



MORYNE

D6.5: FINAL REPORT ON ENVIRONMENTAL AND SOCIAL IMPACTS

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1 Introduction

1.1 Purpose of the Document

The purpose of the document is to summarize the environmental and social impacts of the usage of road and vehicle sensors which can enhance the effectiveness road transport management and the transport safety.

1.2 Document Status Sheet

Version	Date	Description
1.0	15. 06. 2007	The impact of the usage of road sensors
1.1	21. 11. 2007	Interim report on environmental and social impacts of the usage of road and vehicle sensors
1.2	29.04.2008	Final version

Table 1: Document Status Sheet

2 Reference Documents, Abbreviations and Definitions

2.1 Reference Documents

- [1] MORYNE Description of Work
- [2] **Bartus G., Monostori K., Szabó M.** [2005]: A fejlesztéspolitikai intézkedések teljes társadalmi költségének becslése. Fejlesztéspolitika társadalmi hatásai 3. TÁRKI, Budapest. p36.;
- [3] **Dr. Tánczos Lászlóné:** A közlekedési infrastruktúra fejlesztésével és a közlekedési rendszerek működtetésével összefüggő harmonizációs feladatok;
- [4] **Kishore Bhamidipati:** Reference book of the SQL programs (1999)
- [5] **István Bana:** The system organisational methodology SSADM (1994)
- [6] **Michael J. Fernandez:** Designing the data basis (2004)
- [7] **Jeffrey D. Ullmann, Jennifer Widom:** Data basis systems (2004)
- [8] **Joe Celko:** SQL at the highest level (2002)
- [9] KTI studies.

2.2 Abbreviations

ASC: average social cost of the journey

V: speed of the traffic

Q: volume of the traffic

t: time

s: way

2.3 Definitions

The sustainable development is a complex process that can assure the satisfaction of the demand of the present without endangering the possibilities of the future generations in relation with the satisfaction of their own demands. The notion means the sustainable economic, ecological and social development.

3 The environmental and social impacts of the usage of road and vehicle sensors to enhance the effectiveness road transport management and the transport safety

A. Environmental impacts

At the analysis of the environmental and social impacts of the usage of road and vehicle sensors that situation shall be investigated how they can influence the transport process connected to emission (pollution, gas-emission), immission (noise), and other impacts (illnesses).

By proper traffic management measurements the environmental damages can be reduced and the social impacts of the transports will be improved. The mobile sensor usage can support this activity and the sustainable development of transports. It provides awareness of meteorological and actual traffic situation by acquiring real-time data.

In the MORYNE project the final results will be received in Berlin during the demonstration of the usage of mobile vehicle sensors on BVG busses.

The sensors built in into the vehicle measure the various environmental impacts having an influence on the vehicle. The dispatcher-centre will find out about the performance of the services and the road conditions and so dynamic trip plans can be drawn up, that will fit well to the environmental circumstances.

The transport services given by the system are based on the vehicle fleet controlling activities. The safety engineering program packet, as well as the static and dynamic line service planning is based on the information provided by the sensors.

The system keeps a continuous and direct contact with the data collecting units placed on the chosen vehicle through handling the transport oriented tools of the mobile telecommunication and the local data to be achieved on the vehicle. As a result of this it can directly promote the traffic management in making the traffic organising decisions.

The formulation of the above mentioned goals were motivated by social and economic challenges, as e. g. the sudden growth of the population-density, the demand for the improvement of the traffic safety, the demand for the reduction of the utilisation and of the environmental charges, the support of the safe and quick getting of the people to their destination. The developed information and environmental system can exert an important impact on the reduction of the environmental loads through the creation of the harmony between the driver and the environment.

The environmental policy sets goals, means, and measurements and considers the transport processes. Important is the avoiding the smoke, soot, SO₂, NO₂ emissions and acidic rain.

The environment policy is characterised by four types.

Curing environmental policy

This type of the environmental policy is a "fire fighter or the ambulance doctor" of the environmental policies. The direction of the curing environmental activity, as it can be seen from the illustration, shows on the quadrangle of the "impacts. This would like to alleviate the already occurred damages. In general this type of environmental policy is the most expensive and the least efficient solution.

Impact-oriented environmental policy

The tools of the environmental policy would like to improve the immission state and in this case the quality of the environment under conditions, where the emission values will not be diminished.

Source-oriented environmental policy

This environmental policy is spread in the widest circle together with its tools and methods. Its goal is to decrease the harmful material emission. The classic “end of pipe” methods were mainly established as a result of the negative stimulation of the direct regulating methods (norms, limit values, punishments).

Structure changing, preceding environmental policy

Out of the various environmental policies this type is which can get the most positive evaluation. Considering the essence of this policy this is an impact mechanism, that divert the economy or the whole society to an environmentally friendly direction. Its goal is the transformation of the micro- and macro-structures of the society that promotes the transformation in harmony with the nature in long term. The final target of this environmental policy is the insurance of the sustainable development.

The sensor usage can support mainly the source-oriented environment policy and can contribute to the preparation of a structure changing, preceding environmental policy as well. The basic principles, goals and the system of available tools can be determined easier by the available information.

The investigation of materials serving for the assurance of skid-free road surface

- The European Union determines on several fields the legal frameworks for each area to be regulated for the Member States in directives or in frame-directives. The traffic during winter and the theme circle of ensuring the skid-free surface of the pavement do not belong to those areas. There is no uniform regulation in the EU at present for this problem and it is not planned to elaborate such a regulation. The task of the Member States is the elaboration of their own regulating system fitted to their own circumstances.
- The main cause of this situation can be found in the fact that the Member States have very different climatic and road-network characteristics and the uniform regulation would not correspond to each Member State.
- The investigation is more and more appreciated, which will be impact of the salt scattered on the ground water and on its quality.

Table 1: The summarising evaluation of the environmental impacts

Environmental, territorial specialities	Qualification of the skid-free surface assuring materials				
	Roughening materials	Salts containing chloride	Acetates	Materials having plant nutrient character	Alcohol, glycol
Areas sensible for the cleanness of the air	Unfavourable	Neutral	Neutral	It can be stinking	It can be stinking
Outstanding catchments	Mud deposition, but in general not important	Neutral	Temporarily neutral	It can become toxic, it cannot be recommended	It can become toxic, it cannot be recommended
Open carst, one of the outstanding sensible subsurface water protection areas	Neutral	Transitionally unfavourable, it can become toxic, too	Transitionally unfavourable	It can become toxic, it is not to be recommend	It can become toxic, it is not to be recommended

				ed	
Nature conservation areas	Neutral	It cannot be recommended on increasingly protected areas	Its impact is uncertain	It cannot be recommended	It cannot be recommended
Inner areas, which are not belonging to on of the outstanding categories	Because of dust formation it can be used only with conditions	Unfavourable, the utilisation can be recommended only restrictedly	Practically neutral	If it is not stinking, its impact is practically neutral	It cannot be recommended
Other areas	Neutral	Practically neutral	Neutral	Neutral	It can be used only in special cases

Analysis of the domestic situation

- The protection of the natural and artificial environments can be achieved through the reduction and optimisation of the scattering of the environment polluting chemicals.
- The grouping can be made in accordance with the impact mechanism:
 - melting materials (these are the in water soluble chemicals, that exert their effect through the reduction of the freezing-point)
 - roughening materials (they have mineral origin, are composed materials, and they can exert their impact mechanically with increasing the skidding friction).
- The basic types of the materials having skidding elimination character:
 - solid materials: minerals, mining products, industrial products.
 - liquid materials: solutions, organic compounds (alcohol, amides, acetates).
- The freezing point reducing impact depends on the volume of the solutes (concentration) in addition to the physical-chemical characteristics of the given compound.

