrial platforms, into mixed urban areas (residential, shopping/services, business, leisure etc.). A great advantage is that the area is well integrated into the transport system, with good accessibility to the existing facilities of public mass transport in its proximity.

The existing bus stop on Plevnei facilitates two lines 36B, 52 and the IRA hub facilitates 8 bus and trolleybus lines as well as 6 metropolitan lines.

It also has great connection to proposed projects in the area such as the northern mobility corridor (Coridor de Mobilitate CMN in Figure 5), the metropolitan train (Tren metropolitan in Figure 5) and the metro (Metrou in Figure 5) through the intermodal node (Nod intermodal in Figure 5) which will be located at the junction of those major projects, in the future.

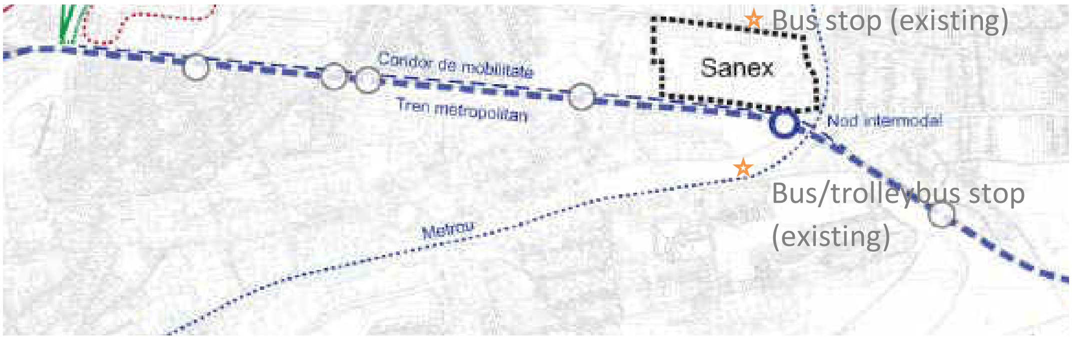


Figure 5. Sanex platform connections to the transport system.
(Source: project manager).

CMN is designed as a complete street from IRA Node to the Railway Station Square on both sides (north and south) of the railway and including it. The implementation of the Sanex project also includes the construction of the first section of CMN, from the western side of the platform to the IRA node which is partially included, and which implies a partial completion of CMN north of the railway (noted as Sanex CMN in Figure 6). This segment is the object of a Public-Private-Partnership investment.

Figure 6. Two variants of the future scenario - Sanex CMN and Complete CMN.

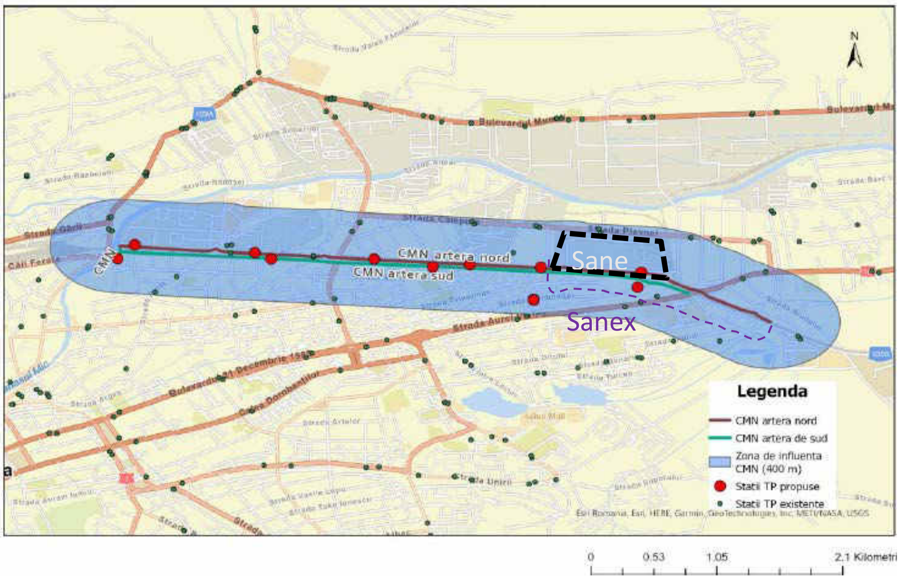


Figure 7. Public transport facilities development in correlation to CMN.

Upon completion of CMN, it will ensure direct auto connection of the platform to the main transport artery of the municipality (East – West), as well as to the CMN Railway Station Square.

Sanex platform is located between two transport arteries. The southbound limit is Câmpul Pâinii Street, which is going to be integrated into CMN, a four-lanes complete street. The northbound limit is Plevnei Street located on a secondary traffic artery of the city. Sanex CMN will provide direct connection to Traian Vuia – Aurel Vlaicu, four-lane streets on the main transport axis of the municipality running from East to West providing a good connectivity in the transport system.

