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State of the Art of Research and Development in the Field of Urban Mobility

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Disclaimer

This State of the Art Report has been approved by the members of the Eurforum consortium at their meeting on 13 February 2007. It does not bind anyone but its authors.

This document will be used as basis for the Eurforum stakeholder consultation. It is therefore to be expected that, following the suggestions made during this process, further changes will be incorporated.

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ADAS	Advanced Driver Assistance Systems
AVM	Automatic Vehicle Monitoring
BRT	Bus Rapid Transit
CIVITAS	Initiative for cleaner and better transport in Europe
CNG	Compressed Natural Gas
CTS	Cybernetic Transport Systems
DRT	Demand Responsive Transport
ECTP	European Construction Technology Platform
ERRAC	European Rail Research Advisory Council
ERTRAC	European Road Transport Research Advisory Council
ETP	European Technology Platform
FCD	Floating Car Data
FP	Framework Programme
GDP	Gross Domestic Product
IPA	Impact Pathway Approach
ITS	Intelligent Transport Systems
NGV	Natural Gas Vehicle
PDA	Personal Digital Assistant
PPP	Public Private Partnership
PRT	Personal Rapid Transit
PT	Public Transport
RFID	Radio Frequency Identification
R&D	Research and Development
SoA	State of the Art
SRA	Strategic Research Agenda
SUMRA	Strategic Urban Mobility Research Agenda
SUTP	(Integrated) Sustainable Urban Transport Plan
T-NEG	Transportation in New EU-member-countries – General Research Network for Harmonization and Integration
TEN	Trans European Networks

1. Executive Summary

A large majority of Europe's population is living in cities and urbanised areas with high density of people, buildings, and traffic. While traffic can be seen as a sign for a vibrant and economical successful city, it is mainly an outcome of people and businesses who want and need to be mobile and therefore travel by foot, by bike, public transport or private motorised vehicles. Cities need to support this mobility for the social function of the city and economic growth and at the same time limiting motorised traffic and its negative impacts on inhabitants and environment. Many cities and towns in Europe have been successfully supporting this process and stepped forward towards enabling more sustainable urban mobility with a more reliable inter-modal urban transport system. Nevertheless, many other urban areas are still struggling with these tasks, maybe due to financial reasons, lack of planning or policy direction, maybe due to missing consideration and integration of all aspects influencing people's and goods' mobility.

While it is mainly the cities' and towns' task to deal with urban mobility aspects, the EU has a great interest to support urban areas as they are Europe's social, cultural and economical centres which play an important role for the sustainable development of the EU. The European Research Forum on Urban Mobility (EURFORUM), funded by the Commission, was founded to give recommendations how to support European urban areas through research and development in the field of transport and mobility. This report presents EURFORUM's first findings concerning the state of the art in research on planning, managing, policy and technology development in the field of urban mobility in Europe. It presents the major aspects of current problems, solutions and research on the European level based on a broad review and evaluation of many state-of-the-art projects and documents. The first section of this report will explain the motivation of EURFORUM's development and its objectives in more detail.

Before developing research recommendations within a EURFORUM Strategic Research Agenda, it should be clearly understood what weaknesses of urban mobility had developed in the past, how main influencing factors will probably develop in the future and what aims, what visions could be imagined for our urban mobility's development. While the EU defined a vision for sustainable urban transport in its working paper on the urban environment [4], EURFORUM took the opportunity to develop a vision for urban mobility in the year 2020. This vision states that urban mobility should support Europe's cities and towns to remain centres of activities and Europe's motors for growth and wealth creation. At the same time severe negative impairments for the cities' cultural and architectural heritage, the inhabitants' health and the environment's viability have to be reduced. To achieve this, mobility in cities and towns must be provided for all users with clean, efficient, inter-modal and fairly priced transportation, which is based on continuously developed and updated integrated sustainable transport plans and continuously monitored quality management.

With this understanding EURFORUM stepped towards a review of mainly European funded research and several policy documents. The review can not be all-embracing but should give a good overview over the current situation of research and practice relating to the cities' and towns' ability to provide urban mobility as described in the vision. This state of the art report is based upon a review of these documents within 15 research topics considering possible focal points of the EU. It leads to the result that much has been done in research and development in the past

years, but some major aspects – often in regards to policy definition and implementation - still remain unsolved due to different reasons. These aspects are:

- Difficulties of cities to implement and enforce possible strategies due to insufficiencies in the processes of planning, policy and monitoring and due to unfavourable allocation of competencies within local governments
- Ways to manage traffic growth also in terms of pricing strategies
- Ways to finance infrastructure, maintenance and operation mainly through the specific direct and indirect users rather than through general taxation
- Ways to institutionally and financially organise public transport (PT) most profitably while ensuring accessibility for everybody through PT
- Lack of comparability of urban transport performance in cities to set incentives through benchmarking of cities and towns across Europe (need for more standardised data collection, analysis and evaluation and standards as a precondition for obtaining EU or national state funds for municipal strategies and measures)
- Estimation and evaluation of the influence and effectiveness of transport demand management strategies on traveller behaviour using methods comparable to those to evaluate infrastructural measures
- Reducing the emissions of motorised traffic significantly
- Promotion and increase of environmentally friendly modes through integrated land use and transport planning, especially supporting usability and safety
- Lack of orientation towards human aspects when planning and designing urban transport space (aesthetics, ergonomics, accessibility, safety, security etc.)
- Integration of standardised and large-scale applicable inter-modal freight transport concepts in urban areas
- Needed assistance of cities concerning research to implement strategies and measures. This focuses on applied research and pilot projects to develop best practices

While these are the main aspects discovered, many others were described as well. Based on these findings, EURFORUM will develop a Strategic Research Agenda for the discussion with major stakeholders in the field of urban mobility. This should support the refinement of the 7th FP and should provide inputs to the planned Green Paper on Urban Transport of the EU.

2. Objectives of EURFORUM

The European Research Forum for Urban Mobility (EURFORUM) is a Coordination Action[1] of the EU within the 6th Research Framework Programme. As this, it is not a research project but an effort which focuses on a better and more innovative coordination of research and development serving urban mobility of persons and goods.

Urban transport issues are under the responsibility of local authorities and national governments. The subsidiarity principle implies that decisions are made as closely as possible to the citizens. Nevertheless, the European Union can take action and help to improve local and regional efforts, e.g. by promoting sustainable urban mobility [2]. The Mid-Term Review of the European Commission's 2001 Transport White Paper [6] stated that there is a great interest in possible EU contributions. Nevertheless, there are already many successful initiatives on the European level in relation to urban mobility. This includes research funding in FP 5 and FP 6, initiatives like CIVITAS but also the EC's Thematic Strategy for the Urban Environment [110] etc. The European Commission actively has supported the creation of "technology platforms" for various transport sectors like ERRAC for rail, ERTRAC for road. They all are "modal platforms" which represent only to a limited extent a multimodal integrated approach of metropolitan and regional transport problems.

Next to the research oriented attempts, the EU also disseminates research results and promotes good practices in order to support the development of sustainable urban transport. These aspects are of high relevance since many decision makers fail politically with the implementation of good approaches on the local or regional level like this report will show later.

EURFORUM aims at filling the gap between existing technology platforms and helps raise the priority of urban mobility research within European, national and local research programmes. It offers a chance for a co-ordinated and integrated approach on mobility research focused on urban areas, where most of the European population lives and most economic activities are concentrated. In EURFORUM all urban transport modes are considered and special attention is paid to integrated approaches and inter-modal transport research issues. EURFORUM focuses on both, technology-oriented and on policy-oriented research. The discussion forum also pays special attention to urban mobility challenges in New EU Member States.

The overall objective of EURFORUM is to better structure and better coordinate European research on urban mobility for passengers and goods by involving all relevant stakeholders in the discussion. EURFORUM will provide a draft Strategic Urban Mobility Research Agenda and could support the development of a Green Paper on urban transport which will be an initiative of the Commission in 2007, according to the Commission Legislative and Work Programme 2007 [111].

The major aim of EURFORUM is to identify and to develop innovative concepts and tools for organising a proper coordination between all relevant stakeholders at EU level concerning research

[1] *"Co-ordination actions (CA) are intended to promote and support the co-ordinated initiatives of a range of research and innovation operators, in order to achieve improved integration of the European research…. They provide financial support only for the additional activities that are needed to achieve the networking or co-ordination of the research and innovation activities of the operators involved." [1]*

on urban mobility of passengers, as well as goods. In order to enable this, the identification of key stakeholders which should be partners of a European body endorsing a future SRA on this topic and the development of an appropriate consultation process are important steps of EURFORUM.

3. Urban Mobility, now and tomorrow

3.1 Introduction

When talking about the topic, one will realise soon that Urban Mobility is a comprehensive field. The term relates to everything from spatial conditions of cities and conurbations, cities' political goals and citizens in urban areas. Also, when talking about "mobility", different definitions and viewpoints appear, so that it seems that a more precise definition of what EURFORUM is dealing with, is needed.

The term "urban" is relating to cities and conurbations, which "are places where people gather for the purpose of economic and social interaction" [112]. EURFORUM does not limit its perspective to a specific type or size of city. However, transportation problems differ with size of town, degree of urbanisation and distance to metropolitan areas. Research needs have to be differentiated for various types of cities and metropolitan regions. This is also true for policy measures undertaken by a city which should be backed by a policy framework at the European level.

"Mobility" as the main theme of EURFORUM describes the ability for people to participate in activities for different purposes at different locations and for goods, providing access to related activities which are often found at different locations. Activities for passenger travel can be residing, working, shopping, educating, recreating etc. Activities for freight transport can be extracting raw material, processing, storing, selling, recycling etc.

The "mobility" talked about in EURFORUM does mainly lead to physical travel of persons on foot, by bicycle, by public transport or car and physical transport of goods in all possible vehicles or vessels. Therefore, other mobility than the physical one outside the house and factory etc. (including virtual mobility) is not mainly considered in EURFORUM except it helps to reduce traffic by substituting physical of people and goods.

Therefore "urban mobility" in EURFORUM can be understood as urban transport of passengers and freight to, from and within a city and in relation to conurbations. It includes users and their interaction, facilities that generate trips, how the trips are planned and operated, the urban transport system (infrastructure, different modes, vehicles, planning, managing and operating, generation and performance of transport) as well as impacts of transport. In this context, EURFORUM talks about one complex urban transport system with modal sub-systems that are strongly interrelated with each other.

Why do we need to think about "urban mobility" in its development until today and in the future? Due to a higher standard of life, a growing car-ownership and the tendency to locate housing and commercial units outside of inner cities, the need for physical mobility of many people gathered together in cities and their vicinity increases the amount of traffic. This requires more transport in-

frastructure such as roads, vehicles, space for public transport, bike lanes and walkways, institutions and technologies to organise traffic and so on.

Nevertheless, transport infrastructure has financial, spatial and societal limits and has to be used efficiently in order to reduce negative effects of traffic such as noise, air pollution, accidents, space consumption etc. On the other hand every human should have access to all aspired activities. Successful cities attract a lot of people and companies who need to be mobile. The way, how mobility is realised and how the intended activities are satisfied, is determined by individual behaviour and decisions. These are influenced by past experiences and individual characteristics, especially when talking about passenger transport but also by public decisions e.g. on the urban development.

Different claims can also be determined when looking at the transport of freight to and in urban areas. The transport system plays a key role for the economic growth of urban areas based on the fast, timely and flexible transport of goods. On the other hand traffic influences cities and their inhabitants negatively in terms of safety, noise, use of space etc. Especially the transport of goods on the road contributes to these negative effects to a great extent. More sustainable ways of urban freight transport are most important to improve the traffic situations in cities and metropolitan regions.
How can research at the European level help to answer these questions? The FP7 Provisional Research Work Programme 2007 (Cooperation, Theme 7 Transport) [5] of the EC states that a broad and comprehensive spectrum of activities is needed to achieve sustainable surface transport in Europe. This implies:

- Socio-economic research in support of the definition and implementation of transport policies.
- Basic and applied research contributing to the technological and scientific progress.
- Development of innovative solutions for surface transport products, processes, operations and services.
- Large scale and multi-disciplinary technology and socio-economic integration, validation and demonstration.
- Supporting programme implementation in aspects related to dissemination and exploitation of existing research results.
- Structuring European surface transport research and strengthening excellence through coordination and networking activities.

The future research in the field of transport should help to achieve reliable accessibility and secure sustainable urban mobility generating as little traffic as possible and mitigating the negative effects of traffic. Research towards such a vision should offer ways helping to solve complex economic and social problems faced by urban agglomerations and to promote a modal shift towards environmentally friendly transport modes in the years/decades to come. The Provisional Work Programme 2007 [5] states that research which focuses on the mobility of people and goods should bring together all elements of a clean, energy efficient, safe and intelligent road transport system. It should aim at ensuring access for all and a high level of inter-modal integration by researching new transport and mobility concepts, innovative organisational and mobility manage-

ment schemes and high quality public transport. Research in the next years should pay special attention to non-polluting modes, demand management, rationalisation of private transport, and information and communication strategies, services and infrastructures. Tools and models which support policy making and implementation should cover transport and land use planning including aspects of growth and employment [5].

EURFORUM will develop a Strategic Research Agenda (SRA) during these steps:

- Looking at the past development and present state of "urban mobility".
- Describing possible challenges, the future may bring to urban mobility and its realisation while concentrating on the developments which are relevant for European countries.
- Defining how transport could support our vision of a liveable European city and mobility could look like in the year 2020 (see section 3.3, page 9).
- Evaluating existing solutions and strategies to meet this vision and possible challenges in terms of research and support of implementation.
- Deriving gaps of knowledge, lacks of past research and cooperation.
- Suggesting main important topics for research and implementation in preparation of a Strategic Urban Mobility Research Agenda of the EU.

Before structuring the SRA, we have to look at urban mobility today and in the future, describing the challenges, urban areas and their transport system will possibly have to cope with in the future.

3.2 Today's Problems and Future Challenges of Urban Mobility

The EC's White Paper [3] refers to a "mixed performance of the common transport policy" in the past and indicates three major problems which are commented below:

1. Unequal growth of different modes of transport

Road transport is predominant, in cities as well as outside of agglomerations and especially in passenger transport. While road transport has significant disadvantages like high energy and space consumption per user, emissions, higher safety risk etc., it's flexibility, comfort and speed makes it very attractive. More efficient and environmentally friendly modes like public transport (PT), cycling and walking do have a much smaller market share. PT often relies heavily on public funds and is subject to many regulations. It competes in an unfair competition with private transport which is not charged for its externally caused costs and therefore has further advantages.

2. Congestion on main roads

As a result of the imbalance between transport modes, the immense growth of road transport has led European cities to suffer from congestion and is costing the EU about 1% of the GDP. Congestion problems are concentrated in and around cities due to them attracting many people and businesses.

3. Harmful effects on the environment and public health

Traffic is one of the major emitter of air pollutants like particular matter, acidifying substances and ozone precursors. "Urban transport accounts for 40 % of CO_2 emissions from road transport and up to 70% of other pollutants from all transport [3]." Emissions of CO_2 by transport are expected to increase in the next years while other air pollutants of transport have been decreasing in the European countries since 1990 [3]. Traffic noise harms people's health and accidents still take a high toll of too many victims.

These major problems of transport in Europe and elsewhere do represent today's problems of mobility in urban areas as well. However, due to the high concentration of people in urban areas, cities and towns generate even higher levels of traffic and more people are exposed to the negative effects of traffic. The EC's working paper Towards a Thematic Strategy on the Urban Environment [4] says: "…if the high density of buildings is the first defining characteristics of towns and cities, then high volumes of traffic is now the second. Traffic has significant impacts on the environment and on the health of urban citizens, as well as on the overall quality of life in towns."

This relates to traffic for passenger transport as well as for freight transport. Freight transport has been growing even faster than passenger transport in the EU-25 and quite high growth rates are forecasted [6]. The Working Group Paper on Sustainable Urban Transport [2] states that the fastest growing type of freight vehicles in urban areas are light commercial vehicle. A reason for these growth rates is the ongoing shift to a service based economy with more flexible and smaller deliveries and increased home-shopping which increases delivery needs.

These developments are not without consequences. The EC's working paper Towards a Thematic Strategy on the Urban Environment [4] explains that 97 % of Europe's urban citizens are exposed to air pollution levels that exceed EU quality objectives for particulates, 44 % for ground-level ozone and 14 % for NO_2. While much progress has been made in reducing emissions of the vehicles through technological developments, the overall growing levels of motorised transport in urban areas are counterproductive. This also accounts to transport-related CO_2 emissions. About 40 % of these are produced by urban traffic and the growing traffic will lead to increasing CO_2 emissions from transport. The consequences for the health of urban citizens are considerable [4]. Additional, the unequal growth of motorised urban transport and its high levels contributes to an increasingly unhealthy lifestyle missing physical exercise and leading to increasing numbers of cardio-vascular diseases.

Furthermore, urban traffic accounts for many injuries and deaths through traffic accidents. In the year 2000, two thirds of the 1.3 million traffic accidents in the EU that led to injuries and one fatal accident in two took place in urban areas [4]. Road accidents have high economic costs and they concern vulnerable users. This for pedestrians and cyclists especially high danger has a direct impact on the choice of transport mode (see section 4.10. on Safety and Security (D1), page 51).

But not only traffic accidents impose dangers to human life in urban areas, so do also high traffic noise levels. Based on the results of a study on traffic noise, exposure and annoyance, the working paper on the urban environment states that a very high number of people in agglomerations

and the vicinity of transport infrastructure are exposed to high traffic noise levels being seriously detrimental to health [4].

High traffic levels and their impacts in cities and towns deteriorate the quality of life in urban areas and support the desire of people to move towards the edge of cities leading to urban sprawl. Besides the already described negative impacts of road traffic, lots of traffic leads to less space for non-transport uses of public and private space, represents a barrier and disrupts communities. It discourages people to be active in public space, letting their children play there and it contributes to the ”progressive weakening of the sense of neighbourhood and local community” [4]. Low accessibility of services and activities through public transport or high prices for existing offers disadvantages lower income citizens which can not afford their own car. Urban mobility is an important aspect of social equity. This is also an aspect for further research.

However, many achievements have been reached during the last years, e.g. vehicle improvements, vast traffic quietened areas in cities, reduction of killed people in accidents during the last years etc. Not only due to the growing traffic levels, these steps are not enough. Cities and towns also have to look towards the future and prepare for the challenges of tomorrow. There are some future trends which are of special concern for the transport sector and in particular for urban mobility:

- Growing traffic levels will offset progress to reduce negative impacts of traffic and worse traffic congestion in many urban areas. This esp. accounts for prospering metropolitan areas. The car ownership in New EU-Member Countries is dramatically increasing and growth rates will most likely continue to be highest there [2].
- The freight transport to and in urban areas will continue to grow, most likely carried by road transport and to marginal parts by more environmentally friendly modes or intermodal transport.
- This leads to remaining transport related poor air quality and high noise levels in many cities and towns. It will also hinder the reduction of road deaths and injuries if nothing is done to reduce the accident rates or at least decouple traffic growth and accidents in the New EU Member States. Nevertheless, there is a growing demand for a higher safety in many countries with ambitious aims (“Vision Zero” in Sweden, “Sustainable Safety Programme” in the Netherlands and other countries).
- The finiteness of oil as the major energy supplier in transport will lead to increasing oil prices. This could be a chance to support the modal shift towards environmentally friendly transport modes and technological development towards non-fossil fuels and drives but will increase the financial pressure esp. for urban citizens with lower income.
- Shrinking demand for public transportation due to increasing attractiveness of cars, high car ownership and other factors are problems esp. in the New EU Member Countries and in smaller towns [2]. It will lead to higher needs for public funding and implies dangers of decreasing quality and accessibility of public transport offers, and of rising ticket prices especially where the population shrinks and economical problems remain unsolved.
- Demographic changes in Europe will lead to a side by side of growing and shrinking cities, more competition for citizens and businesses and the aging of population. Especially

the latter one will lead to changed mobility needs of the overall population and needs for adjusted road space design, issues of safety, orientation, speed etc. In shrinking cities these challenges have to be met under the circumstances of declining financial margins of public authorities.

- In prospering cities and conurbations, population and businesses will further concentrate and support the polarisation of development and prosperity. This further growth might lead to on-going suburbanisation, even though the general trend of suburbanisation slowed down. Reversal trends to the depopulation of the inner cities can be seen in many urban areas and should be fostered as much as possible [2].
- All these aspects will increase the gap between regions and cities with shrinking and growing population. The immigration pressure from other countries and aspects concerning equal opportunities for the inhabitants of urban and rural areas will only be some topics for the on-going discussion related to the processes of increasing spatial heterogeneity.
- The current trends of increasing insecurity (terror attacks, natural disasters etc.) for the European society in general and collective transport passengers and staff in particular will continue.
- There are remaining differences of income, development, infrastructure and technology in the different EU Member Countries which complicates the processes of adaptation and economic growth. This especially accounts for differences between the New EU Member States, Accession Countries and other members. Research and implementation will have to reflect and consider these different stages of development (see section 4.17 at page 77).

All these challenges can not comprise every possible development and their description can not cover the entire field. But they give an overview about what to keep in mind when trying to improve urban mobility with research and implementation of knowledge.

3.3 Vision - What should Urban Mobility look like in the future?

In line with the 2004 report of the Working Group on Sustainable Urban Transport, established by the EU's Expert Group on the Urban Environment [2], objectives to improve urban mobility need to be clear and generally accepted to make striving for a better future and looking for improved measures more effective. Therefore, a vision for urban mobility in the year 2020 seems to be a good starting point to develop further plans and to structure a research agenda along future objectives plus current and future needs.

The working paper Towards a Thematic Strategy on the Urban Environment [4] offers a common vision on sustainable urban transport based on suggestions of the Working Group on Sustainable Urban Transport [2] to give a better orientation to local and national authorities and inspire them to develop their own vision. The final 2006 Thematic Strategy on the Urban Environment does not refer to such a common vision any more [110].

As EURFORUM defines mobility in urban areas as accessibility to everybody to all aspired activities, urban mobility should promote quality and prosperity in European cities. Therefore, the following vision was drafted in EURFORUM as a proposal for urban mobility 2020:

Urban Mobility in the year 2020

Europe's towns and cities are the liveable homes of most Europeans, and form vibrant centres of cultural and social interaction. At the same time they act as the motors of prosperity in an increasingly global economy, concentrating both knowledge and technical capacity.

In order to play this role successfully, towns and cities form the focus points of transport networks for persons and goods, on different scale levels and using different modalities.

Thanks to technical progress and changes in the regulatory framework, the future urban areas are able to cope with the negative impacts of their own success: congestion, pollution, road accidents, economic and social exclusion.

Successful developments and applications of new transport technologies in European cities and towns have made Europe the major global player in the field of sustainable transport technologies.

The following principles apply to urban mobility in 2020:

- European cities and towns are easily and equally accessible for people and goods. A well-organised urban transport supports the reduction of social and spatial segregation.
- Urban transport has developed into a more sustainable and user-oriented system of integrated services and infrastructures, thus contributing significantly to the liveability and wealth of cities.
- All fields of urban planning and development have been effectively linked with each other. A major contribution is made by the integration of land use and town development planning with transport planning and mobility management. Plans are updated on a regular basis at least every five years. Sustainable urban transport plans are mandatory in cities with more than 100 000 inhabitants.
- Although the alternatives to traditional fossil fuels still have low market shares, traffic related air polluting emissions (including greenhouse gases) have decreased significantly thanks to a combination of different factors: e.g. a higher modal share of public transport, cycling and walking; a higher use of shared private transport; increased fuel efficiency of vehicles and less congestion. Local air pollution in particular has decreased dramatically thanks to ever more demanding emission standards for both public and private transport.
- Innovative concepts and technologies have helped to curb noise pollution caused by urban transport.
- Transport safety issues have been integrated in urban transport policies at a high level.
- The internalisation of all external costs into all modes of transport has facilitated a fair pricing system for mobility and enables a well-informed population to more efficiently use the urban transport system.

- Transport infrastructure charging is no longer seen as a tax, but as the price for a scarce commodity.
- The role of user financed systems through road pricing and other integrated pricing strategies as a means for demand management became more and more important inside and outside of cities. It ensures reliable financing of transport infrastructure and maintenance. The role of public transport, shared private transport and soft modes to reduce congestion is considered appropriately by being partially cross-financed through road charging.
- There is a continuous monitoring of mobility patterns, of regulatory frameworks and practices, and of environmental and economic performance on the basis of agreed common indicators and measurable targets at the European level. Benchmarking with other cities and towns has been institutionalised.
- The regulatory framework for public transport enables competition and provides incentives for operators to optimize their technical efficiency, and innovative entrepreneurship while protecting the interests of consumers without inappropriate financial transfers from the public budget. Local authorities retain the freedom to choose the solution that best suits their capabilities and local needs.

