CITY LOGISTICS IN THE MONTENEGRIN COASTAL REGION

Ljubinka Ivanović*
Center for logistics and transportation *"Z-Logistics"* Bar, clt@t-com.me
Željko Ivanović
Center for logistics and transportation *"Z-Logistics"* Bar, bubazel@t-com.me

***Abstract**: The subject of research in this work is logistics flows and systems in the Montenegrin coastal region as a unique geographical area in the south west part of Montenegro. The research presented in this article is based on systematic approach and its objective is forming the basis for designing a new solution of logistic concept for the aglomeration in question. The newly developed concept is designed to facilitate overcoming of numerous currently occuring problems regarding logistics and to enable realization of total optimization of regional logistic processes and making necessary postulates for improved design, organisation, realisation and control of all logistic processes and systems in the region.*

***Keywords:** City logistics, concept, flows.*

* Corresponding author

1. INTRODUCTION

The urbanization of the Montenegrin coastal region (MCR) is taking place at an accelerating rate thus creating large number of problems. Higher flows of traffic in the area, which are unavoidable during periods of urbanization, is placing pressure on the existing traffic network, leading to time losses, traffic jams, higher pollution rate owing to emissions of harmful gases, and higher level of noise and vibration caused by freight vehicles. All these information to initiate the research aimed at elaboration of a programme designed to spur development of sustainable *logistic concept* (LC) for this region, with orientation to quality of logistic service complying with ecologic and economic principles.

The level of awareness of distinctly articulated needs for overcoming numerous problematic areas related to regional logistics, unorganized and random development of logistics in the area of MCR with addition of a series of accompanying negative impacts as well as the fact that logistics in this region was not entirely and integraly analysed in previous period created strong motives for defining the objective of the research – *defining integrated logistic profile of the region*.

2. METHODOLOGICAL APPROACH TO RESEARCH

Research of the logistic profiles is a complex and complicated process. The research process itself for the region in question is based on systematic aproach (Figure 1).

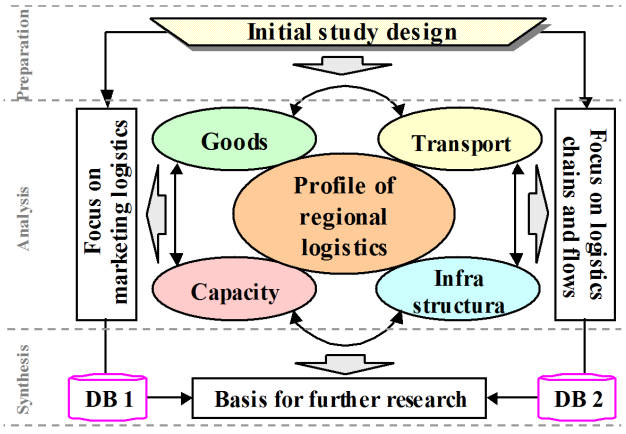

Figure 1. Approach to research

To gain realistic data, the authors conducted investigation which comprises: (i) physical counting of generators on the entire area of the region, and (ii) opinion research of the subjects involved in regional logistics.

3. RESULTS OF RESEARCH

In order to effectively analyse and present basic characteristics of logistics flows in the following units of this work, all generators of logistics demands needed to be divided into groups according to specific economic activities including [2]: generators for regional industry - **G1**, generators for construction - **G2**, generators for retail - **G3**, generators for hotels and catering - **G4**, other generators - **G5**. Defined groups of generators were observed for two specific periods: (i) Off-season period of 273 days; (ii) Season period of 92 days.

The generators of logistics demands on MCR were represented by [2]: (i) 2,503 generators during the off-season; (ii) 3,485 generators during season. Each generator of logistics demands presents a subsystem of marketing logistics of the region with different characteristics of the demand**.** In order to have a better understanding of the facts, both specific period generators of logistics demands are grouped into 26 distinctive groups.

Hotels and restaurants are the most common demand factor when it comes to traveling off-season (23.61%) and during season (29.38%). In addition to this group of generators there are grocery stores, and they participate in the overall structure of generators with 21.53% during off-season period and 18.45% in the peak of tourist season. These two groups make up almost half of generators of the total number of generators during off-season (45.15%) and in the peak of tourist season (47.83%). This indicates that hotel industry and trade are dominant activities in the region.