CMN's area of influence of 400 m includes Sanex platform entirely (Figure 7). Sanex platform benefits from the facilities of mass public transport existing in the proximity which are symbolized with the green dots in Figure 7. CMN implementation will ensure increased PT efficiency and accessibility through the proposed public transport facilities symbolized with red dots in Figure 7.

3.2. Sanex platform reconversion activities

The site has a total area of 230.551 sqm of industrial and quasi-industrial activities considered in the urbanistic reconstruction planning (Figure 8).

It is planned to accommodate high density mixed urban functions - collective housing (31% of the built-up area), shopping center (55% of the built-up area), buildings and spaces for offices and services (5% of the built-up area), proximity facilities for servicing the residential area (education, recreation, sports, health, social services, leisure and parking, 9% of the built-up area).

The platform and some adjacent lands are considered in the urban planning process to provide convenient and efficient access to a diverse combination of land uses (Figure 9). Accessibility of TOD Sanex will be improved from one indirect access point on Branului Street to 4 direct access points to the main bordering arteries – two intersections on Plevnei Street and two roundabouts from CMN Sanex, directly connected to the East-West transport axis (Aurel Vlaicu- Traian Vuia).

TOD Sanex will be served by its own network of public spaces (predominantly pedestrian) and green spaces. The new design plan aims to increase the walking and cycling in the area by creating bike lanes and walking spaces along streets running northbound the platform, separated from the general flow. The street running across the platform from West to East is designed as a shared space with occasional car traffic. With the realization of the Intermodal Node (Nod intermodal in Figure 5), the restructuring of the Sanex complex will make possible a new pedestrian corridor between Someș River and the East Park of the municipality, supporting the development of a high-quality urban public space.

The modal share in the proximity of the redevelopment site (Table 1) shows a reduced cycling rate. The implementation of TOD Sanex would help improve this situation.

Table 1

Percentage in the modal share in proximity of the redevelopment site

Street	Bicycles, %	Heavy traffic, %
Aurel Vlaicu	0.1	6.0
Traian Vuia	0.2	4.9
Plevnei	0.7	8.7
Beiușului	1.5	6.0
Câmpul Pâinii	0.1	7.1

Parking places are located in a dedicated building adjacent to the shopping center and office buildings, with great respect for the green areas dedicated to sports and leisure. Some residential parking places are located mainly in the underground of the residential buildings area. The total number of parking places is presented in Table 2.

Table 2

Parking places available on the site

Total number of parking places	5.606
Commercial	2.650
Offices	800
Residential	2.156

New bus lines with several new bus stops would help reduce car dependency, especially in connection to the railways station square which would help visitors to use reliable transit.

Thus, TOD Sanex will concentrate the mixed-use area of high density within a radius of up to 800 m from the mass public transport facilities, respectively 5-10 minutes of walking and will ensure increased pedestrian accessibility by reducing the area of land dedicated to cars. The availability of multiple activities on the platform is a magnet for inner movements, turning into a reduction of trips in connection to the city.

