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FUA REPORT
INCLUDING SULPITER TOOL FEEDING &
CALIBRATION IN MARIBOR

Final version
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Status (F: final; D: draft; RD: revised draft):	**F**

1. Introduction

First part of this report describes Maribor FUA and its main characteristics. For purposes of freight flows' analysis FUA has been divided into 7 zones (geographical units) based on population density (the biggest municipalities) and on accessibility (defined by a good road infrastructure connection between selected zones). Second part of the report is dedicated to identification of current freight mobility impacts. Analysis was done based on a comprehensive survey performed on a big sample of retailers mainly located within the city centres. Third part of the report is dedicated to the analysis of transport operators flows. Key transport operators have been interviewed to understand type of vehicles used, frequency of deliveries done, and main problems encountered with deliveries to urban areas. Fourth part of the report is dedicated to the traffic counters' analysis. In case of FUA Maribor the analysis was done on data obtained from automatic traffic counters with specific focus on light commercial vehicles which are the most relevant category of vehicles used for delivery in city centres. Fifth part of the report deals with presentation of SULPITER tool results in the form of OD matrices. All the analysis done in previous parts of the report are aggregated and used to provide OD matrices (quantity, deliveries, vehicles) from the tool, for specific supply chains. Provided OD matrices are then used also to perform traffic assignments of freight transport flow on a road transport network. Last part of the report presents the results obtained with Logistics Sustainability Index (LSI) tool. Usability of LSI tool is demonstrated on the case of provisional establishment of Urban Consolidation Centre (UCC) coupled with deployment of electric vehicles for deliveries from UCC to customers located in the city centre.

2. The territorial contest

FUA name, Km² involved in the study-area, N. of inhabitants, N. of municipalities involved, N. of working units (employers)
Functional Urban Area Maribor is according to OECD methodology considered as a medium-sized urban area with 246.306 inhabitants (data 2014). At the administrative level, Slovenia is divided into 212 municipalities (NUTS 5) of which only 11 are urban municipalities (Maribor being the second largest). There are no regions (provinces) as yet in Slovenia due to long-going professional and political debate about the number and size. Since 1995 for data collection and analytical purposes, 12 "statistical" NUTS 3 regions are utilized in Slovenia. From the year 2002, these NUTS 3 (statistical) regions are practiced in regional policy and programming documents known as "development" NUTS 3 regions – this practice will continue until the establishment of administrative regions (provinces) in the future. Until the year 2008, the whole Slovenia was considered as one NUTS 2 (European) region. From January 2008 there are two NUTS 2 European (or "cohesion") regions: WEST SLOVENIA and EAST SLOVENIA. During the past 10 years, several research projects at the national and EU level were trying to define functional urban areas in Slovenia. Different concepts and criteria were implemented, as basic units for implementation of territorial cohesion policies – through participation of academic, research and administrative institutions in different European projects such as: ESON 1.1.1 (2004), ESPON 1.1.3 (2004), ESPON 1.4.1 SMESTO (2006), INTERREG III B CADSES: CONSPACE (2006), RePUS (2007) and EU Framework Programmes. According to "statistical" NUTS 3 regions, extent of Function Urban Area Maribor is best correlated with Podravje statistical region with 41 municipalities and 679 settlements. Geographically the region is located in the northeast of Slovenia bordering Austria and Croatia with well-developed transport infrastructure. The Podravje region covers an area of 2.170 km² (10.7% of the national territory). With 320.100 inhabitants (16.1% of the national population), it is the second largest Slovenian region in

terms of population. Towns (urban municipalities) Maribor (population 113.000, area 147,5 km2), Ptuj (population 24.000, area 66,7 km2), Slovenska Bistrica (population 30.100, area 260,1 km2) and Ormož (population 17.700, area 212,4 km2) are located in the region.

The Podravje region has a long industrial tradition and most companies in Podravje region are in the processing industries such as: metal-processing, chemicals and food & beverages. Among the advantages of the region, a specialisation in agriculture (especially fruit and wine growing) is to be mentioned.

26.126 companies are registered in Podravje region (2016). Largest companies in region are Pošta Slovenije, Boxmark leather, Carrera optyl, Perutnina Ptuj, Swatycomet, ISS facility services, Henkel Slovenija, Dravske elektrarne Maribor, HC Hidromontaža, Impol, Sodo and Talum.

7.256.000 tons of goods were loaded in Podravje region in 2013 and 72,2 mio km were made (54 mio km loaded vehicles, 18,2 mio km empty vehicles), 586.000 trips were made with loaded and 435.000 with empty vehicles.

City of Maribor (city centre) is mostly residential with retail and commercial activities including many small craft workshops and service activities. Presently city of Maribor is faced with cessation of activities in city centre due to concentration of large commercial centres on the outskirts of the old city and problems with delivery options and accessibility of the old city centre (delivery options are restricted in the pedestrian zone in the old city centre).

N. of zones used in the tool and in the o/d matrix

Zoning criteria (nuts level, all of the same nuts dimension or not, all similar dimension or different in dimension, ...)

Please insert a map of the study area (if available please attach also the shape file with area and road graph layer)

Slovenia is divided into 12 statistical regions (NUTS-3 level), which are divided into two cohesion regions (NUTS-2 level).

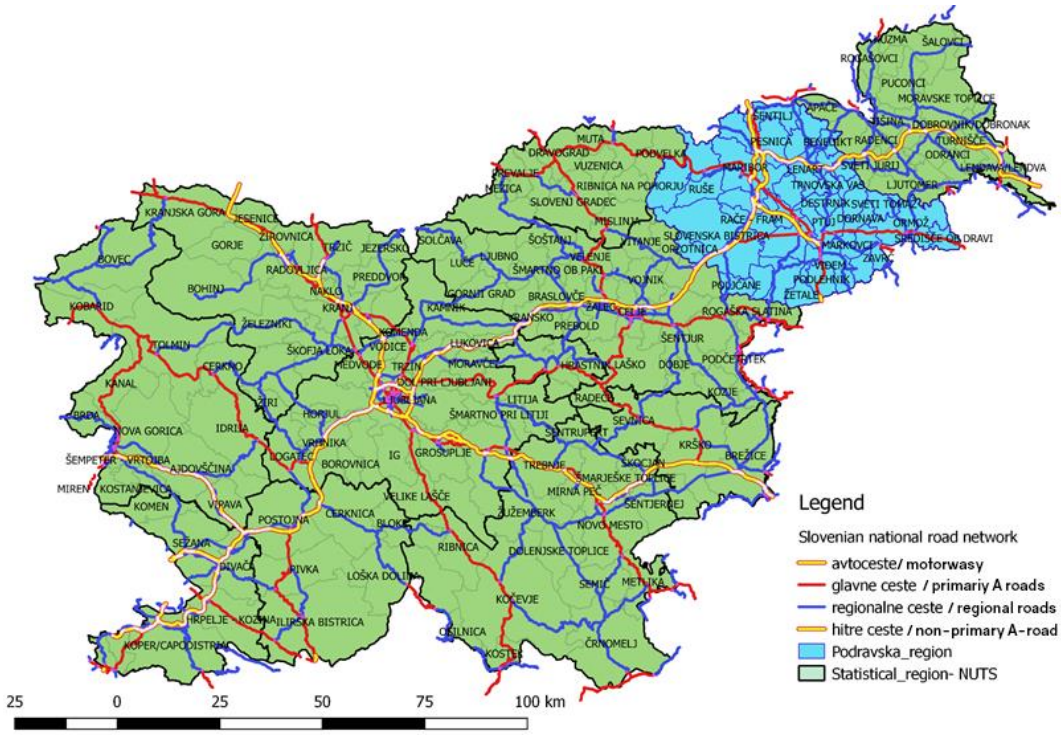

Figure 1: Slovenian national road network, statistical regions and Maribor FUA

Functional urban area (FUA) Podravje region consists of 41 municipalities.

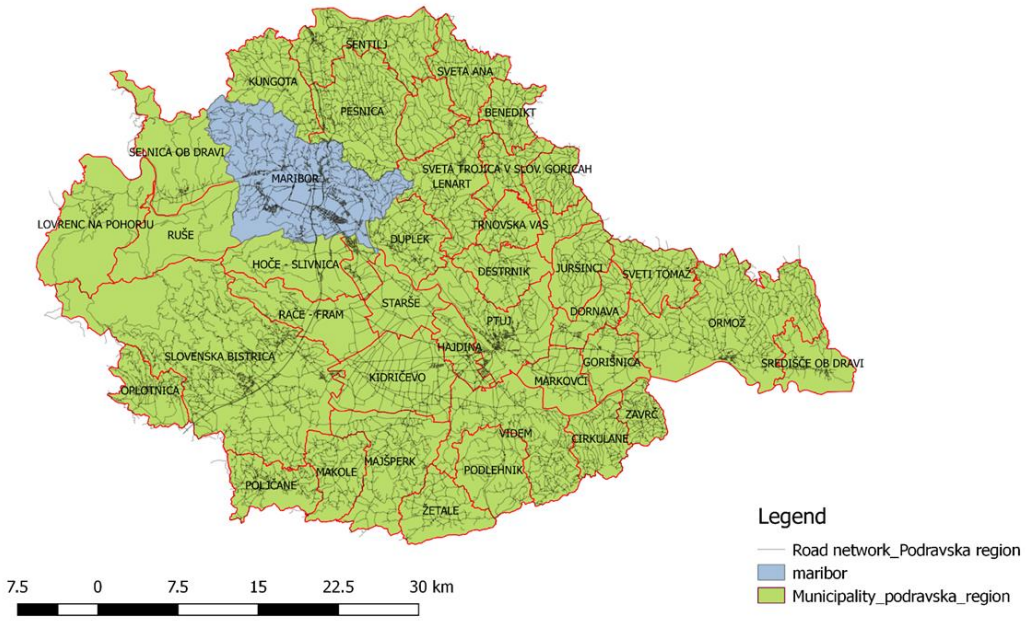

Figure 2: Maribor FUA – 41 municipalities and area of Maribor City

Geographically the FUA Podravje with its 41 municipalities has been divided into 7 Geographical Units (GUs) with Municipality of Maribor as a central unit. The GU has been selected based on road network and based on major cities located within the region.

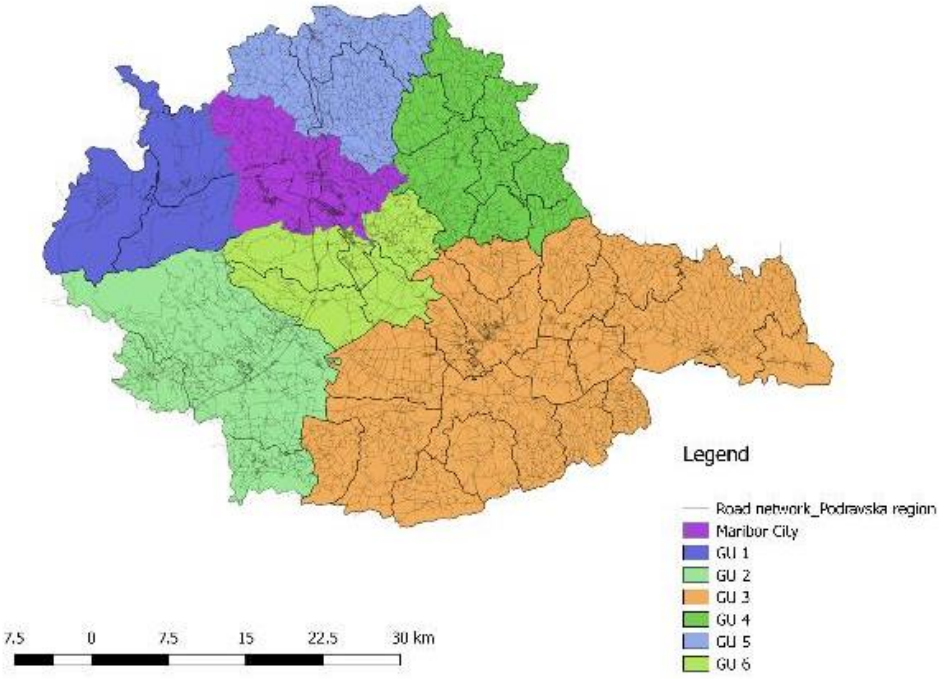

Figure 3: Maribor FUA – Geographical Units (Gus)

3. Current freight mobility impact

Analysis of survey on distribution flows. It may include the following aspects:

- *Total number of interviews (per supply chain)*
- *Number of suppliers (average per category …)*
- *Share of DDP, EX-WORK and OFF TRUCK delivery modes*
- *Frequency of deliveries and type of load units*
- *Number of load units per delivery (minimum, maximum, average)*
- *Usual hours of delivery (distribution)*
- *Share of OWN ACCOUNT COLLECTION*
- *Share of DELIVERIES TO END CUSTOMERS*
- *Problems and suggestions (short analysis and description)*

Please do not include just the figures, but also detail and comment the results.

Survey on distribution flows was focused on two supply chains with the following total number of companies located within FUA Maribor: "G" – wholesale and retail trade = 3.400 companies in total and "I" – accommodation and food services = 1.100 companies in total.

