Final Report for Publication

CAPTURE

Cars to Public Transport in the Urban Environment

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THE EFFECTIVENESS OF PHYSICAL TRANSPORT POLICY MEASURES - THE RESULTS OF 11 CITY DEMONSTRATIONS

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EXECUTIVE SUMMARY

1. THE CAPTURE PROJECT

CAPTURE is a major three year European transport demonstration project. Its aim is to collate and evaluate the effectiveness of physical transport measures designed to restrict or encourage the use of different modes. Such measures include parking management, traffic calming, bus priority measures, pedestrianisation, restriction of road space for the private car, car pooling, encouragement of off-peak public transport use and so on.

The project is a collaborative venture of local authorities from 10 European Union cities and one city from Central Europe. The CAPTURE consortium is a mix of transport authorities, transport operators, leading academics and consultants in the transport policy field. CAPTURE is jointly funded by the Consortium and the European Commission under the Transport RTD Programme. The Cities are:-

Brescia (Italy)
Bucuresti (Romania)
Copenhagen (Denmark)
Greater Manchester (United Kingdom)
London (United Kingdom)
Madrid (Spain)
Mytilini (Greece)
Orvieto (Italy)
Rome (Italy)
Tampere (Finland)
Vitoria-Gasteiz (Spain)

The project has evaluated the implementation of demonstrations of physical measures in each of the 11 cities. The policies under study include improvements to public transport movement and high occupancy cars in corridors, and changes to the access and management of areas with high levels of trip making such as in city centres. Most of the measures aim to improve the ability of travellers to combine the use of several means of transport easily - such as by improving facilities at bus stops and larger interchanges, and moving parking areas to outside central areas to encourage the use of alternative means of transport to gain access to city centres.

Effective transport policies to influence the use of different means of travelling will comprise a package of measures such as the pricing and financing of the transport system, its traffic light control, its organisation and operation, background legislation, its marketing, vehicle stock, land use planning, and the potential to substitute travel. As they form the basic infrastructure, physical transport measures are of fundamental importance in a successful package of policy measures.

The physical transport measures studied under CAPTURE

Ten categories of physical measures were proposed.

1 Changing the capacity of a highway or street.
2 Changing, or varying, the use of a highway or street (or redistributing its use between different travel modes).
3 Physical measures to give priority on a link and at junctions to different means of transport.
4 Physical measures to improve stops and interchanges.
5 Measures to restrict access to an area (either permanently or at particular times or situations).
6 New transport systems (such as escalators, lifts, travelators etc.).
7 Traffic calming strategies.
8 Central area parking strategies.
9 Measures to encourage cyclists.
10 Measures to encourage pedestrians.

These can be seen as falling into the following categorisation of types of physical transport policy measure

Table 1: A typology of urban transport physical measures

CONTEXT DESIGN OBJECTIVE	TRANSPORT CORRIDORS	JUNCTIONS	DEFINED AREAS	ACCESS/ EGRESS POINTS
1. CAPACITY LEVEL				
ROAD SPACE	Widening, reduced lanes	Design, layout, priority measures	Traffic calming measures	Parking space, bus & tram stops
SEGREGATED TRACK	Rail, LRT, Metro	na	Barriers	Stations, Interchanges
RIVERS, CANALS	Vessel management	na	Lock capacity	Docking ports
PEDESTRIAN SPACE	Pavements, crossings	Crossings	Plazas	na
PEOPLE MOVERS	na	na	Escalators, lifts, travelators	na
2. CAPACITY USE				
SEGREGATED	Bus lanes	Bus priority	Cycle paths	Bus boarders, platforms
SHARED	bus/ taxi lanes	Lane priority, advanced stop lines	Pedestrian, bus streets	Stopping points
CONDITIONAL	HOV lanes	Lane merging layout	HGV access to plazas	Stopping points

The 11 CAPTURE cities are in 7 countries (six within the European Union and one in Central Europe). They are listed in Table 2 with an outline of the measures to be included in the evaluation.

Table 2: The physical measures in the CAPTURE test sites

City (and abbreviation)	Coun-try	The characteristics of city	Brief description of CAPTURE measures
Brescia (Bre)	IT	Medium sized industrial city	Improvements to a bus corridor combined with urban traffic control investment
Bucharest (Buc)	RO	Capital city	Improvements for buses throughout the city - bus lanes, park and ride interchanges
Copenhagen (Cph)	DK	Capital city	Improvements to a bus corridor - including cycle lane provision, bus lanes and terminal
Greater Manchester (GM)	UK	Major conurbation	Improvements to a bus corridor - bus shelter designs, and bus priorities, provision of cycle lanes
London (Lon)	UK	Capital city	Improvements to a major bus corridor through the city centre
Madrid (Mad)	ES	Capital city	Improvements to a major arterial road - provision of a High Occupancy Vehicle (HOV) lane, access to a new multi modal interchange and Park and Ride facilities
Mytilini (Myt)	GR	Regional Capital	Improved interchange between passenger and cargo ships, cars, and public transport and central area pedestrianisation
Orvieto (Orv)	IT	Small historic city	Pedestrianisation of central area, parking controls, provision of lifts and escalators for city centre access
Rome (Rom)	IT	Capital city	Parking controls, traffic calming and environmental improvement
Tampere (Tam)	FI	Medium sized industrial city	Improvements to a bus corridor - bus priorities, bus lay-byes, shelters and low floor buses
Vitoria-Gasteiz (VG)	ES	Medium sized regional capital	Pedestrianisation with parking controls outside historic city centre (Not implemented)

The various types of measure planned and implemented in each demonstration site are summarised in Table 3 below.

Table 3: Summary of measures in each test site

	Bre	Buc	Cph	GM	Lon	Mad	Myt	Orv	Rom	Tam	VG
Bus lanes and bus streets		X	X	X	P	X				X	p
HOV lanes						X					
Junction arrangements		x		x	p	x				X	
Public transport prioritisation	X		X	X	x					x	
Bus stops		p	x	X	p		x			x	p
Interchanges			x	x	p	X	P			x	p
Restrict access to an area							X		x		P
New transport systems		X	x	x			x	X		x	
Traffic calming					x		x		X	x	p
Central area parking	X	p			p			x	X		p
Encourage pedestrians		p			x	x			x		p
Encourage cyclists				x	p						

X major part of scheme implemented
x secondary or minor part of scheme implemented
P major proposed element but not implemented
p secondary or minor element not implemented

It can be seen from Table 3 that some types of measure occur in several of the cities. No two cities have exactly the same mix of measures, though three consist of bus lane experiments with other measures. Besides these 3 cities (Bucharest, Copenhagen, and Tampere) all have two or more measure types which are regarded as major parts of the scheme

Types of impact studied under CAPTURE

The CAPTURE evaluation used the idea of common indicators to allow comparison of the effects of physical measures in different city types and for different measures. Surveys were designed in different ways to suit local methods and characteristics, but with the aim that different methodologies of surveys would be linked to allow standard indicators to be measured.

In the main report we look at each major type of measure studied in the CAPTURE project, according to a variety of impacts. Sections 2 and 3 of the report use such a breakdown to separate out different effects of policies. The main impacts are broken down into four main categories:-

TECHNICAL - DOES EACH SYSTEM WORK?

Ease of design
Ease of implementation
Ease of operation

OPERATIONAL - DOES IT HELP TRANSPORT OPERATE?

Speed of public transport
Delays to public transport
Regularity of public transport (the ability to keep to timetables
Effects on other modes

THE SOCIAL AND BEHAVIOURAL IMPACTS - DOES IT HAVE A BENEFICIAL EFFECT ON SOCIETY?

Local level modal shift
City wide modal shift effects
The effects on other road users
Effects on those with reduced
Effects on safety and accident
The effects on the local economy
Effects on perceptions about travel
Valuing the effects

ENVIRONMENTAL IMPACTS - DOES IT IMPROVE ENVIRONMENTAL QUALITY?

Energy use
Pollutant emissions
Noise

Main conclusions and recommendations

Below are tables outlining the summaries of the various conclusions drawn during the study and how they relate to recommendations:-

Table 4: Conclusions and their related recommendations

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
Strategic planning	The goals stated for measures tend to be greater than can be achieved in practice	Be realistic about what can be achieved; don't oversell measures	Encourage an atmosphere where local proposals do not have to exaggerate benefits to gain funding
	In general, a single measure will not have a great effect. Packages of measures linked together are more likely to succeed.	Few plans will be single measure in reality, but the choice of strategy should take a mix of measures into account when relating goals to measures.	Adopt a funding strategy which encourages well thought out package approaches, and long term strategies
			It may be more important to put measures in large congested cities, but it may be easier to try first implementations of new policies in smaller towns and cities
	Authorities can become more interested in the physical measure than the objectives.	Authorities need to clearly state how their objectives will be delivered by the physical measures proposed, taking into account all modes.	
Technical design	There is great variation in the complexity and effort needed for design *within* most categories of measure.	Few types of measure should be ruled out because of perceived difficulty of design. There is normally a simple and cheap solution.	Encourage an easy funding stream for cheap and effective measures.
	Cheap measures can create greater transport efficiency if well planned and in the right location.	Include cheap cost effective measures where possible in designs	
	Use of guidelines can be good or bad (they may save time in design and avoid mistakes, but they can stifle new initiatives)		Ensure that guidelines and restrictions are simple and logical, and allow 'routes' for innovative design
	Measures new to a city or country may be difficult to design (or have designs accepted)	Expect more time needed for design of new measures, even if they are commonplace elsewhere	EU should transfer designs between countries. Member States should be liberal in allowing new measures, using information from EU and other States
	Aesthetic design can lead to more positive views about public transport, walking and cycling	More measures may need good aesthetics and architecture than may be apparent. Be aware of the effects of good and bad aesthetics in public acceptance.	

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
Detailed bus lane design		Don't 'close' bus stops when relocating without careful thought	
		Do not use minimum specifications for, eg bus lanes, unless absolutely necessary	
		Don't change direction of bus lanes too frequently.	
		Bus lanes are not always the best solution for speeding up bus operations (consider junctions and boarding and alighting times)	
Implementation	The likelihood of implementation has to be regarded as being as important as the effects *if and when* the measure is implemented. Institutional culture has tended to play down failures which has not been beneficial	Secure political consensus or significant support from political framework before starting planning.	Research is needed into institutional factors affecting implementation in transport policy.
	Implementation often takes very much longer than expected	Plan physical measures with great care, allowing time for hold ups in implementation	
	The main factors in successful implementation are a) Public participation b) Funding c) Government/Institutions	a) Carry out public consultation, and preferably encourage public participation in decision making especially in visible schemes affecting local areas. b) Ensure funding will be available for schemes c) Ensure government support exists if needed, and discuss with institutions which can affect outcomes	a) Prepare guidelines for successful public consultation and participation b) Allow for time delays for ringfenced funding for local schemes
	The type of measure (within those tested) does not bear a relationship with delays or failures of implementation.	While tried and tested schemes are 'safer' in terms of implementation, don't assume that a simple measure will have simple implementation.	
	While a very simple institutional and decision making structure can aid implementation only two or three bodies are required for a much greater risk of failure or delay.	Consultation with institutions is important even in relatively simple institutional structures.	

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
	While simple political and institutional structures can aid implementation, changes can occur over the timescale	Don't be complacent if the political situation looks strong. It may not always remain so. (eg Vitoria)	
	Many things can change over the time between plans and actuality in terms of technology, policy background and 'fashionability' of measure types	While state of the art measures may seem attractive at the design stage they may be out of date by the time of implementation.	
	There still remains a problem on implementation of measures regarded as anti-car, both in terms of professional and public support. Planners are scared of attempting measures which may be regarded as anti car.	Measures which restrict car use are needed but they have to be put across as beneficial to society as a whole.	Awareness campaigns should stress modal shift, and governments should lead by example
	Packages of measures can have effects for implementation. If one element is crucial problems of implementation may scupper the entire strategy, but elements which work together symbiotically can still have an effect even if not all are implemented	Plan packages with consideration for those elements which are crucial and those which aid a package, and pay special attention to implementation aspects of the crucial elements.	
	Visibility of measures can sometimes hinder implementation though it can give a message of support for public transport, walking and cycling.		
	Some institutions will have pre-formed views on measures being proposed	Be aware of the links between measure types and institutions involved.	Local Authorities need government back up for modal shift policies
		Ensure designs are fully done before start	
		Adopt a step by step approach where possible	
Operational efficiency	The effects of most physical measures are localised.	Major time savings are needed to have an effect over a whole public transport route	
	Measures can lead to reductions in timetable variability. This can increase effective service level as much as increased speed.	Besides planning measures which save time, plan measures which will increase ability to keep to timetable	

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
	Traffic density and levels of violation seem to be the critical factors in success of bus lanes	a) To allow for time savings ensure that priorities are placed where they will be effective	
		b) Ensure that the 'operation plan' includes effective enforcement	
		But (c) It is easier to implement priorities where there are fewer problems. Where cheap and easy priorities can be implemented put them in place. Even if they are violated the legal right is in place for later enforcement.	
	The aim of not harming private car use in measures can lead to physical measures such as bus lanes not being designed to a level where improvements will occur.		
	New measures (such as traffic calming in Roma) were found to be unpopular at beginning but have gained support over time	Don't judge effects in a hurry. Allow time for situation to settle down. By the same score don't close unpopular measures immediately if there is opposition, but seek a 'cooling off of tempers' period which will allow for a less reactive judgement	
Modal shift and travel behaviour effects	Only the very largest measures can ensure effects on modal share which can be measured by surveys.	If measures are to be employed to radically increase the attractiveness of public transport in terms of the basics of journey speeds etc, the commitment and the scale of investment has to be large	
	The relationship between the scale of the physical measure and its effect on modal shift is probably not linear		
	Smaller scale measures may not affect modal share but are important in providing the preconditions for a package of measures to have an effect	Don't expect to judge benefits on modal shift effects	Don't expect to judge benefits on modal shift effects
	Time savings of the scale produced by most measures does not translate into modal shift changes		

	Conclusion	**Local Authority Recommendation**	**National, European, and further research recommendations**
	Time savings of the scale produced by most smaller scale measures do not always translate into timetable savings, though improvements in timekeeping often follow.		
	For real change in modal shift a change in views over the priorities accorded to different modes will be required.		Travel awareness campaigns are needed to help change awareness
	Patronage reductions have accompanied otherwise successful physical measure demonstrations. Background effects and other changes can have a larger impact	Don't judge effects on patronage alone. Evaluation must take account of other factors.	
Other users etc	Physical measures tend to complicate safety issues by creating more scope for incidents although the overall effects are generally neutral	More effort needs to be put into integration of other road users and people with reduced mobility in design	
	Measures do not tend to address needs of people with reduced mobility, unless specifically designed with them in mind	Audits of effects on various aspects should be included in design (PRMs, pedestrians, cyclists, safety issues etc) though these audits need to be simple if they are to be effective.	
	Low priority tends to be given to pedestrians and cyclists in schemes.	Authorities should make special efforts to consult with groups representing pedestrians and cyclists, and to give support to these groups if necessary.	
	Physical measures for public transport can have positive or negative impacts on pedestrians and cyclists	Pedestrians and cyclists need to be carefully considered to ensure that increases in public transport use are not offset by reductions in walking and cycling.	
	Low floor buses are preferred by those with mobility difficulties, and for those with other factors which reduce their mobility such as those with pushchairs, and with heavy shopping	Plan public transport for those with reduced mobility and those 'encumbered' by children and luggage. There is a strong potential for these groups to use appropriate public transport.	
	There is strong support for raised bus boarders, amongst all bus users		

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
Effects on public perceptions	Highly visible measures may have large impacts on public perception of public transport, walking an cycling. In any case the public will take visual cues in assessing their impression of modes	Plan measures with visual and aesthetic characteristics in mind. These can be both positive and negative depending on the mode in question	
	Any restrictions on car use in an area can lead to gridlock and seizure. Once changes are started the negative attitudes tend to be replaced by keenness for more change.	Combine physical measures with information and communication activities for increase awareness in the public.	
Energy and environment	Energy use and pollutant emissions relate very closely to car use levels.		For a reduction in the harmful effects of transport effort must be aimed primarily at reducing car use and car dependence
	The emissions from buses and energy use relate to the services offered (number and size of buses) and also, but less so, to operating conditions.	The goal of reducing environmental damage by transport by switching to use of public transport will not (in itself) reduce the emissions from public transport.	
		Reducing stop-start conditions on bus routes will aid environment	
	Noise reductions can be achieved by surface changes (where noisy) reductions in vehicle numbers and speeds		
Overall effects	The results do not show a 'measure specific outcome' in terms of the results. Similar measures had great success in some cities, and little in others. While some measures have little impact on the use of different modes because of their nature, the usefulness of most measures is dependent very much on how they are specified in terms of local conditions.		
	City size is not a major determining factor in determining the measures which should be initiated		

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
	City type can be of importance. Measures requiring much road space may be inappropriate in crowded historic cities where there is much competition for limited road space, while in more modern industrial cities there may be more scope for making changes. (At the same time the journey patterns which have evolved in the more modern cities may mean that measures have to be different to encourage people to change their travel behaviour).		
Research impacts and evaluation	Evaluation using common indicators is not easy to carry out in differing situations		
	The blind use of common indicators alone would not allow full evaluation of physical (or other) measures.		While some quantitative indicators are necessary for policy evaluation, audit checklist type indicators may be more valid, and allow a wider range of effects to be evaluated
	Measures take time to reach ‘stability’.		Measures should not be fully evaluated until at least two years after implementation

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
Transferability	Comparisons of effects between cities are generally difficult, but in some seemingly unlikely cases there have been great similarities	Measures need to be carefully planned for each city	Listen to local professionals in local proposals
	Demonstration projects can be important in allowing new measures to be tested. New measures can be tried in different cities, and may be expanded in those where tried	If a policy new to a country or area is desired a small demonstration project may be helpful in finding funds and support for future measures	
	The transfer of experience between cities involved in CAPTURE has been good. Examples include transfer of technical ideas between physical measure designers and technicians.		
	The structure of institutions can have a major effect on the possibilities for implementation and use of facilities once built. For example bus stations and interchanges may be underused if there is no requirement for private companies to use them	The political and institutional climate needs to be assessed when considering importing measures that have been successful elsewhere.	

Main conclusions summarised

Travel behaviour effects

- Physical measures do not in themselves generally have a major short term impact on modal split, unless they are very large scale. But this does not mean they should not be encouraged because:
- If travel behaviour is the result of rational decisions made at various times then we would not expect a short term change when the overall changes do not significantly alter the pros and cons of each mode. But:
  a) These smaller changes may lead to a change when people re-assess their travel decisions
  b) The studies have shown increases in PT efficiency. Change in modal split is likely to occur when other policy changes take things to a threshold level for different people.

The summary of this is that modal change will come from a package of measures in a properly thought out strategy. Physical measures are of primary importance because they affect the capacity and efficiency of public transport. To put it bluntly, you can try and persuade people to change their behaviour but if the infrastructure is lacking they will not react favourably.

Implementation Issues

The implementation of physical measures is not an easy task. The simplest conclusions are that small scale, low visibility, cheap solutions are most easily implementable. This means that a large scale 'vision' will be difficult to implement (but we need that vision if we are to achieve change). The implication is that a large scale vision must be made up of small easy to implement elements that fit into a jigsaw.

A wider vision for transport

On a wider level the importance of an infrastructure for public transport and the walking and cycling modes cannot be stressed too strongly. The effects of global climate change are becoming apparent at a very rapid rate, considering the phenomenon was only discussed at all widely less than ten years ago. Since transport consumes some 30% of energy and is still one of the fastest growing sectors of energy use, the importance of measures to reduce dependence upon the private car are of great importance. Added to the environmental arguments, it has become apparent that we cannot solve our congestion problems while allowing for a growing proportion of trips made by cars - no feasible road building programme could allow for that.

As a result we are faced with a 'necessity' to reduce car dependence, and we have learnt that a combination of measures in a carefully designed strategy is the only practicable way to reduce car dependence. The lack of success of physical and other measures has led many to champion other policies such as persuasion techniques (or Green commuter plans or Travel Awareness Campaigns) and pricing strategies. However this shift in emphasis should be set within a strategic policy conclusion that an integrated transport infrastructure is essential for people to change their travel behaviour, whether the background policy favours demand management or more softer measures.

1. INTRODUCTION

1.1 Description of the CAPTURE project

CAPTURE is a major three-year European transport demonstration project. It's aim is to collate and evaluate the effectiveness of physical transport measures designed to restrict or encourage the use of different modes. Such measures include parking management, traffic calming, bus priority measures, pedestrianisation, restriction of road space for the private car, car pooling, encouragement of off-peak public transport use and so on.

The project is a collaborative venture of local authorities from 10 European Union cities and one city from central Europe. The CAPTURE consortium is a mix of transport authorities, transport operators, leading academics and consultants in the transport policy field. CAPTURE is jointly funded by the Consortium and the European Commission under the Transport RTD Programme. The Cities are:-

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Tampere (Finland)
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The project has evaluated the implementation of demonstrations of physical measures in each of the 11 cities. The policies under study include improvements to public transport movement and high occupancy cars in corridors, and changes to the access and management of areas with high levels of trip making such as in city centres. Most of the measures aim to improve the ability of travellers to combine the use of several means of transport easily - such as by improving facilities at bus stops and larger interchanges, and moving parking areas to outside central areas to encourage the use of alternative means of transport to gain access to city centres.

Thus, CAPTURE concentrates on physical measures while other projects in the research programme are more concerned with control and financial measures. The main objectives of CAPTURE are concerned with adding to knowledge about the effects of Transport Policies and what their implications are at the local, national, and European levels. These are grouped as:-

- Decision support - providing advice to policy makers,
- Advancing the state of the art - adding to knowledge about the effects of policies,
- Evaluation and transferability - to evaluate the outcomes of the demonstrations both locally, and in terms of the transferability of results from one site to another.

Effective transport policies to influence the use of different means of travelling will comprise a package of measures such as the pricing and financing of the transport system, its traffic light control, its organisation and operation, background legislation, its marketing, vehicle stock, land use planning, and the potential to substitute travel. As they form the basic infrastructure, physical transport measures are of fundamental importance in a successful package of policy measures.

1.2 The physical transport measures studied under CAPTURE

Ten categories of physical measures were proposed.

1 Changing the capacity of a highway or street.
2 Changing, or varying, the use of a highway or street (or redistributing its use between different travel modes).
3 Physical measures to give priority on a link and at junctions to different means of transport.
4 Physical measures to improve stops and interchanges.
5 Measures to restrict access to an area (either permanently or at particular times or situations).
6 New transport systems (such as escalators, lifts, travelators etc.).
7 Traffic calming strategies.
8 Central area parking strategies.
9 Measures to encourage cyclists.
10 Measures to encourage pedestrians.

The 11 cities are in 7 countries (six within the European Union and one in Central Europe). They are listed in Table 1.1 below with an outline of the measures to be included in the evaluation.

Table 1.1: The physical measures in the CAPTURE test sites

City (and abbreviation)	Country	The character-istics of city	Brief description of CAPTURE measures
Brescia (Bre)	Italy	Medium sized industrial city	Improvements to a bus corridor combined with urban traffic control investment
Bucharest (Buc)	Romania	Capital city	Improvements for buses throughout the city - bus lanes, park and ride interchanges
Copenhagen (Cph)	Denmark	Capital city	Improvements to a bus corridor - including cycle lane provision, bus lanes and terminal
Greater Manchester (GM)	United Kingdom	Major conurbation	Improvements to a bus corridor - bus shelter designs, and bus priorities, provision of cycle lanes
London (Lon)	United Kingdom	Capital city	Improvements to a major bus corridor through the city centre
Madrid (Mad)	Spain	Capital city	Improvements to a major arterial road - provision of a High Occupancy Vehicle (HOV) lane, access to a new multi modal interchange and Park and Ride facilities
Mytilini (Myt)	Greece	Regional Capital	Improved interchange between passenger and cargo ships, cars, and public transport and central area

			pedestrianisation

Orvieto (Orv)	Italy	Small historic city	Pedestrianisation of central area, parking controls, provision of lifts and escalators for city centre access
Rome (Rom)	Italy	Capital city	Parking controls, traffic calming and environmental improvement
Tampere (Tam)	Finland	Medium sized industrial city	Improvements to a bus corridor - bus priorities, bus lay-byes, shelters and low floor buses
Vitoria-Gasteiz (VG)	Spain	Medium sized regional capital	Pedestrianisation with parking controls outside historic city centre (Not implemented)

The various types of measure planned and implemented in each demonstration site are summarised in Table 1.2 below.

Table 1.2: Summary of measures in each test site

	Bre	Buc	Cph	GM	Lon	Mad	Myt	Orv	Rom	Tam	VG
Bus lanes and bus streets		X	X	X	P	X				X	p
HOV lanes						X					
Junction arrangements		x		x	p	x				X	
Public transport prioritisation	X		X	X	x					x	
Bus stops		p	x	X	p		x			x	p
Interchanges			x	x	p	X	P			x	p
Restrict access to an area							X		x		P
New transport systems		X	x	x			x	X		x	
Traffic calming					x		x		X	x	p
Central area parking	X	p			p			x	X		p
Encourage pedestrians		p			x	x			x		p
Encourage cyclists				x	p						

X (shaded)	major part of scheme implemented
x	secondary or minor part of scheme implemented
P	major proposed element but not implemented
p	secondary or minor element not implemented

It can be seen from Table 1.2 that some types of measure occur in several of the cities. No two cities have exactly the same mix of measures, though three consist of bus lane experiments with other measures. Besides these 3 cities (Bucharest, Copenhagen, and Tampere) all have two or more measure types which are regarded as major parts of the scheme

1.3. The policy context

1.3.1 The policy issues addressed by CAPTURE

The main thrust of transport policy in most of Europe is to reduce the dependence on motorised transport (especially the private car) while maintaining an efficient transport system that services the needs of individuals, the economy and society at large. By meeting the objective of reducing levels of car use, helps to work towards important environmental policy goals such as those relating to the effects of pollutants on health, preservation of habitats and global climate change.

There is much consensus over these broad issues and goals, but not in the details of the issues, nor in how to achieve the major goals. Lack of resources (and lack of real guidance from experts) means that we have to learn from small scale experiments in different places.

CAPTURE has taken some of the more interesting experiments being done to solve these issues, and is trying to provide guidance on what practical and likely policy measures will produce visible results.

1.3.2 The objectives and expected impacts of CAPTURE strategies and elements

Objectives

At the start of the project cities were asked to identify the main objectives of the measures which formed the CAPTURE demonstrations. Table 1.3 shows which categories of objective types the measures were aimed at.

Table 1.3: City objectives grouped

Objective group	Objective	Bre	Buc	Cph	GM	Lon	Mad	Myt	Orv	Rom	Tam	VG
Modal Shift	Modal shift to bus	✔		✔		✔	✔				✔	✔
	Modal shift to all other modes than car		✔		✔		✔	✔			✔	✔
	Reduction in total car traffic						✔		✔			✔
	Reduction in single occupancy of cars						✔					
Environmental	Improving environment	✔	✔				✔	✔	✔	✔		✔
	Safeguarding historic monuments								✔	✔		
	Reduction in noise and pollution						✔			✔		✔
Quality of life/ economy	Improving the quality of life		✔	✔			✔		✔	✔		✔
	More rational use of the urban area	✔					✔		✔	✔	✔	
	To increase public participation in transport planning		✔									
Congestion/ transport efficiency	Reducing congestion		✔			✔	✔	✔				
	Improving operational characteristics of public transport		✔	✔	✔	✔	✔	✔			✔	
	Improving intermodal co-ordination		✔				✔	✔			✔	
Safety	Improving safety		✔					✔	✔	✔		
"Learning"	Testing out new or experimental measures	✔		✔							✔	
	Integrating physical measures with control measures	✔	✔	✔			✔				✔	
Social	Improving conditions for certain groups of the population		✔		✔					✔	✔	

Clearly, in implementing physical measures as part of a package, cities will be aiming to address not only the immediate policy objectives relating to operational efficiency and travel behaviour, but also indirectly to contribute to higher level social, economic and environmental goals. This is reflected in the diversity of stated objectives shown in Table 1.3.

The CAPTURE cities were then asked to scale the importance of their measures against a number of transport policy goals, and the results are shown in Table 1.4.

Table 1.4: The importance of different policy objectives in each demonstration

	Bre	Buc	Cph	GM	Lon	Mad	Myt	Orv	Rom	Tam	VG
Reducing the amount of private car travel	7	7	5	8	7	9		9		4	9
Changing modal split towards bus	8	1	9	8	9	9		9		7	
Increasing the amount of walking		2	5		9	3	7	7	9	5	8
Increasing the sociability of the city		2	7			5	7	8	9	5	8
Improving the quality of life in the city	6	4	7	5		9		9	9	7	8
Improving the quality of street environments	3	6	5		7	6	7	9	9	6	8
Developing a sustainable transport system	9	5	9			9		9		5	
Reducing vehicle emissions	8	7	2			9				3	
Reducing traffic congestion	8	8	3			8				6	
Reducing the costs of transport provision	7	6	3			8		8		4	
Improving accessibility to facilities	6	3	5			9		9		7	
Improving road safety	6	6	5			1		9	9	5	8
Improving the economy of the city	6	2	5			9		7		7	
Linking land use and transport policy	8		5			9		9		5	
Improving access for disabled people			5	9		1		9	8	6	
Providing for a more egalitarian city		1	5			8				5	9
Improving mobility of people	8	6	7							5	5
Changing modal split towards urban rail	2					9				4	
Increasing the amount of cycling			5					6		8	
Encouraging the use of trolleybuses		4									
Reducing the need for travel	1	2				1				5	6
Changing modal split towards tram										1	

Number refer to rating from 1 to 9 in terms of importance - levels of shading are *none* = 1-3, *light* = 4-6, *dark* = 7.9

The agreement with different goals shows some similarities and some differences. The three most supported goals are concerned with changing modal split, followed by two concerned with quality of life goals. Two environmental goals follow these with several concerned with the economy and congestion and accessibility. The ones with the lowest levels of support are generally concerned with improving modal use of those modes which are not especially common in all cites.

Expected impacts

In any transport policy initiative it is important to have clear and realistic targets as to what can be achieved. Not all of the expected impacts of measures will relate exactly to the stated objectives; policy makers may anticipate side effects. Table 1.5 shows the expected impacts that cities anticipated from the measures they were introducing.

Table 1.5: The expected impacts of the demonstrations

		City										
Impact grouping	**Examples of expected impacts**	**Bre***	**Buc**	**Cph**	**GM**	**Lon**	**Mad**	**Myt**	**Orv**	**Rom**	**Tam**	**VG**
Change in public transport operational characteristics	Public transport travel speed will increase by X%	✔	✔			✔	✔				✔	
	Public transport will save X minutes/ seconds		✔	✔		✔	✔				✔	
	Interchange time will reduce by XX% or X mins					✔	✔	✔	✔			
	Reliability/ regularity will increase by X%						✔					
Reduction in energy use	Energy use for public transport will reduce by X%	✔					✔					
	Overall transport energy use will reduce by X%						✔					
	Energy efficiency for buses will increase by X%											
Reduction in pollutants	Levels of xxxxxxxxx will fall by X% along the corridor and by X% at distance from the corridor	✔	✔				✔					✔
	Noise levels will reduce by X dB									✔		✔
Changes to traffic levels/ car traffic characteristics	The time when general traffic is congested will reduced to X hours per week											
	Car journey travel times will reduce/ increase by X minutes in the corridor			✔			✔					
	Bus delay at junctions will reduce by X%	✔			✔		✔		✔	✔	✔	✔
	Reduction in traffic levels in area								✔	✔		
	Reduction in vehicle speeds											
Modal split for journeys/ public transport patronage	Bus use will increase by nun passengers per year (trolleybuses for Bucharest)		✔		✔		✔				(	
	The proportion of journeys by bus/ car/ cycle/ walk will change by X%				✔		✔				✔	✔
Safety impacts	There will be an X% reduction in accidents											✔
	There will be an X% increase in perception of safety											
Social impacts	Journeys by those with mobility difficulties/ children in pushchairs will increase by XX% due to better quality boarding.				✔						✔	

It is clear that there is some difference between the types of impact from the policy measures which cities have expectations about. Much of this is due to different physical measures which will have very different impacts, and much is due to the different concerns and interests in the different cities. In some case an objective may be very strong but no measured impacts are stated at the outset by which success may be measured, due to complexity of the objectives and methods, or for other reasons. It is noticeable that only one city had stated safety impacts, though it is likely that most cases will have hoped for reductions in accidents due to detailed design.

1.3.3 State of the art in the assessment of physical policy measures - the place of CAPTURE in the body of research

Research into the effects of physical measures

There have been other attempts to review the effects of physical transport policy measures but a sign of the complexity of the area under study is that few have attempted to assess the effects of various types of physical measures in a systematic or holistic way such as CAPTURE is attempting to do.

One of the most recent attempts to measure the impacts of different types of measures on encouraging travellers to change to using public transport was the "APAS" report undertaken for the European Commission (Transport and Travel Research Ltd et al, 1996). Individual results found from this study are reported in the later subsections of this report. A review framework of "direct" and "indirect" "strategies" was used which is presented in Table 1.6 below.

Table 1.6: Transport strategies which can affect the level of public transport use

DIRECT STRATEGIES	
Pricing	Fare levels Ticketing regime / fare structure Ticketing technology Subsidy regime
Service Pattern	*Routes* *Stops* *Service frequencies/ scheduled journey time* *Operating hours* *Fleet size*
Priority measures	*Link priority/ segregated right of way* *Junction priority*
Service quality	*Vehicle characteristics* *Bus/ rail stop quality* *Terminal/ interchange quality* Number and quality of staff
Information	Information provision
Regulatory regime	Publicity/ promotion
Other	*Park and Ride* Integrated approach

INDIRECT STRATEGIES	
Car ownership	Taxation of car ownership

	Restrictions on car ownership
Car use - general	Fuel tax Restrictions on car use Car vehicle specification
Car use - area specific	*Traffic calming* *Access restrictions* Road pricing *Number of parking spaces* Cost of parking *Restrictions on timing or user type* *Parking enforcement*
Other measures	Information on traffic conditions Land use planning Tele-commuting, tele-shopping Flexible working hours *Increase in road capacity* *Improvements to non-motorised modes*

(From Transport and Travel Research et al, 1996)
Items in italics refer to those considered under the 'physical measures' category

The above table shows how measures of different types fit into an overall picture. CAPTURE is concerned with physical measures, (while other EU Transport Research and Development 4th Framework Urban Demonstration Projects are concerned with 'Financial', 'Control', and 'Persuasion' measures. It can be seen that the above classification does not fit fully into the categorisation later developed, but those in italics show where there is substantial scope for physical measures.

Goodwin et al (1996) report case studies of 'environmentally friendly' physical measures: a pedestrianisation extension in Lüneburg, a new light rail system in Sheffield, studies of transport policy development in York and Oxford and road tolling in Trondheim as examples, backed up by extensive secondary analysis of other data. The individual results are reported in later sections, but the study also looked at overall aspects of the relationship between policy measures and modal shift.

The main thesis of this work is that history has shown that many policies to reduce dependence on the car have failed in their objectives, and that this is mainly the result of adaptive behaviour by car users to continue using their cars. They cite several examples of "what can go wrong" or what can be thought will go wrong in transport policy implementation shown in Table 1.7.

Table 1.7: "What can go wrong with policies designed to reduce car dependence"

POLICY TOOL	REAL OR PERCEIVED NEGATIVE EFFECTS
Park and Ride	People move further out from city centres and increase car mileage. Streets within city become used by cross town traffic
City centre all day parking charges to discourage commuters	Short term parking by shoppers increases overall mileage
Pedestrianisation	If unsuccessful it can drive business to other towns - if successful it can drive out 'useful' shops to be replaced by high value and tourist shops able to pay higher rents.
Traffic calming	Either done cheaply and gives 'traffic calming' a bad name, or is used to provide more parking spaces and therefore encourages greater car use.
'Green belt' around cities	Can encourage 'leapfrogging' of development to outside protected ring
Subsidising public transport	Can encourage higher costs and complacency by operators
New light rail schemes	Use up all money available for transport schemes preventing other solutions, and serve only a small proportion of population
Encouraging cycling	May increase cycling with little impact on car travel since trips are attracted from walk or public transport, or car users continue to use their car as much anyway
Road pricing	Diverts attention from more practical policies - would represent a substantial burden on business and personal expenditure - would cause inequality of access to city centres, and encourage outward movement by car users.
General statements leading to disillusionment amongst transport planners:-	"People are irrevocably committed to their cars and won't give them up, whatever you do" "Politicians are so scared of doing anything that, even where there is public support, policies will be timid and ineffective".

(adapted from Goodwin et al, 1996)

The research highlights the complexity of producing effective policy strategies using a limited number of policy tools in a situation where many people have a 'disposition' towards individually not changing behaviour. It supports the need for a package of push and pull measures to affect real change, and that the composition of the package of measures will need to be customised to local conditions.

This research also highlights the point made by Goodwin (1994) that traffic demand management measures have started in cramped historic cities, and measures then tend to move out concentrically, as problems solved in the more central areas lead to larger problems in the areas outside. These problems are especially apparent in city centre pedestrianisation and control schemes, where adequate provision is not made of the likely wider effects outside the area. The paper concludes that the 'natural' course we can expect is an 'outward bound' movement of measures till all urban areas are covered by demand management measures.

A much earlier attempt to provide a similar overview on measures which can influence the demand for public transport was the International Collaborative Study of the Factors

Affecting Public Transport Usage (1980) which summarises policy measure types in the fashion described in Table 1.8 below.

Table 1.8: Types of scheme and their main objectives

POLICY OR SCHEME	LIKELY TO ACHIEVE ...		
	objective 1 improving road traffic conditions	objective 2 improving public transport	objective 3 optimising 'efficiency' of whole transport system
Traffic management (one way streets, turning prohibitions, junction control)	✔		
Urban road construction and/ or junction improvements	✔		
Car parking provision	✔		
Bus priority		✔	
Traffic management with bus priority	✔	✔	
Improved bus service		✔	
New rail construction and rail improvements		✔	
Priority to other modes (pedestrians, car pools, cyclists)			✔
Park and Ride	✔	✔	✔
Organised car sharing			✔
Staggered work hours, flexitime	✔	✔	✔
Car parking restrictions	✔	✔	✔
Traffic restraint	✔	✔	✔
Town centre segregation		✔	✔

Source - International Collaborative Study ... (1980)

The study also provides much useful information on the effectiveness of many individual measures, much of which is reported in various parts of Section 2 of this report.

The UK guidelines on Transport in the Urban Environment (Institution of Highways and Transportation 1997) are able to provide information on the cost effectiveness of measures such as bus lanes; however it cannot provide analysis of most of the measures which are suggested. This underlines the overall lack of knowledge in the profession about the effects of measures. The 'APAS' review of measures affecting public transport use (Transport and Travel Research et al, 1996) came to the view that for most measures there was little evidence about their effects, and this view is confirmed here.

Some Impact studies have been systematically carried out but are generally concerned with large scale infrastructure implementation - Bay Area Rapid Transit (BART, 1978), The Tyne and Wear Metro (Metro Monitoring and Development Study, 1985), Glasgow underground railway improvements (Gentleman et al, 1980), and the Sheffield Supertram Monitoring Study (South Yorkshire PTE, 1997). At the other extreme there have been various studies of small scale isolated, and generally very novel, transport investments. Many of these are cited in the following text.

1.4 Types of impact studied under CAPTURE

In this report we look at each major type of measure studied in the CAPTURE project, according to a variety of impacts. Sections 2 and 3 use such a breakdown to separate out different effects of policies. The main impacts are broken down into four main categories:-

- Technical - does each system work?
- Operational - does it help transport operate?
- The social and behavioural impacts - does it have a beneficial effect on society?
- Environmental Impacts - does it improve environmental quality and not add to environmental degradation?

Under these main headings we study various aspects.

1.4.1 Technical impacts

The basic question asked in this analysis is "does each physical measure work?". This is covered not only in terms of technical functioning but from a wider perspective from design to operation.

Ease of design - This is the ease with which the physical measures are translated into a design which can be brought forward to reality. *A priore* expectations of the simplicity of a design for any one physical measure are not as simple as might be at first thought. While a high tech solution may require a large input in terms of technical design, a simple solution may also require much effort due to the need for acceptance by politicians or other decision makers, or local standards. It is normally the case that a physical design will go through several iterations, irrespective of its complexity, to ensure that the design conforms to standards and legislation, that it appears to meet its objectives and that it has political acceptance. The stage at which the technical options are tested and their feasibility based on an assessment of their expected impacts, is a critical one in the design phase.

Ease of implementation - As the CAPTURE project progressed it became apparent that the 'results' and 'impacts' of many measures could not be evaluated because what had been planned was never implemented, or was delayed beyond the lifetime of the project. While in the early stages of the project this was regarded as an irritation since new elements had to be incorporated to cover those parts lost, or the demonstration lost some of its strength, it soon became apparent that the relative ease of implementation was of vital importance. In these evaluations we look at aspects of a measure which seem to relate to a good or poor chance of implementation.

Ease of operation
Once implemented, the technical monitoring of physical measures relates both to the individual components (eg the functioning of barriers in an HOV lane, bus priority lane dimensions, junction/ feeder lane layouts etc.) and their overall operation as a system. Related impacts, though not strictly technical, monitor the acceptance and enforcement of the system. The continuous technical monitoring of the CAPTURE demonstrations enabled defective operations to be re-designed during the course of the study.

1.4.2 Operational impacts -does it help transport operate?

While technical impacts refer to the physical infrastructure, operational impacts refer to the effectiveness of all the transport modes using the infrastructure. The basic question asked in this analysis is “does the change help in the way it was intended in terms of such goals as improving the operation of public transport and other modes?”. The effects are those of operation of modes as opposed to the effects on people’s behaviour - we are concerned here with the changes which affect the potential for people to change behaviour.

Speed of public transport - The operating speed of public transport is the primary indicator in this group, especially in the corridor public transport studies. It is measured in terms of the time taken between two points. but its simplicity hides other factors which are described below.

Delays to public transport - The average speed is likely to be made up of periods of vehicle movement and periods when vehicles are stationary. Delays can be measured in terms of time spent stationary, or time when a sensible speed of operation is not possible. Some delays will be due to passengers boarding an alighting and some to traffic conditions.

Regularity of public transport (the ability to keep to timetables) - The other aspect of the operation of public transport is the ability of the buses to keep to timetable and thus provide both a certainty to the passenger about when the next bus will arrive, and the lack of ‘bunching’ which will reduce the effective operating headway although it may not change timetable frequency.

Effects on other modes - While changes may be designed to affect the operational ability of public transport, there will be effects on other modes, whether intentional in the design or not. For example, changes in the layout of a road or changes in its space allocation between the modes using it will have an impact on their relative speeds, ease of operation and points of conflict.

1.4.3 <u>The social and behavioural impacts</u>

This category of impacts assess the effects of physical measures on people; both those using the transport system and non-users affected by it. At the lower level, impacts assess changes in travel behaviour and the relative impacts on different groups in society. The higher level assesses the wider impacts of changes in behaviour for economic and social development.

Local level modal shift effects - Of greatest importance in terms of modern transport strategies is the effects that policy measures can have on the proportion of travellers using different modes of transport. Policy goals such as reducing the need for travel and reducing dependence on the car all have this as a primary aim (if they are to work). Modal split can be measured for both vehicles, and for people or passengers.

City wide modal shift effects - While local level effects on modal share may or may not be beneficial to the goals or reducing dependence on the car the side effects of the measures have to be taken into account. At one level the area being changed may be so small that the overall impact on a city will be unmeasurable. For demonstration projects we would normally expect this to be the case since the demonstration is likely to be a small scale experiment designed to test out an idea for broader use, if successful. But at another level the effects of measures in one area may have other effects elsewhere. For instance bus priorities on one corridor could slow car travel which might encourage cars to use neighbouring corridors. Conversely measures which were successful in encouraging people to public transport might free up road space which led to a redistribution of car traffic towards the corridor, so the effect on modal shift might be shared between two or more corridors.

The effects on other road users - While, in the above paragraphs, we have discussed modal share on its own, we also need to look at the effects on mode users in wider terms - the changes to the quality attributes of modes may not cause a change in mode use in the short term, but may make the use of a mode very much more, or less, pleasurable, practical, safe, quick, comfortable, etc.

Effects on those with reduced mobility - Of special concern is the effect that measures may have on persons with reduced mobility (PRMs). This group includes those with disabilities which may cause problems using one or more modes of transport, those who are with young children, in push chairs, or too young to look after their own safety, and those who are encumbered with luggage, for instance those on holiday, but more commonly, those with heavy shopping or other items.

Effects on safety and accident levels - Fatal accidents are at the top of what can be called the 'safety pyramid' beneath which are serious injury accidents, slight injury accidents, non injury accidents, near misses, and potential conflict situations which may cause accidents. While data is readily available on accidents, information on broader aspects of safety, and people responses to feelings about transport safety are harder to gauge.

The effects on the local economy - At the largest scale there is a belief amongst many that changes to transport infrastructure have an affect on overall economic well-being. This view is doubted by many others who argue that, at most, it provides for a redistribution of economic activity. With the size of the CAPTURE demonstrators we are further down the scale of effects and are concerned with issues such as whether parking provision and traffic levels are having an effect on local businesses.

Effects on perceptions about travel - That physical measures will affect perceptions about travel is a major interest. Most demonstrators are not of a large enough scale to provide measurable impacts on modal share, and this is not surprising, but the perceptions of modes may change (along with operational efficiency). Both of these are of great importance for any potential future changes of modes which may be brought about by further measures, or changes in pricing of transport modes, etc.

Valuing the effects - Cost benefit analysis is the 'traditional' way of grouping together impacts of transport schemes, by trying to place a money value on each type of effect. This approach is often greatly criticised on the grounds that many factors are ignored, particularly those which are harder to quantify.

1.4.4 Environmental Impacts

Here we are concerned with the effects on the wider environment.

Energy use - Physical transport policy measures will have an impact on energy use. These will partly be due to the operation of different transport modes, and partly to the way people use different modes. For public transport use it is normal that large changes in use are required before service levels are changed so most impacts will be due to speed of operation and the removal or addition or congestion - if one more person travels on a bus the effects on energy use are minimal. For private cars the amount of energy used is dependent to a much greater extent on the number of car journeys made and their characteristics.

The energy efficiency of public transport - Related to the direct energy impacts of the schemes are the indirect impacts associated with changes in travel behaviour that accompany the changes. The buses may run more efficiently, but if that were accompanied by a modal shift to public transport the overall transport energy efficiency could be greater. Transport energy efficiency is measured in terms of the energy use per passenger kilometre. Ideally it would also encompass energy needed for a society to carry out activity, ultimately measured in energy used per unit of GDP or unit of quality of life. That is beyond the scope of the CAPTURE project.

Pollutant emissions - pollutant emissions are modelled and relate fairly closely, but not exactly to energy use. In addition the quality of the vehicle stock can have a major effect on pollutant emissions.

Air quality - While air quality is one of the major elements of environmental analysis in transport the CAPTURE studies have not focused on it due to the scale of the measures not being large enough to have immediate impacts in ways that could be measured. In general calculations of pollutant emissions are taken as giving information which can be used to estimate whether any change in air quality is likely. In general, the CAPTURE measures are not large enough to have impacts at the city wide level, and in only one or two are they likely to have localised effects.

Noise - Noise from transport varies greatly. In most CAPTURE sites noise was not considered to be likely to change measurably, so no assessment was made, but in others, such as the traffic calming measures in Rome it was thought to be an issue.

1.5 Hypotheses for testing by the evaluation

The CAPTURE demonstrations were implemented and evaluated over the three year period from 1996 to 1998. The results from each city were evaluated by the city concerned, and an overall evaluation will be made by the CAPTURE team, looking for transferability of results both between the demonstration sites, and also their applicability to other cities. The aim was that we should know the answers to questions from cities such as “Bus lanes worked well in Cities 1 and 2, but not in city 3 - will they work in our city?”.

To a certain extent it is possible to use the CAPTURE demonstrations as a tool for answering very basic questions such as:-

- How much do physical transport measures affect modal split?
- How much more effective is Measure A than Measure B?

But the use of 11 demonstrations in cities of very different sizes and characteristics, and with physical measures of similar dissimilarity, there is not the scope to state, with any statistical certainty, the answer to such questions. To use the results that have been obtained in that way would be to introduce research findings that may be true in one particular instance in a way which seriously mislead future transport planners. Mistakes have been made in the past by taking the successful results from one city and transferring them elsewhere, where they have not had the same impacts.

Rather, the approach taken in this evaluation is to look at some of the current hypotheses concerning the likely effects of policy on modal split, and assess how much the evidence of the CAPTURE demonstrations supports or disproves these hypotheses. The hypotheses available are numerous but there would seem to be key ones which we can put forward as being the most ‘crucial’ over the last few years:-

The following are some of the ‘popular’ hypotheses stated by transport professionals concerning the potential for modal shift in the 1990s

1	A mixture of ‘push’ and ‘pull’ policies is required to affect a modal shift
2	If we pursue ‘pull’ policies on their own, we create the potential for change, but people will stay with their cars.
3	‘Push’ policies will be unpopular but effective
4	‘Pull’ policies are the only effective way to affect a modal shift
5	There is a need for large scale measures to have an effect
6	The only way for progress is to instigate a large number of small scale measures over a period of time
7	We can encourage public transport use by a package of measures, but real time information is of utmost importance.

While CAPTURE is not able to prove or disprove any of these hypotheses with any finality, it is in a position to provide evidence from contrasting situations which will provide much useful insight. It is in this direction that the main effort of evaluation has been made.

2. EFFECTIVENESS OF DIFFERENT PHYSICAL MEASURES

In this chapter we look at what the project has been able to add to our knowledge of the effects of different types of physical measures in a variety of ways. The areas studied are listed in Section 1.4 of this report. Due to the nature of the project (in terms of the demonstrations chosen, and the types of studies carried out) the amount of detail known in different subject areas is varies greatly. In addition the level of detail of information found out about different measure types varies, due to the fact that some important physical transport policy areas were not highly represented in the project. This is especially true of measures to encourage walking and cycling as modes of transport, which are better covered in the OPIUM project. Measure types are grouped by the following breakdown:-

	Category and subcategory of measure type	Section number
1	Changing the capacity or use of a highway	
	a Bus lanes and bus only streets	2.1.1
	b HOV lanes	2.1.2
	c Junction arrangements	2.1.3
2	Physical measures to improve public transport stops and interchanges	
	a Bus stop arrangements	2.2.1
	b Interchange arrangements	2.2.2
3	Physical measures to restrict access to an area	2.3
4	New transport systems	2.4
5	Traffic calming strategies	2.5
6	Central area parking strategies	2.6
7	Measures to improve conditions for pedestrians	-
8	Measures to improve conditions for cyclists	-

2.1 Changing the capacity or use of a highway

Changing the capacity and use of a highway to benefit modes other than the car can take a number of forms. Here we focus on three types of measure:-

- Bus lanes and bus only streets
- High Occupancy Vehicle (HOV) lanes
- Junction priorities

Various other measures could be described under this category including pedestrianisation (which is covered under measures to restrict access to an area (2.4) and traffic calming which is discussed in Section 2.5. In addition, cycle lanes could have been discussed under this category, but the CAPTURE demonstrators did not include significant measures of this type.

2.1.1 <u>Bus lanes and bus only streets</u>

Bus lanes are a long established policy tool in transport planning, to give priority on a link to buses (and usually other modes such as emergency vehicles, cycles, and often taxis).

Bus lanes have been implemented in five of the CAPTURE test sites; Bucharest, Copenhagen, Greater Manchester, Madrid, and Tampere. They were also planned as part of the London and Vitoria-Gasteiz test sites but were not implemented. They vary somewhat in terms of their characteristics, but all except Madrid have strong similarities of :-

- covering radial routes to or from city centres,
- with a length of between 1km and 10kms (in any radial direction),
- not being continuous lanes, but being designed to fit into an existing urban and road structure
- being mixed with other physical measures (varying but with a strong emphasis on links with junction priorities), and with some others incorporating changes to bus stops etc.

The Madrid case has to be classed differently, although it is radial and of length 16.1kms (of which 12.3 kms are shared with high occupancy vehicles (See Section 2.1.2)), it was constructed as part of a purpose built road expansion and is physically separated from the highway for its entire length with a purpose built subway leading buses straight into a Metro/ bus interchange facility.

The bus lane systems in the CAPTURE project can be summarily described as:-

City	Measures	Implemented?
Bucharest	With flow bus lanes in 3 corridors	Yes
Copenhagen	Sections on alternate sides of street (inbound and outbound)	Yes
Greater Manchester	Bus and cycle lanes (mainly in inbound direction)	Yes, but delayed
London	Several short sections of various type	No
Madrid	Bus lane between carriageways of motorway (and HOV lane - see Section 2.1.2)	Yes
Tampere	Several sections of with flow lanes along suburb-centre-suburb route	Yes, but some sections modified
Vitoria-Gasteiz	Bus only streets in central area	No

<u>Technical - does each system work?</u>

Ease of design

- Design of bus lanes varies enormously. At one extreme they can involve painting a line on the road - at the other they can involve building a segregated lane with underpasses and other paraphernalia.
- The width of the bus lane is an issue of importance. The minimum width needed is around 3.0 metres (which was used in the Copenhagen case). With this width there is only just the width needed for a bus to pass so any obstruction, stationary or moving, will cause a hold up to the buses. In streets where there is a lack of space, the minimum width may be necessary, but it will be important to take enforcement issues into account in design.
- Related to this is the issue of what vehicle types will be allowed to use the lane. Rules can vary from only buses, to including delivery vehicles and others. The most common arrangement is to allow buses, emergency vehicles, taxis, and cycles, though this varies from place to place.

- Since enforcement is an issue with bus lanes it is sometimes useful to incorporate design element which will aid self enforcement. In Italian cities small ridges are built in the highway which mean that once a vehicle has entered the lane it will have to stay in it. The idea is that cars will be unlikely to infringe the rule if they know they may be caught later in the lane. Recently, cameras have been started to be used in some cities such as London and rates of infringements of one vehicle per two minutes have been sent fines.

Ease of implementation

The bus lanes in the CAPTURE test sites have met with differing levels of success in terms of implementation. But the reasons for non implementation have tended to not be related to the fact that they were bus lanes, but part of other considerations. In Vitoria the whole demonstration was cancelled, and in London other plans put the bus lane plans ‘on hold’ while the larger schemes were discussed. In some cases elements were dropped, and these generally related to the parking restrictions outside traders premises that accompanied the measures.

But it is true that bus lanes can be controversial for a variety of reasons:-

- They may be seen as taking away space from other vehicles and lead to delays. In general this is not as commonly thought as likely as might be expected, probably because, in most cases they are designed to ensure that other traffic is not slowed.
- In addition the schemes may not get past city authorities if they are seen as likely to have an adverse impact on other traffic. In general this means that the design stage will require ensuring that this does not happen and providing evidence to other authorities that there will not be adverse impacts.
- More commonly, traders may object to the schemes if they have any effect on the parking of vehicles outside their premises.

In most cases there was an element of re-design of schemes from the original to what was implemented. This process seems to be a common theme for bus priority lanes, as a result of either discussion with other authorities, or public consultation.

Ease of operation

The main issues in terms of operation of bus lanes arise from enforcement, aspects of width and design having not been properly planned, and from objections related to the effects on other traffic.

Examples of issues arising from the CAPTURE cities include:-

Copenhagen - The bus lane was implemented in a crowded street with pressure from vehicles, and other road users, and a high degree of commercial activity along the road. It was planned as a narrow lane, which has meant that with parked cars half on the pavement, buses can have difficulties gaining priority. The problem here concerns both design and enforcement (or one or the other depending on how it is viewed).

Bucharest - One of the bus lanes was implemented, but was very shortly painted out by the police authorities on account of traffic problems caused by its implementation. This is a very immediate example of problems which arise in many cases throughout Europe, though not always in such as dramatic fashion. In many cities traffic schemes are implemented, but complaints to other bodies can result in decisions being quickly made to cancel a scheme.

There are other issues surrounding the operation of bus lanes which did not arise in the CAPTURE cities, but can be important. These include the timing of operation - whether the bus lane is operational in peak hours, during the daytime, or for 24 hours a day. Issues here are concerned with the time the lane is needed most and the extent to which infringement may be increased if there is any doubt about when the lane is operational.

<u>Operational - does it help transport operate?</u>

Operational efficiency of vehicle use - bus and car speeds

Bus lanes usually, but not always, succeed in terms of their usually stated goal of speeding up public transport operation. Table 2.1 below shows the results of the CAPTURE bus lanes in terms of speed for buses recorded in surveys along the corridor routes.

