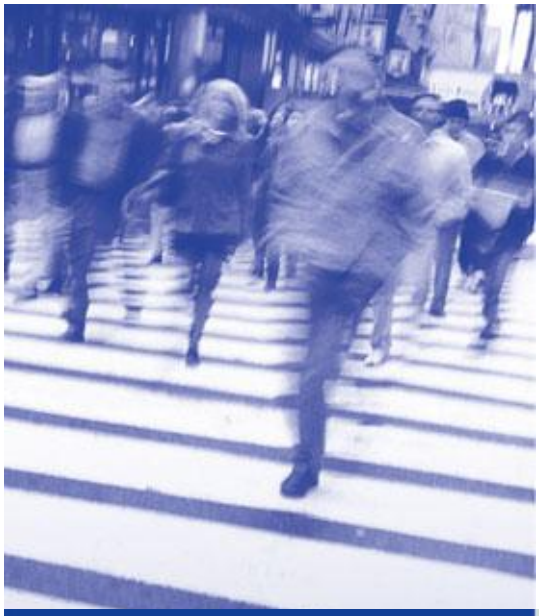

CiViTAS
Cleaner and better transport in cities

ELAN
BRNO • GENT • LJUBLJANA • PORTO • ZAGREB

Short version of congestion charging study

ELAN Deliverable No. 3.2-D1

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	WP1 Alternative fuels & clean vehicles		WP7 Energy-efficient freight logistics
	WP2 Collective transport & intermodal integration		WP8 Transport telematics
x	WP3 Demand management		WP9 Project coordination
	WP4 Influencing travel behaviour		WP10 Project management
	WP5 Safety, security & health		WP11 Research and Technological Development
	WP6 Innovative mobility services		WP12 Impact and process evaluation
			WP13 Dissemination, citizens' engagement, training and knowledge transfer

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CONTENT

1. INTRODUCTION

The main objective of measure 3.2-ZAG Study of congestion charging and dialogue on pricing is to conduct a **study on congestion charging** which aims at:

- Exploring possible reduction of no. of vehicles entering the city centre;
- Exploring limiting exhaust emissions, vibrations and noise caused by traffic;
- Fostering use of PT, bicycles and walking;
- Exploring traffic congestion in the city area in question;
- Introducing to the public polluter-pays-principle in urban transport.

In order to reduce the share of private cars in the modal split, the City of Zagreb decided to develop an outline for a congestion charging scheme within the CIVITAS-ELAN project. A proposal for a conceptual design for a congestion charging scheme in the City of Zagreb has prepared by the Faculty of Transport and Traffic Sciences (ZFOT) in cooperation with all relevant stakeholders. The proposal was submitted to the Zagreb Office for Strategic Planning and Development during an expert roundtable held on 3 June 2011. No date has been set yet when the proposal will be submitted to the City Council. Dissemination activities on the proposal took place during the European Mobility Week 2011 in Zagreb.

The purpose of the congestion charging study is to define the objectives of congestion charging, system design and the acceptance of the selected solution. The basic objective of the study of congestion charging is that the proposed solution contributes to the reduction of traffic congestion in the centre of Zagreb, and ensures the sustainable development of the city.

It should be mentioned that the ELAN measure is only the initial step towards the implementation of such a regime, since it imposes remarkable restrictions upon users. It will represent a challenge to convince the general public about the proposed scheme.

Congestion charging can be applied in several ways, using a **fixed point of charging** (stopping is essential), based on a **license** for a certain area where cars driving within the area need to have a sticker (vignette), **according to the charging area** where we distinguish between zonal charging, cordon and multiple cordon charging (the basic difference in zonal charging is when entering the charging area one can repeatedly enter and leave the zone with one payment, while the cordon charge means that one has to may each time when passing through the zone or area) **and billing based on time or on distance** (charges based on the distance the vehicle yarn or time that a vehicle spends on a charged route or in a specific area and the price may vary with time, vehicle categories and sites).

Congestion charging will be more effective if integrated with policies to promote the use of public transport. These measures are likely to reduce the adverse impact of congestion charging for those passengers which are most disadvantaged. The combination of these policy instruments will depend critically on the urban context in which they apply.

The main technologies are Automatic Numeric Plate Recognition, Dedicated Short Range Communications and Global Navigation Satellite System. The last of them experiencing rapid development and could provide a wider range of charging system.

Business systems are required to manage complex and interdependent monitoring requirements, payments, accounting and enforcement. While such systems are widely available in the private sector, they are still being developed for these complex applications in the public sector such as congestion charging.

Congestion charging will have a wide range of environmental impacts, some of which are easier to quantify than others. While the majority of impacts will be useful, redistribution of traffic can have ad-

verse effects. More importantly, congestion charging and policy that complements it can be designed to be used more directly focused on improving the environment.

Acceptability remains a major concern for cities when considering to implement congestion charging. Acceptability is generally based on the expectations of stakeholders, which up to now are often negative. The roles of complementary policy instruments and the use of revenues from the congestion charging are critical factors to increase acceptability. There is evidence that the level of acceptability is very changeable, and is particularly likely to decrease their value, as the proposal becomes more concrete and before adoption.

Transferability of results from one city to another remains an insufficiently understood aspect of the policy of congestion charging, but not less important because of the lack of empirical results.

Although cities will have to establish their goals for urban road charging, it is very important that these objectives are clearly defined at the outset, and consistently executed.

The design of a congestion charging scheme should have a logical sequence in which first determinates of the overall strategy and where the role of congestion charging is defined as a part of that strategy. This will help demonstrating that congestion charging is necessary, and also will help identifying those instruments which could be complementary policies necessary for its support. Congestion charging should then be designed within the context of complementary policies. At this stage it is appropriate to consider ways of congestion charging that should be adopted, the location and amount of payment. There are serious reasons for keeping the design simple, but one should not overlook the important role of incentives and discounts to increase acceptability.

Benefits enabled by the revenues of congestion charging are critical for determining the acceptability and effectiveness of the system. Most charged drivers will initially be made worse off by road pricing, and it is only when the revenues have been channelled into transport (or other) improvements that they begin to appreciate the personal benefits. It is thus particularly important that the costs of operating road pricing schemes are kept as low as possible. It is also necessary that the excess revenues are made available by public authorities to support their overall strategy.

While a decision on the implementation of road charging is usually indulged by cities, national governments have a responsibility to develop a clear national transport strategy, which will legally enable the implementation of congestion charging.

2. ANALYSIS OF EXISTING CONGESTION CHARGING SCHEMES IN EUROPEAN CITIES

2.1. German cities

Since 1 March 2007 vehicle restrictions can be issued in environmental green zones in cities and local districts in Germany. The requirement is that they are specially marked as being green zones by the city or municipality.

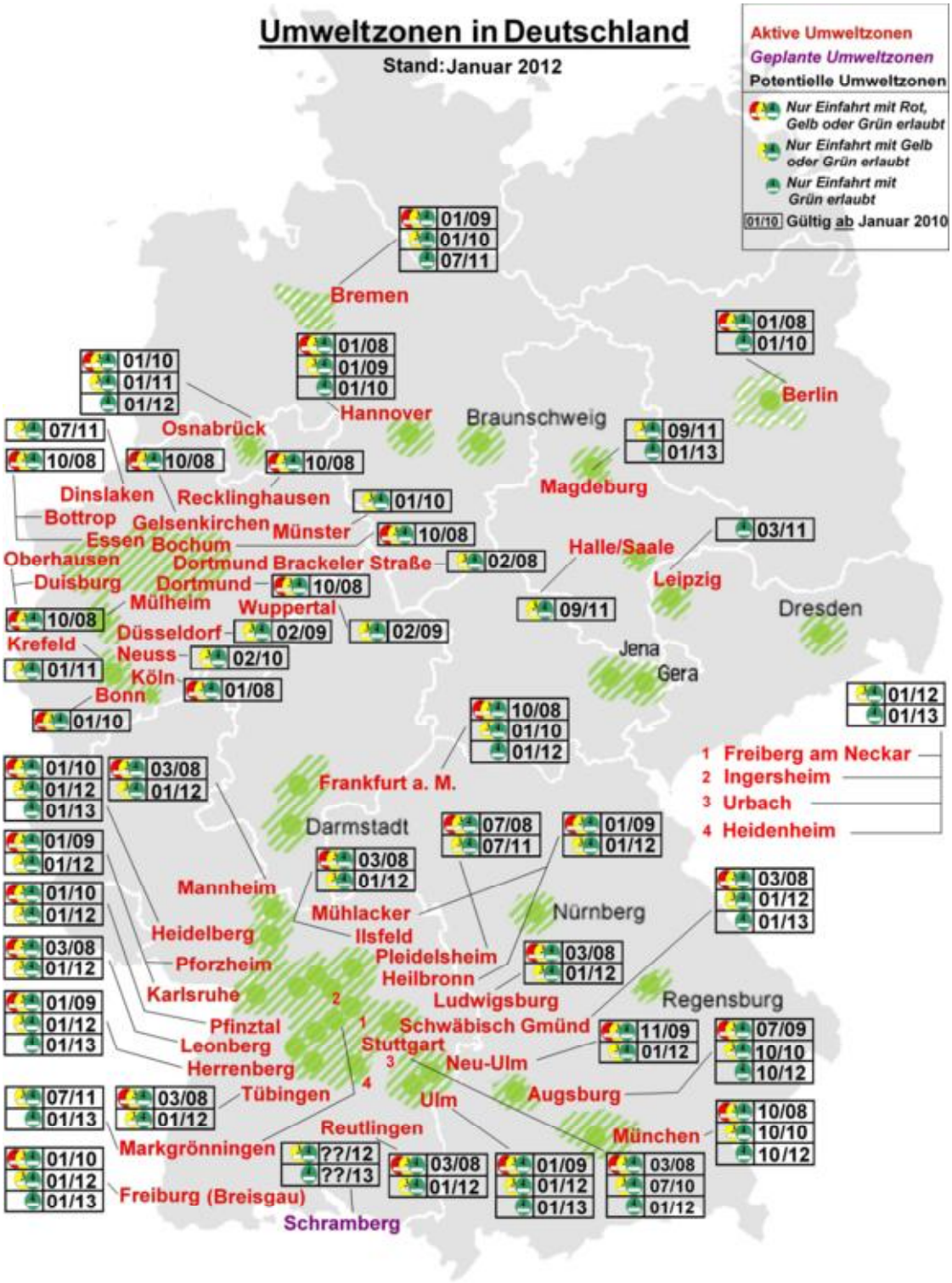
The areas especially threatened by fine particulate matter must be marked as “environmental green zones” with the sign 270.1 (see below). The obligatory additional sign then regulates which vehicles with which colour of environmental badges are allowed access into this area. The sign 270.2 (see below) rescinds the environmental green zone.

Picture 2-1 Sign 270.1

Picture 2-2 Additional sign to 270.1

Picture 2-3 Sign 270.2

Vehicles without environmental badge may not pass through the green zone, otherwise a penalty of 40€ has to be paid. This is also valid for all vehicles registered in foreign countries, like cars, trucks, and buses, as well as for business travellers and for tourists. For this reason it is recommended for all drivers to inform themselves about the environmental badges, and to purchase them on time.



Picture 2-4 Environmental green zones in Germany

2.2. Italian cities

Italian municipalities explored access control in the city centre in so-called *Limited Traffic Zones* (*LTZ*). The controlled zones usually cover the historic centres that suffer from serious pollution caused by congested traffic. Only residents of the area and a limited number of permit holders are allowed to access the zones. The city of Bologna pioneered the policy in the mid/ late 1980's, and despite initial difficulties, this prompted a widespread adoption of the measure. In other towns and cities the policy is gradually evolving to a hybrid form of road pricing by requesting LTZ permit holders to pay an annual fee. To achieve this, a directive (D.L. 285/92) was introduced that allows Municipalities to charge motor vehicles a fee when entering or circulating inside the LTZ. A presidential decree 250/99 approved the installation and operation of automatic access control systems in historic centres and LTZs.