Table 2: The advantages and disadvantages of the utilisation of solid and liquid scattering materials:

	Scattering materials in solid state	Scattering materials in liquid state
Advantages	<ol style="list-style-type: none"> 1. storage, in simple covered salt-containers at the operators 2. the engineering background of the utilisation is resolved 3. no additional activities are required before the direct use 4. concerning the not used up material the storage of "water" is not necessary 5. the specific material-price is lower 	<ol style="list-style-type: none"> 1 the dosage of the scattered quantity can be well regulated 2 the melting process will be started immediately and quicker 3 the material loss is smaller 4 the environmental damage and the corrosion causing impact are lower
Disadvantages	<ol style="list-style-type: none"> 1 the solid granules will be swept away by the traffic 2 in windy weather the granules of the melting material will not be got to the wanted place 3 the environment damaging and corrosion causing impacts shall be taken into consideration 	<ol style="list-style-type: none"> 1. the storage is possible in containers 2. the solution preparation shall be also considered 3. the solution shall be homogenised before utilisation 4. the mechanical tools serving for the scattering of the solution are not assured at every place 5. because of the solution preparation the specific material-price is higher

Comprehensive economic analysis of the operation during winter, concerning the environmental damages and the road traffic during winter

- Antecedents: The skidding eliminating materials used during the winter operation can pollute the natural environment to various extents. The forms of the damage caused to the environment are well known, but the impact on short and long runs of those, as well as the quantification of the advantages and disadvantages rely only on estimations.
- Justification: taking the traffic safety standpoints of the operation during winter and the environmental impacts of the skidding elimination of the road surface using chemicals into consideration, an optimum solution shall be elaborated.
- The results to be expected: in addition to keeping the safety of the road traffic during winter at the proper level the environmental and corrosion damages shall be reduced.

The changes in the environmental impacts

The changes of the environmental impacts can be estimated using two different methods:

- Using a simplified method, where the noise, the air-pollution and the impact of the climatic change can be appreciated with parameters characteristic for the transport volume (vehicle-km, passenger-km, and ton-km) and on the basis of the external costs.
- Using a detailed estimation method, where the estimation of the noise immission (state) and of the air pollution emission (emission) will be made and the specific costs are also in this unit of measure will be expressed.

Environmental impacts of the intelligent transport system in Miskolc

The connection between a town and the public transport becomes apparent in the transport network. The transport network forms the backbone and organisation of the whole town, the connecting link of the areas to be delimited well having different designations, but at the same time separating them from each other.

Besides the inner traffic of the town and in the transport connection the transport network connecting the town to its environment plays an essential role. The town can correspond to its central function only in the case, where it is connected through a properly developed transport network and is able to intervene in real time with a good transport management to its environment. An important segment of this is the automated passenger counting system.

Since the year 2006 the measuring tools have been mounted on 40 buses at the Transport Company of Miskolc exclusive joint stock company, with the aid of which a bus fleet has been operated first in the country at Miskolc, with the aid of which the process of optimisation of the public transport could be continuously supported.

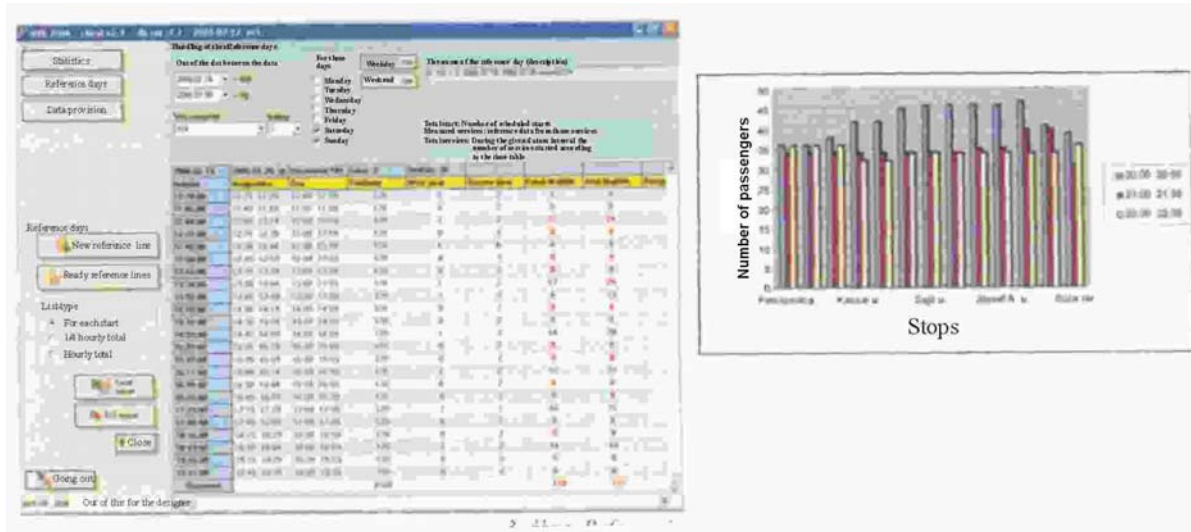


Figure 1: Reference day

Intelligent passenger counting system

- quick and cost-effective transportation, with high exploitation level,
- service optimisation, which is advantageous for the passengers, too.