Table 2.1: Speed of public transport operation - kms per hour

	Before	**After**
Bucharest		
Unirii Blvd 0700-1000	12.5	27.0
Elisabeta Blvd 0700-1000	10.6	16.0
Copenhagen	15.7	16.5
London 0700-1000	18	15
Camden 1200-1500	14	11
1600-1900	13	10
Camb- 0700-1000	21	23
erwell 1200-1500	19	21
1600-1900	14	13
Madrid 0700-0800	37.2	76.1
0800-0900	30.2	50.5
0900-1000	35.8	86.9
Tampere	26.6	27.0

It can be seen that while bus speeds were recorded as increasing in some cases, this was not true for all. Decreases were noted in Bucharest for some timings, and for London. In the case of Bucharest the overall growth in traffic and problems of enforcement were cited as reasons, while the London case demonstrates a case where the bus lanes were not implemented in any case. In Tampere bus lanes were finally implemented at the Pispalan valtatie section, which is very fast and fluent for cars and buses. Because of that no major time savings were achieved for buses. Besides, one typical feature in Tampere is that many cars use bus lanes, and this naturally affects bus operations.

Table 2.2 shows average delays recorded in CAPTURE surveys to buses.

Table 2.2: Average delays experienced on route for public transport - minutes

	Before	After
Bucharest Unirii Blvd 0700-1000 a Elizabeta Blvd	2.5	0.5 1.5 time saving
London 0700-1000 1200-1500 1600-1900 Camb 0700-1000 1200-1500 1600-1900	0.5 0.8 0.9 0.8 0.9 1.6	0.6 0.9 1.0 0.5 0.5 1.4
Madrid	-	3.40 time saving
Tampere	12.2	13.4

It is apparent that in most cases the lowering of delay time is not very large, and may be negative. There are two main factors which are thought to be responsible for this. Firstly, many of the delays associated with bus operations (when stationary) are not concerned with congestion delays, but with delays associated with boarding and alighting times. The detailed studies in the Tampere test site bear this out as Table 2.3 demonstrates.

Table 2.3: Cause of delays - Tampere Test Site - % of delaying time

	Traffic Signals	Boarding/ Alighting	Waiting to keep to timetable
Multisilta-Tesoma before	30	53	17
Multisilta-Tesoma after	28	53	19
Tesoma-Multisilta before	33	56	11
Tesoma-Multisilta after	29	56	15

The effects on private cars for travel speeds and delays are shown in Tables 2.4 and 2.5 below. It can be seen from Table 2.4 that in general, private car speeds have not been slowed down by the measures, except in the Copenhagen case, and in some of the times for London. In London the bus lanes were not implemented, and in the Copenhagen case the measures were designed in the knowledge that car speeds might be adversely affected. We will return to this issue in Sections 3 (conclusions) and 4 (policy recommendations) with respect to the extent to which schemes are planned allowing for reductions in car travel speed. It becomes one of the most important issues in the effectiveness of physical transport policy measures.

Table 2.4: Average speed of private car travel on route - kms per hour

	Before	After
Copenhagen 0800-0900	21.4	17.6
1600-1700	23.4	20.7
London 0700-1000	26	27*
1200-1500	29	17
1600-1900	18	12
Camb 0700-1000	27	29
1200-1500	17	20
1600-1900	11	15
Madrid		20.45
Tampere	40.0	40.6

Note - In London the bus lanes were not implemented so these refer to changes other than bus lanes

Table 2.5: Average delays experienced on route by private cars - minutes

	Before	After
Copenhagen	3.4	5.4
Tampere	4.0	4.2

Also included in this analysis are the effects of changes to a large junction in Bucharest known as Unirii Square. While this is technically a 'junction arrangement' the square is of such a scale that the changes can be regarded as being to several links in a small network. Changes to simplifying the system by taking out 'cross links' and making the two way outer roads into a one way gyratory system (a large roundabout style one way system using adapted existing roads) have lead to decreasing crossing times of 62%, 45%, and 28% for north-south, west-east, and east-west crossings respectively.

The transportation efficiency of public transport

Bus lanes can effect the transportation efficiency of a road system if they increase the numbers of people travelling in vehicles which take up less space per passenger. Although a bus lane will reduce the space available for private cars it will increase the capacity available for public transport, and, as well as cutting journey times, will allow for an increased capacity of flow to be offered. Whether that is the case will usually depend on whether there is increasing demand for bus travel as a result of the priorities (or if demand for transport is growing in any case). Transport efficiency can also be increased for operators if the same number of passengers can be carried using fewer staff, resulting from journey time savings.

In most of the CAPTURE cases there was no increase in service level offered, though the Madrid and Bucharest cases did so. In the Madrid case the whole corridor is an area of large scale urban growth which is encouraging a growth in demand for many types of travel, and in Bucharest the post 1989 revolution changes have been accompanied by changes in work and residence locations, incomes, and general lifestyle, which has led to an increase in mobility both by public as well as private transport. Table 2.6 shows the increase in capacity offered in the Bucharest test site.

Table 2.6: Offered capacity and patronage in Bucharest (Iuliu Maniu Corridor)

	Before	Intermediate	After
Offered capacity	4350	5800	6313
Patronage (inbound/hr)	3295	5650	6094
% of capacity used	76%	97%	97%
Patronage (outbound/hr)	2403	3198	3705
% of capacity used	55%	55%	59%

In general it can be concluded that, in the short term, the introduction of bus lanes, on their own, is unlikely to lead to greater service levels and offered capacity of service. But in situations where there is growing demand which is inhibited by congestion the better services provided by bus lanes can make a great difference, as is the case in Madrid. Other evidence of the possibility for expansion of services comes from Oxford where bus lanes have been in existence for some 20 years. In this case, following deregulation of services in the mid 1980s the city saw a large growth in service levels and in patronage (about 80% growth over 12 years) which has been largely attributable to the bus priorities allowing for growth.

London Transport has carried out surveys of the effectiveness of bus lanes and it seems that the most important determinants of bus journey time along bus lanes are the traffic density and the number of violators. They also found that:-

- Bus priority measures can have a very beneficial effect on the reliability of a bus service. Bus journey times are much more consistent over the areas covered by bus lanes, and the standard deviations of the headways do not change greatly across the length of the bus lane.
- Based mainly on travel time and consistency improvements to passengers, the economic evaluation (based mainly on comparisons of real likely journey times) shows a very positive rate of return of the bus priority measures, in some cases a return in less than a year.
- Whilst much improvement is shown over the area of the bus priority measures themselves, it appears that buses are still caught up in congestion in parts of the route where no bus priority has been implemented. To gain a real advantage for buses and their passengers a new approach, such as reducing road traffic and changing priorities for modes of travel, is required.
- It is essential that all bus priority measures are fully and effectively enforced to achieve maximum benefits.

Following the above work consultants to London Transport recommended that to achieve ‘Total Bus Priority’ it is necessary to:

- Reserve the necessary road space to guarantee buses unrestricted movement along a defined network consisting of those roads with major bus flows. Special arrangements would be needed for access to premises - for example, cars or lorries might be permitted to enter a link but forced to turn left at the next junction;

- Allocate the road space that remains for use by general traffic, protecting potential rat-runs (short cuts) against unacceptable traffic increases.

Such a regime would offer standards of bus journey times and reliability unattainable at present or under any package of measures which represents a compromise between the needs of buses and other vehicles. Reliability standards would be comparable to those offered by a railway, and vehicle frequencies far higher. However, the road space remaining for general traffic would be quite unable to carry current traffic flows.

One serious consequence of this is that the costs and reliability of freight transport could get worse. It may well be that a necessary component of such a scheme would be demand management (perhaps by a method such as road pricing) to restrain general traffic flows to a level which the general traffic network could carry, or allowing freight transport to benefit from bus priorities.

The social and behavioural impacts

Local level modal shift effects

The modal shift effects of the introduction of bus lanes are not, in the short term, as high as might be anticipated relative to the visibility that they appear to have within a city, and on a corridor. Some explanations for this are:-

- While an outsider might see a bus lane and imagine that buses "do not experience delays" the findings on time savings in the previous sections illustrate that a very visible lengthy section of bus lanes may result in a two minute time saving (or less) which, for bus journeys, with a door to door travel time in the order of 30 minutes for most journey lengths, does not provide the incentive for a sudden change of mode.
- There may have been a small effect but it may have been overwhelmed in the year or more between surveys by other background trends leading to higher car use or lower public transport use.

It would seem that for a bus lane to be successful requires that an overall corridor approach is taken and that the number of buses needs to be quite high to give a message to the public that the lane will lead to shorter journey times.

Table 2.7 summarises the modal share implications of the bus corridors in the CAPTURE demonstrations, and it is seen that the change is not large, and even negative in some cases.

Table 2.7: Modal split (percentage) for vehicles before and after implementation

	Before				After			
	PT	Car	Cycle	Other	PT	Car	Cycle	Other
Bucharest								
Unirii Blvd 7-10	2.2	83	0.2	14.8	9	77	0.1	14
Maniu inbound	11	68	-	21	15	57	-	28
Maniu outbound	22	56	-	21	20	56	-	24
Copenhagen	2.8	52	33	12	3.4	48	37	12
Greater Manchester	3.3	71.4	0.8	24.5				
London	4	77	4	15	4	68	5	23
Madrid (bus/car)	1.5	98.5	-	-	2.4	26.5 HOV 71.1 other	-	-
Tampere	4.3	80.2	-	15.4	4	82	-	14

Table 2.8: Modal split (percentage) for persons before and after implementation

	Before			After		
	PT	Car	Other	PT	Car	Other
Greater Manchester	33	55	12	34	54	12
London	39	46	15	39	44	17
Madrid (bus/car)	23.5	76.5	-	34.8	27.4 hov 37.8 other	-
Tampere	39	61	1	37	63	0

Table 2.9: Modal share in the Bucharest Maniu Corridor (%)

	Inbound		Outbound	
	Before	After	Before	After
Car	68	57	56	56
Bus	11	9	22	15
Trolley	0	6	0	5
Goods	12	15	20	14
Emergency	0	0	0	1
Cycle	0	0	0	0
Taxi	9	13	1	9

The Bucharest case shows large increases in taxi share on the Iuliu corridor which is mainly due to the opening of a supermarket, with many people using taxies for food shopping.

While the effects on modal split of the bus lanes does not, at first sight, appear to be encouraging, the longer term picture may well be better, and bus lanes should not be thought of as ‘failing’ because they do not provide an instant shift of modal share to bus. There are several reasons for this:-

- Changes in behaviour take time. People tend to change their travel behaviour when something else, such as a change of job, school, home location, etc. causes them to re-assess their travel requirements and options. If public transport service has improved this will be borne in mind and may lead to a large proportion of people choosing bus where they would have previously chosen a car. These changes take ten years of more to work their way through.
- The creation of bus lanes provides the potential for later modal change. If pricing, or other measures are introduced and the public transport alternative is of poor quality and level of service it is likely that people will carry on using a car, but pay more for it. But if bus lanes and other priorities have been put in place many more will choose the bus option.

City wide modal shift effects

Bus lanes are amongst the larger scale measures in the CAPTURE project, but it is not generally possible to attribute a city wide modal shift to their introduction. More comments on this aspect are made in the sections on city side modal shift in Section Three.

The effects on other road users

Bus lanes can have differing effects on pedestrians and cyclists, depending on whether these groups are considered in design, or not. Cyclists are usually allowed to use bus lanes, and occasionally not. If they are not, there is generally a reduction in their perception of safety, since they would have to ride in the main carriageway with no protection. When allowed to use a bus lane the main factors will relate to the width of the cycle lane, and the behaviour of bus and other drivers using the lane. (A narrow lane which does allow cyclists is likely to have negative effects on bus speeds, since they will be unable to safely overtake cyclists). The arrangements at the start and finish of the bus lane are very important for safety, especially for contra-flow bus/cycle lanes.

Similarly, the effects on pedestrians will relate to whether they have been considered in the planning stage. Contra-flow bus lanes with no protection will make road crossing by pedestrians more difficult and potentially more dangerous, but pedestrian refuges can make road crossing easier and safer.

Effects on those with reduced mobility

Bus lanes, in themselves will have little effect on those with reduced mobility, but the arrangements of stops may well be altered by their design, and the ease of crossing roads to reach stops may be altered.

There is no evidence to suggest that the modest journey time savings achieved in some of the operations would have any greater effect on people with reduced mobility than on other passengers. Research on the attitudes of elderly and disabled people towards bus use has shown that reliability rather than speed of journey is the most critical element. The minor changes in delay times to buses (Table 2.2) are too small to have any significant impact on time keeping and reliability.

Effects on safety and accident levels

The data on accident levels as a result of the introduction of bus lanes for Bucharest is shown in Table 2.10 below.

Table 2.10: Accident data Iuliu Maniu Boulevard, Bucharest - Numbers of accidents

	Before	After
Fatal accidents	5	2
Serious injuries	10	28
Light injuries	20	79
Traffic collisions	39	65

It is noted that in the Bucharest test site there was a reduction in deaths, but an increase in the total number of accidents, probably in concordance with increase in traffic levels over period.

Simple safety audits of the effects of bus lane schemes are summarised in Appendix 2.1. Points of importance include interaction between buses and cyclists in bus lanes (though the problems of this related to a previous situation of interactions between cyclists and all other traffic are quite complex).

There are other ways in which safety can be affected by bus lanes. A city with a network of bus lanes can also provide a network for the emergency services. The bus lane can provide a faster route for emergency vehicles to access accidents in other locations when congestion occurs. (Of course the use of roads by emergency vehicles travelling at high speeds, is also a safety risk in itself).

The effects on the local economy

Of the measures implemented, bus lanes were one of the ones which encouraged most complaints from local traders about difficulties of users parking outside their establishments. These complaints and suspicions were not generally concerned with the bus lane in itself, but with the changes to parking that were required from giving priority to buses. Complaints following implementation were received in the Copenhagen corridor. In Tampere the original plan was to construct a bus lane (4 km) at Pispalan valtatie towards the city centre. This plan was abandoned, because residents were afraid that this new lane (even if it was a bus lane) would create more traffic to the street, and local traders were worried about parking.

On a wider level it would be very helpful if benefits to the local economy could be found for bus lanes, but although there are arguments to suggest there should be some it has not been possible to measure these within CAPTURE. There is a case for special study of these aspects.

Effects on perceptions about travel

The ways in which any of the CAPTURE measures will affect perceptions about modes of travel overall are generally quite limited. In the case of bus lanes one might expect that buses might become to be seen as slightly faster and more efficient than other modes, but they are unlikely to have a large effect unless the bus lanes are over a very wide area. In corridors this is generally unlikely.

Table 2.11 below shows the effects on perceptions of different aspects of public transport in the Tampere test site. In addition to the bus lanes newer low floor buses, and other junction arrangements had been incorporated in the design. The results show only very slight changes in some aspects, and no change at all in others.

Table 2.11: Perceptions of quality attributes of public transport - Tampere

	Before	Intermediate	After1	After2	Summary
Speed	2.5	2.4	2.5	2,42	No change
Comfort	2.55	2.48	2.6	2,6	Small impairment
Stress	2.3	2.16	2.15	2,25	Small improvement
Ease of use	1.75	1.72	1.73	1,69	Small improvement
Punctuality	2.1	2	2.08	2,1	No change
Convenience	2.6	2.55	2.56	2,59	No change

(Scale = 1 to 5 where 1=good rating, 5=poor rating)

In the Autumn 1998 Public Personal Surveys of the test site in Tampere, bus passengers were asked about the effects the physical measures would be likely to have on their on bus use. 15 % of interviewees said that they will use buses more than before thanks to new bus lanes at Pispalan valtatie. However, in reality, bus usage will probably not increase that much. Perhaps some interviewees perceived the question as follows: “Do you think that public transport service level improves because of the measure?”. It can be seen that bus passengers prefer this kind of physical measures.

Table 2.12 shows the relative perceptions of different modes of travel among respondents after the bus lanes and trolleybuses had been implemented in the Bucharest test site..

Table 2.12: Perceptions of modes of travel in the Bucharest test site

	Private car	Walking	Cycle	Bus	Tram	Trolley	Metro
Relaxing	high	high		medium	medium	medium	
Easy/ Difficult	easy	easy		quite easy			
Economic/ Expensive	v expensive	cheap	cheap	Medium	Medium	Medium	
Punctuality	good			poor	poor	poor	
Fast/ Slow	fastest			medium	medium	slow	fast
Safe	medium	safest	unsafe	medium	> med	> mid	med
Environmentally friendly	worst	best			medium	mid	mid
Comfort	best			medium	worst	worst	mid

Valuing the effects

London Transport has carried out an extensive study of the monetary impacts of bus lanes, as part of their monitoring of the London Bus Priority network development. Some of the key findings have been:

- the network studied showed substantial delays to buses on congested parts of the network, with some bus journeys falling to walking speed, and it was estimated that this costs existing passengers about £6 million a year in lost time;
- the ratio of time savings to cost would be very high for all the priority schemes and packages proposed, and using the Department of Transport's cost benefit methods;
- the total value of schemes on the four study routes would be over fifteen times the cost of implementing them;

Table 2.13 shows calculations regarding the costs and benefits of a number of schemes. Most of the benefits accrue from time savings to passengers, but take account of any time losses to other mode users.

Table 2.13: Cost benefit analyses of bus lanes in London

Scheme	Cost of Scheme	Net Annual Benefits - CBP Algorithms	% Ben./Cost
Shepherds Bush Green, south side : bus lane and pre-signals	£387,000	£187,000	48
Shepherds Bush Road northbound bus lane	£160,000	£88,000	55
Fulham Palace Road northbound bus lane to Lillie Road	£160,000	£90,000	56
Fulham Palace Road northbound bus lane to Winslow Road	£81,000	£139,000	172
Fulham Palace Road northbound bus lane to Hammersmith Gyratory	£44,000	£214,000	486
Shepherds Bush Road southbound bus lane	£100,000	£156,000	156
TOTAL	£932,000	£874,000	94

It can be seen that the ratio of benefits to costs vary (as would be expected with different costings for schemes providing different time savings) but for those implemented the costs would be 're-paid' over a period of just over two years, while for some much less than a year.

Environmental Impacts

Energy use and pollutant emissions

The energy use impacts of bus lanes are generally favourable for buses, but the effects may be positive or negative for other traffic depending on details of design. If there is less acceleration and braking due to smoother flow there may be benefits to buses. Modelling of the effects of bus lanes was attempted in many of the cities in which bus lanes were implemented but the results did not provide evidence of an overall increase or decrease in any of the cases. In effect, the changes caused by the CAPTURE measures were small compared with other changes taking places over the study period.

Noise

Noise from traffic relates to engine and braking noise at slower speeds, and tyre noise at higher speed. Bus lanes very rarely have impacts on noise levels, though as buses are often noisier than other vehicles it would be possible for noise levels to rise in the number of buses on a route altered dramatically. No such effects were recorded in CAPTURE. On the other hand, if speeds are moderated with less acceleration and braking noise levels may fall.

Other research

The 'APAS' study of effectiveness of measures influencing public transport use (Transport and Travel Research Ltd et al, 1996) concludes that bus lanes are generally not enough to attract car users. Evidence from Dublin points to marked improvements in bus journey speed but not in patronage or modal shift. The London Red Route scheme led to an increase in bus patronage of around 10%, due to a reduction in travel time variability of around one third, and a small reduction of in vehicle time. After an extension of bus lanes in Berlin respondents held a less positive view about them than before implementation. A similar finding was reported in Merseyside in 1996.

The study does, however, quote other research with some interesting findings. The Bus and Coach Council (1990) reported operational speed increases from 70% to 130% for bus lanes in the cities of Amsterdam, Dublin, Marseilles, Paris, and Toulouse, though no patronage changes were reported. It also reported Heunemann (1993) who surveyed 38 cities and found that in cities with no bus lanes patronage fell by 6% between 1985 and 1990, for those with lanes but no new ones patronage rose by 11%, and for those who had expanded their bus lane networks patronage had increased by 19%. There is no record of the relative amounts of increase, and it is difficult to know what other measures were in place in the cities at the same time. Cities with bus lanes may well be implementing other bus friendly policies at the same time. TRRL (1980) found that the Besancon closure of through streets to all but buses led to a 70% increase in patronage.

Many look overseas for good examples of bus priorities and review Brazilian cities as having made good progress in developing bus priorities. Notable examples in Sao Paulo, Recife, Curitiba, and Porto Alegre are reviewed by the UITP (1992). They cite especially Curitiba with its use of central lanes of highways for segregated tracks, stops at intervals of about 1km reached by subways or footbridges, and the use of convoy operation in the city centre where central lanes do not exist with buses timed to converge at the end of the busway at the same time, then pass through lights system at same time.

Curitiba is described as having a 56km network on five major radials. Loadings up to 18,900 passengers per hour are achieved. On two radials express "Ligeirinho" buses operate with tickets bought at turnstiles before the bus stop, and level access to the bus by use of enclosed platforms. While reports of modal split changes are not available, they would probably not be relevant to a European situation with very different levels of car use, but they do show the kinds of flows that can be obtained using bus operation.

The 'lignes pilotes' in Paris implemented in 1973 (TRRL, 1980) were bus priorities designed with around half total route length in reserved lanes, with average overall speed improvement of 4% and marked increase in regularity leading to waiting times being reduced by 10-20% . Patronage rose by 18% against a city wide experience of 11% between 1973 and 1975. (It is commented that the 1973 oil crisis might have been factor in overall city wide increase). This study points out the importance of increasing regularity and thus cutting waiting times and reducing uncertainty, and also maybe points out that it is easier to build patronage when it is rising anyway. Like many other policies it is easier to build on growth by improvements than to fight against decline.

In Ottawa a 7km bus lane led to 5 minute saving led to 46% gain in morning peak, and 70% in evening. (It seems that changes reported from these earlier experiences may be greater than would be anticipated today. This may reflect many factors, but possibly car dependence has increased somewhat over the twenty year period making change of mode less likely.

Conclusions

Bus lanes have become a common feature of plans to improve priority for public transport. They are relatively easy to envisage, relatively cheap to install, and give a very visible signal to road users of the relative priorities afforded to different modes of travel.

However, it is essential that they are well planned if they are to be effective. The CAPTURE demonstrations have shown that they are capable of providing time savings to public transport, but that that these tend not to be translated into timetable savings. Perhaps the most encouraging of their effect on operations of public transport is that they can help reduce bad time keeping of services and thus improve running to timetable.

It is apparent that many improvements in a single corridor may be able to give a perception that improvements to travel time will exist, more easily than when bus lanes are implemented piecemeal over a city. It may be more beneficial to concentrate effort corridor by corridor, rather than looks to make maximum time savings at sites spread across a city where potential passengers on any one route would only envisage minor time savings. Priority at a junction may provide as much time saving as 500 metres of bus lane, but the 500 metres of bus lane will be very much more visible.

Earlier in this conclusion it was said that bus lanes can provide a clear signal of the priorities afforded to different modes of transport. In some senses that is one of the drawbacks of many bus lanes. In actuality they are often designed in such a way as to not interfere with the capacity given to other vehicles, and in doing so do not give real priority to public transport in the places where it is most needed. While placing bus lanes in places where there is spare capacity is a very laudable aim (especially where the overall amount of road transport is forecast to grow) it may not tackle the problem that public transport is caught up in the congestion caused by other road users.

One way around this is to use junction priorities at junctions where most congestion occurs and this is the subject of Section 2.1.3.

2.1.2 HOV Lanes

The Madrid test site contains the longest and largest HOV lane in Europe, and the only one of its type. It is a two lane road in the central reservation of a motorway of some 12.3 kms in length, separated from the main carriageways by walls. It is a tidal flow system with flow being changed during the day to allow for peak travel demands.

(Other forms of HOV lane being tested, such as one in Leeds in the UK, may be very different, being more similar to a standard bus lane formulation, using existing infrastructure, but allowing cars with more than a pre-defined number of passengers to use the lane).

It is important to stress that in the case of Madrid the HOV lane is combined with a bus lane, so the effects are not only related to car users, but also to public transport.

Technical - does each system work?

Ease of design

The design of the Madrid HOV lane was complex, being integral with the design of the upgrading of a motorway. It is difficult to imagine design of a scheme of that scale not being equally complex. Shorter and ‘with flow’ HOV lanes in other situations can be designed much more easily, being physically very similar to bus lanes.

Ease of implementation

The problems of implementation for a scheme such as the Madrid one are the same as those for constructing a new road, except that there may be extra opposition (or support) because of the inclusion of the HOV aspect. It is likely that in many situations a reconstruction of a road could be easier to implement because of support for priority for public transport that would be provided.

Ease of operation

Enforcement is an issue with HOV lanes as it is with bus lanes. The Madrid system has an ease of enforcement since cars are ‘trapped’ in the system once they enter it so enforcement agencies can more easily apprehend those who are spotted flouting the rules. On the other hand, with smaller scale systems it is more difficult to spot an infringing private car (with only one occupant as against two) than it is to spot a car in a bus lane.

Table 2.14: Use of the Madrid HOV lanes - car occupancy and infractions (7:30-9:30 am)

	Passengers /car on highway as whole			Mean occupancy (persons per car)		% of cars with 1 person in
	1	2	3+	HOV lane	Other lanes	HOV lane
Nov 1991	70	22	8	-	1.36	-
implemented 95						
Nov 1995	47	47	11	2.22	1.14	4.1
Nov 1996	48	49	3	2.06	1.13	2.1
Nov 1997	48	41	11	2.25	1.15	2.9

<u>Operational - does it help transport operate?</u>

Operational efficiency of vehicle use - bus and car speeds

The Madrid HOV lane was very successful in its aims of speeding up bus travel. The overall results are shown in Table 2.15 below.

Table 2.15: Journey time changes in the Madrid test site - minutes (Las Rosas - Moncloa)

	8-9 am			7-10am
	HOV lane	**Other lanes**	**Time saving**	**Time saving**
Nov 1991	na	27.40	na	
Nov 1995	28.02	35.04	7.02	6.40
Nov 1996	24.37	39.17	12.39	9.23
Nov 1997	27.21	31.28	4.07	3.10

It can be seen that until 1997 the journey time savings in the Bus/HOV lane were considerable, but since the opening of the M40 orbital route those savings have been eroded due to faster travel time in the normal lanes.

Overall transportation efficiency

HOV lanes have a similar effect as bus lanes in terms of increasing transportation efficiency in terms of the use of road space, although, if they work efficiently they can further increase the capacity of the lane for carrying people, by using the ‘spaces’ which buses do not use. In addition, again if they are operated efficiently, that use of the HOV lane for high occupancy may increase the flow of other traffic on the other lanes. While a bus lane built into an existing roadway may reduce capacity for other vehicles, that impact will be less with an HOV lane, instead of a bus lane.

The Madrid case is somewhat different, since it involved the construction of extra lanes to incorporate the HOV lane. In effect it has led to an increase in capacity for all forms of road transport, with fairly equal benefits to all modes. It is interesting that in this case of increased capacity on the link for all modes the bus share of modal split has grown.

The social and behavioural impacts

Local level modal shift effects

The changes in the uses of different modes during the operation of the Madrid HOV lane have been very complex as can be seen from Tables 2.16 and 2.17 below.

Table 2.16: Use of different modes in the Madrid test site - Passengers by mode 7 to 10 inbound

	HOV lane		Normal lanes			Total
	Buses	Others	Bus	Others	Rail	
Nov 91			6602	21430	10543	38575
Nov 95	10430	12471	1170	11271	12751	48193
Nov 96	10905	11823	1115	16945	14668	55456
Nov 97	12050	10979	1865	15041	14001	53936

Table 2.17: Use of different modes in the Madrid test site - Modal split (percentage)

	HOV lane		Normal lanes		
	Buses	Others	Bus	Others	Rail
Nov 95	21%	26%	2.4%	24%	26%
Nov 96	20%	21%	2%	31%	26%
Nov 97	22%	20%	3.5%	28%	26%

At first sight it would appear that the changes are almost random, but comparison with the other changes occurring in the area during the period show a remarkable correlation of traveller behaviour with service levels by different modes. As each change in the service level of a different mode is altered the use of different modes shifts towards that mode, and away from others. It is very apparent from this that these changes (which are all of a very large scale compared with most transport changes brought about in cities in Europe currently) there is a distinct and measurable change in travel choice.

In terms of users' perceptions of their behaviour, the following results were obtained from a survey made in 1997.

Table 2.18: Stated changes of mode following HOV lane introduction

Have you (bus users) moved from another mode to use the services using the HOV lane?		
	January 1997	**November 1997**
From car to bus	6	11
From rail to bus	8	16
No change (bus user)	86	73
Have you (2+ HOV lane users) shifted from another mode to use the HOV lane?		
Yes - 1 in car to 2+		17
Bus to 2+ in car		13
Railway to Car 2+		10
From another mode		1
Was not living in the corridor		8
No change		51
How would you travel to Madrid if the HOV lane were removed? (2+ car users)		
Car with 1		9
Bus		6
Railway		14
Other mode		1
No change		67

The Madrid HOV system is complex in terms of its role as a facilitator of modal shift from cars to other modes, in that it involved an overall increase in transport capacity, and an increase in travel speed by virtually all modes. It can be seen from the above tables that the overall modal shifts observed are made up of movements of various types. Some have switched from car driving to bus use, while others have switched from bus use to share cars in the HOV lane.

City wide modal shift effects

Even in a situation as large as the Madrid HOV lane it is difficult to attribute city wide modal shift to each individual change recorded. The situation of large scale investment in transport infrastructure of many types within and around the city is almost unique within Europe. Over a six year period the corridor has experienced great change, with the HOV lane, the rebuilt motorway associated with it, a new rail line, a new orbital motorway and several changes to the metro system designed to allow greater interchange. In addition some 40 kms and 40 new metro stations are planned or being built in the city of Madrid, and integration of all rail lines using a North-South rail link has been completed relatively recently. The overall effects of these initiatives has been very complex, taking place during a period of rapid economic growth.

The effects on other road users

The Madrid HOV lane is on a motorway and, as such has had no direct planned effects on cyclists or pedestrians using the corridor, and no studies were carried out. However it would be expected that there has been some abstraction of car traffic from the parallel route, combined with increases in traffic accessing the motorway which would have had impacts on the attractiveness of walking and cycling. These effects would lead to greater difficulty crossing approach roads but less traffic on roads parallel to the N6.

Effects on those with reduced mobility

HOV lanes tend to do little, directly, for those with reduced mobility. The implications of the Madrid HOV lane are that a motorway is wider than it would have been without the HOV lane. This may mean that fewer crossing points might be built since the cost of a crossing would be somewhat higher than if the HOV lane had not been incorporated into the design. In the case of in-highway schemes the effects will be similar to those where the lane is a bus only lane, except that the level of traffic is likely to be higher in the HOV lane, and possibly, lower in the general traffic lane. The issues here surround aspects such as refuge provision in design.

Car ownership and use by elderly and disabled people is usually below that of the able-bodied adult population and their times of journey are more often outside peak periods, when HOV lanes may offer the best net gains in journey speeds. It would not be expected that these lanes would have any material effect on time keeping and reliability.

Effects on safety and accident levels

Attitudinal questioning on the safety aspects of the HOV lane in Madrid show that 29% of car drivers who did not use the HOV lanes did not because they felt it was “dangerous” and a further 18% felt it was “not comfortable to drive in”. This would probably be due to a possible sense of claustrophobia of driving within confined lanes, in what would otherwise be the central reservation of a motorway. Because of the physical design of the barriers separating the HOV flows this feeling would be exaggerated. The design aspects must be considered when implementing this type of measure.

A simple safety audit of the scheme implies that on most counts there has been little change in the safety levels for car users, based on assessment of exposure, modal choice, route choice. However, travel speeds have increased somewhat, and the interaction aspects are complex. There is less interaction in the lanes themselves, but there are quite difficult interactions at the exits from the lanes into the general traffic flow.

The effects on the local economy

There were no studies of the effects on the local economy of the HOV lanes, although an increase in household construction along the corridor has been detected, as well as a relocation of business areas, changing the patterns of concentration in the Central Business District of Madrid. While there is greater growth in the NW segment of the city, which the corridor serves, there is no evidence that the improvements have added to this pressure - it is the direction towards a mountainous area which is popular for second homes.

Effects on perceptions about travel

Respondents in a household survey were asked questions about their attitudes to the HOV system and ways in which it could be improved. The answers are shown in Tables 2.19 to 2.21.

Table 2.19: What are the most appreciated aspects of the HOV system?

	Bus users	Railway users
HOV/Bus lane	56%	61%
Bus lane	38%	15%
Moncloa Bus Terminal	39%	23%
Moncloa Metro Line 6	22%	28%

Table 2.20 - What would be the best extra measure to manage mobility in the N6 corridor?

	Bus users	Rail users
Forbid cars to use the HOV lane	14%	10%
Road pricing for cars using the HOV lane	4%	5%
Restrict HOV lane to cars with 3+ people	46%	48%
Remove the HOV lane	7%	14%
Do nothing	32%	23%

Table 2.21 - Why car users don't use the HOV lane?

	Car users, normal lanes
Entrance too distant from joining point	12%
Would not save time	6%
Dangerous	29%
Not comfortable to drive in	18%
Longer route	18%
Other	24%

<u>Environmental Impacts</u>

Energy use

Energy use calculations have been made for the Madrid HOV corridor and the results are shown in Table 2.22

Table 2.22 - Energy use in the N6 Highway corridor, Madrid - morning peak inbound

	Bus		Others		Total	
	mill mj	mj/pass km	mill mj	mj/pass km	mill mj	mj/pass km
1991	0.152	0.47	0.837	2.35	0.987	1.46
1995	0.190	0.42	0.581	1.47	0.771	0.91
1996	0.235	0.47	0.906	1.90	1.141	1.17
1997	0.249	0.48	0.696	1.49	0.894	0.95

Pollutant emissions

Table 2.23 summarises information from the analysis of pollutants in the Madrid HOV corridor between 1991 and 1997. The information has been obtained applying emission factors varying with the speed, to the existing flows in the corridors, and differentiating bus and cars. Figures are expressed as total kilograms and grams per passenger in order to express efficiency of each period.

Table 2.23: Pollutant emissions in the N6 Corridor - morning peak inbound

	Carbon Monoxide		Nitrous oxides		Volatile organic compounds	
	Kg	gr/p km	Kg	gr/p km	Kg	gr/p km
1991	5063	7.48	613	0.91	570	0.75
1995	4644	5.47	829	0.97	315	0.37
1996	6954	7.14	1331	1.36	564	0.58
1997	5218	5.52	761	1.01	364	0.38

It can be seen that while some pollutant emissions have improved, others have not, and there have been large changes along the six year timeframe.

Noise

Noise levels will have inevitably changed in proximity to the rebuilt motorway and HOV lane, but it would not be of great value to conclude anything about the HOV lane's role in this compared with other factors of design.

Findings from other research

Experience of high occupancy vehicle lanes in Europe has been limited, with the Madrid lane under study in CAPTURE being the first large scale attempt.

Giulano at al (1990) studied the Route 55 HOV lane in Orange County, California, comparing the results with control corridors. They found it increased car occupancy for the peak period but there was no general improvement during the off peak. They also found that there was no significant increase in ridesharing among the entire population of the corridor.

Leman, Schilller and Teal (1994) argue that new lane construction is simply increasing capacity. It may worsen air quality, reduce public transport share, and increase vehicle kilometres and trips. They argue that it can also encourage urban sprawl and divert resources from "much needed" public transport within cities.

The TRRL (1972) report cites the case of the Shirley highway HOV lane into Washington DC. Eighteen kilometres of route on a freeway led to 10-25 minute reductions in times. They report a "Manyfold" increase in patronage by public transport with the modal share for corridor increase from 27% to 41% in the peak by public transport. Car travel reckoned to be 18% lower than in the absence of the measures. Buses running on schedule increased from 33% to 92%. The mode previously used for bus passengers was, car driver 41%, car passenger 12%, bus 38%, and other 9%. For car poolers the previous mode reported was car driver 39%, car passenger 30%, bus 30%, and other 6%).

A recent HOV lane in Leeds in the UK (Quinn et al, 1998) has taken the form of a bus lane using the existing capacity, but allowing vehicles with 2 or more people in a car. Preliminary studies showed that journey times reduced from 8 to 6 minutes for a 5km trip, incorporating the 1.5 km lane. Journey times for non HOVs increased but were lower than alternative parallel routes, and 8% of trips have transferred to these slower routes.

Conclusions

The HOV lane under study in CAPTURE is a special case for Europe, being the only one of its kind, though there are, at the time of writing, proposals for schemes which would provide a similar increase in overall capacity with the extra capacity being given over to HOV and similar lanes. An example of this are the proposals for widening the M25 London orbital motorway around London with HOV lanes. The HOV lane in Madrid does comprise one of the demonstrations which is of a large enough scale to provide clear evidence of a change in the use of modes. This is thought to relate to two main factors:-

- The scale of the demonstration, being far larger than others measures studied,
- The use of segregation and the space given over which provides for sustained time savings over a large distance.

Thus there are two main lessons here. Firstly if physical measures are carried out on a large enough scale they can have an important effect on operational efficiency which translates into modal shift. Secondly, measures planned need to provide guaranteed priority (using proper enforcement techniques) if service levels are to be improved.

2.1.3 Public transport prioritisation at junctions

By public transport prioritisation at junctions is meant measures such as bus priority traffic signals and the physical measures that are associated with them, such as signing, traffic islands to separate lanes of traffic and suchlike.

Prioritisation to public transport can take several forms including:-

- Extended ‘green’ time to traffic on the bus route to increase the chance of buses getting through unhindered.
- Detection of buses and a change to green for all the traffic
- Detection of buses and a change to green if the bus is known to be running late
- A separate bus lane with a change to green when a bus approaches
- A separate bus lane with a change to green when a detected bus is known to be running late.
- A ‘bypass’ for buses to avoid being halted at lights (used only where there is no conflict with other traffic - right hand turns where traffic drives on the right hand side of the road).

In the CAPTURE project they form the bulk of the Brescia test site measures, and are also incorporated on the bus corridors in Copenhagen, Greater Manchester, and Tampere, and were planned for London though not implemented.

The CAPTURE demonstrations can be summarised as:-

City	**Measure**	**Implemented?**
Brescia	Priority signalisation at 12 junctions with beacons to extend green time for approaching late buses	Yes, but not at all junctions
Copenhagen	Priority signalisation at several junctions using satellite locations, to give advance signal for approaching late buses	Yes
Greater Manchester	Extended green time when detected bus approaching, and change if bus approaching	Yes, but delayed
London	Advance signals using special holding bay	No
Tampere	Exclusive bus lane at junction	Yes
	Priority signalisation in trial use at 5 junctions (SPOT-system optimising signals taking traffic situation into account)	SPOT in trial use

Technical - does each system work?

Ease of design

The aspects of design of priorities involve both physical and technical design. The mix of these will depend partly on the nature of the priority given, but also on local rules governing road layouts etc. For example bus priority lights in the Copenhagen case are designed simply as ‘tram’ style lights using a horizontal or vertical white bar to indicate ‘stop’ or ‘go’. No other physical marking is deemed necessary. On the other hand, in the UK, conventional signalling is used, and a separate traffic island is needed to ensure that buses are segregated from other traffic and there is no ambiguity as to which traffic is allowed to proceed with each signal. It was this issue which made the implementation of an advance signal for buses not possible during the CAPTURE timescale in the London test site. The adoption of different light systems could simplify this design aspect, or the creation of a European standard (if liberal enough) could be useful.

Ease of implementation

In most cases prioritisation is a relatively ‘invisible’ implementation, and does not attract major opposition during construction. It may be that the public tend to find the whole idea of traffic signalling complex, and assume that traffic engineers know what they are doing and will set systems up optimally, or that even if they don't then it will be possible to change things later. There were some problems in the London case related to parking restrictions needing to be brought in, but this was, in a sense, related to bus lane construction rather than the prioritisation itself. In many cities the amount of consultation needed for signalling changes are not as great as for other physical measures.

Ease of operation

The ease of operation tends to relate to the technical aspects of the prioritisation. In most cultures traffic signals are obeyed (with the exception of a tendency for crossing before or after the green period, for which a 'safety zone' is normally built in), so the success depends on the extent to which the system recognises buses and changes. In most cases the systems do work.

Operational - does it help transport operate?

Operational efficiency of vehicle use - bus and car speeds

The operational effects of bus prioritisation depends very much on the design used. Somewhat ironically, the more complex the design the less effect the scheme may have on bus speeds. This is generally due to the sensitivity of the system. An example of this is for schemes which employ vehicle positioning and only trigger a priority if a bus is running late. While a simple system may give a large number of buses a priority, the more complex system will only be triggered in a minority of cases (assuming most buses are running to time). This, the Copenhagen and Brescia schemes are not triggered in all cases.

While these complex designs are obviously beneficial in terms of not giving delays to other traffic when not needed, and in helping buses to run more evenly they may not give drivers the ability they need to make up time at a later point if unexpected congestion or boarding and alighting delays occur elsewhere. However, if a complex system is implemented over an entire corridor, or a wide area it may be that the needs for time retrieval later may not be so crucial. The question is also raised as to whether the extra investment involved in creating a complex system 'pays off' if only a small number of buses benefit.

The effects on car speeds will depend very much on factors discussed above - how often others are delayed (relative to the bus priority given).

It is interesting that prioritisation for buses is often perceived in comparative terms to priority for other vehicles. In general bus priority is considered a *bonus* for public transport, rather than a *right*. The debate about whether bus priorities should reduce capacity for cars is of relevance here, as well as a debate (which is still to be held) about whether bus priorities should be implemented wherever it is not currently possible for public transport to operate at an agreed 'standard' of service level.

Tables 2.24 to 2.28 show the effects of junction bus priorities on travel speeds and bus operations in CAPTURE test sites.

Table 2.24: Speed of travel - kms per hour - Brescia

	Before	After
Bus	16.26	16.69
Private car	32.6	35.8

In Brescia, the speed of both bus and private car travel (Table 2.24) has reduced after the implementation of junction priorities. This is interpreted as a result of increasing levels of traffic countering the effects of the priorities. However, as Table 2.25 shows the patronage of the operation has improved.

Table 2.25: Bus operations - Brescia

	Before	After
Passenger journeys per vehicle kilometre	3.97	4.01
passengers carried by bus	17225	17702

Table 2.26: Bus travel time at junction of Pispalan valtatie and Nokia motorway, where exclusive bus lane was introduced - Tampere

	Bus, Before	Bus, Intermediate	Bus, After	Car, autumn 1998
Travel time (sec)	90	79	72	69
Min. travel time (sec)	17	41	39	38
Max. travel time (sec)	264	125	119	99
Morning peak:				
Travel time (sec)	153	95	82	66
Min. travel time (sec)	105	62	58	38
Max. travel time (sec)	264	118	119	93

Table 2.27: Traffic signal delay at junction of Pispalan valtatie and Nokia motorway, where exclusive bus lane was introduced – Tampere

	Before, bus	Intermediate, bus	After, bus	Car, autumn 1998
Traffic signal delay/departure (sec)	36	24	19	26
Min. traffic signal delay/departure (sec)	0	0	0	0
Max. traffic signal delay/departure (sec)	141	68	63	58
Morning peak:				
Traffic signal delay/departure (sec)	79	42	20	17
Min. traffic signal delay/departure (sec)	46	20	0	0
Max. traffic signal delay/departure (sec)	141	60	55	34

Table 2.28: Travel times and traffic signal delays of buses at junctions equipped with SPOT traffic signal priorisation – Tampere

To the city centre		
	Travel time (sec)	**Traffic signal delay (sec)**
Buses with SPOT transponders	185	37
Buses without SPOT transponders	179	34
From the city centre		
	Travel time (sec)	**Traffic signal delay (sec)**
Buses with SPOT transponders	209	40
Buses without SPOT transponders	228	52

Installing the SPOT-priority system proved to be rather difficult and time taking operation because the system was the first to be installed in Finland. Results show that the system did not operate in optimal way (to the city centre), when the survey was made.

Another issue of importance is the location of bus stops relative to junction priorities. If stops can be relocated to 'after' the junction it is more likely that the bus can make use of priority, rather than triggering it and then stopping to pick up passengers. However, in Copenhagen, where stops were moved there was strong opposition from residents and businesses to these location changes.

The social and behavioural impacts

Local level modal shift effects

Few of the CAPTURE demonstrations have demonstrated measurable changes to modes, and the bus prioritisation studies are no different in this respect. If anything, from the lessons learnt from CAPTURE it is likely that they will have little effect, unless they are highly visible, and unless they impact negatively on other traffic. In other areas of CAPTURE it has been noted that the less visible changes are, the more likely they are to be implemented, probably due to the lower likelihood of confronting those who are likely to be able to halt the implementation. But, by the same token, their invisibility, is unlikely to cause people to change mode, unless the changes to operation are so large as to make a perceptible difference to travel time, despite the invisibility of the measure..

Brescia forms the best example of signal priority changes, and the results in terms of modal shift are shown in Table 2.29 below. It can be seen that the modal share of bus actually fell during the study period, reflecting the increases in car and motorised two wheeler ownership and use prevalent at the time.

Table 2.29: Modal split (percentage) for persons before and after implementation

	Before			**After**		
	PT	**Car**	**Other**	**PT**	**Car**	**Other**
Brescia	32	61	7	28.9	58.3	12.8

City wide modal shift effects

Junction priorities of a traffic light type are ones which, once accepted within a city, can often be transferred across a city quite easily. In this sense modal shift benefits would be likely to be transferable across a city. But in reality it has been seen that the invisibility of such schemes is unlikely to lead to substantial modal shift even on local corridors. More visible implementations, for example associated with bus lanes, where lights will turn green for buses whether or not they need to save time could lead to larger modal shifts, but such schemes come up against the same implementation issues as other large and visible measures, so the simplicity of transferability does not exist in this case.

The effects on other road users

It is often imagined that measures such as public transport prioritisation will have few impacts on other road users. However, the effects can be quite great and can be positive or negative. Light phasing changes can make a large difference to the ease of crossing roads (positive or negative) and the physical changes brought in can be positive to pedestrians in terms of providing refuges for crossing the road, or negative in terms on confusion about when it is safe to cross. Similarly cyclists can find the changes helpful, or unhelpful, depending on whether the bus lane is designed for use by cyclists also, or whether they are forced to mix with the general traffic.

Table 2.30: Numbers of cars recorded through controlled junctions per day (Brescia)

	Before	**After**
Brescia	80000	76400

Effects on those with reduced mobility

Signal priorities are very likely to have effects on all pedestrians which are discussed in the previous section. But in particular the amount of green time in pedestrian phases of traffic lights can have large effects on the ease with which those with reduced mobility can cross roads at signalised junctions. The actual time required will depend upon the junction characteristics, but also local aspects of driving behaviour.

Effects on safety and accident levels

Junctions tend to have higher accident rates than unjunctioned stretches of road, which is not at all surprising given the potential conflicts between vehicles. Most arrangements to change junctions will have to be approved by bodies concerned with safety aspects, so should, at least theoretically be accompanied by an improvement in conditions.

Provided the buses are accessible, people with reduced mobility generally tend to rely for a greater proportion of their total travel on bus services. Thus, in theory, measures which improve bus performance should be relevant to this category of people. However, as noted below, bus priorities are unlikely to have significant effects on perceptions of travel and are, therefore not expected to have much impact on people with reduced mobility.

Interesting examples of safety issues surrounding priority systems in junction design come from the Copenhagen and London test sites. In London it is required that advance signals for buses require a separate 'island' such that two sets of signals can be installed; one for buses in a bus lane, and the other for the traffic in other lanes. In Copenhagen a tram type signalling system (using vertical and horizontal white bars) is used to allow the bus to move forward. The implications for safety are large, with the London method meaning that priority is offered in very few situations because of the high cost of implementation (due to the traffic islands required), and the ability for priority signals to be installed where space exists for such complex arrangements. The Copenhagen system, while being potentially less safe is much cheaper and easier to install. There is a trade off between safety and cost, but also there is scope for public education about pedestrians being aware for their own safety in 'new' situations.

The effects on the local economy

The local economy effects associated with bus prioritisation generally concern the associated changes to parking provision which are often made in close proximity to a junction. Normally it will not be the bus prioritisation measures that will have the effects that will concern local businesses.

Effects on perceptions about travel

Bus priorities are unlikely to have large effects on perceptions of travel unless they make enough change to alter the speeds and flows of traffic in a very visible way. It is far more likely that people will change their perceptions due to, for example, a highly visible bus lane which has little effect on travel speed, than for a less visible junction priority which has a larger impact. Even where the measure is physical (such as a junction signal bypass) it is likely that people will perceive the net gain to be low (since people are likely to think distance covered is more important than time in terms of delays).

However, if many junction priorities are implemented in a corridor, and enough of these are visible to allow passengers and non users a sense that buses are gaining priority and time savings, the effects could be similar to bus lanes in terms of perception of travel time. In addition priorities at all junctions where delays are encountered could lead to timetable savings in the long run.

In the last Public Personal Survey in the Tampere test site bus passengers were asked about the effect of physical measures on bus use. Twelve per cent of interviewees said that they would use the bus more than before because of the new exclusive bus lane at junction of Pispalan valtatie and Nokia motorway. Twenty per cent of interviewees said that they will use bus more than earlier thanks to bus prioritisation at Pirkankatu (SPOT-system). However, in reality bus usage will probably not increase that much. Perhaps some interviewees perceived the question as follows: “Do you think that public transport service level improves because of the measure?”. It can be seen that bus passengers like this kind of physical measures.

Environmental Impacts

Energy use

The energy impacts will depend very much on the time savings accorded, but especially on the extent to which buses, and other traffic have to stop at signals. Stopping and starting at signals uses fuel, but the extra energy used by an idling engine when halted is not so large. This, if the prioritisation causes fewer buses to stop it will save energy.

Pollutant emissions

The pollutant emissions changes brought about by junction priorities will roughly mirror those relating to energy use, with the ability to allow buses to continue directly through a junction having the largest effects.

Noise

The CAPTURE studies of priorities at junctions did not include consideration of noise levels in any of the cases. Noise is not generally one of the major considerations in adopting improvements at junctions, although acceleration and deceleration can increase noise levels considerably. In general it is thought that changes on the level made in the demonstrations would not affect noise levels perceptively.

Other research

A much reviewed city is Zurich where a policy decision was made to not replace an elderly tram system with a new underground system but invest in priorities to ensure that trams had real priority of movement around the city. Transport and Travel Research et al (1996) report that since 1950 public transport use had been increasing by about 1% per year, but between 1985 and 1991 there was a 30% increase mainly as a result of the priorities. (Public transport promotion was also heavily used). Traffic levels have not been reported as falling.

In a study in Doncaster (Astrop and Balcombe, 1996) it was found that the re-routing of a bus along a side road and into a bus advance area had led to savings of 5.6% in bus travel times in the peak and a 34.4% worsening for car travellers. This was reported that the ‘benefits to bus passengers were outweighed by a big disbenefit to car users”. However it could have been used as a study to assess the effects of bus priorities which reduce capacity for other road users. The occupancy of buses had increased (from 18.5 to 20.0 in the peak) and there was much improved adherence to timetables. They concluded that there was no benefit over a normal bus lane.

Conclusions

Surveys in Tampere showed that delays at junctions tended to be the main source of traffic delays for public transport, and while this will not be true for all cases it is apparent that if public transport can avoid junction delays larger time savings can be made in many cases than by putting in bus lanes on sections of road which are uninterrupted by junctions.

In general, for full effectiveness, priority at junctions needs to be combined with improvements on the road leading up to the junction so that public transport can avoid the problems of traffic queuing to get through the junction. The most effective bus priorities built into existing streetscapes are likely to be where buses can bypass queuing traffic and travel directly through congested junctions.

2.2 Measures to improve public transport stops and interchanges

2.2.1 Bus stop facilities and locations

The bus stop arrangements we are discussing in this section are concerned with measures which enhance the ease of access to stops, enhance waiting conditions at stops, and enhance boarding and alighting at stops. In the next section we go on to discuss measures at interchange sites and bus stations and the like. This section is mainly concerned with measures at stops along routes. The kinds of changes included are:-

- New signing at stops
- Shelters at stops
- Seating at stops
- Access routes to and from stops.
- The use of bus lay-byes and bus boarders to ease boarding and alighting. Bus boarders are kerbs protruding into the street to allow buses to stop more easily, with pedestrians not having to negotiate parked cars to reach the bus. Raised bus boarders allow for more level access to the bus.
- Information systems which inform passengers of general, and real time information

Bus stop arrangements were part of the demonstrations in several cities; Bucharest, Copenhagen, Greater Manchester, and Tampere. They were also planned for London and Vitoria, but not implemented. The measures can be summarised as:-

City	**Measures**	**Implemented**
Bucharest	Creating lay-byes	Implemented
Copenhagen	Real time information on arrivals, arrangements for cycle lanes around waiting areas	Implemented
Greater Manchester	New shelters, raised bus boarders, combined with low floor buses	Implemented
Tampere	New shelters, a bus lay-by and bus stop boarder	Implemented

<u>Technical - does each system work?</u>

Ease of design

As with most other measures the ease of design varies, but in general a bus stop is relatively easy to design badly, and quite difficult to design well. At one extreme an unbranded sign can indicate that a bus stops at a point (or indeed the sign itself may be missing, leaving no indication at all to those who do not know!). At the other extreme the measures associated can be every wide ranging including:-

- Posts with signs
- Branding of signing
- Timetables on signs
- Other public transport information on signs
- Real time information on approaching buses
- Shelter
- Seats
- Other facilities such as telephones
- Boarders built out into road
- Lay-bys for buses to drive into

Ease of implementation

Most changes at bus stops are relatively easy to implement, being cheap, and not usually requiring approval of many bodies. In the CAPTURE cases most of the proposed changes were implemented without much delay (except in London and Vitoria where it was not the bus stop changes which caused problems). Even in the Manchester case where other parts of the scheme proved more complex than expected, raised bus boarders were incorporated without delay.

There was opposition to the moving of bus stops in Copenhagen from traders, either where it limited parking of private vehicles, or where bus stops were moved away from shops where people, in the past, made quick purchases such as newspapers while waiting for buses, or after alighting from buses. In areas where the frontage is housing most people do not want a bus stop in front of their house.

Ease of operation

Most changes made at bus stops are fairly simple and need little attention once they are installed. Some systems would seem to be potentially problematic, such as the raised bus boarders in Greater Manchester where there could have problems of safety associated with the high kerb, but in the CAPTURE project lifetime this has not caused a problem. One problem did occur in the Copenhagen case where real time information systems were installed at bus stops. In that case the visibility of the information was problematic in sunlight. In many ways this can be considered a problem of a ‘non physical’ measure, being associated with the technical specification of a real time information system.

Other potential problems can occur with bus stop infrastructure - vandalism being as example. Bus stops and shelters have traditionally been the subject of vandalism in many cities, and most new equipment is designed with that in mind. As a result most new systems reduce the incidence of vandalism, partly through their new and aesthetic design making the stop a feature which local people are more likely to respect, and also because their design tends to make vandalism less ‘effective’, by the use of strong and easily cleanable materials.

Operational - does it help transport operate?

Operational efficiency of vehicle use - bus and car speeds

There is a common perception that bus stops will have no effect on the operation of public transport, since they do not affect the running of buses in streets. There are, however, two examples from the CAPTURE sites where they have had a direct impact.

- The bus boarders in Greater Manchester have slightly speeded up operation, by making a quicker means of stopping at, and leaving from the bus stop area. Without parked cars at the bus stop site buses can approach along their normal line. Also, in some cases, by causing other traffic to queue behind the bus while it is loading passengers, a clearer run ahead of the bus is likely. In addition easier boarding and alighting by passengers can speed up operation, besides being a social benefit to passengers.
- The re-siting of bus stops in Copenhagen was done to move stops to after junctions instead of before them. In this way the signal priority was better able to operate, while not holding up other traffic at the same time.

The transportation efficiency of public transport

The location of bus stops can have an effect on the total transportation efficiency of public transport if they change the ease with which people can access the system. The siting of bus stops is usually based on 'history' and rules governing allowable distances of stops from junctions and suchlike. As a result the locations can often bear little relationship to optimal attraction to those wishing to use them. Often, circuitous journeys on foot are required to access bus stops. Further to this, any return journey by bus will usually require the use of two stops on different sides of the road. The ease of crossing the road can be of great importance, and the siting of stops at distances from junctions can have quite an effect on the ease of access.

The social and behavioural impacts

Local level modal shift effects

The local modal shift effects of bus stop arrangements can potentially be larger than might be imagined. The Greater Manchester experience of combining low floor buses with raised bus boarders has shown a relative increase in the use of the low floor buses on the routes, relative to non low floor ones. While this would imply, at first glance, that the major effect was from the use of low floor buses, as opposed to the bus stop arrangements the ease of boarding and alighting is seen to be of importance. There are also many cases where the re-siting of bus stops could increase patronage (though moving bus stops has to be handled carefully since it often leads to local opposition for other reasons).

City wide modal shift effects

The city wide modal shift effects of changes to stops in a small area of the city are likely to be minimal. But with schemes such as those being tested in the Greater Manchester demonstration and others, the benefits of improved bus stops could be larger than expected.

If bus stop improvements include good quality 'branding' of public transport, with clear to see stops, and have common information provision which enables potential travellers to assess journey possibilities, as is the case in many CAPTURE cities such as Copenhagen, and Madrid, the benefits for public transport patronage could be large.