Existing limited traffic zones in Italy:

1. ZTL[3] ROMA
2. ZTL MILANO
3. ZTL PALERMO
4. ZTL NAPOLI
5. ZTL FIRENZE
6. ZTL REGGIO CALABRIA
7. ZTL TORINO
8. ZTL BARI
9. ZTL BOLOGNA
10. ZTL BOLZANO
11. ZTL VENEZIA
12. ZTL CAGLIARI
13. ZTL SESTO FIORENTINO
14. ZTL SIENA
15. ZTL MESSINA
16. ZTL MODENA
17. ZTL NOVARA
18. ZTL GENOVA
19. ZTL PISA
20. ZTL PARMA
21. ZTL PADOVA
22. ZTL TRIESTE
23. ZTL LUCCA
24. ZTL RIMINI
25. ZTL PORDENONE
26. ZTL VERONA
27. ZTL BRESCIA
28. ZTL ASTI
29. ZTL FERRARA
30. ZTL PESCARA
31. ZTL REGGIO EMILIA
32. ZTL ALESSANDRIA
33. ZTL e AP VITERBO
34. ZTL FORLI'
35. ZTL PERUGIA
36. ZTL ASSISI
37. ZTL GAETA
38. ZTL SIENA

[3] tal. Zona a Traffico Limitato

Picture 2-5 Traffic sign for ZTL

Picture 2-6 Charging zone in Milan

Results from Milan

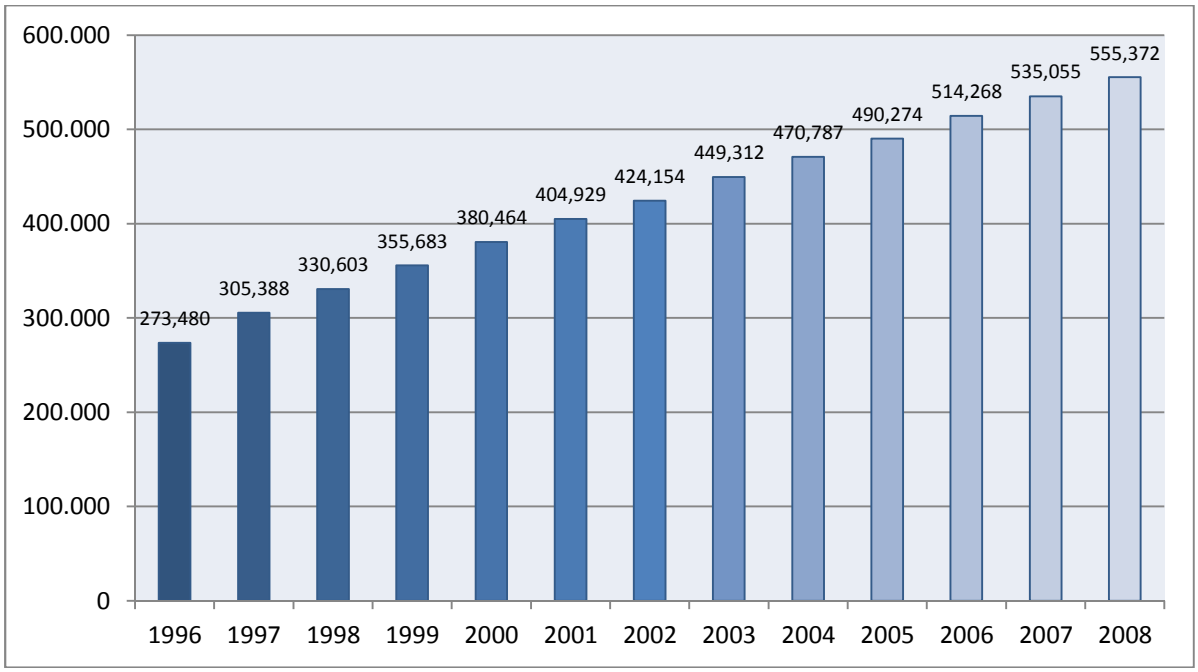
An estimated 98,000 vehicles were entering the restricted area before the Ecopass came into force. According to an evaluation conducted by the Milanese Agency of Mobility and the Environment in December 2008, during the first month traffic inside the ZTL fell to 82,200 vehicles, and for the first eleven months the average traffic flow was 87,700 vehicles. This represents 12.3% fewer vehicles entering the ZTL, while outside of the Ecopass area traffic decreased by 3.6%. Meanwhile, surface public transportation service grew by 1,300 additional daily runs, carrying an average of 19,100 additional daily passengers, an increment of 7.3% for this eleven month period. For the morning rush hour during the same months the number of congested kilometres in the interior traffic network fell by 25.1% and average travel speed improved by 4.0%, translating into Euro 9.3 million saved per year. Traffic accidents inside the ZTL also fell by 20.6%.

The Milanese Agency of Mobility and the Environment report shows that during the first eleven months of the Ecopass programme the number of days exceeding the permitted level of particulate matter of 50 $\mu g/m^3$ fell to 83 days, in contrast to the period January to November 2002 to 2007, when the average number of days exceeding this limit was 125 days. This study also found that between January and November (excluding August when the charge was temporarily suspended), all traffic related emissions were lower. PM_{10} decreased by 23%, particulate matter decreased by 18%, NH_3 fell 47%, NO_x was reduced by 15%, and CO_2 emission were cut by 14%.

Picture 2-7: For certain categories of vehicles entrance is banned in the ZTL

3. ANALYSIS OF CURRENT TRANSPORT SYSTEM IN ZAGREB

As in other CEE (south-eastern European) countries, in Croatia, within the last 20years (i.e. after a period of transition from the previous political regime), there has been a drastic increase in motorization. This has resulted in a very big impact on the environment, the historic core of cities, and traffic conditions. In the years before the transition, the share of industry in pollution was the greatest. But since many of these industries are no longer working, the main culprit, despite cleaner technology is motorized traffic.



Picture 3-1 Number of motor vehicles in Zagreb and Zagreb County

Road and rail corridors in the City of Zagreb, which are predominantly formed in the first half of the twentieth century, were based on the application of the urban matrix of a modern Central European city with a well-developed system of public transport (rail commuter and inter city traffic, and the city's tram traffic). With the growth of the city, personal transport needs of citizens also increased, orthogonal network of existing city streets wider city centre has become inadequate for current traffic load on the longitudinal direction of East -West, which is solved by gradual construction of parallel longitudinal directions (Ljubljanska Avenue and Slavonska Avenue and Zagreb bypass). Today, the lack of network capacity of existing city streets, especially during the rush hour of urban transport, directs citizens to use the Zagreb bypass for routes that it does not naturally belong, and thereby create an unnecessary interference with the transit traffic in an East – West direction.

The railway was built partly on bulwark and partly on the ground of the city, preventing the realization of the functional integrity of the network of city streets especially in the vertical (north- south) communications. The railway in the city has a stiff transport infrastructure with the need to increase bandwidth for the flow of passenger traffic, and is a nuisance for the city road network traffic linking.

According to a survey of households in 1999 the citizens of Zagreb are engaged in walking a quarter of all trips, by car 37%, 37% by public transport, cycling is only 1%. If excluding walking and cycling trips, trips by car and public transport have roughly equal shares of motorized transport.

3.1. Road Transport

The City of Zagreb, as a result of demographic expansion, rising living standards and the citizens' need for increased mobility, suffers from a marked increase in car traffic. Road infrastructure has grown slightly in recent years as is evident from Table 2-1 and as such was not accompanied by growth of individual car traffic.

Table 3-1 Road network of the City of Zagreb

Year	State Roads [km]	County roads [km]	Local streets [km]	Total [km]
2005	69	306	375	750
2006	68	305	375	748
2007	69	306	375	750
2008	74	314	387	775

Source: Central Bureau of Statistics (CBS) Statistical Yearbook 2006 – 2009

The number of vehicles in Zagreb has doubled from 273,480 in 1996 to 548,304 vehicles in 2009 (Source: Bulletin of traffic safety). The share of passenger cars in the total number of motor vehicles is around 80%.

Roads are usually congested during morning and afternoon peak hours, but the overload is often extended to other hours in the day. As an example, the intersection of the Savska and Vukovarska street can be highlighted, where during the day 65,088 vehicles are passing (Table 3-2). Travel speed by car tends to be below 10 km/h in the city centre.

Table 3-2 Number of vehicles at intersections in the CIVITAS corridor

	Intersection	April 7, 2009 10 – 11 am	April 7, 2009 4 – 5pm	April 8, 2009 10 – 11 am	April 8, 2009 4 – 5 pm	AADT
1	Jadranski most- Selska	4,855	6,570	4,956	6,707	80,484
2	Savska - Slavonska	5,017	5,095	3,769	4,985	61,140
3	Savska - GradaVukovara	5,357	5,366	5,096	5,424	65,088
4	Savska - Tratinska	2,777	2,799	2,687	2,855	34,260
5	Savska - Vodnikova	2,313	2,397	2,215	2,410	28,920
6	Klaićeva - Roosveltovsquare	3,008	3,491	2,654	3,410	41,892
7	GjureDeželića - MaršalaTitasquare	2,102	2,045	2,014	2,081	25,224
8	Ilica – Frankopanska	999	990	970	1,034	12,408

Overloaded road segments are:

- Savska street
- Vlaška street
- Ozaljska street
- Ilica
- Slavonska – Zagrebačka – Ljubljanska Avenue
- Dubrovnik Avenue
- Hrvatske bratske zajednice
- Selska street
- Zagrebačka cesta – from Ljubljanska to Tomislavova street
- Vukovarska street
- Heinzelova street
- Đorđićeva street
- Držićeva street

- Zelenivalovi
- Zvonimirova street
- Ribnjak
- Sv. Duh
- Zagrebačka, Bjelovarska i Sesvetska - in the eastern part of town

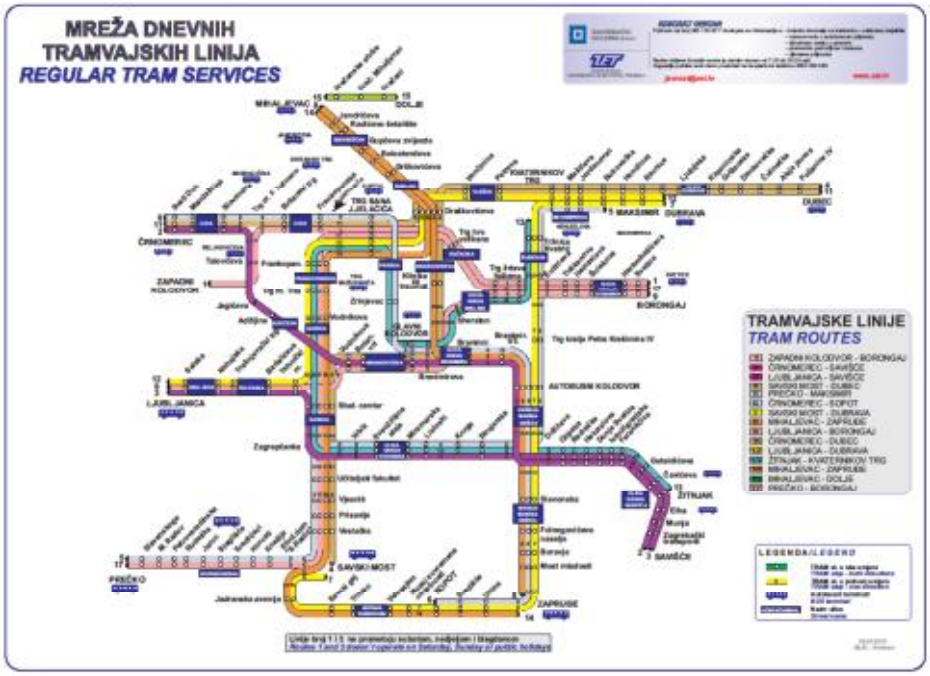
Picture 3-2 Traffic jam in Savska street

Picture 3-3 Traffic jam in Vukovarska street

3.2. Tramway traffic

Regular tram traffic takes place on 116,346 meters of tramlines on which 193 tramcar and 41 trailers are operating every weekday. The total length of railway lines on the 15 daily traffic lines is 148 kilometres, while four night lines have 57 kilometres of length. The number of tram stops is 256. Throughout the whole year in Zagreb, trams transport about 204,000,000 passengers.

In morning peak hour trams are operating with an average travel speed of 12 to 16 km/h, and in some areas (e.g. Savska street) travel speed is even lower and often is below 10 km/h.



Picture 3-4 Tram network 2011

Tram transport which over the years has not evolved in parallel with the city cannot improve short-term acquisition with new vehicles, but it can improve with complete systematic changes in infrastructure and management. An underdevelopment of the tram network is felt on next traffic routes, north-south, west of the street „Savska cesta“ and east of Avenue Marina Držića.

3.3. Bus traffic

Bus transportation, part of ZET (Zagreb Electric Tram) branch, is organized in the City Zagreb area, Velika Gorica and Zaprešić, and the municipalities of Bistra, Luka, Stupnik, Klinča Sela and Jakovlje.

The overall bus network consists of 134 day and four night lines. ZET's network has 2,103 bus stops, of which 1,614 are in the City of Zagreb. Weekdays during peak hour 303 buses are in operation, 185 on Saturdays and 123 on Sundays and holidays. ZET buses transport about 94,000,000 passengers per year.

During morning peak hour travel speed within the bus network in the urban parts of the city is between 15 and 25 km/h, but in certain areas travel speed often is below 10 km/ h.

Since 3 September 2000 a branch of ZET also organizes transportation of school children.