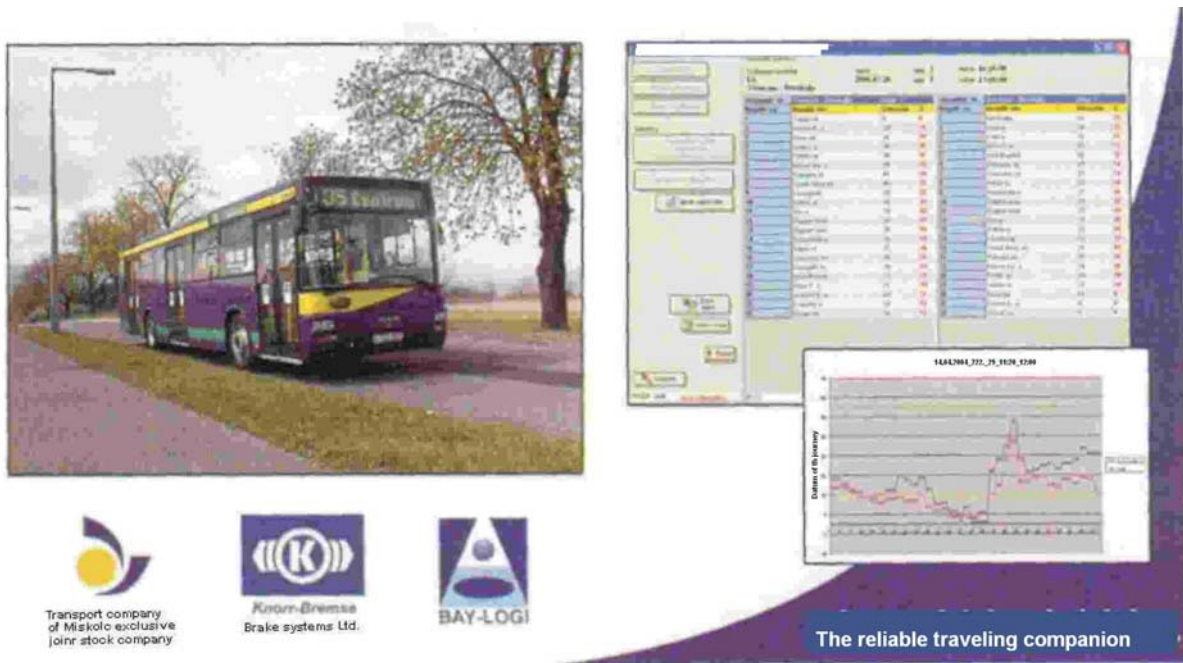


Figure 2: Passenger counting

B. Social impacts

In the social impact aspect the ideal price of the products and services shall reflect the total social costs. The polluting person should bear the costs of the pollution-reduction (the value of it would be determined by the authority). The internalisation of the costs of the damages caused by the pollution is necessary. Environment management methods, and means have to be applied and impact revision of the environment, performance evaluation, ecological marketing, environmental reports (voluntarily) has to be elaborated.

The application of environment evaluating methods, investments (projects) cost-benefit analyses, the estimation of the changes occurred in the quality of the environment and in the value of the natural resources induces social benefits for the society. The reduction of external costs, appropriate pricing, elaboration of rules for the environmental protection and preparing the necessary investments can be accomplished with a well functioning traffic management system. Both the transport company and the society have social benefits from the traffic organisation.

A better overview of the traffic situation provides a possibility to set the proper goals of the regulations:

- the building in of the extreme costs into the economy,
- the stimulation of the material- and energy-saving and of the waste-arm economic management.

Regulation can be effected directly through laws, commands and control. Its characteristic is the overweight of the use of legal pressure.

Its types are: interdiction (material, technology and product),
instruction (recommendation) \Rightarrow frame-regulation.

The benefits of it are calculable reaction, principally easy checking, and relatively quick results.

Indirect regulation is characterised that it built into the economic interests.

Regulation of tax-character: the fiscal tax to create of the source for a task;

The environment regulating tax is for generation of costs, and diverting the consumption (investments).

Benefits: it considers the specific costs better (deprivation in %).

The most important variables for the characterisation of the road traffic are as follows – the speed of the traffic (V) – the density of the traffic - the volume of the traffic (Q). Whilst for the description of the movement of an individual vehicle we shall only know its speed, then in the case of several vehicles we shall have information about the traffic-density and the traffic-volume. By this we understand the number of motor vehicles on a unit of the road section (measure: vehicle/kilometre).

In the micro-economic model the price of the transport can be derived from the required length of time and the distance. In the case of changing the traffic-density the time required for the unit length of the sector will change in reverse proportionally with the speed ($t/s = 1/V$, t – time, s – way). If the speed diminishes, then the journey time will increase, and as a consequence of it the average social cost of the journey (ASC) will also increase. For the sake of simplicity we shall suppose that the vehicle drivers form a wholly homogeneous group and they are facing with the same costs.

The increase of the journey time means first of all as a consequence of the not occurring working or leisure times an implicit cost. On the other hand the fuel consumption, the pollution of the environment, and the other costs will increase in the case of the decrease of the speed. The other costs independent on the speed are the maintenance costs, the insurance and the taxes.

The sensor supported transport organisation and traffic management system can improve the situation, diminish environment damages and pollution, decrease the fuel consumption, save journey time of working people, increase the traffic safety and contribute to the social benefit.

The arrangement of the road traffic at the highest possible level, the augmentation of the transport safety, the safeguarding of a more liveable environment and the improvement of the accessibility belong to one of the most important goals of the development in relation to the road network.

One of the key issues of the cost-benefit calculations is the prediction of the traffic (volume, composition, speed) to be expected on the road network investigated after putting this into service. This does not form a part of the cost-benefit calculation process, but it is an important input data for the process. The determination method of the traffic has to be demonstrated.

In simple cases (by-passing roads of small settlements, pavement reconstruction performed on a shorter section, cross-section extension), therefore when no significant traffic rearrangement can be expected in the area investigated, manual methods are to be used for the prediction, and so the future traffic volume can be determined with the aid of traffic engineering multiplications given in the technical prescriptions of the road construction.

In other cases (e. g. urban by-pass streets, express roads, and longer sections of main roads) the characteristics of the traffic should be determined with the aid of computer aided models.

The specific environmental marginal costs in the road traffic investments can be calculated as follows:

Table 3: Specific external marginal cost of the environment

HUF/vehicle-km	Light vehicle	Heavy vehicle	Suburban multiplication
Noise charge	26 491	48 744	0,5
Air pollution	89 393	12 108	0,8
Climate change	27 123	7 391	1

The following effects can be calculated: travelling time saving, change in the accident risks, operating costs of the motor vehicle, changes of the environmental impact; out of this: noise load, air pollution, climate change.

Potential advantages assured by the sensors:

- scheduled traffic
- reduction of the travel time
- reduction of the vandalism
- increasing the security sense of the passengers and of the drivers
- reduction of the number of accidents
- this promotes the examination of the accidents and damages resulted.

The extent how the accidents will decrease as a consequence of the utilisation of the mobile road sensors:

- no troubles occur in the traffic
- no troubleshooting shall be carried out
- no examination on the spot shall be accomplished
- no measurements shall be made on the spot from the side of the line engineering service
- no vehicle replacement shall be made
- the damaged vehicles should not be repaired.

To what extent and how the traffic sensors can increase the traffic safety:

- the reduction of the number of road accidents(engineering evaluation of the traffic environment)
- the real time information of the driver about the traffic, traffic engineering and technical partners

- the direct connection between the driver and the traffic engineering staff (transmission of talks, pictures and commanding signals)
- the video system improves the personal security of the driver
- the video system improves the personal security of the passengers.

Remarks related to the development plan utilised in the framework of the MORYNE project by the Budapest Transport Company

The main advantages are: Through the precise and in real time performed following up of the prevailing situation in the traffic, the Traffic Controlling Centre can react appropriately toward the bus drivers with the transmission of recommendations in conformity with the traffic situation (e.g. traffic jams, by-pass routes).

Greater safety for the vehicle drivers: the automatic processing of the video-data makes the avoidance of the troubling of the bus drivers during the communication with the Traffic Controlling Centre possible and he can concentrate his attention to the driving of the vehicle concerned.

The safety of the passengers: the use of the video on the bus and outside the bus can protect the passengers and the vehicle driver against the attacks and criminal acts. The permanent, round the clock video data recording can help in the identification of accidents and other events (more passenger, increase of the revenue).

In the case of traffic accidents the Traffic Controlling Centre can make measurements in due time and immediately for the rescue actions without any delay (protection of life and fortune).

If the bus driver is in danger, he can send an emergency call toward the Traffic Controlling Centre, where the video data coming from the vehicle can be seen and they can intervene in due time.

