

Analysing County and Local Public Passenger Transport in the City of Velika Gorica

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Abstract

This paper presents an analysis of the existing local public transport in the City of Velika Gorica and a few solutions to optimize the existing local public transport. In this paper, the management of passenger transport was analysed from a theoretical point of view, with data on transport demand between Zagreb and Velika Gorica being used. Transport demand analysis is shown by graphs, tables, and route data. In the proposed solution, smaller buses on some routes were introduced, timetables were changed, and Route 330 was cancelled.

Introduction

Citizen mobility of today is a significant factor in quality of life. Therefore, traffic planning faces the task of successfully solving mobility challenges, to ensure maximum savings for the users. Today's connection between Zagreb and Velika Gorica relies mostly on private cars and bus public transport. The aim of this paper is to conduct an analysis of the current situation, and to assess the existing transport service.

The chapter "General data" describes the conditions in the City of Velika Gorica. The data about population of the 58 settlements in the gravitational area of Velika Gorica and daily migrations between Velika Gorica and Zagreb is presented.

In chapter "Analysis of existing organization and infrastructure of public transport", an analysis of local public transport and inter-county transport between Zagreb and Velika Gorica is presented. A survey on 180 passengers was conducted to show the results graphically.

The chapter "Transport demand" shows travel time distributions between Zagreb and Velika Gorica, bus occupancy, and characteristics of vehicle fleet operating in Velika Gorica.

The last chapter, "Quality assessment of the existing transport service", provides an evaluation of the data analysed in the paper. Based on the evaluation, hypothetical solution scenarios were proposed.

Analysis of the current public transport service

The area of the City of Velika Gorica is 330 km² and it contains 58 settlements of which Velika Gorica is the only one that is considered an urban settlement. By 2011 census, the City of Velika Gorica had 31,553 residents, with 63,517 residents in the urban area, which makes it the sixth most populous city in Croatia. Figure 1 shows the population from 1900 to the 2001, and currently, there are 63,517 residents in urban area. The census from 2011. resulted in the same population compared to 2001. [1]

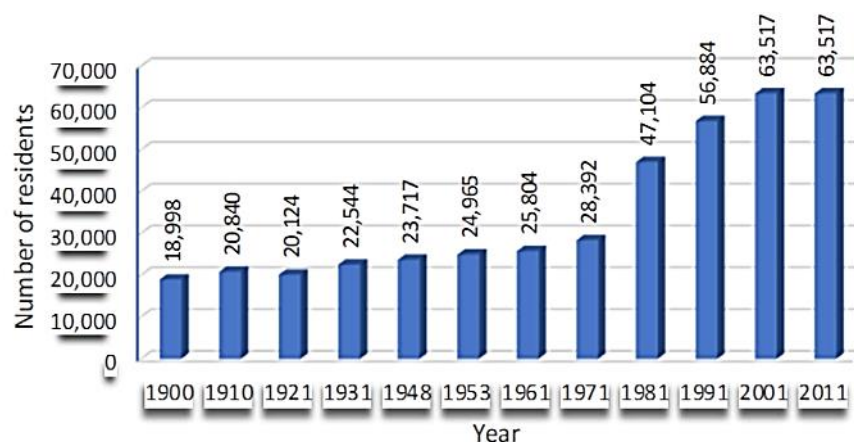


Figure 1. The number of residents in Velika Gorica

Source: [1]

Figure 2 shows all 58 settlements and population in every settlement.