The vehicle park consists of MAN, Mercedes Benz and Iveco - Irisbus vehicles. New vehicles are generally low-floor which is the reason why public transport is accessible to all user groups. In 2008 and 2009 ZET purchased 214 low-floor buses, solo and articulated buses, of which 60 use compressed natural gas. In early 2010 low-floor buses make up 83% of ZET's total vehicle fleet.

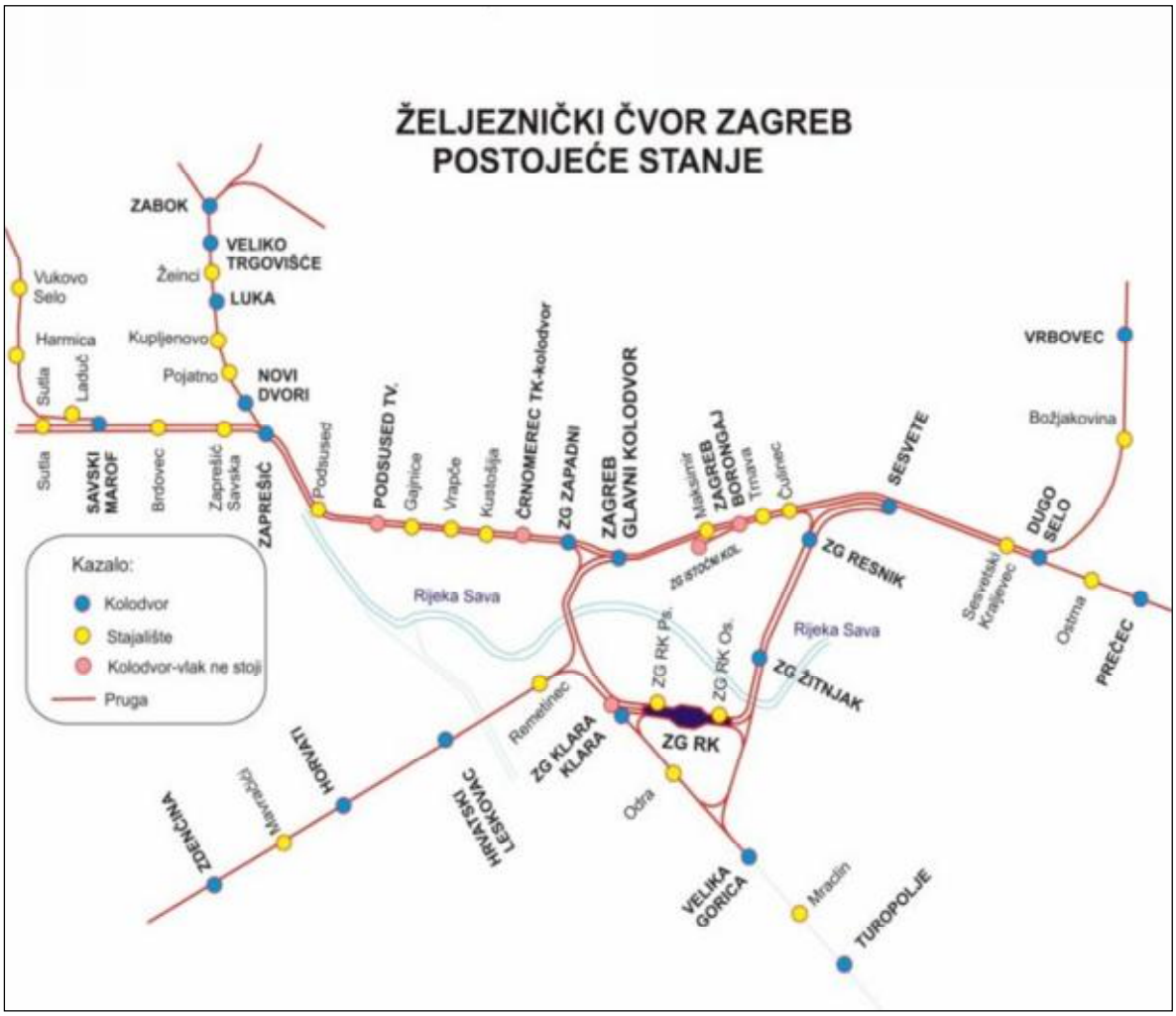
In 2007 ZET introduced biodiesel fuel, and since 2009 also uses compressed gas on their vehicles. According to development plans, buses will be exclusively using biofuel as major contribution to public transport in the city to reduce pollution and eliminate harmful particles, which fossil fuels contain.

Similar to tram transport, the number of passenger on ZET's buses grew until 2007 when the largest growth in the number of passengers was recorded, even 22% more than the previous year. After that, the number of passengers has been falling. The number of buses didn't changed until 2009, when the bus fleet increased by 40% due to new low-floor buses that have been put into operation.

3.4. Railway traffic

Zagreb as the capital of Croatia is the origin of many daily trips to work, school or other needs which causes frequent urban and suburban passenger traffic.

City suburban rail transport takes place in one direction within Zagreb's junction point, and on its spatial diffusion does not cover the entire area of Zagreb. It is organized on an east-west line where the cities' suburban trains complement with local traffic. An insufficient distribution and an overlap of local and urban rail transport are due to a lack of an existing organization.



Picture 3-5 Zagreb railway junction

Urban-suburban rail transport within the City of Zagreb does not meet today's demand for this type of service or the capacity, as well as the quality of service offered. Railway stations are made for temporary solutions where their dimension and lack of equipment does not meet the standard of the railway

station. Electromotor train garnitures that are used in urban-suburban transport with their technical - exploitation characteristics are not intended for this type of transportation.

Except for the fact that a form of urban – suburban rail transportation in Zagreb railway junction exists, and that the system transports about 40,000 passengers daily, and that there is already a single monthly ticket ZET – Croatian Railways (HŽ), which is valid only in Zagreb zone, the overall of urban – suburban railway transport in Zagreb railway junction is not even close to satisfying.

Rail transport in the City of Zagreb operates on 43 kilometres of electrified railways, and the whole track is doubled and electrified. Today train traffic in Zagreb is organized with 107 urban trains and 91 local trains. The above-mentioned city trains are organized with 8 electric motor trains with a capacity of 466-543 seats. The average travel time from place Savski Marof to Zagreb (in one direction) is 54 minutes. Each day up to 40,000 passengers are using trains within the Zagreb area of which about 82% (32,800) are transported inside the administrative boundaries of Zagreb, and 7,200 passengers travel inside the county of Zagreb.

Picture 3-6 Low level of service on Sesvete station

One of the most important indicators of exploitation in the carriage of passengers are the passenger kilometres (PKM), which is actually the ratio of number of passengers on particular route and length distance travelled. As is shown in table 2-3 realized PKM in urban – suburban trains on the route Du-goSelo – Savski Marof (Sutla) is 76%, while other trains realised 24% of PKM.

Table 3-3 Daily carried passengers and realized passengers kilometres by routes during the work day

Route	Passengers	% share	PKM	% share
1. Urban suburban trains	27,037	73%	299,463	76%
1.1. DugoSelo - SavskiMarof	10,796		123,203	
1.2. SavskiMarof - DugoSelo	10,975		108,778	
1.3. DugoSelo - Sutla (Dobova)	2,244		30,165	
1.4. (Dobova) Sutla - DugoSelo	3,022		37,317	
2. Other trains	9,913	27%	94,073	24%
2.1. DugoSelo - Zagreb GK	3,232		33,091	
2.2. Zagreb GK - DugoSelo	3,043		32,474	
2.3. Zagreb GK - Zaprešić	1,138		8,090	
2.4. Zaprešić - Zagreb GK	1,866		13,980	
2.5. Zagreb GK - Mavračići	260		3,060	
2.6. Mavračići - Zagreb GK	232		2,423	
2.7. Zagreb GK - Odra	64		406	
2.8. Odra - Zagreb GK	78		549	
3. TOTAL 1+2	36,950	100%	393,536	100%

Source: Research of Railways Passenger Transport, Zagreb, October, 2005

The average passenger trip length is 10.7 km, which is approximately the length of route from Zagreb GK – Sesvete and Zagreb GK – Podsused station.

Based on surveys of railway passengers, HŽ – passenger transport, in October, 2005, at all stations/stops in urban – suburban transport were obtained following data according to type of transport ticket in urban and suburban transport:

- 60% of passengers use ZET – HŽ ticket
- 15% use HŽ single ticket
- 14% use HŽ monthly ticket
- 9% P-1, P-2, P-4, P-5 tickets and
  2% P-2d, P-5b i PK-12.

From above follows that 22,170 passengers are carried out with HŽ – ZET tickets, 5,543 passengers use HŽ single ticket, 5,173 passengers use HŽ monthly ticket and 4.064 passengers use P – ticket.

Table 3-4 Monthly ticket prices ZET – HŽ in 2011

Working people	**510kn**
Pupils	247kn
Students	247kn
Retired people	247kn
Social	247kn

Source: HŽ – passenger transport, Zagreb, 2011

3.5. Taxi

After many years of a monopole by the Association Radio Taxi Zagreb, citizens can choose which taxi carrier they want to use. In the City of Zagreb taxi services start to perform three new taxi carriers: Rijeka's Taxi Cammeo with 76 cars, Oryx group with about 120 cars and Eco Taxi with about 50 hybrid vehicles.

Permits are for a period of five years for taxi services in the area of Zagreb. Permissions were also granted to 34 private individuals, who are presumed to be the majority to join the Association of Radio-Taxi Zagreb, while the others are executing their own taxi service.

The new companies, Oryx Group and Eco Transport, entered Zagreb's market with the same prices. The start price is 14 kuna, and per kilometre 5.80 kuna. Waiting foruser-to-60 minutes is 40 kuna, and night service is charged extra. Rijeka's Taxi Cammeo with 76 cars provides to citizens of Zagreb initial runs for 15 kuna with the first two kilometres included, and every additional kilometre for five kuna. Tariffs are valid for 24 hours.

Radio Taxi Zagreb, who before becoming Cammeo had a monopoly on the provision of taxi services, now has about 1,100 vehicles, the initial driving charge is 16 kuna, each kilometre is six kuna, two kuna is the storage rate, and night work and holidays is 20% higher. Waiting for user-to-60 minutes is 40 kuna.

Currently, the estimation of 600 inhabitants per taxi, meets the current demand for taxi services in Zagreb.

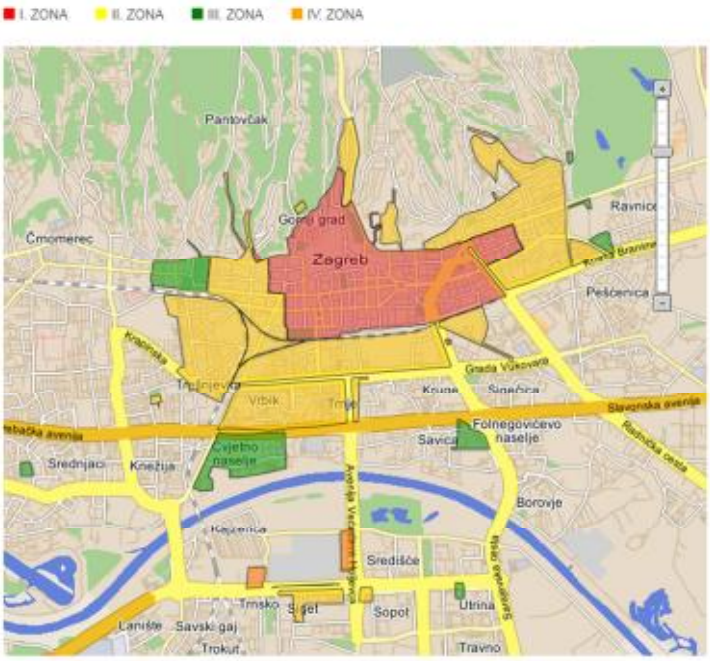
3.6. Parking

The continuous growth in the number of individual vehicles causes a lack of parking spaces. However, a large number of vehicles is circulating in the centre looking for a parking space and additionally burdens the city roads.

In the City of Zagreb parking charges are implemented pursuant to the Decision on the organization and method of parking charging and the Regulations on the use of public parking lots.

The above-mentioned decision and regulations define the parking zones, the time limit and the duration of parking, the price of the parking tickets and the way of using privileged parking tickets and parking surveillance.

The central part of the city is divided into three parking zones (Picture 3-7) with a time-limited parking on 2, 3 or 4 hours, with the exception of certain categories (local residents and legal persons with headquarters in a respective zone).



Picture 3-7 Preview of parking zones in the city

The long-term practice of unauthorized and illegal selling of annual parking tickets in zone I. of Zagrebparking reflected to the parking policy and did not have any effect on reducing the number of vehicles in the centre.

There is a lack of sufficient parking garages to attract traffic underground and to ensure better movement of traffic in the centre. Furthermore, car drivers are often looking for free parking spaces for half an hour, thus further burdening the network.