It occurs frequently that passenger cars park in the lane preserved for the buses and thereby they hinder the running of the buses. The use of the video system placed outside the buses can help in the monitoring of the bus-lane and renders the transmission of a picture (registration table) and the exact place (GPS) to the police possible, which can intervene quickly.

In the case of technical failures the help can arrive in due time from the Traffic Controlling Centre using the sensors, and a consequence of this can be the reduction of the number of service cancellations.

With the utilisation of air humidity sensors, air temperature sensors and road surface temperature sensors the risk of the bus drivers can be reduced (snow, rainfall, frost riving) and thereby the safety of the vehicles and of the passengers can be increased (fewer accidents, cost-reduction).

With the aid of the sensors installed in the vehicles the efficiency of the public transport system can be increased and the consequence of this can be that many people will choose the public transport instead of the individual drive, which can result for us in the revenues. The MORYNE project can help in the implementation of this goal and so during some years a more streamlined, advanced, safe, passenger friendly and efficient traffic controlling system would be able to achieve, accomplished with modern engineering tools.

With the aid of the sensors installed in the buses, information about the data related to the water temperature, volume of the refrigerating fluid, speed, the momentary rpm value of the engine and of the gearbox could be got, which would be therefore of importance, since the Traffic Controlling Centre

could get information in due time about the occurring problems, or which could occur. The utilisation of the recorded data of the digital tachograph and its results can be essential.

The town of Miskolc and the Intelligent Transport

Situation

In the preamble of the Green Paper of the European Union is stated that the efficient passenger transporting systems are fundamental from the point of view of the European economies and of the life level of the European population. It is of importance that the structure of the transportation systems shall correspond to the passengers' demands and it shall be flexible enough and can follow the changes of the demands. The passenger cars have several advantages: the independence, which is the synonym of the flexibility. At the same time its can multiply the traffic jams, the air pollution and the number of accidents as well. These factors afflict uniformly the motorists and those people, who have no automobiles. If we do not want to deprave our living conditions and our environment, then the development of the public transport systems shall be preferred in the transport of the passengers. This means that the public transport should be more flexible and should be adapted to the demand of the community.

Formulation of the consequences

The development of the urban bus networks is a very complicated task, where very many standpoints shall be taken into consideration. The transport associations have the tasks of the network design made in general with undertakings specialised to these types of activity. Therefore their position is very exposed in this field. They have no appropriate software and infrastructure supports in order to perform such a big task independently. The transport associations are under the control of the Municipalities operating them in Hungary and in many cases the available financial possibilities limit the development of the transport relations and time table, otherwise justified by the professional viewpoints. They can reduce those expenses mainly by ceasing or amalgamating the lines, but they shall keep in view the directives of the public services related to the passenger transport.

In itself there is proper target-software for the design of the networks, the common criteria of which are that

- they expect precise input data in order to achieve good results
- they demand high expertise
- they are very expensive product.

It shall be mentioned among the general requirements set against the network that on one hand this shall correspond to the passenger flows, the change shall be assured for the majority of the passengers and on the other hand it shall ensure the proper exploitation of the of the transport means and the economic operation.

The streamlined methods are based on exact passenger flow data and the network will be developed through a calculation method. It occurs frequently in the praxis that the designer of the transport network has no precise data for the passenger flow – since the acquisition of them is a very labour intensive and expensive process – and therefore the traditional methods are used very often (e.g. planning on the basis of the town-structure) with the aid of which a good result can be achieved particularly in the smaller towns.

The more simple town-structure under the relatively few traffic generating and attracting establishments the rational line-network can be found more easily. In the greater towns more advanced methods are required for the appropriate result.

An automated – based on the measurement of the pressure – system assuring the accomplishment of the passenger counting tasks has been developed.

Three institutions have participated in the development of the system:

- Zoltán Bay Applied Research Foundation, Logistics and Manufacturing Engineering Institute, Mechatronic division,
- Knorr-Bremse Transport exclusive joint stock company,
- Urban Transport exclusive joint stock company of Miskolc.

The task of the development was the elaboration of a system, that using GPS technology followed the services, and on the basis of the data measured at the stops determined for each section automatically the passenger load of the buses. After the automatic storage and downloading of the data measured various statistical data can be calculated with the aid of software developed by the company related to the services concerned. The great quantity of data is suitable for the determination of the average journey time of the services, even for different time periods as well. The examination of the passengers' claims will be also more simple, since it can be followed on the level of the service concerned, the buses are to be found in the time given or have arrived to the stop concerned and at what time they have started from the stop. The great quantity of data is suitable further for the calculation of reference data periodically, which is particularly appropriate for the support of the time table planning. We store all the important data of the whole line network (GPS co-ordinates of the stops, length of each section, time table at the daily level, etc.), which will be used together with the data measured and so we can measure all the parameters for the point of time, and so we can measure the average speed related to the individual sections – and even to the whole line-length as well – belonging to the given moment in addition to the dwelling place. Out of these data further conclusions can be achieved for the traffic circumstances of the town or for the traffic relations related to the periods concerning the individual sections.

The tools for the service planning

The flexible transport system, differently from the traditional public transport, cannot be or only can be planned in the rough. The services depend always on the actual ordering both spatially and timely. Two main viewpoints can be, however, fixed:

- the passengers shall get a suitably flexible service,
- the vehicles shall run as few as possible.

These two conditions are in a strong controversy to each others, but with appropriate compromises the task can be resolved.

In the flexible transport systems the basis of the operative planning is the combination of the journeys. Three basic cases of the combination of journeys are possible:

- separated journeys (there is no combination at all)
- chained journeys
- superimposed journeys

The essence of the flexible public transport systems is that the vehicles are running on a flexible route and/or according to a flexible schedule, in other words the system is flexible and not the user.

Accordingly the traffic control of the vehicle, as well as the organisation of the services and the time-table form a composite task different from the traditional public transport, which demands extraordinarily dynamic (even on-line) data as well. The operation of the flexible collective transport

systems and the design of their operation require therefore the use of a computer aided background and the utilisation of streamlined vehicle following systems.

The flexible transport systems are running differently from the traditional public transportation from day to day in accordance with newer and newer service-plans, and therefore the basis for a successful flexible transport system is the well operated service designing activity.

This assumes that the system is operated with a well elaborated communication background or collect the travelling demands with a well built up dispatcher-software. If the two pillars of the system are good and the basic structure of the service corresponds to the local demands, then the flexible transport system will be expectedly able to serve the arising travelling demand on the long run as well.

The experiences gathered with the rationalised public transport network at the Urban Transport Exclusive joint stock company of Miskolc

The General Assembly of Miskolc's Municipality decided on the 30th November 2006 about the introduction of the rationalised network and about the modification of the public service contract concluded with the Urban Transport Exclusive joint stock company of Miskolc operating the transport network.

The introduction of the new public transport network was established on the 1st January 2007. The specialists of the company are observing continuously the functioning of the new network, where the establishment only smaller refinements have become necessary.

The antecedents of the elaboration of the rationalised network

The data of the passenger counting, the survey of the target traffic and ticket utilisation habits have served jointly for the basis of the elaboration of the details related to the details of the new transport structure, which have been used by the specialists of the transportation.

