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A. GŁUSZEK*, J. MAGIERA*

TRANSPORT AS ELEMENT OF SUSTAINABLE DEVELOPMENT OF HISTORICAL CITIES

Nowadays transport is one of the most important factors, determining development of a city. In almost all the cities, the number of vehicles moving in various directions is huge. The traffic jam is a reason of many social and environmental conflicts, and a main source of transport problems. Therefore it is necessary to accept the model of transport development, which should secure mobility of people and simultaneously should allow the lowest environmental pollution. Due to constitutional rule of sustainable development these goals can be achieved. In the paper, the Cracow transport system based on eco-development policy was discussed.

1. INTRODUCTION

Historical city, existing in the conditions of sustainable development, secures its cultural heritage through maintaining its structure and identity in parallel with a harmonized social-economic, spatial and technical development. There are many factors which influence town planning and encourage its sustainable development. They can be itemized as follows: spatial form of town, transportation, building planning and maintenance, energy, ecology, management of environmental resources [1].

2. TRANSPORT AS AN ESSENTIAL ELEMENT IN THE SUSTAINABLE DEVELOPMENT POLICY

In Agenda 21, i.e., XXI century Programme [2], the public transport problems are considered to be very essential for sustainable development of a city. Transport policy is directed to the development of cheaper, less troublesome and safe for environment means of transport, as well as to continuous activity in emission control. In a city, which develops according to eco-development rules, traffic flow should be reduced. Serious

* The Cracow University of Technology, Institute of Chemical and Process Engineering (C-3), ul. Warszawska 24, 31-155 Kraków, Poland, e-mail: magiera@chemia,pk.edu.pl

reduction of individual motor transport is necessary. Before this, local authorities must ensure that public transport facilities meet the needs of the population. In municipal transport this means a public transport development along with a better standard of service that favourizes energy-saving means of transport, common use of cleaner fuels, especially biofuels, and environmentally-friendly vehicles, i.e., less air polluting and less noisy, and also better road safety for pedestrians and cyclists [3].

Motorization is strongly connected with phenomenon of urban sprawl, and that is why transport management has to be integrated with implementation of innovations in town planning area. Each new office, shop, housing estate or shopping centre built in the city suburbs creates a stronger need for travelling, therefore it is of a special importance to design an efficient network of public transport. An active policy of sustainable development of transport, especially public transport, results in increasing the frequency of running, better travelling comfort due to better technical condition, cleanliness of vehicles and stops, legibility of timetables, time and price attractiveness, time and rate integration for different means of public transport, availability of transport due to the shorter distances that should be covered to reach stops, as well as expansion of parking places in Park + Ride System (P+R)*.

3. SUSTAINABLE MOBILITY IN THE CITY OF CRACOW

In Cracow, the transport policy is based on a public transport with a high share of non-motorized means of transport. In the public transport system in Cracow, bus and tram network aided by private minibus lines is exploited. Environmentally-friendly transport in Cracow is organized in the following way: 30–35% of all dislocations in the city during week days are due to motor traffic, the rest travels are due to public transport, bikes or on foot [4]. These data may seem to be amazing, because in Cracow, there is observed little interest in public transport, and bike traffic depends on season, with its average of 1–5% [5]. Cracow inhabitants are tired of noise and contamination of the city centre, hence they look for a comfortable place for living, move from the city centre to suburbs and outskirts, in the areas of the west and south-west of Cracow.

Historical City with its activities localized at one place, which reduces the need for travelling, is changing into the City, where work places, domiciles, shops restaurants, galleries, etc., are situated at such distances that travelling is indispensable, because the distances are longer. Because of the above we deal with heavy motor traffic in the City. According to 2003 year statistics the number of vehicles registered in the City have been growing systematically, but the number of public transport passengers is decreasing. The parameters of the public transport in Cracow are gathered in table 1.

* Park + Ride is a way of combining private travel with public transport.

Table 1

Transport system in Cracow [6]

Year	2001	2002	2003
Elements of tram, bus and minibus network			
Number of passengers [mil]	333,40	331,17	314,30
Length of bus network [km]	1 525,7	1 414	1 386
Length of tram network [km]	286	286	286
Length of minibus network [km]	75	78,7	115
Buses in traffic [vehicles/day]	425	415	417
Trams in traffic [vehicles/day]	329	332	342
Minibuses in traffic [vehicles/day]	43	43	26
Number of vehicles registered in the City area			
Total numbers of vehicles [thousand items]	306,0	315,7	332,2
Numbers of vehicle passengers [thousand items]	255,1	259,0	260,2
Motorization index (total number of vehicles/1000 inhabitants)	410	426	445
Parking places			
Total number of parking places for car including P+R including payment	4 195 340 3 796+340	4 045 – 3 796	4 045 – 3 796
Street parking places for car, total including payment	12 970 7 710	12 970 7 710	12 970 7 710
Kinds of road traffic (vehicle/rush hours) (approx. number of vehicles on the streets of the City, afternoon rush hours)			
Inside traffic, total including cars including other vehicles	41 378 39 069 2 309	41 875 39 538 2 337	45 000 40 000 5 000
Source and target traffic, total including cars including other vehicles	15 503 12 378 3 125	15 689 12 527 3 162	8 000 6 000 2 000
Transit traffic, total including cars including other vehicles	1 587 1 528 59	1 606 1 546 60	2 000 1 500 500