The goal of urban mobility improvements in the future is to maintain and improve urban accessibility while reducing detrimental impacts of traffic. This relies heavily on an integrated strategy and "a broader, more flexible, transport policy toolbox" [6]. The need for and current lack of integrated approaches was highlighted in the White Paper on European Transport Policy [3]: "The lack of an integrated policy approach to town planning and transport is allowing the private car an almost total monopoly".

Based on recommendations of different projects and best practices, e.g. the CIVITAS Initiative [93], some major aspects can be identified which should be part of such integrated strategies towards cleaner and improved transport in cities:

1. Development and up-dating of integrated sustainable urban transport plans (SUTP) considering all seven integration aspects described in section 4.4, page 19. This should be based on regular assessments of the urban transport system's performance.
2. Promotion of integrated land use and transport policies.
3. Demand management and revenue-raising strategies based upon integrated pricing strategies which include improved services, supply and information but also access restriction for cars where necessary, e.g. in inner city areas and other sensitive zones.
4. Energy-efficient, cost-effective and clean public and private vehicle fleets using alternative fuels plus the necessary fuelling infrastructure.
5. Stimulation of non-motorised travel and collective passenger transport, improved facilities and quality of service offered to users.
6. Innovative "soft measures" for managing mobility demand and inter-modal use of transport modes.
7. Integration of transport management systems and related information services
8. New forms of vehicle use and/or ownership, and less car-intensive lifestyles
9. New concepts for the distribution of goods.

10. Integration of concepts and measures to increase road safety and address security issues of road transport, public transport services and interfaces.
11. Implementation of effective monitoring of outcome indicators to evaluate the progress towards policy objectives and to assess impacts.

These keywords along a vision should help to understand which efforts seem to be most important to set future research and development programmes into the right direction.

4. Urban Mobility Research on Planning, Managing and Policy in the Past

4.1 Methodological Background of the SoA Review

This section reports achievements of European urban mobility research so far. It will serve as a basis for the development of forward-looking and adjusted research objectives being structured in the Strategic Urban Mobility Research Agenda (SUMRA).

Due to the great number of documents and research results to review, mainly European projects and very important national research was evaluated. It should also be stressed that even the reviewed research results do not represent the entire field of urban mobility research, development and implementation in Europe. EURFORUM rather tries to concentrate on relevant topics which are of interest for the EU in particular regarding future actions. But EURFORUM can not and does not aim at covering each aspect being relevant for local authorities. Sources which have links to the urban mobility field like major ongoing/completed projects and research programmes have been identified in discussions of the consortium and within the on-going work. These sources include documents of all relevant European Technology Platforms like ERRAC, ERTRAC, ECTP and in general, the following types:

- Project reports and project reviews, state of the art reports
- Policy documents from relevant organisations and the European Commission including Strategic Research Agendas etc.
- Other relevant documents giving an input to the discussion on research in the field of urban mobility

These documents were reviewed and used as a basis for the preparation of this SoA report. The report tries to answer the following questions:

1. What has been achieved in regards to research, development and implementation of concepts and technologies being relevant for the field of urban mobility?
2. How can the existing results be better used to meet future challenges of urban mobility?
3. What are the open research areas of relevance with EURFORUM objectives?
4. Which are the important European Players who are integrated in European research and development concerning urban mobility?
5. Which important actors are missing in the European discussion on R&D regarding urban mobility?

As mentioned before, integrated approaches of planning, managing and developing measures are a basic claim and understanding of EURFORUM. However, to make the broad area of urban mobility more manageable, 12 major subtopics were identified which are shown in Figure 1:

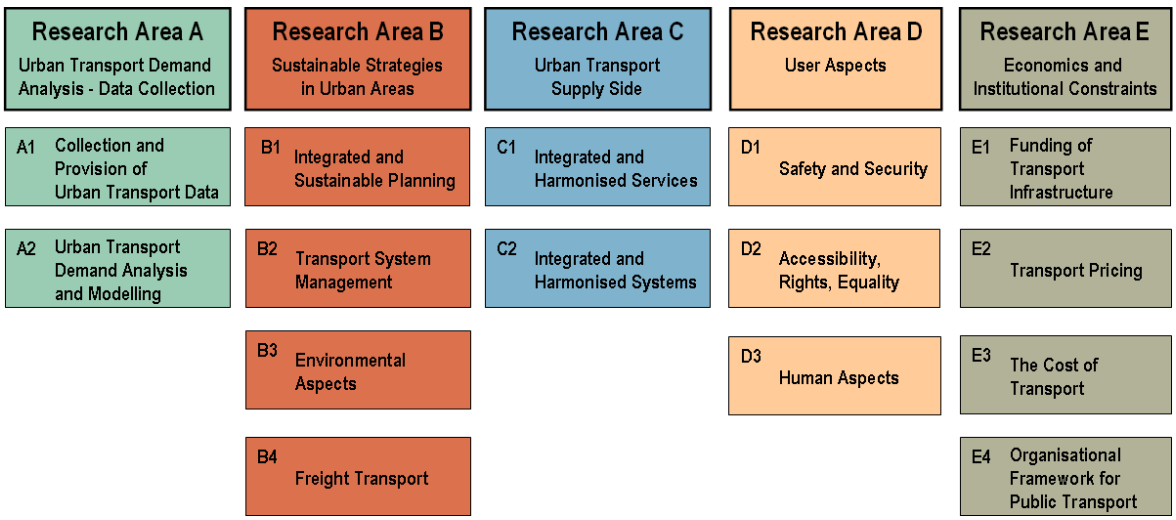

Figure 1: Thematic Structure of EURFORUM

Nevertheless, all subtopics are more or less interrelated. In order to avoid redundant text, each of the following chapters will define interrelations with other sectors where necessary. Each chapter will state in a description of the topic more detailed what specific aspects are covered, how the status can be described and which open questions for future research and implementation could be identified. The gathered open questions do only represent a first list of possible issues and will be further evaluated and structured in the Strategic Urban Mobility Research Agenda of EURFORUM.

4.2 Collection and Provision of Urban Transport Data (A1)

4.2.1 Description of Topic

This topic deals with the **process of gathering facts and knowledge** about the performance[2] of the transport system, causes of trips, the behaviour and needs of travellers regardless of the travel mode or of the method of survey/data collection. The required data differs depending on specific purposes. Below, mostly questions concerning data will be discussed which is needed for policy making and benchmarking, planning/operating, and for further research on system coherences.

4.2.2 Status

The understanding of the transport system, its current situation and developments in the past rely on the gathering of data concerning the system. In addition, interrelations of causes and conse-

[2] *E.g. Travel times, service levels, congestion times/costs to evaluate the quality of the transport system*

quences within the system have to be researched and understood to predict possible changes in the future under certain circumstances. This can only be achieved with reliable, continuous[3] and object-oriented collection of transport data.

There are three major purposes for the collection of data on urban mobility and related topics which are of main interest for this state of the art. They are described in the following sections.

Data Needed for Urban Transport Planning and Operating

Urban transport planning depends on these data collection as much as any other planning needs system information. With respect to passenger travel[4], four major types of data can be identified:

1. Data on **mobility behaviour**, e.g. realised trips/journeys and trip purposes of people, origin-destination relations, mode of travel chosen, trip length, time for trip, speed etc.
2. Data on **land use which generates trips**, e.g. structural data on residents/residential locations, employees/work locations, shopping area/supply facilities, students/facilities for education, other traffic generating facilities etc.
3. Data on infrastructural network / **transport supply** in the system, e.g. data on the network and hierarchy of roads, infrastructure for cycling, walking and public transport, inter-changes etc., travel times and their reliability, data on the frequency of public transport offers, data on the fleet composition (e.g. fleet characteristics concerning vehicle types and capacity, emissions, rates of ownership concerning private vehicles like cars or bicycles etc.).
4. Data on the **traffic flow and operations** to be used for calibrating models (see section 4.3 on A2) and for quality control. This type of data is often collected in traffic censuses, e.g. roadside counts, cordon counts, intersection counts etc. (automatically or manually). Related data refers also to describing situation for parking. Additionally, much data is automatically conducted by modern traffic management systems including facilities for traffic signalisation or public transport operations. Furthermore, data concerning transport safety is collected (numbers, severity, location and reasons of accidents, travel modes involved etc.).

Data Needed for Policy Making and Benchmarking

Data used for policy decisions and benchmarking is often the same as data needed for planning and operating the system. But for political decisions less local data but rather information about the macro level is needed, concerning general trends of mobility behaviour and the quality of traffic operations etc.

Besides already stated types of data, the following types of information are of specific interest for the political discussion:

1. Accessibility of the urban area and destinations within the conurbation for people and goods and depending on the respective transport mode.
2. Availability of the transport system in respect of restrictions to specific goods or barriers for specific groups of people due to the costs of a certain type of mobility.
3. Use of the transport system (modal split, purpose of journeys etc.).

[3] *Continuous data collection could refer to regular conduction of data if possible every five years or the continuous on-line collection of operational transport data.*

[4] *Special aspects of data collection concerning the transport of goods are discussed in section 4.7, page 37.*

4. Socio-economic data and costs of physical mobility.
5. Impacts of traffic on environment and health of the general public, safety, aesthetics and quality of life in the city.
6. Quality of transport offers (objective and subjective).
7. Investment of public money, subsidies etc. (see also section 4.15, page 72)

Data Needed for Research Uses

Data needs for research purposes are usually very detailed and specified based on the respective objective of the research task. Much data is already collected for planning and policy purposes which is often used for further research. Additional data is specifically conducted for research purposes. In general, the availability of data and detailed information about the data background is very important for research uses and should be further eased. Often, models and data are available, but sources are not known, data is badly documented or not comparable. Some initiatives have been started to publicly provide information about already conducted and available transport data on-line, about methods, purpose, spatial limitations, options for using the data and so on[5]. However, such portals are often only available in the national language. Access is therefore difficult for the international research community.

Much background knowledge and scientific methodologies for the collection of transport and mobility data already exist for all stated three major purposes of data collection. The major problems in this field seem to appear during the practical conduction and the use of data in cities and towns. The main difficulties of local actors to collect, prepare and use data on transport and mobility were identified in several projects and documents (e.g. the work of ECMT [125], Working Group on Sustainable Urban Transport [2]):

- Inconsistent use of methods for analysis and evaluation, lacking quality of data collection processing for urban transport planning etc. (old data, not consistently conducted data, lacking integration of surveys and data) lead to incomplete knowledge about the current system performance and mobility needs.
- Lacking monitoring of the continuously changing urban system. Developments and changing processes can not be noticed and impacts of measurements and their success can not be observed. An example for good practice is the regular conduction of household surveys on mobility behaviour in cities in Germany (Mobility in Cities - SrV[6]). It uses a standard questionnaire design to collect information about the mobility behaviour in several German cities every five years. The obtained data is used by the local governments to monitor the development in their city, to discuss new planning efforts and to control the success of past measures. Similar approaches can be found in France, where 76 urban areas are required by law to carry out travel demand surveys approximately every ten years with a subsidy of the French Ministry of Transport. A standard questionnaire is applied and results are used to evaluate local transport plans, to monitor transport policy and its success. Nevertheless, there are still many cities, esp. smaller towns, which do

[5] *One example is the "Clearingstelle Verkehr" in Germany, an internet portal funded by the Federal Ministry of Education and Research (BMBF) and the Federal Ministry of Transport, Building and Urban Affairs (BMVBS): www.clearingstelle-verkehr.de. It functions as a mediator between suppliers and users of transport data and transport models.*

[6] *In the year 2003, 34 cities and towns took part. http://www.tu-dresden.de/srv/SrV_Web/index_08.html (German)*

not obtain such a decision basis regularly. In a recent study in Germany[7], roughly 50 % of 200 cities of different sizes had to state that their basis for decisions was not up-to-date, in smaller cities sometimes older than 15 years, even though dramatic economical and demographical changes had appeared. European projects like TransPlus [17]give a more detailed overview about the barriers, local actors are facing when they try to realise the integration of land use and transport planning, including aspects of lacking monitoring.

- § Difficulty to obtain access to existing databases on transport, high costs and insufficient documentation of existing databases.
- § Lack of data for benchmarking and measuring of sustainability, e.g. socio-economic data, economical indicators. This is also linked to issues concerning funding of transport infrastructure (E1) in section 4.13, page 64 and costs of urban transport (E3) discussed about in section 4.15, page 72.
- § Lacking communication and exchange between different local actors who conduct or need local transport data.
- § Inaccuracy and high expenses for traditional ways of collecting data. New data sources and collection methods are available and might be helpful to reduce costs while increasing the quality and accuracy of data (geo-coding, data collection via internet, digital maps, image processing in transport science, floating car data, intelligent payment systems, mobile phone positioning, computer-aided interviewing etc.).
- § Some collected transport data is never used or not used enough. Data from transport management systems for example is used to manage and control the current traffic situation and sometimes for providing special real-time information concerning the performance of the transport system to the user. But further synergies are often not used (e.g. research and planning uses, long-term monitoring). Reasons might be the high amount of data being generated and archived, the efforts for a good data management system or lacking interfaces between researchers and transport planners.
- § Problems with communication and provision of planning results and data to public due to insufficient integration of public into the planning process and lack of illustrative methods, need for guidelines and good practice.

A major conclusion of many reviewed documents within EURFORUM is the lack of comparable transport data between cities and towns on the European level, partially even on the national level (Extr@Web [8], SUTRA [129]). Reasons for this are:

- § Different conducting methods and thematic orientation of surveys.
- § Differences in terminology concerning transport data, esp. between different countries.
- § Missing standards for definitions, minimal data sets required, collection method, additional indicators possible and documentation to achieve comparable data on transport offers, performance, costs, effects and quality of transportation.

It is a major aspect to improve the sustainability of urban transport that cities will be able to compare their own performance with others [2]. The Final Report of the Working Group on Sustain-

[7] *National Research Project ,"Verkehr in schrumpfenden Städten", FOPS-Programme, www.ivas-dd.de*

able Urban Transport recommends that the EU should support the monitoring progress towards policy objectives by:

- building up links and co-ordinate with the OECD/ECMT's work on urban data collection and local/regional decision-making; and
- by using existing EU research on indicators to select a set of common indicators which can be supplemented by tailored indicators at the local or regional level if needed.

The Thematic Strategy on the Urban Environment [110] calls for an accessible database to monitor the effectiveness of the strategy. So far, monitoring, evaluation and benchmarking across European urban areas have been hindered by the limited availability of comparable data on the urban transport system's performance. The report on National Policy Frameworks for Urban Transport [9] for example states that lots of statistical data on urban transport indicators is available but at different levels, either national or regional, or at city or conurbation level. Comparing different levels with each other is difficult because of the lack of standardised indicators and different scopes of the analyses. In some countries, initiatives of government authorities and researchers led to sets of standardised indicators which could be the basis for future surveys. In Germany for example, a set of recommendations for major household surveys was developed to achieve a higher comparability and modularity of the surveys [10]. In France, local travel demand surveys can be specially subsidised when the local authorities apply recommendations regarding relevant indicators and when the surveying method is based on national guidelines.

Similar results have been obtained in the project ISOTOPE [11] which sees a lack of consistent data on urban transport operations at the European level, while the report on National Policy Frameworks for Urban Transport [9] also recommends the improvement of the transport data basis for benchmarking purposes of urban transport in Europe. The latter also found that there is no statistically representative data on the public perception of urban transport performance and policy. The project PILOT [12] recommends preparing sustainable urban transport plans which require a distinct specification of data needed for the planning process. But a clear guidance for standardised data collection is still missing: specifications on which indicators have to be used at minimum for a specific type of transport data collection, what methods should be applied and what standard definitions should be used. Additional indicators could be added on top of the basic data set depending on the particular survey purpose. Currently conducted research on national standards concerning the collection of data on mobility behaviour[8] will provide recommendations for compiling comparable information for EUROSTAT[9] and represents a first step towards a common standard on data collection. Also, a result of the past European attempts to make urban data available is the EUROSTAT initiative UrbanAudit[10]. This platform provides comparable data for 258 European cities on many topics like demography, environment, economics, travel and transport and others. Nevertheless, until now the available data on urban transport is very limited. The newest auditing phase started in 2006 and will be probably finished in the year 2007.

[8] *Development of passenger mobility statistics with the fundamental objective to further develop the Community statistics on passenger mobility, with particular emphasis on car passenger mobility; (http://ausschreibungen.dgmarket.com/eproc/eu-notice.do?noticeId=1158504)*

[9] *http://epp.eurostat.ec.europa.eu/*

[10] *www.urbanaudit.org*

As a consequence of the above stated lacking comparability of transport data, rare comparable databases specifically looking at urban transport issues like the new “Mobility in Cities” database prepared by UITP [13] need extensive research on the sources of the data from each city, conduction methodology and samples (type, size, sampling procedure etc.) for the data collection and so on. It consumes much time and work resources and is therefore an expensive product, which cannot be easily updated automatically.

Relevant to consider are also the related stakeholders in the usual process of urban transport data collection. Urban transport planning is a task of local and regional planning authorities, transport operators, consulting institutions and various statistical units, as well. Therefore the data collection for planning needs is also within the responsibilities of these actors. Nevertheless, the member countries themselves do see problematic aspects with the further standardisation of urban transport data within the EU. Some countries do not have the means to implement standardised and regular data collection methods while others already have national standards and refuse to accept possible interruptions in time series etc. Therefore, coordination and standardisation of data bases are critical issues, especially when it comes to urban areas.

As shown before, through the EUROSTAT’s initiatives, the European Union is working towards a greater availability of more uniform and comparable urban transport data, regular collection and evaluation. Besides that, the EU is recommended to support the dissemination of knowledge on newest research developments and help reducing barriers for better monitoring based on data collection at the local level by the dissemination of good practice and funding of pilot projects etc.

4.2.2.1 First Identified Open Issues

Needs concerning implementation and reduction of barriers for implementation:

- Improve comparability of urban transport data across European cities for benchmarking purposes regarding data collection and data provision (e.g. recommendations about standardisation for travel demand surveys, especially regarding definitions, collecting methods, minimal set of data required, and others) The application of a standard survey design on cities and towns all over Europe as a EU pilot project would be helpful.
- Promotion of regular data collection and updating of urban land use/transport plans every five years as a precondition to receive EU or national state funding for the implementation of urban transport measures.
- Better data collection about rather less observed transport modes like walking and cycling.
- Establishment of communication and coordination between all relevant actors who collect and/or need urban transport data.
- Extension and improvement of the use of data, generated and collected by traffic management systems.
- Provision of systematic and improved monitoring strategies supporting the evaluation process of transport planning and managing strategies and measures.

Needs concerning further research:

- Develop a common terminology and standards concerning urban transport data collection.
- Explore ways for data integration of data from different sources and based on different analysis methods from European countries/urban areas à data fusion, synthetic matching etc.
- Ways to improve quality and completeness of socio-economic, demographic and urban transport data collection.
- Better use of computer-assisted data collection tools (CADAC) including satellite navigation Systems (GPS, GALILEO), mobile communication systems (like mobile phones, PDA's etc.), electronic ticketing systems, image processing, floating car data etc., but also computer-aided interviewing methods (CAI). Automatically collected spatial and temporal movement data (without direct involvement of the respondents) for example decreases the chance of error, is highly accurate, can be sent and processed within a short time. Furthermore it can partly reduce the costs of data collection if generally available hard- and software can be used without the need of specialised tools.
- Reach higher reliability of online traffic data and its sources and improvement of online traffic state estimation (see also modelling in section 4.3).
- Development of inter-faces for user to easily modify, analyse and evaluate transport related data (GIS-tools, online databases).

4.3 Urban Transport Demand Analysis and Modelling (A2)

4.3.1 Description of Topic

This topic deals with the analysis of system coherences, determinants and their effects in respect to transport demand with a special focus on urban areas. This analysis is based on collected data on urban transport system performance and mobility behaviour of system users or potential users (dealt with in A1). Based on the analysis' results transport models can be developed which represent mathematical reproductions of the transport system and its determinants. They can be used to explain the functionality of the system (and further research it), to forecast developments of the system under certain defined assumptions for the future and to demonstrate effects of measures and policies. In such a way, future structural changes of land use like new traffic inducing facilities, but also infrastructural changes of the transport system like the building of a new light rail line etc. can be examined in regard to their impacts on the transport operations. These results are used to develop a better system understanding but also to evaluate measures as the basis for political decisions. Modelling results of such measures are also often required when courts examine political decisions in legal trials in terms of completeness of the arguments balancing public and private advantages/disadvantages in transport planning.

4.3.2 Status

Urban Transport Demand Analysis and Modelling should be looked at from two different directions: from the perspective of research and development and from the perspective of practical use and implementation of approved knowledge and models.

Urban transport demand analysis refers mainly to basic research of determinants of traffic and mobility needs, their effects and feedbacks. The mathematical modelling of the transport system and of related interactions is based on this knowledge. These analyses are mainly tasks of the national and international research community and some specialised research related consulters. Following the gathering of such basic knowledge and the development of mathematical algorithms for transport models, these models are practically applied by the responsible planning agencies. In regard to urban transport demand these are local and regional planning authorities, but also public transport operators and often contracted researchers or consulting businesses.

Research on System Analysis and Models

The most important topics of research in this field are:

- Determinants of the travel behaviour of individuals or businesses concerning transport of passengers and goods. Models in this area try to reproduce travel behaviour (what, when, where, which transport mode on which route) mostly focused on passenger travel.
- Analysis of the movement behaviour (driving, walking etc.) of single vehicles or people within the existing transport network.

The major goal when practically applying these theories and models is the analysis and forecasting of impacts of measures, policies and determining developments on transport operation, safety, environment and to draw conclusions concerning changes in transport operation and facility design.

Especially in the later years, influencing the travel behaviour through mobility management measures for example led to further research questions concerning relations of travel behaviour and travel information and management, road pricing, policy sensitive behavioural modelling etc. While a lot of knowledge concerning these aspects has already been gathered and practical applications for planning and policy were developed, some uncertainty concerning human aspects are still remaining (see section 4.12, page 60).

There is still research need on how to embody the extremely complex human behaviour in the models' parameters. Traditionally applied model approaches are based on the modelling of single trips or trip chains as theoretical frame for modelling the travel behaviour based on the definition of mostly homogenous sociological groups of the population. They usually consist of 4 stages (generation, distribution, mode choice and assignment) and are considered the main-stream transport research modelling tools. Later developments achieve the simultaneous modelling of generation, distribution and mode choice or simultaneous route and mode choice models [14], [15].

Of special interest are also dynamic traffic assignment and simulation approaches which include route choice models and traffic flow models. They enable the evaluation of the resulting traffic in the network depending on the observed temporal period. The further improvement of these type of models in terms of the comprehensive combination of macroscopic and microscopic approaches, the most detailed modelling of the real situation and possible feedbacks, the integration of and realistic modelling of passenger and goods transports etc. is one major goal of re-

search and development in this area. Also, the further development of software and user interfaces will be in focus.

Due to rather instable data with respect to freight traffic, basic research could not explain variances and has not succeeded in developing similarly sufficient models, yet, as are available for passenger travel on the macro level.

In addition to many improvements of traditional models, other modelling approaches are currently being researched as well. A reason is that trip-based model approaches have limits modelling the complex human behaviour or accurately model impacts of mobility management on transport demand [16]. Mobility management measures for example influence the individual's time and journey planning which can not be adequately modelled with traditional travel behaviour models. Therefore, activity-based person travel models are of specific research interest, since they theoretically enable one to explain interrelations between activities, land use structure, transport infrastructure and transport demand and to forecast behavioural responses to policy-measures. Practically, these microscopic model approaches are accompanied with a high complexity and are very data intensive. Furthermore, they rely on knowledge concerning patterns of individual's time and journey planning behaviour which is not available to the needed extent, yet. Therefore, research within this area seems to be of importance which aims at the complementation of widely used transport models with improved and practically applicable activity-based passenger travel models.

This also contributes to the integration of emission models with activity-based transport models and to the further integration of land use and transport planning in integrated models. Integrated land use and transport models are currently not of such high quality and are limited in terms of their capability to cover all possible policy interventions [17]. Therefore, there is a need to improve integrated land-use/transport models which relies heavily on other improvements like a better understanding of the underlying behavioural reasons, the development of new activity-based modelling techniques and microsimulation, the improvement of spatial resolution and wider consideration of social impacts [17]. Nevertheless, this is under consideration of the limits of models as generalised decision-support tools.