Professional and economic arguments have made the reorganisation of the transport. The transport network that was operated before the 1st January 2007 was designed for an essentially greater town, with a number of inhabitants of 220,000 persons. The population of Miskolc is 173.000 persons at present and the average exploitation level of the transport system was 29 %. The Urban Transport Exclusive joint stock company of Miskolc could not maintain the former network, since on hand the per capita capacity issued by our company (specific passenger seat capacity km performance) and on the other hand the prices of the tickets and abonement were the lowest in Miskolc.

The main steps of the preparatory works done during the elaboration of the network were the following:

April 2003: passenger counting for the target traffic in Miskolc and on its surround

2004-2005: The development of the air-spring pressure based passenger counting system

January 2006: The start with the preparation of the rationalisation of the network.

January-April 2006: Passenger counting and the development of an evaluation system.

April-June 2006: Carrying out passenger counting on the whole bus network.

April 2006: Taking of an adviser into the accomplishment of the network rationalisation task on the 23

May 2006: Survey of the ticket and abonement habits.

August 2006: Evaluation of optimised network proposals, development of a network proposal.

14, 23-24 September 2006: Checking passenger counting on tramway

October 2006: Determination of time table data, traffic engineering possibilities, going to the service lines, determination of changing demands.

November 2005: conciliation with the leader of the Division for Building, Environmental Protection and Settlement Development of the Urban Municipality of Miskolc, on the effect of which we have modified our proposal.

November 2006: Elaboration of time tables.

The introduction of the rationalised network

In connection with the introduction of the rationalised network the main elements of the communication campaign for the information of the population, the representative of the municipality, and the civil organisations are as follows:

The specialists of our association have presented the main causes, ground principles of the network and the more important changes for the population.

They have informed continuously the affected persons using newspaper articles press information and PR announcements.

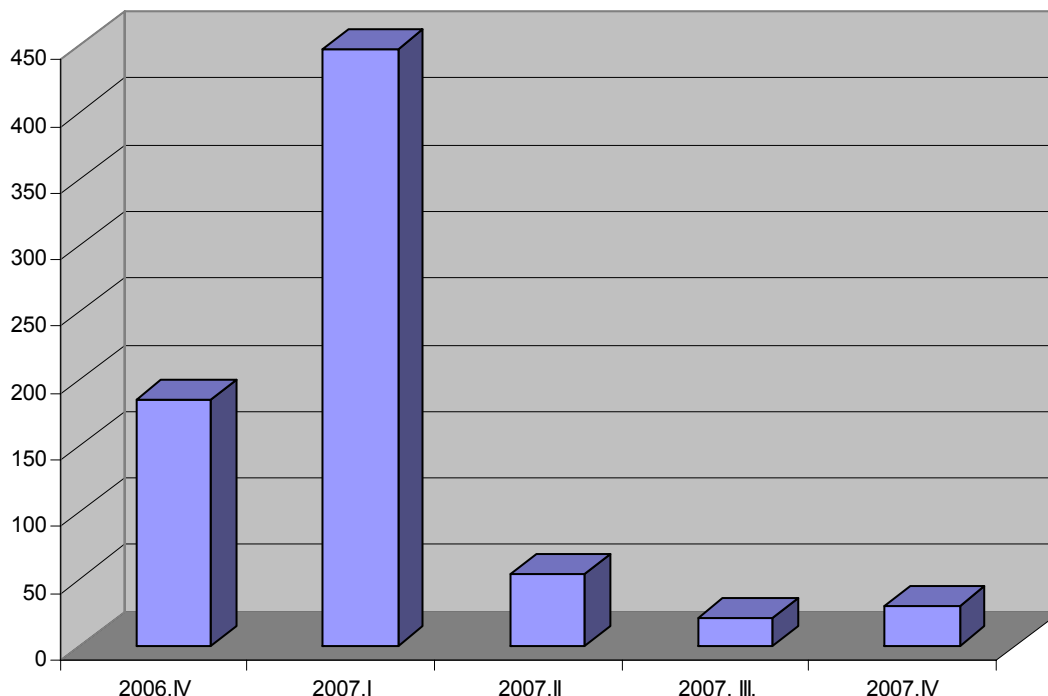
Information was given in addition to this on the vehicles, at bus stops and through direct mails.

Concerning the above described changes they have given information on our home page, or leaflets, as well as with the aid of additional pages of the time table and new time table.

In connection with the introduction of the rationalised line-network the number of observations from the side of the customers has increased to a great extent. Whilst previously the number of the passenger claims was 240 observations quarterly, we could count with 815 observations in the first quarter of the year.

It is essential to emphasise that an important part of the 707 observations connected with the rationalisation, that have come to our association has general character, in which we were asked to reestablishment of the whole previous transport network or of that some services by our passengers. We could not satisfy those proposals and requests, since the fulfilment of those requirements would have caused an important plus burden for the association and so for the Urban Municipality of the county right town of Miskolc. The number of those observations in which the modification of the concrete starting time was required by our passengers was equal to 120. The special problems having such character we have resolved according to our possibilities.

Remark number about rationalization



The development of the traffic performances

The expected transport performances are fixed at yearly level by the Public Service Contract (KSZ) and at monthly level by the business plan. The KSZ prescribes the fulfilment of the yearly plan for 98-102 %. On the basis of the following data it can be said that our association has fulfilled the expected seat-kilometre plan.

The transport performance of the association during the period between the 1. and 12. months of 2007 were 1.375 million seat-kilometres in accordance with the public service contract and with this value the requirement fixed in the contract were satisfied at a level of 98.5 %.

During this period 125.53 million passengers were transported and this value deviated from the planned one with 3.5 %, while from the basis with less than 7.1 %. The 427.28 million passenger kilometres showed 3.6 % less value than the planned value.

The passenger-loss to be experienced in the public transportation was not only in Miskolc characteristic, but in other greater towns of the country as well. Whilst the other greater towns (Debrecen, Szeged, Győr, Pécs) have increased or even decreased only to a smaller extent their service performances, then our association made a diminution of 16 % in the seat-kilometre performances. The rationalisation of the capacities issued was therefore necessary, since on the contrary the loss of our association would have achieved the 1.1 billion HUF.

On the other hand the decrease in the number of passengers calculated with the aid of statistical methods was the smallest in Miskolc (on the basis of the data of the Volán Union).

Results

In relation to the changes made at our association – in two steps, altogether 38 % tariff-increase and

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the introduction of the rationalised network – the following results were achieved:

The revenue of the passenger transport was with 15.4 % higher than that of the basis, which meant an increase of 401 million HUF. The total revenue of the association was 6.402 million HUF, which is with 58 million HUF higher than that of the year 2006.

The total expenditure was 6.434 million HUF, which was with 436 million HUF lesser than the expenditures of the basis period. The exploitation level of the capacities has increased from 28.2 % to 31.3 % at the buses and from 29.9 % to 30.4 % at the tramways.

Taking the national tendencies and the passenger-losses experienced at the other transport firms into consideration, it was probable that the revenues of our association would have decreased further as a consequence of the passenger-losses in the case as well, if the transformation of the network had not been accomplished.

Together with the maintenance of the previous network the costs calculated on the real value would have remained at the level of the year 2006.