The initial aim of the survey was to examine 10% of all companies located in the region which would result in approximately 400 interviews. After few test trials on a sample of commercial entities, the problem with response rate of entities located outside the city centres was notable. For majority of entities, located outside city centre (pedestrian zone), access is not regulated, no problems with deliveries exists and there is no need to improve distribution services. Thus, these companies did not recognize participation in the survey as beneficial and have refused cooperation.

Taking this into consideration survey has been refocused mainly on the urban centre of Maribor (113.000 inh., 147,5 km2) and Ptuj (24.000 inh., 66,7 km2) being the only two cities in FUA with proper city centres.

Maribor:

Ptuj:

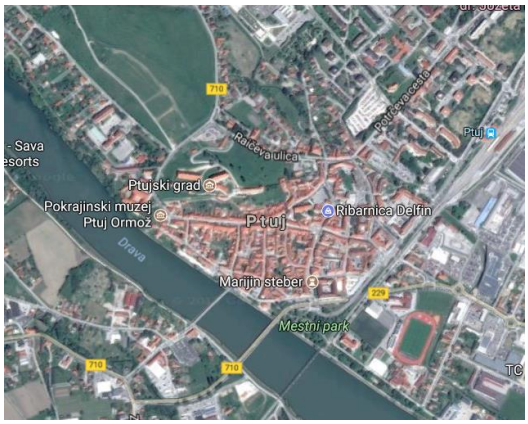

Figure 4: Orto photo of Maribor and Ptuj city centre

The survey was performed in period July 2017 – September 2017. Each survey was initiated by a phone call (appointment arrangement) and followed by execution of interview at the premises. The average duration of the interview was 20 – 30 minutes. Respond rate within the city centres/ pedestrian zone: more than 90%, outside the pedestrian area but within the City of Maribor and Ptuj: more than 80%, in all other areas: near 0%.

In total 120 interviews have been done. Sample of respondents is quite big in the strict city centres (pedestrian zones and around these zones) of Maribor and Ptuj (more than 40% of all commercial activities) but quite small in other parts of the FUA (other cities/small towns are not faced with urban delivery problems therefore majority of entities refused to participate).

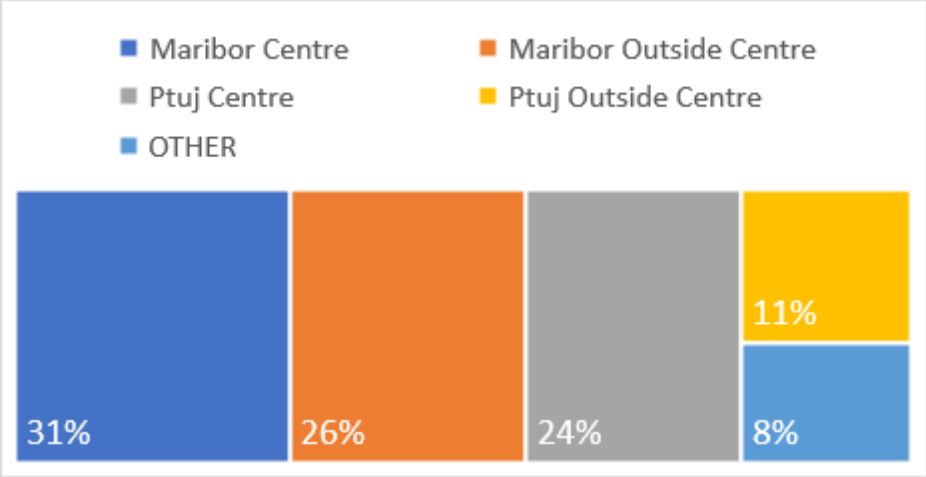

Figure 5: Share of commercial entities interviewed in different parts of Maribor FUA

Majority of interviews have been done within (31%), around (26%) the pedestrian zone in Maribor and within (24%), around (11%) the pedestrian zone in Ptuj.

With regard to companies selection the principle of inclusion of different types commercial entities (retail, Ho.Re.Ca, small shops (crafts) and home accessories) was followed.

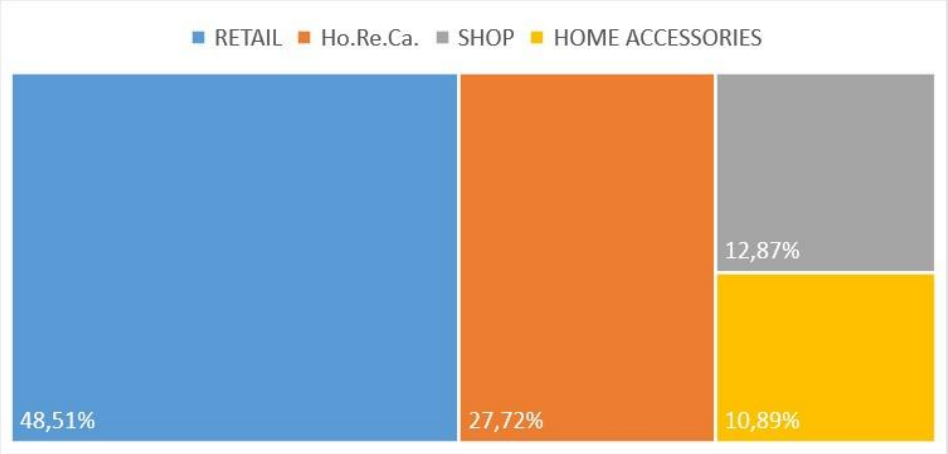

Figure 6: Share of different types of commercial entities interviewed

Mainly interviews were done with retailers (49%), followed by Ho.Re.Ca (28%), small shops and crafts (13%) and home accessories (10%).

Content wise the survey contains questions related to the surface of business units, share of surface devoted to warehousing, number and type of suppliers, vehicles used to perform deliveries, existence of loading bays, delivery frequencies, delivery time windows, main problems with urban freight deliveries – cumulative results are shown hereinafter.

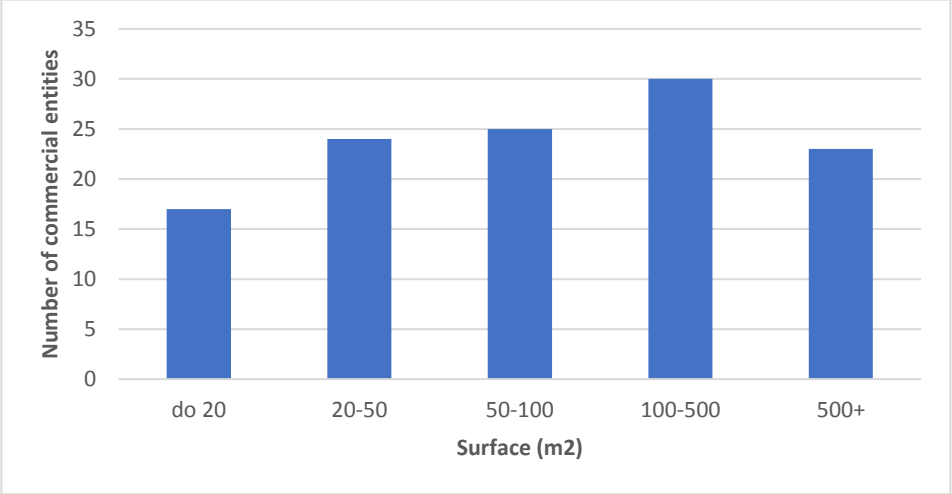

Figure 7: Commercial entities in relation to their ground surface (m2)

Surveyed commercial entities are of various size ranging from small, medium-sized and big entities in relation to ground surface. The average entity has a surface of approximately 100 m2. Smaller entities are located mainly in the strict city centre, larger entities are located outside the city centre.

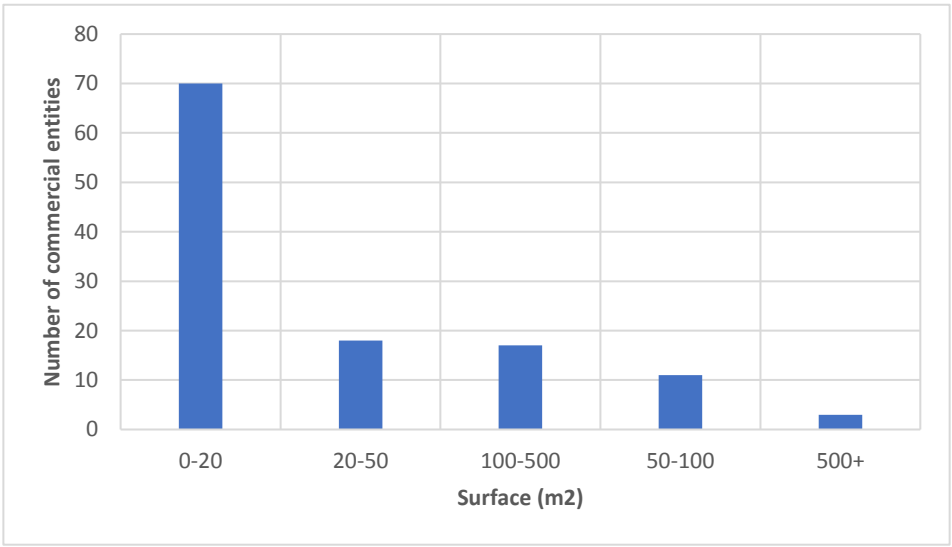

Figure 8: Number of commercial entities in relation to surface (m2) dedicated to warehousing

Commercial entities have rather modest share of surface dedicated to warehousing (vast majority in the range up to 20m2). This indicates that deliveries need to be very frequent and inventories are not substantial.

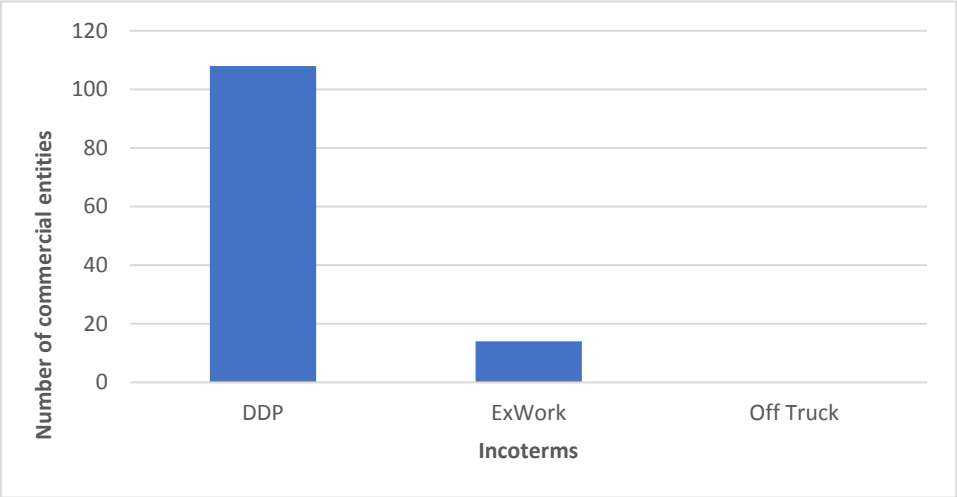

Figure 9: Ways of supply

Deliveries are mainly managed, organized and performed by goods' suppliers. The share of self-replenishment at commercial entities is very low and there are actually no cases of off-truck supply.

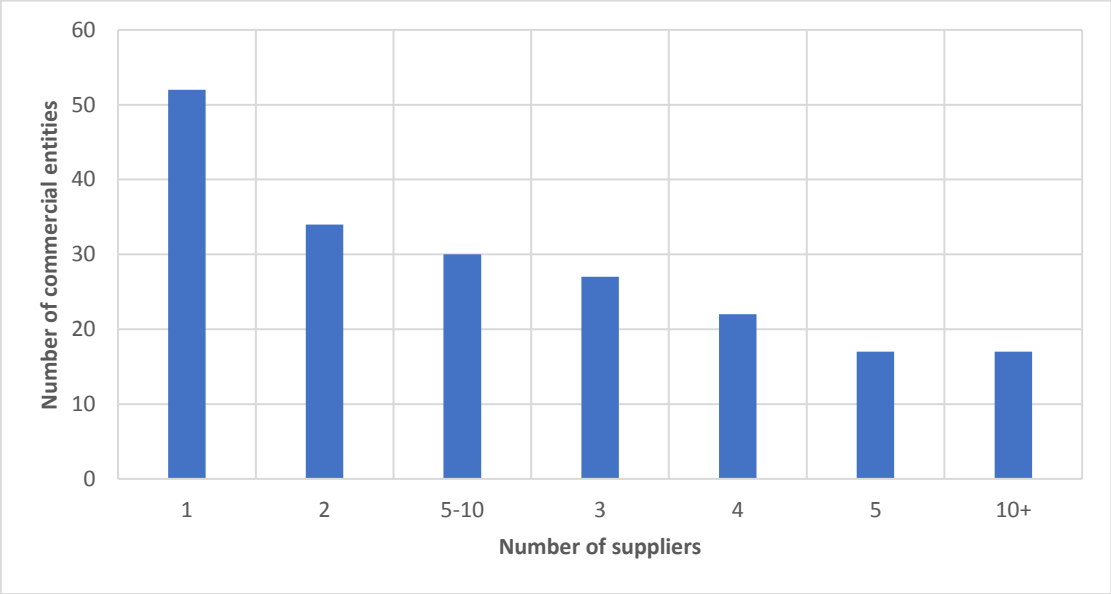

Figure 10: Number of suppliers

Commercial entities have rather small number of suppliers (predominantly 1 or 2). This is characteristic for smaller shops with specialised goods on one side and for bigger retail stores, which consolidate all the goods at distribution centres.