Results of done analysis viewed from the aspect of marketing logistics show that:

1) 30% of generators have a low share of the total storage space of facilities (as in Figure 2);
2) Facilities with food products have a storage area behind the retail section of the building. Moreover in more than 90% of cases associated with adequate space built for a delivery vehicle, so the goods does not pass through sales part in the process unloading the delivery vans.
3) There is greater interest from potential buyers in smaller facilities, as evidenced by the fact that more than 70% of the buildings have an area of less than 50m^2.

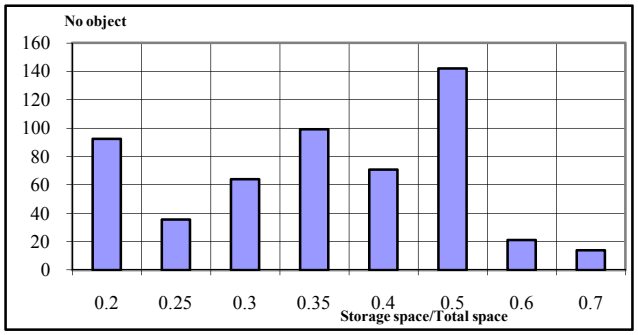

Figure 2. Participation storage in object [2]

4) 2,503 observed generators of logistics requirements during off-season use an average of 3,392.8 road freight vehicles [2] of different capacities per day. Most transport requirements have generators in Bar with average 986.9 requests per day, which represents 29.09% of the total number of transport requests in the observed region.
5) 3,485 observed generators of logistics requirements during the season use an average of 7,354.4 road freight vehicles of different capacities per day, which represents a 116.76% increase in the number of delivery vehicles compared to off-season period.
6) Facilities with food products during off-season period use on average 1,058.9 delivery vehicles per day or 31.21% of the total number (3,392.8) of vehicles in this period [2]. During the season, food facilities move on average 2,201.1 delivery vehicles per day or 29.93% of the total number of these vehicles in this period.
7) Hotels and restaurants in off-season, on average use 956.8 vehicles per day, or 28.20% of the total number of this period. Regarding season period, these facilities run on average 2,971 vehicles per day, representing 40.39% of the total number of vehicles for this period.
8) Craft shops in off-season run on average 227.2 vehicles per day, or 6.7% of the total vehicle's moves for this period. Regarding off-season period, these generators run on average about 360 vehicles, or 4.87% of the otal number of movements for this period;
9) The minimum requirements to run vehicles during off-season are attributed to bookstores 2.6 starts per day or 0.08%, followed by furniture shops 3.2 starts which is 0.09% of all starts per day. These generators also have minimum requirements during the season as well. The average annual number of vehicles runnings per capita during off-season is 9.12,

while the average annual number of vehicles runnings per km^2 is 778,36.

10) In overall structure of commercial delivery vehicles during off-season major presence have delivery vehicles with the capacity of 1.5 t - 3t with a share of 32.1%, while the share of vehicles with carrying capacity up to 1.5t is 26.6%, vehicles with capacity from 3t to 7t is 16.3% and vehicles with a carrying capacity over 7t is 8.4%. This structure can be interpreted as a consequence of the presence of a large number of small facilities, which in most cases to deliver the goods use their own vehicles;
11) In overall structure of commercial delivery vehicles (Figure 3) during the off-season major presence has delivery vehicles with the capacity of 1,5 t - 3t with a share of 32,1%, while the share of vehicles carrying capacity up to 1,5t is 26.6%, vehicles capacity from 3t to 7t is 16,3% and vehicles with a carrying capacity exceeding 7t is 8,4%. This structure can be interpreted as a consequence of the presence of a large number of small objects, which in most cases to deliver the goods use their own vehicles;

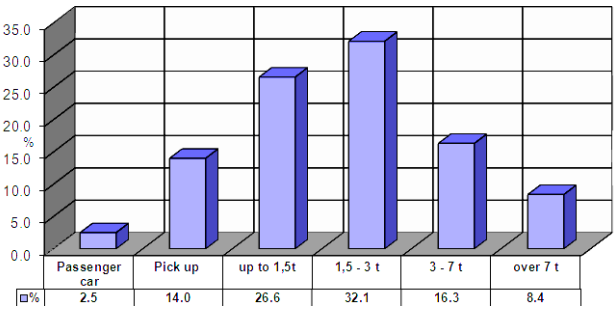

Figure 3. Capacity of delivery vehicles - off-season [2]