Settlement	Population	Settlement	Population	Settlement	Population
Bapča	129	Kuće	1,453	Rakitovec	570
Bukovčak	65	Lazi Turopoljski	57	Ribnica	803
Buševac	886	Lazina Čička	566	Sasl	159
Cerovski Vrh	93	Lekmeno	383	Selnica Ščitarjevska	535
Cvetković Brdo	32	Lukavec	1,140	Sop Bukevski	85
Črnkovec	412	Mala Buna	261	Staro Čiče	790
Donja Lomnica	1,732	Mala Kosnica	49	Strmec Bujevski	366
Donje Podotočje	375	Markuševac Turopoljski	328	Ščitarjevo	442
Drenje Ščitarjevsko	203	Mičevac	1,286	Šiljakovina	672
Dubranec	349	Mračin	1,074	Trnje	62
Gornja Lomnica	580	Novaki Ščitarjevski	158	Turopolje	953
Gornje Podotočje	491	Novo Čiče	1,255	Velika Buna	856
Gradići	1,860	Obrezina	555	Velika Gorica	31,553
Gudci	374	Ogulinac	292	Velika Kosnica	770
Gustelnica	118	Okuje	467	Velika Mlaka	3,334
Jagodno	521	Petina	213	Vukomerić	158
Jerebić	41	Petravec	76	Vukovina	947
Ključić Brdo	214	Petrovina Turopoljska	708	Zablatje Posavsko	61
Kobilić	533	Poljana Čička	688		
Kozjača	342	Prvonožina	42		

Figure 2. Settlement population in the administrative area of Velika Gorica

Source: [2]

Velika Gorica is a city in Zagreb County, bordering Zagreb County and the City of Zagreb. Due to its position in the gravitational area of Zagreb, about 50 to 60% of residents travel to Zagreb daily, which is shown in Figure 3.

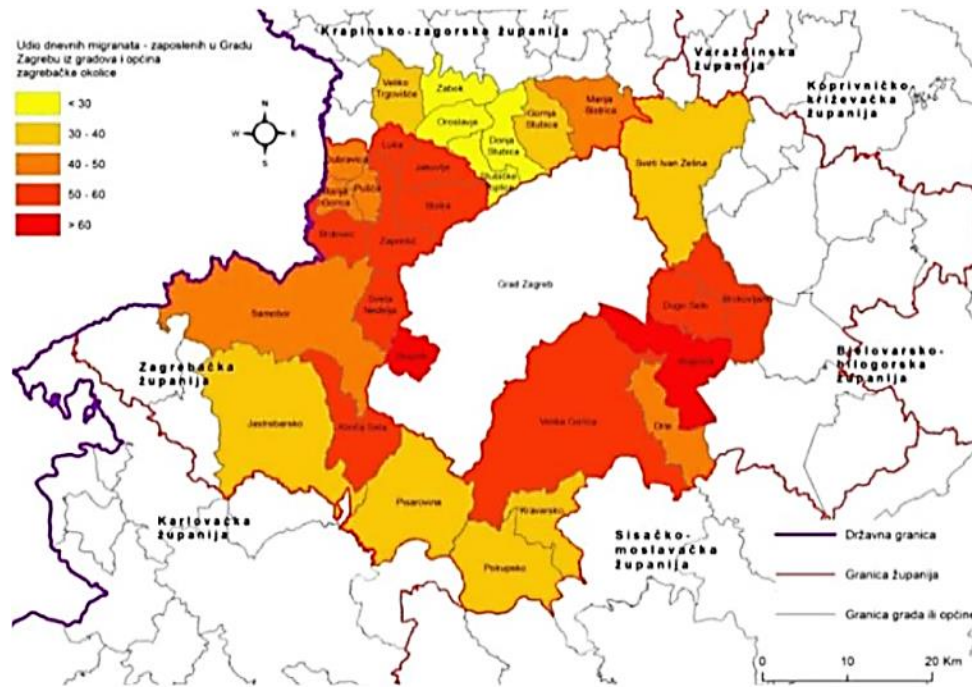


Figure 3. Daily citizen migrations from Velika Gorica

Source: [3]

Local public transport

Local public transport is currently organized to connect surrounding settlements and the administrative territory of the City of Velika Gorica. In total, there is 196 km of local public transport routes in the city, achieving 953,000.00 km yearly.