Figure 11: Delivery location

Deliveries are made mainly to the shop of commercial entities. Only very small share is delivered to some external depots. Commercial entities, located in the city centres, very seldom use external depots, except some specialized businesses – e.g. flower shops that need depots with cooling options for larger quantities of flowers.

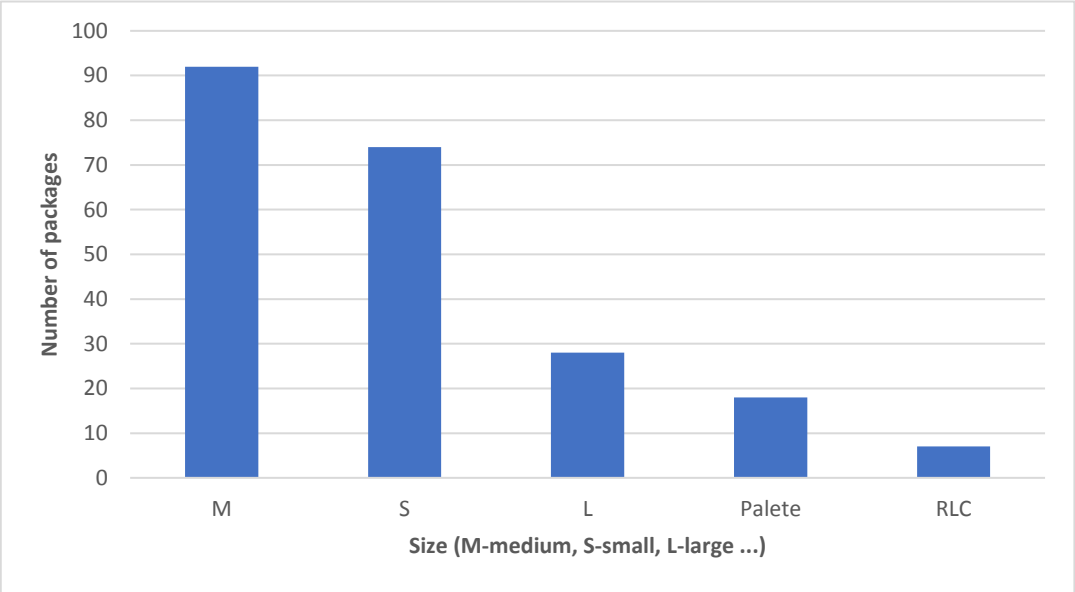

Figure 12: Size of packages/parcels

Packages are predominantly medium or small in size. Only few deliveries include large packages and even smaller number have to do with pallets and RLCs. This indicates that deliveries could be possibly done on foot or by freight bicycle.

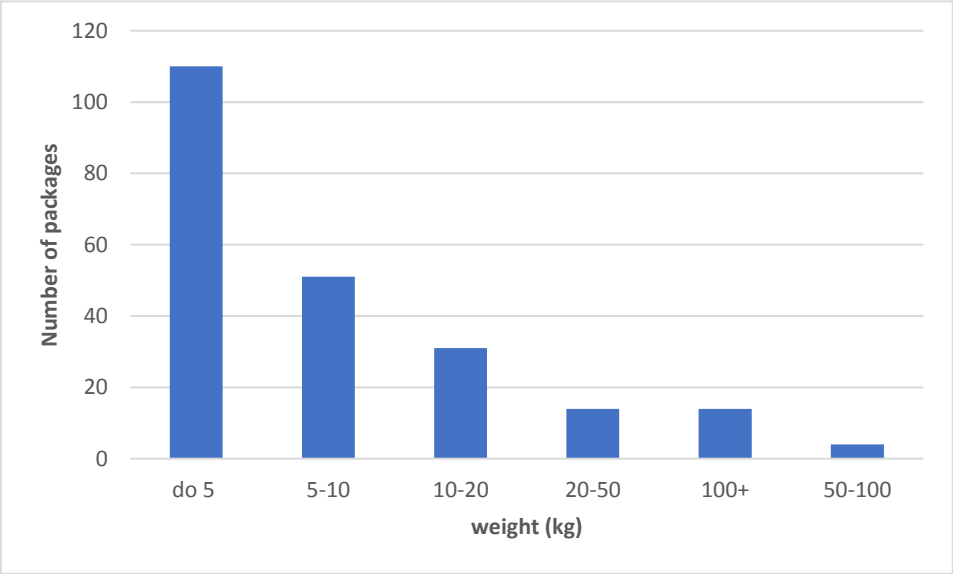

Figure 13: Weight of packages

Lightweight packages (up to 5 kg) are characteristic for shipments to urban centres. This again correlates to previous findings and possibilities for innovative urban freight delivery options.

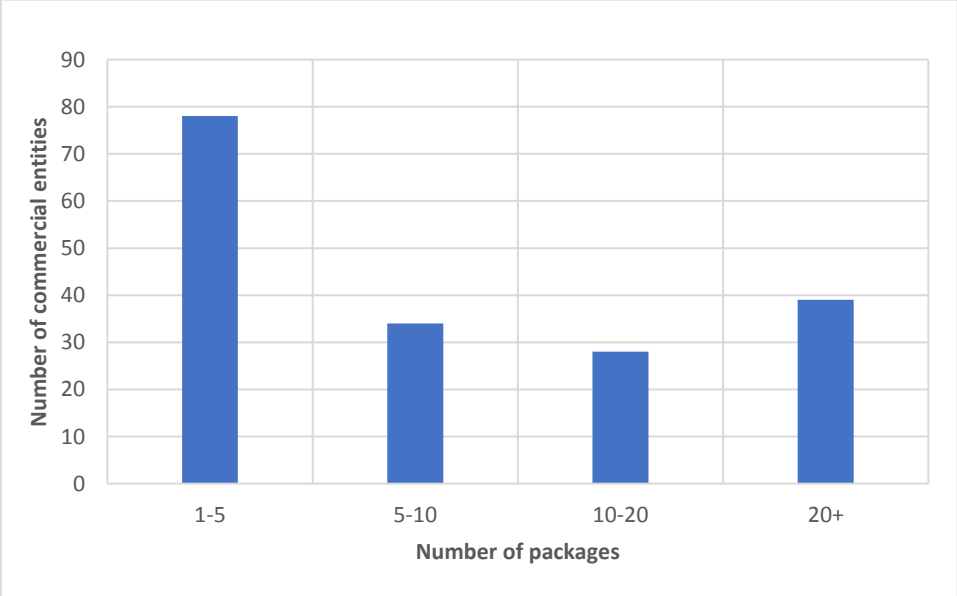

Figure 14: Number of packages per shipment

Majority of commercial entities receive shipments containing small number of packages (up to 5). This again is indicative of frequent orders of smaller number of packages in order to avoid inventories.

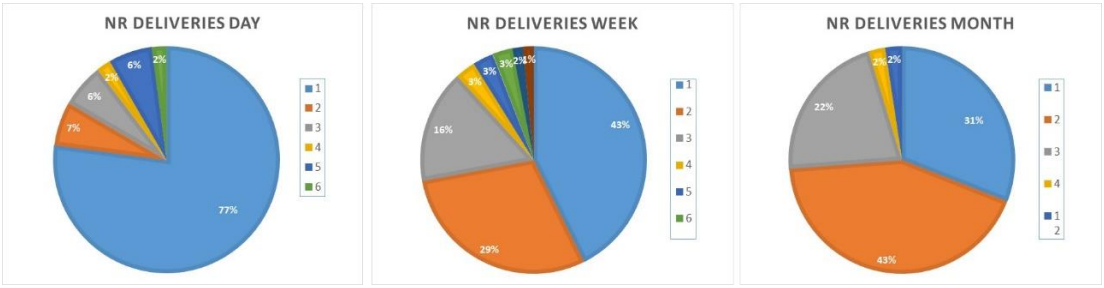

Figure 15: Frequency of deliveries

In the majority of cases, we can notice single daily (one delivery per day) or weekly deliveries. Some commercial entities have up to 6 daily deliveries originating from bigger number of suppliers used by these entities. Moderate sample of commercial entities have deliveries twice or three times a week, the same holds for monthly deliveries. A big number of deliveries is caused by commercial entities not holding inventories thus orders/deliveries need to be more frequent.

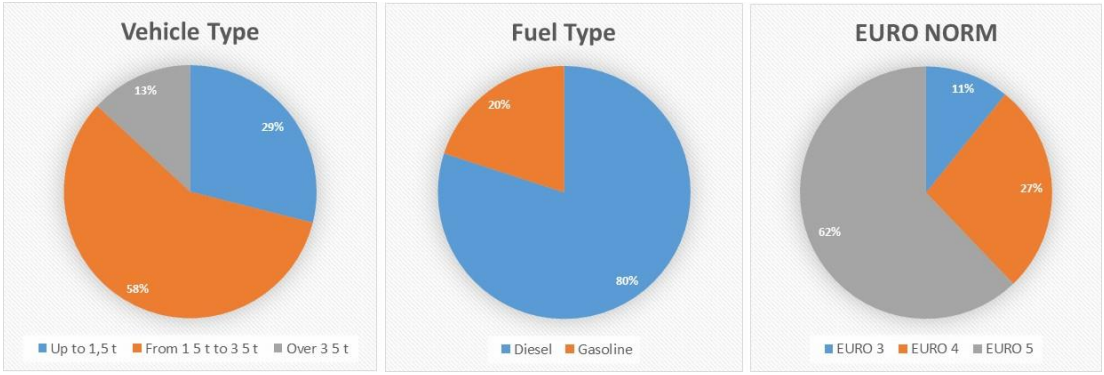

Figure 16: Vehicle types used for urban freight deliveries (commercial entities' own fleet)

The biggest share of deliveries is performed with vehicles from 1,5 to 3,5 tons with mainly diesel fuelled EURO 5 engines. 29% of deliveries are done with personal cars with up to 1,5 tons.

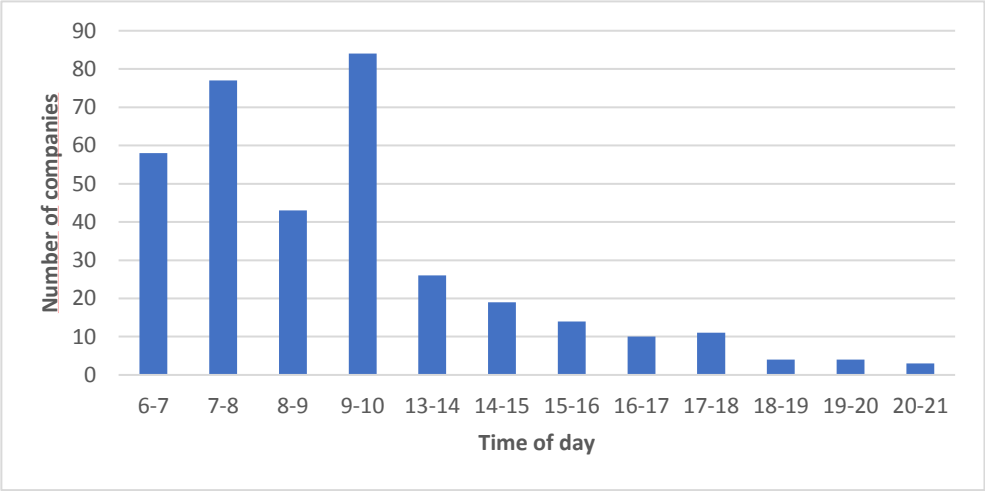

Figure 17: Time distribution of deliveries

Majority of deliveries are performed in the early morning period when vehicles are allowed to enter city centre/pedestrian zone. In the afternoon, when access to the city centre is restricted and only selected express courier companies are allowed access, number of deliveries is considerably lower.

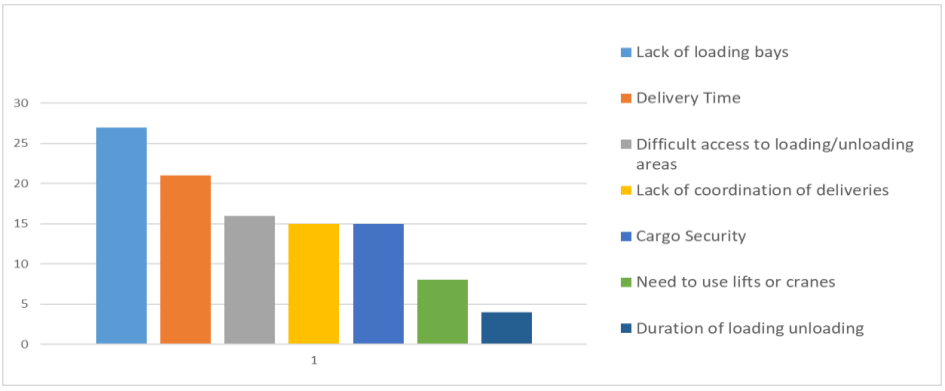

Figure 18: Urban freight deliveries problems identified in FUA Maribor

Commercial entities are mainly lacking loading bays near their premises. These problems arises from two reasons: 1) loading bays are not well positioned, 2.) Loading bays are more or less always occupied (by other delivery vehicles or illegally by private cars). Delivery vehicles are consequently forced to double park or to circulate around the city to find alternative loading bay not yet occupied. In case of illegal parking, retailers/suppliers are often penalized by city wardens.