Table 2-5 shows the number of parking spaces by zone. The total number of parking spaces for which car drivers have to pay increased by 2.6 between 2006 and 2010. It should be mentioned that constantly changing parking fees and time limits do not allow for a quality analysis of the effect of a certain parking fee on a reduction/ increase in the demand for parking spaces.

Table 3-5 Number of parking spaces by zone

	I ZONE		II ZONE		III ZONE		IV ZONE		Total
	Number of parking spaces	Price (kn)	Number of parking spaces	Price (kn)	Number of parking spaces	Price (kn)	Number of parking spaces	Price (kn)	Number of parking spaces
2006	1,875	12	6,345	6	1,606	3	0	0	9,826
2007	1,609	16	9,412	8	3,201	4	0	0	14,222
2008	1,877	16	12,183	8	4,924	4	1,200	5	20,184
2009	6,595	14	9,892	7	2,494	3	1,200	5	20,181
2010	6,595	12	13,356	6	4,245	2	1,450	5	25,646

Source: Zagrebparking

Parking in public areas is paid on weekdays from 7 am to 9 pm for zone I, and from 7 am to 8 pm in zones II and III. On Saturdays parking fees have to be paid from 7 am to 3 pm in all zones.

Exceptions:

- In zone II (Trg Stjepana Radića-Poglavarstvo) a fee has to be paid on weekdays from 7 am to 7 pm and Saturdays from 7 am to 9 pm.
- In zone IV a fee has to be paid all day on weekdays, Saturdays and Sundays.

Table 3-6 Price of parking tickets for each zone in year 2011

ZONE	PRICE	MAXIMUM TIME OF PARKING	DAILY PARKING TICKET
ZONE I	10kn/h	2 h	200kn
ZONE II	5kn/h	3 h	100kn
ZONE III	2kn/h	4 h	50kn
ZONE III.2	2kn/h	6 h	50kn
ZONE IV	5kn/day	All day	

Table 3-7 Monthly price of privileged parking tickets in year 2011

ZONE	INDIVIDUALS RESIDENTS	INDIVIDUAL STRADESMEN	LEGAL ENTITIES
ZONE I	100kn	300kn	600kn
ZONEII	50kn	200kn	300kn
ZONE III	35kn	100kn	150kn

Table 3-8 Prices of parking in the garages in year 2011

PARKING TIME	PRICES OF PARKING IN THE GARAGES (kn/h)						
	Martićeva	Petrinjska	Langov square	Svetice	Kvaternikov square	Rebro	Tuškanac
Mon-Sat 8am - 6pm	7	7	7	7	7	7	7
Mon-Sat 6pm - 8am	4	4	4	4	4	4	4
Sun All day	4	4	4	4	4	-	4
All day (kn)	-	-	-	-	-	60	100

Parking payment is possible by purchasing a parking ticket at a kiosk, so-called commission sales, by purchasing a parking ticket at the parking machine and by purchasing a parking ticket by mobile phone (m-parking).

Working on improving the quality of customer service to park, Zagrebparking was the first worldwide to introduce the option of paying by mobile device (m-parking) in 2001, which is widely accepted throughout Croatia, and after that in many European countries. Today, ca. 78% of users are paying parking space per hour by mobile device.

Table 3-9 m-parking numbers for each zone

Zone	ZONE I	ZONE II	ZONE II	ZONE III	ZONE III	ZONE IV
			CITY GOVERNMENT		MAKSIMIR	VELESAJAM
m-parking numbers	101	102	104	103	106	105

3.7. "Park & Ride" system

"Park & Ride" (P&R) systems began to appear in developed European cities in the 1970s, but in Zagreb it does not exist yet. According to the general traffic plan of 1999, it was planned to set up such car parks in Zapruđe, Borongaj, Dubrava, Mihaljevac, Jarun and on main railway stops. It was calculated that until 2005 the number of cars driving into the city centre would be reduced by 2,200 per day. Yet, the P&R system is Zagreb is not even in the construction phase.

For the application of a P&R system in Zagreb 13 locations are interesting that are located in the wider area of the City of Zagreb, from which three locations are outside the capital (Dugo Selo, Velika Gorica i Zaprešić), but also significantly affect traffic congestion and problems related to parking in Zagreb. In the eastern area there are six locations (Dugo Selo, Sesv. Kraljevec, Sesvete, Dubec, Dubrava and Žitnjak), in the southern part there are two locations (Zapruđe and VelikaGorica), in the western part there are four locations (Zaprešić, Podsused, Vrpče and Prečko), and in the northern area there is one location (Mihaljevac).

To determine the "Park&Ride" locations the following assumptions were made:

- *The existence of an urban transport terminal from which the lines are leading to the city centre* - this assumption enables the acceptance of the location by users;
- *Close to major roads* - the location must be accessible for a larger number of vehicles;
- *Parking space or free space for parking near the transport terminal*

Usage of the P&R is stimulated if the public transport ticket to go to the city centre and back is included in the parking ticket. This way the "Park& Ride" system would become an ideal way to travel for users who do not need a car to go to the city centre.

The system could be implemented quickly because it is not necessary to introduce new lines and public transport terminals. In some cases it would be necessary to increase the number of departures from the terminal and to increase the average speed of public transport. Also, investments in this system would not be high considering the long-term profits.

One of the locations, which can already be called a "Park&Ride" is at railway station Sesvete. Located near the main road at a distance of 500m, the only drawback as with most train stations is the lack of information systems. Distance from city centre is 12km.Transport connections are good; there is a direct connection to the main railways station in the city centre. Travel time is 15 minutes. Also, the bus terminal is nearby. Acceptance by users who are changing their transport mode is very good. The parking lot has a capacity of approx. 1,000 vehicles. While it is not possible to further expand it there are currently sufficient parking spaces available. The terminal has a covered platform and a waiting room inside the building of the railway station.

Picture 3-8 Position of “Park & Ride” location at the railway station Sesvete

(Source: http://maps.google.com)

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The “Park& Ride” system leads to a reduction in the number of vehicles that come into the centre of town, which entails a lot of positive effects on traffic in the city. Reducing the number of vehicles contributes to a reduction of traffic on the streets in the city centre, and therefore leads to lower fuel consumption and waiting time. Reducing fuel consumption will decrease air pollution from exhaust gases of motor vehicles.

3.8. Bicycle traffic

Up to now, bicycle traffic in the city has not been seriously considered as part of transport planning. Bicycle lanes are mostly integrated on city roads as part of reconstructions or when a new road is being built. The consequence of such a partial approach has led to the partial construction of a cycling network that is not linked into a coherent, meaningful whole.

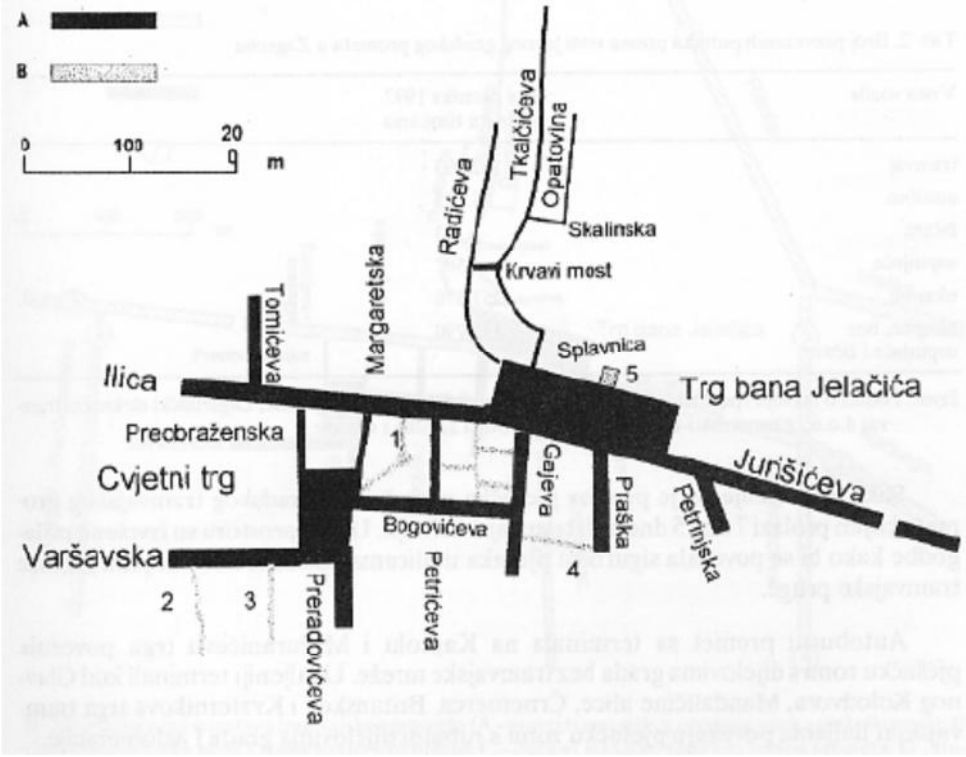
The bicycle is also an underutilized means of transport in Zagreb. According to a traffic study conducted in 1999 only 0.7% of trips were conducted by bicycle. According to a health survey conducted in 2003 it was1%. This is particularly disastrous from the standpoint of air pollution, but the biggest factor in the low use of bikes is the lack of bicycle paths and their connection and lack of sufficient parking facilities for bicycles. Currently, Zagreb does not have a public bike system, but the development and planning of such a scheme is part of the CIVITAS-ELAN project. If the bicycle as a means of transport should have a significant role in the modal split it is necessary to implement a number of measures to boost cycling.

3.9. Pedestrian zone

In pedestrian zones and zones with a limitation for motor vehicles, which are determined by "Order on measures to regulate traffic in the central part of Zagreb" (Official Gazette, 3/95) where vehicles can move only on the basis of approval (decision) of the urban administrative body responsible for traffic, which is issued for a specific day, hour and for a specific vehicle.

The mentioned permission is issued on the basis of Art. 23rd Decision on the traffic in the City of Zagreb, and in order to get it (for moving, construction works and when it is necessary for the functioning of life in the city),a permission must be requested at least one week in advance in writing.

The pedestrian zone in Zagreb has not expanded since 1973, when there were less than 100,000 passenger cars on Zagreb's roads. With the recent construction of ramps in the garage HOTO Centre (2011) Varšavska street is no longer in the pedestrian zone, so the zone is even a bit smaller.

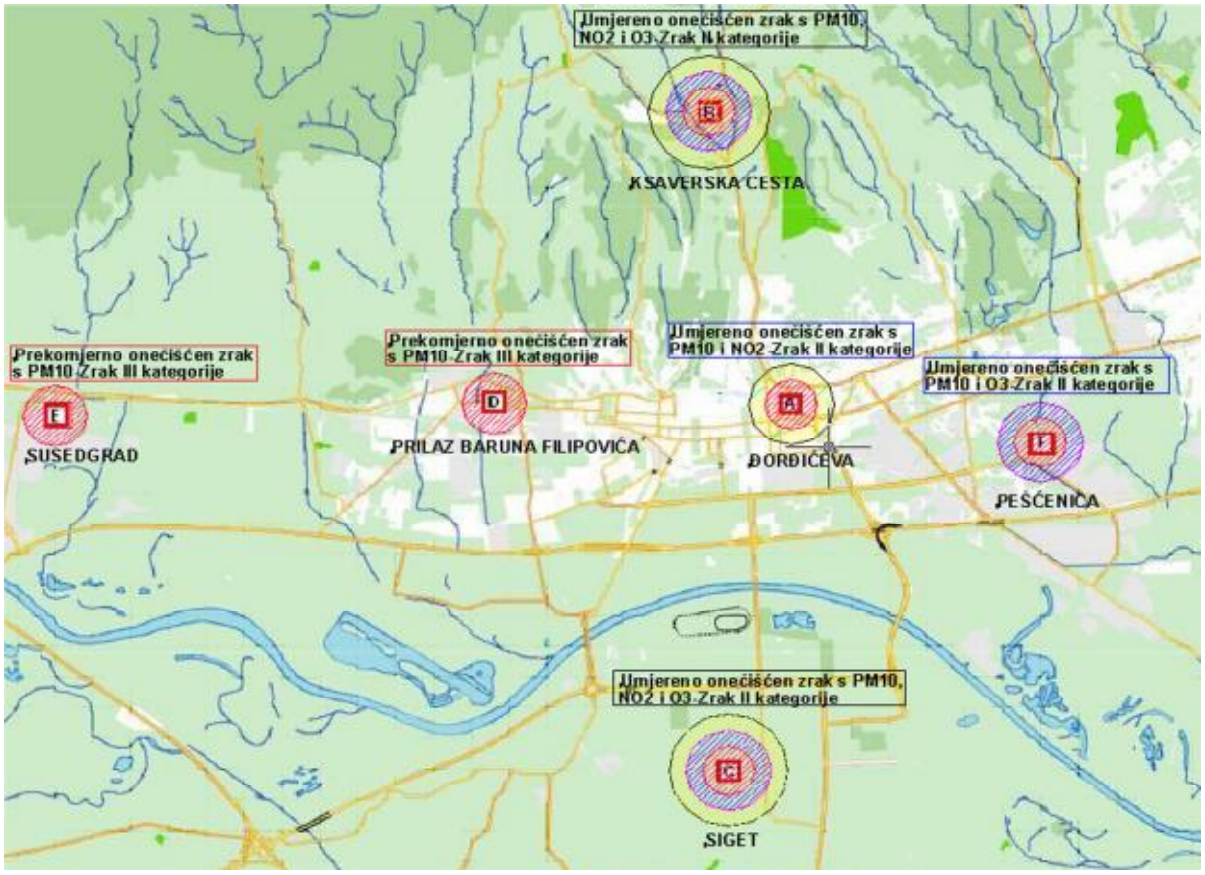


Picture 3-9 The network of streets and squares in pedestrian zone in the centre of Zagreb (A - squares, B – walkway

4. ANALYSIS OF AIR QUALITY IN THE CITY OF ZAGREB

The modern way of life, especially in cities, causes an increase in air pollution, so that a growing number of people is exposed to its harmful effects. Conventional air pollutants are nitrogen oxides, CO_2, CO, ozone, sulphur dioxide and particulate matter (PM_{10}). Out of these the most common pollutants (especially in cities) are particulate matter which may cause a number of acute and chronic diseases, mainly to respiratory and cardiovascular systems. Except from cardiovascular and pulmonary patients, the most vulnerable group of citizens regarding the adverse effects of particulate matter are asthmatics, the elderly people and children.