There are 13 local transport routes connecting surrounding settlements with the administrative territory, [5]:

1. Route 302 → from Velika Gorica to Velika Buna. Some rides go off route to Ključić Brdo and then to Velika Buna
2. Route 303 → from Velika Gorica to Kozjača. Sometimes, depending on the schedule, on its way back to Velika Gorica, the buses pass through Velika Buna with a few more stops on the route
3. Route 304 → from Velika Gorica to Mraclin, with some rides extending to Vukojevac
4. Route 305 → from Velika Gorica to Turopolje
5. Route 309 → from Velika Gorica to Sasi
6. Route 310 → two types:
 - from Glavni Kolodvor to Petrovina Turopoljska;
 - from Velika Gorica to Glavni Kolodvor passing through Petrovina Turopoljska
7. Route 319 → from Velika Gorica to Lukavec
8. Route 321 → from Velika Gorica to Strmec Bukevski, sometimes off route to Sasi and back on route to Strmec Bukevski
9. Route 323 → from Velika Gorica through Ribnica and Lazina, making a small loop and returning to Velika Gorica
10. Route 324 → from Velika Gorica to Čička Poljana
11. Route 325 → from Velika Gorica to Vukojevac and sometimes, depending on its schedule, stops at Mraclin
12. Route 326 → from Velika Gorica to ZTC (Zrakoplovno Tehnički Centar)
13. Route 335 → from Velika Gorica to Pleso, extending to Donja Lomnica and returning to Velika Gorica.

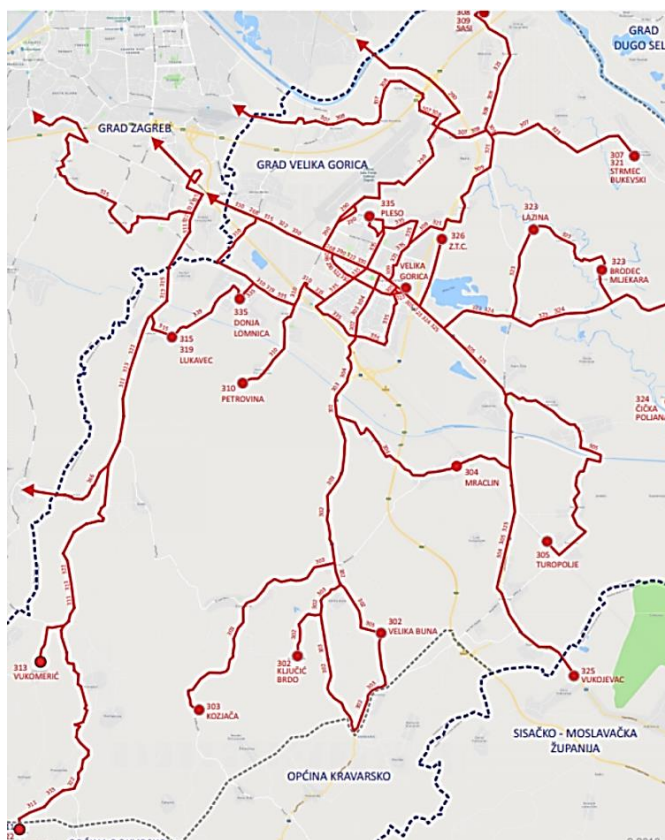


Figure 4. Local public transport routes

Source: [3]

Figure 4 shows local public transport routes in the City of Velika Gorica and the connections with the city. The routes connecting rural areas mostly are not economically effective because of less passengers, but the routes operate subsidized to create acceptable conditions for residents travelling from those parts of region. [3]

Inter-county public transport

Because Velika Gorica is close to the capital and the largest city of the Republic of Croatia, daily migrations between the cities are high. As already shown in Chapter 2, 50 to 60% of residents migrate to Zagreb and among the people, not only commuters (most of them own a private car) travel, but also children to school and students to universities in Zagreb. Local public transport needs to perfectly function mostly because of schoolchildren and students. The routes that operate in between the counties are 268, 290 and 330. These three routes transport most passengers between the cities.