The effects on other road users

Bus stop arrangements affect other road users in subtle ways, but with larger effects for pedestrians accessing the bus stops if they are moved, and affecting other vehicle users in the case of new arrangements such as bus boarders. In addition pedestrians using a road may be affected by changes to the street furniture, and by the presence or absence of shelters, and other facilities that a bus stop may provide.

The CAPTURE study can highlight particular examples of effects, from design issues:-

- In Copenhagen new designs were drawn up to solve problems associated with cycle lanes on footways causing conflicts with people boarding and alighting from buses. This has long been recognised as a safety issue, and special signage has been incorporated on buses to remind passengers of the likelihood of cyclists moving past when alighting. Arrangements were designed which moved the cycle lanes further back from the road side, providing a dedicated space for passengers waiting to board buses, and to stand before crossing the cycle lane on alighting.
- In Greater Manchester the use of bus boarders is an example of how bus stop arrangements can be used to give priority to different modes. Where cars are parked it 'legalises' the arrangement whereby a bus will wait in the traffic flow and hold up traffic behind. In a case where a bus boarder is built into a bus lay-by it similarly causes the bus to hold up other traffic flow, but the use of a bus boarder in a lay-bye can mean that other vehicles may legally park in the rest of the bus lay-bye, thus legalising what already occurred, or increasing the space available for parking.

Effects on those with reduced mobility

The effects of bus stop improvements on those with reduced mobility can be quite profound, and this was so in CAPTURE, especially in the case of the Greater Manchester raised bus boarders, where data showed that the buses allowing level or easy access were used far more frequently by those with reduced mobility than other buses. Of those interviewed at one stop 17% of passengers reported difficulty boarding buses on conventional buses at conventional bus stop arrangements, while 12% found difficulty did so with a bus boarder. At another stop where parked cars were a problem the figures were 29% and 9% respectively - a very large improvement But on a more general level, the waiting environment can be of great importance to those with reduced mobility, with easy access to the area where the bus will be, and space to wait in comfort, with seating and shelter being of importance.

Effects on safety and accident levels

Bus stop arrangements can affect safety in various ways, but especially relating to ease and safety of crossing the road at the site. In virtually all cases a person who uses a bus stop will have to cross the road on an outward, or return journey (since bus stops are usually on opposite sides of a road).

In addition there is a potential safety issue relating to the use of raised bus boarders in the Greater Manchester case study. There are several countervailing factors:-

- With raised kerbs of 160mm there would be a chance of injury if falling off the kerb. As a result they have so far been sited where people would be unlikely to wish to cross the road (to reduce the risk of falling).
- This has to be countered by the safety considerations of boarding low floor buses with level transfer against higher steps. Many accidents occur when people board and alight high step buses.
- Another issue might occur with danger caused to cyclists if they had to pull out to avoid a boarder.

In more general terms bus stop design can have an impact on damage to buses caused by collisions between opening doors and mirrors with shelters and signs, and damage to bus tyres drawing up to kerbs.

The effects on the local economy

The Copenhagen case study found opposition from local traders relating to the re-location of bus stops to after junctions rather than before them. In most cases the complaints were that the lack of people waiting for buses would harm trade, while some complained about the loss of parking caused by a new stop cutting down on people parking outside their shop. In general, however, the bus stop arrangements were not thought by traders to have large consequences.

It is likely that new bus stop infrastructure could have a beneficially effect on the perceived ‘quality’ of an area. Bus shelters are large items of street furniture and can have a large visual impact. Such effects are not, however, measurable in the context of a study such as CAPTURE.

Effects on perceptions about travel

‘The bus stop is a bus operators main advertisement’ is not the whole story, but states the importance of the stationary elements of public transport infrastructure in people’s perceptions of the travelling environment. ‘Branded’ stops and shelters can be very important in creating an image of public transport that is not negative or ‘downmarket’.

In Tampere bus passengers were asked about the effects of bus shelters on bus usage. Fourteen per cent of interviewees said that they will use buses more than earlier thanks to new high class shelters. However, in reality bus usage will probably not increase that much. Perhaps some interviewees perceived the question as follows: “Do you think that public transport service level improves thanks to the measure?”. It can be seen that bus passengers like this kind of physical measures.

Valuing the effects

It is beyond the scope of a project such as CAPTURE to value the effects of a range of improvements at bus stops.

Environmental Impacts

Energy use

Bus stop arrangements are very unlikely to have a measurable impact on energy use, though the operational characteristics described above will have an effect, if the slowing down and speeding up times are changed as a result of the changes. Also, the used of bus boarders mean that buses should spend less time waiting at bus stops, due to potentially shorter boarding and alighting times, and less time waiting for a gap in traffic (since they are located in the main traffic stream).

Pollutant emissions

The pollutant emission characteristics of bus stop arrangement changes will very closely mirror those for the use of energy

Noise

Noise caused by buses starting and stopping is generally greater than during steady rate movement. There will therefore be consequences of moving bus stops which would have effects, but in most urban situations these are very unlikely to be very large, or noticeable.

Other research

Stokes (1987) measured walking distance elasticity (measured for the distance walked at both ends of a journey) in Luton and found values of around -0.1. This low figure disguised some important differences. For shorter distance (up to 500 metres walk distance at both ends the elasticity was greater) and for education journeys it was also higher.

The importance of not using too strict and simplistic formulae for optimising stop distance is highlighted by the 'APAS' study (Transport and Travel Research et al, 1996). It reports that benefits have been obtained from express buses with infrequent stops in the same sentence as reporting that benefits have accrued from hail and ride minibuses with stops whenever desired. It is obvious that service quality (and patronage) rely on stop distances which are appropriate to a style of service, and to the type of area through which the service is passing.

The APAS report indicates that there is no concrete evidence on demand effects of stop quality. It is also true that stops and shelters are normally improved for comfort of users, and for overall image of public transport than specifically to attract new passengers. That said, the CAPTURE demonstration in Manchester has found evidence that patronage at bus boarders with new raised stops has increased.

Conclusions

Bus stop facilities and improvements tend not to be high on the list of priorities when it comes to improving public transport. At its most basic a bus stop need not even include a sign that a bus will stop there - this is often the case in rural areas, or on 'hail and ride' services in urban areas. However, the CAPTURE studies have shown that there can be great benefits of providing improvements at bus stops. The provision of high quality infrastructure can provide a message that public transport is a serious mode of transport, and provision of low floor buses and raised bus boarders can provide a level of service that is significantly higher, and perceived as such by the public.

The importance of improving facilities at bus stops relates to the quality of other aspects of bus service provision. In Bucharest, where needs for public transport revolve more around a larger number of better quality vehicles, spending on improved stops may be a lower priority. But in cities where high motorisation exists and the image of public transport is low improvements at stops can make a large difference.

The benefits of improved stops tends to relate most to those with reduced mobility (where they involve facilities designed to help these people), but also to the overall image of public transport. While this may place these aspects as being of secondary importance in the eyes of many, in many cases they may be a very good use of funds.

2.2.2 Interchanges

Interchanges can take a variety of forms in urban transport systems, but tend to be at the terminus of longer distance services, with crossing points to more local services. Interchanges were included in the demonstrations in Copenhagen, Madrid, and Mytilini. These were generally bus interchanges, linking with metro in the cases of Madrid, but buses only in Copenhagen and Mytilini.

The subject of interchanges and interchange design is a huge area, and CAPTURE is not able to provide anything like a complete coverage of the types of physical measures which can be employed to improve them. (Readers are referred to forthcoming reports from the MIMIC, PIRATE, and GUIDE projects funded by DGVII for further guidance). The overall coverage of physical measures to improve public transport interchange at interchange sites, described in very broad areas, would include:-

- New interchange construction
- Easing transfer between modes (for and those with and without reduced mobility)
- Providing information about modal transfer
- Improving access to and from the interchange to the surrounding area
- Providing waiting facilities
- Providing ‘activity’ facilities while waiting
- Providing new linkages within the transport network using an interchange
- New ticketing systems (especially for through ticketing between modes)

In the CAPTURE demonstrations the following were included:-

City	Measures	Implemented?
Copenhagen	Rebuilding a suburban bus interchange on the site of an existing one to provide extra open space for residents use	Implemented
Madrid	New bus/ metro interchange, new linkages between existing interchanges	Implemented
Mytilini	Newly constructed bus interchange in new site away from old one in centre	Implemented in stages, but not operational at end of project

Technical - does each system work?

Ease of design

Interchange designs are generally very complex compared with most other physical measures to aid road based public transport, walking and cycling. That said, there are various guidelines and set designs for the elements that make up bus interchanges. In the CAPTURE cases the following comments can be made.

- The Moncloa interchange in the Madrid test site is on three levels with an underground bus concourse and a metro level below that. Metro bus interchanges of this type are complex with no 'off the shelf' designs available.
- The Copenhagen and Mytilini interchanges are bus-only and are on surface. The Copenhagen one was a rebuild of an existing interchange designed to take up less space for buses and allow space for local people to use.
- The Mytilini interchange was built on a new site with fewer constraints on space.

Ease of implementation

The three interchanges were implemented relatively easily in terms of basic construction. In the Mytilini case however, there was a long gap between laying out the kerb stones to create the ability for buses to use the space, and building the infrastructure, mainly due to funding difficulties. Following that, there has been a delay due to operators not being happy with using the new site. Such problems are quite widespread, with a reluctance on the part of operators to use new facilities if they are perceived as being away from where it is thought passengers will wish to board and alight, and, in a deregulated environment this can lead to little or no use being made of a new facility. The Madrid interchange had some problems in construction, due to constraints by the armed forces which has a building close to the interchange and the existing metro line no 3.

Ease of operation

As mentioned above, under implementation, there can be problems of operators not wishing to use a new interchange, usually due to location, and this was a problem in the Mytilini case. Also in CAPTURE there was a problem at the Copenhagen interchange that the cramping of space to create a smaller interchange has caused problems of congestion when services are using the interchange to return to schedule, if running early. In Madrid every operator decided to use the new interchange and it is now running over-capacity.

Operational - does it help transport operate?

Operational efficiency of vehicle use - bus and car speeds

The operational aspects of an interchange can have a major impact on the speed of operation of public transport, although in practice it is often the case that it makes little difference. More common is for a changed location for interchange to change routes such that journey times can vary (both for vehicles and for people gaining access to the services). Factors to be borne in mind include:-

- The location of the site - will services have to pass through congested areas to reach the site, or can congested areas be avoided by a new location? Is there a need to make changes to traffic flow in the area of the interchange to allow for easier access to the site?
- Will changes to services to access the interchange have major implications for journey times?
- The level of congestion within the interchange - will the interchange be able to cope with demands for its use?

The transportation efficiency of public transport

Interchange is of vital importance to the overall efficiency of a public transport system. In general most bus operations find that 10% to 15% of passengers use two or more legs on a bus journey, with the implication that interchange is not of importance. However:-

- Interchange with other modes may be very important (especially rail and metro if they exist within a city).
- Interchange with cycling and walking is of importance. Virtually every bus journey includes walking at both ends of the journey, and ‘interchange’ bus stops tend to be those which have higher rates of use for pedestrians as well.
- The ease of interchange effects the propensity to interchange. Under the deregulated UK system less than 10% of journeys typically involve interchange while in cities with planned interchange in the Netherlands the figure is often 15%.
- 10% of passengers interchanging means that nearly 20% of bus person movements are for journeys involving interchange.

The social and behavioural impacts

Local level modal shift effects

The effects of interchanges on the use of public transport relative to other modes can be quite marked, or can be minimal. In a case such as the Moncloa Interchange in Madrid which has provided bus links into new metro lines, and utilised the purpose built bus and HOV lanes the modal shift has been quite noted, but no such increases in bus use have been noted for the other CAPTURE test sites, which consist of facility improvements at existing locations for interchange. In a similar way to the findings on bus lanes, improvements which speed up travel or make travel easier will not have an immediate impact. Time savings or other improvements have to be large to have that initial impact. But that is not to say that the benefits will not be felt later. If other policies encourage a modal shift, that shift is much more likely to occur if the facilities are well planned, efficient, and easy to use.

The access mode to the Madrid interchange in 1996 is shown below:-

Table 2.31: Access mode to the Moncloa Interchange (Madrid)

Access mode	Daily demand	Percentage
Walking	49,500	25.6
Metro	65,500	33.9
Urban bus	38,700	20.0
Suburban bus	32,500	16.8
Others	7,100	3.7
Total	193,300	100

City wide modal shift effects

Interchanges offer great potential for changing modal shift on a city wide basis. Individual public transport lines can seldom serve a large demand for journeys unless they are, like most routes in reality, radial from suburbs to city centre. With the more complex journey patterns that exist in cities today brought about as a result of higher levels of car journey making, the main way in which public transport can attract new journeys is by offering better links for the more complex journey patterns. Such journeys will often therefore require interchange.

The subject of intermodality implied by the above paragraph requires more than physical improvements at interchanges or new interchanges. Other EU funded projects in the 4th Framework such as MIMIC, PIRATE, and GUIDE are aimed at looking at the possibilities for improving intermodality through better interchanges.

The effects on other road users

The interchanges involved in CAPTURE are aimed at improving public transport, and in all cases, particularly bus users. In a sense they have been designed with bus users in mind. The effects on pedestrians and cyclists are variable. On a case by case basis:-

- The Moncloa interchange in Madrid is located close to a suburban shopping centre and a university and has a high level of pedestrian activity around although it is separated from these activities by a major road fed by the ‘improved’ highway. The improved public transport service levels have increased pedestrian flow, and a traffic light controlled pedestrian crossing exists, but the situation is not ideal. The level of cycling in Madrid is very low, and no facilities have been put in place to facilitate cycling in the area.

- The Copenhagen interchange is in an area of fairly high density residential development. With improved facilities and cycle parking it has increased the ease of pedestrian use of the interchange, and allows for cycle/ bus transport somewhat better than existed before. In addition the new bus interchange has been designed specifically to use less space in order to return some of the space for local amenity. (It is possible that in bus operational terms too much space was returned to people, since there is bus congestion in the interchange).

- The Mytilini interchange has been re-sited to outside the centre of the city. As a result people visiting the centre by bus will have an extra 500 metres to walk to reach the shopping area. This in itself accounts for the reluctance of bus operators to use the new facility.

Effects on those with reduced mobility

Redesigning interchanges are an opportunity to allow for easy access by those with reduced mobility, including those with heavy luggage, children, as well as those in wheelchairs and with difficulties walking. While wheelchair access is, generally, only easily possible on metro and some light rail systems, measures can be taken to allow for lower step heights to be needed for access to buses in interchanges. (This of course only makes access at one end of a journey easier, though for those on the margins of 'reduced mobility' this will be a help). In the CAPTURE cases few special arrangements have been made over what would have been expected in interchanges of their type. The Moncloa interchange in Madrid, for instance, is on three levels and has lifts as well as escalators between floors in accessible locations. The Copenhagen and Mytilini interchanges are also designed to local standards.

Just as important is the ease of access for the surrounding area, and issues such as feelings for personal security.

Effects on safety and accident levels

Accidents at interchanges can arise from a number of different interactions that take place. The main categories are:-

- Pedestrians boarding public transport modes
- Pedestrians interacting with moving vehicles
- Pedestrian access to the interchange
- Interactions between moving vehicles

The safety situation is complex due to these various interactions. Design can go a long way to minimising potential conflicts, particularly in the design of pedestrian movement possibilities.

The effects on the local economy

Interchanges can often become retail and business centres in their own right. By virtue of their existence they are likely to attract people, and most interchanges include stalls or small shops of some type. Often the potential of this can be added to in design by including office space and further retail space in the construction. The Moncloa interchange in Madrid includes a level devoted to retail outlets, though the Copenhagen interchange contained none in the design, being located in a square with a number of shops.

Effects on perceptions about travel

The quality of interchange can make a large difference to the perception of travel involving public transport. Studies repeatedly imply that people ‘value’ or perceive waiting time as being at least 3 times and up to 7 times as much as time spent in a moving vehicle. It this is the case the quality of the waiting environment can be of great importance, especially for those waiting between transport modes. In turn it would be expected that improved interchange facilities would, at least for those who use them regularly have a significant impact on people’s perception of travel modes. Surveys in Mytilini carried out before the building of a new interchange found that people wished for improvements as outlined below:-

Table 2.32: Features regarded as having potential to improve public transport system, Mytilini

Feature needed (%)	**‘much’ or ‘very much’ importance**
Short waiting time	40
Punctuality of arrival	40
Protection from the weather	15
Faster trip time than by car or motorbike	5
Bus stations/ stops near house	25
Buses not crowded	8
Continuous service from morning to evening	47
Most indispensable equipment for bus station	**% responding**
Shelter against the sun and rain	63
Seats	24
Information board with itineraries	13

The results imply that the requirements are for fairly basic operational improvements to the service level with short waiting time, punctuality, and all day service being the most desired. Aspects concerning waiting and interchange facilities are rated lower. For facilities at an interchange it is apparent, however that shelter is the most desired.

Environmental Impacts

Energy use

An interchange may have significant impacts on energy use, in terms of time spent by buses in the interchange, brought about by layover and boarding and alighting times, and congestion within the interchange. The ease of access and congestion around the interchange will also have an effect. Bucharest had plans to improve access by buses into interchanges which were not implemented. It is apparent that access into and out of interchanges is of importance in design, and the location of an interchange may be somewhat determined by congestion levels in the vicinity.

Pollutant emissions

Pollutant emissions in interchanges may be very high, with vehicles remaining stationary for some time. In many cases interchange authorities demand that engines are switched off while buses are stationary. Street layouts etc. around interchange will affect ambient air quality - lots of space will allow dissipation, cramped area will not.

Noise

Noise levels for local residents can be high near interchanges, with much relating to the physical design of the interchange, but much also to the vehicles using the interchange.

Other research

The quality and type of interchange is a large topic in its own right. The quantity and type of interchange can have an effect on travel as was displayed by the Tyne and Wear Metro Study where 'forced interchange' from bus onto Metro met with opposition from passengers. However, bus service frequencies were increased as a result of the savings on bus kilometres and patronage was thought to remain stable. However there were extra passengers who cut short their shopping trips at the end of the bus route (Gateshead) rather than interchange. (When deregulation was introduced in Great Britain outside London private bus operators reverted to running through services to Newcastle (2 extra kilometres) though the interchanging services from Heworth (involving a 8 kilometre Metro journey) remained in the commercial environment.

Of relevance to interchange is boarding and alighting time. CAPTURE studies are assessing the importance of boarding and alighting times in total bus delay. Cundill and Watts (1982) found that one man operation times averaged 11 to over 20 seconds per passenger, while for two man operation it was thought to be 8 seconds. York (1993) stresses the importance of pre-paid ticketing and concessionary passes in speeding up boarding times.

<u>Conclusions</u>

Interchange is key to the possible success of public transport in providing for the journey needs and desires that have grown up since car ownership has increased and changed the locations of facilities in relation to home locations. Door to door public transport is no longer capable of providing an alternative to the bulk of journeys currently made by car (or desired by many) since the car with its enormous demands on road space has determined that facilities are located such that large numbers of people can reach them without all going to the same place. The notion of all facilities being available in city centres close to each other is not viable when the private car is the main mode of transport. Collective transport relies on large numbers of people making journeys on the same links in a network. If public transport is to compete with the car, good interchange is vital.

Counter to this is the common finding that people prefer not to interchange on public transport journeys if they can avoid it. To be successful, interchanges have to be located where they can provide real advantage to people making journeys, and be of attractive quality.

All the CAPTURE interchanges are not centrally located ones of a traditional kind. In Madrid and Copenhagen they are located in inner suburbs, with the Madrid case providing interchange from high speed buses onto the city's metro system. It has proved very successful to the extent that it is now operating at overcapacity for buses. It has clearly provided an improvement in service level which is important for public transport provision. The Copenhagen case consists of changed infrastructure at an existing interchange with no plans for changed level of service, and with a major goal being to reduce the space given over to public transport interchange. The Mytilini case is a relocation of facilities from a very central area to a less central one, which has proved unpopular to the extent that bus operators had not agreed to use it, by the completion of the project.

2.3 Measures to restrict vehicle access to an area

In Section 2.1 we discussed measures which were aimed at changing the use and priority of vehicles and people in roads, in terms of transport corridors. In this section we look at what may be similar measures, but with the aim of changing priorities within an area. In changes inn 'areas' as opposed to 'corridors' the general aim is to make movement of people more pleasant, and to slow down traffic speeds and reduce the amount of traffic. The kinds of arrangements covered in this broad area are:-

- Pedestrianised areas and streets
- Restricting vehicle types allowed in streets and areas (usually to buses, cycles, and delivery vehicles only)

Traffic restricted areas were planned in Mytilini, Rome and Vitoria Gasteiz. In addition the London test site was expanded to include the effects of the closure of a strategic river bridge to all traffic except for buses, cyclists, and pedestrians (for repairs to the bridge lasting over two years). This was incorporated since, although it was not planned as a traffic measure in the normal sense of the word, it provides an almost 'laboratory experiment' of the effects of a radical physical measure to restrict access. The measures can be summarised as:-

City	Measures	Implemented?
London	Two year closure of river bridge to all traffic but buses, cycles, and pedestrians	Yes
Mytilini	Pedestrianisation using moveable barriers	Implemented
Vitoria-Gasteiz	Increasing Pedestrianised area, and creation of bus only streets	No

Technical - does each system work?

Ease of design

Design of measures to restrict access varies in ease of design. In the CAPTURE project two examples show the differences possible. In the Vitoria-Gasteiz case a complex system was planned with modelling run to calculate the effect on traffic flows of proposed changes. In addition much detailed planning was carried out to show how the appearance of the streets affected would be changed. This can be contrasted with the Mytilini case where a simple moveable barrier was to be brought to the street each day, and a person employed to watch over the barrier and move it aside if a legitimate vehicle required access.

Ease of implementation

Continuing the descriptions above the ease of implementation can also vary. Of the measures in Mytilini the closure of the main street to shopping was accomplished with relative ease while all other measures experienced long delays due to funding, political, and institutional problems. In the Vitoria-Gasteiz case the entire scheme was abandoned, but the vehicle restriction element, being a major part must be considered as the prime reason for opposition to the scheme. In this case fears over the likely effects of the scheme were instrumental in causing the cancellation of the scheme following elections. The Rome scheme was somewhat different in that some elements were passed but others not. The London Hammersmith Bridge closure was implemented out of necessity to repair a bridge, and although it is an unusual case it may provide lessons for the future that measures to restrict access are done most easily through such a ‘crisis’. If the impacts prove to be beneficial then it may be possible to maintain them after the need has passed.

A large issue in terms of implementation ease is concerned with the degree of restriction that is imposed. A scheme which has wide ranging and radical effects is likely to be opposed more than one which does not. But if two stages are needed there may be more opposition to the second phase of a scheme. Planners need to consider the amount of restriction that will produce the aims they are interested in.

Ease of operation

Aspects of ease of operation relate closely, as with many other measure types, to ease of enforcement. The Mytilini case using an attendant to operate the scheme has been successful, with a good rate of holding to the scheme. In other cases the level of compliance depends on cultural factors relating to compliance with other traffic regulations, and the visibility of infringements. The design of the scheme is also of importance in terms of its ‘self enforcement’ potential. A well designed scheme should not need much extra enforcement than its own construction.

<u>Operational - does it help transport operate?</u>

Operational efficiency of vehicle use - bus and car speeds

The details of the effect of transport operation depends very much on the details of the scheme. A complete ban on vehicles will cause traffic to move to other areas, but is also likely to lead to traffic degeneration whereby journeys made by some people will appear to disappear. Traffic degeneration was a major issue in the London river bridge closure with the closure coinciding with a joint UK Government and London Transport Planning study into the effects of traffic capacity reductions on traffic levels. The issue surrounding this study relates to the findings on the generation of traffic as a result of increases in capacity, and whether a corresponding decrease can be noted when capacity is reduced, without causing widespread congestion.

The London case found various effects on journeys of different types from a telephone survey of 800 respondents who used the bridge by private transport before the closure. The results are summarised below:-

Work Journeys

- The proportion of respondents who typically made commuting or employers' business trips by car via Hammersmith Bridge dropped by 5% immediately after the closure. The proportion who continued to make commuting or employers' business trips (by car or another mode) dropped again between Phase 1 (immediately after) and Phase 2 (six months later) making a total drop of 7%.
- Since the bridge closure there has been an overall drop of 28% (20% in Phase 1) in the proportion of respondents using private transport for commuting and business purposes.
- There has been an increase in public transport usage for work trips from 7% in Phase 1 to 9% in Phase 2. The proportion making work trips by cycle or on foot has remained at 9% since the bridge closure.
- The trend away from car usage for commuting and employers' business is continuing, particularly amongst females (from 80% to 61% to 53% for females and 58% to 46% to 42% for males).
- The number of commuting or business travellers making the journey at least five times a week has also declined (62% in Phase 2, 65% in Phase 1 and 64% before the bridge closure); the reported frequency of non-work trips has also declined, with 22% making trips three or more times a week, compared to 26% immediately after closure and 27% prior to closure.
- The mean reported length of commuting or business car journeys (for those who continue to use private transport), having increased from 50 minutes to 69 minutes immediately after the bridge closure, has now dropped slightly to 66 minutes.

Non Work Trips

- The proportion of respondents who made non work trips dropped by 7% in the eight months following the bridge closure, although it had dropped by 21% immediately after the closure.
- Since the bridge closure there has been an overall drop of 31% (35% in Phase 1) in the proportion of respondents using a car for non-work purposes.
- The proportion of respondents using public transport for non work trips increased from 7% in Phase 1 to 14% in Phase 2. Likewise, the proportion cycling or trips increased from 6% in Phase 1 to 10% in Phase 2
- The mean reported length of non work private transport journeys (for those who continue to use private transport), having increased from 38 minutes to 63 minutes immediately after the bridge closure, has now dropped slightly to 56 minutes on average.

Other Changes

- As in the Phase 1 survey (immediately following the bridge closure), the majority of respondents who continue to drive now use Putney Bridge (43% work and 51% non-work) and Chiswick Bridge (51% work and 50% non-work).

- The most notable change made in the eight months since the bridge closure is that respondents now tend to leave earlier on their journeys than previously (45%), although some have chosen to leave later (14%). A quarter have changed their shopping location and one sixth now walk or cycle more often.
- There is higher awareness (88% in Phase 2 cf 83% in Phase 1) of the public transport alternatives for crossing the river, although many are still using their cars, and there has been very little increase in the reported frequency of use of public transport.

Attitudes

- There is greater agreement that it is fair to let buses use the bridge (80% cf 76%), that it is now safer to walk and cycle in the surrounding area (67% cf 61%) and that the bridge closure is good for the environment (43% cf 33%).
- Most respondents (76%) believe that taxis should be allowed to use the bridge.
- There are some key differences in opinion depending upon whether or not the respondent lives locally (defined as resident in the local and neighbouring postcode areas: W6, W10, W11, W12, W14, SW6, SW14 and SW15). There is greater awareness and likelihood of using public transport amongst local residents, as well as less of a feeling of inconvenience from the bridge closure than amongst those who live less locally. Non locals would prefer a journey time of twice the length than having to use public transport.
- There have been improvements in all aspects of respondents' journeys (cost, travel time, comfort, convenience and reliability) in the seven months since the survey conducted immediately following the bridge closure, presumably as respondents become more used to the alternative routes and modes of transport available.
- At the end of Phase 2 it was decided that a series of in-depth interviews be carried out with respondents who no longer made trips that they had previously made before the closure of the bridge. The aim of the research was to probe into the reasons why respondents had changed their journey behaviour.
- For the majority of respondents the closure of the bridge had **not** been a contributory factor in them no longer making work related journeys. However for some of the respondents the closure of the bridge had had an effect on their non work related journeys. Respondents tend to now shop in other locations which are more accessible by car.

Table 2.33: Percentage Making Work Trips and Mode Used Since Bridge Closure (London)

	Before	Immediately after closure	8 months after closure
No longer made trip	na	5	7
Cycle/ walk		9	9
Public transport		7	9
Taxi	2	2	3
Van/ lorry/ motorcycle	8	8	9
	90	70	63

Table 2.34: Percentage Making Non Work Trips and Mode Used Since Bridge Closure (London)

	Before	Immediately after closure	8 months after closure
No longer make trip		21	7
Cycle/ walk		6	10
Public transport		7	14
Van/ lorry. motorcycle	1	1	0
Car	99	65	69

note: since Phase 1 was undertaken immediately after closure, some infrequent non work trips were not covered in that phase of the research. This has exaggerated the apparent reduction in non work trips in Phase 1.

In conclusion it can be said that people adapt to changes that occur and their adaptations depend on a great many factors concerning their journeys, traffic levels, and alternatives available. But a closure can have a more immediate and larger impact than changes for which it is easy for exceptions to be made.

The transportation efficiency of public transport

A simplistic view of restricting access to an area by vehicles would be that the efficiency of modes excluded would be worsened, while those still permitted would be improved as a result of the exclusion of other vehicles. This simplistic view will often be the case. But there are other factors which affect the situation. Related measures, such as Park and Ride schemes may often increase overall transportation efficiency by discouraging private cars from entering the city at all, thus reducing traffic levels on radial routes, and schemes will very often involve the making of a simpler road network which will reduce the number of junctions and thus increase capacity.

<u>The social and behavioural impacts</u>

Local level modal shift effects

Traffic bans and restricted areas are the surest way of effecting a real local level modal shift. This is almost a truism. But outside the immediately affected area the situation may be very much more complex. The tendency is for initial chaos to be followed by a settling down of journey patterns to a similar level of overall congestion as was found in the area before. This can be attributed to behavioural factors and people’s expectations of journey times and delays in different situations.

Table 2.35: Modal split for journeys in Mytilini - Before surveys(%)

	Work	Education	Shopping	Personal Business	Medical	Entertain -ment
Car driver	39	10	27	32	34	49
Car passenger	5	9	4	5	8	17
Van	.1		.1	.1	.1	.1
Motorcycle	27	26	20	21	16	13
Cycle	3	10	2	2	2	1
Taxi	2	1	4	2	5	2
Bus	1	6	2	1	1	.3
Foot	24	38	41	36	34	17

City wide modal shift effects

It is generally assumed that the city wide effects of traffic restricted areas will be non existent or negligible, but evidence from traffic degeneration studies points to this not being so. It could be stated that the overall amount of traffic is strongly related to the delays and congestion and the removal of roadspace and capacity in one area will have the effect of reducing traffic levels overall IF capacity has been reached in the surrounding area. This implies that where restrictions are easiest to implement (i.e. where the area does not experience high levels of traffic congestion) they will not have a good overall city wide effect, but they can have large effects where conditions are congested already (but it will be more difficult to get them implemented because of the higher likelihood of opposition).

The effects on other road users

In the case of traffic restricted areas these are the groups who should benefit greatly. But in measurement of travel speed they are likely to appear to have not done well, since their ‘speeds of operation’ may not have increased much, and the modal shift may not show much more than would be expected by the abstraction of cars. However, these simplistic measures of benefits tend to hide very great improvements in the environment for pedestrians and cyclists, which go beyond simple measures of transport and travel behaviour.

Effects on those with reduced mobility

The effects on those with reduced mobility will depend very much on details of the design of the restricted area. In cases where kerbs are removed and surfaces are improved the benefits can be very great. Much also depends on access to the area for those with reduced mobility. Bus stops need to be well sited to allow access into the restricted area, and dropping off points or parking for those with disabilities needs to be provided. In the CAPTURE cases the effects were thought to be generally beneficial.

For a limited number of disabled car users, who find it difficult to walk or use their wheelchair over anything more than a short distance, care has to be taken to provide disabled car parking spaces close to or even within the area of restricted access.

Effects on safety and accident levels

Restricting access to an area will tend to reduce the exposure of people and vehicles to risk from other vehicles, due to the lower number of vehicles. This may be countered by more complex arrangements on the periphery of the restricted area, though it would be common for safety issues such as this to be considered in some detail in design.

The effects on the local economy

The effects on the local economy of restricted vehicle access have been found by other studies (eg Goodwin et al, 1996) to be beneficial. With the removal of vehicles there is more space for pedestrians, who tend to spend more time walking, 'window shopping' and suchlike and trade in an area will increase over time. In Mytilini traders in streets which were not part of the original scheme have lobbied to have their streets pedestrianised in order to increase trade.

But in many cases there is strong opposition from traders in the belief that restrictions on parking in particular will drive custom away from their premises. There are obviously business types where this could be the case, but in general such beliefs are not borne out by experience.

In Mytilini after surveys asked businesses what effects the pedestrianisation had had on trade. The results were as follows, showing a good degree of satisfaction, and very little dis-satisfaction:-

Table 2.36: Perceptions of changes in trade following pedestrianisation (Mytilini)

	Very much (%)	A little (%)	Not at all (%)	Small decrease (%)	Big decrease (%)
Increase of sales	12,6	42,4	39,7	3,3	2
Clients can reach the shop more easily	16,7	43,3	36,7	2,5	0,8
Shopping is more enjoyable	11,3	58	29	---	1,7
Improvement of the provision - delivery conditions.	6,4	29,5	62,8	---	1,3

Businesses in streets which had not been pedestrianised were asked about the likely effects that would accrue to them if their street were pedestrianised. The results were as follows, and indicate that there was a perception of greater benefit where pedestrianisation had not yet occurred. The implication could be that pedestrianisation is very popular, but the benefits, while good, are maybe not as great as hoped. An alternative suggestion (in the knowledge that the traders in not yet pedestrianised streets probably know how well other traders are doing) is that the benefits are high, those in streets not pedestrianised want to be, and those where pedestrianisation has taken place are happy, but would like to see more measures put in place to improve the environment.

Table 2.37: Perception of changes by traders outside pedestrianised area (Mytilini)

	Very much (%)	A little (%)	Not at all (%)	Small decrease (%)	Big decrease (%)
Increase of sales	22,3	40,8	33,1	3,8	---
The clients reach easier the shop	32,6	35,4	29,2	2,8	---
There is more pleasure by the clients for shopping	15,7	58,4	19,1	6,8	---
Improvement of the provision - delivery conditions.	5,9	65,5	26,2	2,4	---

Respondents in the pedestrianised streets were asked whether the measures should be expanded to other roads, and those in other streets whether their street should be included in pedestrianisation schemes. The results were as follows, showing that overall, over 70% of traders are in favour of further pedestrianisation, while a minority are against. In those streets pedestrianised a large minority (15%) have no interest in whether it is continued, while only 3% of those not yet pedestrianised responded that way, with the proportion of those against being higher.

Table 2.38: Attitudes to extension of pedestrianisation (Mytilini)

	Yes (%)	No (%)	Of no interest to me (%)
The measures should be expanded to include other roads	73,6	11	15,4
Do you want to apply the measure in your road ?	70,1	26,8	3,1

Effects on perceptions about travel

Studies show that, in general, well planned access restrictions in city centres lead to better perceptions of travel, certainly by pedestrians in the restricted areas. The CAPTURE studies have been able to back up this finding about perceptions by users of pedestrianised streets, but not provide evidence about the perceptions of those travelling to such areas. In any case, such findings from one study would be unlikely to be transferable elsewhere, since the subject becomes so complex when travel *to* the area is considered

Environmental Impacts

Energy use

The energy impacts relate very closely to the traffic implications of restricted areas as described above. In the cases where overall traffic levels may be reduced by the schemes there may be a net benefit, but increases in congestion outside the restricted areas can lead to an increase in energy use if other measures are not taken to ensure congestion does not increase.

Pollutant emissions

The emission of pollutants are almost certain to be lower in a restricted area than was the case before implementation, but as with energy use considerations the impacts outside the area may be negative.

Noise

Noise levels usually fall dramatically as a result of traffic restriction - vehicles being the main source of noise in city centres. In the Rome test site daytime noise levels fell from 70.4 dB(A) to 69.7dB (A), as a result of traffic calming measures alone. Reductions in noise can cause a major improvement to the ambience of such areas. There are cases, however, where noise levels could actually arise, especially where motorised two wheelers are exempted from restrictions. In the case of Rome (in the whole city centre, rather than the test site itself) the large traffic restricted area is not restricted to motorised two wheelers and this has increased ownership and use of them dramatically.

Other research

The 'APAS' study (Transport and Travel Research Ltd et al, 1996) also reviews 26 'traffic restricted areas' in Italian cities where, in general, residential traffic, delivery vehicles, and public transport and usually two wheelers are permitted. It was found that the areas experienced traffic reductions ranging from 20% to 95% (probably depending on the size and characteristics of the area, and the type of vehicles permitted). A study in Turin showed that traffic had increased by 30% in the areas outside the controlled zones.

Conclusions

Restricting traffic in an area is a measure which, if achieved, can provide direct benefits to that area, and usually, in the longer term provides benefits even for those who were initially against the idea. There are cases of cities throughout Europe which have, over many years reclaimed much of the city centre's space from motorised vehicles and made the streets very much more pleasant for people using them. At the same time, however, there are more cities throughout Europe which have patently not succeeded in reclaiming that space.

The key would seem to be in implementation, and if lessons have been learnt it is probably that a step by step approach is essential. Every proposal is likely to have its opponents, and a large grandiose scheme is likely to have more opponents than a small one. If some restricted areas can be introduced which provide real benefits to the people of a city, then it is likely that others will follow more easily than if it is all attempted at once.

Another lesson seems to be that the effects on areas outside (of increasing traffic diverting) are not as great as might be feared in many cases. This is particularly the case where all streets in a city are running near or at capacity. Journeys are likely to be shortened with walking playing a larger role. Findings in small towns where displaced traffic is moved to what were quiet residential streets are not so encouraging. In these case the problems of excessive traffic tend to be displaced to routes and areas where fewer people may complain.

2.4 New transport systems

'New transport systems' can cover a variety of meanings. In the CAPTURE context we include:-

- New links in a transport system (normally metro, rail, travelators, escalators and lifts as transport modes, but also possibly new untried bus routes)
- The introduction of modes not before introduced in a city such as trolleybuses or metro. These may or may not use existing links in the network.
- The use of new vehicles which provide a major difference in level of service - eg low floor buses

Six of the eleven CAPTURE cities included new transport systems in their demonstrations, including:-

City	Measures	Implemented?
Bucharest	trolleybuses on existing bus routes	Implemented
Copenhagen	low floor buses on existing routes	Implemented
Greater Manchester	low floor buses on existing routes	Implemented
Mytilini	new shuttle line	run experimentally
Orvieto	escalator and lift system	Implemented but delayed
Tampere	articulated low floor buses on existing route	Implemented

<u>Technical - does each system work?</u>

Ease of design

By their nature new transport systems are likely to have design complications. A distinction has to be made between those which are new to a city but tried elsewhere, and those which are technologically new. For those new only to the city in particular help from outside can be sought in design, while for those which are untested there will be extra complications. In the CAPTURE case most of the new systems are ones which have been in operation elsewhere and which require little extra infrastructure, and do not need particular design aspects, except to ensure that it is possible for them to operate in the city.

But two cases are different here. Trolleybuses in Bucharest had previously operated on other routes in the city but were introduced on a new route. Here design was needed for the placement of overhead cables and their gantries, though the techniques had been used elsewhere in the city.

In the case of Orvieto the lifts and escalators were not new technologies but are not in common public use outside buildings.

Ease of implementation

There are special factors of implementation which can make the process more complicated, due to the novel nature of the measures. There may be an element of suspicion about the new systems which will cause opposition. But the findings of CAPTURE do not bear this out with a high degree of implementation of measures proposed. It may be that the novelness of the systems encourages support because the system will be new, and possible problems associated with the new systems are glossed over. Maybe the phrase "better the devil you know than the one you don't" does not apply when it comes to transport infrastructure.

What does often occur is delays in implementation due often to more technical than institutional causes. The Orvieto escalator system opened nearly two years later than was expected at the start of the project because of geological difficulties encountered, followed by delays caused by the finding of archaeological remains which allowed an excavation to take place.

Ease of operation

New transport systems are likely to suffer from teething problems (problems commonly encountered in the early stages of operation of an untested system). In systems which are commonplace elsewhere these teething problems are likely to relate to the implementation of the system in a new environment, but in the case of relatively new technology or ideas the system itself will be prone to teething problems.

<u>Operational - does it help transport operate?</u>

Operational efficiency of vehicle use - bus and car speeds

There is always an element of risk attached to new modes of transport, but in general the amount of planning means that there is likely to be an improvement in operation. This was certainly the case in the CAPTURE test sites. There can, however be counterintuitive results:-

- The low floor buses on the Manchester routes were found to take slightly longer for their journeys than the conventional buses (an average of 1.5 minutes for a 30 minute journey). This can be attributed to the use of a longer route on one section. Although boarding times may be higher due to greater numbers and people with reduced mobility boarding this effect is likely to be minimal.

The transportation efficiency of public transport

New transport systems may or may not have a large impact on transportation efficiency. Examples of likely effects are as follows:-

- A new link in a transport system can increase the accessibility of the whole system.
- New vehicles can increase operation speed.
- More powerful engines may increase energy use

The social and behavioural impacts

Local level modal shift effects

New links in a transport system are virtually certain to cause modal shifts by their existence, on that link. The effects on transport for journeys along a corridor affected by a new link are more complex, and are affected by factors such as the previous mode used by the new mode users, diversions of journeys made as results of new linkages available, and the knock-on impacts of the changes to the other modes made by the opening of the new mode.

The Orvieto case has shown that the introduction of elevators has led to a small change in mode use, with the car parking spaces not being used to their maximum capacity, while the increase following the opening of the escalator system was rapid and dramatic. There is evidence here that there are quality aspects of such a new link which can have a big impact. The elevator system provides a good level of service for the vertical element of the journey, while the escalator system provides some horizontal movement as well as vertical, probably providing an illusion that it offering more than the elevator, while in fact probably more effort is required to use it.

Interesting results are available from Greater Manchester where a 10 minute frequency service received a low floor bus for use on one out of three journeys. The services were timetabled such that the low floor buses ran regularly every 30 minutes, and so that users knew which services would be operated by the low floor buses. On an average of over 4000 surveyed journeys patronage on the low floor buses was 10% higher than on the non low floor buses. This does not necessarily imply an increase in patronage, but certainly that that the low floor buses are attractive to users.

The results below show the relative attraction of low floor buses against normal buses for different types of passenger as recorded by patronage on low floor vs normal buses.

Table 2.39: Patronage of low floor buses vs conventional buses - Greater Manchester

	# on low floor	**# on normal**	**% increase in attraction**
All passengers	222	971	10%
with child buggies	67	46	258%
with shopping trolleys	16	37	6%
in wheelchair	3	0	-

It can be seen that for those with buggies the low floor buses represented a large improvement over normal services, with over half of those recorded using the one third of services which are operated by low floor buses. For those with shopping trolleys the difference is not so great. Three passengers in wheelchairs were recorded on low floor buses compared with none on the non low floor buses. While this is not statistically significant it does back up the rather obvious point that they are likely to be more attractive (but probably also that those in wheelchairs are less likely to use public transport).

It was shown in Section 2.1 that low floor buses in Greater Manchester had attracted people as a whole to these buses, and that those with child buggies were especially attracted to them. Table 2.40 below shows passenger views about the low floor buses.

Table 2.40: Views concerning relative improvement of low floor buses over conventional buses (Greater Manchester)

	All respondents (%)	Excluding Don't Knows (%)
Much better	35	46
Slightly better	21	28
About the same	15	19
Slightly worse	2	3
Much worse	3	4
Don't know	24	

In the Mytilini case a new service was implemented on an experimental basis operating from the new interchange on the edge of town, serving several locations within the centre. The Interchange was not fully operational at the time of the test so the results are not based on the fully operating system. In the event 53% of passengers using the service had walked to reach the city centre before using it, while 30% had arrived by bus, and a further 18% as a car driver or passenger.

While virtually all users (98%) would have made the trip if the shuttle line had not existed and 34% would have walked, the remaining 66% would have used a motorised mode (23% bus, 27% car passenger, 8% motorcycle, 5% truck, and 3% car driver). Thus while the measure would not seem to offer a large scale modal shift away from car driving it would have an impact on car passenger journeys, many of which may have led to a special journey, or a detour, to serve the passenger. Many were using the bus as an informal Park and Ride to access the centre, and particularly a medical centre where there were difficulties parking.

City wide modal shift effects

New transport systems are seldom initiated on a city wide basis, and the CAPTURE demonstrations do not include systems through which one would expect immediate city wide impacts. The main ways in which a new transport system could have such an impact would be:-

- If it were of large enough scale on one corridor to affect city wide transport
- If it were possible to introduce the new mode across an entire city at once
- If it formed the backbone of an integrated system, such as a light rail or tram system.

None of the CAPTURE new transport systems fulfilled these criteria, though some of them, such as low floor buses could have been implemented across entire cities in a fairly short space of time in certain circumstances. It is more common though, in most fleet replacement policies, to start with a demonstration, such as the CAPTURE demonstrations, then order more if they are successful in the local situation.

The effects on other road users

The effects on other travellers of new modes can relate to aspects of intermodality - how easy it is to mix with other modes, and with the effects of the new modes on travellers using the same link, or trying to cross it. Most new modes will be built with some kind of intermodality in mind. A new link will normally be designed such that passengers can be attracted to it, and linking with other modes is a sensible strategy. New technologies will also tend to be designed with such intermodality in mind. In the CAPTURE cases the Orvieto lifts and escalators are designed to link cars and buses with walking in the city centre, though by the time of study this was not being used to its full potential. The Mytilini shuttle line is designed as an intermodal transfer between buses and the centre. The low floor buses and trolleybuses in other sites are somewhat different, operating on links which existed before, and there are fewer direct implications for intermodality.

As far as the impacts on other users of the same links are concerned the main effects relate to the number and type of vehicles. Other new modes, not tested in CAPTURE do have known impacts:-

- Tram systems can create new dangers for cyclists, due to the tram tracks, if not properly designed.
- Light rail systems can cause difficulties for pedestrians crossing roads
- Tram systems can take space away from cars.
- Tram and light rail create the opportunity to exclude general traffic thereby improving pedestrian safety.

Effects on those with reduced mobility

New transport systems are likely to be built with ease of access by those with reduced mobility in mind, but this is not inevitable, and depends on the importance of issues related to those with reduced mobility in the society in which the new system is being placed. Low floor buses are an example where the conditions for people with reduced mobility will almost certainly improve, being designed largely with this in mind.

The introduction of low floor accessible buses has been shown to increase use by people with reduced mobility. A recent study in the UK found increases in patronage ranging up to about ten per cent where fully accessible low floor buses have been introduced into local service. Two points are worth making with regard to these increases. First, the growth in use was most apparent among women with small children in buggies or prams. Second, the largest increases occurred where the infrastructure, especially the bus stops, had also been improved (see 2.2.1) and below in the section describing the Manchester results).

Effects on safety and accident levels

New modes of transport can have unexpected effects on safety and accident levels. In general, safety will have been thought about in design, but aspects such as the noise (or lack of) produced by new modes may be different from other modes operating within a city and may result in changes in safety.

The effects on the local economy

It is unlikely that new vehicles such as low floor buses would have any impacts on the local economy, but new links almost certainly would have, though it is not possible to measure these accurately in a study such as CAPTURE. A new system such as the elevator and escalator in Orvieto may well have some minor impacts on changing trade levels in different streets of the town since people using the new facilities will be parking in a different location and using different streets to access the areas of the city that they wish to reach.

Effects on perceptions about travel

Of all the categories of measures dealt with under CAPTURE new transport systems are the ones which are most likely to have an effect on people's perceptions of travel. Analysis of changes to the perceptions of bus travel for Tampere are shown in Table 2.41 below following the introduction of low floor buses and new ticketing systems. The effects are positive, but slight. The use of the scales with a 0.1 point improvement noted for 5 categories would be equivalent to 1 in 10 people asked changing their rating on the 5 point scale by one point.

Table 2.41: Perceptions of quality attributes of transport – Tampere

	Before	**Intermediate**	**After1**	**After2**	**Summary**
Speed	2.5	2.4	2.5	2,42	No change
Comfort	2.55	2.48	2.6	2,6	Small fall
Stress	2.3	2.16	2.15	2,25	Small improvement
Ease of use	1.75	1.72	1.73	1,69	Small improvement
Punctuality	2.1	2	2.08	2,1	No change
Convenience	2.6	2.55	2.56	2,59	No change

(Scale = 1 to 5 where 1=good rating, 5=poor rating)

In the last Public Personal Survey of test site Tampere bus passengers were asked the effect of physical measures on bus use. Thirty per cent of interviewees said that they will use bus more than earlier thanks to new low floor articulated buses. However, in reality bus usage will probably not increase that much. Perhaps some interviewees perceived the question as follows: "Do you think that public transport service level improves thanks to the measure?". It can be seen that bus passengers like the new low floor buses. Bus passengers were also asked, which measure type is the most important one. 44 % of passengers think that low floor buses are the most important. 20 % said that exclusive lanes passing traffic signals (not yet implemented) would be the most important measure type. This has been illustrated in the following table.

Table 2.42: The most important measures at test site Tampere according to bus passengers

Measure	Percent regarding as most important
Bus stop shelters	12
Low floor buses	43
Bus lanes at Pispalen Valtaltie	12
Junction arrangements (Pispalen valtaltie / Nokia motorway)	5
Exclusive bus lanes passing traffic signal	19
Traffic signal prioritisation (SPOT)	8

Table 2.43 shows the relative perceptions of different modes of travel among respondents after the bus lanes and trolleybuses had been implemented in the Bucharest test site. It can be seen that the new trolleybuses are not particularly favourably perceived coming out poorly in terms of comfort speed and punctuality, and medium on most other measures.

Table 2.43: Perceptions of modes of travel in the Bucharest test site

	Private car	Walking	Cycle	Bus	Tram	Trolley	Metro
Relaxing	high	high		medium	medium	medium	
Easy/ Difficult	easy	easy		quite easy			
Economic/ Expensive	v expensive	cheap	cheap	Medium	Medium	Medium	
Punctuality	good			poor	poor	poor	
Fast/ Slow	fastest			medium	medium	slow	fast
Safe	medium	safest	unsafe	medium	> med	> mid	med
Environmentall y friendly	worst	best			medium	mid	mid
Comfort	best			medium	worst	worst	mid

<u>Environmental Impacts</u>

Energy use

New design is likely to encompass a more efficient use of energy than that which existed before. But this does not necessarily mean that the overall use of energy will fall. As an example newer cars tend to have better fuel consumption than older ones, but the choice of larger engine sizes, coupled with rising levels of car ownership and use can, and has, resulted in higher energy consumption. The CAPTURE cases generally involve the use of new technology on existing public transport routes, and have helped reduce energy consumption for those using public transport. Similarly the Orvieto case has replaced car journeys that took a circuitous route to the city centre, by shorter journeys combined with the relatively low energy use of the lift and escalator systems.

On the Maniu corridor of the Bucharest test site the average energy used per vehicle-km per hour for public transport vehicles decreased from 0.3 to 0.29 kg conventional fuel equivalent after the introduction of trolleybuses. This saving is not great, but the capacity offered increased quite dramatically leading to the average energy per passenger-km per hour decreased with 41.14% (from 0.000209 to 0.000123 kg conventional fuel).

Pollutant emissions

Whereas in the cases of most changes studied we have been able to say that pollutant emissions relate very closely to energy use, that is because most measures involve the continued use of the same forms of energy as before. The major difference in the use of new forms of transport is that they may change the nature of people's journeys more, and also that they are more likely to involve the use of electricity, for motive power rather than direct use of fossil fuels. There are three major issues concerning the use of electricity for moving people:-

1. The emission of pollutants is moved from the point of use to the point of generation.
2. The pollutants produced may be very different, depending on the power source for generating electricity. Some sources such as hydro-electricity produce negligible pollutants (though may have effects on ecosystems), while the use of oils and coal for electricity generation produces higher levels of sulphur dioxides than transport. In general the emissions profile has to be considered as being equivalent for the country or region's profile for the generation of all electricity, assuming a distribution grid system is used.
3. It is easier to make large scale electricity production plants 'cleaner' than individual diesel engines used on buses and other vehicles.

Noise

Generally speaking new modes of transport will be designed to have less noise than many older ones. Modern design standards are likely to have low noise as a priority of design.

Other research

Functionally speaking there should be little difference between a creating a new link as a bus, or as a novel mode such as a travelator or a light rail system, except in situations where the geography of roads make a large amount of difference, such as the CAPTURE test site of Orvieto where an escalator allows fast travel vertically.

But several studies point to different effects of light rail systems as opposed to buses in terms of modal shift potential, highlighting 'quality of service' as an important factor. Additionally it makes sense that there are cases where distances are short and modes such as travelators and escalators are modes to be considered rather than traditional buses. For these short modes it is often questioned whether people are attracted to use them from 'normal walking' or whether there can actually be a modal shift from car as a result.

It is in this field that much research has been done. As a guess the money spent on monitoring light rail and metro schemes probably far outweighs that spent on monitoring bus based public transport improvements. One reason for this is that the scale of the projects holds out some hope for measuring a modal effect which can be attributed to the transport change rather than being so small as to be statistically insignificant or 'lost' in the other changes happening at the same time. That said, even the largest such study in the UK, the Tyne and Wear Metro study (Metro Monitoring and Development Study, 1985) found difficulty attributing changes accurately to each of a number of determinants namely the provision of Metro, the provision of integrated bus transport, changes in unemployment levels over the four years of study, and changes to car ownership.

Conclusions

'New transport systems' covers a very wide range of measures. In general, though, where new systems are planned, they are successful. In a sense this is probably due to the need for careful planning to get the new systems implemented (if planned by public authorities) and the need for profit if planned by private companies.

New systems will be very apparent to the travelling public and may encourage people to 'try' the new system. If it is well designed, efficient, and useful to them they will be likely to use it again. If not it may discourage them from trying other implementations of the same systems again.

2.5 Traffic calming strategies

Traffic calming is a well known term in transport planning which covers a very wide range of tools, and can be thought of as a tactic or a strategy in its own right. Hass Klau (1992) points out that it can either be viewed as a set of measures in a specific area to slow down and 'tame' traffic, or as the main thrust of modern transport policy. The way in which it is viewed can determine the way in which it is planned and implemented. The major elements of traffic calming can be described as:-

- Physically slowing down traffic on a link (by road humps, speed tables, chicanes etc.)
- Giving visual signals to slow down traffic (by signing, 'gates', paving changes etc.)
- Creating parking arrangements which encourage slower traffic

Traffic calming was not generally a major element of the CAPTURE demonstrations, except in Rome. Measures were included in the following cities:-

City	Measures proposed	Implemented?
London	pavement widening	yes
Mytilini	moveable barriers	yes
Rome	humps, narrowings	yes, but others not
Tampere	Cutting off street	yes
Vitoria	pavement widening and general scheme in a way	no, along with all measures

Technical - does each system work?

Ease of design

Traffic calming requires much detailed design, as the range of tools available are very wide ranging and have to be chosen depending upon the very local circumstances. Having said that there are several best practice guides, and manuals available which provide ideas for the design of schemes. But there is still the requirement for a very detailed local knowledge to know which types of measures will be effective and acceptable in different circumstances.

While several of the demonstrations incorporated elements of traffic calming as part of a wider package, the Rome test site was unique, being the first implementation of traffic calming in the city of Rome. In this case the design was of extra significance because the techniques employed had to be ones which were likely to work in a situation where there was no ‘history’ in the city to learn from. In cities with widespread traffic calming in existence one can view one area and compare it with others to find cases which are similar, and use past experience to judge what measures are most effective. The Rome case required very careful thought.

Ease of implementation

The ease of implementation of traffic calming varies greatly between cities, areas, countries, and at different times through history. As with the design aspects, in countries where it has become commonplace it is generally easy to implement. The design ideas are known, and the concept is generally very popular (although many can perceive negative aspects such as visual intrusion, displacement of traffic, increased noise and (sometimes) fumes - cyclists often perceive problems with techniques such as chicanes. But as long as bodies such as the emergency services, and public transport operators are consulted at the planning stage there is generally much positive support for schemes by residents. There may be opposition from traders and public transport operators if the schemes are not planned with their concerns in mind The Rome situation was somewhat different. The measures were only passed through the relevant political channels on the understanding that they were an experiment, which could be taken out if unsuccessful. This is similar to previous ‘first implementation’ in other cities in the past, and is a lesson to be learnt in cities where there is no history of traffic calming. Many elements of the Rome scheme also had to be dropped because of suspicion by bodies charged to approve or disapprove the scheme because of their new-ness. These included a mini-roundabout.

Ease of operation

Well planned traffic calming schemes usually work well in terms of their goals of calming traffic. The main problems which are known to emerge are concerned with use by emergency vehicles, and use by buses - emergency vehicles operators will have difficulty travelling at speed through a traffic calmed area, and passengers in buses have been known to experience discomfort when travelling over road humps. Many operators consider common designs of road humps as being incompatible with bus travel.