Practical use of knowledge and models

This takes place at the practitioner level in urban areas or at regional planning authorities. The very different approaches and perspectives of researchers and practitioners complicate the interrelations sometimes, not only with respect to urban transport demand analysis and modelling.

For example, the complexity of transport models is steadily increasing due to the integration of more aspects to model like land use or environmental effects of transport. One of the limits for the practical implementation of such models is the availability of accurate and comparable databases for model construction, calibration and validation. This especially accounts for attempts to use integrated land use and transport models [18]. TransPlus [17] stated that many cities do not apply integrated land use/ transport models due to the models' complexity, possible inaccuracies and other reasons. This kind of modelling requires more than ever a comprehensive data manage-

ment system and the integration of different data sources with different data levels from various institutions. It also needs well-educated and trained users with local knowledge. This is, in addition to the cost-extensive surveys, a cost factor and sometimes makes transport modelling too expensive esp. for smaller municipalities. Therefore, integrated, adjusted models for a whole region or cooperating administrations, including all modes, passenger and commercial traffic and other aspects, seem to be more cost-effective. But this requires a highly flexible system architecture, maximum synergies with available data sources like digital maps, multi-user systems for decentralised and parallel editing of local data, comparable input data, efficient, powerful and well-documented applications and regular updates of transport related digital data. Finally, it also has to be considered that all models will always be a generalisation of the real world and human behaviour. This limits their influence while decisions have to be based upon the well-adjusted analysis of skilled planners and are heavily relying on public acceptance. Therefore, models are very helpful decision-support tools which need to be improved but their significance should not be overestimated.

Modelling impacts of traffic on the environment (e.g. noise and air pollutants) is also an aspect of urban transport demand analysis and modelling. There are several applications in terms of software products available [19] which vary from high-end-planning tools to sketch-planning tools. There have also been attempts of several EU-funded projects to assess the environmental impact of road traffic [20], [21].

Considering the applicants of existing system knowledge and model approaches, there are further reasons why the implementation of up-to-date skills might be hindered:

- The availability of skilled staff in cities and the staff's unfamiliarity with new approaches or models is a major barrier to better use existing knowledge [18].
- Lacking dissemination and communication of research achievements towards the practitioners, limited time of the staff and scarce financial funds of the cities complicate further acquirement of skills.
- Sometimes research concerning the theoretical approaches does not address the real needs of practical planning and policy making.
- Software or user interfaces are not very handy and/or they are expensive.
- Lacking support by the political leaders towards integrated planning and the relevant urban transport demand analysis and forecasting. Under such conditions models are often not part of a continuous planning process, but are only applied for sectoral planning or evaluations of specific purposes. Often models are not re-run or updated regularly [17]. This often also refers to missing data for input or calibration of the models.
- Different actors might give different meaning to the same data and modelling results, depending on their different concerns.
- The communication of decisions based on modelling results is not done adequately or too complex for decision makers.

Especially the guiding in terms of reduction of barriers to implement models in the integrated and continuous transport planning process seems to be a topic for further support by the EU, as well as the spurring of integration of land use and transport planning (see 4.4, page 23)

4.3.3 First Identified Open Issues

Need for further research

- Improvement of existing model approaches concerning the better consideration of human behaviour and more comprehensive modelling of impacts of policy interventions with respect to land use and transport.
- Development of more comprehensive modelling through the combination of macroscopic and microscopic modelling approaches and enabling better modelling of the impact of 'soft' measures like mobility management etc.
- Provision of modelling approaches to better reproduce and forecast freight transport.
- Development of standardised, electronic interfaces to exchange data on urban mobility between different authorities, software applications etc.

Need for Support concerning Implementation and Reduction of Barriers for Implementation

- Good practice on overcoming barriers for practical implementation of integrated land use and transport models like training of staff or policy improvements.
- Incentives to encourage integrated urban transport planning and monitoring.
- Financial aids of EU and national programmes to develop advanced monitoring and modelling in cities.

4.4 Sustainable Strategies – Integrated and Sustainable Planning (B1)

4.4.1 Description of Topic

Different land uses and spatial separation create the need for travel and to transport goods. The transport system determines the accessibility of places and land uses. Thus, planning and management of the urban system needs an integrated approach as suggested by figure 2 on page 24.

While this section will focus on the planning concerning an urban transport system, traffic and mobility management aspects will be discussed in the next section 4.5 on Sustainable Strategies – Transport System Management (B2), starting at page 29.

Planning issues talked about in this section refer to the integration of planning processes, esp. land use planning and transport planning. Besides this, focus will be on sustainable urban transport planning as such.

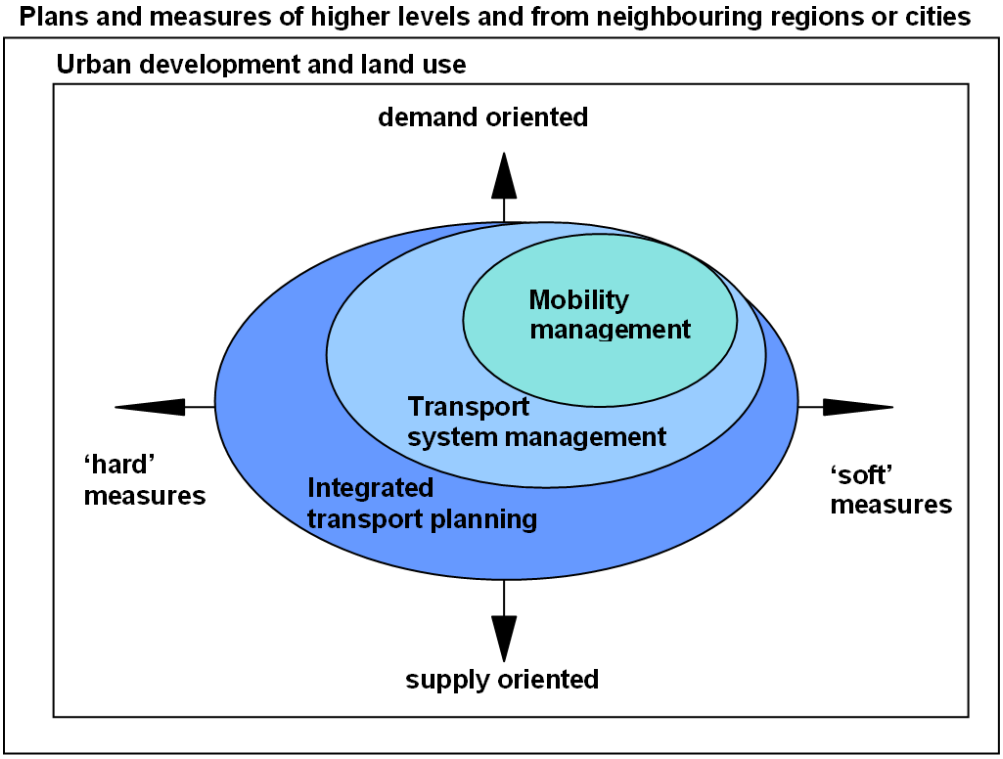

Figure 2: Levels of Integrated Planning Processes (Based on FGSV [22])

4.4.2 Status

Integration of Land Use and Transport Planning

In most EU cities we see that current trends of land consumption and growing transport are unsustainable and worsening accessibility due to congestion and longer distances. Urban sprawl is a reaction to qualities in inner cities, to reduced affordability of central locations and to increasing motorisation and road infrastructure between and around cities[11]. More information on the extent of urban sprawl and land use changes in general are provided by extensive land use databases like the Moland[12] project by the Joint Research Centre of the EU or the Corine Land Cover[13] database by the European Environment Agency. They are helping to monitor urban dynamics and are supporting a sustainable planning process. The Moland project is working towards a proposed common methodology of monitoring land use cover dynamics within the EU.

While these activities help to better recognise and understand the problems, the need for integrated land use and transport strategies in order to control further land cover is recognised as well. TRANSPLUS [17] states the main arguments in favour of such integrated strategies:

1. To reduce the need to travel while maintaining spatial integration and access to services and opportunities.
2. To reduce car depending and motorised individual transport.
3. To reduce the development of green-field-land.

[11] *Research on urban sprawl has been summarized in the report of the European Environment Agency [132].*
[12] *Monitoring Land Use / Cover Dynamics, http://moland.jrc.it/*
[13] *http://terrestrial.eionet.europa.eu/CLC2000*

4. To reduce disparities in the costs of living, travelling and providing public services without hampering the growth of urban and regional economics.
5. To reduce indirect costs which may hamper transactions in a number of city market places (e.g. by facilitating the accessibility to a wider range of employment options on local labour market; by improving accessibility to local retail services for a wider range of consumers; by promoting new transport markets etc.).

There has been an extensive research on the European level concerning developments and planning aspects of land use and transport like TRANSPLUS [17], Ecocity [130], Scatter [131] and others. The LUTR cluster[14] links many of these projects.

TRANSPLUS [17] does also give recommendations on how integration of land use and transport planning should be achieved: "Integration is only realised when it is applied to politics, planning methodologies and organisation of processes or structures. Integration is a multidimensional task. Not only do different policies need to be integrated, but the supporting tools and the supporting organisational structures of town planning and transportation engineering also need to be integrated. Often the strongest integration is found at the policy level. Most cities in Europe try to initiate integrated policies like public transport oriented development. However, integration of the supporting models, monitoring indicators and institutional structures is much less developed." [17]

Major aspects of integration for holistic, cooperatively and consensus oriented strategic land use and transport planning are (based on [134]):

1. Sector integration:
The complex interrelations of different system sectors are reflected by the interdisciplinary cooperation of all relevant sectors when planning a specific sector (land-use development, economical development, environmental development, cultural development, schools and universities, sports, etc.). Goals and strategies of all sectors have to be examined and if possible adopted by the integrated and sustainable transport plan.

2. Vertical integration:
Integration and cooperation of different planning levels (e.g. European, national, regional or land use planning, regional planning levels etc.)

3. Horizontal integration:
Integration and cooperation with neighbouring cities and planning areas

4. Modal integration
Integration and cooperation of all transport modes and their operators (inter-modally and intra-modally)

[14] *www.lutr.net*

5. Integration of all trip purposes and needs for freight transport:
E.g. trips for leisure, shopping, work and the steps in the supply chain of goods

6. Integration of all possible measures
Combining the effects of

- Engineering
  - New or improved infrastructure
  - Vehicle technology
  - Telematics and its equipment
- Enforcement
  - Legal regulations
  - Restrictions
  - Traffic signs
  - Police measures
- Education/information
  - Mobility management
  - Public awareness campaigning
- Economy
  - Pricing
  - Taxation
- Other operational and management measures.

With holistic approaches and integrated concepts of measures, European cities with an advanced planning understanding try to achieve the necessary synergies for an effective and sustainable urban scheme of transport and land use.

7. Integration and participation of all involved actors
In order to achieve a broad political consensus for strategies and measures the early cooperation and consideration of inputs from all relevant parts of the urban society is more and more attempted in European cities.
Also the integration of the management and operating level of the urban transport system into the strategic planning level is relevant. The increasingly important measures and strategies of mobility management have to be in accordance and an integrated part of the land-use and transport master plan as it was indicated in Figure 2.

When integrated measures and strategies are seen with respect to hard measures (infrastructure, technologies) or soft measures (information, education, influences of travel behaviour and travel times) and with respect to demand and supply, the integrated land use and transportation master plan includes all these aspects. Transport system management, as it is discussed in section 4.5, page 29, is influencing the use of existing supply with less infrastructural measures. Transport system management complies traffic management or network management, as well as mobility management which tries to influence trips and individual choices of mode by information and education with little or no investments in terms of infrastructure or technologies.

However, models and solutions available (e.g. mono-centric or polycentric strategies, short distance structure development, more public transport, biking and walking oriented development, car restrictions, etc.) are not always implemented or not used in an effective way. This is due to lack of knowledge and resources in many cities, or that their results do not fit into the political framework. In this situation potentially important impacts are often overlooked or undervalued. TRANSPLUS [17] identified a number of barriers to the realisation of integrated land use and transport policies. A sample of them is:

- Inefficient and unstable taxation system
- Lack of financial resources
- Lack of stability and integration of the administrative structure
- Lack of coherence of the planning and implementation system
- Mono-functional settlements from the past planning tradition
- Inadequate national transport infrastructure
- Priority given to competitiveness and attraction of new commercial developments
- Uncontrolled privatisation
- Immature democratic institutions and citizens awareness
- Unclear land ownership regulation and ineffective land use control
- Opposition of specific stakeholders categories
- Car ownership

The apparent approaches to improve the situation are better coordination between land use and transport planning at the city level and a complete integration of all relevant aspects in a comprehensive more consensus oriented planning and decision making process. Many regions and cities recognized these growing demands for cooperation and integration and established informal integrated and sustainable urban transport plans (SUTP).

Sustainable Urban Transport Planning

The following information was summarised on the basis of European research on sustainable urban transport planning approaches like PILOT [12], SUTRA [129], PROSPECT [133], TRANSPLUS [17] and many others.

Sustainable Urban Transport Planning aims at achieving a sustainable urban transport system, by addressing at least the following objectives:

- Ensuring the accessibility offered by the transport system to all, in line with the objectives below.
- Reducing the negative impact of the transport system on the health, safety and security of the citizens, in particular the most vulnerable ones.
- Reducing air pollution and noise emissions, greenhouse gas emissions and energy consumption.
- Improving the efficiency and cost-effectiveness of the transportation of persons and goods, taking into account the external costs.

- Contributing to the enhancement of the attractiveness and quality of the urban environment and urban design.

The policies and measures defined through SUTP should comprehensively address all modes and forms of transport in the entire urban agglomeration: Public and private, passenger and freight, motorized and non-motorized, moving and parking.

Sustainable Urban Transport Planning (SUTP) is a way of tackling transport related problems in urban areas more efficiently. It builds on existing practices and regulatory frameworks in the Member States, its basic characteristics are:

- A participatory approach - involving citizens and stakeholders from the outset and throughout the process of decision making, implementation and evaluation, building local capacities for handling complex planning issues, and ensuring gender equity.
- A pledge for sustainability - balancing social equity, environmental quality and economic development.
- An integrated approach – of practices and policies between policy sectors (e.g. transport, land-use, environment, economic development, social inclusion, health, safety), between authority levels (e.g. district, municipality, agglomeration, region), and between neighbouring authorities (inter-municipal, inter-regional, trans-national, etc.).
- A focus on the achievement of measurable targets, derived from short term objectives, aligned with a vision for transport and embedded in an overall sustainable development strategy.
- A move towards cost internalisation - reviewing transport costs and benefits also across policy sectors, i.e. taking into account the wider societal costs and benefits.

A method comprising the following tasks: 1) status analysis and baseline scenario; 2) definition of a vision, objectives and targets; 3) selection of policies and measures; 4) assignment of responsibilities and resources; 5) monitoring and evaluation arrangements.
When the EURFORUM thematic structure was developed, integrated and cooperative methods and approaches were considered as a main feature of all research areas. However, some aspects of an integrated and sustainable strategy are of such an importance that they get exclusive coverage as a sub research area in the following sections (also see Figure 1, page 13).

4.4.3 First Identified Open Issues

- Detailed guideline on European level concerning the design/content of sustainable, integrated urban transport policies including recommended instruments.
- Integrated planning needs a cooperative and consensus oriented organisation of the planning process. There is still a need for guidelines and the dissemination of good practice regarding the methodology of sustainable, integrated urban transport strategies and land use planning, as well as their implementation. There is a need to define staged implementation processes to ease the transition towards better integrated planning and a need to create partnerships between less and more advanced cities.

- Identification of barriers for cities to put SUTP in practice or make the planning efficient, guidance on how to overcome these barriers, more research on the benefits of such plans and additional guidance to convince everyone of SUTP necessity [12].
- Complexity of decision-support tools (guidelines, best practice identification, assessment methods, planning methodologies or software tools) in land use and transport policies leads very often to decisions made without having a clear perception of what effects will be caused; therefore a harmonisation of decision support tools to be used for land use and transport planning is needed.
- Development of comprehensive policy sensitive models to evaluate the effects of the wide range of integrated measures.
- Systematic approaches should be developed to evaluate the wide range of measures on a comparative basis.

4.5 Sustainable Strategies – Transport System Management (B2)

4.5.1 Description of Topic

Transport System Management in EURFORUM refers to network management, including traffic management and to mobility management as parts of an integrated and sustainable urban transport strategy. These management aspects of transport use different integrated tools of engineering, enforcement, education/information and economy. They are aimed at increasing road safety, improving the network efficiency, encouraging inter-modality, and limiting the negative effects of transport on the environment.

This topic includes policy measures addressing the whole transport system, specific modes or sectors (parking, access to urban centres, etc.) as well as a wide range of effective measures of mobility management to influence travel behaviour. Technical solutions for the management of the transport network, part of the network or dedicated infrastructures (road, rail, bicycle path, etc.) and esp. new ITS-options of traffic control and guidance, pre-trip information are covered in section 4.9 (C2), page 42.

More managing aspects are related to strategies of transport demand management which also include transport pricing as a means of demand management (see section 4.14 on Transport Pricing E2, page 68).

4.5.2 Status

In the beginning, transport system management measures in European cities were focusing on car traffic (traffic control centres, guidance systems, parking control). However, more and more integrated approaches also including information on, coordination and organisation of existing transport offers as well as communication measures have been applied. Therefore, nowadays network management must be understood as the management of the whole transport network, including public transport, road traffic and the other modes of transport such as cycling and walking. While looking at future developments, it should correspond to an integrated network management strategy. A recently implemented system is the Traffic Centre of Berlin [58]. From such centres all traffic lights can be controlled 24 hours per day and, combined and coordinated with the telemetric

guidance and information systems. The public control centre in Berlin gets most of the relevant data from a privately run traffic management centre in the same building. Data from the modern sensor network is combined and processed with information from the police, transport operators and other sources. Information boards on roads, website and radio stations supply citizens with traffic information. Companies can receive transmissions of special services directly to their own distribution systems, to end-user appliances in vehicles and also via GPS to PDA's (see also section 4.9, page 42).

In European cities mobility management plays an increasing role in reducing car trips. Through information, education and advice in companies, schools, universities, hotels and other big traffic generators, intelligent timing of trips, car sharing, car pooling and increased use of public transport, bicycles and walking are encouraged[15]. With better networking of these approaches the so far positive effects could be further improved. The cost effectiveness of these measures is very good. However, it seems to be more difficult in cities to raise money for effective soft measures than for expensive (often questionable) hard measures. Therefore, comparable evaluation schemes (cost-benefit-analysis) of hard and soft measures would be helpful.

Related to transport system management are the sustainable strategies on land use and transport planning (see section 4.4, page 23), environmental aspects (see section 4.6, page 32), urban logistics (see section 4.7, page 37), , and transport pricing as a means of demand management (see section 4.14, page 68) also addressed in this report, including pricing and infrastructure charging strategies. This section does focus on the aspects of mobility management which are not dealt within other chapters of the report.

Facts concerning demand management and travel patterns:
Current best practices of demand management strategies include many new policy initiatives aiming at managing urban transport demand:

- Seamless mobility services known, such as urban lift sharing services, public bicycles, call a bus services (NICHES Project).
- Public transport services were optimised, supporting an increase of PT use.
- Low emissions zones were implemented.
- Transportation management associations (TMAs) founded [60].
- Local taxes or charges, ring-fenced for transport in use.
- Access restriction in use.
- Parking management is a very important tool.
- First automatic road traffic management systems have been tested.
- There has been research on advanced traffic and travel information systems for travellers (PT and road users).
- Research on individualised and geo-localised traffic and travel information for all citizens has been conducted e.g. [135].

[15] *See also the European Platform on Mobility Management at: www.epommweb.org*

- Research into high-quality PT for cities and urban regions that have populations between 100.000 and 500.000 people has produced a best practice guide on planning and designing a PT network (Extr@Web [8]).

Facts concerning network management:

- The whole transport and PT network management and organisation heavily depends on the level of integration, and the local organisational and institutional framework.
- Best practices of integrated and multimodal traveller information between PT operators and infrastructure managers are available in several cities.
- Integrated ticketing, between PT operators, parking operators and long distance rail transport operators, and more generally between all relevant actors can be found in many European cities.
- Harmonisation of concepts for the different grades of automation of urban rail guided transit systems; integrate the pedestrian scale in the city [75].
- New urban traffic management centres.
- First research in cooperative systems (communication between vehicles, and between vehicles and the infrastructure) was conducted.
- Guided public transport vehicles using dispatching control, possibly coupled with Bus Rapid Transit Systems.
- PT priority rules for traffic management, for trams and buses (BRT).
- Sustainable Urban Transport Planning is being developed and recommended as an integrated transport planning approach (see also section 4.4, page 23) [12].

4.5.3 First Identified Open Issues

The vision for future research in the field of transport demand management is to move away from the management of the movement of vehicles towards the management of movements of persons and influence travel demand.

Demand Management

- Development of comparable evaluation methods of hard and soft measures.
- Evaluation of the consequences of innovative demand management strategies and new mobility management policies on air pollution, noise and congestion.
- Marketing research on new mobility behaviour.
- Evaluation of the opportunity to develop variable charges depending on environmental zones, types of vehicles or congestion situation (see section 4.14, page 68).

Legal and technical framework

- Development of technical standards: ticketing, information integration, charging systems, satellite positioning applications.
- Interoperability of systems and policies.
- Protection of privacy (legal).

Traffic and Travel Information and Traffic Management

- Integrated route planning and guidance concepts (all modes).

- § Improvement of cycling and walking through improved information and management – similar to PT etc.
- § Introduce general speed management systems.
- § Traffic and travel information, information provision: increase the predictability of the journey time with comprehensive trip information before and during the journey.
- § Advanced traffic management models, including models to manage congestion/network overload, models to integrate the specificities of freight traffic on the network.
- § Research models from other industries for creating new advanced traffic management modelling tools.
- § Develop protocols and tools for more effective network management.
- § Improve data collection on congestion and the environmental situation, using for instance satellite positioning, RFID, cooperative systems, etc.
- § Develop decision support systems for processing data and generate traffic management responses.
- § Develop intelligent and dynamic network management systems (road, PT), reacting to a pre-determined set of variables such as pollution, congestion, weather, social events: develop protocols and tools for effective network management.
- § Develop integrated/interoperable interfaces between information systems to provide integrated information on the whole transport network and develop dynamic tools to use this information for dynamic/intelligent network management.
- § Develop cooperative systems for improved road safety and traffic management/ provide vehicle to vehicle and vehicle to infrastructure linkages that ensure optimum integration with other traffic and with traffic management systems (intelligent vehicles in intelligent infrastructure).
- § Multimodal interfaces to support the development of a holistic urban mobility system (cf ERTRAC SRA).

Technologies for new vehicles and services, and the human response to the dynamic signing

- § Research on the human-machine interface: what is the human reaction to a given amount of information. What is the impact on road safety if this information is given on-board a vehicle?
- § Automated vehicles and their integration in the public transport systems and the whole transport system.
- § New concepts for intelligent and flexible infrastructure and for vehicles that interact seamlessly across modes (ERTRAC SRA).

4.6 Sustainable Strategies – Environmental Aspects (B3)

4.6.1 Description of Topic

The conservation of a healthy environment and the reduction of traffic-related effects on the environment are highly relevant issues of urban mobility in order to ensure the long-term living conditions and well-being of people living in cities and congested urban areas. The most important topics under consideration are the reduction of:

- Emissions of airborne pollutants
- CO_2 and other emissions relevant to the climate
- Noise pollution
- Land consumption / sealing off land.

Given that the aforementioned factors result from human behaviour and other factors such as city and traffic planning, this is a complex topic that is related to a broad range of issues, e.g. land use and transport planning (see section 4.4, page 23), human aspects (see section 4.12, There are also direct links with the economics of urban transport, such as the estimation of the monetary value of environmental damages (see section 4.15, page 72) and the use of economic instruments as a regulatory tool (see section 4.14, page 68). The European Commission stated that the monetary value of environmental damages caused by traffic mount up to 1.1% of GDP [6].

Separate from the other aforementioned subtopics, this section treats traffic-related environmental factors, with a focus on technical and legal solutions. The major significance of individual behaviour and planning of problem-solving will also be considered.

4.6.2 Status

The continual growth of traffic is a major reason for growing environmental problems in high-density population areas. The rapid increase of individual traffic and resource-intensive consumer behaviour pose the greatest threats to urban environmental quality and thus human health. In addition to private households, the traffic sector is one of the largest energy end-users with a rising share of CO_2 emissions. Due to high shares of motorised traffic and growing travel distances, the percentages of airborne pollutants are increasing, not just of CO_2 emissions, but especially of NO_2 emissions and particulates. For example, CO2 emitted from traffic will probably be 40% higher in 2010 than it was in 1990 [20]. If increases in emissions by the transport sector cannot be compensated by reductions in other areas, the objective of the Kyoto Protocol [113], to reduce greenhouse gas and methane emissions will be endangered.