Monitoring air quality is an essential precondition for determining interrelation of air quality and health. Air quality in Zagreb is continuously monitored at twelve measuring stations. The Ministry of Environment and Physical Planning is responsible for three of twelve national stations, six measuring stations are under city network (Đorđićeva Street - Emergency service, baruna Filipovića - Health Centre Črnomerec, Ksaverska road - IMI, Pescenica - Technical School "Ruder Boskovic", Siget -Health Centre, Susedgrad - Factory" UTENZILIJA) which is responsible for the Institute for Medical Research and Occupational Health in Zagreb, and three measuring stations (AP Vrhovec, Mirogojska street, AMP Jakuševac) which are the subject of special measurement purposes. Responsible for air quality monitoring at these stations are ECOINA Ltd. (stations Jakuševac), Ekonergd.o.o. (Vrhovec stations) and AndrijaŠtampar (Mirogojska stations).



Picture 4-1 Stations for air quality monitoring in Zagreb (2007)

The programme to protect and improve air quality in the City was adopted through an implementation document for the four-year period from 2009 to 2012.

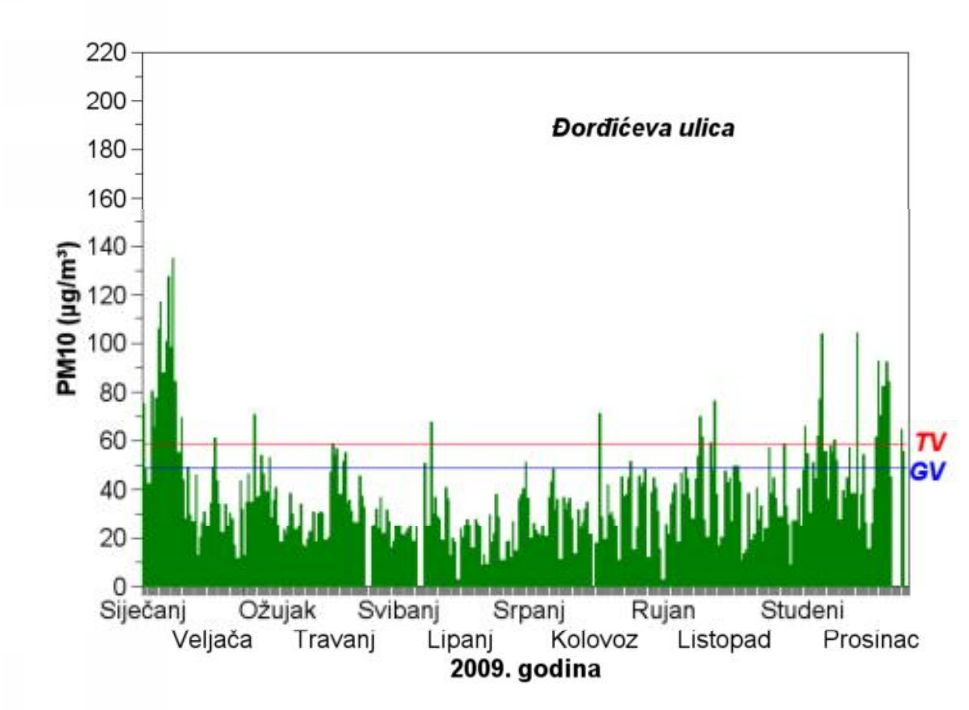
The purpose of the programme is determining the appropriate measures in individual sectors in which an increased impact on the air is registered, the implementation of priority measures, deadlines and those who are responsible for the implementation. Within the existing legislative framework there is also a whole number of measures whose implementation is directly designed to help protect and improve air quality. These measures are taken within the above-mentioned programme to achieve the intended goals, including: continuous improvement of air quality in the town and its preservation within the legally prescribed values in order to protect the health, environment and material goods.

Some of the important measures in the transport sector:

- It is recommended to introduce new measurement parameters at urban network stations, which closely follow the concentration of pollutants in the air. Within the local network at least two measuring stations shall be introduced to measure $PM_{2.5}$ particles.
- It is recommended to introduce targeted, periodic monitoring of pollutants from traffic monitoring stations, for special purposes. It is planned to introduce prefabricated measuring stations of small dimensions that would allow the measurement of emissions of specific pollutants from traffic. The obtained data will be the basis for evaluating and improving measures related to traffic.

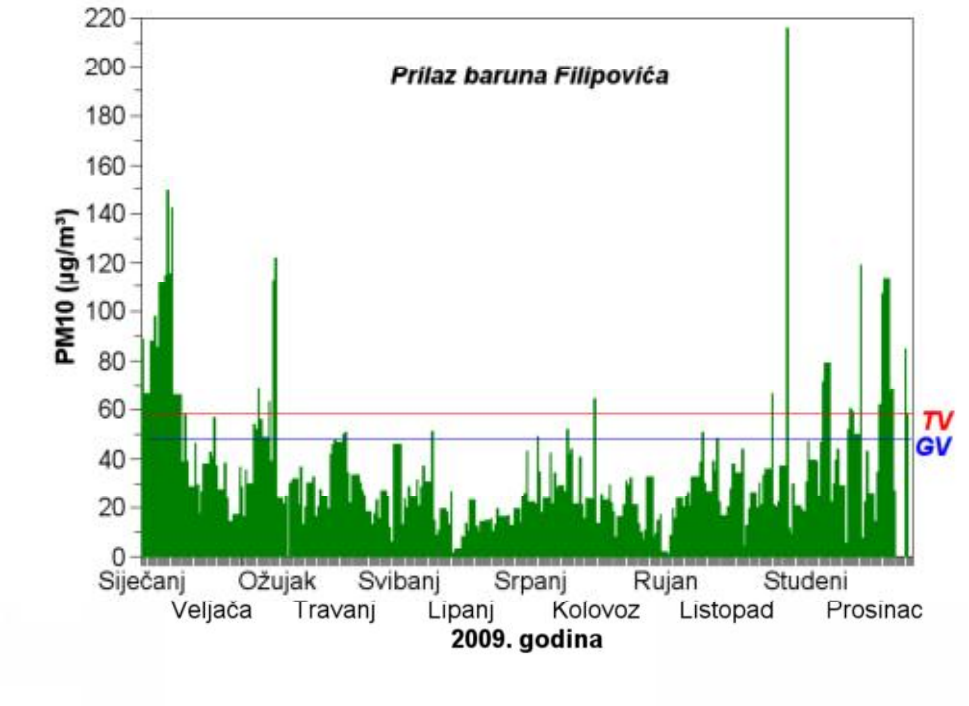
Analysis of results from measurement stations in the city centre:

At the measuring station in Đorđićeva street, in 2007, levels of all measured pollutants in the air were similar to levels in 2006. Due to nitrogen dioxide and PM_{10} particles the surrounding air was of category II quality, and considering all other contaminants it was also of category I quality. In 2007, at the measuring station in Đorđićeva street, the surrounding air was moderately polluted, because there has been a shift in GV (Limiting Values) for nitrogen dioxide and PM_{10} particles.



Picture 4-2 Movements in daily concentration of PM_{10} in 2009 at the Đorđićeva street monitoring station

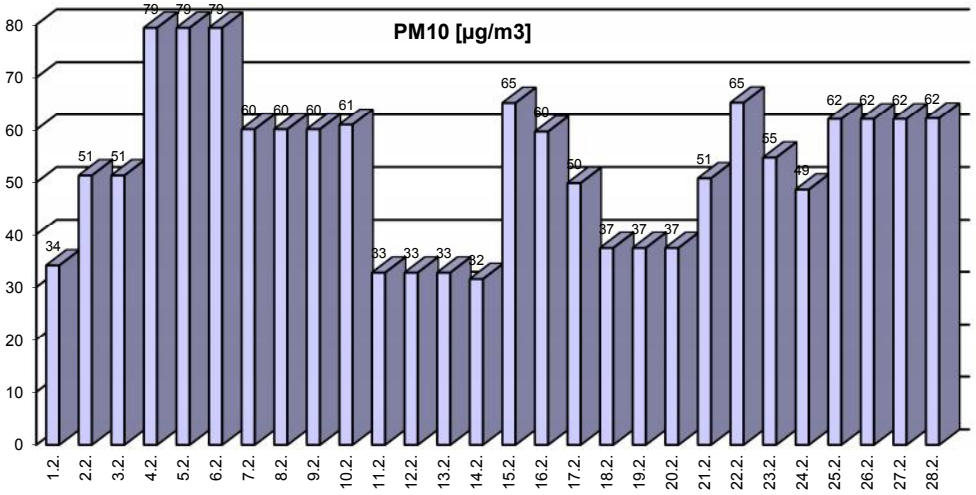
At the Prilaz baruna Filipovića measuring station in 2007 due toPM_{10} particles the surrounding air was of third category quality as in 2006. Other air pollutants measured at the measuring station were in the first category of quality, and levels were similar to those measured in the previous year. In 2007, at the measuring station in Prilaz baruna Filipovića the surrounding air was excessively polluted, because there has been a shift TV (Tolerance Value) for PM_{10} particles.



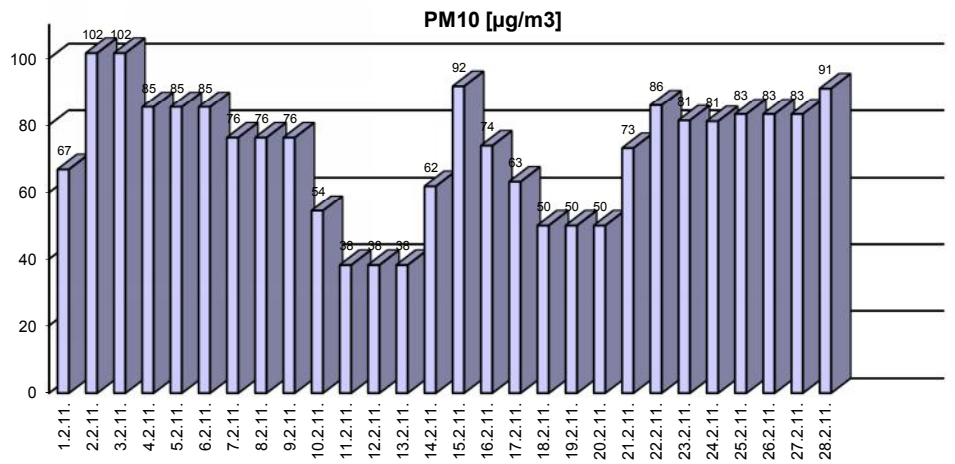
Picture 4-3 Movements in daily concentration of PM_{10} in 2009 at Baruna Filipovića monitoring station

Figures 3-4 and 3-5 show the movements of average daily concentrations of PM_{10} in February 2011 in Đorđićeva street and Baruna Filipovića street. In Đorđićeva street, value of 50 µg/m^3 for PM_{10} for a 24-hour sample has been exceeded 18 times, while in Baruna Filipovića street it has been exceeded 22 times, which is a very high value.

In 2011, the levels of measured particulate pollution in the air were at similar levels as in past years, and there was no significant reduction.