Delivery time is limited to fixed morning time slots and fixed afternoon time slots with no other options. More options for deliveries outside present time windows are required. In addition, initiatives for delivery coordination among suppliers are lacking, simultaneously issues with cargo security at delivery have been noticed.

Analysis of survey on transport operators flows. It may include the following aspects:

- *total number of interviews*
- *type of vehicles*
- *sequence of movements (number of movements, number of stops per trip)*
- *typical quantity*

- *frequency of movements*
- *parking during deliveries*
- *main issues*

Please do not include just the figures, but also detail and comment the results.

Survey on transport operators' flows was focused mainly on transport operators engaged by bigger retail chains in the FUA Maribor. In general, the biggest retailers are outsourcing transport services to few large transport operators covering the majority of all retail shops in the region. We interviewed and gather data from companies that cover 5 of the most important retail chains in the region (Merkator, Hofer, Lidl, Leclerc, Jager) and have altogether 255 trucks and vans.

Characteristics of vehicle fleet:

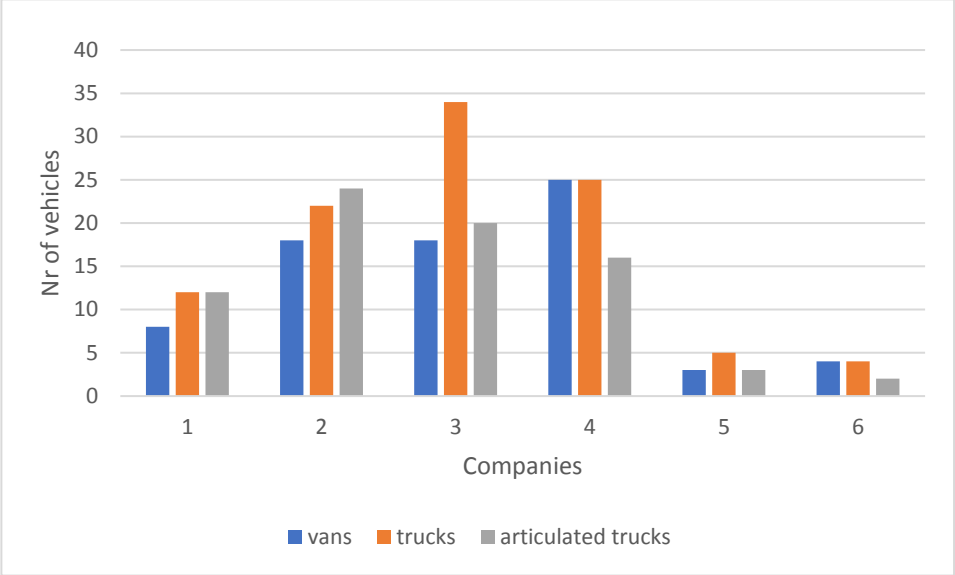

Figure 19: Type of vehicles used (sample of transport companies)

- majority of trucks up to 20 tons (40%), articulated trucks up to 26 tons (30%) and vans up to 3,5 tons (30%),

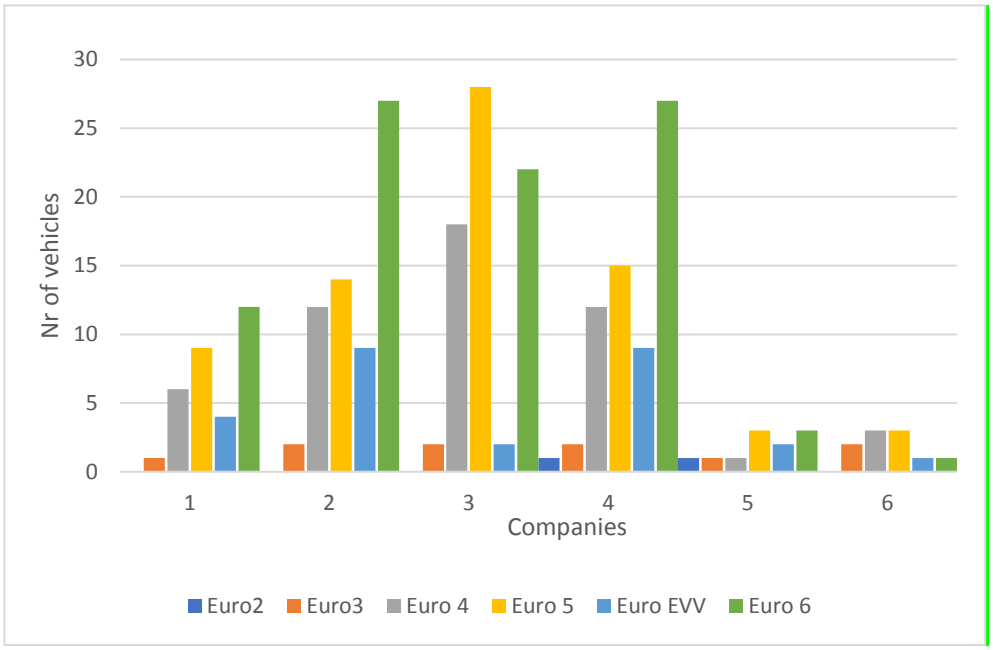

Figure 20: EURO norms of freight transport vehicles (sample of transport companies)

- mainly EURO 5 and EURO 6 diesel engines (75%), others from EURO 2 to EURO 4 (25%,)

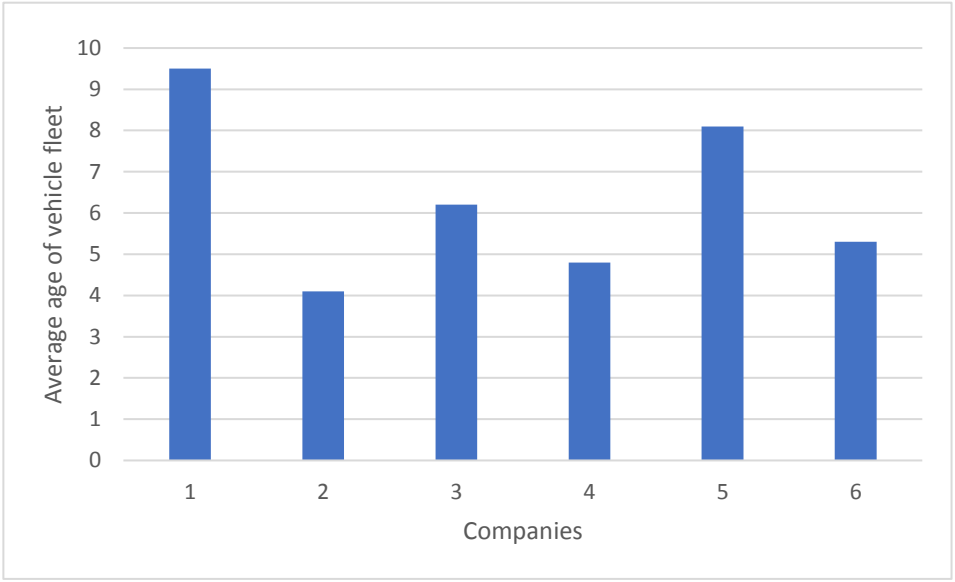

Figure 21: Average age of vehicle fleet in sample of transport companies

- on average vehicles are 6 years old.

The sequence of movements:

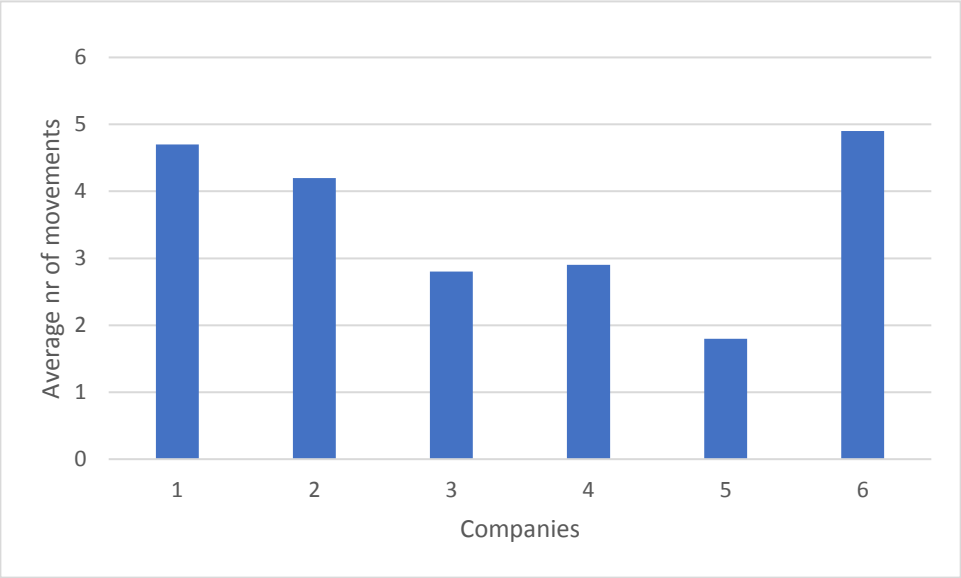

Figure 22: Number of daily movements for a sample of transport companies

- number of stops on one trip depends upon a commodity that is being transported,
- for retailers (groceries) vehicles up to 9 stops per trip – on average 3 to 4 stops, in case of some specialised products (e.g. pharmaceutical products) even up to 20 stops per trip.

Typical quantity:

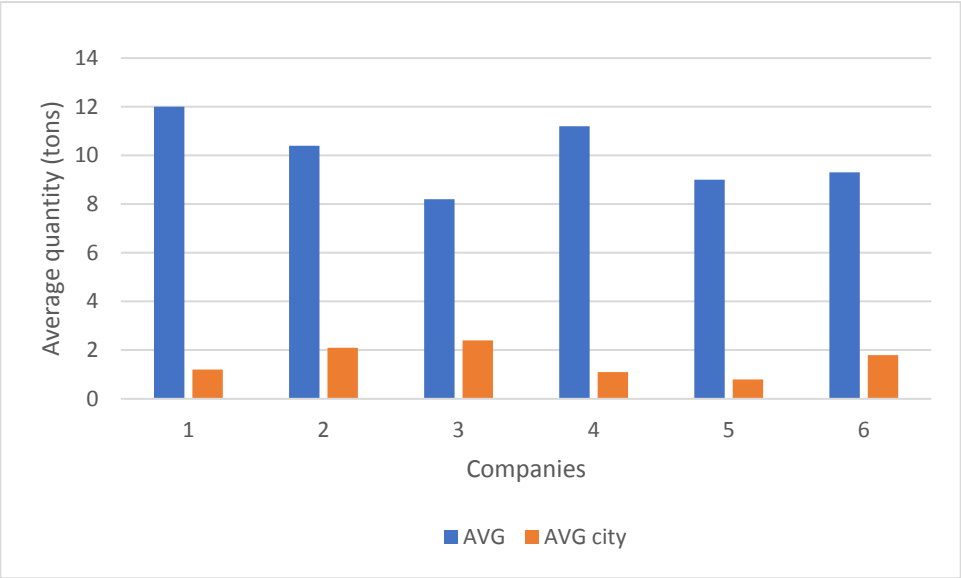

Figure 23: Average quantity of shipments in general and shipments for the city centres (on a sample of transport companies)

- quantitydepends on type of commodity being transported,

- on average the whole shipment weights approximately 10 tons but when considering deliveries to city centres, which are limited to vehicles with up to 3,5 tons, average shipment weights about 1,5 tons (and usually only small part of it is destined to customers in the strict city centre).

Frequency of movements:

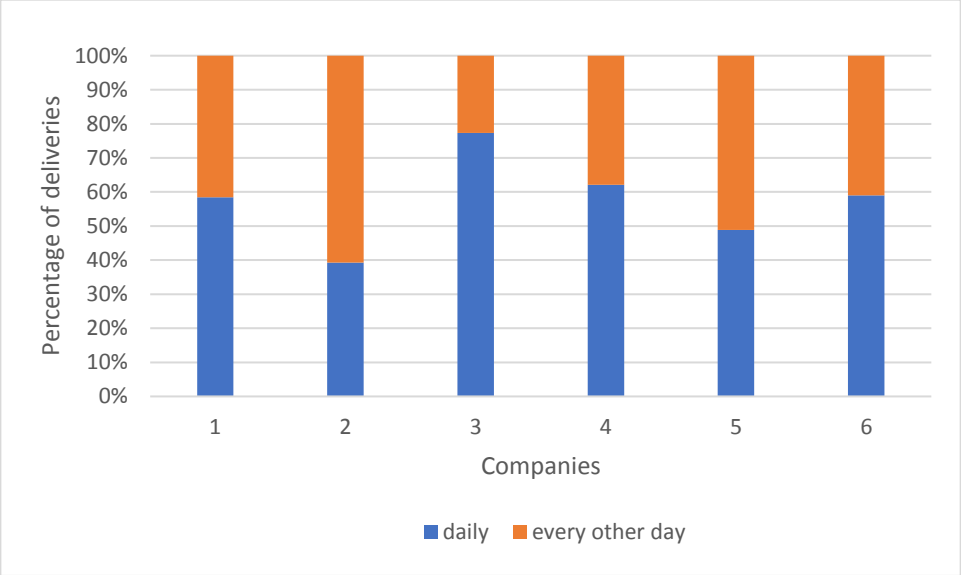

Figure 24: Frequency of movements - dally and every other day (for a sample of transport companies)

- in majority the deliveries are performed daily (60%) or every other day (40%),
- vehicles perform several deliveries per day.