The loss of our association without the rationalisation of the network and the augmentation of the tariff would have been equal to 1.1 billion HUF by the end of 2007, but we had a loss of only 31.63 million HUF booked during this period in relation to this value.

Sensors for temperature and road condition measurements were not in use at the transport company. Their application could induce accident reduction and better organised transport with less traffic jams.

The Budapest Transport Company carried out also passenger counting measuring the air spring loading at busses and trolley busses converting it into electronic impulses. The data were applied for the traffic management.

THE DEVELOPMENT AND MODERNISATION OF THE TRAFFIC CONTROLLING AND PASSENGER INFORMATION SYSTEM IN THE SURFACE TRANSPORT

In the description of the functions supported with information system the displacement (trip) process can be considered as the main organising principle, since the elements and the logic of the basic process (the motion between the starting and destination points) are stable.

The inner systems of the passenger transporting associations and the passenger information systems are illustrated in process-logical order in the Figure 1. There are complex information connections functioning between them. Those are as follows:

The information systems used in the planning process of the passenger transport, the target fields of them are:

- The survey, analysis and planning of the transport demand.

An important part of demand-survey forms the manual and mechanical passenger survey that will be required till the implementation of the planned electronic ticket issuing system. The passenger number measured with the KNORR and SRG appliances used for a long time will be supplemented with a new element, the passenger number coming from the intelligent board system, which will be built in after the evaluation in the process of the time table planning process. Remark: Since in the first phase of the introduction only a part of the vehicle fleet will be equipped with an intelligent vehicle diagnostic system, the existing KNORR and SRG appliances shall be operated further.

- Transport network planning and relation planning

The Transport Company of Budapest (BKV) has presently no adjustable map to be used or multiple purposes containing the actual line-network

The presently used information system describes the spatial line-network only with words (stops, other places, routes, etc.). Therefore it is indispensable to utilise a graphic map for the design of the transport network and of the route.

The designing work shall be started on the graphic map, on which versions can be formed starting from the line-network. The choice of the optimum solution shall be completed with supporting algorithms [e. g. network planning, route planning, investigation of the exploitation level, the passenger traffic at the stops (even hourly, daily or in every 15 min. for every route and altogether), the cross-sectional passenger number, the representation of the performances for the planned and for the effective traffic.

The utilisation of the graphic map shall give the possibility for the views differentiated in time and by functions [e. g. night routes, stops during the night and during the day, various route-types (e. g. garage-routes) the possibility of the representation of the services]. The different plan-versions can be used e. g. in the course of the negotiation with the customer as well.

The line-network forming the basis for the traffic and granted to be published comprehensively comes about as a result of the approval process from the plan-versions.

The actual line-network map can be published in accordance with different representation-expectations for the inner and outer user of the services of the BKV (e. g. in printed form for the passengers, as a part of the passenger information, on the home page, for inner utilisation indicating the official services, etc.).

The visual representation assures the possibility for the delineation of the zone system to be introduced later on and for the analysis of the tariff-calculation in the new servicing system as well.

The dispatcher surveillance and the arrangement of the controlled traffic will be realised on the special view of the approved network model arising during the planning process of the line-network in the complex system to be implemented keeping the time table data attached to it.

The planning process of the operation (time table, appointing of the vehicle, of the personnel for a given service, energy supply

A detailed time-table – starting list, framework for the assignment of the drivers and vehicles - can be established on the basis of the parameter determined by the sponsor. A graphical solution shall be offered for the elaboration of the time-table. The time-tables become to a time-table plan with their assignment to the transport calendar for the purpose of the passenger information and for the dispatchers' activity.

The controlling systems serving for the process of the passenger transport, the fields of them are:

- Information gathering about the outer factors exerting an influence on the transport process
- Operative planning
- The administration of the effective traffic
- The operative checking, controlling and decision support of the public transport for the controlling organ
- Passenger information: investigation of the planned data, real-time updating using the effective data
- Gathering of the vehicle diagnostic parameters

- Influencing the traffic lights at the junctions
- Safety management

The information systems used in the evaluation and analysis of the personnel, the fields of them are:

- Performance, use of resources, financial settling,
- Statistical evaluation, quality control,
- Archivation

The information support of the performance, resource utilisation and financial settlement functions do not form a part of the project, the task is limited to the data transmission through the interface.

The passenger information systems can be also ranked in three main groups, which are indicated in the Figure with grey background. Those are as follows:

- The passenger information systems promoting the preparation of the displacement
- The passenger information systems used during the displacement
- The passenger information systems used after the displacement,

Planning of the passenger transport	The process of the passenger control transport			The evaluation of the passenger transport
	Operative planning	Information gathering		
		Operative checking and control		
	Vehicle diagnostic			
	Safety and security management			
	Preparation of the displacement (trip)	Displacement (trip)	information after the displacement (trip)	



Figure 1: The inner information systems and the passenger information systems of the passenger transporting association in process-logical order

Efforts for the sustainable Transport

A modern transport system is vital to the future. We need a transport system which supports our policies for more jobs and a strong economy, which helps increase prosperity and tackles social exclusion. We also need a transport system which doesn't damage our health and provides a better quality of life now - for everyone - without passing onto future generations a poorer world. This is what we mean by sustainable transport.

Better health

Coronary heart disease is the biggest killer of adults in several countries. Part of the blame is that we drive too much when we could walk or cycle or use more the public transport.

Road traffic is a major contributor to air pollution. Up to thousands of vulnerable people are estimated to die prematurely each year, and similar numbers are admitted to hospital, because of exposure to air pollution, much of which is due to road traffic. Tighter standards and advances in vehicle design have helped to reduce those emissions which cause the greatest concern but in the longer term these gains could be at risk if traffic growth continues unchecked. Even this downward trend in emissions will not be sufficient in all places to reach local air quality objectives set for 2008. We must do everything we can to cut this loss of life by improving air quality, including further controls on vehicle emissions which have brought about significant reductions in emissions without imposing unreasonable burdens on car users or on business.

The organised traffic management of transport companies can reduce the negative effects of individual traffic in the cities. This means less air pollution, accidents and traffic jams which can compensate the situation.

Motorists themselves and their passengers are at most risk from exhaust fumes. Recent studies have shown that cars offer little or no protection against the pollutants generated by traffic. Car drivers face pollution levels inside a car two to three times higher than those experienced by pedestrians. Car

commuters may receive more than a fifth of their total exposure to some pollutants from their daily journey to and from work, as well as adding to the pollution on the streets.

Although serious road casualties have declined, too many people are still killed or seriously injured on our roads and in other transport accidents. Some in society are more at risk. Children are particularly vulnerable and those from disadvantaged backgrounds are more likely to die as a result of road accidents than children from more affluent homes.

But the threat to children's health from the way we travel goes beyond accidents and pollution. Because of worries about safety, many parents now shuttle children to school by car when previously they would have made their own way on foot or by bike.

Traffic contributes substantially to the noise that has become part of the everyday environment and can make many people's lives a misery. There is now some evidence that this noise disturbs sleep and affects performance in school children and that the stress this noise causes may increase the risk of developing chronic heart disease and psychiatric disorders. Noise is an important issue for those living close to airports and under flight paths and near to busy roads.