In the purpose of exploring traffic demand and questioning quality of transportation service, a survey on 180 subjects on these three routes was conducted. Survey on route 330, was conducted on Monday 15th of May 2017. For route 268, survey was conducted on Tuesday 16th of May 2017, and the last route 290 was conducted on Monday 22nd of May 2017.

The passengers were asked about their social status, and 60% of them declared as students and 30% as employed, shown in Figure 5. [1]

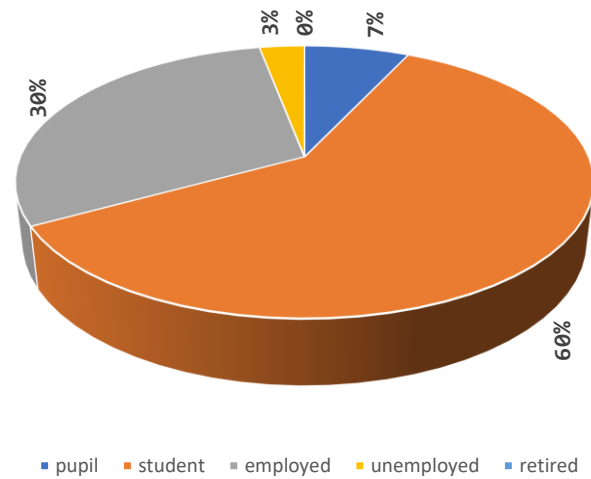


Figure 5. Social status of subjects

Source: [1]

When asked about the purpose of traveling by bus, 29.1% of them stated that the most common purpose is education (school or university), and 23.9% opted to work, as shown in Figure 6. [1]

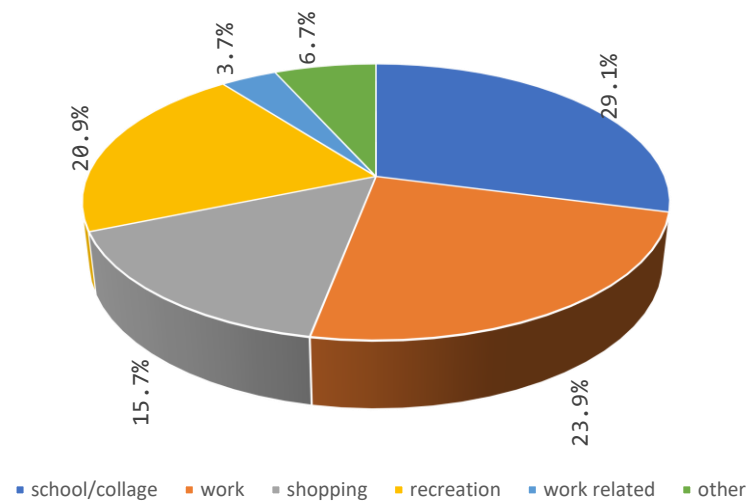


Figure 6. Travel purpose

Source: [1]

Figure 7 shows that 68.3% of subjects travel by route 268, 21.7% by route 330 and 10% by route 290. [3]

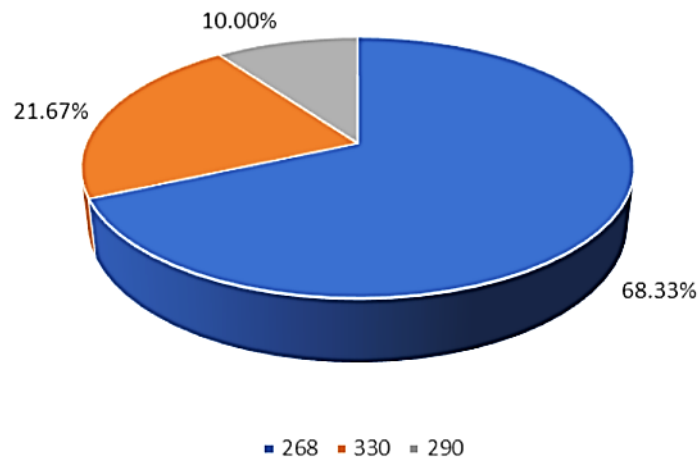


Figure 7. Routes the subjects are using daily

Source: [1]