In addition to the output of airborne pollutants and emissions relevant to the climate, it is noise pollution that poses a particularly great problem in cities.

Numerous studies on the effects of noise pollution on human health indicate that noise levels in the open by day should not exceed the energy equivalent noise levels [(Leq) 65 dB(A)] at which serious noise damage can be determined. However, 65% of the European population is exposed to such noise levels in their environments [48].

Another environmental aspect is the influence of driving speeds on the environmental performance of traffic. Higher vehicle speeds contribute to increased greenhouse gas emissions, fuel consumption and noise. This effects and the need to manage driving speed for road safety and environmental reasons is given more attention in the 2006 release of the OECD/ECMT Transport Research Centre on “Speed Management” [115].

Land as an environmental medium is also affected by urban traffic. Inner-city green spaces are important to the urban micro-climate by absorbing atmospheric pollutants and by exchanging air-

mass, thus contributing significantly to the air quality of cities. Traffic volume leads to extension of road infrastructure and hands to land use and paving. Land use plays a significant role not only in city centres, but also at the outskirts and in suburbanization.

Emissions of Airborne Pollutants

Many airborne pollutants stemming from traffic—e.g. hydrocarbons and carbon monoxide— are highly reduced today thanks to the increased use and technical improvement of catalytic converters and filter technologies. As well the European Commission has been most active in the area of air quality in recent years[16]. The EU emissions standards for vehicles are a tool used to prescribe defined thresholds for carbon monoxide, nitrogen oxides and hydrocarbons, as well as particulate emissions for new vehicles. The challenge is to fulfil the more stringent emission standards in future. Even though the emissions standards for vehicles are met, the EU standard on air pollution is in many places not fulfilled [6].

Nitrogen oxide, stemming in particular from the increased use of diesel-driven vehicles, is far more problematic. Although it is evident that nitrogen oxides (NO_X) have decreased overall, emissions of nitrogen dioxides (NO_2)—a far greater threat to human health—have remained constant and even increased. As a result, the prescribed emissions thresholds are being exceeded in many locations [49].

In addition to nitrogen oxides, particulates are a problem for the urban environment. The EU thresholds are often being exceeded, particularly on main roads and especially in the summer. The current filter technology can minimize this problem. Current developments and discussions are leading to the introduction of filter technology to series production, or even to meet emissions standards without relying on filters through the further development of engines. Various projects such as CIVITAS are important local approaches. However, the effects of these regional projects are limited. While they help to absorb peak emissions, particulates largely originate outside congested urban areas (especially in industrial production, but also in traffic) so that other measures are required for these sources.

CO_2 and other Emissions relevant to the Climate

The forecast growth of traffic levels is leading to increased use of fossil energies and thus an increase in CO_2 and other emissions relevant to the climate. The more efficient design of standard combustion processes has not yet been able to reduce climate-relevant emissions to sustainable levels [6, 118]. Encouraging alternative propulsion technology and renewable energies will thus play a significant role. In its White Papers on Transport [3], the EU is explicitly demanding the advancement of biodiesel and natural gas and, in the long term, propulsion through hydrogen and fuel cells. Hydrogen-driven vehicles are to be used especially in local public transportation and in public fleets.

1 [16] Homepage of the European Commission: http://ec.europa.eu/environment/air/facts_en.htm

With the EU “Directive on the promotion of the use of biofuels or other renewable fuels for transport” [50], target values for minimum shares of biofuels have already been set for the fuel market. This is designed to support the European-wide introduction of biofuels, achieving a reduction of traffic related CO_2 emissions.
There are many projects across the EU that are working to understand the relationship between traffic and ecology and searching for solutions to reduce emissions relevant to the climate. They are focusing on the use of renewable energy and alternative power technology as efficient methods for the reduction of emissions of airborne pollutants.

For example, the CIVITAS projects can be cited as one of the trend setting initiatives. These projects resulted in the EU-wide introduction of clean municipal fleets. The target groups were fleets used by municipal governments, local public transports and taxi companies. For example, more than 40% of the public motorized fleet in Stockholm was replaced by such vehicles, and a network of fueling stations offering biogas and ethanol was created. Cheaper parking fees for clean vehicles are designed to draw more private users to these vehicles [7].

Noise Pollution
Traffic is currently associated with noise pollution, about which the population is increasingly distressed and intolerant. Given its high density, road traffic is the greatest source of noise pollution in urban regions. However, rail lines and flight corridors are also major sources of noise pollution. The greatest noise pollution is located along main roads, from which the noise travels throughout entire urban quarters, especially the densely populated city centres. Noise reduction measures are very limited in urban centres, given that high traffic volume must be handled and given that urban structures (roads, building development, etc.) are not very flexible.

Solutions coming from research on noise pollution are difficult and have yet to be developed. Although great technical advancements have been made in recent decades concerning the development of vehicles and infrastructure (e.g. quieter vehicle propulsion technologies, quieter road surfaces such as “quiet concrete pavements”) that have led to a significant reduction of noise emissions, in view of the growing traffic this is insufficient to reduce specific noise emissions (see [51]).

In addition to national research associations such as the German “quiet traffic” research alliance, there are numerous European networks and projects such as CALM II [52], X-NOISE [53], EURALNOISE [54], SILENCE [55], all of which are seeking to reduce various traffic-induced noises and thus reduce human stress (sleep loss, stress, lower quality of life and productivity). For example, in select cities the SILENCE project is identifying barriers preventing local policies from successfully reducing noise emissions. The primary findings indicate that municipalities do not dispose of the required instrumentation for adequately measuring and modelling noise, nor do they have the tools to meet the prescribed emissions levels.

While many of these programs mainly focus on advanced technical solutions, since 2002 there is an EU directive to combat environmental noise [56]. The directive seeks to hinder, prevent and minimize environmental noise by mapping noise levels on and developing and implementing ac-

tion plans. These will become mandatory, from 2007 and 2012, for all high-traffic and high-density areas with a population of 250,000 and 100,000, respectively. These action plans propose how noise pollution problems and their effects can be prevented or minimized in the relevant cities and high-density areas. This attempted political solution is mandatory for all EU Member States, i.e., these states are responsible for implementing this plan on a national level (see [57]).

Land Use / Land Consumption

Surfaces for connections and to access areas for moving and parked traffic are very demanding on urban space. A study on Vienna has estimated that a single car driver requires 60m^2 of paved surface, whereas a pedestrian requires only 1m^2 [114]. Therefore, the increase of motorized individual traffic within cities is especially problematic.

Inner-city green spaces and protected natural landscapes in cities, especially relevant for city climates and for recreation, are shrinking due to new traffic routes and construction sites. The barricading effects of main traffic corridors are very negative on a city's habitat.

Sealing off surfaces destroys natural habitats and thus biological diversity. Additionally sealed land for traffic is primarily a factor in outskirts and in suburbs. Strategies for reducing traffic space focus especially on networking existing traffic surfaces and expanding them, rather than on building new roads. Land consumption and use by urban traffic is therefore highly relevant to the environment. Given that a sustainable use of land is the most important tool for planning land use, solutions are treated under "land use and transport planning" (section 4.4, page 23).

For all problems discussed herein, improvements through technical advances can be achieved to a certain degree. However, thorough behavioural changes are necessary to reduce the traffic sector's impact on the environment. Environmental problems in cities can ultimately only be solved with a combination of technical solutions and measures leading to behavioural changes initiated by policy instruments.

4.6.3 First Identified Open Issues

Environmental aspects are closely linked to other subtopics. Therefore the following open questions and requirements are very tightly focused and are mainly related to technical aspects. The following open questions and requirements can be found in projects:

Emissions of Airborne Pollutants and CO_2 and other Emissions relevant to the Climate

- Research about cleaner vehicles, alternative energies, efficiency increase in vehicle technology (develop lighter material, optimise brake application, use of recyclable materials etc.) especially for public transport vehicles [28].
- Develop and promote renewable transport fuels.
- Develop new funding rules for environmental-friendly applications [59].

Noise Pollution

- Find technical developments to reduce the noise levels of public transport [28].
- Improve quality of low-noise road surfaces for different weather conditions, maintenance and match historical and cultural preoccupations in relation to street design with noise impacts [55].
- Reduce noise at the source: cars should be more targeted towards lower speed levels. There is need for broader deployment of experimental noise reduction solution for rail [55].
- Research about health, psychological and physical effects of noise on citizens [55].
- Need for integrated impact assessment of measures, e.g. influence of air quality measures on noise and vice versa [55].
- Need for improved modelling tools to simulate the impact of noise abatement measures [55].
- Need for cost benefit analyses tool in terms of noise abatement measures [55].
- Develop traffic management specifically targeted at reducing noise [55].

Land Consumption / Sealing off Land

- Develop and promote guidelines for integrated environmental policy by establishing integrated city and traffic planning, sustainable urban local traffic and long-term financing perspectives in the sectors infrastructure, vehicles, incentives to promote public transport, safety for bicyclists and pedestrians and land consumption [4].
- Reduce urban sprawl [4].
- Improve quality of life in urban areas, e.g. by using speed management strategies [4].
- Strengthen the public transport to shift the modal split by developing a strategic marketing approach, by developing sustainable financing models [69], by integrating Galileo and GPS in public transport, trip planning and freight distribution [119].

4.7 Sustainable Strategies – Freight Transport (B4)

4.7.1 Description of Topic

While much research in the past was carried out to optimise passenger transport in urban areas, many questions concerning urban freight transport remain still unsolved. Therefore this topic deals with the integration of urban freight transport strategies in the transport and land use planning, aspects of inter-modality and logistics, reducing negative impacts of freight transport on the cities' inhabitants and attractiveness while sustaining and improving the accessibility and economic vitality of businesses and cities. Due to the special needs and aspects of the urban freight market, this topic also deals with information needs and provision of data.

4.7.2 Status

The last decade a lot of research was carried out on innovative approaches in city logistics and city freight [60]. Several studies aimed at developing and demonstrating new concepts for goods distribution within the city [61, 117], which were tested in pilot projects. All this research has delivered knowledge about the costs, benefits and feasibility of these concepts. Other studies showed the potential of optimisation of goods distribution.

A next step is to compare these concepts and try to come to a standardisation. This is the case in the inter-modal transport market for freight in the city[17].

Linkages

A broader view on city logistics and city freight has less been subject of research. Not often the linkages between freight transport and other urban transport have been investigated. Urban transport policy in cities all around the world mostly focuses on passenger cars and public transport [62].

Nevertheless, freight transport plays an important role in urban transport. According to the PORTAL report on inner urban freight transport, freight transport with lorries over 3,5 tons is responsible for about 10 % of all urban transport. If vans and cars are added, the share would be much higher [64]. BESTUFS [116] states that urban freight traffic accounts for up to 25 % of the total traffic in France.

Therefore, transport of freight should have an important contribution in urban transport planning, both environmentally and economically [62]. Freight traffic is necessary for the delivery of goods and services. It makes cities dynamic and versatile, and creates jobs. On the other hand freight traffic is responsible for severe damage in the city's living environment, emissions, noise hindrance and it decreases traffic safety [63].

During the last decade environmental initiatives, including combined passenger-freight transport and environmentally-friendly vehicles have been set up. Cleaner vehicles for waste collection & road sweeping, electric vehicles for the distribution of goods as well as environmental zones with restrictions for heavy duty vehicles, inner-city logistics centres and container track systems have been introduced. Innovative approaches in city logistics such as space management for urban delivery, inner-city night delivery and home delivery using locker boxes have also been investigated [61, 71, 60].

As regulations for goods delivery in cities are supposed to increase liveability there, they are on the other hand, restrictions to the city's economy. They have to be applied carefully and within a sustainable urban transport policy. Even though such a policy cannot deal with one of the different urban transport forms exclusively, cities and towns often use isolated strategies. Therefore, integrated strategies for passenger & freight transport, in relation to all transport modes have to be further promoted and supported .

Regarding Data for Urban Freight Strategies

The data-problem is still one of the major problems in the freight sector. Too little data is available about goods transport. There is a lack of reliable, frequently updated flow data. Flow data by the origin – destination relation appears as a very important need for urban transport planning.

[17] *Standardised small containers can optimise transport here. After that, the question is how these concepts can be introduced on a large scale.*

The needs for data vary between the different actors within the transport chain. Today the main actors within the transport chain collect only data, which is useful for their immediate operational purpose. Data for long-term strategies are seldom collected.

The collection of data has become a “puzzle”. The need for data is very high, but willingness to pay is low. There are different reasons for the limited availability of data [64]:

- The information needs are heterogeneous (requiring different kinds of data).
- The used definitions and units are inconsistent.
- Variances of data are so large that modelling is not possible in a valid way.
- Last but not least companies consider their data as confidential and are not willing to share this with other parties as they are afraid of losing their competitiveness.

Several solutions are proposed concerning the data-problem: An official authority has to guarantee an official framework for confidentiality, data collection through a mediator which can aggregate the data, and an independent organisation can be used for harmonising the collected data “ex ante” [64].

Standardisation of data is necessary at a European level. At this moment there is limited comparability of the data due to different and not consistent definitions [9].

Accessibility of data in Europe varies depending on the indicator - input data are mostly accessible (population, city size, car ownership, fuel costs, car prices etc.), intermediate input data and output data/mobility indicators partially are limited and not easily available [9].

4.7.3 First Identified Open Issues

- Better integration of freight transport in integrated transport strategies in urban areas and an improved methodological basis.
- Standardisation of innovative concepts for the distribution of goods in urban areas.
- Large scale implementation of new distribution concepts.
- Urban freight transport planning, cost effective innovative vehicle technology for city distribution, facilitation of cooperative distribution implementation, cost effective urban intermodal transport, cost effective ICT applications for distribution network optimisation, competitive alternative fuels, effective combined passenger and freight transport concepts [61].
- Optimising urban logistics supported by network management [65].
- High level of reliable security and of adequate tracking and tracing [65].
- Market mechanisms and role of free entrepreneurship in urban freight distribution [64].
- Cost effective innovative vehicle technology for city distribution [61].
- Effective combined passenger and freight transport concepts [61].
- Monitoring transport of dangerous goods (GPS and GALILEO) [81].
- Increasing road safety of freight vehicles.

4.8 Urban Transport Supply Side – Integrated and Harmonised Services (C1)

4.8.1 Description of Topic

This subtopic deals with all services that enhance the dynamic interaction between users and the physical transport supply (vehicle operation and infrastructure). Main fields are: traveller information, electronic ticketing and marketing strategies. Such services enable better tailoring of the supply to specific user groups and support a more rational and efficient use of different forms of public and private urban transport. Services integrate different forms of urban transport, and can be operated independently from transport operators or modes. Real-time availability of operational management data forms the basis of those services.

4.8.2 Status

Traveller Information

The importance of real-time, personalised and integrated traveller information is unquestioned. We are facing rapid developments in the field of IT-based traveller information provision. Pre-trip door-to-door planning tools on internet are already widely used, both for car and public transport, and are increasingly based on data concerning the real-time traffic situation. On-trip navigation systems are becoming a more or less standard tool for car drivers. Public transport users increasingly take advantage of real-time information displays on platforms, stops and inside vehicles. [66]

Research has assessed travel behaviour, user acceptance and implementation for the combination of internet-based public transport trip planners with different transport services including car sharing and taxi information, parking information and guidance, electronic booking of car sharing, electronic ticketing of public transport and road pricing [61].

But there is little knowledge on the influence of different forms of travel information on travel behaviour. Some research reports a reduction of 10% of car use after introducing an integrated public transport trip planner [61].

It is important to look at a trip as a chain of small trips. Several modalities can be used in this chain. Therefore attention must be paid – in addition to specific public transport services - to services for pedestrians, bicyclists and car users (who use the car during a part of the trip). This is necessary to make urban transport more inter-modally useable.

For the future, some new developments are seen:

- Ongoing personalisation of information services: systems that are able to “know” the traveller, his habits and his information needs; this is especially a challenge for the public transport user, as it requires personalised services and location measuring independent from the vehicle he might be in. There is very little experience with this type of services [67].
- More integration of public transport and car information, both pre-trip (both planners in one environment) and on-trip (e.g. P&R information).
- Integration of travel information with ticketing and marketing (see below).

- Integrating real-time operational data from different sources, and using it for different purposes. (This requires harmonisation of data models and clear definition of interfaces and responsibilities of the different actors in the field).
- Information services directed at a chain of movements with several transport modalities. Real time traveller information about possible disruptions and changes are of major importance.
- The transfer from one transport mode to another should be pleasant, safe and quick. Attention must be paid to this topic as well.

Electronic Ticketing

In public transport, various projects and implementations in several countries with different electronic ticketing and fare management options can be seen: contactless smart cards, paper tickets with electronic chips, check-in-check-out systems, long-range technology, etc. [66] Electronic ticketing by mobile phone provides a modern image, but is limited to certain user groups [68] (also see section 4.11 on Accessibility, Rights, Equality (D2), page 56). Sometimes combination with other services like parking payment or museum entrance can be seen [66]. Integration with information systems and operational data management systems is still underdeveloped. Here is a strong link with the economics of urban transport. Electronic ticketing offers unprecedented opportunities for price differentiation as a tool for traffic management. The connection between technical possibilities, consumer wishes and marketing strategies should be optimally utilised.

Marketing Strategies

The use of general marketing strategies is still relatively new in the public transport sector [69]. It requires a shift from supply-oriented to customer-oriented management. Personalised information and ticketing services can be a powerful marketing tool. In this regard, ITS can be a catalyst for innovation in the public transport sector [67].

General Conclusion

Up to now, this field is dominated by the rapid growth of technological opportunities. Sometimes research is being outdated by actual developments. However, when technological solutions start to reach maturity, we start to find out that we know too little about how systems are really used and how they influence both user behaviour and organisation of the transport sector. We can see that developments that take place separately, will integrate more and more into one field of personalised services integrating travel information, electronic ticketing and marketing, aiming at the same user groups, making use of the same basic data, and forming one integrated business case.

4.8.3 First Identified Open Issues

- Integration of ITS in existing offers for mobility-impaired people [66].
- Fleet and personal operation-flexible dynamic adaptation. Dynamic business and pricing models [77].
- Business models for TTI (traffic and Traveller Information services in Europe), multiplication of media/device for TTI, adaptive traffic systems, use of floating car data, use of floating car date, also coupled with road pricing infrastructure, intelligent vehicles and infra-

structure, cooperative systems, urban and interurban TTI interfaces, integration of PT and urban road traffic information, dynamic routing/ integrated road traffic information in the journey planner, information for mobile phone users [95].

- § Further extension of ITS applications for PT and inter-modality.
- § Integrated traveller information systems for PT and car use.
- § Better knowledge on how information through traveller information system are really used by user and how it is influencing the users behaviour (see section 4.12, page 60).

4.9 Urban Transport Supply Side – Integrated and Harmonised Systems (C2)

4.9.1 Description of Topic

In addition to topic C1, integrated and harmonised systems of the urban transport supply side deal with the operational and infrastructural aspects of integrated mobility services. Included are aspects of the design of vehicles and other infrastructure for harmonised services, construction and maintenance of such infrastructure, infrastructural aspects of the integration of different transport sub-systems and technological solutions for inter-operable and integrated pricing methods.

4.9.2 Status

Public Transport

Several research projects and operational tests have been conducted during the last few years in the field of public transport concerning the vehicles as much as the infrastructures and operating systems. Several studies have also been executed on ways to improve PT image, on other transport modes for specific target groups and demand driven transport modes.

Progress has been made in designing low emission and low noise buses meeting European environmental criteria (EURO 4). The deployment of large CNG bus fleets has also been assessed through the CIVITAS initiative. It has also been demonstrated that the complete value chain of biogas from its production from organic waste to its use to fuel public transport buses is technically feasible and economically viable. Electric bus technology has also been evaluated [70, 71, 72, 73].

The efficiency of dedicated lanes for buses as well as bus priority at junctions has been asserted. Technical solutions have been studied for rail-based and bus-based options, priority for street public transport, different types of rail-based operations to share the same track, and design of busways so that they can later be converted to tramways. An examination of urban design factors (overhead wiring, rails, signs, stations, stops, guideways, safety barriers, as well as the vehicles themselves), has also been conducted and recommendations given [74]

Bus fleet operating systems have evolved, using GPS localisation technology. Main functions are still monitoring, with provision of real-time data information to passengers; very limited interaction with fare collection systems[18]. For urban guided transports functional requirements specifications

[18] *In terms of using satellite navigation services for electronic, use-sensitive fare management etc.*

have been defined and harmonisation of concepts for the different grades of automation have been agreed between the rail manufacturers and operators on many specifications. It has also been shown that ITS potentially provides a wide range of new opportunities for mobility impaired people [66, 75]

Finally research into automation in road transport has provided a comprehensive review of the status and of the expected developments, from both technical and non-technical perspective of the innovations:
Advanced Driver Assistance Systems (ADAS) (already marketed) which provide cleaner, safe and more efficient operation of vehicles (cars, buses and freight vehicles) but ultimate control remains with the driver for the foreseeable future;
Personal Rapid Transit (PRT) (only test track stage) which uses fully automatic clean driverless vehicles which run exclusively on guideways to segregate them from other traffic and pedestrians;
Cybernetic Transport Systems (CTS) (only pilot demonstrations as shuttle service) which use fully automatic clean driverless vehicles which can run on guideways as well as on streets mixed with pedestrians and possibly other traffic at low speed. [61]

Motorised Road Transport
Research in this domain has focused much on the environmental issue: the objective being to use less cars (car-sharing, carpooling) and cleaner cars, especially for urban trips. Research has also been conducted on traffic management tools and access restrictions.

The MOSES [76] research report provides an overview on the current situation of car-sharing in Europe. It focuses on what has been achieved up till now in terms of operations, technology, marketing, political and inter-modal framework. Some of the topics addressed are open ends for car sharing, instant access to vehicles, one way rides and better management of vehicle fleet. Car-sharing and car pooling schemes have also been set up and assessed through the CIVITAS initiative [70, 71, 76].

Clean public and private fleets of vehicles using CNG or biofuels have been spread out and tested. Barriers for the procurement of clean vehicles have also been addressed. It appears that local authorities are key players for promoting clean vehicles. They can start the market development by making municipal fleets and city bus fleets clean. Private fleets such as taxis can follow, and a broader public can be addressed once there are sufficient fuelling stations, car models, incentives, etc. [70, 71, 72, 60] Nevertheless, the question remains, whether this is the most cost effective way to proceed. Extensive replacements of existing PT fleets will increase the cost of PT compared to private cars, and, depending on the financing scheme, this can be detrimental to the modal share of PT (and thus to the environment).

Assessment of traffic management systems shows that they contribute to existing infrastructure being used more efficiently. A traffic management system is a good tool for reaching goals regarding congestion, emissions and traffic volume. For example, well-tuned traffic signals are very efficient for reducing congestion. [72]

Access restrictions can lead to less traffic, improved mobility and less noise, which means higher quality of life with a more accessible and attractive city centre. It is important to gain approval for car-free zones and strolling zones, both by politicians and citizens. [72]

Non Motorised Transport or Soft Modes

Soft modes (mainly cycling and walking) are at the core of sustainable urban mobility. Safety, convenience and comfort at a lesser degree are key issues. Within the urban planning sector there is a movement with a long standing tradition of attention to pedestrian-friendly design. This is inspired by the fact that qualities or deficiencies of the physical environment are experienced more intensely by pedestrians than by other persons passing by in cars or even on bicycles. A classic study is "The image of the city" by Kevin Lynch. In the COST[19] Action C6 "A city for pedestrians: policy making and implementation" [136] the position of the pedestrian within the urban environment and the State of the Art were highlighted. The COST Action C11 "Green structure and urban planning" [137] offers further insight into pedestrian friendly design.

In the 90's in many countries there was a rise in attention for sustainable transport. In this context effort was put into the promotion of walking and cycling. Guiding studies on the European level were the EU projects WALCYNG[20] (Final report 1998 []) and ADONIS[21] [18] followed by research on walking in FP5 "City of Tomorrow and Cultural Heritage", the so called PROMPT[22] study [82]. Furthermore, in many countries hand-books on pedestrian facilities and facilities for the handicapped were published.