The new deal for transport therefore sets the framework to:

- reduce pollution from transport;
- improve air quality;
- encourage healthy lifestyles by reducing reliance on cars, and making it easier to walk and cycle more;
- reduce noise and vibration from transport;
- improve transport safety for users, those who work in the industry and the general public.

More jobs and a strong economy

The transport system moves goods and people and helps to make the economy tick. Good transport is needed to get people to work and many jobs are based on extensive travel. Transport is also a major contributor to the economy in its own right.

More than four-fifths of domestic freight tonnage goes by road. But traffic congestion now costs the nation billions each year and with traffic forecasts pointing to more congestion these costs can only increase. Important parts of our streets suffer daily from traffic jams but building more roads can just encourage more traffic.

Modern business practices put firms at even greater risk from delay and congestion. 'Just in time' production, for example, means that companies no longer hold large stocks of raw materials, components or finished products on site, depending instead on their suppliers meeting their needs at short notice. They rely heavily on an efficient road network and transport system.

In central Budapest, at any time of the day, drivers face the prospect of spending a third of their journey at a standstill. Even our country towns at the busiest times can grind to a halt through congestion.

The transport measurements therefore set the framework to:

- improve reliability for journeys in all modes, helping to support business and economic growth;
- improve links with international markets;
- support regeneration and the vitality of urban and rural areas;
- make more efficient use of the transport system;
- promote more sustainable transport industries.

A better environment

The way we travel is changing our environment for the worse. The light pollution and noise from transport have changed much of our countryside. Road construction and car parking have made heavy demands on efficient transport organisation.

Climate change is one of the greatest environmental threats facing the world today. Globally, the balance of evidence now points to a discernible human influence on the earth's climate through the emission of greenhouse gases. Transport's share of carbon dioxide (CO₂) emissions, the main greenhouse gas has grown, and is set to grow still further. Four-fifths are produced by road vehicles.

As we use cars more, we have made less use of public transport. Yet buses and trains can have distinct environmental advantages. Buses require less road space per seat than cars and usually emit less CO₂ per occupant.

A fairer, more inclusive society

Nearly a third of households don't have a car. The number who relies on public transport, walking or cycling is even higher because in those homes where there is a car not everyone has regular access to it. Those who can't drive have to rely on lifts (over 4 in 10 women don't have driving licences) and in many families there is a main driver who has first call on the car. In some places, poor public transport and lack of a car combine to produce social exclusion. For example, some families in rural areas have had to make great financial sacrifices to keep a car to avoid relying totally on the little public transport that exists.

Most users of public transport rely on buses to get about. The less affluent - students, retired and unemployed people - use buses more than others. It is these people who have had to face bus fares rising in real terms since 1980. At the same time, the standard of living of bus and coach drivers has fallen.

Being unable to afford transport can limit everyday life. Job, training and education opportunities are more limited and there is less choice in shopping, adding to the family budgets of those least able to bear the cost.

Road traffic has affected some people more than others; the poorest and most vulnerable in society often suffer more than most. Busy roads in towns have cut communities in half and heavy traffic can be a barrier to community life. Road noise contributes to stress and disturbs sleep: those living closest to busy roads bear the brunt. Some of our town centres have been ruined by major roads, putting people in second place to the car. Increased traffic and speed have spoilt streets. Fear of traffic adds to the isolation sometimes faced by older people.

Public transport is not available to everyone, and where it exists is not always accessible to disabled people. Although recorded crime levels on public transport are low, concern for personal security is a significant deterrent to travel, particularly for older people, women and ethnic minorities.

The transport management therefore sets the framework to:

- produce better public transport and easier access to workplaces and other everyday facilities for all, especially people on low incomes;
- reduce community severance caused by transport;
- reduce the need to travel through better planning and technology;
- promote better transport choice for disabled people;
- reduce the fear of, and level of, crime on the transport system;
- promote better conditions for those working in transport.

A modern, integrated transport system

Privatisation, deregulation and competition were key features of the last decade but they have failed to deliver an integrated transport system. This needs to change. We want to work in partnership with industry but the shift of government's strategic responsibility on to the private sector went too far.

Managing competition and regulating monopolies

Whilst competition can bring benefits to some customers as suppliers compete for market share, the wider public interest must always be taken into account. In transport the problems of noise, congestion and pollution associated with individual travel decisions are often ignored and there is concentration on profitable routes at the expense of integrated transport networks which extend choice and accessibility.

Changing travel habits

Using the car less is not as impossible as some think it is. Nearly three-quarters of all journeys are less than five kilometres and 45% are less than two kilometres. Even though many of us could walk or cycle these short distances, or catch a bus, we have increasingly used our cars.

Recent studies concluded that most car trips do not have to be made by car. Using a car currently seems the sensible choice because of factors such as physical and time constraints and the poor quality of alternatives. Some car trips (up to 30%) were judged to be hardly necessary at all or a perfectly good alternative was already available but ignored. This shows the potential for people to use their cars less without making great sacrifices, the stress can be avoided and the money saved.

We know that a very high proportion of people change their travel choices from day to day and year to year, showing a great adaptability in arranging their travel and their lives. The transport management and organisation can make it easier for people to choose different and more sustainable ways of making their journeys, helping them to make the changes in travel behaviour that are needed.

Technology taking the strain

We can all do our bit to make a difference and this will be helped by advances in technology. We are committed to making the fullest possible use of new technologies to deliver the change for transport. As technology works best when combined with other measures, for example, financial incentives to buy greener vehicles, or use public transport to bring forward packages of measures to get the most from technological progress.

Improvements in vehicle technology, for example, will make a significant contribution to achieving our targets for improving air quality and reducing greenhouse gases. And developments in information technology will produce more reliable and comprehensive information to help public transport users and motorists plan their journeys. Technology can also help to make transport safer through, for example, improvements in vehicle design.

The transport management - making a difference

We have international and national targets for protecting the environment. Important is reducing transport's impact on our environment and the proposed targets to drive the process. These have been key influences on our transport organisation concept. Challenging targets are helping to focus attention on reducing greenhouse gas emissions, improving local air quality and road safety, encouraging more cycling and the usage of public transport.

International and national targets and standards

- greenhouse gases - legally binding target to reduce emissions to 12.5% below 1990 levels by the period 2008 to 2012 and a domestic aim to reduce CO2 emissions by 20% by 2010;

- air pollution - National Air Quality Strategy, encompasses health-based objectives for a range of air pollutants to be met by 2010;
- EU vehicle and fuel quality standards - to reduce toxic emissions and noise from new vehicles;
- road safety - existing target for 2000, new target for 2010.
- EU vehicle standards - target to improve fuel efficiency and reduce CO₂ emissions by more than a third before 2010;
- health for reducing all accidents by a fifth by 2010 and reducing death rates from heart disease and strokes amongst people under 65 by a third by 2010;
- public transport - targets to encourage more use of public transport;

Making a difference: on climate change

Following the Kyoto climate change conference in December 1997, there is a legally binding target to reduce greenhouse gas emissions to 12.5% below 1990 levels by the period 2008 to 2012. Also there is a domestic aim to reduce CO₂ emissions below 1990 levels by 2010.

A range of measures will be needed from the transport sector. These will form an essential part of a balanced approach to reducing greenhouse gas emissions. Reducing the overall rate of road traffic growth and local action designed to achieve a switch to less fuel intensive forms of transport will also play an important part.