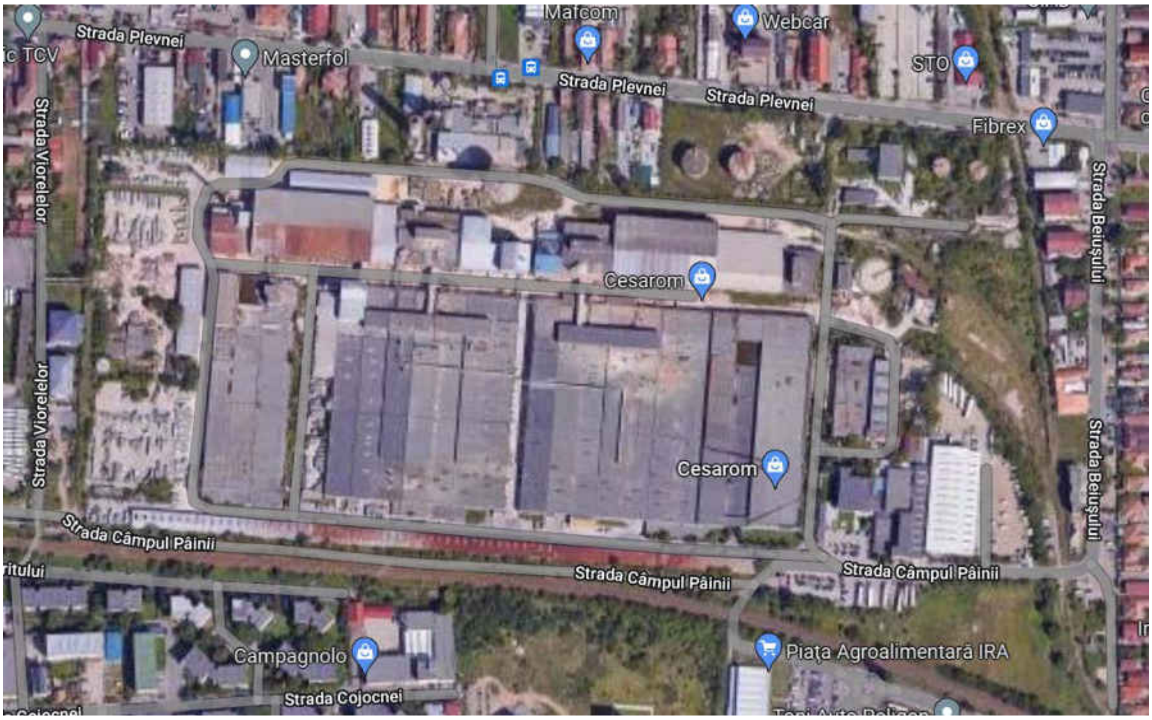


Figure 8. Sanex platform (aerial view, Google maps).

The redevelopment process is planned to embed the needs of all people and users of the transport system [44]:

- Ensuring basic mobility for all inhabitants through quality and unobstructed sidewalks.
- Design of dynamic public spaces with street furniture, landscape elements and active facades of the buildings.

- Designing streets for the safety of cyclists by reducing the design speed or creating separate bike lanes, as well as providing a complete cycling network with appropriate shading elements, smooth surfaces and secure parking.
- Improving access to public goods, services and transport through a dense network of pedestrian and cyclable routes that create short, varied and direct connections.
- Reducing dependence on private vehicles through frequent, fast, predictable and high-capacity public transport.
- Stimulating the use of public transport, walking and cycling by introducing parking fees and reducing the volume of parking lots available.
- Intensifying residential and commercial uses around high-capacity public transport stations to ensure access to quality public transport for all residents and employees.

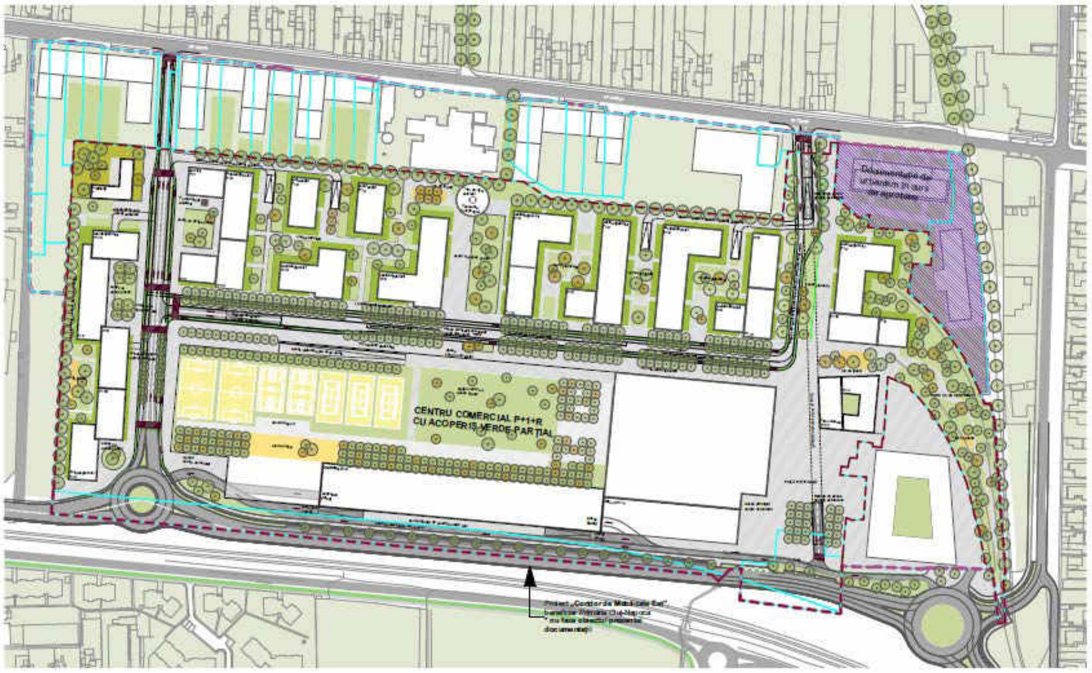


Figure 9. Zonal Plan of SANEX platform restructuration [47].
Source: Planwerk.

- Reducing travel needs and activating public spaces throughout the day by promoting a mix of residential and non-residential uses.
- Reducing travel times and emissions by reusing existing urban land to encourage housing near workplaces, schools, services and other destinations.

Therefore, it is clearly demonstrated that the design of the Sanex industrial site revitalization follows TOD principles stated in the Romanian law. The integrated planning process of the newly designed activities with the transport system is a great tool for sustainable urban growth.