Since some years now the health sector has been stressing the importance of exercise and has been promoting that people walk at least 30 minutes daily. Medical doctors increasingly often prescribe exercise instead of drugs; studies with regard to the ageing of the population reveal that a connecting, convenient, comfortable, conspicuous and convivial walking network will become a crucial factor enabling the elderly to grow old in place. Research within the integrated framework approach by THE PEP: "Transport, Health, Environment - Pan-European Programme"[23] is carried out and promotional initiatives have been started[24].

The Joint ECMT/OECD Transport Research Centre is planning to install a working group on Pedestrian safety, urban space and health (Programme of Work 2007-2009 [126]). This project will probably start in 2008 and be completed in 2009. The study will involve identifying key factors, benchmarking, improvements and conclusions regarding measures on the national level.

Research projects in this field have dealt mainly with finding and disseminating the best practises.

Additional research in the area of cycling includes the following:

[19] *www.walkeurope.org*
[20] *How to enhance WALking and CYcliNG instead of shorter trips and to make these modes safer*
[21] *Analysis and Development Of New Insights into Substitution of short car trips by cycling and walking*
[22] *New Means to Promote Pedestrian Traffic in Cities*
[23] *http://www.thepep.org/en/welcome.htm*
[24] *http://www.euro.who.int/hepa*

- A European network for cycling expertise (Veloinfo [121]).
- Inter-regional cooperation of cities looking at concepts and concrete measures to be implemented to maximise the use of the bicycle as an alternative and more flexible means of transport within cities (UrBike [122]).

Also, there has been a lot of national research on cycling [120]. The introduction of electric two-wheelers and of public bicycles has been assessed as well.

Among the best practices to promote cycling and walking in cities the following proposals have been established:

- Walking - Ensure that different amenities can easily be reached by foot; provide and maintain adequate lighting in public areas; improve home delivery services; introduce traffic calming in areas with mixed traffic; increase the number of car-free areas; and develop attractive pathways
- Cycling - Develop a road infrastructure which gives higher priority to cyclists; develop dedicated bicycle routes; promote cycling as a convenient, efficient and environmentally friendly mode of transport; provide bicycles at places of work; provide city bicycles free of charge; introduce ”call-a-car ”schemes; develop secure parking places for bikes; introduce new types of theft protected cycle racks and storage’s especially close to metros, commuter trains and bus stops; develop “bike and ride”; improve ways to combine cycling and PT in general, and introduce bicycle registration programmes. [61, 71, 72, 18]

Inter-modality and Integration

Inter-modality can be seen as a first step to integration of all modes of transport. It can only be achieved through a good coordination of the transport modes, well designed transfer platforms, interoperable ticketing and traveller information. It has been seen at the beginning as only concerning PT modes, in order to compete with car use. It is now understood that PT should also be well connected with the non motorized or soft modes and even cars in order to reach a better modal split. Full integration implies measures like fare integration, multimodal journey planners, transfer hubs accommodating all kinds of transport or common booking centres. A lot of research has been done in this domain, with ITS systems in mind, and particularly on the topic of e-ticketing and travel information. Quite a few implementations have also been evaluated. Especially the fare management and integration is strongly linked to economic aspects, e.g. concerning transport pricing and the costs of urban transport (see also section 4.14, page 68 and section 4.15, page 72).

Research and demos have shown that when using public transport, passengers strive for smooth and few interchanges. Measures targeted at developing this are vital in order to make public transport more attractive, e.g. easy and integrated ticketing with smart card systems, Park&Ride facilities, secure parking places for bikes, real-time information systems at stations and web-based trip planning tools. Reductions of up to 10% of car use have been achieved as a result of the application of integrated measures such as the integration of the public transport planner with interactive walking/cycling elements or with car travel information [61, 71, 72].

Concerning e-ticketing and fare integration one can see a general movement towards the use of contactless smart cards and tickets, the obstacle being the transition costs. Phone ticketing appears to be the next step towards integration. Main findings are the following [69, 66, 61, 31]:

- Lack of standardisation for interoperable smart card tickets
- Lots of experiences but still remaining difficulties with revenues distribution as part of integrated tariff and ticketing systems.
- Lack of clarity concerning objectives of the fare policy (vague terms).
- No future prospects are seen for electronic contact-based technologies for electronic ticketing (not suitable for high passenger throughputs).
- Proximity technology is used in most applications today and has proven a mature technology (short transaction times, mainly suitable for closed systems).
- Vicinity technology, although tested in laboratories, has shown no satisfactory results regarding high and reliable detection rates (necessary door antennas require high installation efforts and mechanical adjustments, fixed maximum field strength by law limits transmission distance), might be used in combination with manual ticket selection for data collection for statistical purposes, not for automatic fare calculation.
- Long-range technology, specially designed for automatic fare calculation in both closed and open systems, has been successfully demonstrated in CH (user device of smart card format, no user actions required but possible, therefore especially suitable for handicapped people, detection rate is sufficient high; drawbacks: currently proprietary technology, user device still too expensive.
- Focusing on different target groups, various projects and implementations in several countries use different technologies: contactless smart-cards or disposable paper tickets with electronic chips, systems requiring check-in and/or check-out actions, manual ticket selection, integrated electronic bank purses, inter-services (such as access control, parking payment, museum entrance), electronic use devices for long-range technology, mobile phones.
- Current applications apply both to long-distance trips as well as to local transport.
- In terms of automatic registration and fare calculation: users want to be informed about registration itself and its correctness (requires display).
- Findings from Finland (local transport) and Austria (long-distance tickets): SMS based ticketing provides a modern image of the transport operator and may attract new customers of public transport.
- SMS/ Internet/ WAP technology limited to users that are willing and physically able to use, implies manual ticket selection, automatic fare calculation not possible.
- Acceptance of technology/ preference of devices will vary according to target/ user group (frequent/ occasional customers, elderly/ young, handicapped/ not-handicapped).

4.9.3 First Identified Open Issues

Public Transport Vehicles and Rolling Stock

General design

- Innovative design and production methods, low cost rolling stock [56] [69] [77] [78].
- Use of innovative, lighter and recyclable materials [77] [78].

- On board architecture; standardization of communication on the vehicle, detailed interfaces between on-board and wayside "Communication Based Train Control" systems [66] [75] [79].
- Advanced in-vehicle sensors and vehicle management, advanced and intelligent maintenance systems [79].
- Automation of transport systems and processes [56].
- Improvements of the efficiency of passenger exchange to reduce passenger service time).

Propulsion / Environment

- Energy efficient, low emission and low noise propulsion and power systems [78].
- Alternative energies: draw a real European policy for alternative fuels for buses in order to reach 1/3 diesel, 1/3 methane and 1/3 renewable, development of a hybrid parallel traction chain using energy recovery to achieve a 35% reduction in fuel consumption and CO2 emissions, development of CNG's by developing compatible engines and structuring work with industry [77] [80].
- Better management of energy infrastructure and equipment (on board and in stations) necessary for traction, air heating and cooling, escalators, lighting and so on [75].

Safety and Security

- Improved design of rolling stock to prevent vandalism, terrorist attacks and major incidents, using ITS and ICT [96].
- Optimised braking [77].
- Incident management systems [56].

Public Transport Infrastructures

Railway / Light Rail

- Simplify the railway infrastructure [78].
- Make better use of existing infrastructure, adaptation of heavy rail urban infrastructure for light rail, harmonised urban/regional rail installations [78].
- Dedicated street lanes to light rail [78].

Bus

- Develop the BRT or BHLS ("Bus with a High Level of Service") with pilot sites and associated research [80].
- Guided bus systems [56].

Transfer Platforms

- Improve design and optimisation of transfer facilities (pedestrians, logistics), analyse passenger flows: connectivity, inter-modality, information [56] [78].
- Simulate different solutions for transfer points.

Safety and Security

- Creating intelligent infrastructure to detect defects and failures [79].

- Improved design of infrastructure taking into account safety and security to prevent vandalism, terrorist attacks and major incidents [96].
- Safer accessibility for persons with reduced mobility [77].

Public Transport Operations

General

- Serve more customers with less staff , achieve economies of scale [78].
- Innovative use of ITS to better operate PT, with emphasis on global navigation systems, GPS and GALILEO [77] [81].
- EU-wide intelligent infrastructure, independent databases, standards for traffic and transport management systems [78].
- Focus not on technology but on its potentials to make PT more efficient, taking into account opinion of users towards new technology [69].
- Self-training tools for ITS at operating and management levels [79].

Operational management systems / AVM

- Need for a clear definition of objectives of Automated Vehicle Management (AVM) systems, taking into account operational characteristics of the public transport environment; need for better understanding of operational requirements and impacts [66].
- Need for technical profiles related to the system functions and procedures (at control room level, for the depot management, etc.) and operational profiles related both to the use of the system (from the driver to the control room operators) and to the system maintenance [66].
- Need for feasible schemes of operations actions for dispatchers and drivers based on real-time information provided by the systems, need for better support of the control of the operations (e.g. automated actions, simulation of the impact of actions, manage fleet changes) [66].
- Generic architecture with well defined interfaces between AVM and Passenger Information Services (e.g. mobility centres, internet: data formats, protocols, technical links, …), data exchange formats with other systems as analysed on different research projects, e.g. DATEX, TRIDENT, … [66].
- Expand use of AVM for the management of PT operations – Improved route planning and optimised timetables, better planning of traffic signal control, bus priorities, dynamic control of interconnections, integration of DRT services, etc. [66] [69] [78] [79].
- Need to have decentralized implementation schemes for AVM with exchange of control and statistical data on different levels, need for simple (eventually portable) operator terminals and of enhanced on-line dynamic tools for dispatchers [66] [79].
- Need for feasible operational schemes to optimize the use of the AVM data; need for new means of rostering personnel and adapting fleet to allow frequent changes in service offer [66] [77] [79] .
- Cost-effective real-time multimedia transmission between buses and operating centre[79].
- More efficient maintenance concepts: incident oriented, more dynamic and integrated[79].

Others

- Optimisation engines for advanced DRT [79].
- Platform for Location-Based services [79].
- Need for the development of methods for the assessment of urban public transport quality and the assessment of the effectiveness of ways to improve PT quality.

Motorised Road Transport

- More efficient propulsion [81].
- Development of clean vehicles, including biodiesel, biogas, ethanol, NGV, public heavy-duty vehicles, municipal fleet, company fleets, removing obstacles for clean vehicles; promotion of clean cars. Air pollution and reducing CO2 -emission caused by transport need research but also consistent regulations for all vehicles, based on sound technological state of the art research) [72] [80] [81].
- New tools to predict air quality impact of traffic measures, regulations for all vehicles, traffic measures) [81].
- Development of silent vehicles, research on the effects of control of speed limits on noise emission [81].

Intelligent Vehicle Systems [58]

- Development of integrated platforms based on enhanced sensor systems, faster and smarter actuators, evolvable and flexible though robust and safe system architectures with open software and hardware interfaces, supporting multiple functions, able to deal with complex scenarios and interactions such as intersections, perception of vulnerable road users, adverse and night time driving conditions.
- Development of adaptable decision and control systems for different driving situations and variable driver capabilities, to extend the domain of operation and effectiveness support provided by the intelligent vehicle; development of autonomous vehicles capable of operating in dedicated environments or for given manoeuvres.
- Development of a concept for testing different Active Safety and Advanced Driver Assistance Systems.

Cooperative Systems [65]

- Development of common simulation tools and a common test bed, enabling cost-effective evaluation of concepts and systems, available to all EU actors.
- Field trials and demonstrations in real traffic environment for testing and verifying cooperative systems technically at system level as well as proving their positive impact on traffic safety, efficiency and giving basis for cost/benefit assessment. Drivers – Vehicles – Infrastructure – Traffic and Goods Management should all be components, linked with communication systems, in these field trials. These field trials should be developed with a view to be extended into Field Operational Tests of cooperative systems.
- Communication V2V and V2I: study into a dedicated communications approach for V2V and V2I that addresses explicitly the need for low latency and high reliability. Bandwidth needs of each application must be defined and the impact of the application on safety correlated.

- Positioning: accurate and timely positioning, giving attention to a standard approach to augmentation of future enhanced GNSS services to deliver sufficient accuracy.
- Development of a roadmap that indicates how to migrate from “where we are today” to “being able to deploy” cooperative systems.

Infrastructure

- Infrastructure provision: minimise impact on people and environment [81].
- Dynamic allocation of lanes could allow new mobility possibilities, but further researches are also needed in this field [65].

Others

- Vehicle technology for protection against theft and robbery [81].
- Cash car. This system of car sharing is only used by a very few consumers. Work is needed to make this system more attractive and competitive [76].

Soft Modes (Cycling and Walking)

- Better integration of pedestrians in transport planning and city design [82].
- Development of new concepts: living streets day and night, a green network in every city [82].
- Application of GPS and Galileo systems for cyclists and pedestrians [81].

Inter-modality and Integration

General

- Network optimization and specially the interchanges [59].
- Cost effective improvement of urban passenger transport with integration of services and information, better real time information systems and managing of systems, the development of a seamless (multimodal) system with integration of systems, information and charging; need of integration also on the policy level [11] [61] [81].
- Linking walking and cycling improvements with new public transport provision, better information etc. Integration of bicyclists (tickets, multimodal use) [73] [77].
- Improved infrastructure conditions for interoperability within and across modes; interoperability of Urban Guided Transport Management System (UGTMS) [78].
- New systems, equipment for urban transport not addressed by modal platforms [77].
- Harmonisation of standards for transport (road pricing, timetabling in public transport and cross border timetables and slot allocation) [81].
- Extended research on the effectiveness of Park & Ride systems, esp. in regards to their potential to reduce congestion.
- Better knowledge on the optimal design of transfer-stations and waiting rooms.

E-ticketing and fare management systems

- Automatic fare collection based on innovative fare systems and integrated tariffs. Development of new fare models (fare schemes for automatic price calculation, flexible fares…) and their evaluation (according to relevance to users and operators) in order to support the introduction of fare management systems [66] [77] [79].

- Automatic fare collection without user-required actions (Be-In/Be-Out system), further research is needed for long-range technology [66] [79].
- Mobile Ticketing and Automatic Fare Collection. New concepts of background ticket storage and payment (e.g. SMS tickets). Integration of proximity technology into mobile phones will require additional research. Further research is also needed for future integration of electronic fare management systems with mobile payments (for inter-services support or traveller information) [66] [79].
- Door-to-door electronic payment systems. Standardisation for interoperable smart card tickets. [69] [78].
- Automatic fare collection - integration with added transport/non-transport and inter-services. Multi-service contact-less pass [77] [79].
- Interoperability and conformance testing: design tools for introduction and migration concepts, methods and tools for design and conformance testing for Automatic Fare Collection [79].
- Need to address also deterrent factors such as the lack of data protection when using electronic ticketing, high costs of introducing an electronic ticket system, insufficient use of the outcomes of user satisfaction surveys or the fact that when dealing with the identification of the customer's perspective most efforts concentrate on actual PT users, while the group of non-users is often neglected [69].

Access restriction and pricing

- Market development in road pricing (structures for infrastructure provision, pricing schemes, new instruments for organisation and responsibility issues and electronic toll collection technology) [81] (see also section 4.14, page 68)
- Analysis of the effects on social equity of road pricing and other pricing tools such as costs for parking, P&R and public transport fares [61].
- Development of GPS-based systems which can in the future implement distance-based pricing allowing higher flexibility [61].
- Harmonisation of ITS standards for pricing and taxation [81] (see also section 4.14, page 68).

Other

- Architecture of systems.
- Geo referencing, digital maps, use of Galileo.

4.10 Safety and Security (D1)

4.10.1 Description of Topic

Two major aspects have been connected in topic D1: the safety of the transport system regarding users and non-users and the security of the infrastructure. The latter one is of increasing interest due to the newer societal and political developments and includes special aspects of disaster management and incident response management in relation to urban transport infrastructure and operation. Safety of users looks at achievements and solutions limiting the chance and impacts of traffic accidents in urban areas.

4.10.2 Status

In a sense, security and safety have a similar objective which is the health of users. But the approaches to improve safety or security are strongly different, in term of actors, of management and of most solutions. Therefore, these different topics will be dealt with separately in the following.

Road safety

Road safety is one of the major problems of urban mobility plans. In most European countries, two out of three traffic accidents occur in urban areas [4]. Serious accidents are private tragedies and road safety is a high cost factor for the community (major cause of death for 15 to 24 years old, high economic cost (1% GDP)). The impacts are in fact far more important than those of security or other negative effects of the urban transport.

A characteristic is the high level of vulnerable users injured in accidents: pedestrians, cyclists or bikers are often 2/3 of seriously injured people. Road safety in an urban context is firstly a problem for these users and not for car drivers.

Another fundamental point in urban areas is the effect of speed on the number and the severity of the accidents. Speed is the major road safety problem in many member countries and generally one of the top three problems across most member countries. Excessive speed (above the speed limit) or inappropriate speed (inappropriate for the prevailing conditions) contributes to about one third of accidents and aggravating factors in all accidents.

As an example, the probability of a pedestrian to be killed is 80% for in a car colliding at 50 km/h and of 15 % at 30 km/h. That means that speed management is at the heart of any transport policy, with rather low levels when vulnerable users are numerous.

Road safety activities relate to the knowledge of the accidents and the risks reality, to their analysis and to the actions to be led with the objective of reducing the accident level.
The EC White paper mid term review 2006 [6] recommends more focus on safety and security, and mentions accidents in urban areas as one of the worst problem of transportation.

The recent WHO report on traffic injury prevention [123] sets out a number of guiding principles for road safety work which are based upon this line of thinking. It says, among other things, that:
"Road crash injury is largely preventable and predictable; it is a human-made problem amenable to rational analysis. Common driving errors and common pedestrian behaviour should not lead to death and serious injury – the traffic system should help users to cope with increasing demanding conditions. The vulnerability of the human body should be the limiting design parameter for the traffic system and speed management is central."

In addition, the United Nations General Assembly, in its Resolution on improving global road safety [124], has invited member States to take action on inappropriate and excessive speed.

As expressed previously, ITS can play a paramount role in the speed management, and more generally in road safety.

Road safety is now often seen as an entire dimension of the urban mobility policy in different countries. It permits providing everyone, and in particular non-motorised persons, with friendlier public space shared by all.

Road safety is also a condition for the success of any mobility policy or plan. Example: how is it possible to promote walking or cycling if they are dangerous? Another emerging problem for example, is the design of pedestrian crossings of tramway lines. The tram is a more and more successful alternative clean mode in urban transport. While accessibility to people with reduced mobility is a compulsory feature of the service, crossing the tracks can prove at least difficult, at most dangerous for older people or children. Especially in danger are people visually impaired, because the new trams are very quiet and have often the right of way over other vehicles. There is a need for research at first, leading then to regulation[25] to avoid creating new potentially dangerous situations.

Ambitious political commitments are necessary to promote safety, and also high level expertise to analyse problems and propose solutions. Most of the technical solutions are known, the difficulty is now to widespread them throughout a whole city with a long term vision.

Rail safety

The 2001 White Paper on the European Transport Policy for 2010 [3] stated that the time had come to set new objectives for EU transport policy, including putting safety at the heart of its efforts.

Actually, most of the document focuses on road, air and maritime safety. Inasmuch as rail is concerned, the following intentions were announced:

- setting high safety standards for the rail network, based on interoperability regulations established by an independent body and on clear definition of the responsibilities of each player involved in order to ensure smooth operation of this market in which several operators will share the same stretches of the network
- creation of a community structure for safety and interoperability

In the Mid-term review of the White Paper [6], consolidating the European transport safety agencies and developing their tasks was mentioned as on of the main tasks of European transport policy.

The modal-specific achievements and research requirements have been tackled by the modal platform ERRAC[26]. Therefore, they do not need to be tackled separately here.

[25] *There is no regulation ready at hand so far in France for example*

[26] *http://www.errac.org/*

Security

Fight against terrorism is a new European policy and an issue of increasing importance. Many efforts have already been made in that regard at the European level. Within the last three years the European Commission has published almost twenty communications on the potential threats and targets of terrorist attacks, on the protective measures (prevention, preparedness and response) as well as on the management of possible short, medium and long term consequences. A Green Paper has been produced in 2006 on the European programme of critical infrastructure protection (EPCIP). A pilot project “Fight against Terrorism” is currently underway.

Most of the regulations recently adopted at EU level focus on air transport security. Other transport modes, and especially surface public transport, are now the purpose of European research and studies, among which COUNTERACT [84]. New R&D developments are expected on security and on the conditions for implementation of appropriate measures (including their financing). There is also the need for further research in the field of protection against criminality in public transport, at stations and on the way to the stations.

Protection of urban mobility is at the heart of the preoccupations of European authorities, and this issue requires coordination at European level, based on the subsidiarity principal. FP7 has identified security as one of the 10 priority themes of the collaborative research programme. The “Security” theme covers 4 “vertical” activities and 3 “transverse” activities.

Vertical activities:

- Protection against terrorism and criminality: knowledge, detection, prevention and identification of threats, protection against attacks, hushing up and limitation of adverse effects.
- Security of infrastructure and public service networks, including transport, energy and ICT.
- Security at the borders.
- Security recovery in case of crisis.

Transverse activities:

- Integration and interoperability of security systems.
- Security and Society.
- Coordination of research on Security.

Apart from “security at the borders”, all activities have a high relationship with urban mobility and therefore are in focus of EURFORUM.

The subject of anti-terrorism in public transport is relatively new in the European Union, the topic has been picked up in research, but initiatives are recent and no significant results are available yet.

- Existing security knowledge and strategies need to be reviewed in the light of the new threat as they did not cover the challenge of intended major destruction and mass casualties.

- Technology solutions that are currently available have either been developed for operational management and do not serve security purposes or have an airport- or container security background and are not suitable for the environment of urban public transport systems.

Understanding the security threat and vulnerabilities of urban transport system, better protecting passengers and systems requires major effort including investment and R&D initiatives. The sheer dimension of the problem manifests the need for research activities at a European level in order to benefit from each others expertise and coordinate the major investment that will be required.

The importance of regarding safety and security problem as parts of the transport system is now admitted as essential [87].

Need for minimizing the traffic impacts on most vulnerable users, specially pedestrians and cyclists, and oldest people or children, is considered as a strong element of any safety policy [87].

In general as expressed previously, ITS can play a paramount role in road safety, and more especially in the speed management.

4.10.3 First Identified Open Issues

General

- § ITS applications usually pay no special attention to the safety and security of disabled persons or the elderly. Their needs have not been taking into account when designing services for general use especially since they are the vulnerable section of society [66].
- § Problem of devolution of responsibilities for ITS applications concerning safety and security - discontinuities of authority, responsibility or collaboration [66].
- § European PT security legislation, standardisation and certification, better integration of safety and security concerns in design of infrastructure, safer accessibility for persons with reduced mobility, emergency management [66].

Safety

- § The most important inter-modal research question is probably the comparison of the cost of saving a statistical life in rail transport compared to the cost in road transport under current and proposed regulations.
- § Development of a European standard for the definition of transport fatalities and serious injuries. Member States should be required to use these definitions in their statistical reporting of transport accident and fatality/injury data.
- § The motorcyclists and moped safety is one of the major safety problems in many cities. The number of accidents in this category is high and often growing, while the severity of crashes is at a high level as well. The number of motorcyclists is also growing in several European countries, due to traffic congestion, and despite the high risk of this mode of transport. In the future, considering motorcycling more often as an urban transport mode

can be of importance, and safety issues of this mode will have to be fully considered. At this point, research should deal with the specific risks, and imagine preventive solutions.

- § Another point should be considered more strongly: the use of new technologies for safety of non-motorised users (pedestrians, cyclists, bikers). For them, few developments are put forward whereas they are the main victims in accidents.
- § Consider safety as a major criteria in a urban plan like other criteria as noise, pollution etc. (e.g. CIVITAS [7] examples do not include safety as a main criterion).
- § Research on links between safety and social exclusion is needed, with the subjective notion of feeling unsafe (CIVITAS -VIVALDI [70] and URBAMOVE [59]).
- § Safety management has been partly treated in the DUMAS [97] programme, but has to be actualised and linked with urban transport policies.
- § Systematic evaluations (assessment) of measures are a well known need, (ADONIS [18]).
- § Investigate aspects of risk exposures of different modes of transport.
- § A specific and major point related to safety is the speed moderation concept which is emerging. Its consequences on mobility, urban sprawl, and on safety, have to be investigated (FP7 Work programme [5]).
- § Another not yet well treated problem: safety in periurban areas, which means in parts of the conurbation between the city centres and the rural areas. There the traffic is strongly interrelated with the city activities, but still different of traffic if the high density parts of the city (with higher speeds, less equipments…).
- § Educational approaches concerning each individual's behaviour towards other transport users, aging population etc.