Figure 8 shows passenger satisfaction with the service for different quality categories – safety, speed, comfort, accuracy and punctuality of transport.

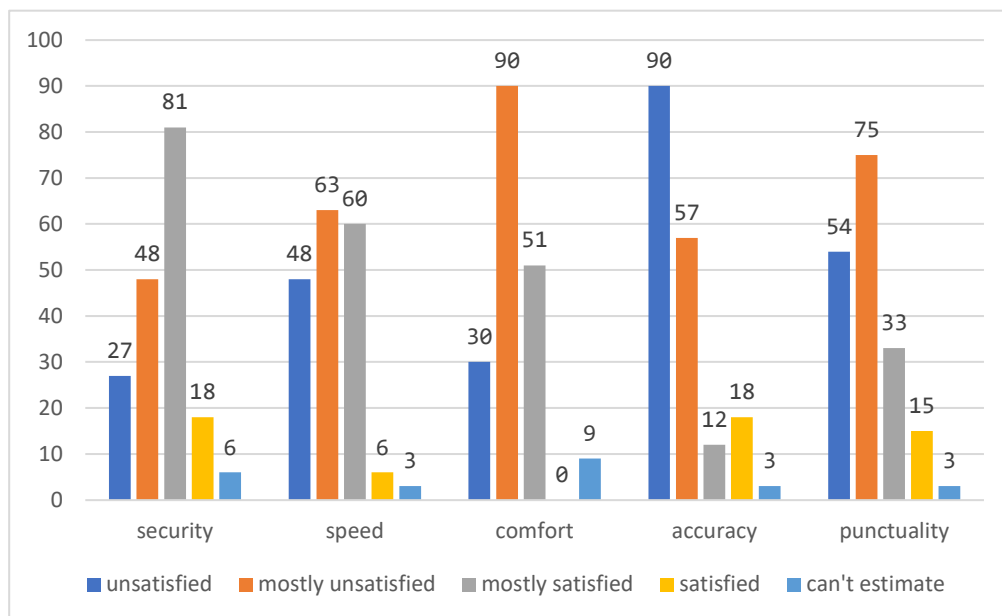


Figure 8. Quality of service and passenger satisfaction

Source: [1]

Transport demand

Transport demand always changes, and it depends on number of factors. The highest transport demand is in commuter periods (6:00 a.m. – 9:00 a.m.) and it's the easiest to predict. But there are other factors influencing demand more difficult to predict such as: weather, social activities, personal errands and day of week, because people tend to get from work earlier on Friday. That's why it's important to conduct surveys and monitor the passenger movements so that demand does not exceed the supply.