In order to minimize a negative influence of cars on Cracow environment, the traffic intensity is reduced. The clue to changing the Cracow transport service-zone lies in limiting car usage. The zone is connected with entrance (access), parking and speed limit. The Cracow City Council in 1993 passed a resolution accepting the division of the city centre into the following zones: pedestrian traffic, limited traffic and limited parking. A limited access to the City centre (Old City) is still forced. From the moment of closing the streets to traffic, as well as distinguishing the parking zones, traffic in the City centre and traffic density were reduced, but the transport conditions in the other districts of Cracow deteriorated. The City did not offer the drivers other alternative, i.e., extra lines of public transport or P+R parking places. P+R system based on bus and tram transport, implemented in Cracow from 1998, was malfunctioning because of a poor promotion, too close proximity to the City centre or annexation of

parking places for other commercial purposes. The last (P+R) sign was dismantled in 2003.

According to transport policy approved by the Cracow City Council a plan to construct a 355 km cycle tracks has been put into operation. Bike traffic in Cracow will be possible not only on separated cycle tracks, but mainly on the streets with the limit of speed (30 km/h zones, living zones) and on counter-lanes for bikes in one-way streets. There are 10 main cycle tracks planned, and only basic part of the Ruczaj Track exists, together with the City centre parts of the Vistula Boulevard Track. In 2006, the northern part of the Central Cycle Track should be finished. It connects the Cracow University of Technology, Mogilskie Roundabout and Kotlarski Bridge; also Nowa Huta Track should be finished. The bike travelling in Cracow should reach at least 5–10% of all transport.

The main condition of sustainable development, called eco-development in the "Ecological policy of the country", is the conception of critical discharge of exhaust gases. If the system of Cracow transport fulfills the above conception it can be called sustainable, i.e., compatible with eco-development. Taking into account the research results, government regulations and international ecological conventions, Poland accepted the following critical discharges [7]:

- achievement of at least 90% reduction of nitrogen oxides' emission in comparison with 1980 level,
- achievement of at least 50% reduction of carbon dioxide emission in comparison with 1993 level.

Table 2

The emission of exhaust gases being forecasted for cars, buses and trucks [8]

Share of car transport [%]	Annual transport (million vehicles-km)			Annual emission (thousand tons)			
	Car	Bus	Truck	2010		2025	
				NO_x	CO_2	NO_x	CO_2
System of concentrated settlement							
25	770	45	66	1.010	195	0.217	74
35	1160	42	66	1.150	253	0.244	97
50	1850	38	66	1.400	357	0.294	138
75	3160	33	66	1.910	555	0.391	217
System of dispersed settlement							
25	850	47	66	1.050	209	0.226	79
35	1310	44	66	1.220	278	0.256	106
50	2130	41	66	1.540	402	0.320	156
75	3740	37	66	2.170	647	0.397	253
Critical charges for Cracow:				**0.250**	**130**	**0.250**	**130**

To satisfy all of the requirements for the reduction of contamination level, Cracow transport should not emit more than 250 tons of NO_x and 130 000 tons of CO_2 annually [8].

Creation of the transport system of sustainable development is connected with the necessity of reducing the number of motor-cars and trucks, radical lowering emission of exhaust gases and radical reducing the fuel consumption. The emission forecast [8] for different fractions of car transport in Cracow is shown in table 2.

Dispersed settlement system is not as easily accessible by public transport as the concentrated one, which results in a strong dependence of its inhabitants on car. This stimulates high level of motorization index and high share of cars in transport. The time of travel is lenghtened, and the environment becomes more polluted.

A radical decrease in emission of exhaust gases (table 2) is due to a total removal of fleet of motor vehicles, which could be replaced with the other, mainly alternative fuel-driven. OECD* studies show that the requirements imposed by Euro IV standard on sustainable development are not satisfied when using conventional cars that emit exhaust gases.