3.2. The estimation of the impact of the Sanex platform development on the local traffic

Firstly, an analysis of the local traffic was carried out. The analysis was performed for all links as well as for all the intersections. For the aim of the paper, the situation on the streets and in the intersection adjacent to TOD Sanex was presented.

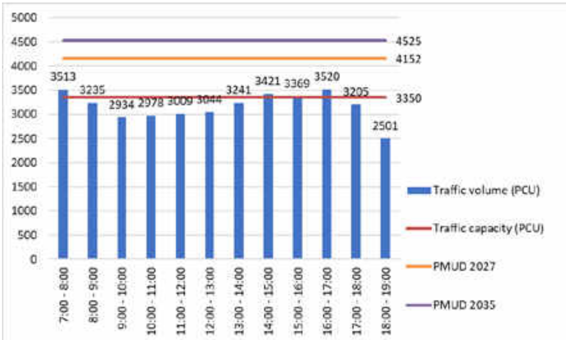
Traffic data for all intersections and links were analyzed in the present scenario and in the perspective in which the investment object would be completed. Two variants of the future scenario were considered in connection to the Northern Mobility Corridor (CMN): Complete CMN (Railway Station Square to IRA node) and Sanex CMN (first section of CMN, from the western side of the platform to the IRA node which would be included).

In the present scenario, three analyzes were carried out for each link to determine traffic volume by vehicle category, hourly traffic volumes in relation to the traffic capacity (V/C ratio) of the sections (Figure 10), respectively the volume of directional traffic on each section.

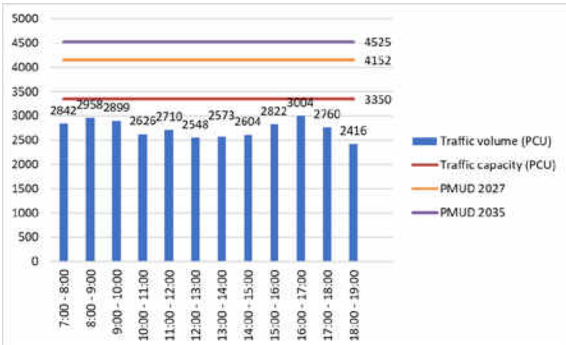
The estimations of the traffic capacities for 2027 (PMUD 2027) and 2035 (PMUD 2035) used in Figure 10 were found in the urban mobility plan of Cluj-Napoca (PMUD [48]). These values emphasized on the efforts of the municipality that had already planned for short- and medium-term developments in the transport system in accordance with the aim of redeveloping the industrial platforms in the northern area of the municipality.

The capacity of all analyzed streets in the extended model was exceeded only for Aurel Vlaicu Street by a maximum of 5%, in 4 hourly intervals which did not represent a major problem. The Romanian standard clarifies that only the links in street network with higher V/C ratio than 25% during peak periods should be considered for improvements.

Aurel Vlaicu Street

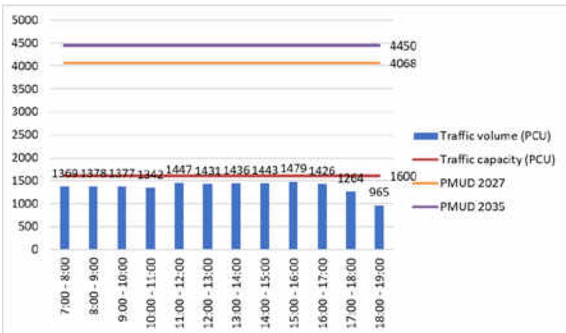


Traian Vuia Street

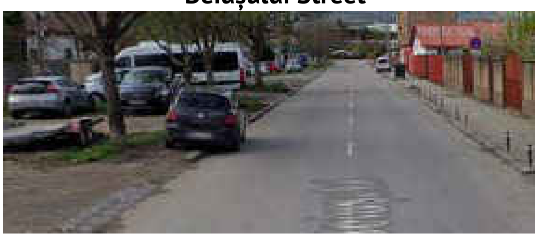


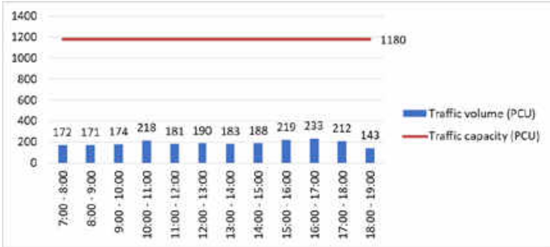
Plevnei Street

PMUD analyzed the future scenario in which the street would have four lanes.



Beiușului Street





Câmpul Pâinii

The street is made up by several disconnected sectors. CMN will be developed over them. CMN Sanex will develop over one segment that is bordering Sanex platform in South, the other segments which are remote remaining in place.