<u>Operational - does it help transport operate?</u>

Operational efficiency of vehicle use - bus and car speeds

While the aim of most of the measures discussed so far has been to speed up traffic flow, the desired effects of traffic calming are to slow traffic down, although a secondary aim may be to regulate speed by reductions in acceleration and deceleration. Traffic calming usually leads to a redistribution of traffic. The Rome test site found that traffic speeds were altered quite radically:-

Table 2.44: Effects of the Rome traffic calming measures on vehicle speeds

	Before	**After**	**Summary of effects**
Vehicle speed (average)	Max 77 km/h Min 31 km/h	Max 25km/h Min 20 km/h	A reduction of 67% for the maximum vehicle speed and 35% for the minimum.

The transportation efficiency of public transport

Traffic calming, though a local measure, is often used as a means of encouraging traffic to use routes that are recognised as 'traffic routes'. Thus it can have an impact on the transportation efficiency of a road system, and thus effect public transport operation. Encouraging 'rat-running' traffic back onto main roads might seem likely to reduce the speed of operation of public transport, which normally operates on the major roads. But with careful design speeds may not adversely affected, since turning traffic is lessened.

The social and behavioural impacts

Local level modal shift effects

Traffic calming can have major effects on modal split *at the very local level*. In the Rome case the effects on traffic levels are shown in Tables 2.45 to 2.47 below.

Table 2.45: Vehicle flows in the Rome test site. (per day)

	Before	**After**	**Summary of effect**
Total vehicles	15000	10000	33% reduction
Small/ medium vehicles	12000	9000	A reduction of 25%
Large vehicles	3000	1000	A reduction of 66%
Motorcycles	2800	2900	An increase of 3,6%
Car occupancy	1.3	1.4	An increase of 6%

Table 2.46: Modal split for vehicles in the Rome test site (%)

	Before		**After**	
	Car	**Other**	**Car**	**Other**
Rome	73	27	70	30

Table 2.47: Numbers of pedestrians recorded in the Rome test site

	Before	After
Rome	264/ hr	296/ hr

It is apparent that the local effects have been very large for traffic counts for a street which was (and still does to a certain extent) operate as a ‘rat-run’ through the area. Of course it is unlikely that this traffic has been ‘degenerated’ and is likely to be using the major road around the periphery of the area. What is also interesting, and probably more significant from a modal shift point of view is that the numbers of pedestrians recorded has increased by about 10%. It appears that the scheme has led to a better ambience in the street to the extent that people are more prepared to use it for pedestrian travel - it is more likely that these pedestrian trips are new ones due to the better ambience than a modal shift in the true sense of the word.

City wide modal shift effects

Although not specifically measured in the CAPTURE demonstrations it can be said that the city wide modal shift effects of traffic calming measures are thought of as being negligible, and, on a case by case basis this is certainly true. The effects are generally to remove some traffic from the traffic calmed area, and onto surrounding roads.

But the Rome study has shown that people visiting the area for using shops and other businesses have changed their mode in many cases, and the introduction of traffic calming can increase the attractiveness of walking in a local area and encouraging activities to be carried out in local areas, thus reducing the need for motorised transport to reach other areas. This, while each traffic calming instigation will have a very negligible effect on the use of modes, its wider application could potentially have a major impact.

The effects on bus users, cyclists, and pedestrians

Traffic calming will almost certainly have effects on conditions for cyclists and pedestrians, but it is less common that it affects public transport users greatly. For pedestrians slower traffic will make it easier to cross roads, and the lower danger of speeding cars and likelihood of less noise is likely to make the walking environment feel safer, and more pleasant. The same is likely to be generally true for cyclists, with fewer cars giving more space to cyclists. The key point is that traffic calming can assist pedestrians and cyclists if it is designed directly to assist them.

Effects on those with reduced mobility

In a similar way to how traffic calming affects pedestrians the effects are likely to be beneficial for those with reduced mobility, especially if crossing roads is made safer and easier. In addition the use of road humps can allow for level road crossing points obviating the need for mounting kerbs. However, care needs to be taken in the design of speed humps to reduce any discomfort felt by elderly or disabled passengers when the bus travels over the hump.

Effects on safety and accident levels

In the Rome case 16% thought there was more pedestrian safety, while 9% thought there was less pedestrian safety as a result of the changes. The effects of traffic calming on safety levels will vary a great deal depending on detailed aspects of design. In the Rome case there are several factors which have been identified. The route choice by car users means that exposure of pedestrians will be lessened, but there are some negative aspects caused by drivers taking short cuts around junctions, crossing to the wrong side of the road in many cases to get through a 'calmed' junction. The lower speeds observed are a positive sign.

The effects on the local economy

The effect of successful traffic calming is generally to create a more pleasant environment for living and working, and it is therefore to be expected that the local economy will benefit in this way, though it is likely that local businesses may perceive that fewer customers in cars will visit the area.

The Rome surveys (Table 2.51 in Section 2.6) show that there are more people parking for a shorter length of time in the area, with a large drop in the proportion parking for commuting. Other categories mainly associated with local trade have shown an increase in the proportion of parking. It is thought that this relates to parking charging rather than traffic calming. The effect of the traffic calming has been to identify parking spaces clearly, and reduce double parking, parking on footways and suchlike. Depending upon the local culture this can either be seen as a reduction in the possibilities for short term parking, or a better environment in which to leave a car with more certainty of being able to leave the space when desired. The increase in short term parking supports the latter hypothesis.

Effects on perceptions about travel

The opinions the business interviewees have on the effects of the measures on the Celio district was:

- positive effects for 44% (55 elements) of which 64% less vehicle speed, 26% more pedestrian safety, 7% less noise and the remaining 3% other positive effects;

- negative effects for 43% (54 elements) of which 22% more traffic, 19% other negative effects, 15% chaos, 15% traffic congestion, 11% negative effects for shopkeepers; 9% less parking spaces, 7% more noise and pollution and 2% less safety.

- the remaining 13% was divided between situation unchanged (8%) and don't know (6%).

The opinion residents have on the effects of implementations in the Celio district was:

- positive effects for 42% (168 elements) of which 57% less vehicle speed, 16% more pedestrian safety, 13% less traffic, 6% more parking places and 6% aesthetic improvement and the remaining 2% elimination of double parking;

- negative effects for 50% (202 elements) of which 64% a more traffic and 10% too narrow road, 9% less pedestrian safety, 8% aesthetic worsening 4% less parking places the remaining 5% other negative effects,

- the remaining 8% : situation unchanged (5%) and no indications (3%).

The opinion residents have on the effects of implementations is more negative than businesses.

Environmental Impacts

Energy use

The energy use effects of traffic calming are complex, but generally quite small. On the positive side traffic calming will slow vehicle speeds and hopefully smooth the flow of traffic, and possibly reduce traffic in an area, which will have beneficial effects of the use of fuel. But, on the other hand, it may be that traffic becomes more congested on adjacent roads, that driving behaviour by some drivers means that they accelerate and decelerate more as a results of road humps than before. In summary the effects are so complex that it would be difficult to precisely assess the overall effect.

Pollutant emissions

The effects on pollutant emission are likely to be even more complex to analyse than those on energy use, and it was not possible to assess the effects in the CAPTURE studies.

Noise

The Rome case has shown that noise levels in this case have fallen overall, though it is likely that there will have been increases at specific points. Table 2.48 shows noise levels before and after the implementation for daytime and night-time.

Table 2.48: Noise levels in the Rome test site

	Before	After
Daytime Leq (0600-2200)	70.4 dB(A)	69.7dB(A)
Night-time Leq (2200-0600)	65.1 dB(A)	63.7dB(A)

(Via Celimontana - Height = 4.5 metres)

Other research

Traffic calming has a varied history in European countries. It has been common practice to calm residential areas in Germany and the Netherlands for over thirty years, and new developments were planned in what might be termed a ‘traffic calmed’ manner in the United Kingdom since the 1930s in some case (eg many of the new towns). Meanwhile in other countries such as Italy the CAPTURE demonstration in Rome is reported to be the first attempt at traffic calming ever in the city.

The 'APAS' study (Transport and Travel Research ltd et al, 1996) reports that traffic calming is thought to have little effect on modal shift though Trench et al (1995) argue for its importance in the very much related area of 'reducing the dominance of the car' (probably an important first step to large scale modal shift).

Wheeler (1997) found that speeds fell in a street in a historic core of a city that had been traffic calmed, and that traffic flows fell by 30%, but that the traffic calming scheme had been combined with new parking controls. There had also been a reduction in the numbers of pedestrians.

A study of the UK 20 mph zones introduced in the late 1980s and early 1990s (Webster and Mackie, 1996) concluded that injury accidents were down by 60% with a calculated 6.2% fall for every 1mph fall in travel speed. In the cases studied traffic levels fell by 27% on average but when those areas with new by-passes are not included the average fall is nearer 15%. The authors do not report whether traffic was diverted or suppressed, but one assumes that in most cases it would be diverted.

Traffic calming can either be viewed as a measure which makes for environmental improvements in a small area, and one which has little effect on modal share outside its immediate area (except for possibly diverting car traffic outside the area), or it can be viewed as an integral part of a wider transport policy reducing dependence on the car (as Hass Klau has argued for pedestrian areas). Witherby (1994) reports how a plan for traffic calming grew into a city wide campaign for a better transport environment, and Rajalin and Summala studied the reasons why slow (or calmed) drivers drove slowly in Finland. It was found that the main reason given was because they felt no time pressure. Research such as this may be key to switching the concept of traffic calming to driver calming - that is, the slowing of traffic without recourse to physical measures.

Conclusions

Traffic calming has become a widely used policy tool in most northern European countries, but is much less widely used in Southern, and Central and Eastern countries. It is now common practice in some Northern European countries for local residents and businesses to campaign for traffic calming in their neighbourhoods, with its implementation in one neighbourhood leading to calls for similar measures in those close by, notably in the UK and Greece, though not in all countries. While the measures were generally designed for residential areas suffering from through traffic, it is now being implemented in inner city mixed use areas, in smaller towns and villages, and on major roads.

The CAPTURE study included the first attempt at traffic calming in the city of Rome, which has proved an interesting case. While there was much opposition from many during its design, and the eventual scheme much smaller and experimental than had been hoped it has proved very successful, and views towards it have been improving since its introduction. There are now plans to extend it, and interest in the scheme from other areas in Rome.

2.6 Central area parking strategies

Central area parking strategies can include:-

- Changes to the provision of parking spaces within an area
- Pricing policy for parking in an area
- Charging structure (in terms of time) for parking
- Provision of information on parking (real time, or non real time)
- Park and Ride and other arrangements to relocate parking.

Four cities in the CAPTURE project proposed central area parking strategies. These were:-

City	Measures	Implemented
Brescia	Parking guidance to car parks with spaces	Implemented
Orvieto	New car park on edge of city centre connected to city centre by elevators and escalators	Implemented
	Changes to parking pricing in city centre	Implemented
	Changes to provision of parking spaces in city centre	Partially implemented
Rome	Parking pricing zone extended into study area	Implemented
Vitoria	Underground car parks to replace on street parking	Not implemented

The measures under study in CAPTURE therefore cover both pricing policy and physical capacity changes for parking provision within the city centres.

Technical - does each system work?

Ease of design

The ease of design of central area parking strategies varies enormously. The types of elements of design in rough order of complexity can include:-

- Signing to show an area has parking controls
- Signing on roadside to show parking conditions
- Lines on roadside to show parking conditions
- Infrastructure to allow for paying for parking
- Changes to road layout to show parking spaces on street
- The construction of new off-street parking areas
- Control systems to show spaces available in car parks

The Orvieto and Brescia schemes involved complex design - technical in the case of Brescia with its parking guidance system, and physical in the case of Orvieto with the construction of a two storey parking area on a steep slope. The Rome case was simpler involving the creation of parking spaces as part of a traffic calming design, and infrastructure to allow for payment.

Ease of implementation

In the CAPTURE cities nearly all of the parking strategies were implemented, a better record than for many other measures. It is possible that this reflects the longer history of measures associated with parking than for some of the other measures being implemented in CAPTURE such as bus lanes, cycle lanes, and new forms of traffic priority. With this history it is likely that designers and planners know what will and what will not be politically acceptable in a city, and will not attempt a proposal which will not be implemented. Thus, while parking provision and control hold the potential to be a very useful tool for encouraging a modal shift, it may be that measures which would cause a modal shift would not be considered as implementable, and would not be considered.

An example of the types of provision which are not considered can be seen from parking pricing strategies, where large price rises are often implemented, but it is common for planners to provide other forms of parking elsewhere, or Park and Ride as a carrot to help with the public acceptability of such strategies.

Ease of operation

The ease of operation of parking strategies depends to a large extent on the level of enforcement (whether self enforcement by drivers agreeing with a measure, or enforcement by other tools such as traffic police). In the CAPTURE test sites enforcement was not considered to be an important issue, though it should be stressed that most cities employ teams of traffic wardens or traffic police to deal mainly with parking.

<u>Operational - does it help transport operate?</u>

Operational efficiency of vehicle use - bus and car speeds

It might seem obtuse to find a relationship between parking provision and efficiency of public transport vehicle use, but figures quoted in the past for the percentage of traffic in a central area that is ‘looking for a parking space’ reach up to a rather unbelievable 75% (in a study in Munich in the 1980s). Even if to reach this figure might require careful sampling of motorists in streets whose main ‘function’ is for parking rather than movement, it is certain that much time and movement is ‘wasted’ compared to a situation where parking spaces were found without any problem.

If public transport operates on roads where substantial amounts of traffic is looking for parking spaces operational efficiency will be harmed. In the CAPTURE test sites this was reported as a problem in Brescia where the scheme was designed, to a large extent, to solve this problem.

The other area where parking provision and strategies can have an effect is in moving traffic to different areas for parking. The Orvieto case is relevant here where some parking provision has been moved from the centre of the city to an area outside the centre. It is equivalent to a Park and Ride system, except that the lifts and escalators are the transport system into the central area.

The transportation efficiency of public transport

It has come to be realised in recent years that parking strategies form one of the major tools which can affect overall transportation efficiency, and affecting modal split as a result, even though the benefits to be had are hard to achieve by virtue of the difficulties in maintaining full control of parking within a city, particularly private parking spaces. To put it in perspective, the main pricing tool discussed currently in transport policy, road pricing, has been recognised as having about an equal potential impact on travel behaviour as parking pricing (if fully controlled) assuming that most traffic in a city centre is trying to access the centre rather than pass through it.

The social and behavioural impacts

Local level modal shift effects

Parking schemes can have an effect on modal split locally by virtue of changing the locations where traffic goes to reach parking spaces. This, in itself, will not affect the modal split on a corridor, but of small areas around parking provision, where the very localised effect could be quite profound.

Another possible effect is that improved parking guidance and information could change modal share in relation to parking availability. If people perceive it will be easy to find a parking space modal share by car could increase, while if they 'know' that it will be impossible they are likely to shift to other modes. If the amount of parking provision and the level of pricing stays the same, and parking guidance schemes are successful in guiding people to available spaces then it can be assumed that the use of cars will increase, since there will be more efficient distribution and more 'efficient' use of available parking space.

City wide modal shift effects

Parking strategies, if on a large enough scale, could have city wide effects on modal split, if the overall provision of parking is increased or reduced by a large scale, or if pricing measures are implemented which encourage a shift to other transport modes. In effect, the financial component of parking strategies can be as effective in encouraging modal shift as road pricing, and it should therefore come as no surprise that the popularity of parking pricing increases is just as low as the popularity of road pricing schemes (Stokes and Taylor, 1994).

The effects on other mode users

Parking policies can have an effect on other mode users. The most obvious effect is on car users, in terms of their access from the parking spaces to their destinations, where location will be of importance. But pedestrians and cyclists can be affected by the positioning of parked cars on streets and the arrangements around the entrances and exits from car parks. Bus users are less likely to be affected, unless guidance schemes and provision cause a difference in the level of traffic.

Effects on those with reduced mobility

Parking can have a major effect on the ease of moving around a city as a pedestrian, and the effects can be greater for those with reduced mobility. Particular problems stem from parking on pavements, where pavements can be nearly totally obstructed, but in other situations crossing roads with pushchairs can be difficult and unsafe (especially when the pushchair has to be moved into the road in front of the person who is trying to cross).

In addition the location of parking is important. Most parking strategies include special allowances for parking by certain categories of people with reduced mobility (usually those with a physical disability).

Effects on safety and accident levels

Parking strategies can have major effects on levels of safety. If parking information systems reduce the time spent searching for a parking space the amount of time spent driving while maybe not concentrating enough on pedestrians may be reduced. Schemes such as the paid parking with marked out spaces in the Rome scheme have reduced the overall amount of parking which makes poor visibility when crossing roads an issue.

The effects on the local economy

Anecdotal evidence from a number of sources tends to support the hypothesis that traders of many types believe that those who are going to spend money in their businesses are car users, and if they find it difficult to park (outside their premises) they will go elsewhere. Research has also shown that this view is generally an incorrect one where pedestrianisation is concerned and that the removal of cars leads to higher trade levels.

The situation for parking strategies is more complex. A parking plan may reduce parking in a street and could, at the same time increase traffic levels and traffic speeds.

Effects on perceptions about travel

Parking a car can be a major factor in the perception of the ease of travel by car. Experience of Park and Ride studies has shown that the perception that it will be difficult to find a parking space is a factor which leads to using a Park and Ride system. Similarly, Park and Ride schemes often only become very highly used when parking charges have been increased in a city centre.

<u>Environmental Impacts</u>

Energy use

Reports on the amount of driving that takes place in city centres by motorists looking for parking spaces may be exaggerated (see *operational efficiency*. However it is certainly true that time spent searching for a parking space may be regarded as ‘wasted’, and the energy used in such driving and getting into and out of car parks may be quite substantial. Those schemes which make for direct access to spaces could have a significant impact on energy use by cars, though this may be countered by a possible tendency to move the car and park in more places if it becomes easier (as is the case in American style out of town retail developments with separate parking spaces for separate ‘shops’).

Pollutant emissions

Traffic searching for parking spaces will tend to operate at low efficiency and will contribute to emissions more than most other driving. Thus measures which either reduce the time spent looking for spaces, or which move parking spaces so that journey lengths are made shorter will have benefits for emissions.

Noise

There is unlikely to be a large effect on noise levels brought about by parking strategies, although the comments made above on energy use and pollutant emissions imply that there could be local changes in noise level owing to different types of driving behaviour.

Other research

Policies concerned with parking provision and controls have come to be considered of great importance in recent years. They are considered as one of the few stick policies which is easy to implement and which is likely to get political approval. There can be problems however, as it can result in more congestion and a worse environment in areas close by where parking is allowed. It tends to found therefore, that successful parking restriction policies have to be followed up with other schemes, such as Park and Ride provision.

The effects on modal shift are varied. In a similar way to pedestrianised areas successful schemes are most likely to involve public transport improvements and possibly Park and Ride schemes. (Park and Ride requires substantial journey time savings by bus, or expensive or difficult parking to be effective, and the reverse may also be true).

Research in the United States has shown that charges for solo drivers (driver only using the car) at workplaces can have an impact. In Los Angeles a charge for solo parking meant a fall from 42% to 8% solo driving, with car/ van pools increasing from 17% to 58%. But transit use fell from 38% to 28%. In Ottawa a charge for all employees gave a 20% fall in solo driving, with most switching to public transport.

Conclusions

Parking is now being seen as one of the key elements of urban transport policy. One of the prime prerequisites of nearly all car journeys is that it is possible to park somewhere. Whereas measures such as road pricing may be difficult to implement because of their newness and lack of having been tested, parking strategies can be developed within existing policies and are more likely to be successfully implemented.

The parking strategies tested in CAPTURE comprise two main approaches:-

- Changing the number of places and pricing of parking in an area
- Providing better information on the availability and location of parking spaces

The benefits of these two approaches are very different in terms of modal shift. While providing information can help reduce some congestion caused by drivers searching for spaces it is primarily a measure designed to make car travel more efficient, whilst most strategies concerned with spaces and pricing are, currently, designed to reduce the attractiveness of parking (and thus car travel).

It is apparent that neither of these strategies is as complete a controller of city traffic as could be possible if the notion of parking strategies were extended. Common to both approaches is the likelihood that the road space freed up by either reducing search time, or by reducing car coming to a centre to park may soon be taken up by extra through traffic in the central area. Studies in many cities, such as Oxford, has shown that this is the case, and other measures such as traffic restrictions are needed to restrict traffic if the benefits are to be felt.

3. MAIN RESEARCH CONCLUSIONS

In this section we summarise the effects of the physical measures in the 11 cities. Whereas the previous section drew findings from many other sources and provided material relating to general aspects of the individual measures under discussion, this section provides findings which relate more directly, only to the actual findings of the CAPTURE demonstrations. In Section 4 we draw on both of these sections to draw policy recommendations together.

3.1 Design aspects

CAPTURE assesses the effectiveness of physical transport policy measures. The project has drawn several lessons which will be of value to the transport planning community regarding the design of measures.

3.1.1 Funding

The main findings can be summarised as:

- Funding is often the major hindrance in introducing physical and/or public transport priority measures;

- Limitations of funding may impose limitations on design;

- The timescale of funding availability may cause designs to be made which can be further developed or improved over time. For example in Mytilini kerbstones were laid for the Bus Station, while the bus station buildings were constructed later.

3.1.2 Organisational aspects

The number of organisations involved in planning and implementation may also have an impact on design. A complex organisational structures with many organisations involved will probably make it more difficult to provide successful experimental designs. If the organisation is complex, it is common for design guidelines to be necessary, due to bureaucratic considerations. This makes it almost impossible to make some innovative solutions. Complex organisation has the same effect also on the implementation of measures.

Once carefully thought out guidelines are created, it can mean that any measure contained in the guidance becomes 'mainstream'. Also with guidelines it is easier to be sure that a design will meet planning standards.

3.1.3 Persons with restricted mobility

It is important to show that the needs of persons with restricted mobility (PRMs) have been carefully considered in the design of physical measures. In an ideal world, mobility impaired people should be able to use all transport modes. A questionnaire was sent to all CAPTURE cities asking about the accessibility of their systems (see Annex 2). In particular, questions were asked as to whether services to PRMs were available within the demonstration area and/or elsewhere in the city. It was very noticeable that, whereas several cities reported services available elsewhere in the city, few had reported them as being available in the demonstration areas.

Several cities operate local bus services with low floor buses. Only three reported the provision of special services (e.g. Dial-a-Ride) specially intended for use by PRMs. Of those cities providing fixed track public transport systems, most reported that these were wheelchair accessible, although there was a view expressed that such access was by no means easy or convenient. Four cities reported that some of their taxis were wheelchair accessible. Step-free access was common for both bus and fixed track systems, but little provision was made for the special needs of those with visual or hearing problems. In terms of provision of travel information, several cities offered this in large print versions. Specially reserved parking spaces were generally available for PRMs, as was the provision of dropped kerbs at pedestrian crossings.

The conclusion must be that, while some consideration is given to those with special needs, the services provided are limited and should be extended. Several CAPTURE cities reported that they propose to produce guidelines on this in the next 2 or 3 years.

3.1.4 Climatic aspects

Climatic aspects have an effect on the design of measures and on measure types introduced. For example, in the Tampere test site, where there is snow in winter, one reason for removing roadside cycle lanes at *Pispalan Valtatie* was that it is difficult to detect the cycle lanes in and sometimes, it is not even possible to use the cycle lanes. That is why gantries must also be used in Finland to indicate, for example, bus lanes, while road markings are enough in Southern European countries. In the United Kingdom such gantries are considered visually obtrusive and have, in many cases, stopped the development of tidal flow bus ways, which require such infrastructure for their implementation.

Bus stop shelters are generally needed more in places where temperatures are low and rainfall is high (e.g. Finland, UK). On the other hand, in Mytilini, shelters are needed to protect passengers from hot sunshine. This also affects lighting requirements. e.g. the need for lighting at bus stops is often dependent on darkness in the morning and evening peaks.

3.1.5 Aesthetic aspects

The bulk of design work for transport infrastructure is concerned with functionality. With most infrastructure brought in because of problems to be solved, the prime goal is to design something that works. There is often a perception amongst design engineers that aesthetics are not part of their task and are of less importance than functionality. Somewhere along the line aesthetics *will* be considered in design. It could be in a variety of ways and at a variety of stages:

- Some aspects of design will be implicit in the minds of the designer;
- Finished technical designs may be passed to graphic designers or architects for the ‘finishing touches’ to be applied;

- Aesthetic design may be an integral part of the design (normally in innovative solutions, or in some cases when a 'tried and tested' infrastructure is being adapted).

The general way in which aesthetics have been considered in the CAPTURE demonstrations is that it is an important aspect, but one to be considered within the key constraints set by matters of functionality and economics.

However, there are some differences:

- In historic cities, aesthetics may be considered more important with much consideration given especially to the materials used, and fairly rigid standards about what kinds of design be allowed. (This can be seen as conserving and enhancing an existing aesthetic, or it may be regarded as stifling innovative design.)

- In some cases aesthetics are used to deliberately draw attention to physical measures and make them a 'work of art'. Special bus stop designs in Hannover are an example of this.

Aesthetics are not absolute, relating very closely to culture. What is ruled out in one location may be totally acceptable in another. As an example, some aspects of design, which are determined by other factors (e.g. climate or economics), may influence what is thought aesthetic in different countries. The example given earlier of overhead gantries being essential in Finland, but their aesthetics being a main reason for not implementing tidal flow traffic schemes in the UK, is notable here.

3.1.6 <u>The psychological clutter of streetscapes</u>

The amount of 'clutter' in terms of signage, advertising, and other stimuli can affect safety. For this reason motorways are generally designed with limited advertising and excess road signage. In urban situations where new physical measures are being tested (as in the case of CAPTURE) the amount of signage used has often been a design issue, in some cases but not in others. There are several issues in design relating to the 'psychological clutter' of streetscapes. These relate to:

- Safety considerations of distraction caused by too much clutter;
- Clutter adding to the stress of driving experience;
- Lack of noticing those signals which are of importance, against those which are most visible (which may not be the largest or brightest coloured);
- Whether too little can also have negative impacts (for instance safety considerations that signage is needed for novel physical measures).

Many newer and novel physical measures are thought to require more signage than other ones, to inform road users about them. This has been most commonly observed for schemes such as traffic calming in rural areas where the clutter is often thought to distract from the benefits given by the scheme.

Many countries have rules relating to the quantity and visual aspects of advertising, and have guidelines on the size, signing, and design of roadsigns. However, there is often less control over commercial clutter. In addition, safety considerations are often the reason given for signage, since it is thought necessary to keep road users informed of what is happening. There may be a case for limiting commercial 'clutter' where traffic and pedestrians mix, especially where signage is needed for schemes.

The issue of psychological clutter is not related solely to the design of transport policy measures. They have to be thought of in relation to the 'clutter' already existing in an area, and a solution for creating an effectively but simply signed transport measure may involve the removal (or moving) of street elements such as litter bins, lamp-posts, barriers and suchlike (bearing safety in mind, of course).

3.2 Implementation of measures

The CAPTURE project has provided much material to assist in the analysis of how and why measures do, or do not, get implemented. Historically this has been an area where little quantitative research has been done due, probably, to the lack of desire of those involved in the planning, implementation, and operation of transport measures to dwell on the past, let alone the failures of the past. However, the 3 year timescale of the CAPTURE project meant that the issue of delays, and cancellations of parts or whole projects, could not be ignored. Rather than try to 'hide' the issue, it became an important issue in deciding:

- which physical measures to adopt;
- what scale to design them;
- how to approach public participation and consultation;
- how to approach institutions charged with making decision concerning implementation; and
- the effort spent on planning and implementation rather than technical design.

There are some key lessons which can be drawn from CAPTURE for those planning physical transport policy measures in the future.

The nature of the implementation process can be described as being composed of four major phases:

- Planning: scheme conceptualisation, planning and design, promotion, approvals and legal arrangements;

- Funding: scheme funding for start-up and for continued operation;

- Commissioning: construction, purchase and installation of equipment, planning of operations, public information and initiation of operations;

- Operation: day-to-day provision of services, maintenance and enforcement, as well as continuing evaluation and improvement of the system.

Three key steps in the process were identified as:

- definition of involved actors;
- definition of their roles and activities;

- identification of decision points.

3.2.1 A summary of the responses to the questionnaire

The results of a survey designed to find the reasons for the success and failure of the implementation of physical measures within CAPTURE is presented in Tables 3.1.

Table 3.1 - Success criteria and obstacles to implementations found in CAPTURE sites

Success criteria codes

		Br	Bu	Co	GM	L	Ma	My	O	R	T	G-V	TOTAL
Public participation	SPP												9
	NPP												4
Funding	LoCost												7
	Bud												4
	Ring												1
Government	PolP												1
	SuppAd												3
Traders	SuppTra												1
Operations	OpTraff												1
	PassAd												1
Environment	Env												1
													32

SPP	Successful public participation	Env	Environmental improvements
NPP	Avoidance of problems by lack of public participation	PassAd	Passenger advantages (information, shelters)
LoCost	Low cost so lack of opposition	PolP	Political priority area for action
Ring	Ringfencing of funds	SupTrad	Support from traders
Bud	Keen-ness to spend budget in financial year	SupAdm	Support from local administration
OpTraff	Operational and traffic advantages		

Obstacles codes

		Br	Bu	Co	GM	L	Ma	My	O	R	T	G-V	TOTAL
Public participation	NIL												0
Funding	Funds												6
Govt	PolCh Elect Sup												2 2 1
Traders	Trad												4
Institutions (with Govt)	Confl Complex												6 1
Operations	Op Rules												3 1
Legal	OthSch LegObs												6 2
Engineering	Eng												5
Safety	Safety												2
Residents	Resid												2
Staff resource	Staff												1
Environment	Arch												1
													45

Eng	Engineering difficulties	Funds	Lack of funds
PolCh	Actual change of political party in power	Confl	Conflicts of interest between institutions
Elect	Elections leading to inaction prior to election because of fear of change of political party	Safety	Safety considerations cause changes to workplan
Sup	Decisions made by superior level of government	Op	Operational problems
OthSch	Other suggested schemes divert attention away from CAPTURE measure	Staff	Limited staff resources
Trad	Opposition from traders	Complex	Complexity of interaction between institutions
Resid	Opposition from residents	Rules	Rules of road incompatible with measures
LegObs	Legal obstacles	Arch	Archaeological finds

The number of Obstacle codes is greater and their distribution across the cities is more diffuse than Success Criteria. However, it is immediately noticeable that Public participation which played a major part in the success of schemes (both from a positive and a negative point of view) was not reported anywhere as presenting an obstacle by respondents.

The other five Success groups do contribute to Obstacles in a significant way (and were often mentioned as such), but a further six Obstacle groups occur, of which “Legal” is quite commonly mentioned, which do not get mentioned as a success criteria.

It is important to stress that Table 3.1 only records listings of the incidence of the various codes as reported by each city. They give no indication of how many times the code was mentioned, nor of what importance was attached to any particular code. However, the fact that this information is aggregated across 11 cities, coupled with the evidence provided by consideration of the commentaries, suggests that these tables are reasonably representative.

Table 3.2 draws together the aggregate incidence of Success and Obstacle factors by group. For this purpose, Government and Institution Obstacle factors have been merged into a single group, as being of a common nature. This table (3.2) enables the identification of three major influence groups (recording between 12 and 18 incidences):

- Public participation;
- Funding;
- Government/Institutions.

Four secondary influence groups (recording from 5 to 8 incidences) are:

- Legal;
- Operations;
- Engineering;
- Traders.

Finally there are four minor influence groups (recording two or less incidences):

- Environment;
- Residents;
- Safety;
- Staff resources.

It is possible that some of the minor influence groups might be absorbed within the other groups, but there seems no obvious advantage to this procedure.

Table 3.2: Incidence of factors by group

	SUCCESS	OBSTACLE	TOTAL
PUBLIC PARTICIPATION	12	0	12
FUNDING	12	6	18
GOVERNMENT / INSTITUTIONS	4	12	16
LEGAL		8	8
OPERATIONS	2	4	6
ENGINEERING		5	5
TRADERS	1	4	5
ENVIRONMENT	1	1	2
SAFETY		2	2
RESIDENTS		2	2
STAFF RESOURCES		1	1

3.2.2 Effects of city type and physical measure type

It was thought that a relationship might be identified between influence groups and city or physical measures type. Thus it might be that capital cities (Bucharest, Copenhagen, London, Madrid, Rome) emphasised different influence groups from other cities.

- Careful inspection of Table 3.1 uncovers no such relationships.

- Table 1.2 shows the types of physical measure implemented in each city. Comparison of this with Table 3.1 again uncovers no form of relationship.

3.2.3 Conflicts between institutions

It was suggested in a preliminary CAPTURE report (July 1997) that the number of actors involved in the implementation process and the complexity of the relationships between them might have a strong influence on the success or failure of projects. It is possible to test this hypothesis with respect to the 7 cities which recorded the Conflicts (Conflicts of interests between institutions) and Complexity (Complexity of interaction) between institutions and Obstacles. The commentaries list the actors involved in these conflicts as follows:

- Bucharest - Public companies subordinated to the Municipality;
- Greater Manchester - Difficulties of the bus company (the promoters) and the local city council (the implementers) communicating with the appropriate communities;
- Rome - Municipal Technical Office and the implementer;
- Tampere - City Council, City Transport, the State;
- Vitoria - Traffic department and political parties.

This evidence would suggest that only two, or at the most three, actor groups were needed to produce a conflict situation. This is a worrying conclusion for most local authorities.

3.2.4 Failures and successes in the CAPTURE demonstrations

Inspection of Table 1.2 in Section One of this report shows that three cities - London, Mytilini and Vitoria - experienced major problems and were able to implement few or no schemes. The situation in London was very complex: the several schemes which had to be cancelled suffered variously from funding problems, conflicts of interest between participating institutions, the existence of other schemes (a major programme of work was current in many parts of the city) and design/safety issues. Mytilini was rather more straightforward - the major problem was with the parking scheme following an embargo imposed from Athens on any schemes involving parking measures in Greece. Electoral influences interfered with the city centre scheme. Finally, in Vitoria it eventually proved impossible to implement anything at all. This was particularly disappointing since there was strong public support for the proposals throughout the city. However, political problems and suggestions for alternative schemes continued to delay the implementation of the programme until it eventually became clear that it was just not going to happen.

Tampere represented a mixture of successes and failures. A very ambitious number of schemes was proposed. It is not surprising that several of these ran into difficulties for a variety of reasons ranging from cost and engineering problems to objections from residents.

On the positive side, a number of schemes were successfully implemented and the Tampere programme may safely be regarded as a success.

Of the remaining cities, while all reported experiencing some obstacles, most scheme proposals were successfully implemented. In the large majority of cases these successes were due to strong public support and the ready availability of funding. These come through as major factors which lead to success.

3.2.5. Conclusions

There are, in summary, three main conclusions concerning the implementation of physical measures in cities.

There are three major influences:

- Public participation;
- Funding;
- Government/Institutions;

and four secondary influences:

- Legal;
- Operations;
- Engineering;
- Traders.

No relationship can be found between these influences and either:

- the city type;
- the physical measure introduced in that city.

While the interaction and conflicts of interests between institutions is a frequently recorded obstacle to implementation, there is no evidence that a large number of actors in a complex decision process is needed to bring this about. Two, or at the most three, such groups will generally suffice.

The first group of major influences is perhaps obvious, although it is useful to have such clear evidence for a result which might have been estimated before the start of the project. The two other groups are more negative but, never the less, helpful for those trying to implement measures. They enable those involved in the process of designing an implementation plan to concentrate on the three pillars of public participation, funding and the role of government and institutions, rather than get overly concerned about issues which have been found to be of less importance.

Other research

Research on the problems and success criteria for implementation schemes tends to arise from different issues to those involved in the CAPTURE study. It is a common theme in political science, although the emphasis tends to be on the planning phase rather than on the implementation phase.

Tengstrom (1998) has studied the reasons for failure of environmentally planned (i.e. new goals in policy) national transport policies in Denmark, Sweden, and the Netherlands (countries generally associated with more forward looking transport polices). He identifies 'government failures' such as failing to analyse the inherent conflicts between the new goals and traditional goals, failure to recognise that the new goals require a different set of policy tools, and a failure to make a realistic analysis of the problems of implementing policy.

3.3 Operational efficiency

The key findings on operational efficiency can be summarised as:

- Time savings on operation have been observed on most but not all improved bus routes. For those where the prime goal was to save travel time, savings have been achieved, but where goals have been mixed, such as improving access to buses using bus boarders, savings have sometimes been reduced.
- Time savings which are made are not always translated into timetable savings. There will be opposition from bus companies to improving speeds on routes due to fears of time loss elsewhere.
- Reliability of services has been improved in most cases, with most measures easing the possibility of keeping to timetables.
- Problems of parking etc. in bus lanes, and other 'side effects' and issues such as enforcement, have meant that savings expected have not always existed.
- Measures not directly related to bus operations have generally been designed to allow for maintaining operation of public transport takes priority over this.
- In general, delays to car traffic have not improved public transport operations. It is general policy now to ensure that public transport operation is not damaged by transport measures.
- Measures which make travel by car significantly more difficult are tolerated in some cases but not in others. In some cities, measures will only be accepted if it can be shown that general capacity will not be reduced, whereas in others the increased, and in some cases have reduced. Most of the demonstrations were planned such that they would not reduce the capacity for private cars.

The efficiency of transport systems is of vital importance at a time when the contribution of human activity to global climate change and pollutant levels is so high on the political agenda. Transport consumes around 30% of all energy, and this proportion has been growing in many areas. Thus, the more efficiently we can offer the mobility that is necessary or desirable for the functioning of society, the less damage we cause to the environment. In this section we look at this issue from a number of angles:

1. The operational efficiency of the public transport network - simple measures of vehicle mileage and operational speed of public transport in operation without asking questions about how many people are carried.

2. The transportation efficiency of public transport - the amount of public transport operation (generally vehicle kilometres) carried out per passenger kilometre.

3. Overall energy use - the total energy used for transport is a measure of the contribution to pollution and global climate change. Such calculations need to take all modes of transport into account. (For example, if public transport patronage rises, thus improving efficiency, car use also rises, and there may be a net reduction in overall efficiency.)

4. The overall transportation efficiency - measured by overall energy use divided by the total passenger kilometres. This measure has to be evaluated alongside the previous measure. For society, it is not necessarily beneficial for more and more travel to be consumed.

The CAPTURE physical measures can be said to have had some benefits on efficiency, and negligible effects in other areas. In terms of operation of public transport from the operators' perspective, benefits have generally been seen as bus flows have become more regular and, in some cases, speeded up. Those cities where fuel use records were kept generally show economies in fuel usage, though not especially large.

When looking at energy used per person kilometre and overall energy use, the effects tend to be negligible, though the Madrid case was able to measure changes which, while fluctuating after the opening of the system, showed a marked improvement compared to the 'before' case. European governments are trying to reduce energy use in the transport sector, but against a background of increasing car ownership and use, and an increasing engine size of cars. The impacts of most of the CAPTURE demonstrations against this background cannot be described as being enough to have a significant impact on energy use. If the aim of policy is to reduce energy use and pollutant emissions, physical measures of the scale of the CAPTURE demonstrators will not have a large impact.

In the wider context, transportation efficiency needs to be carried over a whole 'economic area', since changes to behaviour result in journeys to different areas, the creation of new journeys, and the halting of others. It is not likely that any of the demonstrations (with the possible exception of Madrid) would have had any measurable wider impact. However, the kind of measures that will reduce car dependency will include greater centralisation of urban activity, more restrictions on car use, and greater capacity for public transport to take people to the re-created activity centres. Physical measures are thus likely to form a very large part of a strategy to increase the efficiency of overall transport use, but the measures described here are not enough, on their own, to have such impacts.

3.4 Encouraging a modal shift

A major transport policy aim of the CAPTURE cities is to assess whether physical measures can encourage a shift in use from cars to public transport, walking, and cycling. There are a variety of ways of looking at this issue:

1. An increase in public transport patronage, regardless of what happened to the use of other modes (whether the increase comes from walk, car, or are new journeys altogether). This can be described as a commercial operator's perspective;

2. An increase in the proportion of all trips which were made by public transport, regardless of the mode used for other journeys;

3. An increase in the proportion of all trips which were by public transport, but only if the actual numbers of other motorised trips fell (an environmental and congestion perspective).

In the following discussion, we look at the issue from a variety of perspectives, starting from the perspective of the changes to each main mode, followed by the impact on the modal split for vehicles and people. Finally we discuss the effects of packages of measures over single measures.

3.4.1 Changes in public transport patronage

Increases in public transport patronage were recorded in many of the CAPTURE cities. The largest increases were in Madrid and Bucharest, where there was a general growth in public transport patronage and planning development. The fact that some of this growth of public transport use was at the expense of car travel is encouraging. It is counter to the experience of most cities experiencing population and/or traffic growth since the 1960s, when a decline in public transport often accompanied very rapid car use growth.

3.4.2 Changes in car use

The measures contained in the CAPTURE demonstrations are generally aimed at improving public transport, and other modes, in order to encourage travellers to switch from using their cars. Where this is the case we would hope that the measures would have the effect of reducing the amount of car travel.

But this will not necessarily be the case, for the following reasons, planned or unplanned:

- In some cases, the measures are aimed at reducing car travel (as is the case with the parking pricing and traffic calming measures in Rome). Here, we would expect an effect on car traffic, and less on public transport and other modes;

- In some cases, an increase in road capacity has accompanied the changes (as with the HOV lane and road construction in Madrid). Here, we could expect increases in both public transport use and private car use;

- In some cases, the population in the area has grown (as is the case again in Madrid) and we might expect increases in overall traffic;

- In some cases, the general level of private vehicle ownership is rising rapidly (as is especially the case in Bucharest) and we might expect corresponding rises in car vehicle traffic.

In many cases there have been quite large changes in the numbers of cars observed over the 3 year period of the CAPTURE project.

The very notable decline in car use in the Copenhagen case (a 16% reduction in car traffic) can be attributed to the opening of a new motorway link which provides for an alternative radial route into central Copenhagen avoiding the CAPTURE corridor. It does not therefore necessarily reflect the positive benefits caused by bus improvements.

In most cases there has been no conscious attempt to influence car occupancy levels, and the main aim of the car occupancy surveys were to allow a comparison of modal split for person movements, as well as modal split for vehicles, to be made. However, the Madrid case study, with its HOV lane, includes an effort to increase car occupancy while other case studies may show incidental changes due to the changes in the use of other modes. Other research has shown that increases in public transport patronage can often come largely from those who previously travelled as car passengers.

Conclusions

In most cases the changes in car use are more predictable than for other modes, mainly because of the larger numbers of car journeys observed in surveys. Most cities have seen an increase in car use over the period, which, in itself, would tend to point to a conclusion that the measures have not been successful in the aim of creating a modal shift between cars and other modes.

3.4.3 Changes to other modes

The other modes in this case include walking, cycling, and other forms of public transport such as taxi and train. In most cases (excepting Madrid) train was not included in analysis since there was no train alternative for the journey. In the Madrid case, changes in train use were recorded at various stages of the study which were in accordance to the relative supply of bus, train, and car provision at the time. In this sense train could be viewed as ‘another mode’ for which people were making rational decisions for use, depending upon circumstances.

For walking and cycling the effects are somewhat different, and tend to relate more to how the physical measures designed to affect bus use (and other modes) impacts on walking and cycling.

3.4.4 Local level modal shift effects

The modal shift effects of the CAPTURE measures have not tended to be readily apparent. While an increase in efficiency of operation is measurable, the process by which this feeds into a modal change is much more fuzzy. There are several factors which are of influence here:

- In a majority of cases, people would change their main travel modes on a permanent basis over the medium to long term when a change in circumstances arises, such as a life cycle change or a residential or job change. Unless the physical measures offer a sufficiently large scheme alternative (a new light rail system, new motorway), it would not be possible to detect a direct cause-effect relationship from the measures implemented in CAPTURE and over that timescale;

- Furthermore, other background changes will be occurring which will mask any effects. Of prime importance is the trend towards increasing car ownership and use. Typically, car use increases by around 2% per year, and it is unlikely that the implementation of a typically sized bus lane will result in a corresponding change in bus use in its first year.

Table 3.3 summarises the effects on modal split in each city, drawing general conclusions about current and potential benefits and drawbacks of the systems.

Table 3.3: Summary of comparison of measure effectiveness

	Brief commentary
Brescia	While the measures have enabled bus priorities to increase bus speeds in some cases, this has not lead to a measurable change in modal split. However, the CAPTURE system, along with other improvements which should be made in the future, should provide an efficient public transport system which could lead to increased public transport use.
Bucharest	At a time when motorisation has been increasing at a rapid rate, the CAPTURE measures have made a significant contribution to enabling the continuation of public transport as a viable mode on the scale that currently exists.
Copenhagen	The measures have not been as successful as had been hoped in this respect due to time savings not being possible because of narrow bus lanes, parked cars and other factors.
Greater Manchester	There is strong evidence that the use of low floor buses and raised bus boarders can provide an accessible public transport system which increases the image of public transport and is more attractive to a wide range of passengers.
London	There is little evidence that the bus priorities, on their own, have a large impact on modal split. However, modal switch has occurred where parts of the road system have been closed while maintaining public transport levels. Thus it is felt that a large modal shift could occur where bus priorities are combined with restrictions on car traffic capacity.
Madrid	The increase in capacity for traffic of all types on this corridor has been combined with a rapidly increasing population. It is difficult to isolate cause and effect in the modal changes that have occurred, but it is certain that people have responded in their modal choices to a variety of service level changes over a 3 year timespan.
Mytilini	The pedestrianisation scheme has proved successful with calls for further implementations in other streets within the city.
Orvieto	The provision of a new car park and the relatively low capacity lift providing access to the central area have not had a large effect on modal split. The higher quality access afforded by the escalator system is providing a larger behaviour change and reduce the number of motorists travelling into the city.
Rome	There is evidence of modal shift in terms of people's access to the area caused by a combination of parking charges and traffic calming. However, there may be a change in behaviour of those using cars now visiting other areas rather than changing mode to visit the study area.

Tampere	No significant effect on modal split along the quality corridor. It is felt that the effect will not be measurable until the whole package of measures is implemented.

Steps on the way to future change

As a conclusion to this discussion on the modal change impacts of the CAPTURE measures, we go back to the notion that the physical measures are important steps on a path to a future in the use of different means of transport change. The infrastructure changes have nearly all had a positive effect on improving the operation of public transport and the ease for walking and cycling, and while these have not yet translated into measurable modal change, they are creating the preconditions for future change. They have created the potential for public transport to operate more freely even if car ownership and use carries on increasing in the short term, and with future policy measures such as pricing, it should be possible to affect a more significant modal change. In a sense, we should not be judging physical measures in terms of the modal shift they create in the short term, but in terms of how difficult it would be to effect a modal shift in the future without them.

3.4.5 Combination or package effects

Table 3.4 attempts to uncover elements where packages of measures have had an effect which is greater than the sum of individual elements.

Table 3.4: Evidence of 'Package' effects

City	Package effect
Brescia	The demonstration contains mainly bus priority control, and the effects on modal split are not measurable at the scale the measures were implemented.
Bucharest	A range of physical measures are implemented, plus new vehicles and bus priorities. This package of overall upgrading of public transport has been effective.
Copenhagen	The combination of traffic control and physical measures combined with bus priorities have slowed car traffic but have not in themselves had a large impact on the use of buses. If 'push and pull' measures are needed to effect a successful modal shift, the 'push' measures were not large enough to have an effect.
Greater Manchester	Here, an overall upgrading of a service would seem to have had beneficial effects on patronage, although it is not certain what previous modes the passengers favouring the better services were using.
London	The closure of Hammersmith Bridge to car traffic provided a strong example of how 'push and pull' measures can have a significant effect on modal split.
Madrid	The provision of extra road capacity as well as public transport on this scale is an unusual 'package' to be implemented in Europe in the 1990s. The signs are that it encourages traffic growth, as might be expected, but that modal shift towards public transport can occur along with traffic growth, which might not have been expected.
Mytilini	A key element of the package (central parking restrictions) was ruled illegal elsewhere in Greece, obviating the relevance of other package measures

	(especially the Park and Ride). Thus the lack of a package led to abandonment of other measures.
Orvieto	The new infrastructure was combined with lower parking charges in the newer car park. Thus two 'pull' measures were combined, though the use of the car park was still not at capacity.
Rome	Pricing and traffic calming have been combined and the local effect has been large on reducing traffic volumes, speeds, and noise levels. The effects in the wider area are almost certainly minimal.
Tampere	The policies in Tampere are all 'pull' policies to encourage public transport use. The matter was complicated by changes to ticketing reducing departure amount and the use of city buses, and a rise in patronage was not seen.
Vitoria-Gasteiz	Sometimes a package of measures can be defeated by the political process.

3.5 Distributional and social impacts

So far we have looked at the effects of the measures on the transport system. In this section we go on to look at the distributional effects for different sections of the population:

- Users of different modes, especially those not directly affected by the changes in a planned sense;
- Those with disabilities which may make it difficult for them to travel;
- Safety considerations;
- Effects on the local economy.

3.5.1 <u>The effects on pedestrians and cyclists</u>

The CAPTURE schemes have demonstrated how physical measures can have significant indirect effects on the walking and cycling environments. Table 3.5 below summarises the effects of the measures on the convenience, comfort and safety of walking and cycling from the experience of the CAPTURE demonstrations.

Table 3.5: Overview of effects of measures on pedestrians and cyclists

	Pedestrians	Cyclists
Brescia (no specific changes but junction priority changes)	0	0
Bucharest (bus lanes)	+	+
Copenhagen (arrangements at bus stops)	0	-
Greater Manchester (bus boarders and cycle lanes)	+	++
London (bus lanes for cycle use, pavement widening)	++	+
Madrid (changes to motorway)	0	0
Mytilini (pedestrianisation)	++	0
Orvieto (footway changes on some streets)	+	0
Rome (traffic calming and parking control)	+	+
Tampere (bus lanes and priorities)	-	-
Vitoria (not implemented)	n/a	n/a

Key - changes in level of service

++	Notable improvement	0	No change
+	Slight improvement	-	Slight decrease
		--	Notable decrease

Note: A "0" (No change) can be seen as successful in that a public transport measure has been implemented without adverse effects on pedestrians/cyclists. However, it could also be seen as a missed opportunity: more consideration of walking/cycling at the appropriate stage might have allowed inclusion of measures to assist these modes at little extra cost.

General conclusions

The following general conclusions can be drawn regarding the effects of CAPTURE Measures on walking and cycling (and pedestrians and cyclists):

- Physical measures not aimed at pedestrians and cyclists still have the potential to significantly affect conditions for walking and cycling. The design can of bus lanes can affect pedestrians and cyclists, for example;
- Pedestrian and cyclists were peripheral to the aims of most CAPTURE schemes. Greater Manchester, Copenhagen, Orvieto, and Rome contained measures for which the main aim was to help pedestrians and cyclists;
- Most CAPTURE schemes had only a slight effect on conditions for pedestrians and cyclists;
- A few schemes (for instance Greater Manchester, Mytilini, and London) had directly positive impacts;
- A few schemes had directly negative impacts (for example Copenhagen and Tampere) but the impacts were slight;
- Some pedestrian measures were abandoned/deferred due to costs and political priorities (in London, Tampere, and Vitoria);
- CAPTURE schemes had no discernible, short term impact on the modal share for walking and cycling;
- The level of monitoring of the potential impacts on pedestrians and cyclists was variable. This was made more difficult by the lack of local organisations to represent the interests of these user groups;
- There is scope for a more integrated approach to (public) transport planning so that opportunities to benefit pedestrians and cyclists are considered earlier and more thoroughly.

3.5.2 Effects on those with reduced mobility

It is essential to show that the needs of elderly and disabled people have been taken into account in design, implementation and operation of physical measures. This group of society is composed of people who inter alia have reduced mobility when using transport services often referred to as People with Reduced Mobility (PRMs).

Initial research within CAPTURE dealt with special consideration of those with reduced mobility in the CAPTURE demonstrations, but it soon became apparent that the national or regional picture was as, or more, important in terms of the consideration and guidelines given to PRM in transport policy, and especially the physical aspects of transport policy. The research was conducted by means of special surveys among CAPTURE cities.

Details of the accessibility surveys are presented in Appendix 2.3.

Conclusions drawn on consideration of people with reduced mobility in physical transport policy measures:

- In general terms, the survey results suggest that most cities are aware of the importance of meeting the needs of PRM including the provision of concessionary fares, but there is a good deal of variation country to country and city to city;

- At the national level, specific legislation requiring full access (usually interpreted as meaning access for wheelchair users) remains the exception rather than the rule. The UK has a Disability Discrimination Act (1995) under which regulations determining access to bus, taxi and rail services are being prepared, though they have not yet reached the stage of implementation. No other country has such a comprehensive a set of (draft) regulations as these.

- Buses and coaches are subject to European Directives with which member countries are required to comply. The final version of the EC Bus Directive includes specific provisions for access for passengers with reduced mobility, the standard PRM being wheelchair users "who can freely and normally use their arms and hands" (Section 7.12.1, III/4076/90-EN Dev. 10 of the Bus Directive). The Directive requires that vehicles designed to provide scheduled urban and inter urban services shall be designed to afford easy access to PRM. It follows that, over time, buses used for these services in member countries will have to comply with these design standards. Evidence from the survey is that most countries have buses that offer these levels of access but that they are only available on certain services.

- The development of rail, metro and LRT vehicles that provide a level of access for PRM comparable to that envisaged by the Bus Directive remains the province of individual national governments. The survey results suggest the heavy rail services have made the least progress towards achieving full access, understandably because they are usually the oldest of the various modes of rail-based transport systems. LRT built in recent years (London, Manchester, Madrid, Rome) have been designed to be fully accessible at the time of planning but this does not apply to older metro and train systems.

- While full access is important as a long-term objective, it does require substantial capital investment: considerable improvements in access for less-disabled PRM (i.e. those who do not need a wheelchair), including people with sensory impairments, can be achieved with relatively low-cost adaptations. Many cities are making these types of improvements -

spoken announcements on vehicles, clear labelling of services, specially designed information provision.

- Although quite a lot of work is being done on improving physical access to and within vehicles, there appears to have been little done on disability awareness training. Perhaps this is more a matter for individual operators, but it is certainly of importance - and one could argue for national guidelines being established which would help operators to develop their own training programmes.

- Special services are always likely to be needed by some PRM who will find even fully accessible mainstream services difficult to use. Differences in numbers of passengers on these door-to-door services may reflect differences in eligibility - the differing proportions of wheelchair users suggest this may be a reason, though obviously the scale of the services vary.

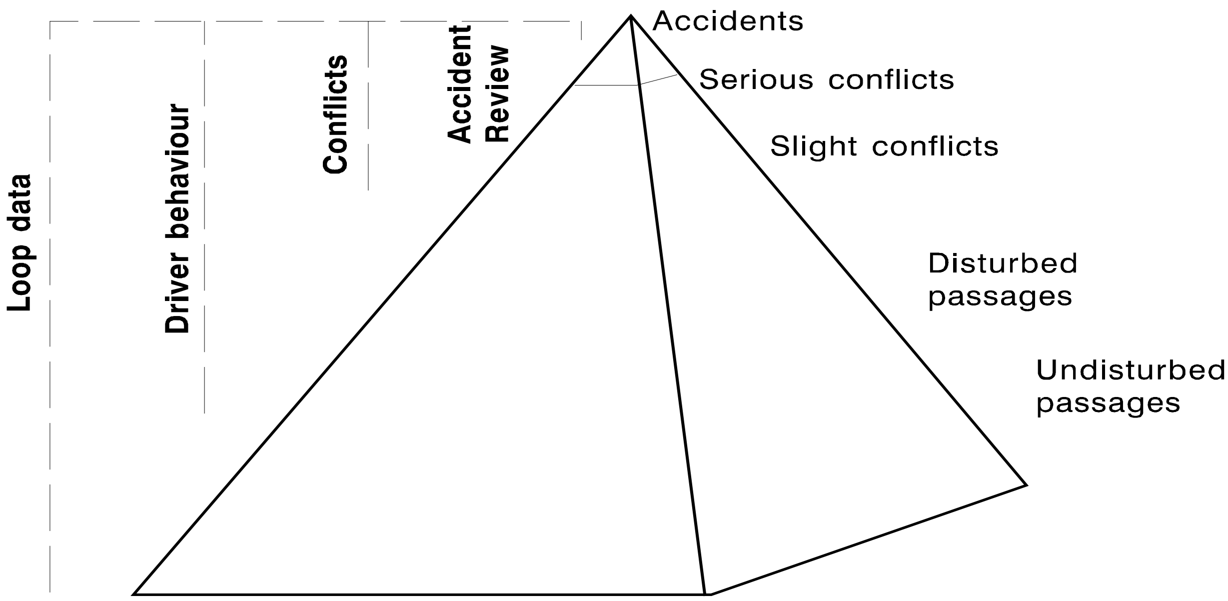
The general conclusion of this work is encouraging, namely that considerable progress is being made in providing facilities for PRM. However, this progress is patchy and many initiatives appear to have been taken on a hit or miss basis. There is a clear need to establish a scale of priorities for such developments, which would take into account both the numbers of passengers who would benefit from any given facility and the cost of providing that facility. It is worth remembering that elderly people in particular have often been regarded as captive to public transport because of their comparatively low car ownership. This is changing. In the future there will be substantial increases in car ownership among people of retirement age, many of whom also have some degree of disablement. In the future it will be just as important to attract these older people to public transport as it is for younger, already high car owning, age groups.