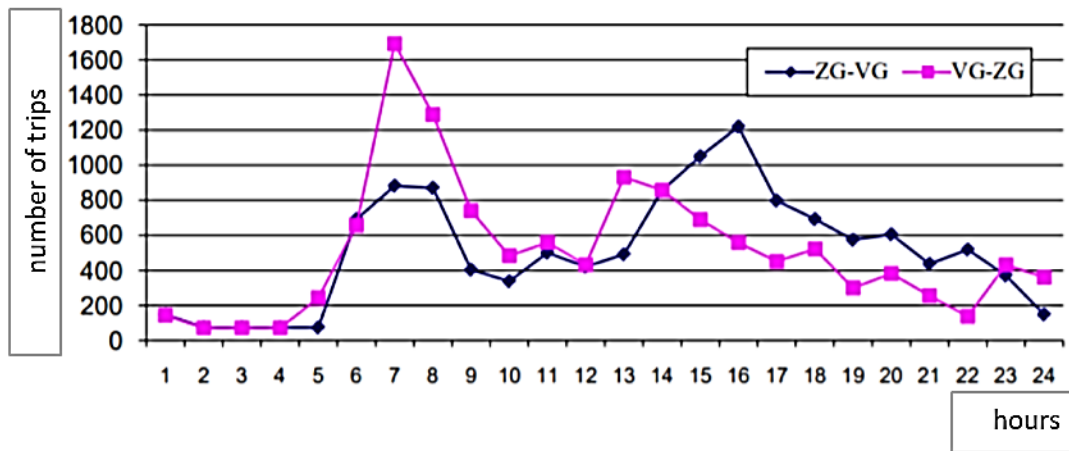


Figure 9. Daily travel distribution between Zagreb and Velika Gorica

Source: [3]

Figure 9, showing daily travel distribution in one-hour segments, reveals the unbalanced travel demand. This unbalanced demand affects vehicle occupancy. [3]

Based on the conducted analysis of public transport routes operating in Velika Gorica (Table 1), there are significant variations in driving speed, mainly depending on traffic conditions. [3]

Table 1. Features of travelling on public transport routes

Route		Travel duration (min)	Average speed (km/h)
Type	Number		
Local	303	29	32,90
	304	28	38,36
	305	20	35,70
	309	20,5	33,37
	319	18	31,00
	321	19	37,58
	323	32	30,75
	324	18	43,50
	335	26	23,08
	Average	21,05	33,56
County	301	47,5	43,26
	302	49,5	38,30
	306	45,5	37,71
	322	52	43,62
	Average	48,63	40,72
Inter-county	307	40,5	26,96
	308	35	29,31
	310	34,5	30,96
	311	57	41,79
	313	40,5	37,04
	315	31,5	33,14

	325	17	50,47
	268	35	26,23
	330	30	30,60
	Average	35,67	33,66
AVERAGE		35,11	35,98

Source: [3]

Table 1 shows the average speed of 36 km/h in the city of Velika Gorica. The average speed is acceptable, but given that most of the routes don't operate in urban conditions, the average speed should be higher.

Table 2. Bus occupancy

Route		Bus occupancy, %				
		Workday		Saturday	Sunday	Week
Local	303	17		11	2	13,5
	304	16		8		14,6
	305	17		17	5	15,3
	309	5		8	1	4,9
	319	11		6	3	9,1
	321	6		8	10	69
	323	19		0	0	19,0
	324	17		13	0	15
	335	6		2	0	4,0
		11		0	0	11,0
		In total	8,5	1	0	7,5
TOTAL		12,50		7,30	2,10	11,33
County	301	28		23	14	25,3
	302	15		17	4	13,7
	306	21		18	10	19,0
	322	20		11	3	16,0
TOTAL		21,00		17,25	7,75	18,51
Inter-county	307	26		15	9	21,4
	308	23		13	7	19,2
	310	18		12		16,6
	311	29		12		25,4
	313	10				10,0
	315	19		18	8	16,7
	325	22		13	0	17,5
	268	50		33	23	42,9
	330	43				43,0
TOTAL		26,67		16,57	9,40	23,47

Source: [3]

As the data in Table 2 shows, bus occupancy is relatively small. Among local routes, the average usage is only 11.33%, among county routes 18.51% and 23.47% among inter-county routes. The highest occupancy is on route 268 (Zagreb – Velika Gorica), with 50% on workdays and on route 330, with 43% on workdays. [3]

Regarding the fact that the study of public transport was done 15 years ago, and the lack of significant changes in quality of service, it's obvious how transport changes are necessary for the City of Velika Gorica. [3]