Picture 4-4 Movements in daily concentration of PM_{10} in February 2011 in Đorđićeva street



Picture 4-5 Movements in daily concentration of PM_{10} in February 2011 in Baruna Filipovića street

5. PROPOSAL OF A CONCEPTUAL DESIGN FOR CONGESTION CHARGING IN THE CITY OF ZAGREB

Indirect congestion charging by using vignettes (stickers) is technologically very simple. The indirect toll have to advantage of the simplicity of collecting funds, low operating costs, no need to build costly infrastructure and of course reducing congestion due to charging. Another advantage is that vehicles do not have to be equipped with On-Board Units (OBU) which is an additional cost.

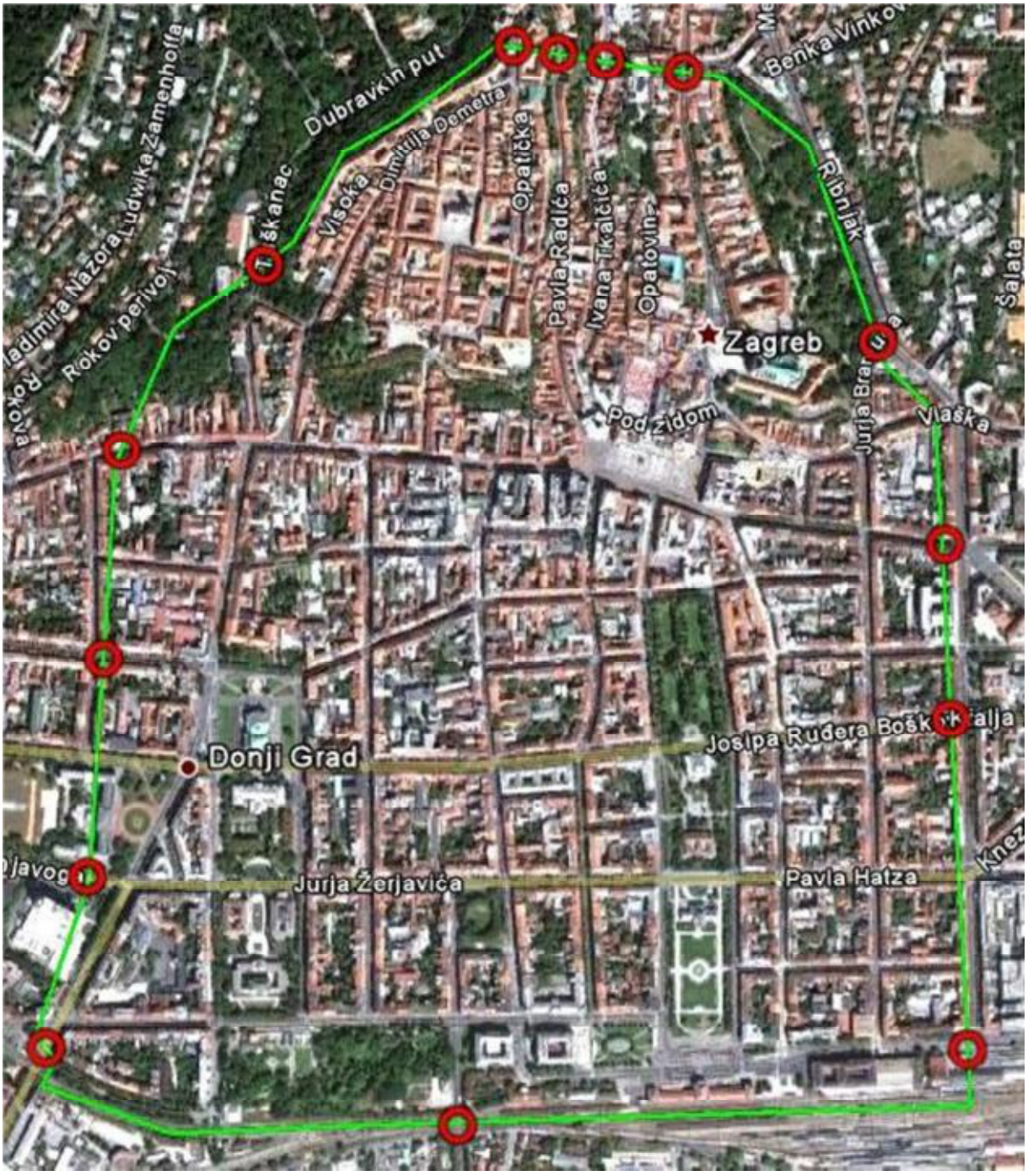
Indirectly toll systems eliminate the costs of building infrastructure (tollgate, roadside equipment), planned maintenance, amortization, regular maintenance, organization of toll collection (workforce, etc.) and the exploitation of which is borne by the users (costs related to the stopping, time, energy , traffic safety, environment).

These were the main reasons to select vignettes as the optimal solution for a congestion charging scheme in the City of Zagreb. Zagreb has two priority objectives. First, to reduce congestion and congestion of the transport system that occurs on the road traffic network at peak and other hours each day. Secondly, to protect the environment by reducing emissions.

5.1. Definition of zone

The selected zone is an area that covers a narrower centre of the city, centred around Ban Jelacic Square (main square). In the north, the zone covers an area of the historic Gornji Grad bounded with the streets Tuškanac, Opatička, Radićeva, Tkalčićeva and Kaptol all the way up to Ribnjak street and a connection to Branjugova and Vlaška. In the west, the border of the zone passes a block of buildings that make Ilica and Medulićeva street Klaićeva, Kršnjavoga to the intersection of the Savska and Vodnikova Street. From Jagićeva street one can turn right into Savska to the south. The southern border of the zone is at the underpass of Miramarska street and Branimirova street. In the east, the zone passes through the building block of Draskovićeva streets, through Branimirova, Boskovićeva all the way up to the connection of Vlaškastreet. The zone covers an area of approximately 2 km².

Picture 5-1 Proposal for an eco-zone in Zagreb



Picture 5-2 Proposal for entry points into the eco-zone in the city centre

Picture 5-3 The proposed eco-zone on a wider area of the city

Table 5-1 presents data from traffic counting at the entrances of the zone (data of 18 March 2010). From 7 am to 8 pm more than 100,000 passenger cars were counted.

Table 5-1 Inbound traffic to the eco-zone (on 18 March 2010)

Counting period	Inbound number of passenger car into the zone
7 am – 8 am	9,621
8 am – 9 am	8,932
9 am – 10 am	8,391
10 am – 11 am	7,985
11 am – 12 pm	7,926
12 pm – 13 pm	7,886
13 pm – 14 pm	7,726
14 pm – 15 pm	7,683
15 pm – 16 pm	8,254
16 pm – 17 pm	8,938
17 pm – 18 pm	7,852
18 pm – 19 pm	7,669
19 pm – 20 pm	6,987
Total	**105,850**

5.2. Definition of the tariff system

The price of the vignette is determined by the type of engines, i.e. engines with lower Euro-standard (larger polluters) will pay a higher amount. Vignettes are categorized into five types (green, yellow, red, grey and white). White vignettes are related to electric vehicles and hybrid vehicles and will be free of charge. The penalty for not having a vignette will be as much as the price of the most expensive vignette (133,33 € or 1,000 kn). Vignettes will apply to Croatian number plates.

Table 5-2 Proposed amount of fees according to the type of vignette

Colour of vignette	Fee on an annual basis in EUR (€)
Type 1	13,33
Type 2	26,66
Type 3	66,66
Type 4	133,33
Type 5	Free

Table 5-3 Categorization by type of a vignette

M1 - PASSENGER CAR	OTTO - 2 STROKE
M1 - PASSENGER CAR	OTTO - without catalyst
M1 - PASSENGER CAR	OTTO - without catalyst + LPG
M1 - PASSENGER CAR	OTTO - without catalyst + CNG
M1 - PASSENGER CAR	OTTO - CATalyst
M1 - PASSENGER CAR	OTTO - REG-CAT - EURO II
M1 - PASSENGER CAR	OTTO - REG-CAT - EURO III
M1 - PASSENGER CAR	OTTO - REG-CAT - EURO IV
M1 - PASSENGER CAR	OTTO - REG-CAT - EURO V
M1 - PASSENGER CAR	OTTO - REG-CAT + LPG
M1 - PASSENGER CAR	OTTO - REG-CAT + CNG
M1 - PASSENGER CAR	WANKEL - without catalyst
M1 - PASSENGER CAR	WANKEL - REG-CAT
M1 - PASSENGER CAR	WANKEL - REG-CAT-EURO II
M1 - PASSENGER CAR	WANKEL - REG-CAT-EURO III
M1 - PASSENGER CAR	WANKEL - REG-CAT-EURO IV
M1 - PASSENGER CAR	WANKEL - REG-CAT + LPG
M1 - PASSENGER CAR	DIESEL
M1 - PASSENGER CAR	DIESEL - EURO II
M1 - PASSENGER CAR	DIESEL - EURO III
M1 - PASSENGER CAR	DIESEL - EURO IV
M1 - PASSENGER CAR	DIESEL - EURO V
M1 - PASSENGER CAR	HYBRID (ELEC. + OTTO)
M1 - PASSENGER CAR	WANKEL - REG-CAT - EURO V
M1 - PASSENGER CAR	WANKEL - REG-CAT + CNG
M1 - PASSENGER CAR	ELECTRIC MOTOR

Based on data obtained from the Croatian Centre for Vehicles (Table 4-4), a forecast on the number of passenger cars (Table 4-6) and a trend analysis of the proportion of each type of a vignette was con-

ducted until 2017. Also, an estimate was made about the purchased vignettes by type until 2017 (Table 4-7). The above analysis, forecasts and estimates will be used as input data for the cost-benefit analysis.

Table 5-4 Number of passenger cars

Year	2007	2008	2009	2010
Type 1	21,829	51,245	81,500	109,685
Type 2	162,248	158,949	154,255	149,705
Type 3	64,787	61,298	56,999	52,508
Type 4	61,254	52,236	45,600	38,997
Type 5	9	18	37	71
Total	310,127	323,746	338,391	350,966

Table 5-5 Share of each type from 2007 to 2010

Year	2007	2008	2009	2010
Type 1	7%	16%	24%	31%
Type 2	52%	49%	46%	43%
Type 3	21%	19%	17%	15%
Type 4	20%	16%	13%	11%
Type 5	0.00%	0.01%	0.01%	0.02%
Total	100%	100%	100%	100%

Table 5-6 Forecast of number of passenger cars

Year	2013	2014	2015	2016	2017
Type 1	164,331	193,692	226,359	260,811	295,902
Type 2	138,769	134,094	122,771	110,647	98,634
Type 3	35,788	24,584	21,101	11,855	4,110
Type 4	25,563	18,624	11,510	7,903	4,110
Type 5	730	1490	1,918	3,952	8,220
Total	365,181	372,484	383,659	395,169	410,975

Table 5-7 Estimation of the share for each type of vignette

Year	2013	2014	2015	2016	2017
Type 1	45.00%	52.00%	59.00%	66.00%	72.00%
Type 2	38.00%	36.00%	32.00%	28.00%	24.00%
Type 3	9.80%	6.60%	5.50%	3.00%	1.00%
Type 4	7.00%	5.00%	3.00%	2.00%	1.00%
Type 5	0.20%	0.40%	0.50%	1.00%	2.00%
Total	100.00%	100.00%	100.00%	100.00%	100.00%

Table 5-8 Estimation of the percentage of passenger cars that will buy a vignette

Year	2013	2014	2015	2016	2017
Type 1	85%	82%	77%	75%	75%
Type 2	70%	62%	57%	55%	50%
Type 3	17%	15%	12%	8%	5%
Type 4	9%	7%	3%	2%	1%
Type 5	free	free	free	free	free

5.3. Passenger vehicles exempted from buying a vignette

As the vignettes apply only to passenger cars it is proposed that the following vehicles receive vignettes free of charge.

- taxis
- rescue services vehicles-ambulance, fire brigade
- vehicles registered to people with disabilities who are exempt from other traffic charges
- vehicles for transportation of people with disabilities

6. PREDICTION OF THE IMPACT OF CONGESTION CHARGING

The focus of this chapter is on the prediction of the impact of the introduction of a congestion charging scheme in Zagreb. It considers the contribution of work carried out in advance of implementing a congestion charging scheme in order to judge its expected impacts, including levels of success in achieving desired objectives and potential negative effects that may need to be addressed.

The prediction may be defined to include the full range of activities carried out prior to implementation in order to help to understand the impacts of a congestion charging scheme. In particular, it incorporates both empirical survey work and model-based studies designed to test the performance of the different scheme options.

A broader prediction may also be defined by including the appraisal of congestion charging schemes, such as the calculation of economic benefits and the assessment of wider impacts via multi-criteria approaches, through which the outputs of other empirical and model-based work are interpreted for policy-making.