Parking during deliveries:

- In general, transport operators did not report specific problems referring to parking during delivery.
- Since deliveries are regular, mainly daily deliveries to particular shops, transport operators managed to align delivery time windows with access restriction in city centres.

In addition to survey on transport operators' flows, analysis of statistical data (gathered by Statistical office of the Republic of Slovenia) on transport operators was done. This allowed for deeper understanding of share of different vehicle types, a total number of trips, total quantity of goods transported and information relevant for generating OD matrices. The analysis also provided quantities and number of trips for different commodity groups. Enquiries were numerous and are shown here except results of load factors analysis in relation to number of trips within 7 zones of FUA Maribor (see below).

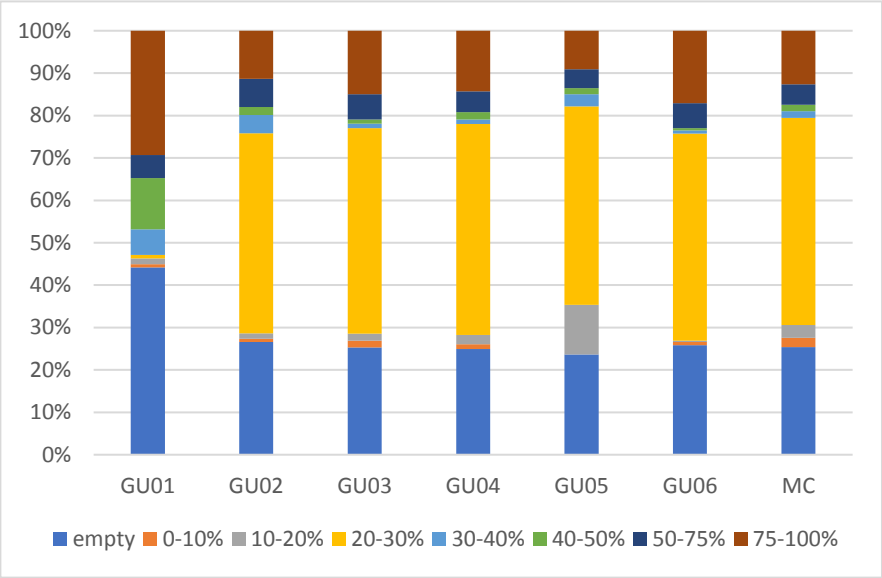

Figure 25: Load factor (utilisation rate) of vehicle trips within zones of FUA Maribor

As can be seen, approximately one-quarter of vehicles travel empty and an additional half of them are utilised below 30% of their capacities. Only 15% of all vehicle trips are performed with fully loaded vehicles. Very similar results are evident for trips between zones of the FUA Maribor. This indicates to the need to consolidate goods and to optimise vehicle trips.

Analysis of traffic counts. It may include the following aspects:

- *AADT (average annual daily traffic)*
- *Total and for different categories of vehicles*

Please do not include just the figures, but also detail and comment the results.

Data on annual traffic flows and traffic volumes in Slovenia is obtained from fixed sensors measurements. Average Annual Daily Traffic (AADT) AADT is the average number of vehicles passing a specific point calculated over a year in a given counting section of each day (usually expressed in vehicles per day). It simply represents the vehicle flow over a road section (e.g. highway link) on an average day of the year. AADT is considered as one of the most important raw traffic datasets used as essential input for traffic models and calibration exercises to be used for planning of new road construction, determination of roadway geometry, congestion management, pavement design and many others. AADT is generally available for most of the European road networks. The data is collected by traffic control centres, refined and disseminated to users by traffic information centres in most of the EU countries.

There are 847 automatic counters on Slovenian roads and 113 permanent automatic counters are situated in Podravje region. AADT is calculated from data obtained from two types of counts: permanent automatic traffic counts and short-period traffic counts. A combination of these two measurements is generally employed to obtain an AADT estimate over a larger road network as follows: "*Permanent automatic stations provide continuous counting of the traffic on selected roads (mostly on highways) for the entire year. They*

offer traffic counts in 15 minute or hourly intervals, 7 days a week and 365 days a year interval. This enables a finer level of analysis and a more accurate annual average than short-term counts".

Location of 113 traffic counters in Maribor FUA (Podravje statistic region) is represented in the following figure.

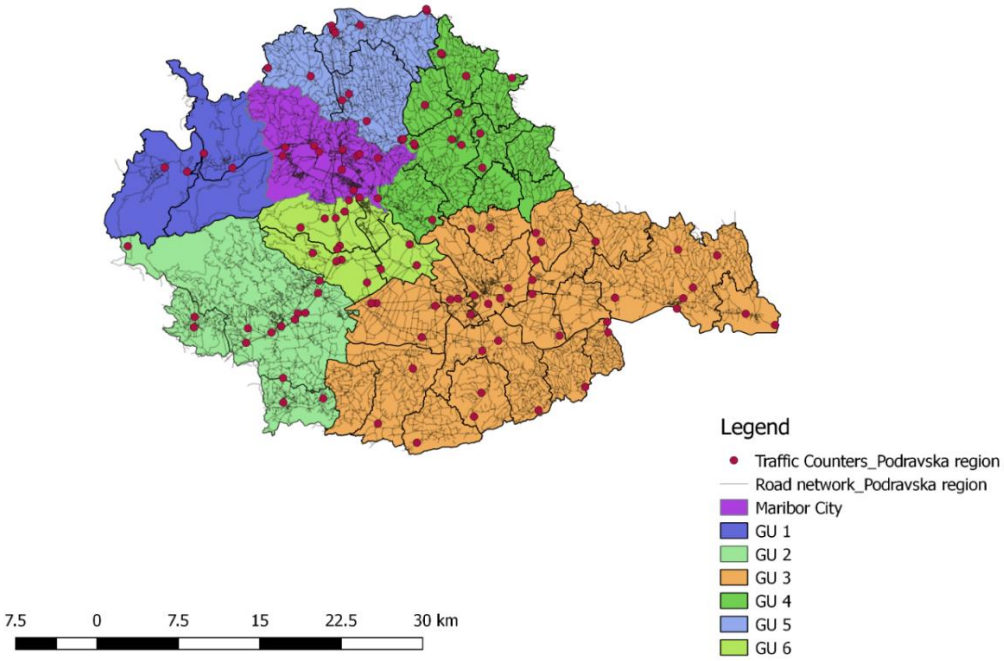

Figure 26: Location of traffic counters

Zones under consideration are equipped with the following number of traffic counters: Maribor City (MC) - 12, GU1 - 4, GU2 – 16, GU3 – 40, GU4 – 13, GU5 – 14 and GU6 – 14.

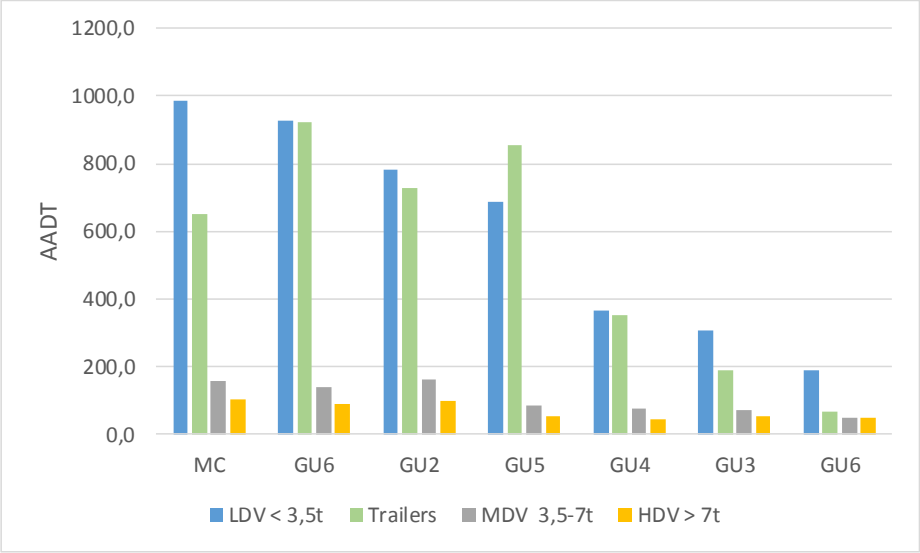

Figure 27: AADT for different freight vehicle categories and FUA zones

LDVs represents the highest share of AADT among all freight vehicle categories. In Maribor City zone AADT (average among all traffic counters in the zone) for this category is almost 1.000, in GU6 925, in GU2 780 and in GU5 685. The second most important category are trailers with AADT in Maribor City zone 648, GU6 921,

GU2 730 and GU5 854. Other vehicle categories are less important and are producing smaller numbers of AADT.

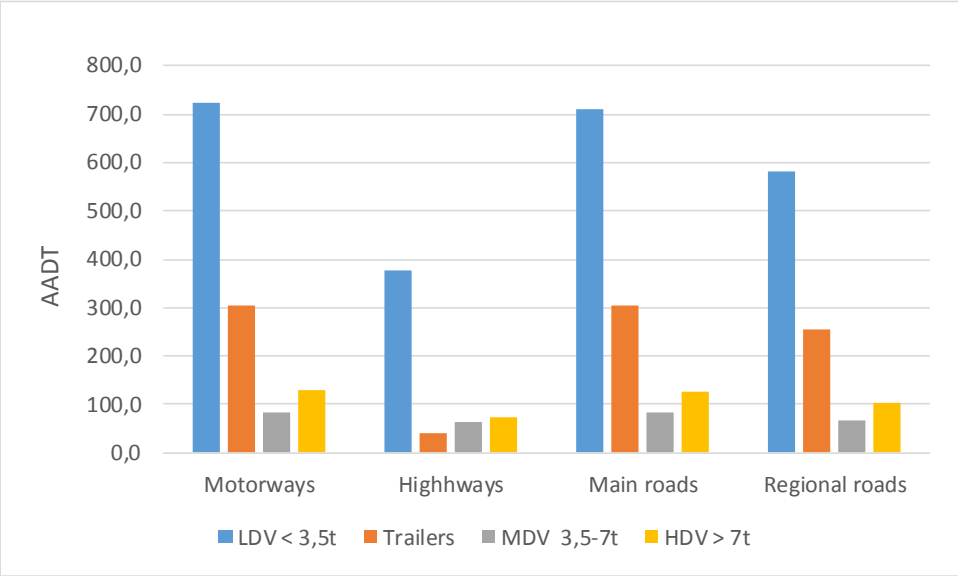

Figure 28: AADT for different freight vehicle categories and road types

LDVs are (on average) the most important among freight vehicle categories on all types of roads. The biggest share of LDV traffic is on motorways and main roads within the cities. Other categories of vehicles have on average lower values.

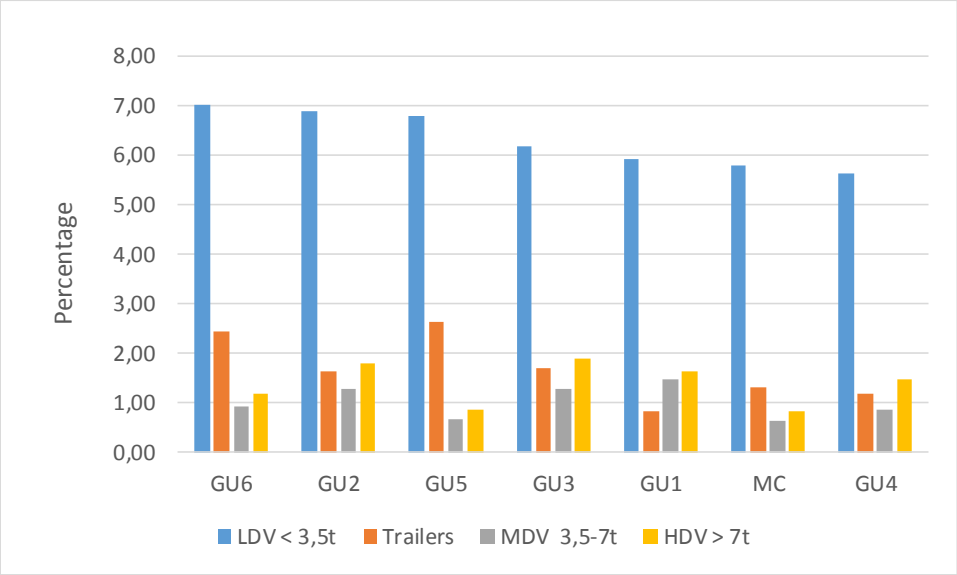

Figure 29: Percentage of freight vehicles AADT in comparison to overall AADT (all vehicle groups)

LDVs represent approximately 6% of the overall traffic in Maribor FUA. Other vehicle categories are much less relevant.