Table 3 shows bus travel data for 2005 (when the last public transport study was made) and Table 4 shows the data for 2009, where it is evident how transport organization made only small changes – the operator cancelled routes 301 and 306, and route 302 operates only locally to Velika Buna. [3]

Table 3. Bus travel data, 2005

Ordinal number	Route		Length, km	Tariff zone	Number of departures				Distance traveled, km				
	Type	Number			work day	saturday	sunday	weekly	work day	saturday	sunday	weekly	yearly
1	Local	303	15,9	3	18	14	6	55	286,2	222,6	95,4	1749	89644,20
2		304	17,9	1	10,5	5,5	0	58	187,95	98,45	0	1038,2	52742,35
3		305	11,9	1	32	22	6	188	380,8	261,8	71,4	2237,2	114216,20
4		309	11,4	2	20	12	6	118	228	136,8	68,4	1345,2	69038,40
5		319	9,3	1	3	4	10	29	27,9	37,2	93	269,7	14656,80
6		321	11,9	2	12	6	4	70	142,8	71,4	47,6	833	42863,80
7		323	16,4	1	9	0	0	45	147,6	0	0	738	37785,60
8		324	13,05	1	6	4	0	34	78,3	52,2	0	443,7	22498,20
9		325	14,3	2	23	15	0	130	328,9	214,5	0	1859	94279,90
10		335	13,2(10)	1	18	6	0	96	196	60	0	1040	52996,00
		In total			151,5	88,5	32	823	2004,5	1155	375,8	11553	590721,45
11	County	301	14,3	4	25	15	14	154	357,5	214,5	200,2	2202,2	11401,90
12		302	14,1	4	17	13	4	102	239,7	183,3	56,4	1438,2	73475,10
13		306	9,05	4	26	15	6	151	235,3	135,75	54,3	1366,6	69983,65
14		322	22,5	5	6	5	6	41	135	112,5	135	922,5	48217,50
		In total			74	48	30	448	967,5	646,05	445,9	5929,5	305690,15
15	Inter-county	307	14,8	3	17	13	6	104	251,6	192,4	88,8	1539,2	78958,00
16		308	13,7	3	41	23	6	234	561,7	315,1	82,2	3205,8	163701,30
17		310	14,8	2	30	10	0	160	444	148	0	2368	120620,00
18		311	20,65	5	14	10	0	80	289,1	206,5	0	1652	83715,10
19		313	14,6	3	4	0	0	20	58,4	0	0	292	14950,40
20		315	3,7	2	28	16	10	166	103,6	59,2	37	614,2	31598,00
21		268	5,6	2	269	215	159	1719	1506,4	1204	890,4	9626,4	497431,20
22		330	5,6	2	104			520	582,4	0	0	2912	149094,40
		In total			507	287	181	3003	3797,2	2125,2	1098,4	22210	1140068,40
In total					732,5	423,5	243	4274	6769,2	3926,2	1920,1	39692	2036480

Source: [3]