3.5.3 Effects on safety and accident levels

Introduction

Evaluation of the safety effects of different measures introduced in a traffic system is important and can be performed both prospectively and retrospectively (Gerhardt 1991, Carsten 1992, Oppe 1992, Grayson et al 1993). However, to really establish a good picture of safety effects is very difficult. In the CAPTURE sites, not only one measure is implemented in the demonstrations, but often a set of measures are combined into one major change of the total context, and to isolate the safety effects of only one of the specific measures is practically impossible (Ekman 1996, Hauer 1997).

Figure 3.1: The Safety Pyramid



Source: Hyden, 1987, Franzen, Kulmala 1994.

One direct indicator of safety is of course the number of accidents (fatal as well as other types) for a specific period of time. However, the accident rate, normally measured over a relatively short period of time, cannot tell "the whole story" about the safety effects of a measure. The safety pyramid approach (or conflict methodology) (See Figure 3.1) has therefore been introduced in CAPTURE to help in this situation. The method generally implies that for every accident there are many more conflicts or near-accidents, and it is stated that there is a proportional relation between the number of accidents and other types of incidents. In CAPTURE the analysis has sought to identify areas of lower or higher exposure or risk of conflict through qualitative rather than quantitative measurement.

In the CAPTURE assessment, a specific group of effects, which might have a bearing on safety, have been identified (after Draskóczy 1994). They are all related to the fact that the introduction of a measure will modify certain aspects of traffic behaviour or traffic system performance:

- **interaction** between road-users (risk for conflicts)
  if the paths of vehicle flows changes and new interaction patterns emerge, risks can increase if encounters are more frequent or new road user groups interact;
- **exposure** (length and purpose of journey, time in traffic, etc.)
  the more time a road user spends in traffic, the more 'opportunities' for an involvement in an accident, e.g. if the need for travel is reduced the exposure (and the risk) is reduced;
- **modal choice** (private cars, public transport, cycling, walking)
  the different modes of transport and different types of road users are more or less 'protected' and this is visible in accident statistics, e.g. the increased use of public transport on behalf of private car use will imply a safer situation;
- **route choice** (OD-matrices, type of streets/roads used, etc.)
  normally there are several alternative routes between an origin (O) and a destination (D) and, depending on what type of roads/streets are used, the relative safety of a route can be established;

- **speed choice** (speed related to road/street type)
  from accident statistics and other reports it is evident that the higher the speed the higher the risk for an accident and the more serious the consequences.

An evaluation of safety effects can therefore be accomplished by the use of indicators normally used for other evaluation purposes (e.g. traffic counts and vehicle speeds are used to look at the traffic flows and the efficiency in traffic). The CAPTURE analysis was also based on the identification of traffic locations with a conflict potential (often between different types of road users), and observations made during city and site visits.

A summary of findings and general conclusions

The main findings, from both analyses of the data collected as well as the prospective safety analysis, are summarised in Table 3.6. In the table is indicated the type of effects to be found. The symbols (++,+,o,-,--) are used to indicate the spectrum of effects from positive, fairly positive, neutral, fairly negative to negative.

It should be clearly pointed out that the general conclusion is that the safety effects of the physical measures introduced in the different sites are found to be neither negative nor positive, i.e. the total safety effects (combining all types of indirect measures and site design analysis and direct observations) are at all sites almost at the same level as before the introduction of the specific physical measure (or set of measures) evaluated.

Table 3.6: Safety effects related to changes in traffic behaviour and prospective safety analysis of the measures implemented (the symbol ? indicates that further analysis might be possible).

CAPTURE test site	interaction	exposure	modal choice	route choice	speed choice
Brescia	o	o	+	o	-
Bucharest	-	o	+	o	o
Copenhagen	--	o	o	+	o
Greater Manchester	-	?	+	?	o
London	--	+	?	+	o
Madrid	-	o	+	+	-
Mytilini	?	?	?	?	?
Orvieto	-	o	+	o	o
Rome	--	o	o	++	+
Tampere	-	?	o	+	o
Vitoria-Gasteiz					

3.5.4 The effects on the local economy

Surveys of the effects of transport measures on the local economy are difficult to conduct quantitatively, since traders are reluctant to let their turnover figures be known, and many factors will be of importance to trade besides the traffic measures alone. Thus the analysis within CAPTURE was qualitative including many interviews with businesses. The main findings can be summarised as follows:

- Most traders who are to affected by physical transport measures tend to take a despondent view of the likely impacts, unless they can see immediate tangible benefits. They tend to take a 'conservative' viewpoint that any change is likely to be harmful, although in most cases experience shows the opposite to be true;

- Most traders operating in a private enterprise environment will, after implementation of measures, attempt to make the best of the situation, whether it has helped or harmed them. If it has helped them, they may play down the benefits, while if it has harmed them they will generally see little point in complaining and will be trying other methods to regain trade;

- In some cases, where good public consultation or participation has not taken place, traders will group together and, often successfully, fight the proposals;

- In general, measures which reduce car traffic in an area are likely to be beneficial for business in the long term, except for those which *really do* rely on car borne visitors (such as those selling bulky goods);

- But the effects on streets outside improved areas may be harmful, especially if traffic increases;

- The effects of changes made in corridors very much depend on detailed planning of the schemes, taking into account the needs for parking and deliveries, and the environment for pedestrians;

- In a case where there were complaints from traders after the opening of a scheme, a suggestion of a year long experimental basis for the measures proved successful in halting opposition.

The main lesson for the CAPTURE studies is that careful planning and consultation are the key requirements for ensuring that the effects on businesses are positive. If they are perceived as being so by a large number of traders (and that perception is likely to relate to a lack of consultation more than the actual measures themselves) a scheme may not be implementable. Measures such as pedestrianisation are generally helpful to trade in the long term (though there may be some 'casualties' and forced movements of businesses), which bus corridor changes have to be designed with care to allay the fears of local traders.

3.5.5 Effects on perceptions of transport

The general findings have been that the effects of physical measures on the public's perception of transport in a city have been beneficial. The benefits have been generally perceived by bus users and there have generally been few complaints by car users, even in schemes which have led to slower conditions for car drivers such as Copenhagen.

There have, however, been complaints by businesses in some cases, notably Copenhagen and Tampere. These have generally related to measures which reduce on-street parking, which seems to be a major concern of many businesses.

Where measures have been planned for those with reduced mobility, there have been very positive benefits. Greater Manchester is the test site which had most measures related to access by those with reduced mobility, and the effects have been to improve conditions not only for those in wheelchairs, those with children in buggies, and those carrying heavy luggage, but the low floor buses giving the greatest accessibility benefits have shown to maintain a higher patronage amongst the general population than normal buses.

The study in Tampere asked respondents what they felt had been the impacts on their perception of bus service quality of various elements of the demonstration on public transport. The results are summarised in Table 3.7 below:

Table 3.7: Effects of various measures on perception of service quality

	Much worse	A little worse	No effect	A little better	Much better
Currently implemented					
- New stop shelters	1.2	1.1	83.5	8.2	6.0
- Low floor buses	1.5	1.7	66.4	17.2	13.1
- Bus lanes	1.3	2.5	81.1	11.2	4.0
- New lanes at intersection	2.0	2.9	83.5	8.9	3.1
Future improvements					
- Junction by-pass	2.9	2.8	74.9	12.0	7.7
- Priority at lights	2.5	1.9	75.9	14.7	5.2

It is apparent that low floor buses are seen as making the greatest improvement. This is highlighted by the results of another question which asked what respondents felt the most important improvement was, with 43% saying the low floor buses, 20% the proposed by-passing of traffic lights, and 12% for the new stop shelters and the bus lanes respectively.

3.6 Energy and environmental impacts

The energy impacts directly attributable to the CAPTURE measures have generally been quite small. The cases where public transport operation has improved have led to reductions in energy use by public transport of up to 3%, but these impacts have generally been overridden by increases in energy use associated with increasing car use and the tendency for cars to have larger engines.

The CAPTURE test sites have monitored emissions of pollutants by modelling of vehicle characteristics and speeds. Currently, the factor having the largest impact on the emission of pollutants is the increase in the petrol driven vehicle fleet with catalytic converters, which, since the introduction of compulsory fitting in 1993, has meant that, with a regular turnover of vehicles (the average lifetime of a car being around 12 years), each year some extra 8% of vehicles have converters fitted. With the effect of a converter being to reduce emissions of most pollutants (other than Carbon Dioxide) by around 50%, this is leading to roughly a 4% reduction in emissions (if car use does not rise). The CAPTURE modelling does not take this factor into account, so that the effect of CAPTURE measures alone can be estimated.

Few CAPTURE test sites (Rome, Bucharest and Vitoria) have measured noise levels, believing that either it is not a major issue of interest in the city in question, or that the effects of the CAPTURE measures will not be measurable. In Rome, however, the effects of traffic calming, increased parking controls, and the associated fall in traffic levels and speeds, on noise levels were dramatic leading to up a 5Db reduction in noise levels (where a 3dB reduction is equivalent to a 50% fall in perceived noise levels).

This kind of effect would almost certainly not have been recorded in any other of the test sites except the pedestrianised streets in Mytilini, and in the Vitoria-Gasteiz test area if that had gone ahead.

In summary, pedestrianisation can have a major effect on noise levels, which can have a very direct effect on the ambience of a street. Traffic restrictions can also have a major effect in some cases (as was shown in Rome) but in other cases the effect might not be so great if speeds are already slower. The introduction of bus priorities and bus lanes will have a complex effect, depending on the speed of operation, and the amount of acceleration and deceleration.

4. IMPLICATIONS FOR POLICY

CAPTURE raises many issues which have implications for policy. We deal with them firstly in terms of conclusions and recommendations arising from the corridor and areal sites (Section 4.1), before summarising recommendations for the local level (Section 4.2) the national level (4.3) and the European level (4.4).

4.1 Corridor and Area site main conclusions and recommendations

4.1.1 Area site conclusions

Measures which reduce traffic levels in areas of cities are difficult to implement but are effective when carried through

Measures which reduce traffic in areas of cities tend to be very visible, involve several bodies, and are almost certain to contain elements which will be unpopular with sections of the community. But carrying through a plan to its conclusion will usually result in a scheme which benefits the city. Real benefits can come in the form of less traffic and a more genial environment within the area affected.

There will be effects outside the area immediately affected by the scheme

While corridor improvements often do not have effects extending beyond those immediately affected, measures which improve conditions for modes other than the car in an area will tend to divert some traffic outside the area, and the effects may not be beneficial on those areas.

There are large differences in the views of traders and businesses affected

In some cases traders will react against any measures which reduce parking outside their premises. In other cases those in areas which are not being affected by the scheme will complain that they should be included because of the environmental benefits they perceive will follow.

Financial resources and local conditions will largely determine what can be done

There are large cultural variations in what can be put into place regarding improvements to areas within cities. While some cities are prepared to spend large amounts of money in improving conditions others have difficulty implementing even the most modest measures. We conclude that there is a learning process to be gone through in many cases of overcoming a fear that any restrictions on car use in an area will lead to gridlock and seizure. Once changes are started the negative attitudes tend to be replaced by keenness for more change.

4.1.2 Area site recommendations

Solutions for problems relating to areas of cities rather than corridors need careful and individual planning

There are no 'off the shelf' solutions for plans to improve an area of a city. It is important to plan changes to an area individually, taking into account the reactions that measures would have, firstly in terms of ease of implementation, but also in terms of user reactions to them.

Side effects outside the affected area should be considered

The likelihood that areal solutions will involve at least some traffic diverting to outside the affected area means that these effects must be borne in mind. While it should not be assumed that all displaced traffic will find another route the notion that such traffic will simply 'evaporate' may be overplayed. Consideration of how car users will react must be made at the design stage.

Carry out public consultation, and, preferably, public participation

Public consultation is one of the keys to successful implementation of areal schemes. There will be strong views from sub groups of the population affected. In the process of dialogue new solutions may be found which all parties will support. With public consultation and participation in scheme designs it is much more likely that the scheme will operate without protest or complaint.

Physical restrictive measures are probably more acceptable than road pricing measures

While physical measures which reduce traffic in an area will almost certainly have some opponents, they will also (if well planned) have strong support from other people. It is much easier to implement parking restrictions, parking pricing, and access controls to reduce traffic in an area than implementing road pricing. This last point is proven only by the lack of road pricing schemes in Europe so far (with the exception of road tolls in Norway).

In cities in which areal improvements have not been tried, start small or experimentally

There is often fear in cities that measures which restrict car traffic will result in hostility and chaos. Once they have been implemented support grows rapidly. It is recommended that cities start with experimental or small scale schemes which will have obvious positive benefits, before attempting a radical scheme in a city with no history of change.

4.1.3 Corridor site conclusions

Corridor measures can speed up journey times

The CAPTURE studies have shown that journey time improvements for public transport follow from measures designed to speed operation. While this would imply failure if it were not true, there are other factors at play which might cause them to be ineffective. Overall they can be taken as being successful in these terms. In the cases where they were not implemented journey times slowed due to increases in traffic.

The time saving benefits of corridor measures may not translate into timetable benefits, but may help operators maintain good timekeeping

While speeds may be increased these potential time savings are not always translated into timetable savings. Usually the effects were felt over the sections immediately affected, but over an entire route length the savings were not enough to provide changes in timetable. However, noticeable improvements in timekeeping and reliability were noted.

Traffic congestion levels and enforcement are the main factors affecting time savings

The main factors which affect the time savings brought about by bus priorities are the levels of congestion before implementation and the level of enforcement of use by cars and illegal parking in the lanes. Illegal parking (and lack of legal control over parking) can undermine some of the effectiveness.

Corridor measures tend not to provide immediate modal split benefits unless they are very large scale

Studies of travel behaviour change show that people tend to re-appraise their travel options when they have a change in their circumstances, such as a new job, moving house, or a different pattern of journey making (eg children starting or leaving school). Thus the modal shift effects of any change typically takes up to, or at least, 5 years to have an effect. In most of the CAPTURE test sites, therefore, modal shift changes were not measurable (and in five years time so much else will have changed that it is unlikely that any change would be attributable to the CAPTURE changes).

Large scale corridor measures can have modal shift effects

Most of the above statements do not apply to the large scale changes made in the Madrid corridor. With each implementation (new HOV lane, new rail lines, and new motorways) behaviour changes were noted which related to the transport supply. The implication would be that several small scale improvement in conditions for public transport would provide an effect on modal choice over the long term.

Corridor measures can also have other benefits

In a similar way to traffic calming measures which, in many countries, started as crude attempts to slow traffic, but have developed into area enhancements which also provide for slower traffic corridor measures can improve a streetscape and the life for those living along it. New street furniture, forms of paving and other aspects can make life better, giving more living space and a more visually attractive environment.

Service quality improvements in corridors show benefits

Those cases where buses, bus stops, and other elements were improved showed benefits to public transport users, even if journey times were not improved. Of particular benefit were low floor buses, and improved bus stop facilities. The visibility of these measures is thought to be a vital factor in improving the public image of public transport.

4.1.4 Corridor site recommendations

Carry out careful analysis of problems and solutions of a corridor.

Look for key problem sections of a corridor, and ensure that measures can be tailored to solve problems in those sections. This does not mean that measures which benefit public transport and other modes in those sections which are not currently in need of improvements should be ignored. These may be easier to implement, and will provide priorities for a time when they may be needed.

Create packages of measures which will benefit corridors

To concentrate on single measures such as bus lanes or priority signals is not likely to provide the benefits that a well thought out package of measures will. It is obvious that different measures will be required for different situations. It is also apparent that even if some elements of a strategy can not be implemented quickly other measures will be in place which can benefit public transport, walking and cycling.

Use the opportunity for change to improve facilities for other modes

Schemes will often be planned for a single mode (often buses) but the opportunity should be taken to integrate other modes such as walking and cycling into the schemes. This may require dedicated facilities for those other modes, such as a new pedestrian crossing, or it may require a more pedestrian friendly/ cycle friendly design, such as a wider bus lane or adding specific details in a traffic calming scheme.

4.2 Local level recommendations

It is at the local level that the most obvious policy implications arise from CAPTURE. The project has been concerned with local level transport policy measures, and most of the measures are ones which will be implemented by local authorities as part of local transport plans. In that sense, the reader working at the local level who has turned directly to this section should go back and read the more detailed research findings relating to the measures they are interested in before reading this. In addition many recommendations relating to the local level are summarised in Section 4.6. In this section we describe the more strategic recommendations relating to the local level to provide the global element of “think globally, act locally”.

At the general level the main findings relating to local areas can be summarised as:-

- *There is no substitute for local knowledge* in determining which policy measures should be implemented in different sites. It was never the intention that a project such as CAPTURE would come up with definitive answers to questions such as “are bus lanes more effective than pedestrian areas in effecting modal shift”, and even less still that the project would be able to provide the information needed for any city to prepare plans for reducing car dependence or effecting a modal shift. The effects of similar implementations in different cities have produced results which are different, and with the numbers of cases studied, it is not possible to state with any statistical certainty which policy types are suitable for different situations. Local knowledge will always be needed.

- *There is a need for real strategies if modal shift is to be achieved.* While the CAPTURE demonstrations are all to be praised for their efforts to reduce dependence on the car and to encourage people to use other modes they have not actually halted the growth in car dependence. This is true of most transport policy at present, and, it is argued, arises from a lack of proper planning of proper strategies to reduce car dependence. At the moment we have a menu of policy measures which transport planners pick elements from, but very few overall strategies which will lead to a reduction in car dependence. This aspect is described in more detail below (Section 4.2.1).

- *There is a need for much more careful thought about the chances of implementation of plans*. One of the main early findings of the CAPTURE study was that several of the measures which were planned to be incorporated in the study did not get implemented, either within the lifetime of the project, or at all. The reasons for this were various, and suggestions to overcome this are described in more detail below (Section 4.2.2 - designing a good and workable strategy).

4.2.1 Designing strategies to effect modal shift and reduce car dependency

In order to have a desired effect, it is important that policy tools are combined to create specified strategies. Before discussing different strategies, it is important to discuss the relationship between policy tools and strategies.

Policy tools can be categorised according to whether they are:

- *Physical* - physical changes to the environment which will encourage or discourage particular journeys or use of modes. These include measures such as bus lanes, cycle lanes, restricted areas, parking polices etc.
- *Regulatory* - the use of legislation to regulate or enable actions.
- *Technological* - the use of measures to encourage journeys or modes. These include traffic light systems, information for public transport passengers, etc.
- *Financial* - these include fiscal measures such as fuel and car taxation, road pricing, parking pricing, public transport fare policy etc.
- *Psychological* - these generally involve media and public relations campaigns.

A strategy is likely to need a combination of these tools to be successful, though in most cases there tends to be an emphasis on one particular type of tool.

There are other dimensions to a strategy. These include:-

- *Geographical scale* - Tools can be employed to affect changes in a small area of a town, in one transport corridor, or can be applied town-wide, over a region, or nationally.
- *Encouragement and discouragement (the balance between pull and push)* - It is now generally accepted that strategies need to include both pull and push measures to be successful in achieving a modal shift. To simplify the issues, pull policies are popular, and

may encourage an increase in the use of non car modes, but are seldom accompanied by a reduction in car use. On the other hand, while push policies may be successful in reducing car use, they tend to be electorally unpopular and, unless alternatives are available, they may simply increase hardship. In general, push policies have to be applied over a wide area, while pull policies are most effective in localised areas.

- *Time scale* - Individual policy tools will be designed to be effective over different time periods.
- *Political scale* - Some measures need to be implemented at different levels of government. In a rational world these relate to the dimensions of strategy outlined above, especially the geographical scale of the measure.

Designing a strategy

Developing a strategy can be seen as a journey from one place to another. If we wish to travel from A to B we look at a map and decide the best route and means of getting there. At the outset we have to make decisions such as on the main mode we wish to use. If we choose public transport, we will have to build the rest of the journey details around the use of a train, bus, or plane, which has set starting and ending points. If we choose private car, we will almost certainly make use of a major road which will take us most of the way.

As part of a strategy to reach point A, we may often set off in a counter-intuitive direction. We may also change course on the way if we encounter traffic congestion or spot an alternative route on the map that looks as though it will be attractive or avoid possible congestion ahead.

Relating this to the transport policy problem, we are currently at the stage where we know where we want to go, but are supporting any policy which takes us in that direction without thinking about its wider consequences. Using the journey analogy, we are using whatever modes we have to head straight for our destination, rather than looking at the overall journey. This could be described as “end gaining” (Alexander, 1932). We are usually told to think about the ends, and less about the means, but in complex situations this can be a disastrous strategy.

Three basic strategy types

Three basic forms of strategy to achieve change are described here which could be adopted.

1) Using targets (An incremental approach)

One strategy which is becoming common policy in many fields is to set targets for change, and monitor progress towards them. The advantage of such a strategy is that when faced with an enormous change, incremental targets can be shorter term and progress can be seen to be made. Concentration on targets and indicators may, or may not, be helpful. A target of reducing car mileage by five per cent over a ten year period may, if achieved, be taking us in the right direction, but if it is achieved by, for example, increasing fuel tax with no other measures, it may make the next ten per cent reduction much harder to achieve. This is because those who can reduce their mileage will have done so and there will be no transport alternatives in place to facilitate the next ten percent reduction.

In terms of the journey analogy, this is like marking towns on the map in a straight line and following the most straightforward route between each.

2) *A fully planned and staged approach*

In the case of fuel price rises described above, a better policy might have been to invest in public transport, walking and cycling, while allowing only a small increase in taxation. This could have then been followed by heavier taxation increases which would encourage more people to make journeys by alternative modes. An adaptation of this approach is that advocated by the OECD and ECMT (1995) which recognises the need for timetabling and phasing of different measure types.

Under this strategy we should be doing the groundwork to ensure that policies are straightforward and will lead to the desired goals, rather than fighting against human nature. For instance, to discourage people from using cars for journeys requires that they feel safe walking or cycling. Thus, one of the important pre-requisites for a successful policy to encourage walking and cycling may be to reduce private car speeds to a point where people feel safe being on streets. Such a strategy would therefore consist of two major stages; the first being the creation of the prerequisites for the big push, and the second being the big push itself. (In the journey analogy the first stage is getting to the trunk route, and the big push is the travel along the trunk route). In reality there is a need for 'carrots' and 'sticks' in both stages of the strategy.

In this view of things, there are also policies which may appear counterproductive, such as park and ride but which may form important groundwork for convincing people that action can be taken which will benefit them and which work simultaneously towards sustainability.

3) *Defining the goal and being adaptable (An opportunistic approach)*

Some schools of corporate strategy imply that the world is too complex and dynamic to make a fully planned strategy either feasible or workable (Bate, 1994). An analogy is made with crossing a rough sea in a small boat. One has to pick up winds and currents where they exist and run with them, rather than plotting out a course from the start and sticking with it. This strategy can be viewed in two ways; it has to be the most sensible, but it is also the easiest to claim that one is following when one hasn't got a clue what one is doing! It can either be an organic, effective and dynamic pro-active approach, or it can be an excuse for reactive panic management!

Going back to the road journey analogy, this strategy is like using intuition when hearing of traffic congestion on the car radio; it may be good if you know the area well, but it could be disastrous.

Of course, the real world "map" is more complex. The importance of these types of strategy is not so much in deciding which strategy is the correct one for reducing car dependence. A complete strategy will involve elements of all three. The importance is more in thinking about the long term implications of particular policy strands in these terms.

It seems that the optimum overall strategy would include:

- *Distinct stages planned using co-ordinating policies and actions by all levels of government*. We should know which policies will be effective under which conditions. For example, road pricing may only be effective where public transport provision is good enough to provide an attractive alternative, and where locations of homes, workplaces, and shops are such that journeys can be made by other modes. Logic, common-sense, and research can all contribute here.
- *The use of targets and standards where a strategy element is agreed upon*. Each element of a larger strategy should ideally be seen as part of the wider strategy, and targets and monitoring processes should be developed for that element. For instance, a policy may be two staged whereby initially a public transport system that is competitive with the private car is provided and then policy tools are used which are designed to affect a modal shift. The improvement of the public transport system should be subject to targets and monitoring of progress towards those targets.
- *The ability to change course and take advantage of unforeseen circumstances*. Examples of such circumstances are environmental disasters which can affect public opinion and allow previously unpopular policies to be acceptable or desired. Also, building upon other fashionable trends such as encouraging cycling as a mode of transport when exercise and health are being promoted.

In general, it would seem that most measures so far introduced to reduce dependence on the car and to encourage modal shifts can be viewed as tactical rather than strategic. When planners talk of strategies they are often talking about long term plans, but seldom about fully considered strategies which will ensure that the goals we are talking about are achieved.

4.2.2 Designing a good and workable strategy

One of the major findings of the CAPTURE project was that what is planned is often not implemented. This seems like a very obvious statement, but in most monitoring and research only that which is implemented is studied and that which is not is ignored. In CAPTURE a decision was taken to accept that some elements (or entire plans) were not being implemented and look for the reasons why, and suggest ways in which mistakes could be lessened in the future. Section 3.2 looked at many of the reasons why success in implementation varied so much. In this section we return to the theme to suggest ways in which the 'inefficiency' caused by planning and trying to implement schemes which never materialise could be minimised.

What is suggested is described below. It is recognised that this is a 'starting point' for discussion and different elements may be of use to different situations. The basic steps in design should include:-

- *Gaining consensus for the need for change* - There is a need for consultation and participation by key actors, and the public. In general this stage may be relatively easy, but it is important that all bodies involved in decision making understand to goals of projects such as to effect a modal shift.

- *Gaining consensus over methods for solving agreed 'problems'* - this stage is more complex. While there is a general consensus that it "would be a good thing" to reduce dependence on the car and to encourage people to use other modes, there may be widely differing views about how to achieve that goal. It is at this stage that consultation with the public is of utmost importance, in order to educate those affected both in terms of what the schemes will actually involve, and how they are designed to improve conditions. It is important that such consultation is done at an early stage so that suggestions from local people can be incorporated (and with very local knowledge they may be better solutions than local authorities or outside consultants can provide), and that the consultation does not just result in hostility to a scheme that has become imprinted as the only solution to those proposing it.

- *Adopting a plan with a 'logically arguable likelihood' of success* - It is often apparent (particularly in hindsight) that many schemes put forward and put into action were never likely to succeed in the goals they set out to achieve. Any scheme which gets as far as being formally proposed should be capable of withstanding critical analysis of its likely success in achieving its goals if it is implemented.

- *Consideration of the likelihood of adoption* - While the actual conditions which determine whether or not a scheme will see its way to completion are complex it is apparent that some sort of local assessment of the likelihood of adoption should be made. Learning from past mistakes, delays, and suchlike is crucial, and in general, assessments of these kinds will be made, but with the belief that "things will be different this time". Of course some measures may be essential to a strategy but will be described as having a very low likelihood of success. Perhaps some of the more controversial elements should be piloted in areas where they are likely to be implemented in order to give them a higher chance of success elsewhere.

- *Ensurance that overall goals are not prejudiced by possible or likely changes to detail* - contingency plan - an example of this problem on a large scale is the Sheffield Supertram system in the UK which was originally designed in a planned public transport system to act as the 'backbone' to the system. But after the design stage the UK government brought in its deregulation of the bus industry which meant that the system was in competition (on price and service levels) with bus services which, from many key locations were able to access the city centre much faster and more cheaply.

- *Cohesive management of plans* - it is important that plans are constantly overseen towards their conclusion. If key personnel change more than is absolutely necessary some key understandings of the project will be lost.

It could be said that it is impossible to decide how to proceed from where we are without agreeing on the goal, and certainly in many senses, this is true. Clear direction and strategy can only be created by actors who are clear and have a common understanding about the end goal. It is this lack of a common vision concerning an end state for transport policy which has been responsible for the lack of progress towards a sensible transport strategy. It is also true that if direction is agreed, then strategies can be defined, and it is here that there is more scope for consensus.

4.3 Member State level

While physical transport measures tend to be implemented in local authority areas and much more independently of central governments than is the case for other measures (such as pricing which tends to require government legislation) there are many ways in which central governments direct and influence the types of measures used in different areas. These include:-

- Larger measures which either require an element of government funding for their implementation, or may require legal change (such as an Act to allow light rail systems to be constructed).
- Central government funding approval being required for plans before funding from central taxation can be freed up for local use.
- The need of government approval for schemes in terms of reaching design standards (normally based around ideas of safety).
- The use of experiments and demonstrations.
- Approval needed in cases where 'national' roads or infrastructure will be involved.

Since the extent of government interference and assistance varies between countries it is difficult to provide any concrete guidance as to the role of national government in the implementation of physical transport policy measures but some conclusions which have arisen out of the CAPTURE project are:-

Need for a good review of local schemes put forward

Reduction in car dependence is likely to come about by a carefully thought out strategy (see Section 4.2.1) which is made up of a large number of transport policy tools working together. There is a need for a body with a role to assess local plans from outside and review them in terms of their progress towards higher goals of transport policy, and the national or regional level is probably the appropriate one.

Social exclusion

The main aspect of social exclusion relevant to transport policy relates to the ease of carrying out life without resource to using a car. While car ownership and use is regarded as the normal way of behaving there is still a large minority in any society who do not have full or partial access to a car. Many households, especially in cities, do not own a car (with a variation from about 15% (eg. Brescia) to 80% (eg. Bucharest)), and many more individuals in households do not have a licence or access to use a car as a driver when they wish. Children in all households do not have access to a car as a driver. It should be a role of national or regional governments to ensure that local plans benefit all groups in society including those without access to a car. In the current policy background of reducing dependence on a car this should be no contradiction with general policy.

Competition between cities

Some schemes which are well grounded and would be likely to succeed in solving transport problems if implemented are often not considered fully because of a fear that neighbouring cities would 'gain' as a result. This argument is often used against measures which restrict car access to city centres, on the grounds that the economy of neighbouring towns and cities would benefit from people choosing to shop, or set up businesses there to the detriment of the city which would benefit in traffic terms. That this argument is normally flawed (drawing evidence from pedestrianisation schemes which tend to show that a more attractive environment is beneficial to the economy) could be supported by national and regional government by encouraging similar measures in neighbouring towns, and being a 'listening post' for such issues where they arise.

Not allowing local politicians to get away with political ambition schemes

National or Regional governments, if they have a role of vetting schemes, should ensure that schemes which are designed with power politics in mind rather than improving the transport situation are not supported. Most do this, and it should be noted that none of the CAPTURE schemes could be described in this way being generally smaller scale low cost schemes. Indeed it is likely that the lack of overenthusiastic support by local politicians may have been a reason for non-implementation in many cases. The types of scheme which tend to be put forward for political power reasons tend to be highly visible schemes such as light rail systems, or excessively technological schemes which are thought of as putting a city "in the forefront" in some way.

4.4 European level

The main direct interest of the European Union in transport policy is concerned with the effective functioning of the economy across the member states, in creating 'sustainable mobility' whereby goods and people may travel through the European Community area efficiently, safely, and under the best possible social conditions. There are a variety of ways in which local level transport initiatives and demonstrations are of importance to this goal.

In a wider sense the kinds of demonstrations are also of importance. The European Union is able to take a lead in matters such as world-wide environmental protection, and in terms of creating an efficient economy within the EU the effects of transport congestion can be crucial. Thus in two important spheres, congestion and the environment, the implications of the CAPTURE project are of importance.

The European Union goals are best described in "The Citizens' Network" (European Union, 1996), which sees the Union's main roles in:-

- Disseminating Know How and setting Targets,
- Aligning R&D priorities with user needs,
- Making community instruments effective,
- Modernising the regulatory framework, and,
- Improving standards.

To these ends the following recommendations arise out of CAPTURE.

- The knowledge learnt through the CAPTURE project and others in the RTD programme should be dissemminated widely, in a co-ordinated fashion, drawing together the lessons learnt from CAPTURE and the other projects.
- The best practice examples from within CAPTURE should be especially disseminated, while ensuring that the benefits of the approaches are not exaggerated. Examples of demonstrations which deserve especial mention and consideration include:
  * the HOV lane in Madrid, which may be a suitable model for other large cities, although the increase in overall capacity may not fit in with all transport policy aims;
  * the lessons from the other corridor sites that measures can have a synergy when applied in a package, but that a rapid modal shift should not be expected;
  * lessons from Greater Manchester and other cities that improvements to the bus fleet can have positive impacts;
  * the lessons from many sites that implementation issues must be treated very seriously.
- Intermodality has been a key in many CAPTURE case studies. Equally important to the creation of purpose built interchanges are the ways in which small scale measures can encourage intermodality, at bus stops and through the use of low floor buses, and through the use on short distance new modes of transport,
- The use of telematics technology has generally been quite low in CAPTURE demonstrations. Telematics measures can generally be implemented without delay, once they are agreed upon, but the benefits are often greater to private motorists than to public transport passengers. In the CAPTURE test sites the non-telematics measures generally had a larger impact on users than the telematics measures.

Lessons for central and eastern European countries

The conference held in Bucharest in the final six months of the project was especially useful in learning the differences in needs for public transport policy direction in Romania against Western European countries. It came over strongly that low cost solutions were most useful, not least since in discussion in the conference it was realised that low cost was also one of the main criteria for success in implementation in Western European countries. The most strongly felt needs amongst participants from Romania were money for better vehicles, and improvements such as tram lines and trolleybus equipment, and better vehicle maintenance.

There was a feeling amongst CAPTURE partners that it was easy for Western Europeans to be somewhat naive in assumptions about the situation in CEEC cities. This naivety was apparent both in terms of expecting that Western ideas on policies and practice were relevant to CEEC cities, and also downplaying the level of change possible.

However, it is apparent that there is a very serious and sometimes heated debate needed in Romania about the direction of transport policy. On the one hand many argue for catering for the needs of the private car very strongly, using arguments of personal freedom and short term benefits to the economy. At the same time others argue that environmental concerns and congestion must be tackled using demand management in some form. This debate would seem to have strong parallels with the debates held in many western countries in the late 1980s and early 1990s leading to the ‘new realism’ in transport policy and the shift from a ‘predict and provide’ approach to a ‘demand management’ approach. But the debate is being held at a different stage of motorisation, before many of the negative consequences of car dependence had become fully apparent. It appeared to CAPTURE partners that the negative consequences of high levels of motorisation and the spatial and economic changes which inevitably go with these high levels are not fully appreciated by many Romanians. But it will be difficult for the European Union to advise Central and Eastern European countries to adopt policies which slow motorisation without appearing to be hypocritical.

That said, and in recognition that this analysis could be wrong, the opinion of many CAPTURE partners was that in terms of the project's aims, the concern about more money for operating the current public transport system was the most pressing need. At the same time it was felt that an opportunity existed (or could exist) for ensuring that the problems of congestion experienced in Western European countries caused by high levels of car ownership should be tackled now, while car ownership and levels of use are still relatively low. For Bucharest it appears that bus lanes could be very cheaply implemented on most major streets, as long as the relevant parties could be persuaded to support the schemes. If this were done, and even if they were not enforced especially well when implemented, the necessary 'infrastructure' for bus priority would be in place to give public transport an advantage over private transport in the future.

While it is apparent that the Romanian situation will not be precisely reflected in other Central and Eastern European Countries discussions with others from the Associate City Network would seem to back up these findings.

4.5 Implications for future research

4.5.1 Project self-assessment

CAPTURE represents one of the first attempts to apply common methods of assessment and monitoring to a set of physical transport measures in differing circumstances. It has not been able to do all it had hoped to do, and no excuses are made for this. Here we ask some questions about the usefulness of CAPTURE and aim to answer them:-

Was the overall approach a good one? The project aimed to assess the effects of different measures using the notion of common indicators to measure the effects in different areas of effect. A large amount of freedom was given to cities involved in the project to collect data for indicators in ways which were appropriate to the city and the peculiarities of the test site, with the proviso that findings needed to be statistically valid. Overall, it is considered that this was a good approach but that the number of indicator areas chosen was unrealistically large, meaning that many cities could not collect all indicators and they concentrated on those they could collect easily, in some cases leaving important gaps.

Are the common indicators the right types? - Related to the points made above it is considered that the indicators chosen were of the type that was needed, but that more effort should have been put into ensuring that all 'key' indicators were collected and/ or calculated in each city. Some further work is needed to ascertain an optimal list of indicators for future demonstration monitoring.

Have we proven that the indicators can be easily measured for different case studies? While some indicators were easy to calculate for all test sites, others were not, and some were somewhat irrelevant for many test sites. The attempts to compare the effectiveness of a pedestrianised city centre against improvements to a bus corridor in any quantitative manner has eluded the project. This is not to say that the indicators were difficult to measure, but that their relevance to different situations was different.

4.5.2 The need for 'CAPTURE' and related studies

One of the major conclusions of this research is the paucity of real information on how physical (and other policy measures) can affect modal shift. Studies tend to quote potential benefits where they are known, but gloss over the cases where there is very little or no objective knowledge. In effect, the effectiveness of physical and other measures to effect a modal shift is generally assessed in a subjective way. This happens for two separate main reasons:-

- Impact studies (even of very large scale measures) are open to other important changes (in the economy and suchlike) so that before and after studies often do not find measurable consequences. The world is not a laboratory.
- Most actors in the monitoring process are not able to be purely objective about their task, whether that is due to pressure from those who control money for this and future implementations, or from promotion of ideas and policies themselves.

There are several 'good practice guides' in existence including Transport 2000 Trust (1997) and Stokes et al (1992) on bus travel, DANTE (1998) on measures to reduce the need for travel, and ADONIS (1998) on measures to encourage walking and cycling. These are seldom based on a scientific study of the effects of policies, but often a mixture of knowledge of effects as well as suggestions for how things could be done better.

As a result of these factors it is very rare to be able to accurately measure impacts. CAPTURE is a step in the right direction in objectively monitor changes and responses, but it is argued here that what is needed is a much more concrete data collection exercise over as many areas as possible to monitor changes in circumstances and changes in behaviour. On a base of hundreds of observations regression analysis might be able to calculate reliable elasticities.

4.5.3 The testing of popular transport related hypotheses

In Section One a list of current commonly found statements about transport policy were put forward for consideration as hypotheses which the CAPTURE project was able to provide some insight into. In this section we return these hypotheses, and discuss them in groups.

Push and pull policies

Four hypotheses were put forward which relate to whether encouragement, and/or discouragement was the best method for proving for a change in the use of modes in the future.

1	A mixture of push and pull policies is required to affect a modal shift
2	If we pursue 'pull' policies on their own, we create the potential for change, but people will stay with their cars.
3	'Push' policies will be unpopular but effective

4	'Pull' policies are the only acceptable way to affect a modal shift

The project has not so much provided evidence which supports or refutes any of these hypotheses, but rather has shown the importance of a planned strategy, if change is to be achieved.

We are not going to achieve significant modal shift without a planned strategy to achieve it. And we cannot come up with a strategy unless we know what we are aiming at, and have a reasonable consensus about that goal. We need push policies as well as pull ones and we will continue to spend large sums of money for little return, or carry on with small scale experiments with even less return until we agree on what we want and take unpopular decisions.

The table below lists some of the common push and pull measures which could form packages of measures.

Type of measure	**Measures**
Push	Area wide parking management Parking space restrictions Car limited zones and time of day bans Congestion management Road pricing
Pull	Bus and tram priority High service frequencies Passenger friendly stops and surroundings Park and Ride, Bike and Ride Cycle networks Improved pedestrian connections
Push and Pull	Redistribution of carriageway space Redistribution of traffic signal times Public transport awareness raising Enforcement and penalising

from Topp and Pharoah (1994)

4.5.4 Measure a modal shift or the potential for modal shift?

The research, in highlighting both the lack of clear evidence of modal shift, and the need for both push and pull measures to effect a change raises the question of whether we should expect measures of the type studied in CAPTURE (that is generally small scale affordable measures) to be capable of producing a measurable modal shift on their own. A simplistic conclusion might be that none of them are likely to work, so we may as well give up on trying to implement demand management measures - this conclusion should not be drawn from the CAPTURE study.

The evidence on push and pull combinations (or lack of them) should maybe point us in the direction of seeing a target achieved when we have created a potential for modal shift. For instance if we can increase operating speed by a certain percentage we may make very little difference to the overall modal shift, but we are helping to create a situation where, if push policies such as pricing are introduced, then more people will be in a situation where they have a realistic alternative for their journey.

We have to view improved infrastructure as a step on the way towards modal shift, rather than measuring the success by the modal shift created. As Section 4.2.1 pointed out, if we aim towards modal shift alone we may make some unwise policy choices in the early stages of policy formulation.

4.5.5 The importance of common indicators in evaluation

While little comparable research has been done on the relative benefits of investment of different types of physical measures CAPTURE has developed a common method of investigation and evaluation. While it is not the perfect tool for comparability of physical measures it has been useful to develop such a tool. There is an enormous number of new schemes which are being tried and tested at the moment and it is important that a simple but comparable methodology is developed whereby the relative costs and benefits of one scheme or policy type can be compared with another.

4.5.6 Targets and Standards as policy goals?

In terms of affecting a modal shift targets are often suggested as a way of encouraging a modal shift. Targets such as “double the modal share of cycling by the year 2005” are typical. In certain instances these may be fine, but are often seen as unreachable. If this is the case people charged with their implementation have no guidelines as to the best way of working towards the target, and may see no rational reason for the level or the target date set.

On the other hand the use of standards may be more useful. In the same way that we set standards for emissions of pollutants from vehicles we could set standards for travel by public transport, walking and cycling, and say that services or facilities offering a level of service below that show a need for improvement. For bus travel, for instance, we could say that buses should be able to travel at 20 kph along their journey, and if they do not, steps should be taken to increase speed of travel. This could mean action to, for instance:-

- Improve boarding and alighting times
- Put priorities in place which would lead to real time savings, even if this meant restricting capacity for car travel.

There would still be need for decisions to be made about the way of achieving the target, but there would be a clear logic to where and when changes were needed to increase level of service, and where it was reasonable to restrict car travel.

4.6 Overall conclusions

Below are tables outlining the summaries of the various conclusions drawn during the study and how they relate to recommendations:-

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
Strategic planning	The goals stated for measures tend to be greater than can be achieved in practice	Be realistic about what can be achieved; don't oversell measures	Encourage an atmosphere where local proposals do not have to exaggerate benefits to gain funding
	In general, a single measure will not have a great effect. Packages of measures linked together are more likely to succeed.	Few plans will be single measure in reality, but the choice of strategy should take a mix of measures into account when relating goals to measures.	Adopt a funding strategy which encourages well thought out package approaches, and long term strategies
			It may be more important to put measures in large congested cities, but it may be easier to try first implementations of new policies in smaller towns and cities
	Authorities can become more interested in the physical measure than the objectives.	Authorities need to clearly state how their objectives will be delivered by the physical measures proposed, taking into account all modes.	
Technical design	There is great variation in the complexity and effort needed for design *within* most categories of measure.	Few types of measure should be ruled out because of perceived difficulty of design. There is normally a simple and cheap solution.	Encourage an easy funding stream for cheap and effective measures.
	Cheap measures can create greater transport efficiency if well planned and in the right location.	Include cheap cost effective measures where possible in designs	
	Use of guidelines can be good or bad (they may save time in design and avoid mistakes, but they can stifle new initiatives)		Ensure that guidelines and restrictions are simple and logical, and allow 'routes' for innovative design
	Measures new to a city or country may be difficult to design (or have designs accepted)	Expect more time needed for design of new measures, even if they are commonplace elsewhere	EU should transfer designs between countries. Member States should be liberal in allowing new measures, using information from EU and other States
	Aesthetic design can lead to more positive views about public transport, walking and cycling	More measures may need good aesthetics and architecture than may be apparent. Be aware of the effects of good and bad aesthetics in public acceptance.	

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
Detailed bus lane design		Don't 'close' bus stops when relocating without careful thought	
		Do not use minimum specifications for, eg bus lanes, unless absolutely necessary	
		Don't change direction of bus lanes too frequently.	
		Bus lanes are not always the best solution for speeding up bus operations (consider junctions and boarding and alighting times)	
Implementation	The likelihood of implementation has to be regarded as being as important as the effects *if and when* the measure is implemented. Institutional culture has tended to play down failures which has not been beneficial	Secure political consensus or significant support from political framework before starting planning.	Research is needed into institutional factors affecting implementation in transport policy.
	Implementation often takes very much longer than expected	Plan physical measures with great care, allowing time for hold ups in implementation	
	The main factors in successful implementation are a) Public participation b) Funding c) Government/Institutions	a) Carry out public consultation, and preferably encourage public participation in decision making especially in visible schemes affecting local areas. b) Ensure funding will be available for schemes c) Ensure government support exists if needed, and discuss with institutions which can affect outcomes	a) Prepare guidelines for successful public consultation and participation b) Allow for time delays for ringfenced funding for local schemes
	The type of measure (within those tested) does not bear a relationship with delays or failures of implementation.	While tried and tested schemes are 'safer' in terms of implementation, don't assume that a simple measure will have simple implementation.	
	While a very simple institutional and decision making structure can aid implementation only two or three bodies are required for a much greater risk of failure or delay.	Consultation with institutions is important even in relatively simple institutional structures.	

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
	While simple political and institutional structures can aid implementation, changes can occur over the timescale	Don't be complacent if the political situation looks strong. It may not always remain so. (eg Vitoria)	
	Many things can change over the time between plans and actuality in terms of technology, policy background and 'fashionability' of measure types	While state of the art measures may seem attractive at the design stage they may be out of date by the time of implementation.	
	There still remains a problem on implementation of measures regarded as anti-car, both in terms of professional and public support. Planners are scared of attempting measures which may be regarded as anti car.	Measures which restrict car use are needed but they have to be put across as beneficial to society as a whole.	Awareness campaigns should stress modal shift, and governments should lead by example
	Packages of measures can have effects for implementation. If one element is crucial problems of implementation may invalidate the entire strategy, but elements which work together symbiotically can still have an effect even if not all are implemented	Plan packages with consideration for those elements which are crucial and those which aid a package, and pay special attention to implementation aspects of the crucial elements.	
	Visibility of measures can sometimes hinder implementation though it can give a message of support for public transport, walking and cycling.		
	Some institutions will have pre-formed views on measures being proposed	Be aware of the links between measure types and institutions involved.	Local Authorities need government back up for modal shift policies
		Ensure designs are fully done before start	
		Adopt a step by step approach where possible	
Operational efficiency	The effects of most physical measures are localised.	Major time savings are needed to have an effect over a whole public transport route	
	Measures can lead to reductions in timetable variability. This can increase effective service level as much as increased speed.	Besides planning measures which save time, plan measures which will increase ability to keep to timetable	

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
	Traffic density and levels of violation seem to be the critical factors in success of bus lanes	a) To allow for time savings ensure that priorities are placed where they will be effective	
		b) Ensure that the 'operation plan' includes effective enforcement	
		But (c) It is easier to implement priorities where there are fewer problems. Where cheap and easy priorities can be implemented put them in place. Even if they are violated the legal right is in place for later enforcement.	
	The aim of not harming private car use in measures can lead to physical measures such as bus lanes not being designed to a level where improvements will occur.		
	New measures (such as traffic calming in Roma) were found to be unpopular at beginning but have gained support over time	Don't judge effects in a hurry. Allow time for situation to settle down. By the same score don't close unpopular measures immediately if there is opposition, but seek a 'cooling off of tempers' period which will allow for a less reactive judgement	
Modal shift and travel behaviour effects	Only the very largest measures can ensure effects on modal share which can be measured by surveys.	If measures are to be employed to radically increase the attractiveness of public transport in terms of the basics of journey speeds etc, the commitment and the scale of investment has to be large	
	The relationship between the scale of the physical measure and its effect on modal shift is probably not linear		
	Smaller scale measures may not affect modal share but are important in providing the preconditions for a package of measures to have an effect	Don't expect to judge benefits on modal shift effects	Don't expect to judge benefits on modal shift effects
	Time savings of the scale produced by most measures does not translate into modal shift changes		

Conclusion	Local Authority Recommendation	National, European, and further

			research recommendations
	Time savings of the scale produced by most smaller scale measures do not always translate into timetable savings, though improvements in timekeeping often follow.		
	For real change in modal shift a change in views over the priorities accorded to different modes will be required.		Travel awareness campaigns are needed to help change awareness
	Patronage reductions have accompanied otherwise successful physical measure demonstrations. Background effects and other changes can have a larger impact	Don't judge effects on patronage alone. Evaluation must take account of other factors.	
Other users etc	Physical measures tend to complicate safety issues by creating more scope for incidents although the overall effects are generally neutral	More effort needs to be put into integration of other road users and people with reduced mobility in design	
	Measures do not tend to address needs of people with reduced mobility, unless specifically designed with them in mind	Audits of effects on various aspects should be included in design (PRMs, pedestrians, cyclists, safety issues etc) though these audits need to be simple if they are to be effective.	
	Low priority tends to be given to pedestrians and cyclists in schemes.	Authorities should make special efforts to consult with groups representing pedestrians and cyclists, and to give support to these groups if necessary.	
	Physical measures for public transport can have positive or negative impacts on pedestrians and cyclists	Pedestrians and cyclists need to be carefully considered to ensure that increases in public transport use are not offset by reductions in walking and cycling.	
	Low floor buses are preferred by those with mobility difficulties, and for those with other factors which reduce their mobility such as those with pushchairs, and with heavy shopping	Plan public transport for those with reduced mobility and those ‘encumbered’ by children and luggage. There is a strong potential for these groups to use appropriate public transport.	
	There is strong support for raised bus boarders, amongst all bus users		

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
Effects on public perceptions	Highly visible measures may have large impacts on public perception of public transport, walking an cycling. In any case the public will take visual cues in assessing their impression of modes	Plan measures with visual and aesthetic characteristics in mind. These can be both positive and negative depending on the mode in question	
	Any restrictions on car use in an area can lead to gridlock and seizure. Once changes are started the negative attitudes tend to be replaced by keenness for more change.	Combine physical measures with information and communication activities for increase awareness in the public.	
Energy and environment	Energy use and pollutant emissions relate very closely to car use levels.		For a reduction in the harmful effects of transport effort must be aimed primarily at reducing car use and car dependence
	The emissions from buses and energy use relate to the services offered (number and size of buses) and also, but less so, to operating conditions.	The goal of reducing environmental damage by transport by switching to use of public transport will not (in itself) reduce the emissions from public transport.	
		Reducing stop-start conditions on bus routes will aid environment	
	Noise reductions can be achieved by surface changes (where noisy) reductions in vehicle numbers and speeds		
Overall effects	The results do not show a ‘measure specific outcome’ in terms of the results. Similar measures had great success in some cities, and little in others. While some measures have little impact on the use of different modes because of their nature, the usefulness of most measures is dependent very much on how they are specified in terms of local conditions.		
	City size is not a major determining factor in determining the measures which should be initiated		

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
	City type can be of importance. Measures requiring much road space may be inappropriate in crowded historic cities where there is much competition for limited road space, while in more modern industrial cities there may be more scope for making changes. (At the same time the journey patterns which have evolved in the more modern cities may mean that measures have to be different to encourage people to change their travel behaviour).		
Research impacts and evaluation	Evaluation using common indicators is not easy to carry out in differing situations		
	The blind use of common indicators alone would not allow full evaluation of physical (or other) measures.		While some quantitative indicators are necessary for policy evaluation, audit checklist type indicators may be more valid, and allow a wider range of effects to be evaluated
	Measures take time to reach 'stability'.		Measures should not be fully evaluated until at least two years after implementation
Transferability	Comparisons of effects between cities are generally difficult, but in some seemingly unlikely cases there have been great similarities	Measures need to be carefully planned for each city	Listen to local professionals in local proposals
	Demonstration projects can be important in allowing new measures to be tested. New measures can be tried in different cities, and may be expanded in those where tried	If a policy new to a country or area is desired a small demonstration project may be helpful in finding funds and support for future measures	
	The transfer of experience between cities involved in CAPTURE has been good. Examples include transfer of technical ideas between physical measure designers and technicians.		

	Conclusion	Local Authority Recommendation	National, European, and further research recommendations
	The structure of institutions can have a major effect on the possibilities for implementation and use of facilities once built. For example bus stations and interchanges may be underused if there is no requirement for private companies to use them	The political and institutional climate needs to be assessed when considering importing measures that have been successful elsewhere.	

4.6.1 Conclusions summarised

Travel behaviour effects

- Physical measures do not in themselves generally have a major short term impact on modal split, unless the are very large scale. But this does not mean they should not be encouraged because:-

- If travel behaviour is the result of rational decisions made at various times then we would not expect a short term change when the overall changes do not significantly alter the pros and cons of each mode. But:-

  a) These smaller changes may lead to a change when people re-assess their travel decisions

  b) The studies have shown increases in PT efficiency. Change in modal split is likely to occur when other policy changes take things to a threshold level for different people.

The summary of this is that modal change will come from a package of measures in a properly thought out strategy. Physical measures are of primary importance because they affect the capacity and efficiency of public transport. To put it bluntly, you can try and persuade people to change their behaviour but if the infrastructure is lacking they will not react favourably.

Implementation Issues

The implementation of physical measures is not an easy task. The simplest conclusions are that small scale, low visibility, cheap solutions are most easily implementable. This means that a large scale ‘vision’ will be difficult to implement (but we need that vision if we are to achieve change). The implication is that a large scale vision must be made up of small easy to implement elements that fit into a jigsaw.

A wider vision for transport

On a wider level the importance of an infrastructure for public transport and the walking and cycling modes cannot be stressed too strongly. The effects of global climate change are becoming apparent at a very rapid rate, considering the phenomenon was only discussed at all widely less than ten years ago. While the cause has not yet been established as being directly as a result of human combustion of fossil fuels, it has not been disproved, and it would seem folly and self delusion of the largest kind to carry on regardless with our current rate of use of the earth’s fossil fuels. Since transport consumes some 30% of energy and is still one of the fastest growing sectors of energy use the importance of measures to reduce dependence upon the private car are of great importance. Added to the environmental arguments, it has become apparent that we cannot solve our congestion problems while allowing for a growing proportion of trips made by cars – no feasible road building programme could allow for that.

As a result we are faced with a 'necessity' to reduce car dependence, and we have learnt that a combination of measures in a carefully designed strategy is the only practicable way to reduce car dependence. The lack of success of physical and other measures has led many to champion other policies such as persuasion techniques (or Green commuter plans or Travel Awareness Campaigns) and pricing strategies. However this shift in emphasis should be set within a strategic policy conclusion that an integrated transport infrastructure is essential for people to change their travel behaviour, whether the background policy favours demand management or more softer measures.

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APPENDIX ONE IMPACTS IN EACH OF THE TEST SITES

A1.1 BRESCIA

A1.1.1 A description of the measures and the features of the test site

The city of Brescia is situated in the North of Italy. It has 200,000 inhabitants, but it reaches 400,000 including suburbs and 1 million people in the whole Province.

The test site within the CAPTURE project assessed the impact of the application of several technologies to the control and management of traffic, parking, and information systems.

Various impacts are evaluated keeping in consideration a cost/benefit analysis, the entity and type of energy savings, pollution consequences, traffic flow improvements, travelling time savings and all other possible related areas.

The test site includes the design, implementation and test of a system for giving priority to buses at junctions during latest 6 seconds of green phase. The involved area includes the urban part of the city of Brescia (around 30 km^2) and exactly 9 cross junctions equipped with local tag systems for bus recognition and microprocessor units for traffic lights control and communications with the bus control centre.

The minor part of the test site evaluates the impact of an automatic centralised monitoring of parkings in Brescia. The area covered by the trial interests the urban area of city and in particular the 2 parking areas situated close to the downtown (nearly 1,130 parking places) named Cassola and Ospedale.

The area has 170,000 vehicle trips per day which is a high level for the size of the city centre. The area contains 15% of the city’s bus stops and 25% of ASM’s total patronage.

Description of the infrastructure

The infrastructure selected for the Brescia demonstration uses the global positioning information provided by the Automatic Vehicle Monitoring system (AVM) for buses and trams.

The vehicle position using the AVM is accurate to within a range ± 60 to ± 140 metres. The AVM information is updated every 40-50 seconds (using vehicle radio polling). While the AVM accuracy is acceptable for operating the bus network, it is not accurate enough for the traffic lights to know promptly and with precision the location of the bus to instigate a bus priority phase.

In contrast, the level of precision of the Siemens analogue system (‘Nancy’) is ± 10 metres including a continuous updating of the vehicle position. However, the overall results of the Siemens system, in terms of meeting the requirements for bus priority, is no greater than 50% (information supplied by Siemens, who produced the software linking the traffic lights system and the AVM Nancy system).

The eventual choice of system for the Brescia experiment was a vehicle position system using fixed posts (coils) combined with the AVM system which selects vehicles for signal priority according to operational parameters input by the public transport operator ASM Brescia.