Security

- ITS solutions adapted for PT environment.
- Training programmes for security and operational staff.
- Vandalism-resistant surface materials.
- Improvement of objective security, and subjectively experienced security in vehicles of public transport, on PT stations/interchanges and on the way to stations.

4.11 Accessibility, Rights, Equality (D2)

4.11.1 Description of Topic

This topic deals with measures and tools aiming at:

- § Improving the ease with which people can access services and facilities for whatever purpose (commuting to work, joining in entertainment activities, buying products and services).
- § Enforce the right of citizens to be mobile and their aspiration to boundless mobility.
- § Ensuring that transport policies result in advantages that are equally distributed among citizens or are particularly addressed to groups with special needs (children, the older, people with impaired mobility, low income citizens, individuals living in poor neighbourhoods…).

A related topic is that of social exclusion as it can be caused by a biased distribution of accessibility.

4.11.2 Status

In nowadays societies, mobility is a key feature of urban life and though generally it is not formally acknowledged as a "right", mobility is a shared central value. Accessibility is a key factor for economic dynamism and social vitality and it represents a concept much broader than mobility, that is to say accessibility is not limited purely to physical movement. It is also true that when we speak of accessibility and mobility, not only people but also freight transport should be taken into account as the ease of access to facilities such as seaports and airports may be a key economic issue for urban revitalization.

The ongoing process of motorisation, urban sprawl and suburbanisation has sharply increased transport demand and changed the travel patterns in terms of length, time constrains and number of destinations and purposes. Then, the new challenge becomes finding a stable balance between transport flows and city life and identifying the trade-off between the growing need for travel and the logical limits existing, such as congestion, pollutant emissions and noise. Moreover, whatever restriction to individual mobility is implemented to tackle these limits, this is likely to increase social exclusion.

Among the factors affecting accessibility it should be mentioned land use, i.e. how activities and services are located geographically and the different impacts on mobility need of a disperse distribution of facilities against a more concentrated one (see section 4.4, page 23). Policy options should be monitored and evaluated according to their impact on accessibility. In the UK, Local Transport Plans for 2006-2011 include accessibility as a priority and the Department for Transport has developed a Guidance on Accessibility Planning in Local Transport Plans where authorities are encouraged to use core and local indicators to assess the distribution of accessibility impacts of transport schemes on different areas and to monitor the effectiveness of funds spent for accessibility measures.

Another issue to be taken into account is the dissemination of mobility substitutes like telecommunications and delivery services, able to reduce people's need for mobility.

Equity, too, is an issue of increasing importance in the transport policy. Growing concern is dedicated to meeting the special needs of certain segments of the population[27]. It is generally recognized the inequality caused by the indiscriminate increase in the use of private cars that has resulted in bigger pollution, damages to pedestrians and cyclists and high level of congestion resulting in poor public transport services.

The Stockholm trial of congestion charging, run in 2006 is an example of integration of social inequalities concerns in mobility policy: the local government, in fact, has always considered social

[27] *Needs of people with reduced mobility for example , e.g. EMTA Survey 'What information for people with reduced mobility in the field of transport?', www.emta.com/IMG/pdf/summary_eng.pdf*

equity as a priority while implementing the charging scheme. This raises an important question on how best assessing the effect of mobility policies on social and environmental inequalities. Growing interest and request for further research refers to assessing inequalities impacts of mobility policies such as: introduction of tolls to restrict the access of private vehicles in the city centre, regulatory and fiscal measures to reduce car use and increase alternative modes market share, adoption of different tariff schemes for collective transport. In parallel, measures to prevent inequality effects should be implemented. For example, equity audits can be conducted as part of policy planning, implementation and evaluation in order to assess its equity effects or revenues coming from new tolls could be earmarked to public transport and other alternatives to private cars (walking and cycling).

Accessibility and social inclusion represent priorities in the transport policy of the European Union as already testified in 1993 by the adoption of the Community Action Programme for Accessible Transport, containing a long list of priority measures to ease transport and travel for passengers with reduced mobility. Recently, in the Mid-term Review of the 2001 Transport White Paper [6], the European Commission has called for action to improve service quality and assure basic passenger rights in all modes of transport, “notably as regards passengers with reduced mobility”. Even stronger emphasis is used by the European Conference of Ministers of Transport [88], where higher quality in transport system (i.e. vehicle design, infrastructure, driver training, information, etc) is seen as a means to more equitable systems and “in this way, accessibility is a key element in ensuring the social sustainability of the transport sector”.

Therefore, research in this sub-area deals with mobility, use of data and figures on travel styles, land use and transportation planning, accessibility for freight and passengers activities, transport policies and tools for people with special needs, enhancement of transportation systems and diversification of transport offer, behavioural change and modal choice motivations (cost, time, comfort, personal security, etc).

Over the last years the European Union has addressed accessibility and equality issues through a variety of projects and activities dealing with the transport dimension. A number of pilot, demonstration and validation projects have been dedicated to these topics as well as structural funds and Directorate General Employment and Social Affairs budget line.

The MATISSE [89] project dealt with social exclusion and highlighted the important impacts of transport on this issue. It also put forward the need for a greater cohesion between policy areas at European and national level and for better integration in joint working of social and transport agencies at all levels of government.

The ECLIPSE [90] project, as a follow-up to MATISSE [89], aims to disseminate best practices and evaluation tools for professional to fight social exclusion, to liaise with Member States engaged in the National Action Plans process to ensure that transport is taken into account as a factor affecting social exclusion, to favour dialogue between the different Commission Directorates General taking initiative on this issue as suggested by the MATISSE [89]results.

Other projects are instead more focused on technological aspects. For example, the on-going European project UNIACCESS [91] insists on the relevance of a philosophy of universal design as a condition to make buses, railways, taxis and supporting infrastructures universally accessible. Universal design is also seen as an occasion to enhance the quality, usability and safety of public transport as well as the competitiveness of the European industry. Yet, there is still a lack of reliability of specific devices designed for the disabled (e.g. boarding aids to get on buses or trains). These lacks should be addressed as well, because such devices represent a fair amount of investments and because they create a potential risk for the disabled user and discourage the use of PT.

More attention should be paid to the design of new infrastructure which could generate new difficulties for particular groups like people with reduced mobility (e.g. pedestrian crossings of tram tracks in city).

Information system and ticketing also play a role in accessibility and social inclusion matters. In Norway, a research study, thought recognizing the contribution of information and technologies to the enhancement of public transport services, stressed that new IT solutions should work as a complement rather than a substitute to traditional means of information (e.g. printed timetables and network maps) as some users might have difficulties in using new tools. With a similar view, the on-going European project ASK-IT [92] deals with the role of Information Communication Technology in aiding and improving the everyday lives of mobility impaired people. The final aim is to develop handheld devices to provide real-time information primarily for travelling but also for work and leisure services, with emphasis on a seamless service provision and personal needs and preferences of the users.

A long list of CIVITAS projects can be mentioned, too. Among these, in fact, there are successful examples related to the provision of flexible demand responsive transport services for mobility impaired travellers (e.g. Bristol Dial-a-ride service expansion or “Drinbus” service in Genoa), improvement of accessibility for disables or elderly people, introduction of way finding systems for blind/partially-sighted pedestrians (e.g. the guiding lines integrated in the pavements by the City of Brugge), development of infrastructure management systems removing barriers to users, implementation of strategic plans for alternative modes, park and ride and park and walk facilities, measures addressing public transport aiming to increase its modal share and accessibility levels (e.g. bus priority measures introduced in Suceava). These measures specifically focused on public transport might include bus-stops, access to buses and other public transport vehicles, platforms to access the bus, the connections between bus stops and others systems of public transport, installation of technology providing visual and audio information on urban buses, introduction of new articulated low-floor vehicles, dedicated lanes, priority at traffic lights,

As regards the expansion of flexible transport services, the CONNECT [94] project should also be mentioned as it has created an expert network putting together, in a single knowledge portal, all knowledge on the subject (demand responsive transport, shared taxis, carpooling, car sharing, etc.).

4.11.3 First Identified Open Issues

- Assessment of the effects of mobility policies on social and environmental inequalities.
- Does competition in the public transport sector have an impact on equity?
- How to measure accessibility and incorporate these measures into land use and planning and into transport models?
- Ways to achieve barrier-free travel, including the improvement of existing technological solutions.
- Development of accessible mobility substitutes.
- Ways to finance innovative transport system?
- How to commit those that are generating transport demand (businesses, commercial and leisure centres, service providers)? Businesses in particular should be committed in assuring accessibility to their employees.

4.12 Human Aspects (D3)

4.12.1 Description of Topic

Planning, the use and operation of transport facilities is always determined by human individuals as users, operators, drivers - people who benefit or suffer of transport, and people who decide on transport facilities. Therefore human aspects are closely linked with all other EURFORUM themes regarding urban mobility. Table 1 shows what human behavioural aspects are covered by this SoA report on urban mobility.

Human Aspects	Described in		Content of Topic
	Topic	Section	
Empirical studies on mobility behaviour	A1	4.2	Collection and Provision of Urban Transport Data
Mathematical modelling of mobility behaviour	A2	4.3	Urban Transport Demand Analysis and Modelling
Influences on mobility behaviour through land-use, transport supply and a wide range of different measures	B1	4.4	Sustainable Strategies Land-Use and Transport planning
Influence on behaviour of integrated management measures	B2	4.5	Sustainable Strategies – Transport System Management
Human behaviour as one cause of environmental problems, solutions to reduce human stress through pollution, noise etc.	B3	4.6	Sustainable Strategies – Environmental Aspects
Influence on behaviour of different service strategies (information, marketing)	C1	4.8	Urban Transport Supply Side – Integrated and Harmonised Services
Influence on behaviour of improving transport systems	C2	4.9	Urban Transport Supply Side – Integrated and Harmonised Systems
Ensure Safety of European citizens	D1	4.10	Safety and Security
Ensure mobility of all citizens	D2	4.11	Accessibility, Rights, Equality
Socio-economic aspects	E3	4.14	Transport Pricing

Table 1: Allocation of human and behavioural aspects in other chapters of SoA-report

Nevertheless, there are special themes left which will be shortly discussed within this chapter:

- Mobility behaviour, its determinants and ways to simulate behavioural changes.
- Further ways to influence mobility behaviour including users and requirements of drivers, personnel, operators, not covered in other chapters of this report.

4.12.2 Status

Mobility Behaviour and its Determinants

Mobility enables participation in (access to) activities for different purposes at different locations. The following main determinants of mobility behaviour are well known, researched and a basis for modern transport modelling (see section 4.3):

- Personal characteristics (e.g. age, health, income, education, gender, car availability).
- Settlement structure e.g. spatial allocation of land uses.
- Provided transport infrastructure.

Less known determinants of human behaviour are arisen from the field of social psychology and their impact on mobility behaviour – influence of norms, social perception, stereotypes, emotions, conformity, status thinking, communication etc. An upcoming topic within this field is the relation between individual life-style and mobility behaviour. Life-styles are an expression of a substantial degree of freedom of action of the individual and therefore can contribute to explain mobility [99, 100]. Lifestyles and working conditions are getting increasingly diverse and the developments of human lives are very heterogeneous[28]. In a study on mobility and life-styles in the EU-25 [101], seven different types of European lifestyle have been clustered. However, there seems to be hardly any study existing on European level concerning this theme.

There is a lot of knowledge concerning reasons, why specific transport modes are used or about barriers to not use a mode (e.g. ADONIS [18]). Open questions remain in respect to habitual behaviour and how to change users' habits. How can users be approached and how can their subjective valuations of transport options be influenced without impairing the individual's freedom of choice and without increasing social exclusion? Special priorities in this field are emerging from the aging of our society, including aged generations of habitual car users. A question arising in this field esp. from the perspectives of safety or the public transport is how to ensure behavioural changes of the future elderly in terms of modal choice?

Ways to Influence Mobility Behaviour

Due to the coverage of most relevant influences on mobility behaviour in other chapters in this report, this chapter will only deal with research in respect to:

- education
- effects of teleworking

[28] *http://www.bmbf.de/en/4630.php*

Education

This topic includes the education of users of the urban transport system to increase safety and efficiency of transport, as well as the education of drivers and professionals in the transport sector.

The latter one is of special interest to ensure high quality services, to cope with new technologies and market developments and to ensure safety and security, esp. in public transport but in other areas as well (taxi services, mobility management centres, traffic management centres etc.). The education of drivers and professionals in the transport sector and related problems has been mentioned very seldom in European documents concerning urban mobility. Studies exist about the sector of Public Transport (PT). The personnel of PT companies is an important human resource. VOYAGER-project [28] stated that the development of managing staff and the management of competencies are two important measures to improve the competitiveness of companies. The VOYAGER State-of-the-art report [28] concluded that without new management strategies of human resources and in particular rearranging the training and development of all management levels, PT companies cannot meet their strategic objectives in the new competitive environment. According [28] staff development is an important aspect to mobilise the personnel of PT companies to provide satisfactory service to the customer. Furthermore it is crucial for managing the changes in markets, the development of new organisational structures, introduction of new technologies and new working methods. Strategic Management-Development programmes (MD-programmes) for instance, for managers have been developed and implemented already in different European countries like France, The Netherlands, Romania and Germany. The European Training & Development Foundation (ETDF/Paris/France) stated in their study, that there is an increasing interest in competency management [28]. Nevertheless, the current used systems and application of competency management are different in European countries.

The key problem, which is stated in VOYAGER [28] related to the area of “training and human resources development” is the lack of financial resources. It is mentioned, that due to privatisation, reorganisation and cost reduction programmes, the companies dedicate less money to Human Resources Development. In terms of management development, many PT companies have difficulties in hiring top managers, since they can not offer salaries which are common in other industry sectors. Another problem can be seen in the lack of career and training programmes. As said in [28] the often negative image and reputation of the job as a driver causes problems. One mentioned reason is the lack of possibilities to obtain an official diploma.

On the other hand, competition can lead to better quality of services through personnel because of sophisticated personnel choices.

Two projects are funded by the European Commission to improve the education of drivers in Europe: 2TRAIN [103] and TRAIN ALL [104].

Educational measures for transport users can mainly have the following reasons:

- Raise awareness and motivation to make smart travel choices (e.g. mobility management).

- Develop skills to use desired travel modes (e.g. driving school, cycle training, training for the elderly on how to use PT etc.).
- Ensure safe and considerate travel behaviour (e.g. awareness campaigns, safety driving training etc.).

The White paper on the European Transport Policy in 2010 [3] states that “the importance of information and awareness in European transport policy is a key to the success of inter-modal transport systems and the efficiency and safety of movement of goods and people.” The Extr@Web initiative looking at travel awareness campaigns [127] indicated national research in this field but no research on EU level. It also recommended research in this field as another area of potential expansion and with the need to gain more acceptability and importance by travel authorities and the public. National projects concerning the improvement of safe travel behaviour in Extr@Web [128] found that safety trainings have a significant effect on the behaviour, even though the specific training method depends much on the addressed user group (age, mode of transport, experience etc.).

Tele-working

Studies from the MOBINET [105] project have led to the result, that tele-working has an impact on mobility behaviour. It was noticed, that tele-working can influence the timing of trips, especially the work trips International and German studies come to the conclusion, that tele-working could help to spread the traffic volume over the whole day [9]. According to MOBINET, tele-working has led to a reduction of PT use. One reason for the reduction of trips could be that some tariff offers like weekly tickets became less efficient for a customer using tele-work. Another reason could be the flexibility of needed travel outside of peak hours which might allow the tele-worker to use the private car instead of PT. This shows, that such measures could also have counterproductive effects and have to be further researched in case potentials of such societal changes like tele-working, internet shopping/learning etc. are evaluated to be remarkable. Difficult seems to be the promotion of such measures and the chances to influence moves towards such measures. Critics also see the decrease of social contacts and physical exercise, as well as the increase of delivery traffic as problematic when discussing about tele-working, internet shopping/learning etc.

4.12.3 First Identified Open Issues

- What are the factors influencing modal choice? How to induce a behavioural and modal change in favour of non-motorised means and public transport?
- Variation of life-styles influences mobility in cities and need for research on other socio-economic and socio-psychological influences on mobility behaviour.
- Need for better knowledge of consumer wishes and needs concerning integrated multi-modal travel possibilities, development of more flexible mobility concepts and improvement of PT in aspects which are advantages of the private car use.
- Research on how to change the habitual behaviour concerning modal choice and how to approach users most efficiently.
- Need for research on acceptance of new, flexible and inter-modal transport concepts (acceptance research of transport offers and measures are vitally important for success of concepts and their measures).

- Need for better knowledge of the optimal design of transfer-stations and waiting rooms.
- Lack of knowledge about the effects of mobility management including information services on traveller's behaviour and how information of these systems if really used à very important aspect for transport modelling.
- Applied projects and good practices in European cities to influence travel motivation and modal choice.
- EU wide standards for minimum requirements (minimum standards, minimum behaviour specifications) of driving personnel in urban transport companies to increase safety of transport system and service.

4.13 Funding of Transport Infrastructure (E1)

4.13.1 Description of Topic

Throughout EU Member States, there is an increasing pressure on public funds for transport infrastructure. This section looks at two so-called "innovative" instruments that have been proposed as an alternative: public private partnerships and land value capture.

4.13.2 Status

Public Private Partnerships (PPP)

EU Policy Papers on PPP

At European level, it was recognised that recourse to PPPs could help to put in place trans-European transport networks, which had fallen very much behind schedule, mainly owing to a lack of funding (see the White Paper on European Transport Policy [3], the Communication from the Commission of 23 April 2003 on "Developing the trans-European transport network: innovative funding solutions - interoperability of electronic toll collection systems", COM (2003) 132 [23], and the Report of the high-level group on the trans-European transport network of 27 June 2003 [24]).

Actually, as explained in the Green Paper on Public-Private Partnerships and Community Law on Public Contracts and Concessions [25], there is no Community level definition of the term. In general, the term refers to forms of cooperation between public authorities and the world of business which aim to ensure the funding, construction, renovation, management or maintenance of an infrastructure or the provision of a service.

The Green Paper identified the following elements as normally characterising PPPs:

- The relatively long duration of the relationship, involving cooperation between the public partner and the private partner on different aspects of a planned project.
- The method of funding the project, in part from the private sector, sometimes by means of complex arrangements between the various players. Nonetheless, public funds - in some cases rather substantial - may be added to the private funds.
- The important role of the economic operator, who participates at different stages in the project (design, completion, implementation, funding). The public partner concentrates primarily on defining the objectives to be attained in terms of public interest, quality of

services provided and pricing policy, and it takes responsibility for monitoring compliance with these objectives.

- The distribution of risks between the public partner and the private partner, to whom the risks generally borne by the public sector are transferred. However, a PPP does not necessarily mean that the private partner assumes all the risks, or even the major share of the risks linked to the project. The precise distribution of risk is determined case by case, according to the respective ability of the parties concerned to assess, control and cope with this risk.

The aim of this Green Paper was to launch a debate on the application of Community law on public contracts and concessions to the PPP phenomenon.

The Green Paper also points out that in the transport sector, the organisation of a PPP may be subject to specific sectoral legislation. For urban transport, the relevant regulation is the Council Regulation (EEC) No 1191/69 on action by Member States concerning the obligations inherent in the concept of a public service in transport by rail, road and inland waterway, as amended by Regulation (EEC) No 1893/91, and the amended proposal for a Regulation of the European Parliament and of the Council on action by Member States concerning public service requirements and the award of public service contracts in passenger transport by rail, road and inland waterway (COM(2005)319 final [106]).

Following the Green Paper consultation, COM(2005) 569 [26] final presents the policy options following the consultation.

In 2006, the European Commission published its Mid-term review of the 2001 Transport White Paper “Keep Europe moving - Sustainable mobility for our continent” [3]. In the context of the funding of the Trans European Networks (TEN) and of Intelligent Transport Systems, it insisted that a more active use of public-private partnerships can accelerate the implementation of projects, increase value for money and ease pressure on public finances.

On 26 October 2006, the European Parliament rejected the idea of a regulatory framework specific to PPPs but took a stance in favour of a Directive on concessions and an interpretative communication on institutionalised PPPs.

To the best of our knowledge**, no specific EU policy documents exist on the use of PPP in urban transport**.

EU Research on PPP

The central purpose of the 4th Framework Programme project PROFIT [27] was to provide structured information and guidelines concerning the process of application of PPPs to finance and operate projects. However, the scope of this project was limited to the TENs.

The use of PPP in urban transport was mentioned in the state of the art report of the VOYAGER [28] project, where the following issues have been identified:

- The allocation of risks between the partners.
- The complexity of the contracts.
- The higher financing costs compared to the public sector.
- PPPs are more difficult to apply in local transport when the system cannot raise enough revenue to cover operations costs due to municipality imposed tariff restrictions and/or a lack of adequate demand. In these cases it is necessary to agree on a subsidy regime.

VOYAGER [28] concludes that "PPPs are most suited and in fact most applied in local and regional transport to largely self-financing projects such as new airport links with a fairly stand alone position in the integrated transport system (another source of external influence risk)."

The European Investment Bank has recently published two volumes of EIB Paper [29] [30] dedicated to PPPs.

From these papers, the following conclusions seem particularly noteworthy:

- Public-private partnerships can offer *productive* efficiency gains over traditional public provision. Indeed, PPPs seem to be better at providing incentives for life-cycle cost savings than traditional public procurement; the builder and the operator have the right incentives to minimise life-cycle costs.
- However, the pursuit of productive efficiency may jeopardise allocative efficiency, as cost-cutting may lead to quality-cutting. The division of risks, in turn, can become a source of productive inefficiency if it fails to allocate each risk to the partner in the best position to manage or bear it. And, finally, the fact that the partnership requires the establishment of a long-term contract with a high degree of incompleteness imposes a significant cost on it.
- High transaction costs are perhaps the worst, and least studied, drawback of PPPs.
- Fiscal policy should be a non-issue in deciding how to finance and provide services. The shifting of investment between public and private sector books does not create any leeway in public finances or in the economy more broadly. In other words, there is no macroeconomic case for – or against – public-private partnerships.
- The PPP model is suitable for some public services but not for others. In the case of transport, public-private partnerships for roads, bridges and tunnels seem to make eminent sense. However, the case for public-private partnerships is doubtful when public safety is of considerable concern – railway networks being a prime example.
- Competition for public-private partnerships is key for getting value for money.

Land Value Capture

The argument in favour of Land Value Capture can be summarized, maybe somewhat crudely, as follows. Public transport improves accessibility of a certain area. This will lead to an increase of the value of land within that area. Taxing away these increases in land value and earmarking them for the funding of public transport infrastructure, is an efficient and fair source of funding for public transport.

It is efficient because land values (as opposed to property values) do not depend on actions undertaken by the owners. Therefore, this tax does not affect incentives for development negatively. On the contrary, land value taxation provides incentives for developing property rather than letting it stay idle for speculative reasons. Moreover, it induces a higher population density and less urban sprawl.

It is also fair because it is public transport investment that has led to this increase in land value in the first place. Therefore, if farebox revenues are not sufficient for recouping this investment, it is not up to the general taxpayers to pay for this deficit.

We have no knowledge of European research specifically dedicated to this instrument.

It has briefly been discussed in the context of the Urban Transport Benchmarking Initiative [31]. However, the sample of cities involved in this project was too small to reach any meaningful conclusions.

Value capture was also succinctly mentioned in the State of the art report of the VOYAGER [28] project.

The feasibility of the instrument depends of course largely on the economic impact of transport infrastructure investment. In this respect, we can refer to the 5th FP TranSEcon [32] research project who aimed to provide qualitative and quantitative evidence regarding the existence of the direct and indirect effects and impacts of transport infrastructure investments in 13 European cities. These effects have been analysed using existing data-bases together with stakeholder interviews in the 13 European case studies. The selected case studies cover a good range of city and intervention types (in terms of geographical distribution, city size, transport policies and investments).

The general conclusion of the project is that transport infrastructure investments offer great potential for socio-economic effects. Not all of these effects are positive. The spatial development of the settlement from the point of view of sustainable mobility and land development requires special attention: depending on the investment project and the changes of accessibility it causes, both desired and undesired concentrations and/or urban sprawl can result. Therefore, “everything is possible” in principle, it all depends on the framework conditions.

4.13.3 First Identified Open Issues

- The development of a generally accepted methodology for quantifying the benefits and costs of PPP compared to traditional procurement, both ex ante and ex post.
- Estimating the transaction costs linked to PPPs.

From a recent internal UITP document, the following research questions have emerged:

- The main difficulty with land value taxation lays in the practical estimation of land value, as real world transactions relate to property, not land.
- How to disentangle the individual contribution of each publicly provided good to the global value of a property?