12) carrying capacity up to 1.5t is 26.6%, vehicles with capacity from 3t to 7t is 16.3% and vehicles with a carrying capacity over 7t is 8.4%;
13) In overall structure of delivery vehicles during summer season, the highest representation have vehicles with carrying capacity up to 1.5t with the share of 32.1%, followed by vehicles with capacity from 1.5t to 3t with 31.7%, then vehicles from 3t to 7t with 15% and vehicles with a payload over 7t accounted for 5.7% in total structure;
14) The total retention time of vehicles in off-season is 163,453.8 minutes per day, or 48.17 minutes per vehicle, with a large number of vehicles taking up to 35 minutes to unloding;
15) During the season, the total waiting time of all vehicles is 46,4426.8 minutes, or 63.01 min/vehicle, which represents a difference of 300,973 minutes per vehicle, with a large number of vehicles taking up to 35 minutes to unloding. waiting biggest reasons are: (i) the number of vehicles on the road, (ii) the profile view, and (iii) the number of requests for delivery;
16) In off-season 539 stores with foodstuffs used 1,058.9 vehicles/day, or 21.53%, while the first four groups of generators with 549 facilities, used 42.04 vehicles/day or 1.24%. The largest number of generators (Figure 8) required 1.5 deliveries/day;

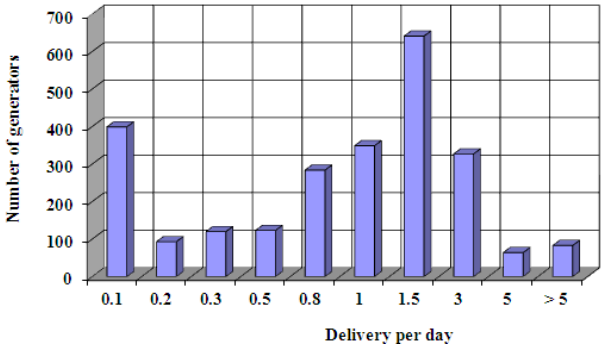

Figure 4. Objects in the generation of requests off season

17) Generators during the season used an average of 7,354.4 vehicles/day, or +116.76% compared to off-season. The largest number of generators (Figure 5) required 3 deliveries per day;

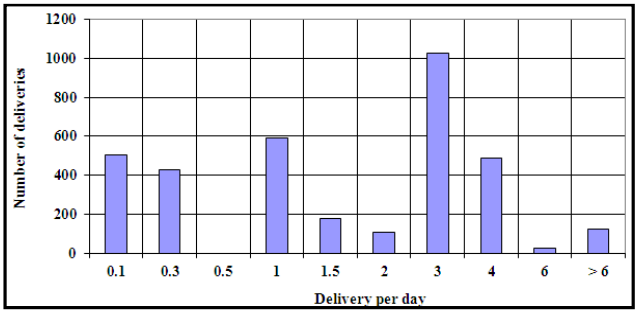

Figure 5. Objects in the generation of requests - season

18) Size of delivery per generator is between 0.5t and 0.7m^3. Weight of the package usually varied between 20 and 50kg;
19) Retail food stores in 90% of cases have their own delivery vehicles, and 30% have vehicles with different capacities;
20) Unloading goods involves two manual workers in 70% of cases, three workers in 10% of cases, and more than three workers in 20% of cases;
21) In 60% of cases goods are being unloaded by hand, or in 40% of cases by hand carts and pallet trucks;

22) In 30% of cases, goods are ordered only in writing, and in 50% of cases both in writing and by phone, and in 20% of cases only by phone;
23) In 10% of cases there is a positive opinion about the night supply of goods.

About 72% of transported goods is carried out starting with a large number of runs of freight vehicles, while the remaining quantity of goods (about 28%) generates a small number of requirements for runs of freight vehicles.

3.1 Logistics flows for regional industry – G1

The industry in the MCR generated 44,779t of goods (as in Figure 6).