Using this solution, it has not been possible to continuously follow the position of each vehicle approaching signalled intersections. Instead, the method of managing the bus priority system has been limited to prolonging the signal green time.

For this reason the Brescia experiment has involved only ten junctions. The technical solution adopted for detecting buses is based, for economic reasons, on pre-existing equipment located on board the buses.

Description of the experimental system

The aim of the system was to link the bus monitoring system (AVM) with the traffic lights to provide, in certain circumstances, public transport priority through the ten intersections.

The main objective of the Brescia demonstration is to allow, as far as is possible, more regular public transport services. In this way, delays would be reduced and commercial speeds increased.

The strategy is to apply ‘selective’ vehicle priority when it is running significantly behind its schedule and depending on the importance of the route (priority coefficient).

To achieve these objectives the system was designed to:

- acquire data from the AVM system on all the buses (i.e. running condition and passenger load) and process the information to determine which vehicles to prioritise;

- transmit this information to the intersection micro-controllers (the micro-controller is a device incorporated in the traffic light regulator dedicated to the control of the intersection, where the priority command can be imposed);

- receive and process the results of the bus priority actions and store the data for historical trend analysis.

The software inside each junction micro-controller is able to detect the presence or otherwise of bus identification codes of approaching vehicles.

The ASM Brescia system is made up of transmitters (TAG) positioned on the vehicles, which cyclically transmit their own identification code, and inductive coils positioned on the carriageways close to the ten signalled intersections (as a rule approximately 50-60 metres from the stop line).

A priority coefficient that is associated with the vehicle identification code is transmitted to the intersection micro-controllers. The function of the intersection micro-controllers is to recognise the buses to be prioritised and to communicate to the signal control the request to activate a vehicle priority.

The priority coefficient is used to:

- allow the intersection micro-controller to choose which vehicle to allow priority to in cases where two or more delayed buses arrive in the vicinity of the same intersection;

- activate different types of priority commands depending on the situation of individual buses (e.g. only prolonging the green phase, providing dedicated phase, changing light phases, modifying the phases at nearby intersections, etc.).

However, in the CAPTURE experiment, the priority coefficient was not used. It was felt to be more efficient to provide the vehicles concerned with longer green phase. It would be prolonged by approximately a further 6 seconds only if the vehicle passes the detector coil within 5 seconds of the green time nominally assigned to other vehicles. This limits the changes to the traffic light cycle and therefore does not penalise other vehicles. In any other situation the system does not react because either the bus will pass through during the normal green phase or it will reach the intersection during the red phase. Lengthening the green phase by 6 seconds ensures that the buses will pass over the stop line, so saving them a waiting time at red of between 45 and 60 seconds depending on the traffic light cycles. Locating devices were already on board the vehicles, used by the Transport Section for vehicle identification when they required fuel. By using the same technology for vehicle priority, it had a significant impact in containing the demonstration costs. The roadside detector coils were connected to the micro-controllers.

The experience gained from the Brescia demonstration has brought to light some difficulties in the management and maintenance of the coils, which were often destroyed by roadworks and subsequently needed to be reconstructed. Moreover, the engineering work involved in the installation and commissioning of the equipment at the intersections was hampered due to electromagnetic disturbance induced in the coils. This impedes the correct recognition of the vehicles, a factor that would not be encountered had it been possible to install equipment in the bus garage.

This problem prompted the need to review the performance of the equipment in terms of its sensitivity. The review showed a significant failure rate in the recognition of passing vehicles. These problems resulted in significant delays to the start of the Brescia trial.

A description of the data collection process

Due to the problems with the detector coils, data collection focused on a sample of 4 equipped intersections where the vehicle detection rate was considered adequate, as shown in the table.

During the demonstration, it was decided to prolong the green phase to all vehicles where they were detected within the time window permitted rather than to give priority only to late running vehicles. This decision was taken to obtain a larger sample (and therefore statistically significant) than would have been possible with restricting the priority green phase only to those vehicles that were behind schedule.

The evaluation of the priority system also assessed the impacts on other traffic to determine the upper limits of the benefits of using it without causing undue traffic problems.

Every intersection in the demonstration included more than one bus route and therefore the priority could benefit vehicles operating on different routes.

The vehicle detection system software cannot currently collect data for the codes of the vehicles where bus priority has been activated. At the project design stage, this facility was not considered necessary, particularly given the more complex task of ensuring that the vehicle to ground transmission system was sufficiently reliable without this additional data burden. Instead, it was preferred to opt for a more streamlined data collection whereby the base station received the total number of prioritisations executed (extension of the green phase) and the detection success rate.

Due to the inability to detect specific vehicle codes and therefore bus routes, it is not possible to determine the impact of bus priority on time savings over affected routes. Any benefits, in terms of reductions in running times, are masked by delays due to traffic congestion over the survey period.

In addition, the vehicle location system only detected around 82% of routes due to technical problems arising from the lack of response to the detection coils, or the radio link between the vehicle and the base station.

By reducing the number of equipped intersections to only four, it has limited the extent to which the effects of bus priority can be measured, given that it was not possible to create a system where bus priority through a series of linked interchanges on the same route could be achieved.

Results of the analysis

Running times on the affected routes was collected in two periods in March and April 1997, the first period was characterised by the operation of the system ‘switched on’, and the second a period with the prioritisation system ‘switched off’.

For the reasons given above, a comparison between the two periods did not reveal any appreciable differences between the running times on the various routes on those stages affected by the 4 priority intersections as shown in the Figures.

The proportion of bus priority activation has been analysed relative to the number of vehicles passing each intersection. It was important to establish the probability of buses being detected when approaching intersections and the consequent activation of a priority green wave.

It was confirmed that this probability is tied to the relationship between the time window (terminal part of the green phase) in which the green prolongation is established and the overall traffic light cycle.

Depending on the intersection, an overall prioritisation percentage was obtained of between 5 and 13% with an average of 11%.

The time savings involved due to not stopping at intersections was also evaluated. Among the sample of 894 prioritised runs in the survey period, a time saving of 835 minutes can be estimated, taking into account the different traffic light cycle mean duration times at each intersection. Time savings are not significant in a small scale bus priority trial such as this.

However, the results can be considered significant when simulated to include all significant intersections on the public transport network.

An analysis was conducted of the possible effects that could be expected from extending the priority system to some seventy intersections consisting of 355 routes. Those intersections having an annual traffic volume greater than 50,000 public transport vehicles were included.

It has also been assumed that 5% of vehicles passing will be given priority, given the initial results of the trial. In addition, an average time saving for each bus priority was set at 45 seconds.

On the basis of these conservative assumptions, the simulation indicates an annual operating time saving in the region of 4,600 hours, which is some 1% of the total, and a theoretical increase in the commercial speed also in the order of one percentage point.

The savings which could be achieved by passengers in terms of overall journey times throughout a year have been calculated to be approximately 220,000 hours annually, although the average benefit to passengers on each journey (0.5 minutes) was not seen as a significant time saving. However, the average reduction in the stop times along the route would contribute to an improvement in the overall journey ‘comfort’.

Conclusions of the Brescia demonstration

The results of this Brescia trial has allowed the local CAPTURE participants to identify what the benefits could be of implementing the bus prioritisation system over the whole network of strategic intersections in the city.

The trial was strictly limited, from the design stage, by the performance of the existing equipment which could not be modified. If it could be possible to improve the vehicle locating system to within ± 10 metres range and if the vehicles themselves were able to be continuously monitored approaching intersections, then both the existing traffic light regulators and the system connecting the AVM to the micro-controllers would operate more efficiently.

If the Brescia system is to be expanded, a careful evaluation of any repercussions on other traffic on the affected routes would need to be made. In the end, a compromise would need to be reached between the needs of public transport and those of private transport, which is a political decision, outside the purely technical evaluation of this trial.

Regarding the present situation, building on the CAPTURE experience, the trials are being extended to include other city intersections. ASM Brescia are now implementing all of the 9 intersections originally scheduled. Initial results at these intersections shown that the bus detection probability, at the new intersections, is similar to the CAPTURE trial, confirming the previous results.

To extend this type of bus priority to a high frequency bus network, a new and more reliable vehicle detection technology would be required, or alternatively improve the vehicle positioning systems so as to permit a locating accuracy of not less than ± 10 metres. To achieve this objective, the present layout adopted for the vehicle detection system would need to be modified to create a system able to follow the approach phase of the vehicles nearing the intersections. This would be achieved by new methods using a dynamic type of polling to the AVM central control, combined with a positioning precision which will guarantee that any modification to the traffic light cycle will permit the public service vehicle to safely move through the intersection.

It is evident that these changes will involve the complete modification of the present AVM system. An innovative vehicle location system is needed in which a new interface between the remote bus sensing system and the traffic light controls can be set up which will allow for the continuous monitoring of prioritised vehicles when moving through signalled controlled intersections.

The CAPTURE trial in Brescia has been a limited one combining physical measures with traffic signal priority for public transport. At the end of the trial, the city have confirmed their wish to continue expanding the system. The CAPTURE trial has shown them how the system should develop and the potential pitfalls in its installation as well as operating problems such as priority routes, priority through sequences of interchanges and priority to delayed vehicles. A significant expansion of the system will depend on more fundamental political decisions on the extent to which the needs of a more efficient public transport network take priority over the disbenefits that could occur to other traffic on the road network.

A1.2 BUCHAREST

Bucharest, the Romanian capital has a population of 2.35 million inhabitants, distributed on an administrated area of 719 sq. km, including suburbs. The real conurbation surface is 228 sq. km and comprises 2 million inhabitants. The largest Romanian city and the main political and administrative centre can be seen, from the urban and traffic point of view, split into three concentric areas well defined:

- central area – an area of public, political and administrative institutions and residential zones
- median area – with mainly residential destination and some industrials and commercial enterprises
- peripheral area – large zones of block of flats and important industrial enterprises

Due to this configuration, with large distances between the residential areas and business areas (often opposite), the percentage of the pedestrian trips is low (approximately 5%) and the majority are using the surface and underground public transport means.

The poor tradition of bicycle trips is the reason for non-existing special bicycle lanes in Bucharest. The total number of motorised vehicles has increased by 39% from 1990 till present. In 1995 the motorised vehicle number was 212/1000 inhabitants and the cars number was 170/1000 inhabitants.

In the last few years a characteristic of the Bucharest traffic was the increase of the congestion rate due to the increase of the motorisation level. This has had a direct effect of decreasing the general travel speed.

The main objective for the Municipality is to maintain a high percentage of the public transport usage within the total Bucharest transportation. In order to achieve this objective, the Municipality is looking to increase the service quality, to reduce the traffic jam on the roads where public transport is involved, to increase traffic safety and the intermodal co-ordination.

Taking into account RATB proposals based on the technical solutions submitted by the Institute of Urban Design – PROED (as subcontractor) and after several technical meetings, the Municipality approved a set of feasible technical solutions of high importance for the public transport efficiency. At the beginning, the physical measures had to be implemented on certain restricted areas. According to the results of the CAPTURE impact analyse, the measures can be extended to the whole urban area.

A1.2.1 Description of the capture measures and the test site

The CAPTURE demonstration in Bucharest comprised the following elements:

1. *Iuliu Maniu* Blvd. - introducing 2 trolley lines on a 4.2 kms long corridor;
2. *Unirii* Square - implementing a roundabout system with bus lay-bys;
3. *Unirii* Blvd. - implementing a public transport lane on one side of a 600 metres corridor together with stop platform facilities;

4. *Elisabeta* Blvd. - implementing a public transport lane on contra-flow on a 1 km long corridor.

The initial plan for the CAPTURE demonstration included additional elements: the regulation of on-street parking, green light priority for public transport on *Maniu* corridor, a longer exclusive public transport lane on *Unirii* corridor and interchanges between surface and underground public transport.

Due to several problems encountered since the beginning of the project some elements had to be abandoned, smaller schemes had to be adopted, and a new corridor (*Elisabeta* Blvd.) was substituted in order to maintain a high level of impact from the CAPTURE measures. The problems encountered included:

- a Governmental crisis which also precipitated a local council crisis (the position of Prime Minister and General Mayor of Bucharest were assigned to the same person); as a consequence local elections had to be organised;
- political pressure from different interest groups within the Municipality;
- the refusal of the Traffic Police Department to sustain law enforcement when introducing the physical measures;
- a lack of public money.

The main goals of the Bucharest schemes relate to:

- maintaining the high level of public transport modal split against the car;
- improving the performance of public transport;
- passenger time savings;
- reducing congestion;
- enhancing environmental quality and safety conditions.

Unirii Blvd. is an important radial corridor linking the city centre with several residential areas in Bucharest. The corridor is a fairly new boulevard with banks and foreign companies located there together with residential zones that are rapidly developing. The exclusive bus lane was initially designed (and introduced) on the whole corridor (2 kms long with 3 additional traffic lanes in both directions and 3 major junctions). However, it was removed after only two days for a variety of subjective reasons. The measure had been approved several times by the Municipality, which understood the importance of such a measure on this corridor, but each time it was obstructed by the Traffic Police Department (which has right of veto in the Commission of Traffic Control and Safety). After a year of intense lobbying and frequent meetings with the local authorities and the Traffic Police, a compromise was made. The bus lane was introduced only on a segment of the corridor (0.6 kms) and only for a test period (3-4 months). The bus lane was finally implemented on 6 June 1998. Five bus routes are travelling along this segment with stops at the start and end of it and with platforms connected to the kerb by alleys and traffic lights on both ends.

Unirii Square is the most complex traffic junction in Bucharest. Located downtown, in an important shopping and business zone, the 0.8 sq. kms area is linked with *Unirii* Blvd., the CAPTURE site described above. Eleven streets radially enter this junction from all over the city. Large vehicle flows cross the square every day, with public transport buses on every side. On the north-south direction, an underpass crosses the square, ensuring that all the traffic on this axis flows under the function. With 2 to 5 lanes (depending on street width and traffic flows) and 2 lay-bys for bus stops, the Square has a large roundabout bisected by a road running from east to west. The second phase, designed to eliminate this road across the roundabout and to create facilities for pedestrians, will not be implemented due to the lack of money.

Maniu Blvd. is a 4.2 kms long corridor representing the main exit from Bucharest on the west side of the city. The corridor crosses an important residential district with more than 150,000 inhabitants. Both directions have 3 lanes of 3.5 m wide carriageway for general traffic (i.e. both private and public transport) and a 2.5 m lane next to the kerb, used for parking. The plan was designed to include the implementation of a trolley-bus system (i.e. an environmental-friendly transport system), exclusive bus lanes together with priority at traffic lights for all public transport on the corridor, combined with the rearrangement of on-street parking. Unfortunately, due to poor management at the local level, and without any planning, below-street repairs of the water network started along the whole corridor. As a result, no exclusive lane will be implemented for the time being. The only physical measure introduced was the trolley-bus line.

A supplementary physical measure introduced as part of the CAPTURE demonstration was the exclusive lane for public transport on a contra-flow section along *Elisabeta* corridor. The measure is part of a one-way system designed and implemented in central Bucharest, including important shopping, leisure and business areas. The 1 km long corridor has 3 lanes for general traffic on a one-way system (i.e. private cars and public transport) and one lane on a contra-flow basis for trolley-buses and buses. Signs to limit traffic speeds have also been installed.

A1.2.2 Findings specific to Bucharest

1. *Maniu* corridor

On 6 October 1996 a trolley-bus line was implemented on this corridor as a response to popular demand from the passengers in the *Maniu* residential area. After almost a year, another trolley line was implemented on the same network (although the route was different, both lines were crossing *Maniu* corridor).

Surveys of traffic and bus times were carried out by RATB in the morning peak hour of a weekday, in normal weather conditions.

The results showed a decrease in the average speed of public transport vehicles on the direction to the city centre after both lines were implemented (the first line has a frequency of 7.79 vehicle/hour/direction and the second one 12.19 veh/hour/direction). The planned exclusive bus lane has not yet been implemented so traffic remains slow on the corridor. In the outward direction, due to the fact that not so many vehicles are coming from the centre to the residential zone in the morning peak, the average speed was higher, shown in the Table below.

Table A1.2.1: Average public transport vehicle speed on Maniu corridor

	Before	After
Direction (Inbound) *Valea Cascadelor* - *Leul* Square	20.13	18.66
Direction (Outbound) *Leul* Square - *Valea Cascadelor*	20.20	21.74

The passenger capacity increased by 45% after introducing two lines and not 11% as it was previously forecast with one line.

Table A1.2.2: Passenger capacity on Maniu corridor

	Before	Intermediate	After
passenger capacity (persons/hour/direction)	4.350	5.800	6.313

Comparing the 'before' situation (June 1996) with the 'after' situation (October 1997), it may be concluded that the percentage of public transport vehicles on the corridor increased from 11% to 15% in one direction (to the city centre in the morning) and fell from 22% to 20% for the other direction. While fewer buses are running, they have been replaced with trolley-buses. The percentage of taxis has increased dramatically. A possible reason for this may be that a METRO supermarket has recently been opened and persons buying goods from there are transporting them by taxi.

Table A1.2.3: Vehicle modal split in the direction to the city centre

modal split %	Before	Intermediate	After
car	68	54	57
bus	11	6	9
trolley-bus	0	4	6
goods vehicle	12	24	15
emergency vehicles	0	0	0
cycles	0	0	0
taxi	9	12	13

Table A1.2.4: Vehicle modal split in the outbound direction

modal split %	Before	Intermediate	After
car	56	54	56
bus	22	10	15
trolley-bus	0	4	5
goods vehicle	20	23	14
emergency vehicles	0	0	1
cycles	0	0	0

taxi	1	8	9

The share of private cars for inbound trips actually fell from 68% to 57%. At the same time, the number of persons travelling by the metro along the corridor fell to 6% per day. A possible explanation could be that some private car users and metro users preferred the new trolley-buses.

On both inbound and outbound journeys, the number of passengers carried along the corridor by public transport increased by 85% and 54% respectively, as shown in the Table below..

Table A1.2.5: Passenger flows

passengers carried per hour	Before	Intermediate	After
Direction (Inbound) *Valea Cascadelor* - *Leul* Square	3,295	5,650	6,094
Direction (Outbound) *Leul* Square - *Valea Cascadelor*	2,403	3,198	3,705

The average energy consumed per vehicle-km per hour for public transport vehicles has decreased by 3% from 0.3 to 0.29 kg conventional fuel. The average energy per passenger-km per hour decreased by 41.14% (from 0.000209 to 0.000123 kg conventional fuel), largely as a result of the increase in patronage.

According to the data obtained by PROED from the special laboratory of the Municipality, the pollution levels after introducing trolley-bus lines are compared with the national standards.

Table A1.2.6: Pollutant emissions

	After levels	National levels
SO_2	0.111	0.750
H_2S	0.099	0.015
NO_2	0.216	0.300
CO	8.550	6.000
O_3	0.000	0.100
Dust	0.570	0.100

It can be seen that the levels of H_2S, CO and dust are higher than admissible national standards and by a considerable margin.

Despite the benefits of introducing trolley-buses, the total number of accidents on the corridor increased dramatically by 135% in 1997 compared with 1996. The highest growth occurred in those receiving light and serious injuries (295% and 180% respectively).

Table A1.2.7 - Accident levels

	Before	After
fatal accidents	5	2
serious injuries	10	28
light injuries	20	79
traffic collisions	39	65

This phenomenon can be explained by the growth of passenger numbers when trolley-buses were introduced. The CAPTURE team conclude that there is a need for an exclusive public transport with lane signal priority and also to regulate the on street parking.

2. *Unirii* square

Since the CAPTURE demonstration was implemented on 25 October 1996, average speeds on the roundabout have increased by 25% due to both a new computer system which reduces the traffic signal cycle from 150 seconds maximum to 110 seconds maximum at some point, and to an increase in the number of lanes (from 2 to 4 and 3 to 5 - the side roads have been changed into one-way roads).

The time taken to cross the Square is as follows:

Table A1.2.8: Time taken to cross Unirii Square

Direction	Percentage time reduction
North-South	62%
West-East (using the road across the roundabout)	45%
West-East (going round the roundabout)	28%

The North-South decrease in crossing time (62%) was a result of the traffic using the new underpass.

There were no major changes in the vehicle modal split after introducing the roundabout in the Square: the total number of vehicles crossing the Square remained almost the same. The traffic surveys were undertaken at 7 points around the Square of which only 5 had public transport flows.

The overall number of vehicles crossing the Square decreased by 15% from 12,723 to 10,879 due to the new underpass.

The public transport route has improved by eliminating a left turning at one of the major crossings (near *Unirii* Blvd.). In this way the traffic conflicts between RATB buses and other vehicles fell from 80 to 21 per year at this point after introducing the roundabout system (a reduction of 73%). By creating a lay-by for buses near the metro station, the number of person accidents fell by 67% (the pedestrians were no longer obliged to cross the street to get to the metro station).

The introduction of a roundabout at a major central intersection meant an improvement for buses crossing the Square in terms of the average speed and the crossing time. There have also been safety benefits for both cars and pedestrians. In this way all parties are seen to have benefited from the physical measure.

3. *Unirii* corridor* (segment *Mircea Voda - Bratianu*)

The traffic counts and bus timings were undertaken on the corridor in June 1997 (before) and again in June 1998 (after), both in a weekday, morning peak, under normal weather conditions (23°C). Five bus routes were operating along the corridor in both the 'before' and 'after' situations.

Table A1.2.9: Operational Characteristics - Unirii Boulevard

	Before (June 1997)	After (June 1998)
bus frequency (no. of vehicles/hour/direction)	98	89
average speed of bus travel on corridor (km/hour)	12.5	27.0
RATB average speed in Bucharest (km/hour)	16.5	16.7
trip time (seconds)	180	78

The average speed of buses along the corridor more than doubled, increasing by 116% compared with the 'before' situation. Considering the average bus speed in Bucharest (approximately 16.7 km/hour from RATB statistical data), the negative situation before the trial (with 4 km/hour less on the corridor than the RATB average) has changed, becoming faster than the city average by over 10 km/hour. In this way, the trip time in the trial segment fell by 56% or 102 seconds.

The mean bus frequency decreased largely because one route ran on a longer route with the same fleet size, and a number of buses operating on other routes were redistributed.

Table A1.2.10: Modal split, Unirii Boulevard

modal split (standard vehicles)	Before		After	
bus	154	10.4 %	113	5 %
car	1,127	76.0 %	1,066	51 %
goods vehicles	78	5.3 %	445	21 %
taxi	121	8.2 %	463	23 %
2-wheel vehicles	1	0.1 %	3	0 %
total	1,481	100 %	2,090	100 %

* the after surveys were performed only 3 days after implementing the bus lane on the corridor. The general traffic has not yet adapted to the new measure.

During the CAPTURE demonstration, the total number of vehicles increased by 41%. The decrease in public transport vehicles by half is due to the decrease in bus fleet serving the 5 lines operating on the corridor. In the 'after' survey, the goods vehicle traffic has increased almost 6 times and taxis almost 4 times compared to the 'before' situation. One of the causes for this could be the business area development in the zone.

Table A1.2.11: Energy use, Unirii Boulevard

	Before	After
average energy per vehicle-km/day (kg conventional fuel)	21.3	20.5

The energy used per vehicle-km has decreased by 3.75 %.

It was not possible to do a safety evaluation because of a shortage of time from introducing the measure. The police data is not yet available.

An interview with specialists and decision-makers in the transport field was undertaken by RATB on a sample of 47 people, of which 85% were travelling on *Unirii* corridor, and 75% travelling using their own car. All respondents agreed with the CAPTURE measures, whether they had a car or not: 46.8% had no objection to the measure the 53.2% partially agreed with them.

The immediate advantage of introducing the bus lane is that after one week from introducing the measure, there was an increase in average speed of buses and decrease in trip times per route segment. The bus lane is implemented on a third of the whole corridor length. The physical measure is implemented on too small a scale to affect, in any way, the passenger modal split or the traffic behaviour of car drivers on the rest of the corridor or in the vicinity.

The measure could be effective on a larger scale and for a longer period, causing changes in travel behaviour. Additional law enforcement powers would also assist the system. The Traffic Police Department currently doesn't have the legal framework to apply a traffic violation fine. Furthermore, the measures on this segment would be more effective if combined with 'green light' priority for buses. If the results remain satisfactory, it is possible that the bus lane will be extended to the whole corridor.

4. *Elisabeta* corridor

The contra-flow exclusive bus lane was implemented on May 2nd 1997 together with the one-way system in the city centre. Traffic surveys were performed 'before' (in May-June 1996) and after (June 1997) by RATB and PROED SA.

The average speed of public transport on the exclusive bus lane increased by 51% and the vehicle frequency by 28.12% per hour and direction.

Table A1.2.12: Operational characteristics, Elisabeta Corridor

	Before	After
average speed (km/hour)	10.6	16.0

frequency (veh/hour/direction)	82.5	105.7

After introducing the contra flow bus lane, the number of cars overall increased by 25%. However, with 3 lanes operating, the number of cars per lane is in fact 16% lower than before. The general traffic lane is more used than before, meaning that the one-way system is working.

Table A1.2.13: Car traffic, Elisabeta corridor

	Before	After
Car numbers on the general traffic lane	6,481	8,148
Car numbers per lane	3,241	2,716

The energy used per vehicle-km measured in kg conventional fuel was calculated only for RATB vehicles.

Table A1.2.14: Energy use, Elisabeta corridor

	Before	After
energy per veh-km (public transport)	2.04	1.68

It registered a fall of 17.64%, underlining the benefits of the contra flow lane to bus operating costs.

Regarding pollution, the 'after' levels are compared with the national standards.

Table A1.2.15: Pollution levels, Elisabeta Corridor

	After levels	National levels
SO_2	0.089	0.750
H_2S	0.034	0.015
NO_2	0.193	0.300
CO	6.325	6.000
O_3	0.016	0.100
Dust	0.096	0.100

The levels of H_2S and CO are higher than the national levels by 56% and 5% respectively.

For safety issues, the contra flow lane was compared with the 'before' situation. The Police statistics showed 38 traffic collisions in the 'before' situation and none since.

Perception of different transport modes in Bucharest

RATB performed an attitudinal survey, using the CAPTURE methodology, to a sample of 50 persons to assess the perception of public transport quality among transport modes. The respondents split into 2 categories - persons with and without cars. Despite this, 94% of respondents travel by public transport; of these, 42% are using public transport every day and 22% use it 2-3 times a week.

The respondents were asked about their perception of different transport modes in Bucharest. The private car was seen as the most relaxing mode of transport, followed by walking. Public transport modes (bus, tram, trolley-bus) were regarded as neither relaxing nor difficult. The mode of transport ranked 'easiest' was walking; car and bus are 'quite easy'. The most economical modes are again walking and bicycle, relative to cars that are regarded as 'expensive' and 'very expensive'. Public transport modes are neither inexpensive nor expensive. Concerning punctuality, the car has the highest marking and bus, tram and trolley-bus the lowest. The fastest way of travel is considered to be the car, the second position being held by metro and bus, and only after this, the tram. The slowest public transport mode is seen as the trolley-bus. Regarding safety aspects, all of the motorised modes are seen as being of medium risk (with a higher quotation for tram and trolley-bus), but the safest mode is walking. An interesting aspect is that bicycle is regarded as a dangerous mode because there are no bicycle lanes in Bucharest. The most environmentally friendly mode is seen as walking. Car and bus are regarded as the most polluting modes while tram, trolley-bus and metro are considered 'ecological'. The last aspect studied was comfort. The most comfortable mode was the car, bus and metro are ranked as medium comfort, the last position being held by tram and trolley-bus.

Overall conclusion of the effectiveness of the CAPTURE demonstration

In the Bucharest context, and compared with the situation before CAPTURE, all of the measures implemented under the CAPTURE project have been a success. At least two or three key success indicators are improved compared to the 'before' situation.

The real gain for the city is that the CAPTURE project represents a start. These kind of measures were introduced for the first time in Bucharest. The bus lane is a success even if on a small scale. A better enforcement of measures would bring better results and effectiveness. For the first time, the Traffic Police saw the necessity of introducing regulations and penalties for not respecting the physical measures applied to public transport (it was proposed to change the Road Code in Parliament for theses kinds of measures).

The CAPTURE demonstration, even if not at the scale it was originally planned, represented a start and a break point for the Bucharest Municipality which is now more aware of the need for physical measures to improve the effectiveness of public transport in the city. The important next step is to further encourage an attitude shift among the authority, passengers and car users, building on the positive results of CAPTURE. There is considerable road space and scope to extend CAPTURE measures across the city to assist the regeneration process and to prevent the further growth in car use.

A1.3 COPENHAGEN

A1.3.1 Description of measures and test site

The project in Copenhagen used as a demonstration project in CAPTURE, is named PrioBus and is being implemented gradually on several bus lines.

The specific Copenhagen test site is a radial corridor from the centre of the city, stretching 4 km through the island of Amager. The traffic condition in this area is very congested, with an AADT of about 30.000 vehicles. There is a high volume of bicycles on the existing bicycle lanes, about 12.000 AADT.

Description of the physical measures

The existing bus lanes have been extended from a total of 2.3 km to 3.9 km. The width of the bus lane is 3.0 - 4.5 metres, with the widest sections where bicycles are allowed in the bus lanes. Bus lanes are separated by a 30 centimetre white painted line, and the word BUS painted on the road surface.

At the bus stops there are real time information poles and improved shelters for the waiting passengers.

On board the buses there are real time information displayed for passengers and bus drivers. It is also possible to obtain green light at traffic signals, if the buses are delayed.

Objectives of the Copenhagen project

By improving the physical conditions for buses and the service level for the bus passengers, it is expected that the passenger volume will increase.

As a demonstration project it is also an objective to use the results in further extensions in other corridors in the city of Copenhagen, and hereby expand the bus priority and real time information system to the whole city.

Surveys

The following surveys have been, or will be carried out before and after implementation of the PrioBus system:

- Traffic counting of bus passengers, cars and bicycles;
- Interviews with bus passengers, bus drivers, car drivers, bicycle riders and shop owners;
- Passability for buses and cars;
- Accidents among bus passengers and drivers, car drivers, cyclists and pedestrians;
- Productivity;
- Regularity;
- Parking analysis for cars and counting of parked bicycles;
- Environmental effects.

From the results of the surveys the following effects will be examined:

- Operational efficiency;
- Modal shift;
- Environmental effects;
- Economic effects;
- Safety.

All the 'before' and 'after' surveys have been undertaken, except interviews with bus passengers at bus stops.

A1.3.2 Findings specific to Copenhagen

Preliminary qualitative impression results

Passengers are satisfied with the dynamic real time information systems and with the physical improvements at bus stops.

Bus drivers are satisfied with the extension of the bus lanes, the priority system at traffic signalised intersections and the display system in the buses, that shows deviations from the timetable.

The service level for the individual transport modes has decreased.

Preliminary findings from the surveys

The mean speed of car travel (peak hour) has reduced from 24.4 to 17.6 km/h, or by 28%. The level of car traffic on the route (on a typical day) has dropped by 13%.

The mean speed for buses (same period and direction of travel) has reduced from 15.7 to 16.5 kph. or by 5%. The total number of boarding bus passengers from all bus stops on the test site has increased by 3%.

The modal split indicates, that the bus percentage has increased from 2.8 to 3.4 %, while the car percentage has decreased from 52.0 to 48.0 % and the bicycle percentage has increased from 33.6 to 36.9 %.

A1.3.3 Conclusions

- Passengers - both in buses and waiting at bus stops - are very satisfied with the dynamic real time information systems and the physical improvements at bus stops.

- Bus drivers regard the extension of bus lanes - together with the bus priority system at traffic signalised intersections and the display system in the buses to show deviations from the timetable - as an important support to improve regularity.

- New bus lanes taken out of existing road and parking capacity has improved public transport, and has lowered the service level for the individual transport modes.

A1.4 GREATER MANCHESTER

A1.4.1 A description of the CAPTURE measures and the test site

Greater Manchester is a large conurbation with a population of over 2.5 million people in an area of approximately 1300 square kilometres. It consists of ten administrative districts, with Manchester as the regional centre. The CAPTURE demonstration site forms part of a major radial corridor to the west of Manchester city centre. The CAPTURE corridor, known as the A576 Eccles New Road, forms the central part of this strategic route. The corridor runs through a predominantly residential area, with other key land uses being Hope Hospital (a major accident, emergency and specialist hospital) and Pendleton shopping centre, which is situated at the eastern end of the corridor.

The purpose of the demonstration project was to trial a number of low-cost measures to improve the quality and efficiency of travel by bus with a view to extending the approach across the conurbation if successful. The objective of the project was to influence modal choice in favour of the bus and halt the decline in bus patronage. A number of measures were introduced to improve:

- operational conditions (namely bus lanes and signal priority for buses);

- the passenger waiting area (new bus shelters, bus boarders and raised kerbs at bus stops); and

- the vehicle (through the introduction of new low floor buses)

Improvements to the passenger waiting environment were also examined, with trials of bus boarders in other corridors and measures to introduce safe and secure waiting rooms at bus stations to improve personal safety for passengers, particularly in the evening.

The project was promoted by Greater Manchester Passenger Transport Executive (GMPTE), the body responsible for implementing public transport policy in the county. The other partners in the project were Salford City Council, who as the Highway Authority are responsible for on-highway bus priority measures and for works to footways, and Stagecoach, one of the main bus operators, who introduced new low floor buses on one of the routes using the corridor.

A1.4.2 Surveys

A survey programme examined the following:

(i) Operational efficiency	-	surveys of bus and car journey times
(ii) Changes in travel modes used	-	bus passenger loading counts
	-	traffic counts (links and junctions)
	-	car occupancy counts
(iii) Accessibility issues	-	boarding and alighting counts by type of passenger

		passenger interview surveys at bus stops
(iv) Attitudes of users	-	passenger surveys at bus stops and bus stations
(v) Environmental issues	-	calculated from other data for air quality / energy
	-	analysis of continuous accident records

A1.4.3 Findings specific to Greater Manchester

Patronage change on low floor buses

In addition to the CAPTURE corridor, low floor buses have been introduced on a number of other routes in Greater Manchester. An analysis has been undertaken comparing patronage on low floor buses with that on standard buses operating on the same route. The analysis eliminates the differences caused by factors such as long term patronage changes or changes in the services run by other operators. Electronic Ticket Machine data for three routes was analysed as shown in Table A1.4.1. Actual patronage figures cannot be shown because of an agreement with bus operators regarding the commercial confidentiality of ETM data.

Table A1.4.1: Greater Manchester Patronage Comparison

Service No	Low Floor Bus Journeys Sampled	Non Low Floor Bus Journeys Sampled	% Change in Patronage on Low Floor Buses
42	209	400	+9%
19	2,433	2,917	+9%
M10	222	971	+10%

It should be noted that the M10 bus route, where patronage is 10% higher on the low floor buses, compared to 9% higher on the other two corridors, is the CAPTURE demonstration corridor where, in addition to the introduction of low floor buses, there have also been a number of complementary improvements to the footway to make it easier to use the low floor buses.

A more detailed on-bus boarding and alighting survey of the M10 route has been carried out. This survey also recorded the type of passenger using the buses. The survey confirmed the higher patronage levels using low floor buses (shown as 13% in this survey), but more significantly showed the extent to which people with restricted mobility prefer these buses. See table A1.4.2.

Table A1.4.2: Passengers with buggies etc

	Pax with Buggies	%	Pax with Trolleys	%	Wheelchair Pax	%
All Buses	113	0.99	53	0.46	3	0.03
On Low Floor Bus	67	2.03	16	0.48	3	0.09
On Non Low Floor Bus	46	0.57	37	0.46	0	0.00
Difference		258%		6%		-

Bus boarder surveys

Interview surveys have been carried out with passengers at the raised bus boarders at Pendleton Shopping Centre, and at two other locations where bus boarders have been constructed. Table A1.4.3 shows responses at the raised bus boarders. From this it is clear that there is a high level of satisfaction with the raised boarders.

Table 1.4.3: Passenger Views on Raised Bus Boarders shown as a %

	Much better	Slightly better	About the same	Slightly worse	Much worse	Don't know
All Respondents	35	21	15	2	3	24
Excluding Don't Knows	46	28	19	3	4	-

Similar views were reported by passengers at the other locations. See table A1.4.4. At these stops the extent to which passengers experienced problems at the stop, and the nature of those problems was also examined. At the Newport Street stops in Bolton town centre 17% of passengers reported problems in boarding buses before the bus boarder was constructed and this reduced to 12% in the 'after' surveys. At the four bus boarders on Reddish Road in Stockport area, 29% of passengers reported problems in the 'before' surveys and this fell to only 9% in the 'after' surveys. The biggest single reported problem was parked cars. This accounted for 33% of the complaints in the 'before' surveys but fell to 14% of complaints in the 'after' surveys. This indicates the effectiveness of bus boarders.

Table A1.4.4: Passenger Views on Bus Boarders shown as a %

All respondents

	Much Better	Little Better	Same	Little Worse	Much Worse	Don't Know
Newport St 1	25	25	17	1	4	27
Newport St 2	35	20	8	-	2	35
Reddish Rd	39	18	12	6	9	16
Average	35	18	13	3	4	27

Excluding Don't Knows

	Much Better	Little Better	Same	Little Worse	Much Worse
Newport St 1	35	35	23	1	6
Newport St 2	54	31	12	-	3
Reddish Rd	46	22	14	7	11
Average	45	29	16	3	7

It should be noted that improving accessibility at bus stops is not only a social benefit for those passengers with mobility difficulties, but it also gives operational benefits where passenger boarding times can be reduced. The effectiveness of bus boarders in removing the parked car problem, so allowing buses to get to the kerbside at bus stops more easily and removing the need for passengers to have to manoeuvre between parked cars to board the bus, is a good example of this.

Bus station surveys

Interview surveys were carried out with passengers using 3 the new passenger waiting areas, which incorporate glass screens and automatic doors. Two of the waiting areas are at Bury bus station and the third is at Bolton bus station.

Passengers were asked to rate various attributes using a 4 point scale, where:

1 = poor
2 = adequate
3 = good
4 = very good

Table A1.4.5 shows how passengers rated the 3 waiting rooms.

Table A1.4.5: Passenger Rating of Waiting Rooms

	Bolton	**Bury (Stand R)**	**Bury (Stand S)**	**Mean**
Cleanliness	2.90	2.87	2.83	2.87
Lighting	2.95	3.28	2.98	3.07
Temperature	2.43	2.50	2.53	2.49
Draughtproof	2.38	2.29	2.21	2.29
Comfort	2.47	2.91	2.53	2.64
Fume Free	2.73	3.0	2.98	2.90
Safety	2.64	2.93	2.94	2.84
Position in Bus Station	2.93	3.12	3.00	3.02
Sample	58	77	30	165

Virtually all the scores were in the range 2-3, meaning passengers rated the facilities adequate to good. Suggestions were made for improving the waiting rooms, mainly relating to the need for heating (12%) and more comfortable seats (12%). This probably reflects the low cost nature of the schemes. The extension of the waiting rooms to other parts of the bus station was suggested by 9% of people, which suggests that they liked the improvements.

Of those interviewed, 21% said that the waiting rooms would encourage them to make more journeys by bus.

Operational efficiency - bus lanes

Comparative surveys of car and bus journey times were carried out in April 1998 on the section of the demonstration corridor between Pendleton shopping centre and Manchester

City centre, where during the course of the CAPTURE project sections of an existing bus lane have been extended.

Tables A1.4.6 and A1.4.7 show the average car and bus journey times inbound during the morning peak and outbound during the evening peak. The adjusted bus journey time figure is the total bus journey time less the dwell time at the bus stops. It is the adjusted bus journey time figure that has been used for comparison with the car journey times.

Table A1.4.6: Operational Efficiency Inbound AM Peak (07.00-10.00)

	Route A	Route B
Average car journey time	7.48	7.09
Average bus journey time	8.3	8.03
Average adjusted bus journey time	7.05	6.34
Difference by bus	0.43+	0.35+
Maximum difference by bus	3.51+	3.02+

Table A1.4.7: Operational Efficiency Outbound PM Peak (15.30-18.30)

	Route A	Route B
Average car journey time	8.31	7.46
Average bus journey time	8.26	7.16
Average adjusted bus journey time	6.39	5.55
Difference by bus	1.52+	1.51+
Maximum difference by bus	8.07+	4.36+

The time when buses gain the most advantage from the bus lanes is outbound during the evening peak. Even allowing for the dwell time at bus stops, the bus is quicker than the car over the full 3 hour period. During the height of the evening peak the journey time benefits by bus are very obvious. Inbound the adjusted bus journey times are quicker than the car, particularly at the height of the morning peak.

The variation in journey times for buses is less than that for cars. Again this was more noticeable outbound where the range for the adjusted bus journey time was from a quickest journey time of 5min 32sec up to a slowest of 8min 3sec, a variation of 45%. For cars, the range is from a quickest journey time of 5min 10sec. to a slowest of 15min 41sec, a variation of over 300%.

A1.4.4 A summary of the findings

(i) The introduction of low floor buses has generated additional patronage with some evidence that patronage gain is higher where complementary measures at bus stops have been introduced;

(ii) There is clear evidence that passengers with restricted mobility, such as those pushing child buggies, are choosing to use low floor buses rather than standard floor buses;

(iii) Passengers have expressed support for both the bus boarders and the raised bus boarders;

(iv) There are operational efficiency benefits from the bus lanes both in terms of improvements in overall journey times and the improved regularity and reliability of service.

(v) Passengers approve of the improved waiting facilities at bus stations and there is some indication that they may encourage more bus journeys

But ....

Delays in the implementation of bus lanes and signal priorities have meant that “after” surveys could not be completed in time for inclusion in this report. However, interim “after” surveys to show the impact of the completed bus lanes will be carried out in January 1999, with full “after” surveys following as soon as the signal priority schemes are fully operational. Results available by the end of March 1999 will be published in a supplementary report.

The CAPTURE project has provided a major impetus to the introduction of similar schemes elsewhere in the county. The Greater Manchester authorities have now embarked on a programme of introducing bus priority on 20 major corridors. This will be combined with other improvements to buses, bus services, stops, shelters and passenger information. On the CAPTURE corridor itself, the measures will be extended to cover the whole of the radial route. Major bus operators have seen the advantages of such schemes, and are now making financial contributions to fund bus priority as well as fitting transponders to their fleets and investing more money in low floor buses. On the CAPTURE corridor, First Manchester, the other major bus operator, introduced new low floor buses on the route as a consequence of the investment made in bus priority.

A1.5 LONDON

A1.5.1 A summary of the CAPTURE corridor proposals

In the Central Sector, which covers the main commercial centre of London, one of the first corridors to be studied as part of the London Bus Priority Network was along the bus routes 68 and 168. This corridor stretches from Hampstead in the north of London to Norwood in the south running through the areas of Camden, Holborn, Waterloo, Elephant and Camberwell. The CAPTURE test site was the section between Camden and Camberwell.

The London Bus Priority Network was designed to a number of objectives as given below:

- to improve, in particular, the conditions, and reliability, of bus operations on major bus routes through the introduction of appropriate bus priority measures and the enforcement of obstructive parking utilising and, where necessary, the removal of offending vehicles;
- to establish and implement the co-ordinated and coherent application of waiting, parking, and loading enforcement regimes on major bus routes;
- to improve conditions for all road users and frontages on major bus routes by reducing congestion;
- to improve road safety generally and, in particular, for pedestrians and cyclists on important local roads by enhancing the attractiveness of bus operations on major bus routes;
- to alter the traffic balance in favour of buses at those locations on major bus routes where this can be properly justified;
- to improve conditions for bus passengers at stops and interchanges along major bus routes;
- to provide improved opportunity for passengers to use bus services for longer journeys.

As this corridor was one of the first to be studied it was expected that it would also be amongst the first with major schemes to be implemented.

Unfortunately, this was not to be the case in practice. There are many other corridors in London where we have implemented substantial amounts of bus priority schemes, but this has depended on the willingness of the local authorities to implement schemes. The 33 local authorities in London are each separate entities with their sets of officials and elected members, and so institutional difficulties can cause delays.

Table A1.5.1: Bus priority measures on the corridor

Borough	Road	Scheme	Implemented
Camden	Camden High Street	Footway buildout, signal scheme	Implemented
Camden	Castlehaven Road/ Hawley Road	With flow bus lanes and pre-signal	May be implemented Later
Camden	Camden Street	Off-side with flow bus lane	Later
Camden	Euston Bus Station	Refurbishment and improvements	Implemented
Camden	Russell Square/ Southampton Row	Contra flow and with flow bus lanes	Under Review

	Southampton Row		
Camden	Kingsway	Footway buildout	Implemented
Camden	Kingsway	Banned right turn	Implemented
Westminster	Aldwych	Remodel bus facilities - more direct route	New study to be undertaken as part of the 1998/99 LBPN
Lambeth	Waterloo Station	New interchange facility	Under review
Lambeth	Waterloo Road	Modified waiting/ loading restrictions	Under review
Southwark	Walworth Road/ Camberwell Road	Queue relocation, pre-signal	Redesign taking place
All	All bus stops	24 hour clearway, new shelter & stop	Some completed

A1.5.2 A summary of the survey results

Two main parts of the corridor have been studied in more detail as it was expected that there would have been major bus priority schemes implemented. These were at Camberwell Road and Camden High Street.

There have been three main sets of surveys, the first in June 1994, the second in June 1997 and the final set undertaken in June 1998. The main analysis is of the Camden High Street measure, a busy shopping area in Inner North London.

Camden High Street

This scheme was implemented in order to manage traffic in a more orderly manner in this busy shopping street. It comprised kerb build outs, and better designation of available road space into loading/servicing areas, bus stopping places, and through traffic. At weekends there is a very heavy pedestrian flow due to the popular Camden Market. The waiting and loading, both legal and illegal, tended to obstruct both the free running of traffic including buses, and also led to pedestrian problems, with people being crowded or spilling onto the roadway.

Implementation commenced in February 1997, and the works were broadly completed by September 1997. All works were completed by February 1998.

The scheme was only in part of Camden High Street, namely the one-way northbound section from Parkway to Castlehaven Road, a distance of about 360 metres. All traffic data relate to this one way section of road.

Results - travel modes used

In the 1994 surveys, 34% of people on Camden High Street were travelling by bus. Buses only comprised 3% of the traffic flow in the afternoon peak period, showing the efficiency of buses in moving a third of travellers in 3% of the vehicles. Bus loadings are taken from LT BODS surveys.

Table A1.5.2: Camden 1994 modal split survey results

1994	Total	Cars	Heavy Goods	Buses	Cycles
AM 0800-0900	810	625	120	35	30
% Vehicles	100%	77%	15%	4%	4%
Occupancy		1.31	1.00	11.70	1.00
Number of people	1,378	819	120	410	30
% People	100%	59%	9%	30%	2%
PM 1700-1800	1,185	995	110	35	45
% Vehicles	100%	84%	9%	3%	4%
Occupancy		1.31	1.00	21.70	1.00
Number of people	2,218	1,303	110	760	45
% People	100%	59%	5%	34%	2%

Table A1.5.3: Camden 1998 modal split survey results

Average June 1998	Total	Cars	Taxis	Light and Heavy Goods	Buses	Pedal Cycles	Motor Cycles
AM 0800-0900	651	423	9	150	32	19	19
% Vehicles	100%	65%	1%	23%	5%	3%	3%
Occupancy		1.29	1.71	1.20	12.27	1.00	1.00
Number of people	1,169	545	15	181	393	19	19
% People	100%	47%	1%	15%	34%	2%	2%
PM 1700-1800	948	644	53	103	36	51	62
% Vehicles	100%	68%	6%	11%	4%	5%	6%
Occupancy		1.39	1.75	1.26	21.97	1.00	1.00
Number of people	2,020	895	92	130	791	51	62
% People	100%	44%	5%	6%	39%	3%	3%

As can be seen there has been a decrease in the number of vehicles through the area between the two surveys; most of the drop being in car numbers. However, the reasons for this are not clear, as it is not typical of the general growth experienced in traffic in London over the last 3 years. However, in all cases the average loadings of buses has increased slightly and also the proportionate modal share. The increase is only slight and may not be statistically significant given the amount of variation that takes place. Even so, it would not be possible to attribute the change in ridership to the measures.

A 1995 daily count gave the flows below:

Table A1.5.4: 1995 CAMDEN - average annual daily flow

	Number	Percent
Pedal cycles	342	2.3%
Motor cycles	602	4.1%
Cars	10,893	74.8%
Buses and coaches	455	3.1%
Light goods vehicles	1,538	10.6%
Rigid 2-axle lorries	896	6.2%
Rigid 3-axle lorries	34	0.2%
Rigid 4 or more axle lorries	25	0.2%
Articulated 4 or less axle lorries	13	0.1%
Articulated 5 axle lorries	10	0.1%
Articulated 6 or more axle lorries	3	0.0%
Total heavy goods vehicles	964	6.6%
All motor vehicles	14,554	100.0%

Results - operational efficiency

The results of the analysis of Traffic Speeds surveyed in Camden High Street are shown below (in km/hr), compared to the 1994 Inner London Average for the Department of Transport's London Traffic Monitoring Report (published 1996).

Table A1.5.5: Comparison of speeds in Camden

		CAMDEN SURVEYS		
Speeds km/hr	**1994 Average Inner London**	**1994**	**1997**	**1998**
AM Bus		18	15	16
AM Car	21	26	27	27
OFF Bus		14	11	12
OFF Car	24	29	17	19
PM Bus		13	10	10
PM Car	20	18	12	14

This shows a deterioration in bus speeds and car speeds over the three years when the surveys were carried out. Following the implementation of the scheme, there has been little difference in the peak speeds, though a very slight increase has been recorded in some cases.

It should be noted that the main purpose of the shared use of the footway was to allow freer movement of both pedestrians and traffic during peak pedestrian flow times. Because the main hours of operation of Camden Market tend to be at weekends rather than during Monday to Fridays, when the surveys were carried out, the full advantages would not show up in the above. A lesson from this would be that 'before' surveys, in particular, should therefore be carried out at times when the actual advantages would be more clear.

a. London in General

'Attitudinal' surveys were carried out in the Kingston area in outer London in March 1997. This provides data on the 'perceptions' of bus priority which could be usefully related to the rest of the London area. Of car drivers, 46% used buses occasionally but 18% would never use a bus. Of the factors that would encourage car users to use buses more, 27% quoted "more buses" and 22% "greater reliability".

Of bus users 29% never use a car but 71% use one occasionally. Frequency was an important factor (86%), and 79% also cited reliability. Only 37% considered that the bus journey time was important. The single most cited factor that would give the greatest benefit for bus passengers was bus reliability (41%) ahead of 30% for bus frequency. Only 5% of car users were aware of the London Bus Priority Network programme.

b. The Camden test site

The main beneficiaries of the CAPTURE scheme would be pedestrians going to the market who would have more pavement space, and hence a safer and less crowded walk. A pedestrian count and walking speed survey as well as an attitude survey would be useful at weekends when the market is in operation. During the week, when the shared area is used for loading for adjacent businesses, it would also have been useful to obtain their views as well as the pedestrian surveys.

The economic effects

For bus priority schemes there is a standard London Bus Priority Network evaluation. Methodology was based on standard values of time. However, it is considered that, because of the very slight change in speeds and journey times, a standard economic assessment would not be worthwhile.

In any case, for a scheme such as this, a Goals Achievement type assessment would be more appropriate, given the various non-economic factors involved.

The safety impacts

The UK has one of the lowest overall casualty rates in Western Europe. Accident information has been collected for the 'before' situation. To get a full picture of changes it is usually considered that 3 years of information should be used. Therefore, it is still too soon after implementation of the scheme for any 'after' accident data to be statistically significant. Data relate only to the link, and not to the junctions at the ends of the link. However, comments can be made on the 'before' situation. The measured rate on this section of road was 24 accidents per km per year. With 3.78 million vehicles per annum on this section of Camden High Street, this is the equivalent of 634 accidents per 100m vehicle km/annum. The national rate for built up areas 'A class' roads is 93 per 100 million-veh km (from Transport Statistic for Great Britain 1997 edition). Therefore, the accident rate here is about 7 times the national average.

The scheme, as implemented by creating better conditions for pedestrians, should reduce accidents, but there is no evidence of this so far.

The measurement of environmental effects

London Transport has commissioned a computer model to ascertain emissions levels. The London Transport emissions model has been developed to allow the estimation of the effect of various public transport initiatives or policy changes on emission levels to be estimated. It allows quantification of changes to health-based emissions from traffic on a corridor, area or a London wide basis. It is particularly detailed in its treatment of bus emissions. The model will be used to estimate the effect of initiatives for cleaner bus engines and fuels in London. It will also provide a tool for appraising the emissions impacts of Intermediate Modes and other scheme proposals, and of wider possible changes in traffic mix (for example, due to the introduction of road pricing) which may be associated with policy changes. However, the model is not yet available for use as it is still in its final testing stages.

A summary of the impact of the Camden scheme on different groups

The main impact is on the general traffic flow and pedestrians. By regulating parking, a free area is kept for pedestrians when it is most needed, at the weekends; whilst during weekdays, essential loading can take place out of the way of traffic and buses. Buses would benefit operationally from the more regulated traffic flow and from the freedom from parking obstructions that the bus boarders would give; bus passengers who become pedestrians once off the bus would also benefit from the increased pavement width and better waiting environment that a bus boarder gives. Local businesses should benefit from the better regulated loading regime.

Conclusions

In retrospect, a better set of surveys would have given a useful indication of the actual effects of the Camden scheme and hence given a more robust evaluation of this part of the London Test Site.

A1.6 MADRID

A1.6.1 Description of measures and test site

Before the implementation of the BUS/HOV lane in N-VI North-West access in Madrid, the situation of this corridor had worsened during the late 80´s and the early 90´s. Recurrent delays and congestion, together with a demand profile with non equal peaks in the morning and the evening, were the result of a complex pattern of urbanisation with substantial growth in population along the municipalities in the corridor, maintaining the daily commuting trips to Madrid central city.

The general policy of the Ministry of Public Works when this type of situation occurs, is to increment the capacity of the roads, either constructing supplementary roads, increasing the number of lanes, or implementing orbital roads.

At the same time the organisations in charge of public transport, have tried also to promote public transport in this corridors, building new infrastructure, or improving the existing services, not always in co-ordination with the Ministry. It is important to stress that the accesses to Madrid depend on the central government, while the provision of metropolitan public transport services, excluding RENFE, is responsibility of the local and regional governments.

The corridor of the N-VI in Madrid has serious problems for road widening or duplication of the existing roads, since it is constrained by two protected green areas (Monte del Pardo and Casa de Campo), and the buildings and existing residential or employment land use limits in many cases with the strict right of way of the road. Furthermore, the socio-economic characteristics of the population in the corridor make very difficult to reach a substantial switch to public transport. That was the reason why an increment of the total capacity in terms of passenger-trips should be reached, combining every mode and considering the high occupancy vehicles as a "new" mode in the corridor. Implementing an infrastructure like this, needed a co-ordination between all the organisations before mentioned, since every mode in the corridor should be promoted with such a scheme.

The existence of an initial design to enlarge the N-VI, gave the opportunity to the Ministry to change it and adapt the new BUS/HOV infrastructure in the original project.

The CAPTURE project has taken the BUS/HOV facility as a demonstration project, since it is an unique opportunity to evaluate the benefits of this kind of schemes. Consorcio de Transportes de Madrid has been the associated partner, since it has participated since the beginning in the conception of the infrastructure and has planned the bus services and interchanges to adapt them to the new situation. Furthermore, Consorcio de Transportes initiated with the Ministry the evaluation of the BUS/HOV lane, and has continued within the CAPTURE project to measure the performing indicators which are presented in the following pages.

The BUS and High Occupancy Vehicle (HOV) lane, which is the infrastructure measure taken as the demonstration project within CAPTURE, is a special case compared to the rest of cities, since the construction and implementation occurred shortly before the beginning of the

CAPTURE initiative, and only several improvements and changes have taken place during this time.

This means that the Madrid demonstration site offers a good opportunity to evaluate the results of infrastructure measures when in full operation, and to investigate in depth several aspects regarding public acceptance and success over a 3 year timespan.

On the other hand, the particular features of the area where the infrastructure has been implemented, and the complexity of the wider transportation system and the existing demand, have made the impacts in some cases more difficult to isolate. Several other improvements and new schemes in the transportation system in Madrid, have directly affected the performance of the BUS/HOV lane.

A description of the Madrid demonstration site

The Study area

The area where the BUS/HOV lane has been implemented is situated in the North-West zone of Madrid, where an extensive suburban development has taken place extending the existing built up area within the metropolitan area of Madrid.

Some features of this area are:

- population in the corridor has grown rapidly from 157,151 inhabitants in 1986 to 204,143 in 1991, and 265,871 in 1996;
- the spread of land use development, with a low building density;
- high car ownership as a result of the high income level of residents in the area;
- restraints on the future growth of the corridor, as a result of the location of two huge ‘green’ areas to both sides of the area: Monte del Pardo and Casa de Campo;
- the existence of a high proportion of commuting trips to Madrid city centre.

These factors, combined with the opportunity to develop a new infrastructure due to the congestion problems on the motorway N-VI, made it possible to implement the BUS/HOV facility.