- § How to improve the political acceptability of land value capture?
- § What changes in the legal framework are necessary for the implementation of land value capture?

4.14 Transport Pricing (E2)

4.14.1 Description of Topic

Traditionally, transport infrastructure has been freely available for its users (both private vehicle and public transport companies). However, the European Commission has now long been advocating a "correct" pricing of infrastructure, in order to internalise external effects of transport on the one hand and to recover transport investment on the other hand. In reality, implementation of these principles has been slow. While technical barriers may have been an important barrier in the past, political constraints are predominant nowadays.

4.14.2 Status

EU Policy Papers on Transport Pricing

The introduction to the final report of the IMPRINT EUROPE Thematic Network [33] gives an excellent overview of the evolution in European policy on transport pricing (p.10).

The landmark documents of European Commission policy on transport pricing were the Green Paper "Towards Fair and Efficient Transport Pricing", 1995 (in which the importance of pricing to reflect external costs was recognized) [108] and the White Paper on Fair Payment for Infrastructure Use, 1998 [109]. The 1998 White Paper made the case for Marginal Cost Pricing but also recognized that it might be appropriate to depart from marginal social costs when cost recovery requirements are stringent.

The White Paper on the Common Transport Policy (2001) [3] proposed a framework directive on pricing, which would set out the principles to be followed in all modes of transport. An important link was also drawn between pricing and financing. The proposed framework directive was later abandoned (IMPRINT EUROPE Final Report p. 6 [33]).

In 2006, the European Commission published its Mid-term review of the 2001 Transport White Paper "Keep Europe moving - Sustainable mobility for our continent" [6].

A whole section of this document is dedicated to the issue of smart charging. It refers to the increasing use of infrastructure charges throughout the EU and to the adoption of the new road charging directive (the Eurovignette directive) as a framework for the introduction of modulated tolling for lorries on the trans-European network. These distance-based user charges can be channelled to the financing of infrastructure in some cases.

It also announces the Commission's intention to present a generally applicable, transparent and comprehensible model for the assessment of all external costs (no later than 10 June 2008) to

serve as the basis for future calculations of infrastructure charges accompanied by an impact analysis of the internalisation of external costs for all modes.

With respect to infrastructure charging in *urban* areas, the document emphasises that the task of the EU is to promote the study and exchange of best practice across the EU. However, as charging affects traffic flows between modes and across the entire internal market, the Commission announced to launch a broad-based process of reflection which also includes rail, air, waterborne and urban transport.

The state of the art Report published in 2006 by the IMPRINT NET [34] project observed that "(s)ince the publication of the 1998 White Paper [109], the EC started to implement these principles at a modal level through legislation. The process has been slow, and the few directives issued find difficulties in being translated into national laws by Member States mostly because at the national level the principle of social marginal cost pricing is not smoothly accepted".

EU Research on Pricing

It is beyond the scope of this work to give a complete overview of all research undertaken in this field at the European level – good overviews are provided in the final report of IMPRINT EUROPE and in the state of the art report of IMPRINT NET [34]. We will therefore limit ourselves to the most recent research, which anyway incorporates the lessons learned from previous projects.

As explained in Delle Site, 2006a [40], at the start of the 5th Research Framework Programme there were seven main research questions:

- How can the monetary values of intangibles be estimated?
- How should the marginal cost pricing principle be implemented?
- What are the real life impacts of road charging schemes?
- How can road charging be implemented in practice?
- Is it possible to raise acceptability of road charging schemes?
- What is the best use of revenues from charges?
- How can pricing measures be integrated with other measures?

In the 5th Framework Research, the following projects are the most relevant for our concerns:

- CUPID [35]
- IMPRINT EUROPE [33]
- MC-ICAM [36]
- PROGRESS [37]
- Urban Case Study in REVENUE [38]
- SPECTRUM [39]

The CIVITAS [7] project also funded some measures in urban transport in participating cities, including parking pricing.

The most important subjects covered in these projects were (we refer to [40] for a more comprehensive review):

- Barriers to implementation of pricing reform (MC-ICAM, CUPID, REVENUE, PRoGRESS, SPECTRUM), including technology (reliability, cost, interoperability) and institutions (subsidiarity principle, national laws, lack of co-ordination, disconnected decision making structures).
- Public acceptability and political strategies (IMPRINT EUROPE, CUPID, PRoGRESS, SPECTRUM, REVENUE).
- Implementation paths for reform (MC-ICAM).
- Benefits from implementation, including environmental benefits and other non-user benefits (MC-ICAM).
- The degree of differentiation across vehicle/infrastructure users, over time and spatially (MC-ICAM).
- Revenue use, including earmarking and cross-subsidisation between modes and regions (MC-ICAM, IMPRINT EUROPE, CUPID, REVENUE).
- Supplementary measures and actions; investments to increase capacity, non-price regulation and information provision systems, land use policies, reserved bus lanes, institutional reform (MC-ICAM, CUPID, PRoGRESS, SPECTRUM).
- Relation of infrastructure pricing with the pricing and subsidisation of public transport (MC-ICAM, IMPRINT EUROPE, PRoGRESS, SPECTRUM).
- Relation with urban sprawl (IMPRINT EUROPE).
- Relation with labour market (IMPRINT EUROPE).
- Long run versus short run marginal social cost as a basis for marginal social cost pricing (IMPRINT EUROPE).
- Exemptions from charges (CUPID).
- Cordon versus distance-based charging (CUPID, PRoGRESS).

The approaches included research projects (MC-ICAM, REVENUE, SPECTRUM), Thematic Networks (IMPRINT EUROPE, CUPID) and Demonstration Projects (PROGRESS). Some projects covered all modes (MC-ICAM, IMPRINT EUROPE, SPECTRUM), while some had a specific focus on urban transport (CUPID, PRoGRESS, REVENUE Urban Case study).

Several projects (MC-ICAM, IMPRINT EUROPE) agreed that urban areas have the most urgent need for action.

In the 6th Framework Programme, IMPRINT NET has been the successor project to IMPRINT EUROPE. A state of the art report has been published in March 2006. For road and rail transport, this report concludes that there is a need to move from establishing a theoretical framework and improving valuation methodologies to the more mature stages of designing and implementing a policy, and assessing the impacts.

Finally, in May 2006, a new 3-year EU funded project to promote and support road user charging in urban areas (CURACAO [41]) was kicked off. Until now, this project has produced no deliverables.

Delle Site, 2006b [42], summarizes the state of the art in *urban* pricing as follows:

> 'The pricing schemes showed overall benefits in terms of congestion reduction and environmental impacts while maintaining acceptable boundary congestion levels as a side-effect. Maximum benefits are achieved if pricing is combined with complementary measures. Acceptability is a main concern, although opposition seems to reduce after implementation. Success factors of urban road charging schemes include proper communication, transparency and accountability in the allocation of revenues, hypothecation of revenues within the transport sector, a strong scheme promoter.'

4.14.3 First Identified Open Issues

- Estimates of the infrastructure and operating costs of pricing systems (MC-ICAM).
- Estimates of the adjustment costs incurred by agents when making policy-induced changes in location, auto ownership or other choices (MC-ICAM).
- Further evidence is needed on particular types of impacts – land-use, regional economic, distributional; (IMPRINT EUROPE).
- Complexity and simplicity are important research issues – to what extent should we seek ultimately to portray the full complexity of variations in marginal social costs in prices? (IMPRINT EUROPE).
- Processes and institutions also need research - what bodies should set or regulate prices and be responsible for allocating the revenue (IMPRINT EUROPE). Implementing pricing reforms and deciding on the utilisation of possible revenues (as well as on how to cover possible deficits) raises fundamental institutional questions as to who bears these responsibilities, and how coordination could best be ensured should these responsibilities not reside with the same institutions. The impacts on the efficiency of decentralising investment decision making to lower levels of government, agencies and private firms are a key issue here. (IMPRINT NET).
- Practical experience suggests that heavy goods vehicle charging can have significant effects on the types of vehicles selected and the way they are used. There is however no real evidence of the impact of charges on mode split. (IMPRINT NET).
- Acceptability should be further investigated by questioning "acceptability of what, through whom and under which conditions and circumstances". (IMPRINT NET).
- Empirical evidence should be collected on the impacts on travel patterns of discounts and on the loss of benefits resulting from exemptions and discounts. (Delle Site, 2006a [40])
- Optimal combination of road charging with other measures needs further research. [40]
- Analysis of the implications of different solutions for re-allocation of road space would be valuable. [40]
- Research is needed to deepen the understanding of the behavioural responses to pricing and other policies of the stakeholders in the freight transport and logistics markets. [40]

The following items also deserve attention (some of these points have been suggested by Arnott (2001) [46]):

- Further road pricing studies should have a special focus on employers' cars used by employees for home-to-work trips.
- Amongst the complementary measures to road charging, the following deserve specific attention: the pricing structure of public transport, PT improvement measures (reserved lanes, prioritisation).
- Current models of traffic congestion do not take into account automobile characteristics (car length).
- Research should look more into congestion that is not of the link flow type, such as nodes congestion and pedestrian-car interaction.
- Parking related congestion is a particularly important research topic, particularly the trade-off between reducing congestion due to cars cruising for parking and the capacity reduction due to on-street parking and double parking. More research should be invested in parking policies (taking into account the difference between public and private parking, on street and off street parking).
- The relation with the economics of agglomeration and the benefits of face-to-face interaction.
- Take better into account the specifics of urban freight (do not consider trucks as simple car-equivalents); for instance regulate truck size as a complementary measures to congestion pricing.
- Cost-benefits analysis should take better into account the irreversible nature of much investment in a context of uncertainty (move to real option analysis).
- The economics of pedestrian congestion.
- The potential of flexible work hours as a means to reduce congestion.

4.15 The Costs of Urban Transport (E3)

4.15.1 Description of Topic

Social marginal cost pricing obviously requires good quality estimates of the costs of transport. However, there remain numerous questions on the appropriate methodology for estimating external costs. Moreover, all existing work is plagued by an absence of publicly available standardised and comparable data.

4.15.2 Status

Social marginal cost pricing obviously requires good quality estimates of these costs, as has for instance extensively been argued in IMPRINT EUROPE [33].

Again, there is a long history of EU funded research in this area, and we concentrate again on the most recent work (5th and 6th Framework Programme).

The 5th Framework Programme Research Project UNITE [43] had three core objectives:

- To develop pilot transport accounts for all modes, for the EU-15 and additional countries.
- To provide a comprehensive set of marginal cost estimates relevant to transport contexts around Europe.
- Deliver a framework for integration of accounts and marginal costs, consistent with public finance economics and the role of transport charging in the European economy.

UNITE's [43] successor project in the 6th Framework Programme is GRACE [44], whose aim is to provide new evidence on the costs of transport infrastructure use for all modes of transport, and on the consequences of charging these costs to users.

This project has until now produced 2 deliverables, Information requirements for monitoring implementation of marginal social cost pricing and Information requirements for examining optimal complexity of transport pricing.

The state of the art report produced in IMPRINT NET [34] gives a good overview of the achievements up to date in this field:

- Extensive research has been carried out in the valuation of social external costs showing that methodologies and tools are available to calculate external cost values with acceptable accuracy levels, although the maturity of the methodologies still varies between modes and cost categories.
- The strong orientation of the EU policy towards the adoption of the principle of marginal social costs for pricing reforms has played a major role in orienting research on external costs of transport. In order to estimate marginal costs, research has turned to test and implement bottom-up methods, in particular econometric methods and engineering methods.
- The most common approach to the calculation of environmental costs is the Impact Pathway Approach (IPA). The IPA adopts the principle of estimating costs starting from the chain of events (physical changes) induced by the transport activity.
- There is general consensus about the methodology to be used to estimate marginal congestion costs or benefits.
- The methodology for the estimation of traffic accident costs is well established.

4.15.3 First Identified Open Issues

- Infrastructure costs and scarcity costs are still under-researched areas on which research efforts are lately converging.
- Major differences in the assessment of external environmental costs still exist. Values can thus vary by as much as a factor 10, particularly for what concerns local effects, mainly owing to different approaches to exposure modelling.
- The main outstanding problem in the estimation of the costs of congestion is that different models use different speed-flow relationships and therefore yield different results.
- The possibility to estimate the link between accident risk and traffic volume (risk elasticity) is limited by the poor availability of information on exposure to risk.

- The most critical issue concerning noise costs estimation remains the availability of data on exposure.
- The Final Report of IMPRINT EUROPE ([33] p. 30) had also pointed out that generalisation – how to estimate costs for particular circumstances from available evidence – remains a major issue (this is especially a problem for congestion and local environmental impacts).

4.16 Organisational Framework for Public Transport (E4)

4.16.1 Description of Topic

Subsidising public transport is recognized by economic theory as an acceptable second best solution if it is politically difficult to impose social marginal cost pricing on private modes. Moreover, public transport companies often have to fulfil public service obligations and thus require some sort of compensation for doing so. However, concerns have sometimes been raised that this public funding may have led to covert state support for inefficient operators. The European Union is now about to introduce a new regulation that is meant to settle this discussion. However, several questions remain open.

4.16.2 Status

EU Policy Papers on the Organisation of Public Transport

In most areas of urban transport, the subsidiarity principle implies that the intervention of the EU cannot go beyond the study and exchange of best practices.

However, some aspects of the *organisation* of public transport are affected by EU legislation on state aid, competition and intra-Community trade.

The basic document is Council Regulation 1191/69 which defines the conditions under which public authorities may pay compensation for public service obligations they impose in the area of passenger transport by railway, road and waterway.

In 2000, the Commission proposed a new draft regulation (COM(2000) 0007 [107]) “to open up the market while guaranteeing the transparency, quality and performance of public transport services by means of regulated competition”. Getting this draft approved was also included in the Action Programme of the 2001 White Paper [3].

After several years of difficult negotiations, a new proposal (COM(2005)319 final [45]) was introduced.

The most important elements of this new draft are:

- The obligation to establish a public service contract determining the content of the public service obligations as well as the level of financial compensation.
- The opening up to competition of public service contract, while recognizing the possibility for a public authority to provide these service itself or to award them directly to an internal operator.

A political agreement on a revised proposal was obtained during the Transport Council meeting on 9th June 2006. The second reading of the European Parliament began on the 18th January 2007. As from this date runs the 3 + 1 month deadline.

EU Research on the Organisation of Public Transport

ISOTOPE

The final report ISOTOPE was published in 1997 and directly influenced draft regulation COM(2000) 0007 [107]. The aim of the project was to assess the relative merits of existing legal and organisational frameworks for Urban Public Transport (UPT) across Europe, and identify areas for improvement.

MARETOPE

In some sense, MARETOPE can be considered to be the successor project to ISOTOPE. The overall objective of the MARETOPE project was to investigate in an integrated way the impacts of changes in the regulatory framework on the roles and activities of the different stakeholders in public transport organisation: public transport operators, public authorities, users and producers of transport means and systems.

Furthermore, it also focused on the identification of barriers to change and the development of tools to support decision-makers in that process and in the management of transition periods.

A major downfall of the research was that there were a limited number of cases in which a sufficient time lag had passed after the implementation of reform that could allow measurement of the full extent of impacts. Recommendations from the research refer to a set of improvements that authorities and operators should undertake in order to create the basic data that will enable the assessment of their performance.

VOYAGER

The state of the art report of the VOYAGER project gives a good summary of the main concerns raised with respect to the introduction of competition in the PT market:

- Fear of decreasing attention to social and other wider community needs when introducing form of competition.
- Preferential position of the former, mostly publicly owned PT operator.
- Missing access to market information.
- Fear of worsening labour conditions.
- Lack of flexible forms of market access for different modes.
- Unfavourable PT market environment.
- Danger of unbalanced market forces.
- Transition period when introducing competition.
- How to combine the binding nature of a contractual agreement with the flexibility required to effectively and efficiently managing the overall mobility.
- Duration of contractual arrangements.
- Lack of integration through increasing number of actors

- Reluctance by authorities to transfer competencies to an integrating overall authority
- Lack of integration of PT policies and other urban (transport) policies

To the best of our knowledge, no further EU sponsored research has been conducted on this issue. However, this does not mean that the research agenda in this field is closed.

In a survey paper, De Borger et.al. (2002) [47] draw the following general lessons from the scientific literature on the performance of public transport and its relation with the organisational framework in which it operates:

- In the last decades, important differences in technical efficiency have been observed. Ownership, the risk sharing properties of contracts between operator and public authority, and the level and nature of subsidies to operators all directly affected public transit performance. However, the efficiency effect of improving competitive conditions in the industry has not convincingly been shown.
- While some network characteristics influencing efficiency levels are under the control of the companies or the public authorities (e.g. number of stops; network length; length of lines, etc.), others are largely exogenous (e.g. the average operational speed is mainly determined by transport infrastructure and congestion levels). The results do suggest that it may be wise to allow operators some freedom to organise their production to achieve maximum efficiency. Moreover, public authorities can influence the efficiency of transport operations by improvements in the transport network so as to reduce, for instance, congestion levels.

4.16.3 First Identified Open Issues

De Borger et.al. (2002) [47] identified the following areas for further research on this issue:

- The choice between input and output monitoring as well as the precise specification of outputs may demand more reflection.
- Many studies suffer from the lack of appropriate data.
- There is a huge need for comparative international research to provide more details on the relative performance of operators working under different regulatory regimes.

The following points could be added:

- The administrative costs linked to different contracts forms.
- In a tendering regime, how to avoid collusion between bidders.
- The optimal level of delegation to lower level of government, taking into account administrative capabilities.

4.17 Key Issues of New EU Member States

This section will highlight some major topics to consider when looking at the state of the art of research and implementation in the field of urban mobility in all Members States of the EU. There are still considerable differences between the New EU Member States and other members, and even considerable differences between the New Members, i.e. between Malta or Cyprus and the former socialist states.

This section relies on information from cooperation partners of the EURFORUM consortium from the Czech Republic, Lithuania, Poland and the Slovakia[29], several reports [4], [98], and knowledge from scientific discussions and exchange.

When reviewing the situation in the New EU Member States of the 5. Enlargement, part I, one has to keep in mind that the Central and Eastern States do represent special situations due to their socialistic past. This and the lack of financial funds are major reasons for problems in the development and transport sector in these countries. Besides some similarities between these countries being the main discussion theme in this section, one should also keep in mind, that there are significant differences between them, as well. This refers to their individual development after the political change, different developments in terms of regulations, planning instruments, political, societal and economical circumstances. It also has to be seen that all new EU Member States face similar problems of the future concerning the urban transport system like Member States from the EU-15.

Nevertheless, most enduring differences between the Central and Eastern States and other members result from the countries' history - for example the often high centralisation of planning and decision making in these countries which hinders flexible and locally adjusted strategies and cooperation. Of course, this does not mean that there is no decentralisation. In Poland for example, land use planning is generally decentralised and local authorities are exclusively responsible for developing a land use master plan which does also serve as the basis for local transport planning.

Depending on the organisational structure of the countries – centralistic state structures vs. federalist state structures – municipalities and regional administrations in the new EU countries are often not able to implement independently vital transport projects (especially infrastructure projects) relevant for this specific region or city without financial support of central authorities.

The Twelve Candidate Countries Overview Report [98] states that in addition to that civil society is still less influential on local and national politics than in other Member States. It also explains that some former socialist countries have strong functional spatial divisions while Malta faces considerable sprawl.

[29] *The members of T-NEG (Transportation in New EU-member Countries - General Research Network for Harmonization and Integration), a network of researchers and practitioners from the Central and Eastern European Countries and Germany. (http://www.tu-dresden.de/srv/t-neg/Deutsch/Englisch/index.html)*

Concerning the development of long-term policies, it should also be noted that the young democracies of the Central and Eastern States more often lead to less stable political grounds due to a higher fluctuation of politicians and administrations and still existing consequences of their political transformations. Instruments and regulations are not as settled as in the other Member States and are under transformation due to requirements and adjustments following the accession to the EU.

In [98], all countries were identified to be struggling with the decay of their historical inner cities and mass-produced, pre-fabricated housing in all former socialist states which lead to great challenges for renewing of housing and infrastructure, partially low mixture of use and therefore impacts on the transport system at great dimensions. In stronger relation to transport and mobility, the main problems in these countries can be described as follows (apart from exceptions):

- The rapid increase in car ownership (motorisation) is leading to congestions and increased traffic accident rates in cities, partially to higher rates of motorisation than in comparative EU cities [98]. This also leads to dramatic collapses of the share of public transport in Central and Eastern European States which had/have the advantage of a very high market share of PT of partially above 50 % [98]. This development is also driven by other reasons than the wider availability of cars, like an older vehicle fleet in PT, lacking coordination of different PT operators and missing one-ticket systems, decreasing funding of PT and restrictions in routes served and reduced operational frequencies due to lowering the costs. As found in Poland, the decrease of shares of PT could be stopped in most bigger cities, but is still going on in middle sized and small towns.
- Another result from the extremely fast rising car ownerships are massive car parking problems in city centres.
- Nevertheless, the mobility of many people in the Central and Eastern European Countries, esp. the mobility of labour force is often more heavily relying on public transport due to a lower income of many private households compared with other countries of the EU-25. The number of low income or unemployed people who are limited to PT (besides walking and cycling) in their choice of transport modes is still higher. The removal of less used, “un-economic” lines of public transport imposes great difficulties on them and leads to further impoverishment and their social exclusion from the community. Due to the fact that there are old used cars available at a low price in the new members, worsening PT services also support the increasing use of private vehicles by the population.
- An ageing road infrastructure in urban areas, despite efforts from local governments to modernise, is not suitable for the rapid increase of passenger car transport and parking. Also, missing infrastructure for bicycle traffic is limiting the use of bicycles for everyday travel needs. In addition to this, the spatial structures in cities of many former socialist countries are severely functionally set-up with separated functional uses of neighbourhoods. The resulting limited mixture of functions leads to a higher need for transport because the needs of the inhabitants can not easily be met within their neighbourhood [98]. In Malta, [98] states that urban sprawl and uncontrolled developments are additional reasons for the increasing shares of motorised private transport.
- While there is political support of cycling favouring strategies, especially the supply of cycling infrastructure is not proceeding so fast due to lacking funds. The provision of safe

cycling facilities is most likely a major aspect to improve the use of bikes due to safety issues being the major reason to not use a bike, particularly in cities and towns.

- Even though there is an awareness of the necessity of SUTP at most transport planning levels – national, regional or local – there are still barriers existing which hinder the implementation of a sustainable transport planning strategy. One of these barriers is the somewhat theoretical perception of these policies by authorities and responsible planners. They do not see clear links to their local situation and they are missing more detailed and locally transferable guidelines on what indicators to use, what steps to take, how to best approach public and decision makers and so on – despite of quite a number of research projects, demonstration initiatives and decision-making handbooks on the EU-level.
- Another barrier is the urgency of traffic problems which leads to high pressure focussing on road network extensions and renewals. The fast rising shares of motorised road transport mislead many local authorities to concentrate all their efforts on eliminating ”hot spots” in their local road network where congestion problems for example are the worst. This often oversees the need for long-term, integrated and sustainable planning strategies which should aim at a balanced transport system, combining car-restrictive policies with supporting strategies for PT, walking and cycling.
- Even if local authorities pass long-term transport plans, there has to be stated, that the integration of transport planning, land use planning and other planning activities is often lacking [98]. This leads to urban sprawl increasing the pressure on the transport system. Additionally, there is still a lack of instruments to control urban sprawl which is intensifying especially around bigger cities in Poland for example. Like in most other countries, the coordination of land use planning is not required while economic interests and lacking communication networks between neighbouring municipalities support the independent development of land use policies instead of integrated approaches.
- Another problematic aspect is the inadequate integration between various transport modes (inter-modality) and in general a poor coordination of transport and land use planning between neighbouring municipalities.
- Traffic Management Systems could help to deal with the increasing traffic problems in cities and towns, to manage congestion and better operate existing road infrastructure and public transport. Such systems are not as much used as in other Member States, often because of scarce public funds to support the development of such intelligent transport systems. Another barrier to the implementation of ITS is the greater willingness of local authorities to spend available funds on “hard” infrastructure as building of roads than on the development of ITS.
- Local authorities and politicians often do not see the need and benefits of mobility management for their city or town.
- In general, there is great opposition of politicians and public voices against the introduction of road pricing.