In general, Maribor FUA attracts and generates important volume of traffic flows. The majority of traffic is on the direction towards Celje and Ljubljana, the second most important is the traffic towards Austrian border and almost equally important the traffic towards Murska Sobota (and further on towards Hungary) and Ptuj (and further on towards Croatia).

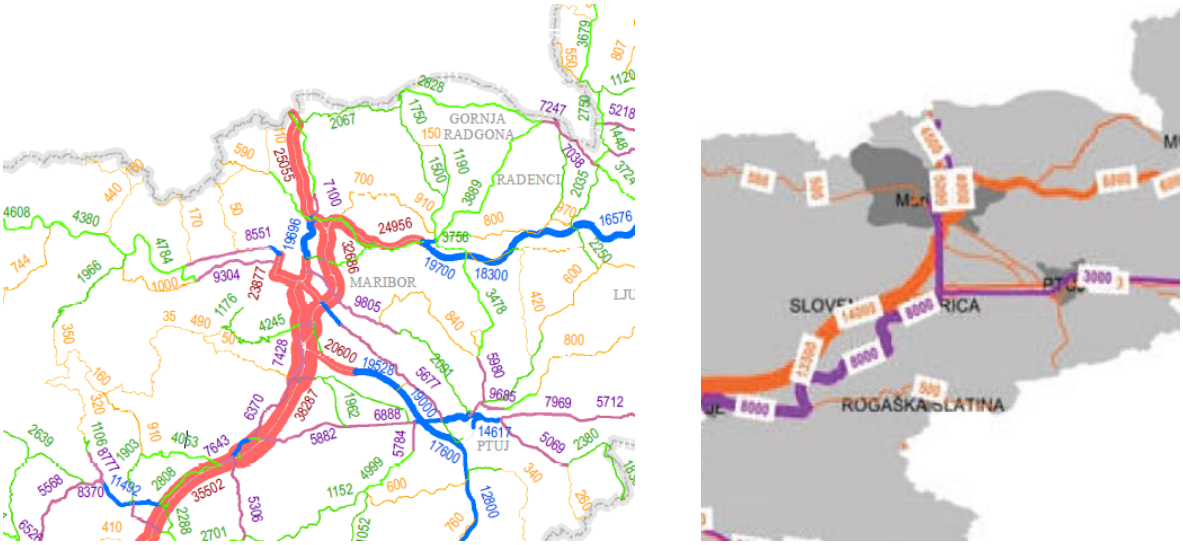

Figure 30: AADT on roads in Maribor FUA (on left side - *Source: Slovenian infrastructure agency*) and freight flows (in 1000 tons/year) for road and rail (orange and purple) on sections transiting Maribor FUA (on right side - *Source: Transport Development Strategy of the Republic of Slovenia Until 2030*).

As can be seen from the Figure 30, substantial share of traffic is transiting (bypassing) Maribor FUA, especially in direction "Ljubljana – Austria". This is valid for general traffic (left side of the figure) as well as for freight traffic flows (right side of the figure). At the same time a bit bigger share of freight flows is evident in direction to Murska Sobota (and further on to Hungary) in comparison with direction to Ptuj (and further on to Croatia).

Please report below the 3 matrixes (quantity, deliveries, vehicles) from the tool, for each considered supply chain:

At the very beginning of the modelling exercise, socio-economic data has been gathered for defined zones. A number of inhabitants and zones' surface has been obtained from official statistical data. Two supply chains (Foodstuffs – G47.1/G47.2 and Home accessories - G47,5) have been selected as a basis for generating OD matrices. Data on retail employees was obtained from Slovenian Business Register, number of warehouse employees was assessed via expert opinion (this data is not included in any publicly or commercially available database).

Table 1: ID zones, inhabitants and employees - FUA Maribor

Id Zone	Inhabitants	Surface (km²)	Retail Employees		Warehouse Employees	
			Foodstuffs (G47.1 + 2)	Home accessories (G47.5)	Foodstuffs	Home accessories
MC	111.735	148,00	304	430	55	60
GU1	14.602	210,00	0	11	0	2
GU2	33.993	331,00	65	53	10	8

GU3	84.177	856,00	69	41	11	6
GU4	22.572	273,00	18	36	1	4
GU5	20.538	190,00	39	0	5	0
GU6	35.844	192,00	49	13	5	2

As can be seen from the table 1, zone MC (Maribor City) has the highest population and also the biggest share of employees in relation to other zones in the FUA. Other zones are much less relevant for selected supply chains.

The second step was to define distances between selected zones in the FUA. This has been done with real distance measurements on Google maps (shortest route between the central position of two zones).

Table 2: The origin-destination distance matrix

Origin/Destination	MC	GU1	GU2	GU3	GU4	GU5	GU6
MC	10,500	20,000	24,000	34,000	21,000	28,000	13,000
GU1	20,000	2,300	34,000	49,000	37,000	41,000	29,000
GU2	24,000	34,000	1,500	32,000	28,000	34,000	16,000
GU3	34,000	49,000	32,000	24,000	20,000	57,000	25,000
GU4	21,000	37,000	28,000	20,000	1,500	29,000	26,000
GU5	28,000	41,000	34,000	57,000	29,000	1,800	28,000
GU6	13,000	29,000	16,000	25,000	26,000	28,000	2,300

The third step was to generate origin-destination quantity goods matrix for selected supply chains. Since neither survey on distribution flows nor survey with transport operators provided acceptably accurate data, we decided to obtain this data from the database available at the Slovenian Statistical Office. For the category of "Foodstuffs" we selected NSTR category nr. 4 - Food products, beverages and tobacco and for the category "Home accessories" a combination of various other categories relevant for this type of transported goods.

Table 3: Origin-destination quantity goods matrix – Foodstuffs

Origin/Destination	MC	GU1	GU2	GU3	GU4	GU5	GU6
MC	209,8	6,6	13,4	15,3	4,2	9,7	5,8
GU1	4,9	0,0	0,0	0,0	0,0	0,0	0,0
GU2	8,6	0,0	1,0	2,9	0,0	0,6	4,6
GU3	64,3	6,4	40,8	244,4	24,2	10,8	19,3
GU4	10,1	0,0	2,1	12,1	11,3	2,0	16,6
GU5	0,0	0,0	0,0	0,0	0,0	2,0	0,0
GU6	4,0	0,0	1,0	1,5	0,3	0,0	1,0
Total	301,8	13,0	58,3	276,2	40,0	25,2	47,3

What concerns the foodstuffs supply chain, two zones are of major importance, MC (Maribor City) with 209,8 tons/day and GU3 (zone of Ptuj and surrounding towns) with 244,4 tons/day. Freight flows between zones and intra zonal flows in other regions are much less relevant in this respect.

Table 4: Origin-destination quantity goods matrix – Home accessories

Origin/Destination	MC	GU1	GU2	GU3	GU4	GU5	GU6
MC	42,3	1,4	2,8	35,1	4,0	4,9	14,9
GU1	1,4	0,0	0,0	0,0	0,0	0,0	0,0
GU2	2,8	0,0	0,6	9,9	0,6	0,0	0,0
GU3	35,1	0,0	5,4	31,1	16,4	0,0	0,5
GU4	4,0	0,0	0,0	10,8	0,0	0,3	0,7
GU5	4,9	0,0	0,0	0,0	1,5	0,0	12,8
GU6	14,9	0,0	13,6	4,3	0,0	0,0	10,1
Total	105,4	1,4	22,4	91,3	22,5	5,2	38,9

What concerns the Home accessories supply chain, quantities of two most important zones (MC and GU3) are still prevailing in terms of intra zonal flows: MC (42,3 tons/day), GU3 (31,1 tons/day) and flows between zones MC-GU3 (35,1 tons/day).

In addition, transport service share and the shipment size were determined. Data was obtained from operators' surveys and amended with expert opinion. As already indicated in previous sections analysing results of transport operators' survey, this value differ quite substantially among transport operators and are very much dependent on the type of transported commodity. In consideration of these aspects, assessment of these values is supplemented with expert opinion.

Table 5: Transport service share and shipment size

Transport service share - p[r/od]	Foodstuffs	Home accessories
Retailer on own account (%)	13	18
Wholesaler on own account (%)	70	75
Third party (%)	17	7
Total (%)	**100**	**100**

Shipment size - q[r] (t)	Foodstuffs	Home accessories
Retailer on own account	0,1	0,1
Wholesaler on own account	2,2	1,5
Third party	1,2	0,8

On these basis several OD matrices were generated, indicating quantities of goods (Foodstuffs and Home accessories) for the retailer on own account, a wholesaler on own account and third party. The importance of MC and GU3 zone is again recognized but this time also the number of deliveries per day is shown: over 1.000 daily deliveries of foodstuffs and 377 daily deliveries of Home accessories in Maribor FUA.

Table 6: OD matrices – quantity of goods

Foodstuffs

Foodstuffs - retailer on own account [t/day]

Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	30,42	0,00	6,50	6,90	1,80	3,90	4,90	**54,44**
GU1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
GU2	4,49	0,00	0,96	1,02	0,27	0,58	0,72	**8,03**
GU3	4,99	0,00	1,07	1,13	0,30	0,64	0,81	**8,94**
GU4	0,34	0,00	0,07	0,08	0,02	0,04	0,05	**0,61**
GU5	2,06	0,00	0,44	0,47	0,12	0,26	0,33	**3,69**
GU6	2,06	0,00	0,44	0,47	0,12	0,26	0,33	**3,69**
Total	**44,37**	**0,00**	**9,49**	**10,07**	**2,63**	**5,69**	**7,15**	**79,39**

Foodstuffs - wholesaler on own account [t/day]

Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	163,81	0,00	35,03	37,18	9,70	21,02	26,40	**293,13**
GU1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
GU2	24,17	0,00	5,17	5,49	1,43	3,10	3,90	**43,24**
GU3	26,90	0,00	5,75	6,10	1,59	3,45	4,34	**48,13**
GU4	1,82	0,00	0,39	0,41	0,11	0,23	0,29	**3,26**
GU5	11,10	0,00	2,37	2,52	0,66	1,42	1,79	**19,86**
GU6	11,10	0,00	2,37	2,52	0,66	1,42	1,79	**19,86**
Total	**238,89**	**0,00**	**51,08**	**54,22**	**14,14**	**30,65**	**38,51**	**427,49**

Foodstuffs - third party [t/day]

Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	39,78	0,00	8,51	9,03	2,36	5,10	6,41	**71,19**
GU1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
GU2	5,87	0,00	1,25	1,33	0,35	0,75	0,95	**10,50**
GU3	6,53	0,00	1,40	1,48	0,39	0,84	1,05	**11,69**
GU4	0,44	0,00	0,09	0,10	0,03	0,06	0,07	**0,79**
GU5	2,70	0,00	0,58	0,61	0,16	0,35	0,43	**4,82**
GU6	2,70	0,00	0,58	0,61	0,16	0,35	0,43	**4,82**
Total	**58,02**	**0,00**	**12,40**	**13,17**	**3,44**	**7,44**	**9,35**	**103,82**

Foodstuffs - retailer on own account [deliveries/day] - NDod [r]

Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	304,22	0,00	65,05	69,05	18,01	39,03	49,04	**544,39**
GU1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
GU2	44,88	0,00	9,60	10,19	2,66	5,76	7,23	**80,31**
GU3	49,95	0,00	10,68	11,34	2,96	6,41	8,05	**89,38**
GU4	3,38	0,00	0,72	0,77	0,20	0,43	0,55	**6,06**
GU5	20,61	0,00	4,41	4,68	1,22	2,64	3,32	**36,88**
GU6	20,61	0,00	4,41	4,68	1,22	2,64	3,32	**36,88**
Total	**443,65**	**0,00**	**94,86**	**100,70**	**26,27**	**56,92**	**71,51**	**793,91**

Foodstuffs - wholesaler on own account [deliveries/day] - NDod [r]

Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	74,46	0,00	15,92	16,90	4,41	9,55	12,00	**133,24**
GU1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
GU2	10,98	0,00	2,35	2,49	0,65	1,41	1,77	**19,66**
GU3	12,23	0,00	2,61	2,77	0,72	1,57	1,97	**21,88**
GU4	0,83	0,00	0,18	0,19	0,05	0,11	0,13	**1,48**
GU5	5,04	0,00	1,08	1,15	0,30	0,65	0,81	**9,03**
GU6	5,04	0,00	1,08	1,15	0,30	0,65	0,81	**9,03**
Total	**108,59**	**0,00**	**23,22**	**24,65**	**6,43**	**13,93**	**17,50**	**194,31**

Foodstuffs - third party [deliveries/day] - NDod [r]

Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	33,15	0,00	7,09	7,52	1,96	4,25	5,34	**59,32**
GU1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
GU2	4,89	0,00	1,05	1,11	0,29	0,63	0,79	**8,75**
GU3	5,44	0,00	1,16	1,24	0,32	0,70	0,88	**9,74**
GU4	0,37	0,00	0,08	0,08	0,02	0,05	0,06	**0,66**
GU5	2,25	0,00	0,48	0,51	0,13	0,29	0,36	**4,02**
GU6	2,25	0,00	0,48	0,51	0,13	0,29	0,36	**4,02**
Total	**48,35**	**0,00**	**10,34**	**10,97**	**2,86**	**6,20**	**7,79**	**86,52**

Home accessories

Home accessories - retailer on own account [t/day]

Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	6,16	0,16	0,76	0,59	0,52	0,00	0,19	**8,36**
GU1	2,46	0,06	0,30	0,23	0,21	0,00	0,07	**3,34**
GU2	3,57	0,09	0,44	0,34	0,30	0,00	0,11	**4,85**
GU3	3,31	0,08	0,41	0,32	0,28	0,00	0,10	**4,49**
GU4	2,96	0,08	0,37	0,28	0,25	0,00	0,09	**4,02**
GU5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
GU6	2,46	0,06	0,30	0,23	0,21	0,00	0,07	**3,34**
Total	**20,91**	**0,54**	**2,58**	**1,99**	**1,75**	**0,00**	**0,63**	**28,40**

Home accessories - wholesaler on own account [t/day]

Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	25,66	0,66	3,16	2,45	2,15	0,00	0,78	**34,85**
GU1	10,24	0,26	1,26	0,98	0,86	0,00	0,31	**13,90**
GU2	14,89	0,38	1,83	1,42	1,25	0,00	0,45	**20,22**
GU3	13,77	0,35	1,70	1,31	1,15	0,00	0,42	**18,71**
GU4	12,34	0,32	1,52	1,18	1,03	0,00	0,37	**16,77**
GU5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
GU6	10,24	0,26	1,26	0,98	0,86	0,00	0,31	**13,90**
Total	**87,14**	**2,23**	**10,74**	**8,31**	**7,30**	**0,00**	**2,63**	**118,35**

Home accessories - third party [t/day]

Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	2,40	0,06	0,30	0,23	0,20	0,00	0,07	**3,25**
GU1	0,96	0,02	0,12	0,09	0,08	0,00	0,03	**1,30**
GU2	1,39	0,04	0,17	0,13	0,12	0,00	0,04	**1,89**
GU3	1,29	0,03	0,16	0,12	0,11	0,00	0,04	**1,75**
GU4	1,15	0,03	0,14	0,11	0,10	0,00	0,03	**1,56**
GU5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
GU6	0,96	0,02	0,12	0,09	0,08	0,00	0,03	**1,30**
Total	**8,13**	**0,21**	**1,00**	**0,78**	**0,68**	**0,00**	**0,25**	**11,05**

Home accessories - retailer on own account [deliveries/day] - NDod [r]

Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	61,59	1,58	7,59	5,87	5,16	0,00	1,86	**83,64**
GU1	24,57	0,63	3,03	2,34	2,06	0,00	0,74	**33,37**
GU2	35,73	0,91	4,40	3,41	2,99	0,00	1,08	**48,53**
GU3	33,06	0,85	4,07	3,15	2,77	0,00	1,00	**44,90**
GU4	29,63	0,76	3,65	2,82	2,48	0,00	0,90	**40,24**
GU5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
GU6	24,57	0,63	3,03	2,34	2,06	0,00	0,74	**33,37**
Total	**209,14**	**5,35**	**25,78**	**19,94**	**17,51**	**0,00**	**6,32**	**284,04**

Home accessories - wholesaler on own account [deliveries/day] - NDod [r]

Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	17,11	0,44	2,11	1,63	1,43	0,00	0,52	**23,23**
GU1	6,82	0,17	0,84	0,65	0,57	0,00	0,21	**9,27**
GU2	9,93	0,25	1,22	0,95	0,83	0,00	0,30	**13,48**
GU3	9,18	0,23	1,13	0,88	0,77	0,00	0,28	**12,47**
GU4	8,23	0,21	1,01	0,78	0,69	0,00	0,25	**11,18**
GU5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
GU6	6,82	0,17	0,84	0,65	0,57	0,00	0,21	**9,27**
Total	**58,09**	**1,49**	**7,16**	**5,54**	**4,86**	**0,00**	**1,76**	**78,90**

Home accessories - third party [deliveries/day] - NDod [r]

Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	2,99	0,08	0,37	0,29	0,25	0,00	0,09	**4,07**
GU1	1,19	0,03	0,15	0,11	0,10	0,00	0,04	**1,62**
GU2	1,74	0,04	0,21	0,17	0,15	0,00	0,05	**2,36**
GU3	1,61	0,04	0,20	0,15	0,13	0,00	0,05	**2,18**
GU4	1,44	0,04	0,18	0,14	0,12	0,00	0,04	**1,96**
GU5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
GU6	1,19	0,03	0,15	0,11	0,10	0,00	0,04	**1,62**
Total	**10,17**	**0,26**	**1,25**	**0,97**	**0,85**	**0,00**	**0,31**	**13,81**

Following the process of OD matrices creation, definition of time interval share and the vehicle type probability was done. A number of stops per tour have been obtained from transport operators' survey focusing on characteristics of deliveries to urban areas. The probability of transport services for the morning and afternoon period and the probability of selection of LGV or MGV has been obtained from the combination of distribution survey and transport operators survey.

Table 7: Time interval share and the vehicle time probability

Stops/delivery per tour - nd	4

Transport service - p [τ/od]	Foodstuffs	Home accessories
Morning (%)	85	84
Afternoon(%)	15	16
Total (%)	100	100

Vehicle type - p [v/τod]	Probability
Light Goods Vehicle (LGV, < 1,5 t) (%)	20
Medium Goods Vehicle (MGV, 1,5 - 3,5 t) (%)	80
Total	100

As a final result of the model, 4 matrices were created to be used for assignment of vehicles to road transport infrastructure in the Maribor FUA. Two matrices are for LGVs and two for MGVs.

Table 8: OD matrices for morning and afternoon and for LGV and MGV

Table AS1 - Morning LGV - total [vehicle/day]								
Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	20,93	0,09	4,17	4,30	1,32	2,25	2,92	**35,98**
GU1	1,37	0,04	0,17	0,13	0,11	0,00	0,04	**1,86**
GU2	4,57	0,05	0,80	0,78	0,32	0,33	0,48	**7,32**
GU3	4,72	0,05	0,84	0,83	0,32	0,37	0,52	**7,64**
GU4	1,85	0,04	0,25	0,20	0,15	0,02	0,08	**2,59**
GU5	1,19	0,00	0,25	0,27	0,07	0,15	0,19	**2,12**
GU6	2,55	0,04	0,42	0,40	0,18	0,15	0,23	**3,98**
Total	**37,18**	**0,30**	**6,89**	**6,90**	**2,49**	**3,27**	**4,47**	**61,50**
Table AS2 - Afternoon LGV - total [vehicle/day]								
Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	3,74	0,02	0,74	0,76	0,24	0,40	0,52	**6,41**
GU1	0,26	0,01	0,03	0,02	0,02	0,00	0,01	**0,35**
GU2	0,83	0,01	0,14	0,14	0,06	0,06	0,08	**1,33**
GU3	0,86	0,01	0,15	0,15	0,06	0,07	0,09	**1,38**
GU4	0,35	0,01	0,05	0,04	0,03	0,00	0,02	**0,49**
GU5	0,21	0,00	0,04	0,05	0,01	0,03	0,03	**0,37**
GU6	0,47	0,01	0,08	0,07	0,03	0,03	0,04	**0,73**
Total	**6,72**	**0,06**	**1,24**	**1,23**	**0,45**	**0,58**	**0,79**	**11,07**
Table AS3 - Morning MGV - total [vehicle/day]								
Origin	MC	GU1	GU2	GU3	GU4	GU5	GU6	Total
MC	83,73	0,35	16,66	17,20	5,29	8,98	11,70	**143,92**
GU1	5,47	0,14	0,67	0,52	0,46	0,00	0,17	**7,44**
GU2	18,29	0,20	3,19	3,10	1,28	1,33	1,91	**29,30**
GU3	18,86	0,19	3,37	3,31	1,30	1,47	2,08	**30,57**
GU4	7,38	0,17	0,98	0,81	0,60	0,10	0,33	**10,36**
GU5	4,74	0,00	1,01	1,08	0,28	0,61	0,76	**8,49**
GU6	10,22	0,14	1,69	1,60	0,74	0,61	0,93	**15,92**
Total	**148,70**	**1,19**	**27,57**	**27,62**	**9,95**	**13,10**	**17,87**	**246,00**

Table AS4 - Afternoon MGV - total [vehicle/day]								
Origin	**MC**	**GU1**	**GU2**	**GU3**	**GU4**	**GU5**	**GU6**	**Total**
MC	14,97	0,07	2,96	3,05	0,95	1,59	2,07	**25,66**
GU1	1,04	0,03	0,13	0,10	0,09	0,00	0,03	**1,42**
GU2	3,34	0,04	0,58	0,56	0,23	0,23	0,34	**5,32**
GU3	3,43	0,04	0,61	0,59	0,24	0,26	0,37	**5,54**
GU4	1,39	0,03	0,18	0,15	0,11	0,02	0,06	**1,95**
GU5	0,84	0,00	0,18	0,19	0,05	0,11	0,13	**1,50**
GU6	1,88	0,03	0,31	0,29	0,14	0,11	0,17	**2,91**
Total	**26,89**	**0,23**	**4,95**	**4,94**	**1,81**	**2,31**	**3,17**	**44,30**

Aa can be seen from the table 8, the biggest share of vehicles to be assigned on the road network are MGVs in the morning period (246 vehicles in total), followed by LGVs in the morning period (61 vehicles in total), MGVs in the afternoon period (44 vehicles) and LGVs in the afternoon period. At this point it needs to be emphasized once again that this represents only two supply chains which are most relevant for distribution flows in the region. Total number of freight vehicles to be assigned on the network is substantially bigger.

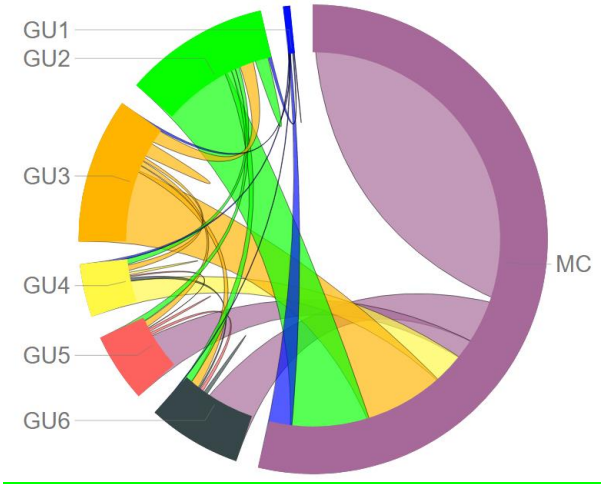

Figure 31: Shares of vehicle trips within and between zones (geographical units) of the Maribor FUA

The majority of vehicle trips for the analysed supply chains have its origin and/or destination within the city of Maribor. This clearly confirms that the city of Maribor is a central cone of the FUA and that measures implemented in the Municipality of Maribor would influence the entire FUA.

TRAFFIC ASSIGNMENT – TRAFFIC MODEL

In order to fully understand the urban freight transport in the Municipality of Maribor (as central part of wider FUA Podravje region), we have deployed multi-modal transport model on whole Municipality of Maribor area based on:

- statistical data about economic production in whole Podravje region,
- survey among transport companies and
- data from national traffic counters.

Model includes 5 separate categories of freight vehicles, which are assigned to the road network simultaneously with personal cars (in order to avoid assignment of freight vehicles to the empty road network).

With the model, efficiency of wide range of traffic measures in the city can now be tested (e.g. widening of pedestrian zone, changing of corridors allowed for heavy freight traffic, changed system of deliveries in the city centre, etc.).