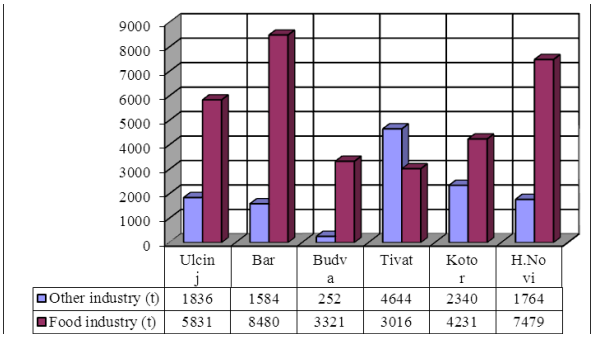

Figure 6. Flows for the industry per city [2]

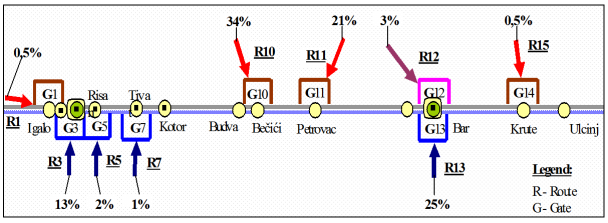

Figure 7. G1 - Goods flows [2]

Table 1. G1 - Transport facilities (%)

Type of transport facility	Direction of delivery of goods for the industry (R – Route)								
	R1	R3	R5	R7	R10	R11	R12	R13	R15
Car & pick up	-	-	-	-	-	-	-	-	-
Van	-	-	-	2	2	-	-	90	-
Van up to 3,5t	-	-	-	3	3	-	-	10	-
Van over 3,5 – 7t	15	-	-	-	10	10	-	-	-
Van over 7t	80	-	-	-	85	85	-	-	-
Wagon	-	-	-	-	-	-	100	-	-
Ship	-	100	100	100	-	-	-	100	-
Airplane	-	-	-	-	-	-	-	-	-

Table 2. G1 - Frequency of transport facilities (number)

Type of transport facility	Direction of delivery of goods for the industry (R – Route)								
	R1	R3	R5	R7	R10	R11	R12	R13	R15
Car & pick up	-	-	-	-	-	-	-	-	-
Van	-	-	-	-	203	122	-	-	365
Van up to 3,5t	44	-	-	-	183	110	-	-	120
Van over 3,5 – 7t	65	-	-	-	305	183	-	-	-
Van over 7t	145	-	-	-	1,078	647	-	-	-
Wagon	-	-	-	-	-	-	135	-	-
Ship	-	5	1	2	-	-	-	7	-
Airplane	-	-	-	-	-	-	-	-	-
TOTAL	**254**	**5**	**1**	**2**	**1,769**	**1,062**	**135**	**7**	**485**

The needs of industry according to characteristics and representation of certain manufacturing activities are divided into two groups: the food industry with a share of 72.26%, and for the rest of the industry with a share of 27.74%. Regarding goods flows, 59% of goods flows (Figure 7) were implemented by land routes, and 41% by water routes.

3.2 Logistics flows for the construction - G2

Regional generators related to construction in the region of the MCR [2] have generated 154,004t of goods (as in Figure 8).

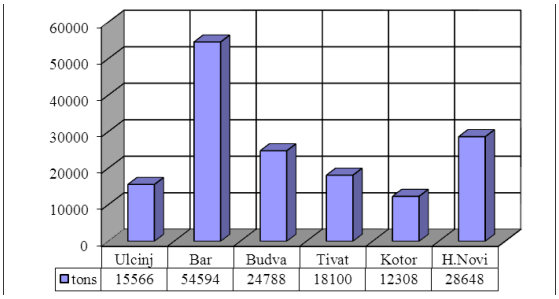

Figure 8. Flows for the construction per city [2]

Regarding the directions, 21.82% of goods flows (as in Figure 9) were implemented by land routes, and 78.18% by water routes.