Table 4. Bus travel data, 2009

Ordinal number	Route		Length, km	Tariff zone	Number of departures				Distance traveled, km				
	Type	Number			work day	saturday	sunday	weekly	work day	saturday	sunday	weekly	yearly
1	Local	302	10	3	32	16	10	102	320	160	100	1860	95640
2		303	15,9	3	22	14	6	55	349,8	222,6	95,4	2067	105925,80
3		304	17,9	1	11	5,5	0	60,5	196,9	98,45	0	1083	55033,55
4		305	11,9	1	32	24	6	190	380,8	285,6	71,4	2261	115334,80
5		309	11,4	2	20	12	6	118	228	136,8	68,4	1345,2	69038,40
6		319	9,3	1	4	4	10	34	37,2	37,2	93	316,2	17037,60
7		321	11,9	2	12	6	5	71	142,8	71,4	59,5	844,9	43601,60
8		323	16,4	1	9	0	0	45	147,6	0	0	738	37785,60
9		324	13,05	1	32	15	8	183	417,6	195,75	104,4	2388,2	122578,65
10		335	13,2(10)	1	18	7	0	96	196	60	0	1040	52996,00
		In total			160	87,5	41	852,5	2096,7	1107,8	492,1	12083	714972,00
12	County	325	14,3	2	25	15	0	140	357,5	214,5	0	2002	101601,50
13		In total			25	15	0	140	357,5	214,5	0	2002	101601,50
14	Inter-county	307	14,8	3	17	13	5	104	251,6	192,4	74	1524,4	78040,40
15		308	13,7	3	38	23	6	234	520,6	315,1	82,2	3000,3	153179,70
16		310	14,8	2	50	17	0	160	740	251,6	0	3951,6	201265,20
17		311	20,65	5	14	10	0	80	289,1	206,5	0	1652	83715,10
18		313	14,6	3	5	3	0	20	73	43,8	0	408,8	20746,60
19		315	3,7	2	31	18	10	166	114,7	66,6	37	677,1	34787,40
20		268	5,6	2	275	225	167	1719	1540	1260	935,2	9895,2	511442,40
21		330	5,6	2	103			520	576,8	0	0	2884	147660,80
22		322	22,5	5	6	5	6	41	135	112,5	135	922,5	48217,50
			In total			539	314	194	3044	4240,8	2448,5	1263,4	24916
In total					724	416,5	235	4036,5	6695	3770,8	1755,5	39001	2095628,6

Source: [3]

From the data in Table 3 and Table 4, it's obvious how, no matter the two cancelled routes (301 and 306) and shortened route 302, in 2009, travelled distance became larger.

Discussion

After analysing public passenger transport in Velika Gorica and its surrounding settlements, it's evident that there are some improvements needed. In the study of public transport from 2005, the analysis showed many public transport routes poorly utilizing available passenger seats (Table 2), which indicates a need to consolidate the process.

In terms of low vehicle occupancy, there's insufficient transport demand, which can be solved by introducing low-capacity buses, or by reducing the number of departures. Many routes don't justify their existence economically because of low vehicle occupancy (Table 2), but they are important for the residents depending on these routes, despite the lack of space for improvement. These routes should start using minibuses to increase vehicle occupancy and reduce the costs, improving their economic justification. Departure frequency is also important because of transport demand. As explained in Chapter 4, transport demand is the highest in the morning, when many adults and children go to work or school, and yet some of the routes don't depart in the morning.

By analysing routes 268 and 330, the average speed difference is relatively small despite that the Route 330 (Zagreb - Velika Gorica) is an express route. Therefore, Route 330 should be terminated, and Route 268 should increase departure frequency. Consequently, the passengers would be more satisfied, as the survey reported many of the passengers unhappy with the regularity and comfort of the service.

To implement any of the given alternatives in practice, a detailed analysis of public transport demand, with investigating possibilities to reconstruct public transport network, should be conducted.

Conclusion

Demand for local public transport is growing every year. More people are starting to use buses, trains, trams, and other modes of public transport rather than private car. The cost of owning a private vehicle is pushing people towards public transport because of the costs, such as registration, gas, yearly maintenance and so on. Public

transport is not only cost-effective, but it's also better for environment and for future city growth. But for the people to use public transport, it needs to be punctual, comfortable, fast, secure and cheap.

Local public transport in City of Velika Gorica is fairly spread given it contains 58 settlements. As a lot of those settlements have a population smaller than 1000 residents, many of those routes aren't economically effective but if these routes didn't exist, the conditions for residents wouldn't be acceptable.

Based on conducted survey, the majority of passengers are unhappy with current public transport service, and the greatest dissatisfactions are related to frequent bus delays, departure regularity and schedule adherence. With the new timetables proposed for these three routes, based on the survey, the problem with regularity would be solved, but the travel time problem wouldn't, because in commuter periods, buses share the infrastructure with private cars.

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