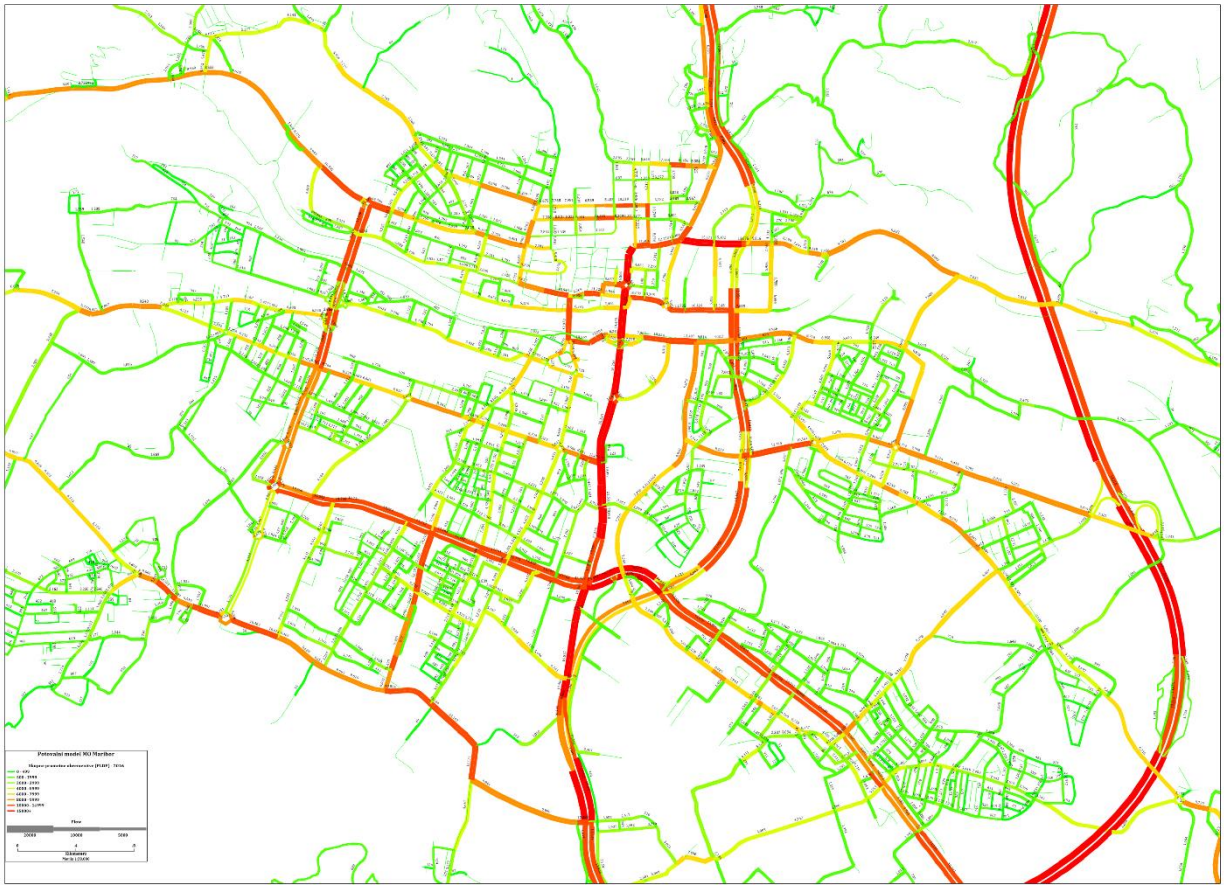

Figure 32: Annual average daily traffic – all vehicles. Transport model of current situation (without implemented traffic measures).

Multi-modal transport model of current situation provides solid base for analysis of current driver behaviour, defining real main traffic flow directions and evidencing current bottlenecks for personal cars as well as for 5 different categories of duty vehicles. It allows us to search for more optimal routes for traffic in transit and better organisation of traffic flows in the city by itself. It also represents initial state towards which all future scenarios can be compared.

Traffic model results confirmed expected list of most problematic routes/directions in the city and its surrounding. Additionally, it provides exacts number of vehicles (for each vehicle category) what enables development of traffic measures, focused on specific vehicle category) and later also their testing.

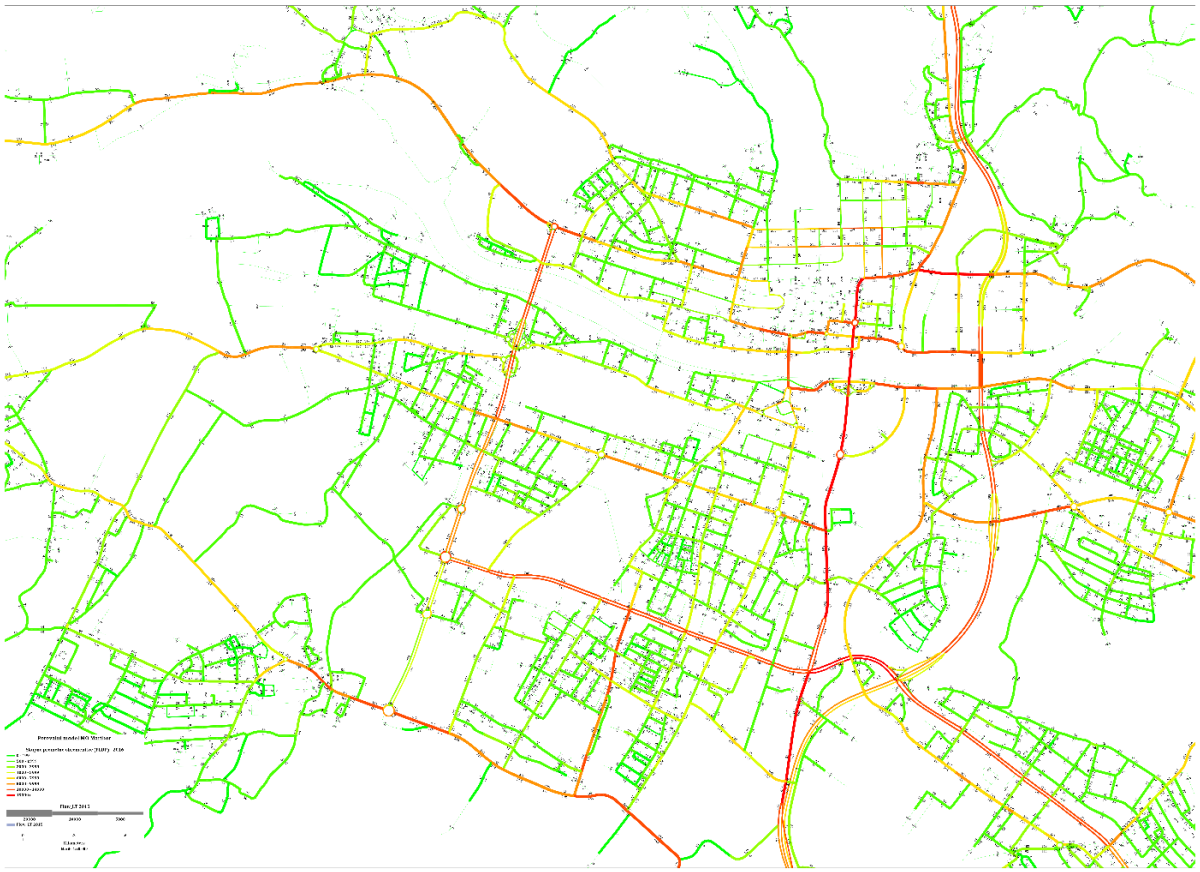

Figure 33: Annual average daily traffic – light duty vehicles. Transport model of current situation (without implemented traffic measures).

Fig. 33 represents initial traffic situation for light duty vehicles. While heavy duty traffic in the city is limited to certain road corridors & times, this is not valid also for a light duty vehicles. For them are (at the moment) valid the same rules as for personal vehicle traffic. With the developed transport model we are now able to deal light duty vehicles as isolated group and check the efficiency of suggested measures specifically on this transport mode and also on overall transport system in the city.

Consequently, there was tested wide range of traffic measures:

- resizing of pedestrian zone (since light duty vehicles must follow certain set of strict rules to use pedestrian area),
- redefining of future corridors for heavy freight traffic (since there are planned some major changes in road network – south bypass ring road, construction of several important links in the city, widening of pedestrian zones / shared space zones, ...)
- changes of delivery system for the city centre (changes in allowance times for delivery, changes of delivery system – introduction of loading bays and trolleys & Urban Consolidation Centres.

Please provide a comment (qualitative description) for you tool's results, e.g.:

- *Vehicle-km travelled by each type of vehicle within the study area*
- *Traffic pollutant and greenhouse emissions*
- *Network assignment*
- *Other?*

Road transport is prevailing mode for short distance freight deliveries which is typical for functional urban areas addressed by the project SULPiTER. The same holds true for the functional urban area of Maribor - practically all freight deliveries are performed by the road transport.

Statistical office of the Republic of Slovenia is (among others) providing data on number of performed trips, total volume of transported freight and occupancy rates of freight vehicles. For the Podravje region (NUTS 3 category corresponding to the FUA Maribor), 49% of all trips (in total 750.000 per year) and 62% of road freight transport (in total 9,3 mio ton per year) has its origin and destination within the urban functional area. In that respect, supply chain aspects and logistics activities of FUA are of most importance. When considering occupancy rates of transport trips within the region, 40% of empty driven kilometres and 48% of empty trips can be observed, showing the problem of low utilisation of freight vehicles and empty runs within the FUA.

LS INDEX:

Logistics Sustainable Index methodology has been applied to Maribor FUA based on information gathered by University of Maribor, Municipality of Maribor and with support of experts and stakeholders. "Before" is to be understood as current situation and is the basis for evaluation of measures considered for implementation.

Table 9: Impact area performance for before scenario

Before	
Impact area	**Impact area performance**
Economy and Energy	0,400
Environment	-0,329
Transport and mobility	0,312
Society	0,231
Policy and measure maturity	-0,320
Social acceptance	0,168
User uptake	0,092
LSI	**0,555**

In order to demonstrate usability of LSI for logistics measures' impact evaluation, establishment of Urban Consolidation Centre (UCC) including deployment of electric vehicle for delivery from UCC to pedestrian zone in Maribor city centre was considered. The impact on LSI is shown below:

Table 10: Impact area performance for after scenario

After	
Impact area	**Impact area performance**
Economy and Energy	0,430
Environment	-0,285
Transport and mobility	0,498
Society	0,282
Policy and measure maturity	-0,174
Social acceptance	0,326
User uptake	0,130
LSI	**1,207**

With the implementation of proposed UCC (together with electric delivery vehicle), the LSI would increase from 0,555 to 1,207. This should be seen as positive. As costs have been considered as negative values and benefits as positive ones, when the Logistic Sustainability Index increases, the overall performance of the chosen city logistics measure improves, as well.

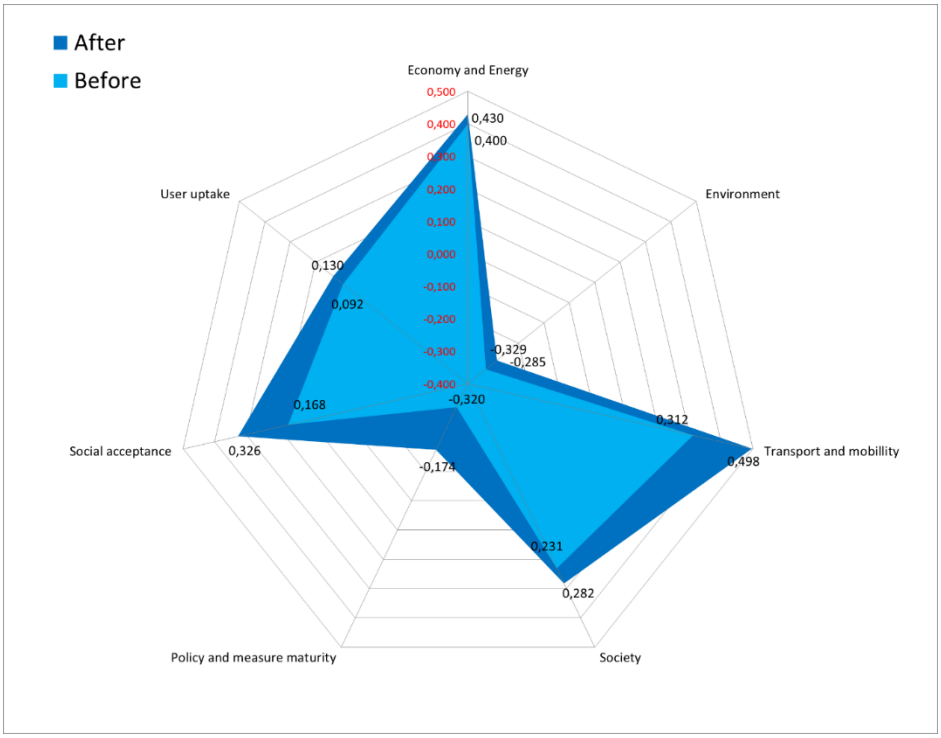

Figure 34: Performance per impact area for "Before" and "After" scenario

Overall, the effect is positive for all impact areas of LSI. Most positive effect is evident in "Transport and Mobility" for number of accidents is lowered, level of service as well as safety and security are higher. Both the "Society" and "Social acceptance" impact areas demonstrate an increase as the perceived quality of life and the involvement degree of the stakeholders oriented towards environmental preservation involved are higher in the "after" scenario. "Economy and Energy" performance improves only slightly since the costs for

establishment of UCC are considered as negative effects diminishing positive impact to lower level. The "Environment" impact area shows moderate increase for the vehicle/kilometres and number of diesel vehicles are only moderately reduced. "Policy and measure maturity" and "User uptake" both show increase for participating stakeholders have expressed acceptance of the proposed measure.

The usability of LSI has been sufficiently demonstrated and the LSI will be further used for evaluation of measures within Freight Quality Partnerships.

4. Annexes

- *Complete tables of the O/D Matrices*
- *The final results of the LSI calculations*
- *The distribution surveys - database*
- *Transport operators survey – questionnaire + database*
- *SHP files*