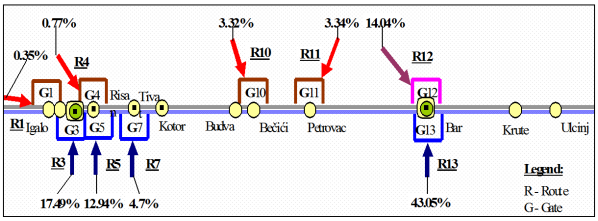

Figure 9. G2 - Goods flows [2]

Table 3. G2 - Transport facilities (%)

Type of transport facility	Direction of delivery of goods for the construction (R – Route)								
	R1	R3	R4	R5	R7	R10	R11	R12	R13
Car & pick up	-	-	-	-	-	-	-	-	-
Van	-	-	-	-	-	-	-	-	-
Van up to 3,5t	3	-	2	-	-	3	3	-	-
Van over 3,5 – 7t	7	-	13	-	-	10	9	-	-
Van over 7t	90	-	85	-	-	87	88	-	-
Wagon	-	-	-	-	-	-	-	100	-
Ship	-	100	-	100	100	-	-	-	100
Airplane	-	-	-	-	-	-	-	-	-

Table 4. Frequency of transport facilities (number)

Type of transport facility	Direction of delivery of goods for the construction (R – Route)									
	R1	R1	R3	R4	R5	R7	R10	R11	R12	R13
Car & pick up	-	-	-	-	-	-	-	-	-	-
Van	-	-	-	-	-	-	-	-	-	-
Van up to 3,5t	3	16	-	10	-	-	406	296	-	-
Van over 3,5 – 7t	7	19	-	34	-	-	676	445	-	-
Van over 7t	90	98	-	92	-	-	2452	1815	-	-
Wagon	-	-	-	-	-	-	-	-	131	-
Ship	-	-	9	-	11	4	-	-	-	15
Airplane	-	-	-	-	-	-	-	-	-	-
TOTAL		**133**	**9**	**136**	**11**	**4**	**3534**	**2556**	**131**	**15**

It is clear that the construction industry uses sea water gates and dominant transport system, which can be interpreted as a positive influence not logistics opportunities in the region.

3.3. Logistics flows for trade - G3

Retail trade in the region generated 232,087t of goods. Grocery stores participate with 81.70%, stores with technical goods participate with 6.37%, stores with consumer goods participate with 1.25%, with footwear and textiles with 0.57%, and stores with other goods with 10.11%.

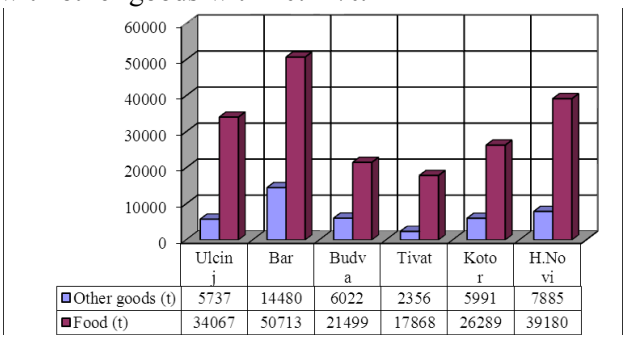

Figure 10. Flows for trade per city of the region [2]

69.4% of goods flows (as in Figure 19) were realized by land, 30.5% by water, and 0.1% by air way.

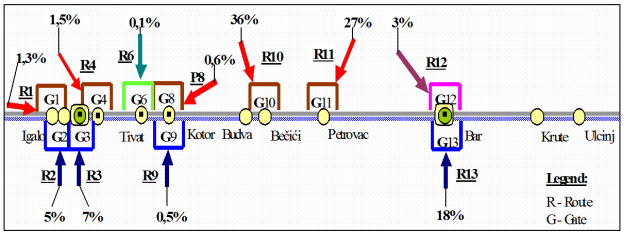

Figure 11. G3 - Goods flows [2]

Table 5. G3 - Transport facilities (%)

Type of transport facilities	Direction of delivery of goods for the trade (R – Route)										
	R_1	R_2	R_3	R_4	R_6	R_8	R_9	R_{10}	R_{11}	R_{12}	R_{13}
Car & pick up	-	-	-	1	-	3	-	3	2	-	-
Van	2	-	-	11	-	20	-	13	14	-	-
Van up to 3,5t	3	-	-	24	-	45	-	18	19	-	-
Van over 3,5 – 7t	30	-	-	32	-	30	-	34	35	-	-
Van over 7t	65	-	-	32	-	2	-	32	30	-	-
Wagon	-	-	-	-	-	-	-	-	-	100	-
Ship	-	100	100	-	-	-	100	-	-	-	100
Airplane	-	-	-	-	100	-	-	-	-	-	-