A further related area is evaluation, which involves measuring the actual outcomes of congestion charging schemes after implementation.

The prediction has a tangential link to the objectives of road pricing which helps understanding how proposed schemes will perform against the objectives set.

A particular concern regarding the relationship between objectives and prediction is the danger of optimism bias. Experience suggests that planners may tend to assume the best case when predicting the outcomes of proposed schemes, leading to a potential underestimation of costs and overestimation of benefits. In the UK, this phenomenon has received formal government recognition. In the case of congestion charging, the cost of implementing appropriate technologies, collecting payments and enforcement are all areas where costs could quite conceivably be underestimated.

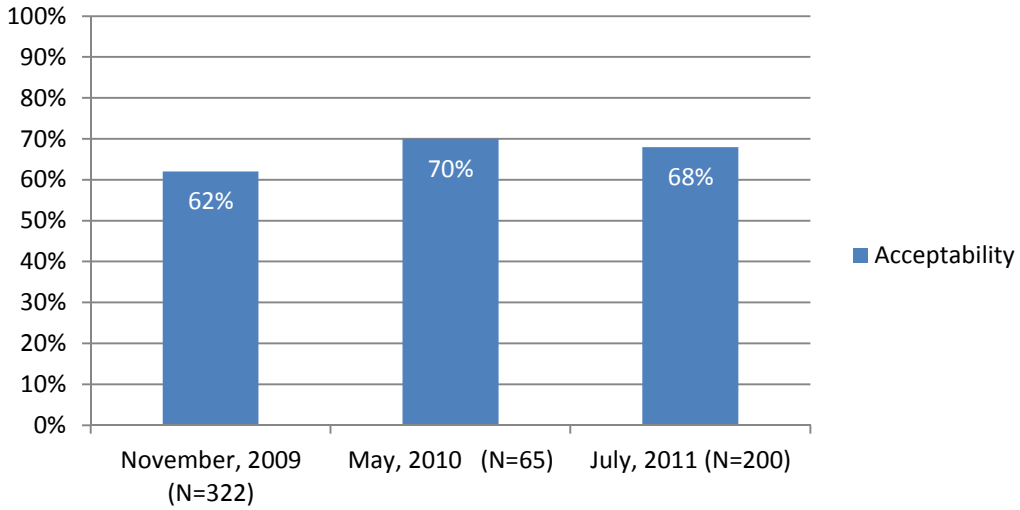
It is estimated that the introduction of an eco-zone in the City of Zagreb will lead to:

- **a reduction of the number of vehicles in the zone by 10 %; and**
- **an increase of air quality by 15 %.**

It will be necessary to conduct a detailed traffic counting and local air quality measurements in order to get accurate information about the effects of the eco-zone.

7. RESEARCH ON ACCEPTABILITY FOR THE CHOSEN SOLUTION

A research study on the acceptability for the chosen congestions charging scheme by Zagreb's citizens was carried out through three surveys in 2009, 2010 and 2011. It is significant to emphasize that the results of all of three surveys exceed 50% of acceptance. The 2011 survey already included the exact boundaries of the eco-zone where vignettes should be introduced.



Picture 7-1 The level of acceptability in 2009, 2010 and 2011 (N = sample size)

7.1. Survey on the acceptability of congestion charging in 2009

In November 2009 the survey was mailed to a random sample of average 800 citizens of the Zagreb municipality, that is, people living in the city of Zagreb. All respondents were 18 years or older. The survey was filled in and returned by 322 respondents. Answers from the survey are presented using tables and figures.

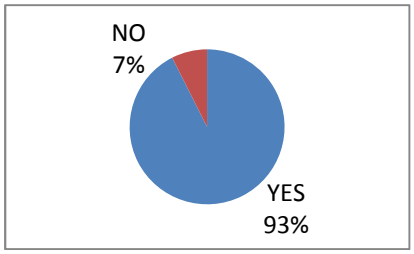
Table 7-1 Gender of respondents

Gender	
% Men	*45*
% Women	*55*

Table 7-2 Year of respondent

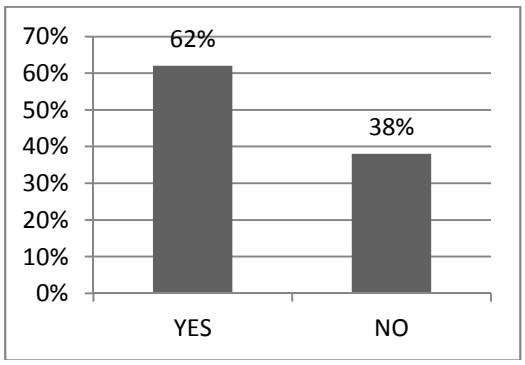
Years	*18 - 29*	*30 - 39*	*40 - 49*	*50 - 59*	*> 60*	*All*
%	*24*	*35*	*21*	*15*	*5*	*100*

On the question about owning a driver's license 93% of respondents answered yes (Picture 7-2).



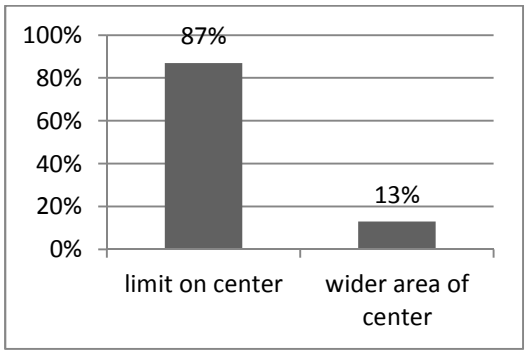
Picture 7-2 Question about owning a driver's license

On the key question "Do you support the idea of introducing an "Eco-zone" in the city centre where drivers will have to pay a traffic congestion charge (when passing through the city centre)?" 62% of respondents answered “Yes” and 38% “No” (Picture 7-3).



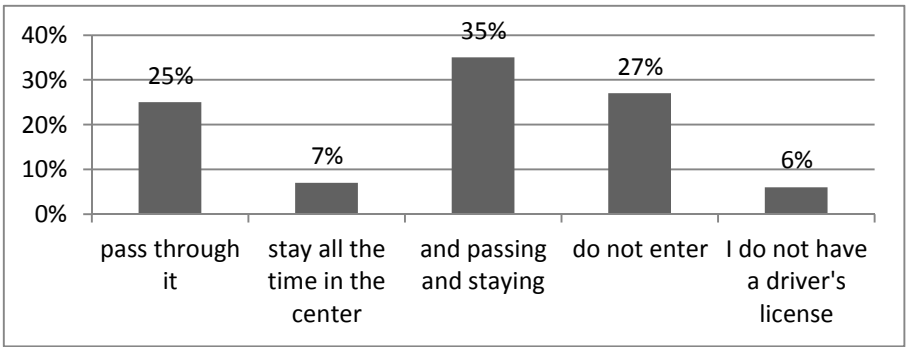
Picture 7-3 Level of support about paying traffic congestion charge in Zagreb

The relationship of the question "Do you think that charges should be limited to the city centre (e.g. green waves, Frankopanska ...) or extended to the wider city centre area (e.g. Črnomerec–Dubrava)" and the previous question was to test citizens’ attitudes on the possible area of the charging zone. The majority (87%) answered that the eco-zone should be limited to the centre.



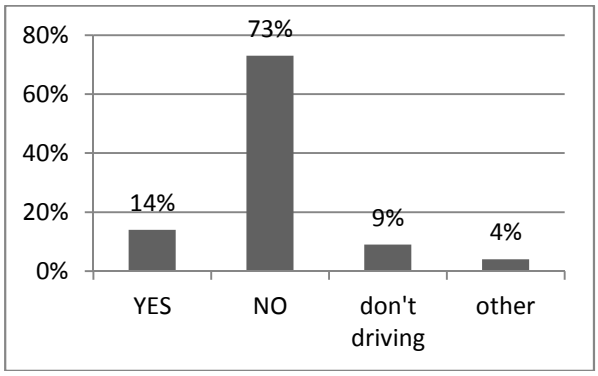
Picture 7-4 Question about area of the zone

On the question "When you enter the city centre by car during weekdays you …?", answers were: 25% pass through it, 7% stay in the centre, and 35% were passing and staying. 27% do not enter at all and 6% do not have a driver’s license. Hence, the congestions charging scheme would affect 60% of the vehicles: the 25% in transit and the 35% in partial transit.



Picture 7-5 Question about entering the city centre by car during weekdays

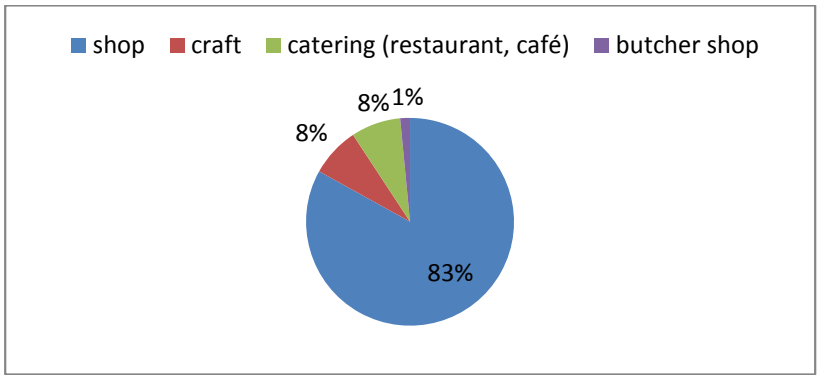
The last question about the satisfaction with the existing parking billing system showed that 73% of respondents were not satisfied.



Picture 7-6 Satisfaction with existing parking billing system

7.2. Survey on the acceptability of congestion charging among businesses in 2010

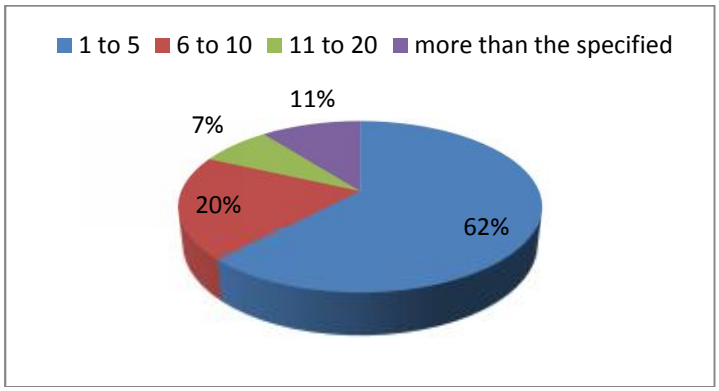
In May 2010 the survey was conducted to examine the attitudes of the business sector about the acceptability of congestion charging. The survey was anonymous and was conducted on a sample of 65 business subjects in the city centre.



Picture 7-7 Share of business subjects by type of activity

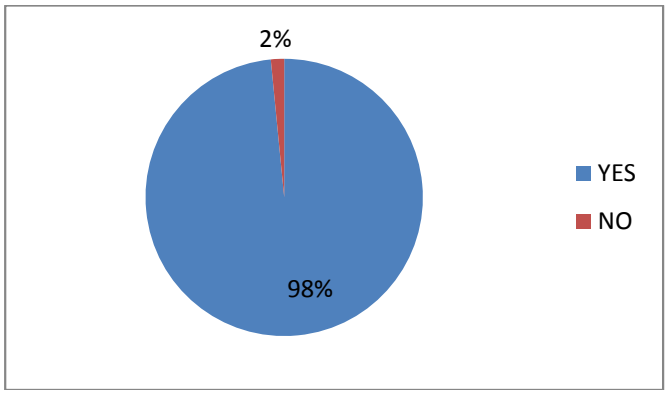
Most of the business subjects are dealing with commercial activity (Figure 7-7).

It should be pointed out that 62% of businesses have between 1 and 5 employees (Figure 7-8).



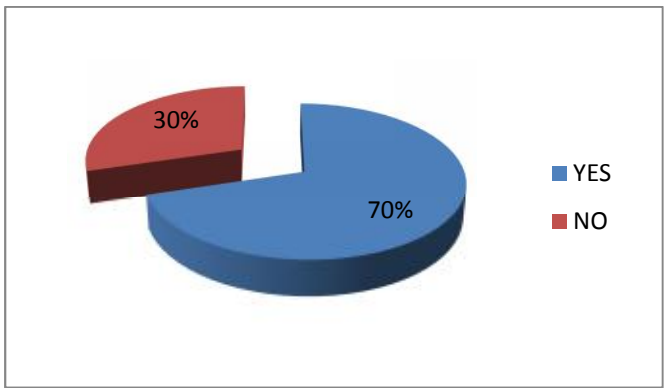
Picture 7-8 Size of businesses

Awareness of traffic congestion in Zagreb is nearly 100% (Figure 7-9).



Picture 7-9 Answers of respondents on the question about awareness of traffic congestion

On the question of whether respondents would support the introduction of an "eco-zone" where they would have to pay a fee for entering the city centre, 70% answered affirmatively.