Making a difference: on traffic and congestion

Increased traffic and congestion is at the heart of many of the problems we face. Local traffic authorities are already required to consider setting targets for traffic reduction in accordance with local circumstances. The amount of traffic on our roads will be a powerful indicator of how things are going, at both national and local levels.

We know that the transport management will make a difference at the local level. Analysis points to a reduction in public and private transport peak journey times of as much as 20-25% in the centres of the largest urban areas by 2010. This reduction in congestion would bring benefits to business and the environment.

Local air quality

It is estimated that European initiatives aimed at tightening vehicle and fuel standards have the potential to reduce busy central urban area road traffic nitrogen oxide emissions by up to 67% and particulate emissions by up to 70% below 1996 levels by 2010. Action at the local level, bringing together user charges and complementary public transport packages directed at tackling congestion and bus as well as directed at promoting cleaner buses and lorries, have the potential to deliver further significant savings. Further reductions in particulate emissions of up to a half appear possible.

Reducing urban road traffic emissions will make our towns and cities healthier places in which to live and work, bringing benefits in particular for those suffering from respiratory disorders including the increasing number of children with asthma. Better air quality will also benefit drivers and passengers who are currently exposed to high levels of pollution in busy city centres.

More inclusive society

The transport organisation will produce a step change in public transport bringing significant benefits to both town and country with better mobility for all in society. The measures we are introducing will

tackle the transport needs of women, disabled and elderly people and people on low incomes. Reducing road traffic congestion and increasing public transport in city centres will make it easier for local authorities to reallocate road space to cyclists and pedestrians.

Extending the range of targets

The transport companies will help to draw up new targets - for example, for promoting public transport. In doing so, it will balance the costs and benefits of such targets and seek advice from the Commission for integrated transport on the form they might take.

At the same time, new indicators can be publishing so as to allow progress to be measured. For example, a series of indicators is being developed to report on the performance of the trunk road network. Report on transport trends has been already published, containing key indicators covering a wide range of transport topics: for example, on the use of different forms of transport, on transport safety, changes in the level of air pollutants, greenhouse gas emissions and road traffic. Further work will be carried out that is needed in some areas to ensure that targets and indicators are appropriate and effective. One such area is noise.

Environment and equity concerns about transport

The last twenty years have seen a dramatic growth in both vehicle numbers and the distances driven in all industrialised societies. Car-ownership is now the norm for most households. Ever-rising car-ownership has led to increasing concerns about the harmful effects of transport on the natural environment and quality of life for groups without regular access to a car. Nevertheless, policies which aim to mitigate the environmental impacts of traffic may sometimes come into conflict with the social inclusion of low-income and other disadvantaged groups and communities.

Traffic congestion is an everyday fact of life in many towns and cities, resulting in increased noise and air pollution and streets that are less safe for pedestrians and cyclists. At the same time, more and more people are relying on the car as their primary means of transport. People are travelling far greater distances than they did even ten years ago in order to meet their basic lifestyle commitments.

This is associated with ever more dispersed land-use patterns, which in turn demand greater and greater car dependency. As more people look outside of their local area to work, shop and play, there has been an accompanying decline in local facilities. Public transport services have also deteriorated as people abandon them in favour of the car. Therefore the public transport management.

In recognition of both the environmental and social impact of over-reliance on the car, since the early 1990s policies have been introduced to reduce this dependency. These policies may, at times, come into conflict with the social inclusion of some disadvantaged groups and communities. One of the main aims is to locate the role of transport in the lives of these people and to evaluate the extent to which the present system of transport and transport policies meet their basic needs.

Local transport plans

The city administration wants to see integrated transport locally as well as nationally, which is why we are introducing local transport plans as a core part of our policy. Local authorities will set out in these plans their strategies for transport. There will be new tools to tackle congestion and pollution which will provide local authorities with new and dedicated sources of funding for transport measures. But they are not relinquishing responsibility for what happens locally, they will need to be satisfied that these new powers will be used as part of clear transport strategies that have the local communities.

They want more priority for public transport, improved facilities for people to interchange when travelling and better information for passengers. They want bus lanes that are properly enforced so that buses are more reliable as well as more frequent. They will improve choice and reliability of journeys in ways which safeguard the environment and the health of the nation. They will change the

focus of road investment to reflect the needs of all road users, giving top priority to maintaining and managing our existing roads and getting them to work better.

The transport management supported by the project results can integrate these transport plans into the practical traffic and the goals to have a sustainable transport can be approached more effectively.

The city administration can accomplish the following:

- new local transport plans;
- integrated transport strategies for local needs;
- local targets for improving air quality, road safety, public transport and road traffic reduction;
- more certainty of funding;
- greater use of traffic management;
- new powers including road user charging and levies on parking to tackle traffic jams and traffic growth;
- new sources of additional funding for local transport: better for the environment and better for business;
- better interchanges;
- tackling the pinch-points in transport networks that lead to congestion;
- buses to lead our transport revolution for the 21st century;
- upgraded quality partnerships between local authorities and bus operators:
- quicker, more reliable services;
- higher quality vehicles with staff trained in customer care;
- easy-to-use buses - to help access for disabled and elderly people and parents with young children;
- exclusive contracts for bus routes to ensure integrated networks.

Bus and coach safety

Investment in improving the quality of vehicles and infrastructure which will be encouraged by our policies for the bus industry should bring safety benefits in addition to encouraging public transport use.

But buses in towns are frequently involved in accidents with pedestrians, though the reasons for this are unclear. Further research is planned on safety at bus stops. The siting of bus stops and location of crossings should take account of the need to minimise the risk of accidents, whilst encouraging a safer, more pleasant walking environment.

Other research projects are looking at bus passenger safety, and all casualties in accidents involving buses, coaches and minibuses to see if changes to the construction standards for these vehicles could improve safety for passengers and for other road users.

All these measures are designed to make bus travel safer and, thus, to encourage bus use. The supervision of traffic flow can contribute to the safer bus transport. Better bus services in urban and rural areas will help to improve alternatives to the car and reduce social exclusion.

Bus Design

We need to improve the image of the bus, if we are to attract people who are used to the style and comfort of modern cars. The latest generation of buses demonstrates an increasing recognition of the importance of interior design quality and comfort and the industry is currently investing in new buses. The new equipments can provide safe, environment protective traffic flows in the city traffic.

Conclusion

The environmental and social impacts of the usage of road and vehicle sensor network were analysed in this study. The sensor supported traffic management system can define the optimal number of operating busses, reduce the air pollution and gas emission.

The level of public transport can be improved so it will attract more drivers to use the busses which results less congestion and accidents as well the health of the citizens will be protected more.

Bus drivers can be informed in time about road bottlenecks, bad weather conditions, skidding road surfaces. The interactive communication between bus drivers and traffic centres enables to diminish the potential risks of passenger transport. The public transport efficiency and safety can be increased by reducing the driving risks through adjustment of external conditions; the traffic fluidity will be improved through the real-time knowledge of the traffic situation and of current blocked ways in the city.

Considerable results can be gained in cities and metropolitan areas with a population of a million or above, however in smaller cities can be introduced the management system partly in an effective way.