The objectives of the demonstration project

The main objectives of the demonstration project were:

- to decrease the number of car trips along the corridor, by increasing the car occupancy and thus improving existing congestion problems;
- to influence travellers to switch from using cars to using buses, improving the bus services by using the new BUS lane;
- to improve the environmental and energy conditions along the corridor, as a result of a more rational use of the different transport modes.

Description of site

The BUS/HOV facility is located on the North-West radial motorway to Madrid (N-VI). It is physically separated by concrete barriers from the other lanes. It extends from the suburban village of *Las Rozas*, some 18 km from the urban core, to the urban district of *Moncloa*, ending in a new interchange station.

The BUS/HOV facility consists of two different stretches. The first one extends from *Las Rozas* to the exit for HOV in *Puerta del Hierro*, where the N-VI connects with the first ring motorway (M-30). It has two reversible lanes of 3.5 m and shoulders of 1.5 m, for buses and HOVs. The second one, from the *Puerta del Hierro* exit to the metro and bus station of *Moncloa*, is a single lane for the exclusive use of buses. This lane has a total width of 5.5 m with a lane of 3.5 m and shoulders of 1 m. The length of the HOV facility is 12.3 km, and that of the bus lane, 3.8 km.

The facility operates on a reversible-flow basis (inbound in the morning and outbound in the evening). Access points to these lanes have been designed so that vehicles can join reversible lanes without altering the normal operation of the main traffic flow. A Traffic Management System has been implemented to inform users about the type of operation currently existing, to cope with accidents and to measure basic traffic characteristics in the central BUS/HOV lanes and in the other lanes.

The access points to these two stretches of road are provided by junctions at the starting and finishing points, and by some intermediate junctions. The design of the junctions was critical, since the BUS/HOV lanes are located in the central part of the motorway. Besides the start and end junctions, other junctions have been made at three intermediate points between *Las Rozas* and *Puerta del Hierro* (*Las Rozas*, *Plantío* and *Aravaca*), using old junction alignments to the N-VI.

The BUS/HOV lane was opened in a first phase in December 1994, and from that time, up to the present date, major changes in the transport system of the corridor have been or will be soon introduced (e.g. the opening of the M-40 ring motorway north section, a new railway express service in the corridor, which affect the operation of the BUS/HOV system).

<u>The surveys conducted</u>

A survey and field work plan has been developed, to investigate the following aspects:

- operational efficiency (by measuring time savings, vehicles and passengers, occupancy);
- modal split (passengers travelling by different modes in the corridor);
- the attitude of users (through telephone surveys).

There were existing traffic and passenger counts and travel time surveys from the period before the lane was introduced. The CAPTURE surveys can all be considered ‘after’ surveys. Nevertheless, in the interviews that have been carried out, the users have been asked about their behaviour before the opening of the lane, obtaining responses for the ‘before’ situation retrospectively.

The following table shows the entire programme of surveys conducted in Madrid within CAPTURE.

Table A1.6.1: CAPTURE surveys in Madrid

Date	Location	Survey type	Before/ After	Date Analysis Completed
March 1996	Corridor	Cars: Travel times, counts, occupancy Buses: Travel times, counts Railway: Counts	After	June 1996
November 1996	Corridor	Cars: Travel times, counts, occupancy Buses: Travel times, counts Railway: Counts Telephone survey	After	April 1997
April 1997	Corridor	Cars: Travel times, counts, occupancy Buses: Travel times, counts Railway: Counts	After	July 1997
November 1997	Corridor	Cars: Travel times, counts, occupancy Buses: Travel times, counts Railway: Counts	After	April 1998
January 1998	Corridor	Telephone survey	After	July 1998
April 1998	Corridor	Cars: Travel times, counts, occupancy Buses: Travel times, counts Railway: Counts	After	July 1998

A1.6.2 The findings specific to Madrid

The efficiency of the BUS/HOV infrastructure is particularly important during peak hours, where major congestion problems exist, and therefore most data refers to peak hour trips in the morning, from the residential areas to the city centre.

It should be stressed that the data variations which occur throughout the whole period of operation are influenced by several other schemes on both public and private transport, which have been developed at the same time; these are:

- December 1994: Opening of the first phase of the facility. The basic total length was opened in March 1995
- May 1995: The Metro circle line was opened
- June 1995: The Interchange terminal in Moncloa was opened
- June 1996: The Railway Green Corridor and line C-10 was opened
- December 1996: The Metro line 10 to Príncipe Pío opened and the ending of M-40 ring road completed
- February 1998: The connection of metro lines 10 and 8 completed

Average private car occupancy in the corridor

There have been continuous counts in the HOV lanes as well in the all-purpose lanes, measuring the number of passengers in private cars. In addition to the counts carried out within the scope of the CAPTURE project, there were also existing surveys from the 'before' situation, made with the same methodology. The average car occupancy for the corridor has risen from 1.36 passengers in November 1991 (passengers/vehicle in peak hour 7:30-9:30h) to 1.67 passengers/vehicle in November 1997, a rise of 23%. Table A1.6.2 shows the evolution of this indicator differentiated by the type of traffic lane.

Table A1.6.2: Mean occupancy of private cars (period 7:30-9:30 inbound Madrid)

Date	HOV lane	Conventional lane	Total
11/1991	-	1.36	1.36
03/1995	2.23	1.15	1.49
06/1995	2.11	1.16	1.48
11/1995	2.22	1.14	1.53
03/1996	2.16	1.14	1.61
11/1996	2.06	1.13	1.57
11/1997	2.25	1.15	1.67

Changes in traffic flow in the corridor compared to changes in passenger flows

The total number of vehicles (cars and buses) using the corridor has increased during the morning peak hour (7-10h) from 16,054 in November 1991 to 18,442 in November 1997 (a rise of 14.87%). The number of vehicles in the HOV lane has fallen from 5,908 in November 1995 in the same period, to 5,218 in November 1997, with a peak of 6,042 vehicles in November 1996.

At the same time, the number of passengers in buses and cars during the same period has increased from 28,032 persons-trips in November 1991 to 39,935 persons in November 1997 (a rise of 42.46%), which shows a higher growth than the number of vehicles. Table A1.6.3 shows the changes in traffic flows and passenger flows throughout the period.

Table A1.6.3aa: Traffic flows (vehicles) in the corridor (peak period 7:00-10:00 inbound Madrid)

Date	HOV Lane			Conventional lanes			Total
	Bus	Others	Total	Bus	Others	Total	
11/1991	-	-	-	244	15,810	16,054	16,054
03/1995	199	5,228	5,426	123	10,906	11,029	16,456
06/1995	222	5,344	6,009	77	10,681	10,758	16,324
11/1995	268	5,640	5,898	92	9,960	10,052	15,960
03/1996	247	5,566	5,813	88	11,912	12,000	17,813
11/1996	295	5,747	6,042	87	14,976	15,063	21,105
				ENDING	M-40 RING	ROAD -	
11/1997	334	4,884	5,218	116	13,108	13,224	18,442

Table A1.6.3b: Passengers in the corridor (peak period 7:00-10:00 inbound Madrid)

Date	HOV Lane			Conventional lanes			Total
	Bus	Others	Total	Bus	Others	Total	
11/1991	-	-	-	6,602	21,430	28,032	28,032
03/1995	8,625	11,641	20,266	1,775	12,500	14,275	34,541
06/1995	6,825	11,266	18,091	1,135	12,336	13,471	31,562
11/1995	10,430	12,471	22,901	1,170	11,371	12,541	35,442
03/1996	8,765	12,018	20,783	1,335	13,589	14,924	35,707
11/1996	10,905	11,823	22,728	1,115	16,945	18,060	40,788
				Ending	M40 ring	road -	
11/1997	12,050	10,979	23,029	1,865	15,041	16,906	39,935

Travel time in private vehicles along the corridor

Travel time for private vehicles along the corridor was analysed by comparing the movements of vehicles using the HOV lanes against those using the conventional lanes, and obtaining time savings due to the HOV lane. Several measurements have been obtained at different points within the corridor, and during different periods. For the peak hour (7-10h), time savings have varied from 15 minutes 35 seconds in June 1995 to 2 minutes 42 seconds in November 1997. Travel time is very sensitive to the season and the traffic conditions on feeder roads which accounts for the degree of variation in the measurements. Table A1.6.4 shows the comparison of travel time along the years.

Table A1.6.4: Comparison of travel time (inbound Madrid)

Date	Type of lane	7 h	8 h	9 h	7 - 10 h
11/1991			35 min 29 s	19 min 56 s	
03/1995	HOV LANE	8 min 56 s	12 min 10 s	8 min 00 s	
	OUT LANE	13 min 10 s	21 min 04 s	14 min 29 s	
	TIME SAVING	4 min 14 s	8 min 54 s	6 min 29 s	6 min 32 s
06/1995	HOV LANE	9 min 15 s	10 min 46 s	8 min 38 s	
	OUT LANE	19 min 13 s	34 min 02 s	22 min 10 s	
	TIME SAVING	9 min 58 s	23 min 16 s	13 min 32 s	15 min 35 s
11/1995	HOV LANE	9 min 40 s	22 min 01 s	8 min 02 s	
	OUT LANE	13 min 29 s	29 min 04 s	16 min 47 s	
	TIME SAVING	3 min 09 s	7 min 03 s	8 min 45 s	6min 32 s
03/1996	HOV LANE	8 min 47 s	13 min 48 s	7 min 22 s	
	OUT LANE	13 min 18 s	27 min 42 s	16 min 15 s	
	TIME SAVING	4 min 31 s	13 min 54 s	8 min 53 s	9 min 06 s

11/1996	HOV LANE	9 min 45 s	20 min 55 s	8 min 54 s	
	OUT LANE	15 min 36 s	33 min 43 s	17 min 52 s	
	TIME SAVING	5 min 51 s	12 min 48 s	8 min 58 s	9 min 12 s
11/1997	HOV LANE	8 min 24 s	20 min 38 s	8 min 49 s	
	OUT LANE	9 min 04 s	24 min 30 s	12 min 22 s	
	TIME SAVING	40 s	3 min 52 s	3 min 33 s	2min 42 s

Patronage of suburban buses and railways

One of the main effects of the new facility has been an improvement of the bus services along the corridor and subsequently an increase in the demand. For the peak period (7-10h), the number of passengers using suburban buses along the corridor has increased from 6,602 in November 1991, to 13,915 in November 1997, a growth of 111%. The proportion of passengers using buses in the Bus lane is 87% of the total (there are some buses not using the new facility).

The demand for suburban railways has been influenced by the different rail schemes implemented in the corridor. From a situation of 10,543 passengers in November 1991, the demand rose to 12,751 passengers in November 1995 and 14,001 in November 1997, a 30% rise in 6 years. Table A1.6.5 shows the evolution of these figures along time.

Table A1.6.5: Patronage of suburban buses and railways along time (peak period 7-10h, inbound Madrid)

Date	Bus passengers (total lanes)	Railway
11/1991	6,602	10,543
03/1995	10,400	n/a
06/1995	7,960	n/a
11/1995	11,600	12,751
03/1996	10,100	n/a
11/1996	12,020	14,668
11/1997	13,915	14,001

Changes in the use of different travel modes in the corridor

Comparing the three modes serving the study area, suburban buses, suburban railways and private car, for the morning peak period (7-10h), there has been a moderate change since November 1991. In November 1991, 55.6% of passenger trips were made in private cars, 27.3% by the railway and 17.1% by suburban buses. In November 1997, 48.3% of trips were made by private car, 25.9% by the railway and 25.8% by suburban buses. Table A1.6.6 shows these trends, differentiating between the HOV lane and the other lanes.

Table A1.6.6: Modal split in the corridor (peak period 7-10h, inbound Madrid). Percentages on passengers trips

Date	Suburban buses			Private car			Railways
	HOV	C. lanes	Total	HOV	C. lanes	Total	Total
11/1991	0.0	17.1	17.1	0.0	55.6	55.6	27.3
11/1995	21.6	2.4	24.0	25.9	23.6	49.5	26.4
11/1996	19.7	2.0	21.7	21.3	30.6	51.9	26.4
11/1997	22.3	3.5	25.8	20.3	28.0	48.3	25.9

Operational and environmental efficiency

Overall transport operations in the corridor have been improved since the implementation of the new BUS/HOV facility. Congestion occurs less often than before, and that has marginally influenced the average speed of traffic and a shift of traffic flow from the earlier hours in the peak period to later departure times.

In terms of the functional performance of the different modes in the corridor, the shift to public transport has meant a more efficient use of the transport supply. The introduction of a ‘new’ mode (i.e. High Occupancy vehicles) offers a good alternative mode for certain trips.

The popularity of the HOV facility, the relatively high growth of passenger trips relative to traffic growth and the rise in the use of public transport has also an impact on energy consumption and environmental pollution.

Transfer conditions in bus terminal

A key element in the transportation improvements in the corridor has been the development of Moncloa terminal, in the urban extreme of the facility. Benefits of this terminal are the direct connection of suburban buses with urban modes, the easiness of transfer between modes, the improvement of information, waiting facilities, etc.

The Moncloa interchange in the Madrid test site is on three levels with an underground bus concourse and a metro level below that. Metro lines in the interchange are lines 3 and 6, this one a circular line of a key importance in Madrid metro network.

The BUS lane coming from the N-VI corridor can access directly to the interchange, not having interferences with the general traffic, excepting one traffic light before entering to the terminal.

Regarding the bus terminal, 28 lines can access this terminal, most of them are using the BUS/HOV lane. Every operator decided to use the new interchange when opened, and this has brought problems of capacity, which will be solved in the future with an extension of the interchange. These problems of capacity were also due to the fact that the construction of the interchange was constrained by the existence of a building of the armed forces nearby and the existing configuration of the metro line 3.

The access mode in the Moncloa interchange in 1996 is shown in Table A1.6.7 below:-

Table A1.6.7: Access mode to Moncloa Interchange, 1996

Access mode	Daily demand	Percentage
Walking	49,500	25.6
Metro	65,500	33.9
Urban bus	38,700	20.0
Suburban bus	32,500	16.8
Others	7,100	3.7
Total	193,300	100

This shows the importance of the metro connection for those trips coming from the corridor and distributing through metro in the central city. Urban bus is also an important mode. The walking access has a high participation, since the interchange is located close to many residential and commercial activities of the city centre and a university and has a high level of pedestrian activity around although it is separated from these activities by a major road fed by the 'improved' highway. The improved public transport service levels have increased pedestrian flow, and a traffic light controlled pedestrian crossing exists, but the situation is not ideal. The level of cycling in Madrid is very low, and no facilities have been put in place to facilitate cycling in the area.

Finally, it is worth to stress that the interchange includes space for retailers outlets, which also contributes to improve the comfort and attraction of the interchange

Public acceptance

Several telephone surveys have been carried out within the project to assess the public acceptance of the BUS/HOV facility, as well as to investigate the impact it has on the overall patterns of mobility. Tables A1.6.8 to A1.6.12 show some of the results of these surveys. Among public transport users, the most appreciated scheme in the corridor has been the HOV/BUS lane itself, followed by the Moncloa terminal. There is a preference among these respondents to restrict the HOV lanes to cars with 3 or more persons. Conversely, those not using the HOV lane feel that it is dangerous and uncomfortable.

Table A1.6.8a: Shifts from other modes to HOV lane (bus users)

SHIFTS FROM OTHER MODES TO HOV LANE: Bus users		
	January 97	November 97
Yes, car → bus	6.2%	11.3%
Yes, railway → bus	7.8%	15.5%
No change	86.0%	73.2%

Table A1.6.8b: Shifts from other modes to HOV lane (car users 2+)

SHIFTS FROM OTHER MODES TO HOV LANE: Car users (2+)	
Yes, car 1 → car 2+	17.0%
Bus → car 2+	12.5%
Railway → car 2+	9.8%
No change,	50.6%
Other modes	1.2%
Not living in the corridor	8.1%

Table A1.6.9: Changes in mode of travel if HOV doesn't exist

AS DO YOU MOVE TO MADRID, IF HOV LANE IS REMOVED: Car users (2+)	
Car 1	9.4%
Bus	5.7%
Railway	13.6%
Not change	66.8%
Other	0.8%

Table A1.6.10: Most appreciated action in the corridor

WHAT IS THE MOST APPRECIATED ACTION OF THE HOV SYSTEM?		
	Bus users	**Railway users**
HOV/Bus lane	55.9%	60.5%
Only Bus lane	38.1%	15.1%
Moncloa Bus Terminal	39.1%	23.4%
Moncloa Metro line 6	22.1%	27.7%

Table A1.6.11 - Best policy in the corridor

WHAT IS THE BEST POLICY TO MANAGE THE MOBILITY OF THE CORRIDOR N-VI?		
	Bus users	**Railway users**
Forbid to the cars the use HOV lane	13.9%	10.4%
Road pricing for car using HOV lane	3.5%	4.5%
Restrict the cars with 3+ persons	46.0%	48.2%
Remove HOV lane	6.7%	14.0%
Nothing to do	32.3%	22.9%

Table A1.6.12: Reason for not using HOV lane

WHY DON'T YOU USE THE HOV LANE? Car users normal lanes	
Entrance too far	11.8%
Does not save time	5.9%
Dangerous	29.4%
Not comfortable to drive into	17.6%
Longer way	17.6%
Other	23.5%

Roughly 1 in 4 respondents had changed mode to using the bus. Of these, almost 60% had transferred from rail though 40% had changed from using their cars. Of the private car users in the HOV lane, roughly 1 in 5 now took passengers, and 1 in 8 had transferred from public transport modes. The remaining 70% had not changed their car occupancy but took advantage of the HOV lane.

Energy fuel savings

The results of calculations on energy consumption for the HOV corridor are presented in Table A1.6.13 below:-

Table A1.6.13: Energy use in the N6 Highway corridor, Madrid - morning peak inbound

	Bus		**Others**		**Total**	
	mill mj	**mj/pass km**	**mill mj**	**mj/pass km**	**mill mj**	**mj/pass km**
1991	0.152	0.47	0.837	2.35	0.987	1.46
1995	0.190	0.42	0.581	1.47	0.771	0.91
1996	0.235	0.47	0.906	1.90	1.141	1.17
1997	0.249	0.48	0.696	1.49	0.894	0.95

As it can seen the absolute figures show a different tendency in bus and others (cars). While bus energy consumption has increased along the time as a result of the increment of bus services, energy consumption in cars has varied along the time, following the pattern of traffic variation, but with a final figure in 1997 (0.696 mill-mj), 17% less than the consumption in 1991. The total energy consumption has decreased from 0.987 mill-mj in 1991 to 0.894 mill-mj in 1997.

More interesting to analyse is the unit consumption in mj/pass-km. The bus figures are more or less constant, reflecting the fact of an increasing number of passengers accompanying the increment of services. However, the car unit consumption has decreased in a 36,6% from 1991 to 1997. This is the main effect of increasing car occupancy in the corridor.

Pollution emission reductions

In table A1.6.14, the results of calculations on pollution emissions for the HOV corridor are presented

Table A1.6.14: Pollutant emissions in the N-VI Corridor - morning peak inbound

	Carbon Monoxide		Nitrous oxides		Volatile organic compounds	
	Kg	**gr/p km**	**Kg**	**gr/p km**	**Kg**	**gr/p km**
1991	5063	7.48	613	0.91	570	0.75
1995	4644	5.47	829	0.97	315	0.37
1996	6954	7.14	1331	1.36	564	0.58
1997	5218	5.52	761	1.01	364	0.38

The most significant reduction in absolute figures have been related to volatile organic compounds, while the other pollutants have remained constant or even increased, as a result of the general traffic growth.

Again, the unit pollutant emissions show a better behaviour. The CO emissions decreased from 7.48 gr/pass-km in 1991 to 5.52 gr/pass-km in 1997. COV emissions decreased from 0.75 gr/pass-km in 1991 to 0.38 gr/pass-km in 1997. Only NOx emissions has shown a increment from 0.91 gr/pass-km in 1991 to 1.01 gr/pass-km in 1997, which shows the significant importance of this pollutant in buses and how small is the effect of occupancy increments.

A1.6.3 Conclusions

The results show a modal shift to public transport and a more rational use of private cars. Despite the rapid urban development and beyond the corridor, traffic levels were held to a 15% increase despite the fact that passenger numbers increased by 42%. The additional passenger demands were met by a 23% rise in car occupancy, a doubling of bus use (111%) and a 30% rise in rail use. Now the numbers of daily AM peak bus passengers equals that for rail. Of those 1 in 4 that have changed to using buses, 60% transferred from rail. The HOV must be a major factor for the increase in bus use. Of the total am peak flows of about 17000 vehicles, roughly one third use the HOV lane and its use has fluctuated around 5000-6000 vehicles per day. Just over 2/3 of drivers on the HOV lane were already taking passengers when it was introduced. However, 1 in 5 drivers on the lane changed their behaviour and started to take passengers to be able to use the lane. The lane also had a smaller reverse impact in that roughly 12% of respondents had changed from public transport to using cars. However, of the 1 in 4 that had changed to commuting by bus, 40% of them previously used cars.

An increase in the average travel speed and the decrease in congestion have made private car trips along the corridor more comfortable, while maintaining efficient operations and more acceptable environmental conditions.

The development of the Moncloa terminal has been a key aspect to complement the BUS lane, contributing to the success of public transport.

The public acceptance of the facility has also been a key point in the trial, although several aspects can be improved, such as the sense of danger in driving within the facility, which is a design issue involving the lane barriers. Further policies such as a further increase in the minimum vehicle occupancy for the HOV lane could have potential future problems.

It is the particular characteristics of the Madrid corridor that have contributed to its success.

- Under the Madrid experience HOV´s can be very efficient whenever certain conditions are met. Firstly the corridor where they can be implemented must suffer congestion problems and there must be no alternative roads. It is important to consider socio-economic characteristics of the population living in the corridor. The nature of the trips in the corridor is important - commuting trips being the most appropriate to use these type of lanes (and also adapting to a reverse flow operation). Problems can arise due to the fraud, although in the case of Madrid it has not been important. Enforcement must be consider in the design. The physical outline of the elements of the facility is also important, and the geometric design of barriers, gates, panels, etc. must be carefully planned. Another important issue is the management of the HOV lane. Ideally, a system should be introduced, to match persons who can share vehicles. The experience of Madrid in this respect has not been very successful, but depending on the corridor, it can developed conveniently (for instance, transport plans in companies, in educational centres, etc.).
- HOV lanes won't be extended in principle in Madrid. The corridor of N-VI has not congestion problems upstream, and in other accesses where congestion problems occur, the construction of new toll roads, or free roads, is the current policy. As far as the design is concerned, no changes are foreseen.
- A policy of 3+ HOVs can be introduced in the future, if congestion problems still occur. The situation can change in several directions. Some opposition is expected to take place, and the main problem is that the car sharers are normally family members, which makes more difficult to enlarge the group travelling to Madrid. Probably a modal shift towards the bus can be expected, but this can be affected by the construction of new orbital roads and alternatives to the N-VI, which will divert traffic to other roads, but not affect the modal split.
- It is difficult to say if the HOV lane has been cost-effective, since it was implemented within a major project of road widening. This can be also a tip for possible application in other cities, since it can be convenient to take advantage of a major road improvement and co-ordinate and build an infrastructure of this type.

A1.7 MYTILINI

Mytilini is the capital of the island of Lesvos at the North Eastern edge of the Aegean Sea. The population of the city is approximately 25 000, while the population of the whole island is 150 000. All city activities are concentrated along a linear zone at the sea front. The city is the main gateway for the island of Lesvos. The port caters for approximately 180 000 passengers, 25 000 small cars and 15 000 trucks per year (arrivals i.e. approximately double with departures). About 30 % of annual arrivals are concentrated in August, and 65 % in a nominal extended tourist season (June-September). An additional 170 000 passengers arrive at the airport, approximately 60 % of which, arrive during the period June-September. Mytilini is the focal point (roads, public transport) for all interurban trips within the island.

The Mytilini test site originally consisted of five main elements:-

1. The closing of streets for certain periods of the day to accommodate conflicts in use.
2. Intermodal co-ordination by relocation of urban and interurban bus terminals to a common site.
3. The utilisation of a bus shuttle service linking the combined terminal with the port.
4. The construction of a Park and Ride facility near the passenger port
5. A parking management scheme in the central area involving charging for parking.

The relocation of bus terminals has been completed but due to administrative details the transfer of KTEL operations (independent operators of the buses) are not over. Park & Ride measures has been dropped down due to legal problems with the general policy of parking control in Greece. This referred to a recent decision of the High Court, declaring the Athens Municipality scheme illegal. Although it is thought that this problem will be overtaken soon, there is not enough time to implement it during the CAPTURE project. The shuttle bus system operated as a trial during the study period in order to test it.

The streets where pedestrianisation is implemented are: Ermoy street and Christoygenon street. Ermoy street is the most commercial street in the town, narrow and without sidewalks. Christoygenon street is situated along the old port, with restaurants and taverns. Both of them are pedestrianised with moveable barriers during the following hours:

First Mid part of Ermoy street	10.00 – 13.30 17.00 – 20.00
Second Mid part of Ermoy street	10.00 – 13.30
Christoygenon street	10.00 – 15.00 18.00 – 02.00 (morning)

Additional planning elements

The renovation of the square beside the urban bus terminal has been completed creating a second major distraction area along the Cornish, and the renovation of the traditional centre along the Ermoy street has not begun yet and it is unclear when works will start due to the existence of archaeological ruins.

The partners involved in the CAPTURE demonstration were led by TRENDS Europe (Athens) for most of the timescale with ADEM sa (the Municipal Company for Mytilini) also as a partner.

A1.7.1 Pedestrian areas

Currently, pedestrian areas exist on the major section of *Ermoy* Road (the main commercial street) and along two smaller side streets, *Voutsika* and *Sapfous*. During CAPTURE, the measure has been extended to part of *Archipelagous* Street, which is a side street off *Sapfous* Square which was pedestrianised in 1997. In addition, there is another partial pedestrianisation at *Christoygenon* Street, which is an area close to the old port, with many taverns and coffee shops.

The nature of the pedestrianisation scheme varies depending on the volume of traffic on each road. The Municipality considered both permanent and temporary traffic restrictions using barriers, during different times of the day or season. So for each road we have the following situation:

Archipelagous Street

The scheme is permanent. The measure has been a success and it is planned to expand it to the rest of the road.

Christoygenon Street

This scheme applies only for the five summer months (May until the end of September) and between 10.00 - 14.00 and 17.00 - 02.00. The area has many tourist activities and the owners of the restaurants favour the expansion of this measure on a permanent basis.

Ermoy Street

Ermoy Street is the busiest commercial road in the old city. The main part of the road is pedestrianised during shopping hours (08.00 - 13.30 apart from Sunday and 17.00 - 20.30 three times per week). Along the rest of the road, the pedestrian scheme applies only in the morning (08.00 - 13.30).

Voutsika and *Sapfous* Streets

These schemes are the same as in *Ermoy* street.

The CAPTURE findings

Surveys of traders in the pedestrianised area and the wider city centre were undertaken, attempting to interview all 238 traders in the centre. The surveys collected information about the general characteristics of the shops in the pedestrian areas and good delivery arrangements. Further questions related to traders' experiences and attitudes to the pedestrian schemes; namely:

- How satisfied are you with the pedestrian scheme?

- Do you think it should be extended to other roads or sections of road?
- What other measures, in addition to pedestrianisation, should be implemented to improve the image and use of the market area (e.g. more green areas, architectural renovation, cleaner environment, improvements to public transport provision in the city, improvements to the parking areas in the city centre etc.)?

General and travel characteristics

A majority of the traders rented their property (83%) and the rest (27%) owned them.

The table below shows the travel modes used by traders to receive goods at the shop or wholesale warehouse and the modes used by them to deliver goods to customers. Nearly all of the traders in both categories receive goods by lorry and roughly 1 in 5 of them also use small lorries. Few retail outlets delivered out to customers; however, 58% of wholesale traders did so. Of the wholesale deliveries made, 4 in 5 trips were made by lorries, although 1 in 5 traders also used two wheelers.

Table A1.7.1: traders' travel modes used for the delivery of goods to and from retail and wholesale outlets

Transport Mean	Goods in (%)		Goods out (%)	
	In retail sales	**Wholesale**	**In retail sales**	**Wholesale**
All modes	94.0	98.0	6.0	58.0
- *Two wheel*	12.4	2.4	88.2	22.2
- *Private vehicle*	6.0	2.4	---	11.1
- *Small lorry*	22.2	19.0	23.5	17.0
- *Lorry*	89.1	92.8	76.5	61.0

Multiple response question

Table A1.7.2: Traders' frequency of travel for the provision and delivery of goods (all modes)

Transport Mean	Goods in (%)		Goods out (%)	
	In retail sales	**Wholesale**	**In retail sales**	**Wholesale**
Every day	21.7	64.5	64.7	65.0
3 - 4 times / day	11.0	6.5	---	15.0
1 - 2 times / day	13.2	---	5.9	5.0
2 - 3 times / month	13.5	12.9	29.4	15.0
Less than 1 time / month	40.6	16.1	---	---
Total	100.0	100.0	100.0	100.0

Table A1.7.2 shows the frequency with which traders travel to receive or deliver goods.

The total number of trips per day into/out of the old commercial centre were estimated at 180; a trip rate of 0.55 trips per day.

Table A1.7.3: The times of traders' trips to receive or deliver goods (per cent)

Time period for receiving/delivering goods	In retail sales (%)		Wholesale (%)	
	Goods in	Goods out	Goods in	Goods out
Until 10.30 am	66.5	36.4	62.5	45.8
10.30 am - 13.30 pm	2.8	9.0	5.3	16.7
Afternoon hours	28.5	18.2	30.4	25.0
Outside shopping hours	2.2	38.4	1.8	12.5
Total	100	100	100	100

While just over 1 in 3 retail traders delivered goods outside shopping hours, only 2% received goods during these hours. Little wholesale goods movements occurred outside shopping hours. Two thirds of retail and wholesale traders received goods in the morning period when roughly 1 in 3 retail deliveries and 1 in 2 wholesale deliveries also occurred.

The impacts of the pedestrianisation scheme

Regarding the provision or delivery of goods to the retail and wholesale outlets, 2 out of 3 traders did not notice any marked improvement with the pedestrian scheme, although 30% noticed a slight improvement. 60% of the traders, however, felt that customers could reach their shops more easily and 70% felt customers were enjoying shopping more. This clearly reflected in sales figures, with 55% of traders reporting an increase in sales and 23% of these had seen a significant increase in sales - shown in Table A1.7.4. These impacts led almost three quarters of traders to the conclusion that the pedestrian schemes should be expanded.

Table A1.7.4: Traders' stated impacts of pedestrian schemes in Mytilini (%)

	Large increase (%)	Small increase (%)	No change (%)	Small decrease (%)	Big decrease (%)	Total (%)
Increase of sales	12.6	42.4	39.7	3.3	2.0	100.0
Clients can reach the shop more easily	16.7	43.3	36.7	2.5	0.8	100.0
Shopping is more enjoyable	11.3	58.0	29.0	---	1.7	100.0
Improvement of the provision - delivery conditions.	6.4	29.5	62.8	---	1.3	100.0

	Yes (%)	No (%)	No interest (%)	Total (%)
The measures should be expanded to include other roads	73.6	11.0	15.4	100.0

Table A1.7.5 indicates which other measures traders would like to see accompanying pedestrian areas to enhance the attractiveness of the commercial area. The main features cited by traders related to the quality of the environment rather than transport access - paving over the whole street (56%), introducing green areas (91%) and architectural renovation of the whole centre (54%). Improving public transport access (52%) was cited twice as often as improving parking conditions (23%).

Table A1.7.5: Traders' preferences for accompanying measures

What others measures must be taken in purpose to improve the image and use of the pedestrianised areas	%
Paving of the street	55.5
More green areas	90.8
Cleaner environment	28.0
Architectural renovation of the old centre	54.2
Improved public transport	52.0
General improvement to the parking environment	22.6
Introducing no parking areas in front of the shops	---
Short term parking in front of the shops	33.5

Multiple response question

Future plans for pedestrianisation

In the case of traders working from premises where no pedestrian scheme operated, they were asked whether they would prefer a scheme and what impacts they would expect.

Those traders who worked on streets without a pedestrian area expressed a clear preference to have their street pedestrianised (70%). The expected impacts of introducing a scheme on higher sales turnover (67%), easier access to outlets (68%) and more enjoyable shopping (74%) broadly mirrored the results among traders where schemes had been introduced with the exception of improvements to goods delivery or provision where 71% felt pedestrian areas would make an improvement relative to only 36% of traders where schemes had been implemented.

Regarding accompanying measures, traders' preferences again mirrored those traders in pedestrian areas (comparing Tables A1.7.5 and A1.7.7); with stronger preferences for measures increasing the paved area and green spaces and a preference for public transport improvements over parking provision.

Table A1.7.6: Traders' expected impacts of introducing a pedestrian area

	Large increase (%)	Small increase (%)	No change (%)	Small decrease (%)	Large decrease (%)	Total
Increase of sales	22.3	40.8	33.1	3.8	---	100.0
Customers can reach the shops more easily	32.6	35.4	29.2	2.8	---	100.0
Customers enjoy shopping more	15.7	58.4	19.1	6.8	---	100.0
Improvement to goods provision and delivery	5.9	65.5	26.2	2.4	---	100.0

Table A1.7.7: Traders' preferences for accompanying measures should pedestrian areas be introduced

What others measures must be taken in purpose to enhance the image and operation of the commercial area	%
Paving of the street	70.1
More green areas	97.0
More cleanness	39.0
Architectural renovation of the old centre	53.0
Improvement of the urban transports	39.0
General improvement of the parking conditions in the city	29.8
No parking in front of the shops	---
Short time parking in front of the shops	36.6

Multiple response question

Conclusions regarding pedestrian areas in Mytilini

The pedestrian areas as applied in Mytilini are very flexible, being able to adapt to the operation of different types of shops (retail, small warehouses). This is particularly important for a small city such as Mytilini, where the decentralisation of functions (retail, small warehousing) is very difficult and, in fact, may not be desirable.

The measure had proved very popular among shopkeepers, since most reported an increased turnover. In the medium term, the extension of the measure will help to counter the pressure to develop out of town shops (especially for the wholesale and shopping centres) which are not easily served by public transport, or other environmental friendly modes (bikes, walk).

The comparative success of the CAPTURE measures has increased the support for its extension to the whole of the traditional commercial district.

A lot remains to be done in terms of the physical appearance of the roads (aesthetics). Even so the simple and low cost (virtually no cost) measure of closing the street for carefully selected periods of the day seems to work extremely well. In terms of the implementation strategy, the step by step approach (closing a small section first - then others gradually) has given traders time to adapt and given the Municipality the opportunity to 'fine tune' the measure and gradually extend it, not by imposition, but inducing the interested parties to ask for it.

A1.7.2 Shuttle bus

A survey was conducted in November 1998 for 6 days to assess the impact of the shuttle bus and accompanying measures. The survey generated a small sample of only 61 passengers.

The small sample only allows for a general impression to be gained of the use of the service, so only overall conclusions are presented rather than detailed tabulations.

The shuttle operation was scheduled to run for one month to test the responses of the public to such a service. The public Transport Company (KTEL) ran it. Due to vehicle availability the frequency achieved was not satisfactory (40 minutes headway). Furthermore, old buses were used. So the new service, to a large extent, was not able to convey an image of improvement over the current public transport situation. It was simply a new connection along the busiest part of the city - but it was also free of charge.

The general results of the 'after' surveys are the following:

- The characteristics of the market segment attracted were no different from those of persons currently using Public Transport in Mytilini (mostly older, lower income, female). The service failed to attract more mobile segments of the population which is hardly surprising, since the attributes of the service were no different from the current level of service of the Public Transport system and the service had only been operating one month.

- Many passengers used the service in the form of Park and Ride (particularly to a medical centre where parking problems existed). Despite the small sample of the 'after' survey, this finding is encouraging, for the further development of this policy (i.e. Park and Ride combined with parking restrictions in the centre).

- Opinions concerning footpaths and access to bus stops are also no different from earlier findings - namely that infrastructure provision is poorly rated. This is again a finding that is expected to guide city policy (for transport issues) in the following 4 years.

- The shuttle service attracted trips away from private transport (42% of respondents) but also from walking (34%). No new trips were generated; the trips would have taken place anyway. Such services could be an effective mechanism for keeping cars out of sensitive city areas.

- The opinions regarding service improvements are also no different from the 'before' survey (i.e. higher frequencies needed, new small buses to cope with narrow streets etc.).

- Despite the small sample, it has provided useful data for future policy initiatives. Another benefit of the experiment was the establishment of co-operation between two different organisations who have never worked together before (the municipality and the private sector KTEL organisation).

A1.7.3 Overall conclusions

In summary the Mytilini test site has demonstrated two opposing themes. On the one hand it has demonstrated that benefits of pedestrianisation can be achieved with great ease, and the benefits can be immediate. On the other hand it has demonstrated that implementation problems can affect not only particular elements facing implementation, but that these can have damaging knock-on effects if other parts of a package are dependent upon measures which face implementation problems.

A1.8 ORVIETO

A1.8.1 A description of the measures and the capture test site

Orvieto is a small historic city sited on a volcanic rock, similar to many historic walled cities in Europe. Its economy is based on tourism and surrounding agriculture. The main objectives of the CAPTURE test site are:

- to reduce local and tourist car traffic and eliminate large buses from narrow city centre streets;
- to increase the use of public transport and walking;
- new short distance transport systems: a funicular railway, escalator systems and elevators;
- new peripheral parking areas (at *Campo della Fiera*);
- the provision of electric minibuses in the historic centre;
- the reorganisation of road traffic focusing on the creation of extensive pedestrian zones and area restrictions for traffic access;
- changing central parking area parking controls;
- associated pricing strategies (i.e. for both parking and public transport);
- traffic calming measures to discourage illegal parking.

The Orvieto new alternative mobility system derives from a feasibility study made by the Umbria Region in 1980. It is a multimodal system specifically oriented to serve the mobility demand from/to the historic centre and is dimensioned to replace completely the private traffic. The system consists of two preferential routes to the Rupe, one on the EAST side and one on the WEST side, two "Park and Ride" areas (Ex Campo della Fiera and Station parking) and a distribution system in the historic centre.

The interventions in the Orvieto test site have been brought about by geological problems of La Rupe. The Italian Government passed a special law entitled "Urgent Measures for consolidation of the Rock of Orvieto and Preservation of the Scenic, Archaeological and Artistic Heritage". One sector of special interest is transport. Motor traffic and in particular tourist traffic, the circulation of heavy vehicles, tourist buses, have been identified as one of the major causes of the deterioration of the city and the rock itself.

During the CAPTURE project, these measures have been implemented in five stages:

- *December 1996:* Opening of the elevators from the parking area at *Campo della Fiera* at the foot of the rock to *Via Ripa Medici* in the city centre;

- *January 1997:* a new fare system for daily and seasonal parking;
- *June 1997:* traffic access control restrictions at *Piazza San Giovenale*, in the city centre;
- *June 1997:* accompanying measures to prevent tourist traffic from entering the historic centre and to redirect traffic to *Campo della Fiera* to park.
- *November 1998:* the opening of the escalator system from *Campo della Fiera*. The opening of escalators was delayed from the end of 1997 to March 1998 due to discovery of archaeological remains and then for technical problems from March to November 1998.

The opening of escalators was delayed from the end of 1997 to March 1998 due to discovery of archaeological remains and then for technical problems from March to the end of November 1998. The Escalators have been opened on 30^{th} of November 1998.

The new transport systems directly involved in the CAPTURE project are the elevators and escalators from ex Campo della Fiera car park to la Rupe. All the actors and bodies involved in the implementation process are the Region of Umbria, the Province of Terni and the Municipality of Orvieto. The design of scheme has been made by consultants of Municipality (Building trades association) which have also realised the measures.

The Municipality is the main actor promoting the scheme. It is responsible for formal approval. The Municipal Committee is the scheme initiator and Lead agency. It is the political body responsible for planning policies of traffic, mobility and transport. It takes all decisions and gives all formal approvals. The Region of Umbria (Regional Council*)* plays an important part in scheme initiation and promotion, it is responsible for formal approvals and funding (New transport systems). The ATC *(*Azienda Trasporti Consorziali) is the agency owner of Public Transport in the Province of Terni. It is responsible for managing public transport (Urban and Suburban). It agrees with the Municipality all the strategies and policies about P. T. The Traffic Police is responsible for enforcing operational characteristics of the scheme

A1.8.2 The results of the Orvieto trial

A. Surveys of bus passengers, funicular railway and elevator users

Public transport passenger counts have been undertaken by the transport operator Azienda Trasporti Consorziali (ATC) from 1990 to the first half of 1998. The data collected are passenger numbers on the funicular railway, buses (Line 1,2, 3) and minibuses (A, B, C). The methodology was to estimate passenger numbers by the proceeds from ticket sales and counts of the number of normal and season tickets purchased. Data on bus service journey times and where passengers board and alight are not available.

The results show that the number of passengers have increased every year. In 1997, passenger numbers were 1.2 million, an increase of 10% on the 1996 figure. In 1998 the Funicular passengers have been reduced of about 14% (1.041.828 passengers/year in 1998 and

1.140.000 in 1997). In 1998 the passengers/year for buses and minibuses were about the same of 1997.

This rate of increase is a clear indication that the policies are working.

B. Traffic surveys

Every day, the Orvieto municipal police count vehicles going on and off the rock (locally called the Rupe). The period of data collection is 08.00 to 20.00 from Monday to Sunday. The data recording the 'before' situation was collected in November and December 1995. An automatic traffic counter was located at the 3 main access points to the Rupe for a week at each site. These surveys do not take into account vehicle type or car occupancy.

In 1995 about 9,400 vehicles per day entered the Rupe and 9,500 left the Rupe. In February and March 1998, the 'after' surveys were carried out using the same methodology as for the 'before' surveys. In 1998, the vehicles entering the Rupe were about 10,500, and those leaving the Rupe were about 10,200. This represents an increase of about 11.7% over the two years for the vehicles entering the Rupe, and an increase of about 7.4% for those leaving the Rupe. Therefore, despite the increased use of the *Campo della Fiera* car park and the opening of elevators in 1996, the traffic growth on the Rupe has not been halted.

C. Survey of pedestrians

Pedestrian counts were carried out along the main roads and in the squares of "La Rupe". These counts were carried out at two or three locations, for a period of five minutes a day and for two different days of the week, in July 1997, at the height of the tourist period. The pedestrian numbers surveyed in *Piazza della Repubblica* averaged 80 persons/hour, while the number of pedestrians recorded in *Corso Cavour* averaged 200 persons/hour.

D. Interviews with those parking vehicles on the Rupe

Within the evaluation framework of the CAPTURE project, surveys were conducted in the old city on the Rupe to identify the differences between the situation before and after the implementation of the physical measures.

The questions were devised to assess how the different measures affected the use of parking areas. The interviews analysed the journey purposes of travellers (commuters and visitors), the use of the parking area before and after the opening of the elevators, and the response of travellers to the different parking charges levied. The surveys were carried out in June 1997.

The sample sizes of carpark users are fairly small: approximately 80 commuters (having season-tickets) and occasional users of the *Campo della Fiera* car park, and about 70 users of parking areas on the Rupe (visitors). The surveys were carried out at the Rupe parking area situated above the *Campo della Fiera* parking (*Piazza dell'Erba*; *Piazza Vitozzi*; *Piazza del Popolo*; *Slargo Signorelli*). The residents of the Rupe were excluded from the interviews. Only visitors were questioned. Drivers who parked in the study area (70) were interviewed on one 'typical' day: Tuesday 10/06/1997. The survey was conducted from 08.00 to 19.00.

The interviews revealed that 66% of visitors took between 0 and 10 minutes to park their vehicles. 1 in 2 leave their car parked for 1 hour, 1 in 3 for 2 hours, and only 21% for longer. The average time parked at the Rupe parking area was about 2 hours.

The reasons given for driving into the historic centre (the Rupe) were for commuting to work (23%), travel in the course of work (37%), family or personal reasons (23%), 8% for shopping, 3% for education, 3% for leisure and 2% for other reasons.

Of traffic entering the Rupe, a small proportion are tourists, 45% of respondents parked there more than 5 times a week, 20% between 2 and 4 times a week, 12% parked there about once a week, 15% parked between 1 and 3 times a month, and 8% less than one time a month.

The vast majority of visitors (81%) had no passengers, 17% carried one passenger and the remaining 2% 2 or 3 passengers - the average vehicle occupancy rate was 1.2. Nearly all the visitors were aware of the *Campo della Fiera* parking facility (about 90%); 2 in 3 of these didn't park there because they felt it was too far from their destination. All the visitors had finished their journey on foot; 87% of them doing so within 5 minutes and the remaining 13% between 5 and 15 minutes. Over a half of the visitors (59%) were not resident in the Orvieto municipality and, of these, only 20% had the special parking permit giving them a price reduction of 50% as for residents.

Drivers parking on the Rupe were relatively insensitive to the range of charges levied at the different car parks. Current charges on the Rupe were 500 or 1,000 lire per hour. However, about 40% of visitors would have continued to park in the Rupe parking even with a parking fee of L 4,000/hour. If the fee was 2,000 lire per hour, 30% would have parked at *Campo della Fiera* (with a fee of L. 1,500 /hour), although 15% would have continued to park on the Rupe.

E. Interviews with those parking vehicles on the *Campo della Fiera* site

These surveys were conducted on two 'typical' weekdays: Tuesday and Wednesday (10/11 June 1997); market days (Thursday and Saturday) were not surveyed. The survey was conducted each day from 08.00 to 19.00.

The methodology used for the interviews is the same for the interviews to the Rupe parking users. The drivers were interviewed when they returned to collect their parked car. The residents of the Rupe were again excluded from the interviews. The sample size was about 80 visitors. This sample, considering that the average number of vehicles present in the *Campo della Fiera* car park, in a typical weekday, was about 130/150 vehicles (ATC data) can provide statistically significant results. Other surveys will be carried out after the opening of escalators from the *Campo della Fiera* parking to *Piazza Ranieri*, outside of the CAPTURE timescale. It was found that: one half of those interviewed held parking season tickets and the other 51% were occasional users. 60% of visitors lived in the Orvieto Municipality, the other 40% visiting from other municipalities (the main cities cited are Terni, Perugia, Siena, Roma etc.). 70% of the season ticket holders came from Orvieto Municipality while only 23% came from other municipalities. In contrast, 46% of the occasional users came from Orvieto and 54% came from other cities.

All of those interviewed had found parking spaces immediately. The cars are left parked for longer durations than those on the Rupe: 11% less than 1 hour, 35% for 1-3 hours, 18% for 3–6 hours, 14% for 6-8 hours and 18% for between 8 and 12 hours. Season ticket holders park on average for longer time periods than occasional users. Only 3% of season ticket holders leave their car for less than an hour compared to 20% of the occasional users. 10% of season ticket holders park between 1 and 3 hours relative to 59% of occasional users. In contrast, 59% of season ticket holders park for more than 6 hours. The average time cars are left by visitors at the *Campo della Fiera* car park is about 4 hours. Those parking at *Campo della Fiera* were more than twice as likely to be commuters (56%) than those parking on the Rupe, and half as likely to be work related trips (19%). Other reasons cited to park at *Campo della Fiera* included 11% for leisure, 8% for family or personal reasons, 5% for shopping, and 1% for education. The differences between season ticket holders and occasional users at *Campo della Fiera* are as follows: 88% of season ticket holders came to the historic centre for travel to work; the other 12% for education (3%), leisure (3%), family or personal reasons (3%), and other work reasons (3%); 24% of occasional users for travel to work, 35% for other work reasons, 19% for leisure, 15% for family or personal reasons and the remaining 7% for shopping. The frequency of parking at *Campo della Fiera* did not vary much from that on the Rupe. At *Campo della Fiera*, 55% parked there more than 5 times a week relative to 45% on the Rupe. Overall, 95% of the season holders at *Campo della Fiera* had a trip frequency of more than 5 times a week against the 15% of occasional users.

76% of visitors travelled alone in their car, relative to 81% of those who parked on the Rupe, 14% carried one passenger, 10% carried 2 passengers and 2% 3-4 persons.

A majority of parkers at *Campo della Fiera* (82%) used the elevator to reach the historic centre, the remaining 18% using the minibus line C. After the escalators were opened in November 1998, the minibus service will be stopped.

The installation of the elevator had a positive impact on the travel behaviour of motorists visiting Orvieto; only 37% of visitors parked their cars in the *Campo della Fiera* car park before the opening of elevators, the remaining 63% didn’t park there before. Previously, a majority (89%) of this latter group had parked on the Rupe, 6% had travelled by bus, 4% by funicular, and 2% on foot.

After the opening of the elevators, a reduction of *Campo della Fiera* parking fees was made in January 1997 with special season tickets for commuters. In the CAPTURE surveys, some questions were asked to assess the effects of the cheap fares and/or the elevators on parking location choice. The main reasons for choosing the *Campo della Fiera* car park were: 25% cheaper fares, 25% the opening of elevators, 7% good information and the remaining 43% for other reasons. These other reasons are divided as follows: 44% because the trip is more comfortable and convenient, 24% for the parking features, 12% due to the adverse parking problems on the Rupe, 3% because the car park was near to the job and remaining 18% other reasons. The season ticket holders had chosen to park at *Campo della Fiera* mainly for the cheap fares (32%), the occasional users mainly for the elevators (33%). 38% of season ticket holders and 71% of occasional users used the car park for its comfort and convenience.

Finally, parkers at *Campo della Fiera* were presented with two price alternatives, a parking fee double (L.1,000/hour) and triple (L.1,500/hour) the current fee, and a parking fare of L.4,000/hour in the parking on the Rupe.

The season ticket holders and the occasional users both replied in the same way. About 90% of both groups preferred to park at *Campo della Fiera*. Only 10% of both season ticket holders and occasional users would switch to the public transport to reach the Rupe. It demonstrates that the increase of parking fares is not enough to persuade the car park users to switch to using public transport for their trip rather than their cars.

A1.8.3 Conclusions

The effects of new transport systems implementation in the Orvieto test site have been recorded before and after the opening of elevators from the ex Campo della Fiera car park to via Ripa Medici. The surveys after the opening of escalators from the ex Campo della Fiera to Piazza Ranieri could not be carried out within the project timetable due to their late opening.

The main effects of implementation is an increase of ex Campo della Fiera car park users from 1996 to 1998. Use of the ex Campo della Fiera car park increased from 80 in the 1996 survey to about 500 in 1998, an increase of about six times. And with opening of escalators this number will be further increased. The increase of ex Campo della Fiera users are not only due to the opening of elevators and escalators but also to the reduced fares introduced in January 1997. The results of interviews to the car park users had demonstrated that the increase is due for the 25% to the opening of elevators and for the other 25% to cheap fares, 7% information and the remaining 43% to other reasons, such as comfort, car park features and so on.

This is a large effect of the physical measures even if traffic in the test site has not been reduced. In 1995 the vehicles entering the Rupe were about 9400 units and those going out of the Rupe were about 9500. In February and March 1998 the after surveys were carried out using the same methodology as before surveys. In 1998 the vehicles entering the Rupe are about 10500 units and those going out of the Rupe are about 10200.

An increase of about 12% (1100 vehicles/day) has been recorded between the two years for the vehicles entering the Rupe, and an increase of about 7,4% (700 vehicles/day) for those going out of the Rupe.

In 1998 the public transport passengers/year have been reduced of about 14% for the Funicular while passengers/year have remained the same for buses and minibuses. The cause of reduction of Funicular passengers is due to events in Umbria during 1997 and 1998 (the earthquakes in particular) that have reduced the number of tourists. Another reason is that after the opening of elevators and escalators many Station car park users and PT passengers have changed their destination from Station car park to ex Campo della Fiera.

In any case the CAPTURE experience had produced other positive effects like the implementation of some physical measures to support the new transport systems. A series of protected pedestrian route and pedestrian areas have been implemented near the arrival of elevators and escalators (Via Ripa Medici and Piazza Ranieri) and in the other roads where the conflicts between pedestrians and cars are very high (due to the reduced dimensions of roads).

Other physical measures have been implemented in via Filippeschi. All these interventions referred to a general scheme included in the Urban Traffic Plan redacted in the 1997. Many other interventions of physical measures will be implemented in the historic centre during 1999.

The main goals of these measures are to reduce the private car traffic and the illegal parking in the historic centre.

The CAPTURE experience in Orvieto showed that the implementation of innovative measures in the small cities is more simple than in the larger cities. The experience of Orvieto can be taken as an example for other historic cities with the same features.

A1.9 ROME

A1.9.1 A description of the measures and the capture test site

The CAPTURE test site in Rome includes the historic *Rione Celio* area adjacent to the Coliseum, in the historic centre. The area covers about 33,000 square metres and has a population of about 3500.

The physical measures introduced in Rome are part of a series of schemes that the Municipality of Rome has implemented within the ring motorway. The most important schemes are:

- an extension of the 'Blue Zone' traffic restricted area in central Rome;
- the selective management of parking areas by regulating street parking, reserving parking zones for residents, reducing street parking for commuters, limiting the introduction of paid short-term parking, accompanied by compensatory measures to avoid having to increase the overall supply of parking in the *Celio* area.

The physical measures implemented (September 1997) in the CAPTURE test site "the Celio" are:

- on-street and off-street paid parking areas for non residents, using a residents' permit scheme (free parking);
- a reorganisation of traffic movements in the area;
- traffic calming measures at *Via Celimontana* (narrow carriageway over entire street, improving pavement, pinch points, planting);
- the re-design of *Piazza Celimontana* (introduction of a paid parking area, improving pavements and planting) which remain in progress.

A1.9.2 The study findings

Table A1.9.1 below shows a summary of results from the 'before' and 'after' surveys carried out in the test site.

Vehicle counts and vehicle types

The vehicles counts were conducted on 20-21 May 1997 for 24 hours by automatic counter. The 'after' survey has been conducted in the same period on 25-26 May 1998 from Tuesday to Wednesday for a period of 24 hours. In 1997, the total number of vehicles recorded in *Via Celimontana* were about 15,000 vehicles/day, of which about 13,000 were small and medium sized vehicles, 2,000 were large vehicles and 2,800 motorcycles. After the CAPTURE measures were introduced, traffic is down by one third. In 1998, the total number of vehicles recorded in *Via Celimontana* was about 10,000 vehicles/day, of which 9,000 were small and medium sized vehicles, 1,000 were large vehicles and 2,900 were motorcycles.

There was a reduction of about 5,000 vehicles/day comparing 1998 to 1997, of which about 4,000 were small and medium sized vehicles and 1,000 were large vehicles. The survey reveals a slight increase of motor cycles/day, although there was a proportionately larger reduction in large vehicles.

Table A1.9.1: A summary of the impacts of physical measures in via Celimontana

Data	Before the CAPTURE implementation	After the CAPTURE implementation	The Main Results
Surveys	***Via Celimontana***	***Via Celimontana***	***Via Celimontana***
Vehicle counts	15,000 vehicles/day	10,000 vehicles/day	A reduction of 33% of vehicles/day
Vehicle speed (average)	Max 77 km/h Min 31 km/h	Max 25km/h Min 20 km/h	A reduction of 67% for the maximum vehicle speed and 35% for the minimum.
Car occupancy (average)	1.3 persons/vehicle	1.4 persons/vehicle	An increase of 8% for the car occupancy
Vehicle types	12,000 Small/medium vehicles/day 3,000 large vehicles/day 2,800 motorcycles/day	9,000 small/medium vehicles/day 1,000 large vehicles/day 2,900 motorcycles/day	A reduction of 25% A reduction of 66% An increase of 3.6%
Interviews	500 residents 140 shopkeepers 120 visitors	540 residents 130 shopkeepers 120 visitors	
Pedestrian counts	264 persons/hour	296 persons/hour	An increase of 12%
Noise survey	LAeq (6.00-22.00) 70.4 dB (A) LAeq (22.00-6.00) 65.1 dB (A)	LAeq (6.00-22.00) 69.7 dB (A) LAeq (22.00-6.00) 63.7 dB (A)	A reduction of 0.99% during the day A reduction of 2% during the night
Bus passenger counts Interviews	36 passengers (8.00-8.25) 17 passengers (17.00 - 17.19) 100 passengers	Not carried out because the minibus terminus has been moved from *Piazza Celimontana*	

Vehicle speeds

In 1997, the vehicle speeds were recorded as a range. Maximum vehicle speeds were 77 km/h and minimum speeds 31km/h. In 1998, maximum speed was 25 km/h and the minimum speed 20 km/h. A reduction of about 67% for the maximum vehicle speed recorded in 1997 and 35% for the minimum value. This result is the most important that the implementations had in the test site. Furthermore, the range of vehicle speeds in 1998 was only 5 km/h relative to 46 km/h in 1997.

Car occupancy

In 1997, the car occupancy was surveyed on different days and the average was 1.3 persons/vehicle. In 1998, the car occupancy average is 1.4 persons/vehicles. Of about 130 vehicles counted in 25 minutes: 63% was carried by 1 person and the remaining 37% was carried by the driver and one passenger.