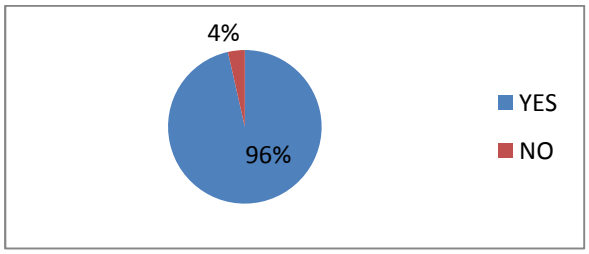


Picture 7-10 Attitude of businesses about the introduction of an "eco-zone"

7.3. Survey on the acceptability of congestion charging in 2011

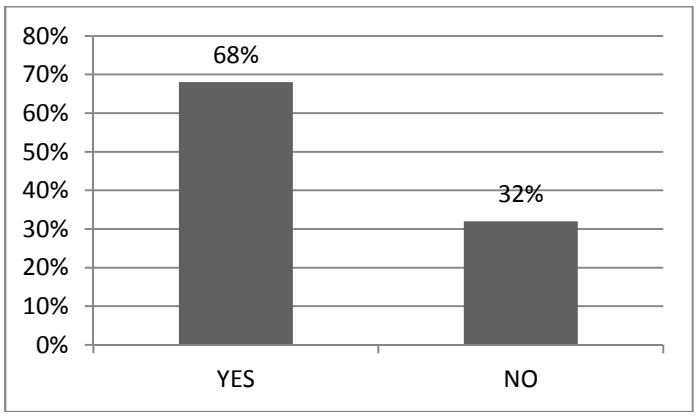
In July 2011 a survey was conducted to test citizens' attitudes about the acceptability of a congestion charging scheme. The survey was anonymous and was conducted on a sample of 200 citizens of Zagreb. 71% of respondents were male and 29% female. 90% of respondents owned a driver's license.

96% respondents answered that there is a traffic congestion problem in the centre of Zagreb.

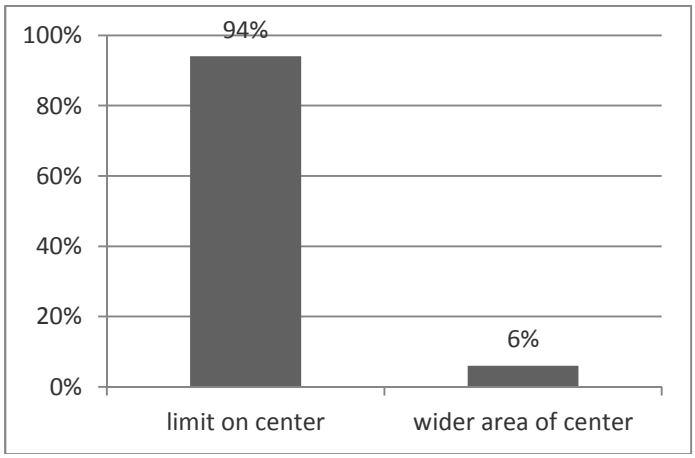


Picture 7-11 Answers of respondents on the question about awareness of traffic congestion

On the question of whether they would support the introduction of an "eco-zone" where they would have to pay a fee for entering the city centre, 68% of respondents answered affirmative (Figure 7-12). 94% of respondents were for the limitation of the zone to the city centre (Figure 6-13).



Picture 7-12 Attitude of citizens about the introduction of an "eco-zone"



Picture 7-13 Attitude of citizens about the size of the zone

The answer to the question about how high the annual fee should be with respect to the environmental category of the motor vehicle (e.g. “worse engines” - EURO 0, “better engines” EURO III and above) are in the Table 6-3.

Table 7-3 Amount of annual fees (according to survey) according to the environmental category of the motor that should be paid

	"worse engines"	"better engines"
The average value	626 kn	312 kn
This maximum amount	2,000 kn	1,000 kn
The minimum amount	200 kn	100 kn

Respondents also were asked to propose how high the average amount of fines should be if a driver would not have a vignette (Table 7-4).

Table 7-4 Average amount of fines due to not having vignettes

	amount of fines
The average value	2,792 kn
This maximum amount	20,000 kn
The minimum amount	200 kn

7.4. Political process

The proposal for the conceptual design for a congestion charging scheme in the City of Zagreb was prepared by the Faculty of Transport and Traffic Sciences (ZFOT) in cooperation with all relevant stakeholders. The proposal was submitted to the Zagreb Office for Strategic Planning and Development during an expert roundtable held on 3 June 2011 (see below). No date has been set yet when the proposal will be submitted to the City Council.

On 3 June 2011 the Faculty of Transport Sciences organised an expert roundtable entitled “Proposal for the introduction of an “eco-zone” in the City and dialogue on prices”. All relevant stakeholders were invited: The City of Zagreb, “Zagrebacki Holding” Co., department “ZET”, non-governmental organisation ODRAZ, non-governmental organisation BICIKL, etc.

Picture 7-14 Dialogue on pricing and congestion charging

Names of participants (incl. affiliation):

1. Višnja Bedenko, City of Zagreb, Office for Strategic Planning and Development
2. Stjepan Kelčec-Suhovec, City of Zagreb, Office for Strategic Planning and Development
3. Ivan Zajec, City of Zagreb, Office for Strategic Planning and Development
4. Marko Slavulj, Faculty of Transport and Traffic Engineering
5. Štefica Mrvelj, Faculty of Transport and Traffic Engineering
6. Marko Ševrović, Faculty of Transport and Traffic Engineering
7. Davor Brčić, Faculty of Transport and Traffic Engineering
8. Branko Mikinac, "Zagrebacki Holding" Co.,department "ZET"
9. Krunoslav Tepeš, City of Zagreb, Office for Transport
10. Alan Ordulj, City of Zagreb, Office for Transport
11. Branko Mikinac, "Zagrebacki Holding" Co.,department "ZET"
12. Stipan Matoš, "Zagrebacki Holding" Co.,department "Zagrebparking"
13. Tihana Damjanović, Non-governmental organisation ODRAZ
14. Marina Marić – Turk, Non-governmental organisation ODRAZ
15. Edi Sadiković, AKD d.o.o.
16. Krešimir Pišćak, AKD d.o.o.
17. Bernard Ivčić, Non-governmental organisation Zelena akcija
18. Georg-Davor Lisicin, Croatian Automobile Club (HAK)
19. Milan Živković, Student

The acceptability of the proposed solution by citizens was explored by a survey. The survey was conducted from 1-7 July 2011 on a sample of 200 citizens. During the survey the potential location of the "eco-zone" in the city centre was shown. Results revealed that 68% of citizens would support the introducing of an "eco-zone" in the city centre.

8. CONCLUSION

Due to the trend of an increasingly urbanized population all over the world, cities are intensively developing their transport strategies to enable sustainable living in urban communities. The inability to increase the capacity of urban road networks increases the need to plan and implement transport demand management strategies. One of the more commonly used strategies in cities in developed countries is the introduction of congestion charging. Examples of a number of cities that have implemented this strategy show the positive effects achieved in the transport system.

The study analyses the current transport situation in the City of Zagreb: public transport, cycling and walking. Also, the parking system and park and ride system that have an impact on transport demand management is being analysed. Rising living standards over the past ten years have led to an increase in the number of private cars as well as to increased mobility in the City of Zagreb (increasing mileage of passenger cars on an annual basis). The number of motor vehicles has reached about 500 cars per 1000 inhabitants, and with this number Zagreb is equal to other Western European cities. Unlike other Western European cities Zagreb is only starting to encourage non-motorized modes of transport. The CIVITAS-ELAN project is the first large scale sustainable urban transport project in Zagreb.

Zagreb has not yet implemented a public bicycle system, no concept for a bicycle network has been established, and there aren't sufficient parking facilities for bicycles resulting in a minor share of cycling in the modal split. The pedestrian zone was defined in1973 and since then its boundaries have not changed. Before the CIVITAS-ELAN project there was almost no culture of dialogue on traffic issues. With CIVITAS-ELAN, a dialogue with citizens has started but there is still a lot of work to be done.

Public transport – the backbone of the total number of trips – has been neglected in recent decades. A big problem in the central part of the city is the low travel speed of trams and buses which makes public transport uncompetitive in relation to the use of private cars. In some areas of the traffic network travel speed is below 10 km/h. No "Park and Ride" system has been implemented, but people use free surface near the terminals and PT stops to park their cars.

The level of service in suburban rail traffic is low during peak hours. The situation may improve considerably as Croatian Railways plans topurchase18 new motor trains for urban and suburban transport with a capacity of 500 passengers each which enables doubling the frequency during morning and afternoon peak hours.

The PT system in the City of Zagreb would profit from the introduction of another subsystem of public transport (BRT –bus rapid system, LRT-light rail, etc.) that would have a greater transport capacity and attractiveness for medium length trips due to a higher operating speed.

With the entry of new operators into the taxi market and the abolishment of a long existing monopoly of the Association of Radio Taxi Zagreb citizens have begun to use this mode of transport more often.

Due to the frequent changes of the parking tariff policy there is no real positive effect in order to reduce traffic congestion in the city centre. The strategy was not fully implemented in practice, and therefore the parking policy objectives have not been fully achieved.

The City of Zagreb has two priority objectives related to congestion charging. The first objective is to reduce traffic congestion caused by excessive use of cars within the network traffic at peak hours. The second objective is to protect the environment by reducing emissions as tolerant values of air quality are crossed for one or more pollutant parameters on a regular basis. The study also addresses other indirect goals such as liveability, health, equity, safety, environment, intergenerational equity, and raising revenue.

In order to reduce congestion and protect the environment by reducing emissions direct and indirect models for billing transport infrastructure are known. The main characteristic of the direct model of congestion charging is that the process of identifying and accounting fees takes place immediately before or immediately after using part of the infrastructure or the charging zone for which the fee was introduced. These models, in principle, require the construction of a specific infrastructure or the use of an extra unit in vehicles which increases the price of the system. The main technologies are Automatic

Numeric Plate Recognition, Dedicated Short Range Communications and Global Navigation Satellite System.

The advantages of an indirect toll are its simplicity of raising funds, low operating costs, and the fact that there is no need to build expensive infrastructure. The indirect model of congestion charging using vignettes technology is very simple. Furthermore, the surveys conducted with citizens, businesses, professionals and local authorities about an acceptable solution for a congestion charging scheme in the City of Zagreb have led to the selection of an indirect model for billing transport infrastructure.

The design of the congestion charging scheme covers the spatial selection of the zone, the billing technology, the tariff model, the time period of billing, how to use revenues from the scheme and how to ensure privacy.

Within the study a possible “eco-zone” in Zagreb’s city centre of approx. 2 km² has been defined. Although there is a problem of congestion in the wider city area, an area where traffic congestion problems are most obvious is primarily chosen.

The introduction of EURO standards allows grouping certain vehicles in certain categories. According to the proposal for the City of Zagreb vignettes would be categorized into five types: green, yellow, red, grey and white. The tariff model of vignettes is determined by the type of engine which means that engines with low Euro-standard will pay a higher amount.

The analysis has revealed that of the registered fleet (private cars) within the city of Zagreb in 2010 11% would have to have a grey vignette for the biggest polluters (vehicles with Otto engines without catalytic converters, cars with diesel engines without EURO standards). The concept of the high price of 133 € (1,000 kn) is to discourage these vehicles from entering the city centre.

White vignette would apply to electric vehicles and hybrid vehicles which would be free of charge to stimulate the use of such vehicles. The fines for not having a vignette will be similar to the price of the most expensive (grey) vignette. It is proposed that the vignettes refer to the Croatian number plates which have to be renewed (bought) each calendar year.

It is estimated that in the case of an introduction of the eco-zone in the City of Zagreb the number of vehicles in the zone would be reduced by 10% and air quality would increase by 15%.

A research on the acceptability of a congestion charging scheme was carried out through three surveys during 2009, 2010 and 2011. According to these surveys the acceptability by stakeholders is above 60%.

No date has been set yet when the proposal will be submitted to the City Council but before a charging model could be introduced detailed traffic counting needs to be conducted in the area as well as local air quality measurements and noise measurements in order to evaluate the set goals. According to the study it is planned to start the implementation of the vignettes in 2013.

Up to now the City of Zagreb has no model to collect data systematically which makes traffic analysis and planning of the transportation system rather difficult. Therefore, the data associated with the introduction of a congestion charging scheme was collected by the University of Zagreb. It is important to note that the City of Zagreb should conceptualise a model of collecting data on the transport system, so that in the future proper decisions could be made about the overall transport policy of the city.

The proposed design of the congestion charging scheme for the City of Zagreb and monitoring the achievement of objectives could be then transferred to other major cities in the Republic of Croatia which are facing similar traffic problems.