These problems do not represent the entire field and not all particular situations in all New EU Member States. There have been major achievements of research and implementation in the field of urban mobility in these countries, as well. This regards for example to:

- Increasing development of coordinated and long-term strategies for the development of the public transport system and road transport.
- Decentralisation of responsibilities and financing to local and regional authorities in order to better address the respective regional needs. In parts and in combination with insufficient provision of funds through the national government, this also can lead to negative effects like the closing of less economical lines of public transport etc.
- Development and application of intelligent transport systems to solve traffic problems.
- Higher significance of bicycle transport i.e. with the National Cycling Strategy of the Czech Republic and others.
- EU-funding helps to overcome the lack of investment funds for transport planning and infrastructure and EU-programmes like CIVITAS lead the way in promoting sustainable transport policies.

In respect to the further development and implementation the following aspects can be named:

- Due to the large socio-economic role of public transport and its market advantage in many New Member States, attempts to decrease the network, limited operational frequencies and especially closing PT lines should be carefully discussed and consequences considered.
- Application of sustainable urban transport planning in urban areas and cities, integration of transport strategies with land use planning and policies of neighbouring communities.
- Focusing on the interoperability of different transport modes.
- Implementation of strategic transport management and responsible authorities to allow more effective one-ticket systems and coordination of PT networks/schedules etc.
- Further and stronger enabling of a wider public participation in decision-making on sustainable development.
- Ensuring of education and promotion on sustainable travel, increasing awareness and encouragement towards sustainable travel habits.
- Improvement of infrastructure and conditions for pedestrians and bicyclists.
- Completion and harmonisation of legal acts on building, transport, land use etc.

As a result of little transport research on EU level with respect to the special needs and situations of the new EU countries, the following first list of recommendations for future research on and support from the EU level was established:

- Development of a framework for sustainable urban transport planning as an orientation for local and national initiatives [4].
- Supporting the exchange of experiences and adjustment of best practices from other EU Member States and of city-partnerships especially concerning the implementation of SUTP and integrated land use planning strategies. This should explicitly include cities and urban areas with less developed planning approaches and experiences.
- Linkage of EU funding to European policy, for example concerning SUTP.
- Supporting the development of new ways to apply modelling instruments for the definition and assessment of public and private urban transport demand (and thus ensuring mobility) as well as for the application of progressive modelling instruments (simulation, visualisation). Special attention should be given to a stronger support of the exchange of ex-

periences in transport modelling between old and new EU Member States by the EU, as well as the support of a standardisation of transport modelling approaches for all EU members.

- § Ways to deal with the rising transport flows especially in the frontier regions and urban areas, and in respect to freight transport.
- § Improvement of intelligent transport systems with respect to reliability and affordability.
- § Stronger integration of cities and towns in the New Member States in European research projects and a stronger consideration of special problems in these countries within the research.
- § Stronger support and enabling of exchange between researchers from all Member States.

These aspects can be seen as a first list of needs for research, integration and implementation in the New EU Member States. It includes recommendations being of particular interest for these countries as well as aspects being similar to those to be recommended for urban areas in other countries. A more detailed discussion of these open issues will be done while developing EURFORUM's SRA.

4.18 Identification of Key Stakeholders in the Field of Urban Mobility

A very important aspect to consider when trying to evaluate the past research and urban mobility development, is the active participation of different stakeholders in the process of discussion, policy making, research and implementation. The development of an internal stakeholder strategy of EURFORUM has determined the following types of stakeholders as the most important in the area of urban mobility:

1. Supra-national political authorities (European Commission, European Parliament, Committee of Regions)
2. Local/regional/national (elected) politicians in charge of transport, environment, urban development, industry, etc and their related administrative authorities
3. Public transport operators of metro/tramway/bus/trolleybus/waterborne system
4. Urban freight distribution companies
5. Managers of transport infrastructure (stations, rail infrastructure, freight distribution centres)
6. Manufacturers of transport vehicles (cars, buses, trains, ferries, trucks, two-wheels) and related systems (ITS industry)
7. Fuel suppliers
8. Transport users (public transport, cars, cyclists, pedestrians)
9. Transport employees and unions
10. Research providers/Academics/Consultants
11. Others e.g. transport safety, urban planning, financing institutions, city and real estate developers, standardisation

Most administrative and financial responsibilities within urban areas belong to the local or regional levels. They are much influenced by national policy and legal frameworks, but also by actions and strategic frameworks of the EU, influencing national developments and trying to give orientation to

urban planning and policy more and more. Therefore, implementation issues concerning measures and strategies in the field or urban mobility are mostly influenced by the local stakeholders. Nevertheless, almost all interest groups are integrated in higher levels and have lobby organisations influencing the national and European developments.

The EU has to and wants to use its influence on some major aspects which seem to be of special importance for a development of sustainable mobility approaches in cities and towns. This especially relates to aspects of integrated and long-term planning, the supporting of diversified energy supply for transport and the promotion of good practices in planning, policy and technology [3].

When looking at key stakeholders for research activities in the field of urban mobility, the interest and impact of the European level depends a lot on the particular research topic. Topics relating to financing and pricing, organisational aspects of public transport and issues of safety and security seemed to be of interest for the EU so far. Other stakeholders in research are mostly national authorities funding mobility research, researching organisations and universities etc., national and regional statistical agencies and partially local/regional authorities.

While many implementation projects aim for the discussion with local user groups, research projects which are not closely connected to user aspects, lack input from and discussion with user representing organisations. However, this lies in the nature of such research, esp. basic research and can therefore not state a general lack of user integration. But to successfully implement application-oriented research and successfully support (not force) more sustainable mobility behaviour in cities, the users have to be put at the heart of research and development. The best research results will not be helpful if the concept fails in everyday life application and when user needs or preferences are not adequately addressed within these concepts. In this context, special consideration will have to be paid to acceptance questions of road pricing, special user groups gaining influence/weight in the future like the mobility impaired or elderly and groups being of essential importance for the future of Europe, like children and families. Especially the consideration of these user groups seems not to be qualified enough in existing technology oriented platforms (ETP's) while their relevance for urban transport questions is immense and their acceptance of new measures can back up local authorities' policy choices or reversely impede their success.

Therefore, the development and suggestion of an adequate stakeholder structure will be one major task of the further work of EURFORUM. The next step will be to identify and develop innovative concepts and tools for organising a proper coordination at EU level between all the identified stakeholders and creating a forum at the European level which can effectively represent stakeholders of European research on urban mobility. This forum is needed to bring up all those items that are innovative, unconventional and which are too easily overlooked or forgotten in the institutional process in order to provide recommendations for innovative and inter-modal research on urban mobility issues.

5. Conclusion

The state of the art-report on urban mobility describes the initial point to develop a modified research agenda on this issue for the 7th FP.

For this purpose European research projects and political programs have been evaluated. Special consideration was given to the problems of new Member States.

The results of this review are impressive. Even though urban mobility is an affair of the local and regional level, the European Union initiated a substantial amount of research to make its contribution to an effective and sustainable development of urban land use and transportation, its economies, its integrated planning and development and for technological advancement in all areas. The European Commission actively supported the creation of “technology platforms” for various transport sectors which document progress and perspectives for modal development. Integration, human aspects, more cooperation and consensus building us in political decision processes are important topics for urban mobility research and support of implementation processes.

However, even though solutions and strategies exist, the unsustainable development of major indicators of urban transportation could not be stopped. Motorisation, car use, space consumption and urban sprawl, affordability and quality of life in inner cities seem to be major causes of increasing congestion, costs and environmental burdens of the urban transport sector.

Central points for a more effective and more sustainable integrated urban transport system were often regarding to policy priorities and support of implementation process:

1. Specific approaches and sector solutions alone will not be sufficient to reach the goals of urban mobility improvements. Coordination of all actors, processes and concepts will lead to a more cost-effective mobilisation of reserves and synergies. Integrated planning, managing, designing and operating has to be further developed through research and European pilot projects. It also should be claimed as a pre-condition for EU or national state funding of local measures/concepts.

2. Barriers for the implementation of integrated sustainable strategies lead to lacking application of research results on related concepts and measures in many urban areas, e.g. lack of financial and personal resources on the local level, political priority not given to the development of integrated locations, immature awareness of institutions and citizens regarding the complexity of the system and the necessity of interrelated multimodal push and pull measures and inefficient and unstable taxation systems to finance transport. These barriers have to be identified and eliminated. “Soft measures” of mobility management tend to be very cost efficient and need more acceptance by decision makers.

But of course, most important further research is needed as well to provide technological solutions and help to find answers to so far unsolved questions of urban mobility:

1. More comparable urban transport data through standardised collection and analyses of data would allow European benchmarking of cities and better monitoring of locally ap-

plied strategies and measures. Regular, continuous, integrated and multimodal data collection according to European standards, which should be developed, would lead to a better comparable basis for decisions and funding. The data would allow a regular updating of transport plans and forecasts as basis for implementation and evaluation of measures and strategies. Research has to help develop such European standards of data collection and analysis which should be a pre-condition for European and national state funding in combination with integrated sustainable transport plans.

2. Further research efforts are recommended to develop a more reliable, fair and intermodal comparable system to finance investments in and maintenance, operation of the (urban) transport sector. Charging costs primarily to direct and indirect users[30] or to tax payers; public private partnerships (PPP), internalisation of external costs etc. are some of the major issues.

3. There are still research needs to enable safe travel, providing more flexible transportation and liveable public space while reducing negative impacts on the environment. This refers to technological developments of cleaner and more cost-efficient vehicles, technologically standardised concepts for inner urban freight, transfer solutions, solutions for inter-modal travel/transport information and more.

4. Questions are still arising from the complexity of human behaviour being of importance to model the effects of information and mobility strategies on the behaviour as well as to ensure the acceptability of future mobility concepts.

This State of the Art report on urban mobility describes the situation and first identified open questions for future research and development in the fields of 12 different thematic topics (see Figure 1, page 13).

A Strategic Urban Mobility Research Agenda will be developed on the basis of this State of the Art report also considering basic research needs. However, special consideration is given to applied research to improve urban mobility problems.

European cities appreciate the research attempts of the European Union. However, they are in need of more support for implementation and better local level oriented dissemination of re-search results and best practices. It is hard to convince urban decision makers with theoretical findings but easier to demonstrate the success story of good examples.

Considering the situation of urban mobility in New EU Member States, slightly different aspects of research and implementation should be emphasised due to such factors like:

- Rapid increase of car ownership
- Aged infrastructure
- Scarce public funds

[30] *E.g. land value capture (see section 4.13, page 64)*

- Sometimes still sectoral and centralised planning
- Less experience in participation and cooperation processes
- Less inter-modal transport concepts.

The development in these countries needs a specific framework for exchange and funding and the stronger integration of local researchers and decision makers in European projects on urban mobility. Guidelines to establish sustainable integrated urban transport planning, effective tools for demand management and mainly stronger integration and participation should be developed, considering particularly the special situation in these countries.

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Annex

Annex 1: List of Reviewed Documents

Projects and Project Reviews

Title of Project or Review	Particular Reviewed Document	Relevance for EURFORUM
PLUME: Planning and Urban Mobility in Europe	Third annual State-of-the-Art Review, July 2005 and Final Report, September 2005, www.lutr.net/deliverables.asp	relevant
EXTR@WEB: Exploitation of Transport Research Results via the Web	Second Annual Thematic Research Summary – Urban Transport, March 2006, http://ec.europa.eu/transport/extra/web/themes_analysis.cfm	relevant
ADONIS: Analysis and Development of New Insight into Substitution of Short Car Trips by Cycling and Walking	http://cordis.europa.eu/transport/src/adonisrep.htm, May 2006	not so relevant
BESTRANS: Benchmarking of Energy and Emission Performance in Urban Public Transport Operations	http://www.tis.pt/proj/bestrans, May 2006	not so relevant
CONNECT: Co-ordination of Concepts for New Collective Transport	Reports of Expert Network on Flexible Transport Services, 2004/2005, http://projectapps.vtt.fi/Connect/portal/alias__Rainbow/lang__en/tabID__1/DesktopDefault.aspx	relevant
COUNTERACT: Cluster of User Networks in Transport and Energy Relating to Anti-Terrorist Activities	Annex 1 to the Proposal No. 022669	relevant
ELTIS: European Local Transport Information Service	PARAMOUNT, Large Scale Dissemination for Clean Urban Transport [37] http://www.eltis.org	not so relevant
EURNEX: European Rail Research Network of Excellence	Periodic Activity Report 2005, February 2006 www.eurnex.net	not so relevant
FAMS: Upgrade of Current Demand Responsive Transport Services	2002/2003	not so relevant
GUIDEMAPS: Gaining Understanding of Improved Decision Making and Participating Strategies	Handbook, Internal Report I2 and Deliverable D2 – „Review of common practice in decision-making in local and regional transport schemes“ http://www.isb.rwth-aachen.de/guidemaps/downloads/Resources/Review_of_common_practice.pdf and http://www.civitas-initiative.org/docs1/GUIDEMAPSHandbook_web.pdf	not so relevant
ISOTOPE: Improved Structure and Organisation for Transport Operations of Passengers in Europe	http://cordis.europa.eu/transport/src/isotope.htm, May 2006	relevant
LIBERTIN: Light Rail Thematic Network	Final Report, 2005 http://www.libertin.info/pdf/Final_public_report_libertin.pdf	not so relevant

MARETOPE: Managing and Assessing Regulatory Evolution in Local Public Transport Operations in Europe	Handbook, October 2003 http://ec.europa.eu/transport/extra/web/index.cfm	relevant
MODUrban: Modular Urban Guided Rail Systems	Several project documents, 2005/2006 http://www.modurban.org/	not so relevant
MOSES: Mobility Services for Urban Sustainability	State of the Art Report, December 2001 and Implementation Report, December 2004	not so relevant
NICHES: New and Innovative Concepts for Helping European Transport Sustainability	State-of-the-Art in Developing Innovative Urban Transport Concepts in Europe, June 2005 http://ange.archangelis.com/typo3/niches/fileadmin/New_folder/Deliverables/NICHES_DeliverableD1.3_FINAL_web.pdf	relevant
NPF-Urban Transport Project: National Policy Frameworks for Urban Transport	Final Report on Assessment of Urban Transport Statistical and Public Perception Data, Executive Summary October 2005 http://www.npf-urbantrans-port.org/dwn/D5.5_ExecSummary_Eng.pdf	relevant
PORTAL: Promotion of Results in Transport Research and Learning	Final Report, September 2003 http://eu-por-tal.net/project/start_offrep.phtml?sprache=en	not so relevant
PROMPT: New Means to Promote Pedestrian Traffic in Cities	Several Documents, http://prompt.vtt.fi/, October 2006	relevant
QCITY: Quiet City Transport	http://qcity.dyndns.org/content_frame.php May 2006	not so relevant
SAFETRAM: Passive Safety of Tramways for Europe	Information site at Cordis 1998-2002 http://cordis.europa.eu/fp5/projects.htm	not so relevant
SILENCE: Quieter Surface Transport in Urban Areas	State-of-the-Art on Barriers and Solutions to Implementing Noise Scenarios http://ange.archangelis.com/typo3/dummy/fileadmin/public_reports/SILENCE_I.D7_300106.pdf	not so relevant
SILENCE: Quieter Surface Transport in Urban Areas	State-of-the-Art on Noise Abatement Policies and Tools in Cities, Noise Abatement Priorities and Necessary Technologies, September 2005 http://ange.archangelis.com/typo3/dummy/fileadmin/public_reports/SILENCE_I.D1-2-3_POLIS.pdf	not so relevant
TRANSECON: Assessment of Urban Transport and Local Socio-Economic Development	Final Report, December 2003 http://www.boku.ac.at/verkehr/transecon.html	not so relevant
TRANSLAND: Integration of Transport and Land-Use Planning	TRANSLAND Structured Overview, September 1999 http://www.inro.tno.nl/transland/d2d.pdf	relevant
UrBike: Urban Bicycling - Maximisation of Bicycling in Cities	http://www.urbike.net/	not so relevant

INNER URBAN FREIGHT: Inner Urban Freight Transport and City Logistics	Summary of Projects and Results from Topic: Inner Urban Freight Transport and City Logistics http://eu-por-tal.net/material/downloadarea/kt8_wm_en.pdf	relevant
CIVITAS – VIVALDI: Visionary And Vibrant Actions through Local transport Demonstration	Policy Recommendations Report, November 2005 http://www.civitas-initiative.org	relevant
CIVITAS – MIRACLES: Multi Initiatives for Rationalised Accessibility and Clean Liveable Environments	Demonstrator Fact Sheets of Rome, Cork, Barcelona and Winchester, 2005 http://www.civitas-initiative.org	relevant
CIVITAS – TELLUS – Transport and Environment Alliance for Urban Sustainability	Demonstrator Fact Sheets of Berlin, Rotterdam, Gothenburg, Bucharest, Gdynia www.tellus-cities.net, May 2006 http://www.civitas-initiative.org	relevant
CIVITAS - TRENDSETTER – Setting Trends for Sustainable Urban Mobility	Sustainable Urban Transport. Final Report from the European Project Trendsetter, 2006 http://www.civitas-initiative.org/	relevant
Urban Transport Benchmarking Initiative	Public Transport Organisation and Policy - Working group report , Annex A5 of the Final Report, July 2006 http://www.transportbenchmarks.org/pdf/final-reports/FINAL-UTB3-A5-DISABLED-TRANSPORT-REPORT.pdf	not so relevant
VOYAGER: Vehicle for Mobility - Advancing Public Passenger Transport in Europe	State-of-the-Art Report http://ec.europa.eu/transport/extra/web/index.cfm	relevant
VELOINFO: European Network for Cycling Expertise	www.velo.info	not so relevant
tr@nsITS: Intelligent Public Transport Systems	Intelligent Public Transport Systems – State-of-the-art in Europe, 2004	relevant
ERA-NET TRANSPORT: Transnational Transport Research Road Map	Deliverable 1.1, Overview of Research Programming and Cooperation Mechanism, January 2005 http://www.transport-era.net/fileadmin/fe_documents/81/ENT_DEL_1_1__WP1_v22.pdf	relevant
ERA-NET TRANSPORT: Transnational Transport Research Road Map	Deliverable 1.2, Analysis of Barriers to Cooperation and Development of an Initial Proposal of Cooperation Procedures, May 2005 http://www.transport-era.net/fileadmin/fe_documents/81/ENT_DEL_1_1__WP1_v22.pdf	relevant

ERA-NET TRANSPORT: Trans-national Transport Research Road Map	Deliverable 1.3, Benchmark of Practices of trans-national Cooperation in Transport Research Programs and Policy, October 2005 http://www.transport-era.net/fileadmin/fe_documents/81/ENT_WP1_DEL_1_3_v20_Final.pdf	relevant
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MC-ICAM: Implementation of Marginal Cost Pricing in Transport – Integrated Conceptual and Applied Model Analysis	Final Report for Publication, March 2004, http://www.its.leeds.ac.uk/projects/mcicam/	relevant
IMPRINT EUROPE: Implementing Pricing Reform in Transport – Effective Use of Research on Pricing in Europe	Final report for publication, 15 July 2004, http://www.imprinteu.org/	relevant
CUPID: Co-ordinating Urban Pricing Integrated Demonstrations, Thematic Network	Synthesis Report http://www.transport-pricing.net/xCUPID29-09-03/Del5%20Update.PDF	relevant
PROGRESS: Pricing ROad use for Greater Responsibility, Efficiency and Sustainability in citieS)	http://www.progress-project.org/	relevant
SPECTRUM: Study of policies regarding economic instruments complementing transport regulation and the undertaking of physical measures	http://www.its.leeds.ac.uk/projects/spectrum/index.html	relevant
REVENUE Urban case studies	Deliverable 5. REVENUE (Revenue Use from transport Pricing). http://www.revenueeu.org/public/freports/REVENUE_D5_final.pdf	relevant
UNITE - UNIfication of accounts and marginal costs for Transport Efficiency	http://www.its.leeds.ac.uk/projects/unite/	relevant
GRACE: Generalisation of Research on Accounts and Cost Estimation	http://www.grace-eu.org/index.html	relevant
EIB Papers on PPP: Innovative financing of infrastructure – the role of public-private partnerships	EIB Papers Volume 10. n°1/2005, Infrastructure, economic growth, and the economics of PPPs http://www.eib.eu.int/Attachments/efs/eibpapers_v10n01_en.pdf; EIB Papers Volume 10. n°2/2005, Lessons from the early movers, http://www.eib.eu.int/publications/publication.asp?publ=221	relevant
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ERRAC: European Rail Research Advisory Council	Strategic Rail Research Agenda, Main Report, September 2002 http://www.errac.org/	relevant
ERRAC: European Rail Research Advisory Council	Strategic Rail Research Agenda, Technical Annex, September 2002 http://www.errac.org/	relevant
ERRAC Rail21: European Rail Research Advisory Council Rail 21	Sustainable Rail Systems for a Connected Europe, February 2006 http://www.errac.org/	relevant
ERTRAC: European Road Transport Research Advisory Council	Vision 2020 and Challenges http://www.ertrac.org/	relevant
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ERTRAC: European Road Transport Research Advisory Council	Research Framework http://www.ertrac.org/	relevant
VOYAGER: Vehicle for Mobility - Advancing Public Passenger Transport in Europe	Future Trends, Impacts and Key Challenges, August 2003	relevant
VOYAGER: Vehicle for Mobility - Advancing Public Passenger Transport in Europe	Policy and Research Recommendations	relevant
UITP: International Association of Public Transport	Public Transport in 2020 – from Vision to Action www.uitp.com	relevant
UITP: International Association of Public Transport	Strategic Research Agenda for Urban, Suburban and Regional Public Transport and Urban Mobility in the European Union www.uitp.com	relevant
ECTRI (European Conference of Transport Research Institutes)	URBAMOVE: Urban Mobility Initiative, ECTRI's Strategic Research Agenda for Urban Mobility in The European Union, May 2005 http://www.ectri.org/liens/pageproduceddocs/TRA%202006%20Urbamove%20CNobis.pdf	relevant
European Commission	Keep Europe moving - Sustainable mobility for our continent. Mid-term review of the European Commission's 2001 Transport White Paper, September 2006 http://ec.europa.eu/transport/transport_policy_review/doc/2006_3167_brochure_en.pdf	relevant
Working Group on Sustainable Urban Transport	Final Report, January 2004 http://ec.europa.eu/environment/urban/sustainable_urban_transport.htm	relevant

Commission of the European Communities	Communication from the Commission to the Council and the European Parliament on Thematic Strategy on the Urban Environment, February 2004 http://europa.eu/eur-lex/en/com/cnc/2004/com2004_0065en01.pdf	relevant
European Commission	Green Paper "A European Strategy for sustainable, Competitive and Secure Energy", March 2006 http://europa.eu/documents/comm/green_papers/pdf/com2006_105_en.pdf	relevant
European Commission	Green Paper on Energy Efficiency "Doing more with less", June 2005 http://eur-lex.europa.eu/LexUriServ/site/en/com/2005/com2005_0265en01.pdf	relevant
ECTP: European Construction Technology Platform	Strategic Research Agenda for the European Construction Sector, Final Version, December 2005 http://www.ectp.org/documentation/ECTP-SRA-2005_12_23.pdf	relevant
ECMT: European Conference of Ministers of Transport, Council of Ministers	Sustainable Urban Travel, Implementing Sustainable Urban Travel Policies: Applying the 2001 Key Messages, June 2006 http://www.cemt.org/index.htm	relevant
ECMT: European Conference of Ministers of Transport, Council of Ministers	Access and Inclusion: Improving Transport Accessibility for all: Policy Messages, 2006 http://www.cemt.org/index.htm	relevant
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ECMT: European Conference of Ministers of Transport, Council of Ministers	Transport and Environment: Review of CO_2 Abatement Policies for the Transport Sector, 2006	relevant
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eSafety Forum Working Group	Stakeholders' Contribution to the Formation of the FP7 Work Programme on Information and Communication Technology for Mobility, June 2006 http://ec.europa.eu/information_society/activities/esafety/forum/index_en.htm	relevant

Committee of the Regions	Opinion of the Committee of the Regions on Cohesion Policy and cities: the urban contribution to growth and jobs in the regions, April 2006 http://www.cor.europa.eu/en/documents/opinions.htm	relevant
Michel Destot	DG TREN Forum: Urban transport, June 2006 http://www.reseau-gart.org/upload/document/2/4/1/8/tele.pdf	relevant
ATLANTIC: A thematic long-term approach to networking for the Telematics and Intelligent Transportation Systems community	Traffic and Traveller Information Services in Europe – Country Digest and Good Practice in TTI service implementation and Practitioners Handbook for TTI Service Implementation in European Cities and Regions http://www.atlantic.net/index.cfm?PID=125	not so relevant
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ERA-NET TRANSPORT	Themes for Future trans-national Cooperation in Transport Research Programming, May 2005 http://www.transport-era.net/about-ent.html	relevant