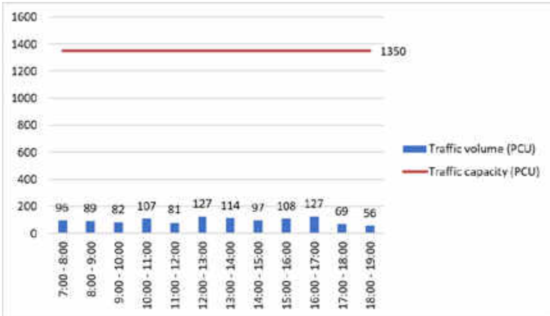


Figure 10. The characteristics of the adjacent street network in the present scenario – the existing situation

(Foto source: Google maps).

Secondly, the trip generation analysis was conducted. The results were used to estimate the impact of TOD Sanex construction on the local traffic through the attracted/generated traffic.

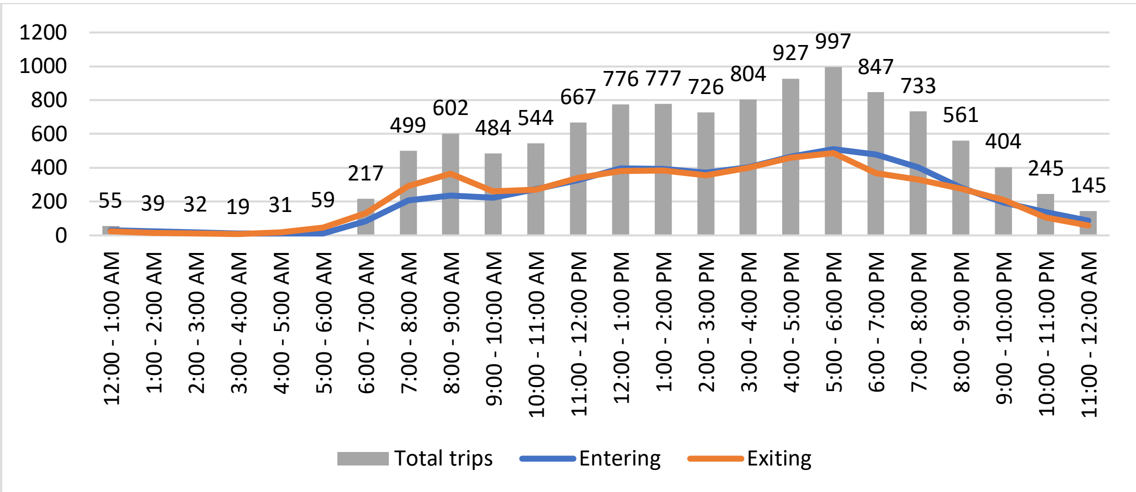


Figure 11. Attracted/generated trips.

These values correspond to a significant traffic intensity of 997 PCU in the peak period of 5-6 pm (Figure 11), which must be integrated into the existing traffic flows in the transport network, using all four access points in the perspective in which the investment would be completed.

CMN was designed as a complete street. The corridor transverse profile is shown in Figure 12. In order to be operational, CMN needs to be entirely built, including the dual carriagway on the both sides of the railway.

According to the transport model for CMN, when it would be operational, the corridor would attract traffic volumes of 50% of the traffic capacity of 2700 (PCU/h) considering a speed of 50 km/h. Sanex CMN will provide a four-lane street connection to the Ira Node on the north side of the railway, supporting the circulation in both ways.

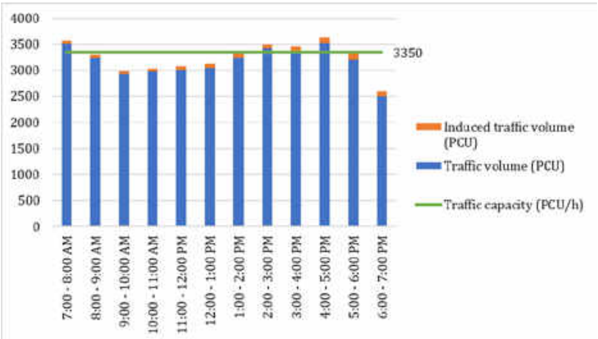
The third step was to develop the traffic model. Induced traffic was distributed in a percentage of 10% on Plevnei Street using the two northern accesses, respectively 90% on the CMN on the two southern accesses. The southern flows were distributed in two variants, according to the stages of CMN completion:

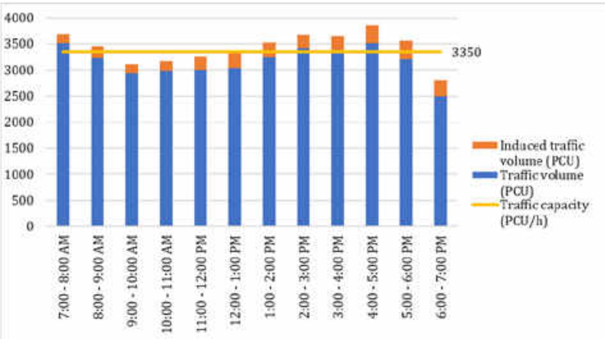
- Variant 1: Complete CMN – half traffic towards the Railway Station Square and the other half towards IRA Node.
- Variant 2: Sanex CMN – all traffic towards IRA Node.