Table 6. G3 - Frequency of transport facilities (number)

Type of transport facilities	Direction of delivery of goods for the trade (R – Route)										
	R_1	R_2	R_3	R_4	R_6	R_8	R_9	R_{10}	R_{11}	R_{12}	R_{13}
Car & pick up	-	-	-	69	-	89	-	5113	2606	-	-
Van	40	-	-	213	-	186	-	7241	5849	-	-
Van up to 3,5t	37	-	-	334	-	251	-	6016	4762	-	-
Van over 3,5–7t	181	-	-	223	-	84	-	5681	4386	-	-
Van over 7t	129	-	-	66	-	3	-	1783	1253	-	-
Wagon	-	-	-	-	-	-	-	-	-	697	-
Ship	-	4	6	-	-	-	2	-	-	-	13
Airplane	-	-	-	-	335	-	-	-	-	-	-
TOTAL	**387**	**4**	**6**	**905**	**335**	**613**	**2**	**25834**	**18856**	**697**	**13**

3.4 Logistics flows for hotels and catering – G4

Generators regarding the hotels and catering were generated 76,643t of goods (as in Figure 20).

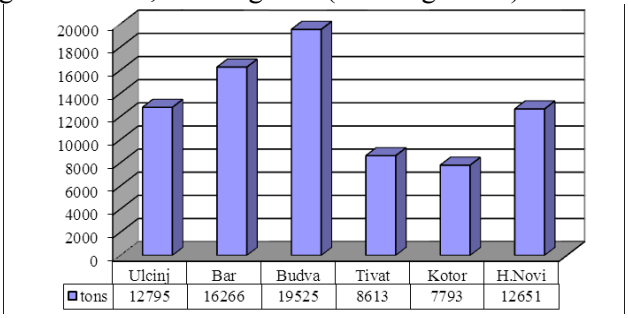

Figure 12. Volume of trade in goods per city – G4 [2]

78.95% of goods flows (as in Figure 13) were realized by land ways, 21% by water ways, and 0.05% by air ways. K10 and K11 gates are the busiest when it comes to hotels and restaurants. With all previous load can be concluded that in these directions has the largest road network congestion and to the right to look for a good solution.

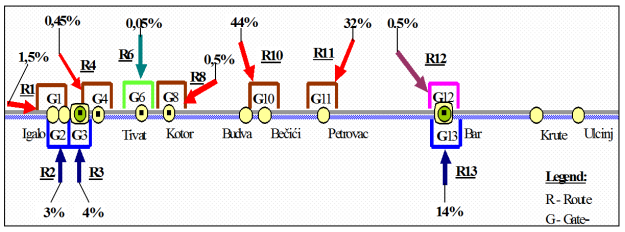

Figure 13. G4 - Goods flows [2]

Table 7. G4 - transport facilities (%)

Type of transport facilities	Direction of delivery of goods for the hotels and catering (R – Route)									
	R_1	R_2	R_3	R_4	R_6	R_8	R_{10}	R_{11}	R_{12}	R_{13}
Car & pick up	-	-	-	2	-	3	3	2	-	-
Van	2	-	-	16	-	29	14	15	-	-
Van up to 3.5t	4	-	-	24	-	38	17	18	-	-
Van over 3.5 – 7t	32	-	-	31	-	28	37	35	-	-
Van over 7t	62	-	-	27	-	2	29	30	-	-
Wagon	-	-	-	-	-	-	-	-	100	-
Ship	-	100	100	-	-	-	-	-	-	100
Airplane	-	-		-	-	100	-	-	-	-

Table 8. Frequency of transport facilities (number)

Type of transport facilities	Direction of delivery of goods for the hotels and catering (R – Route)									
	R_1	R_2	R_3	R_4	R_6	R_8	R_{10}	R_{11}	R_{12}	R_{13}
Car & pick up	-	-	-	23	-	38	3360	1633	-	-
Van	15	-	-	37	-	74	3144	2450	-	-
Van up to 3.5t	18	-	-	34	-	58	2291	1764	-	-
Van over 3.5 – 7t	74	-	-	19	-	21	2493	1715	-	-
Van over 7t	59	-	-	8	-	1	814	612	-	-
Wagon	-	-	-	-	-	-	-	-	39	-
Ship	-	2	3	-	-	-	-	-	-	5
Airplane	-	-	-	-	132	-	-	-	-	-
TOTAL	**166**	**2**	**3**	**121**	**132**	**192**	**12102**	**8174**	**39**	**5**

3.5 Logistics flows for other generators – G5

Group of other generators were generated 63,757t of goods.