Global emission of exhaust gases depends not only on elementary emission index, but also on mobility and kind of transport service, an average transport distance. An average mobility in Cracow equals 1.8–2.2 travel per day and inhabitant. An average transport distance in Cracow equals 8.5 km (complex studies of traffic in 2001). In transport policy for Cracow, 25% of car transport is recommended. This number was calculated based on the complex studies of traffic in 1994. This result can be achieved if public transport is effectively used (75% of whole transport fraction) and car transport is significantly limited at moderate level of road making. Maximum acceptable share of car transport in all transport equals 35% and is limited by the size of street-road system. We need such a public transport (65% of transport fraction) that will use a transport network in the most effective way and a significant limitation of car traffic at large-scale road making. Share of car transport in mass transport probably will approach 50%, if no regulations in transport policy are undertaken; and this means continuation of the current trend. This level of car traffic causes a huge load of pollutants in environment. As large as 75% share of car transport in mass transport is typical of American cities. But this is associated with a substantial road investments, and for Cracow this would cause drasting changes in its structure, and also the damage to monuments. In the circumstances, public transport would be significantly reduced and less effective (only 25% share in public transport).

* Organization for Economic Co-operation and Development.

4. CONCLUSIONS

Calculations made for the city of Cracow show that its sustainable development will be possible if the share of cars in public transport does not exceed 35%. This share can be accepted only if fleet of motor vehicles would be shortened. Based on the forecast made for the year 2010 one can analyse the trends towards car transport in Cracow in sustainable development conditions. Better standards of cars allow reduction of the exhaust gas emission, which however is not low enough to fulfill the requirements of sustainable development. In 2010, a critical discharge of the exhaust gas will be exceeded 4 times (NO_x) and 1.5 time (CO_2) assuming 25% share of cars in public transport. In the case, this share reaches 75%, the level of allowable emission will be exceeded 8 times (NO_x) and 4 times (CO_2). The process of the city expansion has just begun and adverse tendencies would be strengthened.

So, there is no doubt that the Cracow City Council should radically limit car traffic, otherwise there is no chance for a sustainable development of the city. Many drivers will be opposed to this tendency.

We have great hopes of developing the bike transport, which can be possible provided that the bike marketing will be effective. This allows us to use a bike as everyday and mass mean of transport to workplace, or school; however, such a transport also needs substantial investments in infrastructure for cyclists. Replacing over 5% of car transport by bikes would reduce annual car transport from 770 million to 616 million km, and emission of NO_x, CO_2 were decreased respectively by 217 tons and 38 000 tons per year. In the case of NO_x, the figure is close to the critical discharge for Cracow, and in the case of CO_2 the figure is about 1/3 of the critical discharge value [8].

REFERENCES

[1] BOGDANOWSKI J., *Miasto historyczne w dialogu ze współczesnością*, Nadbałtyckie Centrum Kultury, Wydział Architektury Politechniki Gdańskiej, Gdańsk, 2002.

[2] Agenda 21, United Nations Conference on Environment and Development, Rio de Janeiro, 3–14 June, 1992, www.un.org/documents.

[3] II Polityka ekologiczna państwa, Rada Ministrów 2000, www.mos.gov.pl/.

[4] RUDNICKI A. et al., *Alternatywna polityka transportowa – opcje*, Biuletyn Instytutu na Rzecz Ekorozwoju, Warszawa, 1998.

[5] *Krakowska polityka rowerowa*, http://krakow.rowery.org.pl/.

[6] *Raport o stanie miasta 2003*, Prezydent Miasta Krakowa, Wydział Strategii i Rozwoju Miasta Urzędu Miasta Krakowa, Kraków, 2004.

[7] *Alternatywna polityka transportowa w Polsce według zasad ekorozwoju*, Instytut na rzecz ekorozwoju, Warszawa, 1999, http://www.ine-isd.org.pl/.

[8] KOPTA T., *Transport w mieście dla ludzi i dla środowiska – opcje rozwoju transportu oraz sposoby ich parametryzowania*, http://www.transport.most.org.pl/.

TRANSPORT ELEMENTEM ZRÓWNOWAŻONEGO ROZWOJU MIAST HISTORYCZNYCH

Transport jest obecnie jednym z najważniejszych czynników determinujących egzystencję i rozwój miasta. Prawie wszystkie miasta muszą rozwiązać problem zatłoczenia motoryzacyjnego. Zatłoczenie jest przyczyną zarówno licznych konfliktów społecznych, jak i skażenia środowiska przyrodniczego, ale przede wszystkim źródłem większości problemów komunikacyjnych. Dlatego naglącą potrzebą jest przyjęcie takiego modelu rozwoju transportu, który zapewniałby mobilność odpowiadającą zapotrzebowaniu społecznemu i możliwie najmniej obciążałby środowisko. Można to osiągnąć, stosując konstytucyjną zasadę zrównoważonego rozwoju. W artykule omówiono system transportowy Krakowa, opierając się na polityce ekorozwoju.