Figure 12. CMN transvers profile [48].

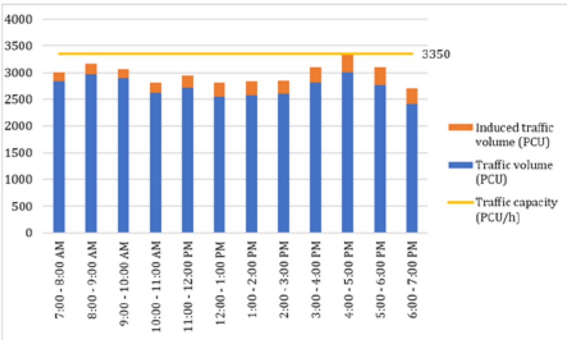
Variant 1 **Variant 2**

Aurel Vlaicu Street

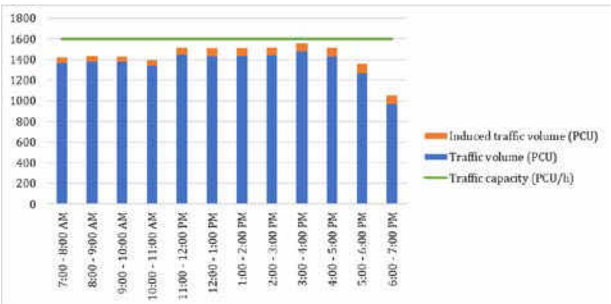


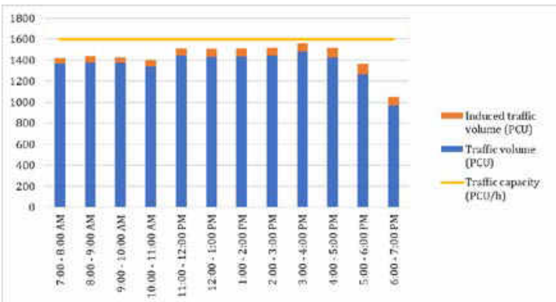


Traian Vuia Street



Plevnei Street





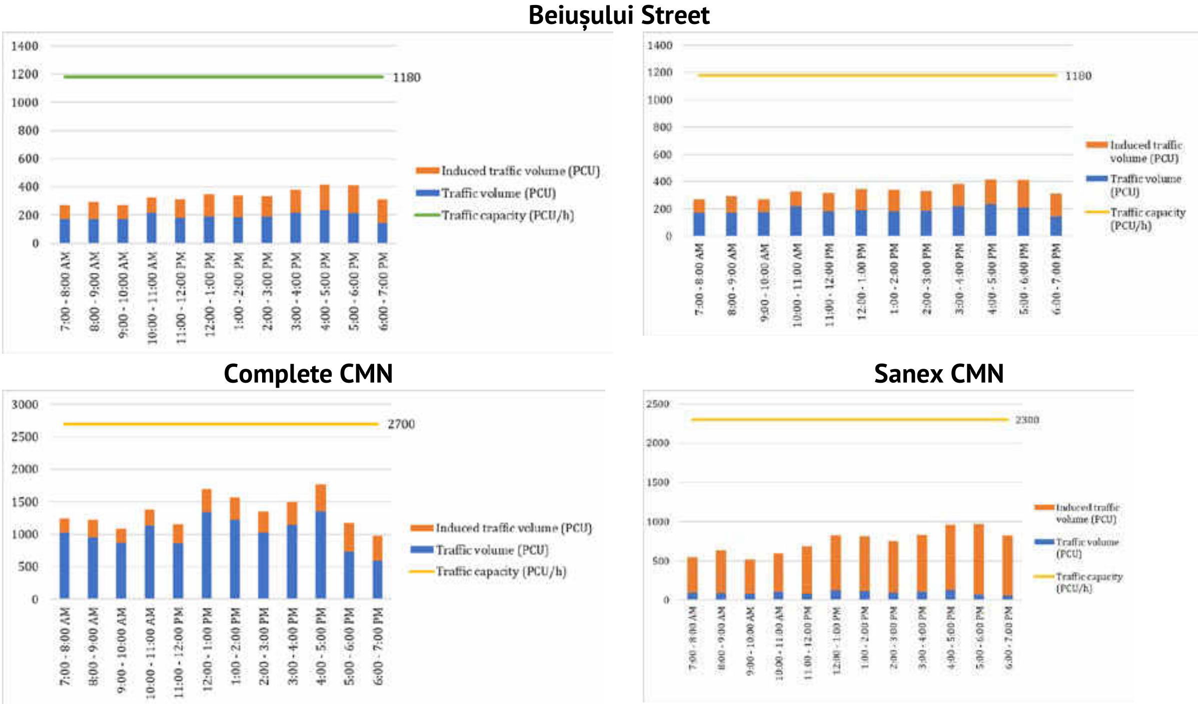


Figure 13. The characteristics of the adjacent street network in the future scenario – the two variants of the model.