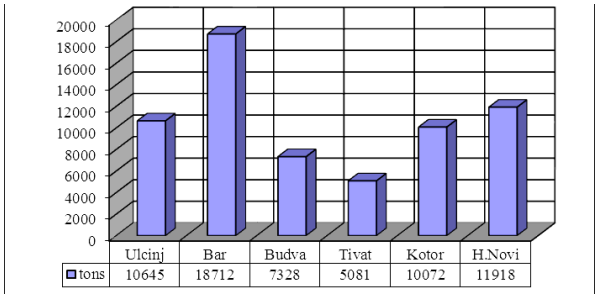

Figure 14. Volume of trade in goods per city – G5

Regarding the directions, 4.81% of goods flows (as in Figure 15) were implemented by land routes, 74.13% by water routes, and 1.05% by air.

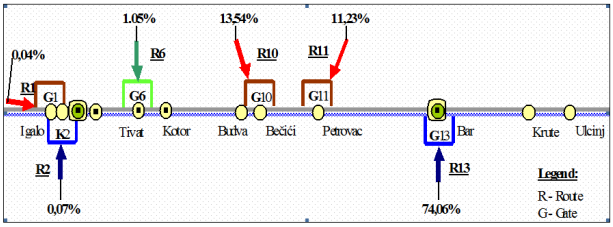

Figure 15. G - Goods flows [2]

Dominantly loaded gate K13, which is convenient because it uses the waterway.

Table 9. G5 - transport facilities (%)

Type of transport facilities	Direction of delivery of goods for the other gen (R – Route)									
	R_1	R_2	R_3	R_4	R_6	R_8	R_{10}	R_{11}	R_{12}	R_{13}
Car & pick up	-	-	-	2	2	-	-	-	-	2
Van	4	-	-	20	20	-	4	-	-	20
Van up to 3,5t	5	-	-	20	18	-	5	-	-	20
Van over 3,5 – 7t	41	-	-	38	35	-	41	-	-	38
Van over 7t	50	-	-	20	25	-	50	-	-	20
Wagon	-	-	-	-	-	-	-	-	-	-
Ship	-	100	-	-	-	100	-	100	-	-
Airplane	-	-	100	-	-	-	-	-	100	-

Table 10. Frequency of transport facilities (number)

Type of transport facilities	Direction of delivery of goods for other gen. (R – Route)						
	R_1	R_2	R_3	R_4	R_6	R_{10}	R_{11}
Car & pick up	-	-	-	48	41	-	-
Van	5	-	-	965	816	-	5
Van up to 3,5t	3	-	-	579	440	-	3
Van over 3,5 – 7t	14	-	-	550	428	-	14
Van over 7t	7	-	-	125	135	-	7
Wagon	-	-	-	-	-	-	-
Ship	-	1	-	-	-	4	-
Airplane	-	-	14	-	-	-	-
TOTAL	**29**	**1**	**14**	**2267**	**1860**	**4**	**29**

4. DIRECTIONS FOR FURTHER RESEARCH

The performed studies provide the basis for further research, which can be directed in three directions:

1. *Research on the developed simulation model*: (i) the analysis of the optimal size of the LC in the region, (ii) economic and environmental effects of changing the structure of the transport means in transporting and distributing goods, (iii) analysis of optimal cooperative relations between regional logistics operators.
2. *Research on the annex simulation model for the introduction of new distribution technologies*: (i) exploring possibilities of introducing new technologies of distribution based on a combination of fast boats and cross docking terminal, which would be associated with fuel cell vehicles for further distribution of goods, (ii) economic analysis and environmental effects of new technologies of distribution;
3. *Research that can be done using modern methods of operations research*: genetic algorithms, bee colonies, Hub location problems, etc.

5. CONCLUSION

All-embracing definition of the characteristics of the existing logistic system within the MCR as well as empirical data gained through research make solid foundation for development of a simulation model and further research on him in order to develop a new concept of logistics in this region.

The importance of the article is that it showed the practical application of a methodology for the analysis of regional logistics.

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