The fourth step was to estimate the impact of TOD Sanex development on the local traffic using induced traffic values in the perspective in which the development would be completed (Figure 13).

The traffic capacity was exceeded on Aurel Vlaicu Street by 8% in 4 hourly intervals in Variant 1 and 15% in 7 hourly intervals in Variant 2 (Figure 13). The traffic capacity was not exceeded on Plevnei Street or Traian Vuia Street. The V/C ration does not exceed the limit of 25% in any case (Table 3).

Considering the V/C ration in present and future scenario, the traffic capacity would only be exceeded on Aurel Vlaicu Street, with or without Sanex redevelopment. The impact of the Sanex redevelopment on the local traffic in the case that CMN would be completed, would be 3% increase in V/C ratio.

Table 3

V/C ratio (%)

Street	Scenario 1 - Present	Scenario 2 - TOD Sanex implementation Variant 1 Complete CMN	Variant 2 Sanex CMN
Aurel Vlaicu	105	108	115
Traian Vuia	90	94	99
Plevnei	92	97	97
Beiușului	20	35	35
Câmpul Pâinii	9	-	-
CMN	-	65	24

In case that CMN Sanex wouldn't be implemented, the transport model would be different. Respectively, it was estimated that the induced traffic was distributed in a proportion of 50% in the analyzed network. This would generate exceeding traffic capacity on three links, with a maximum of 19% during eight hourly intervals on Aurel Vlaicu Street, 3% in 1 hourly interval on Traian Vuia Street and a maximum of 18% during eleven hourly intervals on Plevnei Street.

Therefore, the results of this comparative analysis denote that implementing Sanex redevelopment together with Sanex CMN has a major impact both in the development of the area and in the support of the induced / attracted traffic resulting from the implementation of the redevelopment. Furthermore, CMN will be financed partially from private investments and the municipality will also benefit from the public-private partnership.

In the present scenario, two analyzes were carried out for each intersection. Simulations were carried out using Arcady/picady to evaluate the level of service of each intersection and the delays. For accurate modeling of road traffic, the results from the traffic counting were used. The centralized situation for the intersections requested in the study in the current version and the perspective of achieving the objective is presented in the following.

The model of the main intersection, I13, was analyzed in both scenarios – current situation with existing traffic flows (Scenario 1 in Figure 14) as well as in the perspective of the platform redevelopment with additional values of the induced traffic (Scenario 2 in Figure 14).

The induced traffic did not change the exploitation parameters. The results showed that additional values of the induced traffic did not influence the level of service, which remained C but the delays varied from 18 s in Scenario 1 to 19 seconds in Scenario 2.

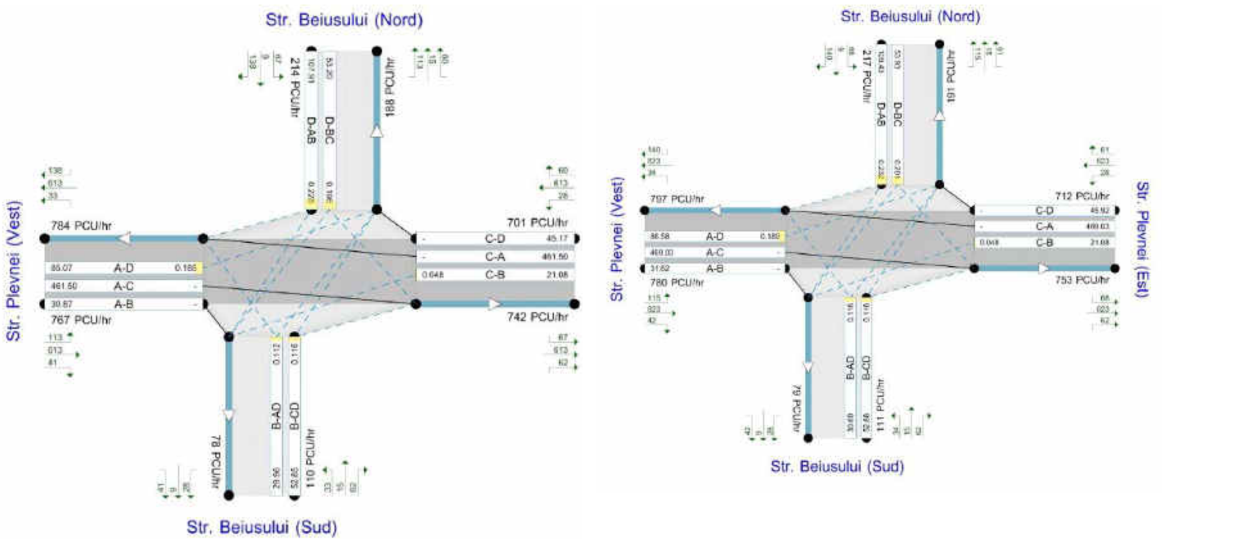
The design of the intersection proved to be correctly chosen. On a medium or long term, it would be possible that intersection I13 would need a reconfiguration taking into account the microscopic modeling of the intersections in the proximity of the development.

The traffic on Beiușului Street represented about 1% of the total traffic in I13.

There were in total 22 intersections that were analyzed since IRA Node was modeled as a suite of 3 intersections. From these, only four intersections changed the level of service, 2 of them from D to E, one from C to D and one from A to B with an increase of 3 seconds delay on average.

Scenario 1

Scenario 2 – with additional value of induced traffic



a)

	AM						
	Queue (PCU)	95% Queue (PCU)	Delay (s)	RFC	LOS	Junction Delay (s)	Junction LOS
	A1 - Scenario 1						
Stream B-CD	0.27	~1	12.37	0.21	B	18.43	C
Stream B-AD	0.33	~1	28.61	0.25	D		
Stream A-B	-	-	-	-	-		
Stream A-C	-	-	-	-	-		
Stream A-D	0.44	1.00	12.74	0.31	B		
Stream D-AB	0.69	1.00	15.93	0.41	C		
Stream D-BC	0.75	2.00	36.43	0.44	E		
Stream C-D	-	-	-	-	-		
Stream C-A	-	-	-	-	-		
Stream C-B	0.09	~1	10.24	0.08	B		

	AM						
	Queue (PCU)	95% Queue (PCU)	Delay (s)	RFC	LOS	Junction Delay (s)	Junction LOS
	A1 - Scenario 1						
Stream B-CD	0.27	~1	12.63	0.22	B	19.17	C
Stream B-AD	0.36	~1	30.07	0.27	D		
Stream A-B	-	-	-	-	-		
Stream A-C	-	-	-	-	-		
Stream A-D	0.45	1.00	12.96	0.31	B		
Stream D-AB	0.73	2.00	16.47	0.42	C		
Stream D-BC	0.81	2.00	38.64	0.46	E		
Stream C-D	-	-	-	-	-		
Stream C-A	-	-	-	-	-		
Stream C-B	0.09	~1	10.33	0.08	B		

b)

Figure 14. Intersection I13 modelling – level of service and delays – two scenarios: a) Intersection model; b) level of service and delays.

5. Conclusions

The redevelopment of the industrial platforms into multifunctional areas including housing, shopping, services, offices, leisure and so on will reduce traffic in connection to the city, shortening the trip lengths and reducing travel times for people. Moreover, it will offer more affordable housing near basic facilities and services.

TOD Sanex will generate additional local traffic volumes of significant values in comparison to the present flows. However, the results of the analyses prove that the induced traffic doesn't have a considerable impact on the conditions of the local traffic in any of the two scenarios - at the present time or in the perspective of the redevelopment. The estimated V/C ratio, level of service and delays in the two scenarios show that induced traffic can be integrated by the current street network, which has different reserve capacity on different links. Thus, the network could operate in appropriate conditions.

Furthermore, the variants of Scenario 2 in which two different stages of completion of CMN are analyzed – Complete CMN against Sanex CMN, denote that implementing Sanex redevelopment together with Sanex CMN has a major impact both in the development of the area and in the support of the induced/attracted traffic resulting from the implementation of the redevelopment. Furthermore, CMN will be financed partially from private investments and the municipality will also benefit from the public-private partnership.

In perspective, traffic is expected to gradually increase in the analyzed area. To counteract this situation, the local authority plans to implement compensatory measures that will restore the V/C ratio within limits. Investments such as the construction of the CMN to increase the capacity of the road infrastructure or implementing suitable public policies to guide the integrated planning of the new developments or redevelopments are just two specific examples in this regard.

The implementation of public projects in the area, such as metro and metropolitan train will lead to an increased use of public transport, as an alternative to car usage. It is necessary to encourage the future residents to use public transport considering the great accessibility to public transport routes and the great connection with other parts of the city.

The findings in this paper could be used to guide the future development in the area, focusing on ensuring a safe and efficient street network in accordance with the urban mobility plan of the municipality. Continuing to integrate TOD principles into urban planning in Cluj-Napoca will lead to better implementation of sustainability in the development of the city.

TOD Sanex is the first documented case study in Romania. Further research should focus on differentiating horizontal and vertical urban densification. Authors need to analyze several case studies from different urban areas to develop a detailed methodology for implementing TOD.

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