Pedestrian counts

In 1997, pedestrian counts were carried out in *Via Celimontana*. The counts were recorded at different times of a typical weekday (29/05/97). There were about 264 pedestrians/hour. In 1998 the counts recorded an average of 280 pedestrians/hour (an increase of about 6%).

Noise meter survey

In 1997, a traffic noise survey was conducted using a sound level meter located in one position in *Via Celimontana*. The counts were conducted during a typical weekday for a period of 48 hours (26/05/97). The survey revealed different noise levels during the day, it was divided in two different periods (06.00-22.00 and 22.00-06.00) and the noise equivalent levels were:

- LAeq (06.00-22.00): 70.4 dB (A)
- LAeq (22.00-06.00): 65.1 dB (A)

In 1998, another noise survey was conducted in the same period of ‘before’ surveys (May 1998), using the same sound level meter located in one position in *Via Celimontana* near the implementations.

This year the noise equivalent levels for the two different periods (06.00-22.00 and 22.00-06.00) were:

- LAeq (06.00-22.00): 69.7 dB (A)
- LAeq (22.00-06.00): 63.7 dB (A)

The ‘after’ surveys reveal a slight reduction of the noise equivalent levels of about 2 dB (A) during the night and 1 dB (A) during the day.

Surveys of residents, businesses and visitors

In 1996 and 1998, surveys were conducted in the Rome test site: the *Celio* district and part of the *Monti* district. The purpose of the surveys was to identify the different traffic and safety problems, and the perception of the local environment.

In 1996, about 500 residents, 140 businesses, and 120 visitors (who had parked their cars in the test site) were interviewed. In 1998, 540 residents, 130 businesses and 120 visitors were interviewed.

The main results focus on respondents' views on traffic, safety and environmental issues in the test site and the difference between the 'before' surveys and 'after' surveys with reference to the implementations realised.

The results of interviews with representatives of business

In 1996, 65% of commuters used private cars to go to the *Celio*; by 1998 this had reduced by 10%. The cause of this reduction can be attributed to the introduction of paid-parking for non-residents (L.2,000/h from 09:00 to 23:00).

The reduction of private vehicle use has encouraged a rapid increase in the use of motorcycles from 11% (1996) to 23% (1998) while the use of public transport has reduced slightly from 24% (1996) to 22% (1998).

As far as businesses perceptions of traffic in the *Celio* district are concerned: 55% (1996) and 54% (1998) consider it very bad, 26% (1996) and 24% (1998) bad, 13% (1996) and 15% (1998) acceptable, and only 6% (1996 and 1998) good. Thus, despite the benefits in terms of traffic calming, businesses perceived no difference.

Users' perceptions of safety when crossing *Via Celimontana* on foot was considered very bad by 37% (1996) and 39% (1998), bad by 26% (1996) and 22% (1998), and acceptable by 23% (1996) and 14% (1998). However, while 16% considered safety good or very good in 1996, in 1998 the remaining 25% considered it good or very good. Thus, while a higher proportion of businesses found road safety good or very good after the CAPTURE measures, the overall balance of opinion showed little change.

The impression the interviewees had of the environmental quality when walking through the district was very bad for 34% (1996) and 37% (1998), bad for 24% (1996) and 17% (1998), and acceptable for 20% (1996) and 24% (1998). The remaining 22% in both years said it was either good (18%) or very good (4%). These qualitative assessments show a distinct spread of views relating to the quality of the environment and point to a wide variety in expectations. The introduction of paid parking in the *Celio* district was unpopular with about 72% of businesses, although just over 1 in 4 agreed with the idea. Those against the introduction of paid parking proposed other solutions to the parking problems in the district: 28% requested more parking enforcement, 15% wanted more parking space, 11% wanted free parking, and 9% suggested special parking permits for businesses.

The opinions the business representatives had about the effects of implementing physical measures in the *Celio* district were:

- 44% felt the impacts had been positive, of which 64% cited slower speeds, 26% a safer pedestrian environment, and 7% far less noise;

- virtually the same proportion (43%) felt the results had been negative, of which 22% cited more traffic, 19% other negative effects, 15% 'chaos', 15% traffic congestion, 11%

negative effects for shopkeepers, 9% less parking spaces, 7% more noise and pollution and 2% less safety;

- the remaining 13% was divided between those who felt the situation was unchanged (8%) and those who did not know (6%).

The results of interviews with residents

In 1996, the traffic situation in the *Celio* district was considered by 53% of respondents to be 'very bad', 27% felt it was bad, and only 5% good. However, in 1998, the traffic situation is considered by 34% of residents very bad, 32% bad, 24% acceptable, 9% good and 1% very good. Thus, the CAPTURE implementations have had positive effects on the opinion of residents: there was a reduction of the negative opinion from 80% (i.e. very bad and bad in 1996) to 66% in 1998.

The same pattern was found regarding respondents' perceptions of safety when crossing *Via Celimontana* on foot: in 1996 safety was considered to be very bad by 30%, bad by 30%, acceptable by 24%, good by 13% and very good by 3%. In 1998, safety is considered very bad by 26%, bad by 27%, acceptable by 26%, good by 19% and very good by 2%. Thus residents believe the safety situation in *Celio* has marginally improved.

The impression residents have of the environmental situation walking through the district was: in 1996, very bad or bad for 36%, acceptable for 31%, and 33% good or very good. In 1998, the proportion feeling the environment was very bad or bad had increased by 9%, 3% less found it acceptable and 7% more found it good or very good. The residents thus have a more negative impression of the local environment in 1998 (43%) compared to 1996 (36%).

A majority of residents (59%) consider that the introduction of paid parking for non-residents (L 2,000/hr) had not solved the local transport problems, the remaining 41% felt it had. In this context the opinion of residents is more positive than that of local business.

A majority of residents did propose some alternative solutions to the parking problems in the Celio district: 28% required more parking enforcement, 16% more parking places, 9% free parking, 6% underground car parks, and 6% improved public transport.

The opinion residents have on the effects of implementations in the *Celio* district was:

- 42% felt the physical measures had been positive, of which 57% cited slower speeds, 16% better pedestrian safety, 13% less traffic, 6% more parking places, 6% aesthetic improvements and the remaining 2% the elimination of double parking;

- in contrast, 1 in 2 residents felt the results of the measures had been negative. Of these, 64% cited more traffic and 10% too narrow roads, 9% less pedestrian safety, 8% felt the visual environment was worse, 4% cited fewer parking places and the remaining 5% 'other' negative effects.

The opinions *Celio* residents have about the effects of the CAPTURE measures is more negative than those of businesses.

Interviews with visitors who had parked their cars in the test site

The interviews revealed that, in 1996, 55% of visitors against the 69%, in 1998, find a parking space in less than five minutes, 29% take between 10 and 15 minutes to park, compared with 26% in 1998, and the remaining 16% (1996) against 5% (1998) find a space in more than 20 minutes. The average time to find a parking space in the district was 9 minutes 40 seconds in 1996 and 7 minutes 10 seconds in 1998. Thus, the introduction of paid parking had reduced the time for visitors to find a parking space in the *Celio* district.

Visitors to the district arrive mainly on an occasional basis: about 29% (1996) and 48% (1998) go to the area 1-3 times a week, while about 32% (1996) and 8% (1998) go there more than four times a week, and the remaining 39% (1996) and 44% (1998) answered less than once a week. It is clear that the measures have had a marked effect on the market for non-residential parking spaces in *Celio*. The reasons for coming into the district in 1996 were travel to job (26%), travel in the course of work (17%), for family or personal reasons (41%), for shopping (5%), for pleasure (2%), and other reasons (9%). By 1998, only 8% of visitors travel to/from work, 20% travel in the course of work, 37% for family or personal reasons, 13% for shopping, 9% for pleasure and 13% for other reasons. So after the introduction of the physical measures and paid parking, the percentage of commuters reduced by 69% and there was an increase of the percentage of occasional visitors, who leave their car for shorter periods (1 or 2 hours).

The introduction of the measures has also benefited 73% of visitors, being able to find a space more quickly. Of this 73%: 40% stated that they used a private car, more in 1998 than in 1996, 34% made the same number of car trips, and the remaining 25% were not sure.

A1.9.3 Conclusions

The CAPTURE experience in the Rome test site was very interesting because the implementation of the physical measures was the first example of traffic calming measures in Rome and one of first examples in Italy.

The effects of the physical measures have been very positive, even if the opinion of residents is not too much positive: only 42% of the interviewed people (about 540 residents) think that the measures have had positive effects (168 elements). The shopkeepers have a slightly more positive opinion than residents (44%).

The main positive effects can be outlined as follows:

- a reduction of commuters’ private car traffic (10%) with a destination internal to the Celio district; anyway the intervention has encouraged the use of motorcycles (an increase of about 4%), while the use of public transport has been reduced of about 2%;
- a reduction of vehicles daily traffic (about 33%) and vehicles average speed (67% maximum value and 33% minimum value);
- a slight reduction of noise levels (about 1% during the day and 2% in the night).

Another positive aspect of this experience has been the collaboration of local residents associations the opportunity to contact the City Council for the approval and the realisation of the physical measures scheme and for their acceptance by residents and shopkeepers.

These positive results encouraged the extended use of the physical measures to all the Celio and to other areas in Rome with the same features, within the efforts of the City Council transport policy, which are directed to reduce private traffic into the historic centre by means of pedestrian areas, new rail transit systems, optimisation of the existing road public transport, telematic control of road lights and of the access to the historic centre, extended parking pricing.

Difficulties emerged during the project due to the bureaucratic process for the approval of the scheme and the scarce acceptance of the measures as a consequence of the lack of experience in this field. The presence of some politicians who accepted and supported these innovative measures has permitted their realisation.

The Italian experience in the CAPTURE project has demonstrated that the realisation of physical measures is easier in little cities than in larger cities like Rome.

A1.10 TAMPERE

A1.10.1 A description of the capture measures and the test site

Tampere is a city in southern Finland with a population of 190,000. Tampere has been classified in the CAPTURE project as a medium sized regional capital. The demonstration site of Tampere, bus route 26 of Tampere City Transport, is the high travel demand corridor running due south for 8 km and due west for 8 km from the city centre. The 18 km long bus route 26 is a typical cross-town route with 42 bus stops to both directions.

The following organisations were involved in the Tampere test site:

- The Ministry of Transport and Communications, Finland
- The City of Tampere
- Tampere City Transport
- Traficon Ltd.

Main goals

The main goal of the Tampere test site is to improve the situation of public transport in terms of modal split and travel speed. The expected impacts are:

- a 5 % increase in the average number of passengers per departure of bus route 26;
- a 2 % change from car to bus in modal split on the ’26 corridor’;
- a 10 % reduction in travel time on route 26.

Measures

Originally it was intended that 12 measures would be implemented along the CAPTURE corridor during the project. Three measures were abandoned (exclusive lane for buses at a junction, combining bus stops, enforcement of the use of bus lanes in the city centre). Cancellations were made, because some measures would have reduced the public transport service level if they would have made the buses faster. There were also various organisational and budget related reasons not to implement these measures.

The implementation of three measures was delayed. Unfortunately these measures are the most important measures to make the route 26 faster: exclusive lanes for buses passing traffic signals (2 cases) and traffic signal prioritisations. These measures were delayed because of organisational and institutional reasons and the resistance of residents. The weather in Finland was very cold during the spring of 1998 and this fact also delayed implementation. The aim is to implement these measures during the year 1999.

Exclusive bus lanes passing traffic signals were planned to be constructed at two junctions: at *Lempääläntie* and at *Pispalan Valtatie* Street. Buses could pass traffic signals from the right hand side using these new lanes. Implementation was delayed and lanes will probably be constructed during the year 1999.

Lane arrangements were made in summer 1998 at the junction of *Pispalan Valtatie* and the Nokia motorway to make the junction easier and faster for buses. An exclusive bus lane was constructed towards the city centre. Junction and lane arrangements were also made in *Hämeenpuisto-park* in autumn 1996: a turning lane was constructed for cars turning left from *Pirkankatu* to *Kortelahdenkatu* and the street *Kauppakatu* was cut off.

Pispalan Valtatie Street has now 2+2 lanes along the section between *Satakunnankatu* and *Rajaportti*. There is overall 1.5 km of bus lane at this section.

4 high quality bus stop shelters were installed at *Lempääläntie* in *Multisilta*. *A* bus stop boarder was also built at *Tammelan Puistokatu* Street, outside the CAPTURE corridor.

Traffic arrangements (including bus prioritisation) relating to the proposed Tampere Multi-Modal Passenger Terminal were simulated using the HUTSIM simulation programme

Low floor buses were introduced on route 26 during 1997.

Public transport priority at *Pirkankatu* between *Mariankatu* and *Satakunnankatu* was implemented using the SPOT-technique. SPOT optimises public transport prioritisation at several signal controlled junctions taking traffic situation into account: other examples of local SPOT controllers exist in Turin, Italy.

Traffic arrangements will also be changed in the Central Square of Tampere following a design competition. Construction works began in May 1998.

A1.10.2 The CAPTURE findings specific to Tampere

The effects of the CAPTURE measures have been studied by the following surveys:

- Bus Timings and Passenger Counts (‘before’-’after’ survey);
- Traffic Counts and Vehicle Occupancy Survey (‘before’-’after’ survey);
- Passenger Survey (‘before’-’after’ survey);
- Key Actor Interviews (‘after’survey).

Furthermore, some background information was collected during the project relating to accident statistics, bus fuel usage, air quality and private car travel times and delays.

The proportion of travellers using different means of transport

Modal split has been studied at two measurement points along the corridor: at *Lempääläntie* and *Pispalan Valtatie* Streets - presented in Table A1.10.1 below.

Table A1.10.1: Modal split in the Tampere test site

MODAL SPLIT, VEHICLES (%)				
	PISPALAN VALTATIE		LEMPÄÄLÄNTIE	
Survey time	**Modal split (%)**	**Sample size**	**Modal split (%)**	**Sample size**
Autumn 1996	Car: 82 Buses: 5 Goods vehicles: 11 Others: 2	8 592	Car: 79 Buses: 3 Goods vehicles: 17 Others: 1	5 048
Autumn 1997	Car: 81 Buses: 6 Goods vehicles: 12 Others: 1	7 991	Car: 79 Buses: 3 Goods vehicles: 18 Others: 0	4 907
Spring 1998	Car: 78 Buses: 4 Goods vehicles: 11 Others: 7	9 055	Car: 78 Buses: 3 Goods vehicles: 19 Others: 0	5 214
Autumn 1998	Car: 84 Buses: 5 Goods vehicles: 10 Others: 1	8 693	Car: 81 Buses: 3 Goods vehicles: 16 Others: 0	5 056
MODAL SPLIT, PERSONS (%)				
	PISPALAN VALTATIE		LEMPÄÄLÄNTIE	
Survey time	**Modal split (%)**	**Sample size**	**Modal split (%)**	**Sample size**
Autumn 1996	Bus: 48 Car driver: 39 Car passenger: 13 Others: 0	22 128	Bus: 30 Car driver: 53 Car passenger: 16 Others: 1	9 638
Autumn 1997	Bus: 50 Car driver: 37 Car passenger: 13 Others: 0	21 898	Bus: 30 Car driver: 53 Car passenger: 17 Others: 0	9 265
Spring 1998	Bus: 38 Car driver: 43 Car passenger: 16 Others: 3	19 366	Bus: 23 Car driver: 58 Car passenger: 18 Others: 1	8 592
Autumn 1998	Bus: 48 Car driver: 38 Car passenger: 14 Others: 0	21 952	Bus: 26 Car driver: 56 Car passenger: 18 Others: 0	9 101

Pispalan Valtatie was the main street running west from the city centre and 6 bus routes of Tampere City Transport drive along the street. Furthermore, many private bus routes drive via *Pispalan Valtatie*. At *Lempääläntie* there are not as many public transport routes; thus public transport is more used at *Pispalan Valtatie*.

It can be seen from the table above that there were no great changes in modal split between Autumn 1996 and Autumn 1998. However, in the Spring of 1998, the proportion of buses and especially bus passengers were lower than in other surveys conducted. One reason for this is the fact that many bus passengers cycle or walk in spring, when the weather is better.

It is difficult to estimate the changes in travel behaviour referring to these surveys. That is because sample sizes were small in the surveys (one day surveys). There were no great differences in the weather during the survey period. However, it can be said that the implemented CAPTURE physical measures had no effect on the modal split at these locations.

Operational efficiency

The operational efficiency of route 26 has been surveyed by timing surveys. Some indicators are presented in Table A1.10.2 below.

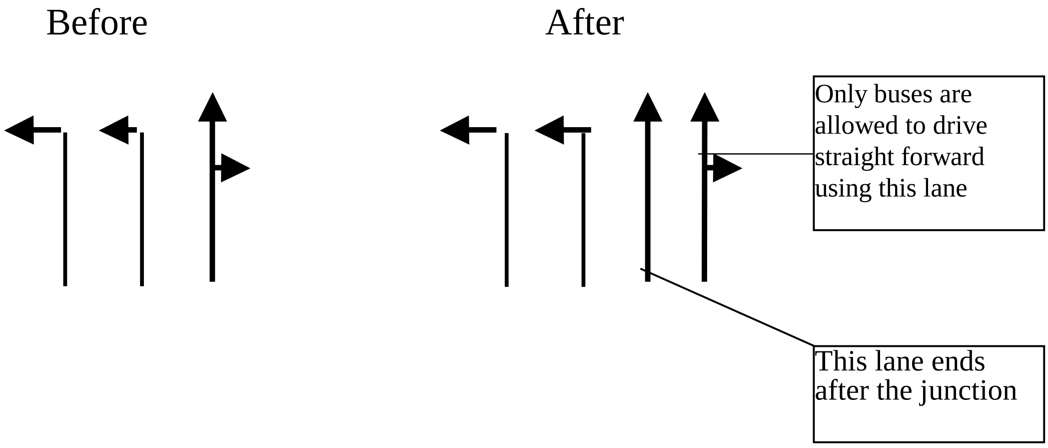
Table A1.10.2: Operational efficiency

Survey time	**Travel speed (km/h)**	**Mean total delay/departure (min)**	**Percentages of delay types (%)**
Spring 1996	26.6	Not measured	Not measured
Autumn 1996	26.3	12.2	Passenger board/alight: 55 % Traffic signals: 31 % Other including schedule balancing: 14 %
Spring 1997	26.6	13.3	Passenger board/alight: 54 % Traffic signals: 28 % Other including schedule balancing: 18 %
Spring 1998	27.0	13.0	Passenger board/alight: 55 % Traffic signals: 33 % Other including schedule balancing: 12 %
Autumn 1998	26.2	13.4	Passenger board/alight: 55 % Traffic signals: 29 % Other including schedule balancing: 16 %

There are no great changes as far as travel speed and delays are concerned. This could be expected, because only detailed design measures were implemented. It seems apparent that the most effective way to make route 26 faster is to implement traffic signal prioritisation. It is difficult to reduce bus stop delays, but it should be possible to reduce traffic signal delays (currently about 30% of all delays).

In the following description, the effects of one single measure are described. At the junction of *Pispalan Valtatie* Street and *Nokia* motorway, an exclusive bus lane was constructed for buses driving towards the city centre. Earlier there were two lanes for vehicles turning left and one lane for those driving straight forward or turning right. Now there are two left turning lanes, one lane for vehicles driving straight forward (general traffic lane) and a combined lane for buses driving straight forward and vehicles turning right.

Figure A1.10.a: Lane arrangements at the junction towards the city centre:



Thanks to this new exclusive bus lane, buses can drive straight up to the junction passing private cars. This bus lane continues after the junction, while the general traffic lane (straight forward over the junction) ends. As a result of the lack of space, the general traffic lane ends almost immediately (about 30-40 m) after the junction. This creates problems and conflicts, because cars try to drive fast and merge to join the continuing lane before the buses. There are also quite a lot of private cars, which illegally use this new bus lane when crossing the junction.

In Table A1.10.3 some indicators concerning this measure are presented.

Table A1.10.3: Changes at the Pispalen valtaltie/ Nokia motorway junction

Survey time	**Bus travel time over the junction (seconds)**	**Bus delay/departure at the junction (seconds)**
Spring 1997	90	36
Spring 1998	79	24
Autumn 1998	72	19

Even though the travel time of route 26 from the terminus to the end of the route was the same, this measure clearly showed that these kinds of physical measures really can speed up bus traffic. However, if large changes in travel times and speeds are required, a package of measures must be implemented in one single corridor, because the effect of one measure easily disappears due to the varying conditions of the traffic network (weather, traffic volumes etc.).

The passenger loadings of route 26 are presented in the following table.

Table A1.10.4: Passenger loadings

Survey time	Passengers/service run	Total passenger amount/day
Spring 1996	64.4	7,234
Autumn 1996	67.8	7,649
Spring 1997	63.7	6,100
Spring 1998	62.4	4,953
Autumn 1998	64.6	6,024

Regional transport operations began in early 1997 in the Tampere region. Nowadays same bus tickets can be used in buses of both the private companies and Tampere City Transport. Due to the new regional transport operations, Tampere City Transport has decreased the number of departures on route 26. Earlier there were about 55 departures/day and currently there are about 45. This has reduced the total number of passengers/day. There are no great changes in the number of passengers per service run, especially when autumn surveys are regarded.

Passengers' perceptions on transport modes and measures

In the Public Personal Surveys interviewees' images about various travel modes (bus, car, cycle and walk) were asked using pairs of adjectives (e.g. relaxing <> troublesome, fast <> slow). Passengers were asked how certain adjectives describe various travel modes. As far as bus is concerned, the following results could be found. Bus was regarded as

- the safest (in all 4 surveys made)
- the easiest (in 3 of 4 surveys made)
- the most uncomfortable (in all 4 surveys made)
- the least flexible (in 3 of 4 surveys made).

Because bus was regarded as the easiest, interviewees probably thought that it is easy to be bus passenger on board bus (e.g. compared to driving car by yourself). In other questions (uncomfortable, least flexible) the whole travel chain has been taken into account.

In autumn 1998, passengers were asked, which physical measure was the most important for them on route 26. Low floor buses were cited as the most important improvement (by 44% of interviewees). 20% thought that the exclusive lanes passing traffic signals (not yet implemented) would be the most important, and 12% answered that the bus lanes at *Pispalan Valtatie* Street were the most important measure.

Public transport service level improvements on route 26 were mentioned by 68% of interviewees as a result of the CAPTURE measures implemented.

A1.10.3 Conclusions

It seems apparent that those CAPTURE measures, which have been implemented in Tampere, have had no direct effect on increasing bus patronage on route 26 nor have they affected the modal split. However, bus passengers think that the level of service quality on route 26 has increased thanks to the CAPTURE measures.

There were no significant changes in bus travel speeds and reduced delays. This is not a surprise, because only detailed design measures were finally implemented. These measures were:

- Bus lanes at *Pispalan Valtatie* Street in both directions (total 1.5 km). However, *Pispalan Valtatie* Street is a very fluent street without great problems at this section, and these bus lanes have had no marked effect on bus speeds;

- An exclusive bus lane at the junction of *Pispalan Valtatie* and *Nokia* motorway. The new lane makes it possible for buses to pass car queues before traffic signals. Mean travel time of bus (from the bus stop before the junction to the stop after the junction) decreased by 7 seconds compared with previous surveys made in the spring of 1998. Traffic signal priority for buses will be implemented later at this junction;

- Traffic signal priority (SPOT technique) for buses at *Pirkakatu* Street. The system was in trial use, when the last survey round was made. The implementation of the system has proved to be difficult (the first application in Finland), and the SPOT system has not yet operated optimally.

In more general terms it can be concluded that in cities of the density and structure of Tampere that:

a) Bus lanes on their own would give limited advantage given traffic conditions
b) But a combination of a and b with light priority is the answer and gives a relative advantage to buses over cars. However in cities like Tampere it is unlikely to expect this to create a mode shift without ‘stick’ measures.
c) Detailed physical measures at junctions may assist bus vehicles and reduce delays where traffic levels do not warrant bus lanes on the whole stretch of road

A1.11 VITORIA-GASTEIZ

A1.11.1 Introduction

This report summarises the situation in Vitoria-Gasteiz as the demonstration test site within the CAPTURE project.

The trial was eventually not implemented due to a cumulative set of circumstances, which modified the original plans according to the CAPTURE timetable. This report focuses on those items carried out throughout the implementation process revisiting the main obstacles encountered.

First, a brief description of the test site is given in order to provide an overview of the scheme and second, a review of the initial plan of CAPTURE measures is presented. The demonstration was defined according to the CAPTURE methodology, trying to obtain practical indicators related to the objectives and expected impacts through the measurement of relevant parameters. A data compilation campaign was conducted to obtain the 'before' measurements of which the main results are provided in Section A1.11.3. After this phase, the implementation, process commenced as described in Section A1.11.4.

Following political changes which prompted a review of transport policy, a new scheme of measures to be implemented in CAPTURE was discussed and approved, but unfortunately outside of the CAPTURE deadlines. However, the Vitoria-Gasteiz experience does shed light on some key implementation issues which may help the decision making process in those municipalities in Europe which are attempting to encourage a modal shift to cleaner modes of travel.

A1.11.2 A description of the Vitoria-Gasteiz demonstration site

A1.11.2.1 <u>The Study Area</u>

Vitoria-Gasteiz has a population of 215,000 inhabitants with a population density of 25,000 hab/km^2. The city enjoys a well-developed road network.[1] The existence of a central hill as a geographical obstacle has led to two one-way circular roads being implemented with radial roads providing access links to the central area depending on the topography. Longer distance trips comprise only 4% of the total number of trips compared to approximately 530,000 local trips/day within the city. These trips are distributed among the different modes of transport as follows: 13% by public transport, 31% by private vehicle and 56% on foot. Daily traffic flows on downtown main streets may reach 20,000/25,000 vehicles/day as maximum, and up to 800 vehicles/hour-lane at peak hours. The pedestrian area is essentially located downtown, with

[1] Back in the early 80s, Vitoria-Gasteiz was one of the first Spanish cities to incorporate pedestrian laws, parking regulations, via security policies, traffic circulation improvements and regulation and usage of advance tools for traffic management. These measures made the city a reference for the rest of Spanish cities. It has been observed over the last few years that influences such as city growth and diversification, the elevated use of motorised vehicles and its uncontrolled development as well as the low rates for public transport use, have slightly deteriorated this scenario. This situation takes into account the rational end point for initial measures (80s) and the need to incorporate a new fresh wave of planning methodology.

up to 40,000 m^2 and approximately an additional 60,000 m^2 semi-pedestrian zone. It also has a bicycle lane network about 30 km long.

The chosen trial area for CAPTURE was the *Ensanche* district which represented a district typical of the problems transport policy was addressing. The *Ensanche* area attracts many trips and needs to improve its public transport operations and the walking environment. Such measures may lead to disadvantages for private vehicles either within *Ensanche* or driving through it to other parts of the city.

A1.11.2.2. The objectives of the demonstration project

The Vitoria-Gasteiz trial assesses the viability of certain physical measures as technically accepted and politically feasible options.

The overall intended aims of the scheme as initially proposed by the City Council were:

- to enlarge and develop the main pedestrian area, to promote public transport, cycling and walking in the *Ensanche* area and to reduce the use of private vehicles.

The objectives in terms of desirable impacts are the following:

- to prove that by giving priority to public transport facilities over private cars public transport travel times can be improved;
- in parallel to this, a set of alternative options which minimise the disbenefits to private vehicles (i.e. simple measures to improve the capacity of other roads without causing undue environmental impacts).

The expected impacts of CAPTURE in Vitoria were:

- a 25% reduction of private vehicle trips through the city centre;
- a 10% increase in the use of public transport.

A1.11.2.3. A description of the measures

The physical measures typologies considered in this scheme can be grouped in the following 4 types:

Pedestrianisation	**Access restrictions**	**Public Transport**	**Parking**
• Widening of side walks • Increase pedestrian zones	• By type of vehicles • By changes in road geometry • By traffic light restrictions	• Bus lanes or bus only streets • Bus Terminal relocation • Bus Stop relocation • Line itinerary changes • Changes to traffic flows	• For residents only • For loading/unloading operations only • Parking restrictions • The creation of new parking spaces • The creation of time regulated surface parking lots

Accompanied by general traffic calming strategies as those including urban furniture. And other specific designs: bollards, raised junctions, road hump, narrowing, signs and markings.

A1.11.3 The surveys conducted

According to the scheme of measures initially approved, the following surveys were conducted:

Surveys completed

- O/D survey for those motorised vehicles using the *Ensanche* Area (Roadside survey on a cordon).
- Traffic counts (automatic) on selected sections to define the flows in the *Ensanche* Area.
- Traffic counts (manual) and vehicle classification at selected points on the cordon.
- Pedestrian counts at selected points in the cordon.
- Bus timing and passenger count surveys to identify public transport patterns in the *Ensanche* Area.
- On the street-survey in order to identify individuals' perception about the *Ensanche* Area.
- Accident data collection in the *Ensanche* Area.

Programmed surveys not conducted

- Public transport vehicle fuel use records.
- Energy consumption and vehicle emissions.

A1.11.4 The findings

The impacts of the CAPTURE measures proposed for Vitoria-Gasteiz have not been possible to fully evaluate due to the failure to implement them for political reasons. However, the test site has a value for CAPTURE in assessing the issues surrounding the implementation process and how these relate to the current situation and public acceptance of the suggested measures.

A1.11.4.1. <u>The implementation process</u>

Even when the planning stage is designed in order to guarantee an adequate process of implementation, the political acceptance and its social support is needed to reach the expected goals. In this case, the planning process was started by the Traffic Department of the municipality who produced a Traffic Master Plan for all transport modes within the city.

The planning process can be classified in the following stages:

- Preliminary studies: those including a diagnosis of the current status and problems concerning the transport system and the urban environment. Technical staff from the Urbanism Dept., Public Transport Authority (TUVISA), Traffic Dept. and Public Consultation Dept. produced suggestions to solve the main problems encountered. The CAPTURE physical measures were designed during this stage (1995 and 1996).

- Mobility studies: under the direction of the Transport Dept. of the Basque Government, a Household Mobility Survey was produced in order to provide the municipality with a relevant wide database for transport planning purposes. After this, the municipality started to develop an analytical transport model (EMME/2) to better understand urban mobility. The model analyses the traffic and environmental impacts of different policy alternatives. This stage was covered in 1997 at the time of the 'before' CAPTURE surveys.

- The Traffic Master Plan (TMP) was finally produced including all of the background studies and a definition of each measure to be implemented. These measures were the result of feasibility studies. This Plan was approved during 1997 and it is included in the scheme of CAPTURE measures[2].

Despite the degree of forward planning and design, the political climate has been inappropriate for the success of the demonstrator for the following reasons:

- First, other suggested schemes in Vitoria have diverted the political attention away from the initial plan. The Basque Government has introduced a new plan to build and finance a Light Rail Transit (LRT) System in Victoria without any previous consultation to the City Council (mid 1997). These circumstances have produced a lot of discussions and public consultation process, affecting directly the implementation of the CAPTURE measures. Finally the LRT offer was rejected by the city.

- The existing political composition of the city council when CAPTURE was launched has been modified several times during the course of the project affecting directly the Traffic Department in charge of CAPTURE. Initially, in 1996, the Traffic Councillor was from the Socialist Group; in 1998, the councillor represents the opposition (Basque Nationalist Party). These circumstances have produced a hiatus in leadership and reduced the priority of the CAPTURE measures in the context of a debate about the LRT Project which split public opinion.

- Finally, municipal elections in November 1998 produced a slower political momentum to implement CAPTURE measures, even when the Traffic Department had tried to define a new scheme of measures, more simple than the previous ones.

A1.11.4.2 <u>The transport situation at the time of designing the CAPTURE measures</u>

Some aspects of the current situation regarding the transport system have been studied within the CAPTURE project, according to its survey methodology. The following tables summarise the results of the 'before' surveys:

[2] For the CAPTURE demonstration in the Vitoria-Gasteiz test site, several measures of this TMP were taken as an integrated scheme of measures: i.e. those physical measures considered within the *Ensanche Area*.

Description	Obtained result
Index of numbers of passengers carried by bus (peak period: 12.30-14.30)	3,279
Index of numbers of cars recorded (daily average, entrance to the study area)	44,000
Average car occupancy	1.37
Index for numbers of cyclists recorded (daily average)	260
Index of numbers of pedestrians recorded (daily average, entrance to the study area through out main pedestrian routes))	34,500
Modal split (percentage) for vehicles before implementation	
PT	2.48
Car	76.84
Cycle	0.58
Other	20.10
Modal split (percentage) for persons before implementation (not walking)	
PT	33
Car	67
Other	-
Speed of PT operation (average in the study area, km/hr)	9.28
Average speed of private car travel on route (km/hr)	15

The surveys and their analysis of results have provided to the municipality with evidence for action:

- Public transport commercial speeds need to rise to improve its patronage level relative to other modes;
- To increase the level of the service to private vehicles to reduce congestion in the city centre (such as access restriction strategies);
- New strategies have to be designed to improve the accessibility to the city centre by both public transport and on foot (such as reviewing parking policy).

A1.11.4.3. <u>The effects on people's perceptions of the transport system</u>

These can be summarised in the following 5 items, in order of importance:

- Measures related to parking strategy is the issue concerning people the most, i.e. number of parking lots for residents and to combat illegal parking;
- Measures designed to increase the level of safety for cyclists have to be reinforced;
- To improve the image and quality of public transport;
- People will accept strategies to restrict the use of private vehicles if public transport is improved;
- More pedestrian areas are not perceived as priority because they feel that the existing pedestrian areas are enough.

A1.11.5 Conclusions

The integrated package of proposed measures for the city centre of Vitoria-Gasteiz requires implementation in a number of phases. The planning and design studies that have been completed and the public consultation exercise has demonstrated the feasibility of the project and its public acceptance. The political support for the trial has been diverted due to reasons mainly linked to the political elections and until the next Government composition is clarified.

APPENDIX TWO DETAILED RESULTS FROM SPECIALIST SURVEYS OF CAPTURE DEMONSTRATIONS

In this annex the detailed results of surveys with particular concerns in each city within CAPTURE are presented. The annexes consist of:

2.1 Evaluation of effects on pedestrians and cyclists
2.2 Safety evaluation
2.3 Evaluation of effects on people with reduced mobility

2.1 EFFECTS ON PEDESTRIANS AND CYCLISTS

Introduction

The purpose of this report is to describe the impacts of the CAPTURE demonstration projects on pedestrians and cyclists. The evaluation is based on the descriptions of the physical measures, survey data supplied by the cities and site visits. It attempts to make judgements about positive and negative impacts, which cannot always be deduced from the survey results. It is mainly concerned with changes in conditions for pedestrians and cyclists rather than actual changes in the walking and cycling modal share which are hard to detect, even when specifically monitored.

2.1.1. Brescia

<u>Pedestrians</u>

- High levels of walking in the central area, including to/from buses.
- No specific measures for pedestrians were incorporated in the CAPTURE measures.
- Bus priority at traffic signals is likely to have slightly increased the pedestrian waiting time at these signals.
- No obvious effects of the parking management system on pedestrians.
- Increased bus speeds in narrow streets due to bus lanes have increased hazards, particularly as footways (sidewalks) are often narrow and the radii on corners are sometimes very tight. Also the raised bus lane markings are difficult to cross with wheelchairs, buggies etc.
- No information available on the attitudes of pedestrians to the measures - but unlikely that they would notice any impacts.
- Overall, the CAPTURE measures are unlikely to have had a significant impact on levels of walking. In so far as the measures have improved public transport relative to private cars, they may have improved general walking conditions. However, there are no measures to specifically improve walking conditions and several associated features or outcomes may have made walking conditions slightly worse in certain locations.
- Additional or improved pedestrian crossing phases *could* have been provided within the new signal traffic-control systems, given higher policy priority, and some additional planning and resources.

Cyclists

- Medium levels of cycling.
- No specific measures for cyclists were incorporated in the CAPTURE measures.
- Increased bus speeds in narrow streets has slightly increased hazards to cyclists.
- No obvious effects of the parking management system on cyclists.
- No information available on the attitudes of cyclists to the measures.
- Modal split and traffic flow effects are not yet available.
- Overall, the CAPTURE measures are unlikely to have had a significant impact on levels of cycling. In so far as the measures have improved public transport relative to private cars, they may have improved general cycling conditions. However, there are no measures to specifically improve cycling conditions and increased bus speeds may have made conditions slightly worse.
- It might have been possible to provide advanced stop lines for cycles at traffic signal junctions but legality of such measures is uncertain in Italy.

2.1.2 Bucharest

Pedestrians

- Medium/high levels of walking.
- Limited specific measures for pedestrians (pedestrian crossing refuge on *Unirii* Blvd./*Dimitire Cantemir* Blvd.; pedestrian area on *Unirii* Blvd.).
- Bus lanes increase the separation distance between most motor vehicles and pedestrians, which should increase pedestrian comfort and perceived safety - although as there is already a parking lane this effect may be small.
- Although public transport has increased its modal share, total motor traffic flows have increased which will reduce pedestrian comfort, etc.
- Modal split changes are not available for walking. Probably no significant change or slight decrease due to improved public transport service.
- The pedestrian refuge will help pedestrians to cross more easily, in two phases if necessary.
- On *Elisabeta* corridor, before every junction the kerb is modified to permit easier access for different categories of people (especially for disabled persons who use wheelchairs).
- Easier interchange (in *Unirii* Square only) has reduced pedestrian walking distances and improved their safety.
- The pedestrian area measure in *Unirii* Square was not implemented due to lack of funds.
- No walking lobby or pedestrian representative group. No specific views from pedestrian standpoint.
- Overall, only minor changes to pedestrian conditions as a result of CAPTURE measures.

Cyclists

- Very few cyclists in central Bucharest.
- Cyclists are permitted to use the bus lane. Bus lanes are beneficial to cyclists - although the *Unirii* Blvd. lane is only 600m at present.

- One bus stop build-out was constructed on *Elisabeta* Blvd. in *Kogalniceanu* Square, but others were not implemented. (These project into the carriageway and can be hazardous for cyclists unless there is normally kerbside parking.)
- Introduction of trolley buses has probably had a slight positive effect on cycling conditions: quieter, cleaner, fewer buses, following a more predictable path.
- Speed limit signs on *Elisabeta* corridor were implemented at one location only - to protect an old building - with no noticeable impact.
- There is a non governmental organisation, called TER, which tries to lobby for cyclists. However, the cycle lobby is weak.
- If the principles of a public transport lane and control of parking are accepted by the authorities and the public, particularly the Traffic Police, this could be very beneficial to cycling conditions, both by the creation of more bus lanes and parking controls, and also by establishing the principle that sustainable transport modes should be given priority within traffic management planning.
- No effect on bicycle modal share.

2.1.3 Copenhagen

Pedestrians

- Medium/high flows of pedestrians.
- New and modern bus shelters at bus stops - but counted as a benefit for bus passengers.
- More complex crossing environment for pedestrians as bus priority lane is not continuous and changes sides.
- Higher speed buses.
- Relocation of bus stops closer to corners to improve convenience has reduced some walking distances.
- Some complaints due to the reduction in the number of bus stops.
- Improved safety by separation of bus passengers from cycle track by relocation of cycle track to back of bus stops.

Cyclists

- High cycle flows.
- Higher speed buses now pass closer to cyclists - slight increase in those cyclists finding this a problem.
- Bus priority (special signal for buses) at intersections also includes special priority signals for bicycles.
- Relocation of cycle track to back of bus stops is considered generally beneficial to cyclists. However, the percentage of cyclists now finding alighting/boarding passengers to be a problem has increased.
- Relocation of bus stops closer to corners masks cycles from turning vehicles and creates a safety hazard for cyclists.
- More and better quality of cycle parking facilities at the bus terminal.
- Overall the attitude surveys with cyclists found a slight increase in those who thought conditions had worsened. However, this was not large and the bicycle modal share had not declined.

2.1.4 Greater Manchester

Pedestrians

- New or modified pedestrian refuges at 6 junctions should help pedestrians to cross more easily.
- PUFFIN crossings (innovative signal-controlled pedestrian crossings) are to be introduced at 4 locations. These should help pedestrians to cross more easily.
- Bus boarders and low floor buses are beneficial to bus passengers, not only to those with a recognised mobility impairment. Reduced problems with stepping onto the bus and fewer obstructions by parked cars.
- The bus boarders probably make it easier for all pedestrians to cross the road at the bus stop by reducing the crossing width and providing a section free from parked cars - but on one side only.
- Bus lane measures will presumably increase the separation distance between pedestrians and most motor vehicles, which should increase pedestrian comfort and perceived safety.

Cyclists

- Bus lanes and cycle lanes should be beneficial.
- The consultation publicity (e.g. leaflet) presented the principles as a joint bus/cycle scheme, planned in an integrated way, which is helpful to promoting cycling in general and may establish/reinforce the principle of integrated planning, design and implementation of sustainable modes.
- Sections of cycle lanes are to be provided where there is no bus lane, where possible.
- The width of the bus lanes and cycle lanes largely determines the level of service for cyclists. The bus lanes will be 3.5m wide and the cycle lanes 1.5m wide. The 3.5m bus lane is narrower than desirable but still provides a valuable facility for cyclists; the 1.5m cycle lane meets UK standards.
- Increased restrictions on kerb-side parking, and increased parking enforcement that bus lanes bring, will benefit cyclists.
- Bus boarders (capes) that project into the carriageway can be hazardous for cyclists unless there is normally kerbside parking which is the case at these sites.

2.1.5 London

Pedestrians

- Very high flows and densities of pedestrians in central London, particularly at Camden Lock Market.
- Footway widening (Camden High Street) was for pedestrian benefit. It was implemented as an indirect bus priority measure although it benefited general traffic as well as buses. The official use of footway space for delivery vehicles outside peak pedestrian times is unusual and innovative.
- Pedestrian crossing facilities have often been incorporated into new bus priority signals.
- Traffic reduction (Hammersmith Bridge closure) has improved the pedestrian environment on the bridge and its immediate approaches.

- Traffic restraint (Hammersmith Bridge closure) has led to a mode shift to walking on the corridor itself (the only measure to do so).

Cyclists

- Bus priority measures generally beneficial to cycles.
- Cycles are permitted to use most bus lanes and bus priority measures in London. Where restrictions are imposed, e.g. some contra-flow bus lanes, these are often ignored by cyclists and hard for the police to enforce.
- There is an increasingly integrated approach to the planning of the London Bus Priority Network and the London Cycle Network.
- Although bus lanes are often below the desirable width for buses and cycles (4.0-4.5m), any bus lane is usually beneficial to cyclists compared to no bus lane.
- Traffic restraint (Hammersmith Bridge closure) has led to a mode shift to cycling on the corridor (only measure to do so).

2.1.6 Madrid

Pedestrians

There are no direct impacts on pedestrians from the motorway HOV lane. There may be some indirect impacts from the increased motorway traffic capacity on the pedestrian environment in the city but these are likely to be diffused and have not been evaluated.

Cyclists

There are no direct impacts on cyclists from the motorway HOV lane. There may be some indirect effects in the city, as above for pedestrians. There are few cyclists in Madrid.

2.1.7 Mytilini

Pedestrians

- High concentrations of pedestrians and a high percentage of local journeys on foot.
- Pedestrianisation scheme (temporary barrier) popular with local traders and businesses. (Views of pedestrians not obtained.)
- The relocation of the bus station, enabling pedestrianisation of *Saphous* Square, has improved the pedestrian environment in this central area (though no specific survey data).
- The shuttle bus has attracted a very high percentage of pedestrians. A majority of passengers previously walked to the city for the same trip, and 34% said they would otherwise have walked on the present trip.
- CAPTURE bus user survey shows everyone is dissatisfied with the condition of the sidewalk pavements leading from their houses to the bus stops.
- Other pedestrian measures not yet implemented.

Cyclists

- No specific cycle measures.
- Very few cyclists.
- No obvious impacts.

2.1.8 Orvieto

Pedestrians

- High concentrations of pedestrians in compact historic area.
- Comprehensive walking 'aids' (escalator and elevator), proposals to improve pedestrian routes and to reduce motor traffic levels.
- Some traffic calming to reduce speeds which helps pedestrians.
- However, traffic flows increased by around 10% - this could be statistical sampling error or background trend.
- The measures could significantly increase the distance that drivers are prepared to walk from their cars to their final destination, and the public transport catchment area, and local walk trips in general - but yet to be fully implemented.
- Survey report does not give details of impacts on pedestrians, or the pedestrian counts.

Cyclists

- Few cyclists due to topography - steep gradients on access roads to La Rupe.
- No specific measures for cycles.
- Reduced traffic flows and fewer heavy buses should improve conditions for cyclists. However, traffic flows have increased - as above.

2.1.9 Rome

Pedestrians

- Reduced traffic flows (-50%) and considerably lower speeds have improved conditions for pedestrians (as measured by speeds and flows). Large vehicle flows have decreased by 66% but motorcycle flows have increased slightly.
- The perceptions of residents and businesses regarding traffic, pedestrian safety and the environment, following the physical measures, were mixed. Business people felt that conditions had improved. However, more residents (36% 'before' and 43% 'after') thought that the environment when walking had worsened and that traffic had increased. It may be that some people perceive more constant traffic flows, even though slower moving and fewer vehicles, to be "worse" than faster, intermittent traffic.
- Easier crossing at 2 narrowed intersections.
- Angle parking creates some crossing problems - harder for pedestrians to pass between parked cars. (But the more orderly parking is helpful.)
- Pedestrian flows seem to have increased - but not statistically significant.
- No walking lobby or pedestrian representative group. No specific views from pedestrian standpoint.

Cyclists

- No specific cycle measures.
- Few cycles.
- Reduced traffic flows, fewer large vehicles and lower speeds beneficial to cyclists.
- Narrowed carriageway at build-outs can result in cyclists being squeezed by overtaking motor vehicles, or harassed by those unable to pass.
- Angle parking creates dangers to cycles - vehicles reversing with poor visibility.
- No cycling lobby or cycling representative group. No specific views from cyclists' standpoint.

2.1.10 Tampere

Pedestrians

- No specific pedestrian measures - earlier plans for zebra crossings and additional sections of footway were not implemented.
- Pedestrian flows not surveyed but considered "low" (*Pispalan Valtatie*).
- Cycles track now located on the south side footway. Such changes are usually unpopular with pedestrians. No additional width provided although 4m width is a good standard for shared use at low flows. No segregation of any form between cyclists and pedestrians - quite usual in low flow locations.
- Bus priority (SPOT) at traffic signals is likely to have slightly increased the pedestrian waiting time at these signals.
- Bus lanes increase the separation distance between most motor vehicles and pedestrians, which should increase pedestrian comfort and perceived safety.
- No walking lobby or pedestrian representative group. No specific views from pedestrian standpoint.
- No user views in surveys.

Cyclists

- Cycle flows moderate (100 in peak hour, two-way, on *Pispalan Valtatie*)
- Cycle lanes (both sides) removed to create bus lanes and relocated to the footway on the south side only. This was already 4m wide and was not widened. This is usually less convenient for commuter cyclists but possibly preferred by less-confident cyclists. Compulsory for cyclists to use cycle tracks.
- Cycle track/footway is interrupted by 3 side roads and 11 accesses to houses along its 700m length. In these locations, drivers are legally required to give way to cyclists on the cycle way, although it can be confusing.
- Previously it could be dangerous to use the roadside cycle lanes during winter because of snow: snow was cleared from the motor vehicle lane, but there was always snow on the cycle lane. House owners are responsible for clearing the snow from the walk/cycle track and most house owners do it as soon as possible.
- No cycling lobby or representative group. No specific views from a cyclist standpoint.
- No user views in surveys.

2.1.11 Vitoria Gastiez

Pedestrians

- Proposals would directly benefit pedestrians due to widened footways (side walks), access restrictions which reduced traffic flows and traffic calming to reduce speeds. However, measures not implemented.

Cyclists

- No specific measures for cyclists. However, the proposals would benefit cyclists due to reduced traffic flows and speeds - but not implemented.

2.2 SAFETY EVALUATION IN EACH CAPTURE TEST SITE

The annex will highlight some details of the implementations made in the test areas and corridors as well as other factors that have been seen as important when brought into the context of the safety evaluation work of the CAPTURE measures introduced.

2.2.1 A summary review of the test sites

Brescia

General remark: No data available from the area outside the test site.

Interaction: The rather high levels of pedestrians in the areas could indicate risks for accidents as no specific measures were taken for this group. However, as the access to the area by private cars has been decreased the overall assessment is that the new patterns of interaction have not increased the risk.

Exposure: As the number of vulnerable road users are the same no changes in exposure can be identified.

Modal choice: There is a reported increase of public transport users.

Route choice: Changes not reported.

Speed choice: The measures implemented have established priorities for buses and as a consequence the speed of public transport has increased. Under the circumstances (narrow streets, many pedestrians, etc.) this must be indicated as a somewhat negative effect.

Bucharest

General remark: The size of the CAPTURE measures are relatively small.

Interaction: Cyclists are allowed in the bus lane which will increase the possibilities for interference and therefore also the risk. It is not a serious matter for the moment as the bus lane is only 600 m but when it is expanded this risk has to be taken into account.

Exposure: The total flows of all modes have increased and it could be stated that the general level of risk might have increased, but this is a general trend in the city and not related to the set of CAPTURE measures.

Modal choice: The proportion of public transport has increased relative to the other modes.

Route choice: No changes reported.

Speed choice: No changes reported.

Copenhagen

General remark: The CAPTURE measures introduced are both physical and technical (information systems). At the same time a parallel motorway has been built and the traffic there has started during the CAPTURE demonstration. This motorway is included in the set of measures evaluated for their combined safety effects.

Interaction: The introduction of the bus lanes has created conflict situations at many of the bus stops between cyclists and passengers entering or leaving buses. There are also conflicts caused by parked cars in the bus lanes and between cars and buses when the bus lanes have to be 'merged' into ordinary street lanes.

Exposure: There has been no change in travel time in any of the modes using the corridor.

Modal choice: In the corridor no change is reported, the situation outside is unclear but could probably be clarified after some more analysis work.

Route choice: It is clear that some of the traffic has moved to the newly opened motorway, giving a somewhat positive safety effect both inside (lower flows) and outside (using a safer road type) the corridor.

Speed choice: No effects reported.

Greater Manchester

General remarks: Not all measures are in place.

Interaction: The joint use of the bus lanes at some places by buses and cyclists will increase the possibility of conflicts and the risk for accidents. However, as there also are special cycle lanes, the safety effects are only seen as somewhat negative.

Exposure: Data might be available to make possible an analysis of the changes in exposure, but such an analysis has not been performed.

Modal choice: There has been noted a small increase in the use of public transport use, especially the low-floor buses, but the data about modal split outside the corridor have not been thoroughly penetrated.

Route choice: An analysis has not been performed but could possibly be conducted using available data.

Speed choice: No changes have been reported.

London

General remarks: The CAPTURE schemes have not been implemented as planned, and the safety evaluation is based on other public transport related measures found in the London area.

Interaction: The use of bus lanes of cyclists (also with counter flows) will increase the number of conflicts, especially when combined with cars parked in the bus lanes forcing buses to make avoidance manoeuvres.

Exposure: There has been a small change in travel time reported, especially where bus priority schemes are implemented.

Modal choice: No specific data collection has been performed to cope with the modal choice in the specific CAPTURE area. Based on continuously on-going measures of travel patterns in London, such an analysis could be performed for London as a whole.

Route choice: Some of the measures (e.g. the bridge closure) have had somewhat positive safety effects. The effects on a larger scale are difficult to analyse, but could perhaps be found in the substantial data material collected.

Speed choice: No specific effects have been noted.

Madrid

General remarks: The measure implemented has been part of a large development scheme in Madrid and the expansion of a suburb area outside the city centre. The number of people travelling back and forth to this area has increased during the project period.

Interaction: The merging of HOV lane traffic with traffic in ordinary lanes has become a problem as the flow of vehicles has increased. The result is a queue of cars, the tail being found in the HOV lane forcing vehicles to an abrupt stop. Data collection has been performed so that after an analysis it might say something about the effects outside the corridor.

Exposure: The use of the HOV lane has made the time for travel less than before the introduction. However, the increase of the traffic in the last phase of the project has increased the time spent for travel again. An analysis on the areas outside the corridor can be performed.

Modal choice: An increase in the HOV lane use has been reported but data analysis related to the surrounding areas and the travel patterns as a whole have not been performed within the project.

Route choice: The routes chosen by the travellers shows a slight preference for using the HOV lanes (and the surrounding motorway network) introduced. However, an analysis of travel patterns as a whole has not been performed (data might be available).

Speed choice: The speed of the vehicles has increased slightly which might have a somewhat negative effect in the corridor. No analysis made outside the corridor.

Mytilini

Interaction: The pedestrianisation scheme has improved safety in the roads and square with high pedestrian flows. Against this, the future combined function of the new terminal (relocation of urban and interurban bus terminals combining with P & R sites) will result in the concentration of many traffic functions in the same area and may increase the accident risk.

Exposure: Pedestrians are at much lower risk in the pedestrianised streets, while there may be increases in surrounding streets due to route changes.

Modal choice: The introduction of the trial shuttle bus increased by 27% the number people who are using the bus instead of mechanised transport means (car, motorcycle).

Route choice: No changes.

Speed choice: No changes.

Orvieto

General remarks: The number of pedestrians are high in the historic area. There has been no reason to collect data about the area outside the test site. The measures have been implemented late in the project.

Interaction: The separation of the increased pedestrian areas from the public transport vehicles (and some other vehicles) is somewhat unclear and can cause a conflicting situation.

Exposure: Difficult to evaluate as no details about the movements in the area are available. The late implementation has not yet allowed the effects to be stabilised.

Modal choice: It is clear that the introduction of new parking schemes and the support for the pedestrians (escalator and elevator) will probably have a more clear effect in the future, but a change towards less use of cars in the test site area can be expected.

Route choice: No specific changes inside the test area are expected.

Speed choice: The speed of the remaining traffic in the test site has not changed so far.

Rome

General remark: The effects of the measures implemented are probably very local in the test site. Data about the surrounding area are not collected, but a traffic model can be used to analyse the effects of restricted access to an area, etc.

Interaction: The physical design of one of the new intersections (the inner part of the *Piazza Santa Maria*) allows very risky behaviour from many road users, mainly cars. During only a short observation period visiting the site a clear majority of cars in one direction makes a short cut crossing the other side of the street, and causes most of the on-coming traffic (however low volume) to make evasive manoeuvres or break heavily to avoid an accident. The situation could be easily be solved by a physical barrier in the street to 'guide' the traffic into the correct lane.

Exposure: In the areas the time for exposure is less but it is probable that it has increased outside the test site area.

Modal choice: Changes have not been identified. Outside area not analysed.

Route choice: This is the most positive effect of the measures implemented. It is very clear that the traffic flows have gone down in the test area, but it has not been possible to identify if and where these flows have been redirected.

Speed choice: The traffic calming measure has been effective and a lower speed has been reported from the test site. No changes in speed choices have been reported from the surrounding areas.

Tampere

General remarks: The implementation was partly delayed, and data collection made late. Some further analysis is possible.

Interaction: The merging between buses using bus lanes and ordinary traffic is "controlled" by signs showing 'right of way' for the buses. This situation can probably be improved by using other more advance signal control sequences of intersections.

Exposure: An analysis has not yet been possible.

Modal choice: No changes reported.

Route choice: The intention being a change of traffic from the test site corridor has been partly fulfilled. However, a full analysis of changes in travel patterns has not been performed within the project.

Speed choice: No changes reported.

Vitoria-Gasteiz

General remark: The CAPTURE measures proposed were not implemented.

2.3 EFFECTS ON PERSONS WITH REDUCED MOBILITY

Introduction

It is essential to show that the needs of elderly and disabled people have been taken into account in design, implementation and operation of physical measures. This group of society is composed of people who inter alia have reduced mobility when using transport services.

Throughout this appendix they will be referred to by the acronym PRM (for Persons with Reduced Mobility).

Research within CAPTURE dealt with special consideration of those with reduced mobility in the CAPTURE demonstrations but it soon became apparent that the national or regional picture was as, or more, important in terms of the consideration given to PRM in transport policy, and especially the physical aspects of transport policy. The research was conducted by means of special surveys of CAPTURE cities.

Accessibility audit

As a first stage in identifying what facilities might be provided to assist PRM, an Accessibility Audit was carried out. This took the form of a short questionnaire addressed to all cities in the consortium.

The first four questions asked whether any special facilities were provided for PRM on buses, light rapid transit (LRT) / tram services, metro / underground services and heavy rail services respectively. Six of the cities reported operating local bus services with low floor buses. Only three reported the provision of special services such as Dial-a-Ride. Four cities provide LRT services, only one of which was operated in the demonstration area. In three cases the services are wheelchair accessible. Four cities operate Metro services and all are wheelchair accessible. London commented that wheelchair access, while available, was not easy. Most cities operate rail services though not in the demonstration area. These services are generally wheelchair accessible.

The next three questions addressed issues relating to public transport infrastructure, the availability of service information and fare levels. Those cities which have fixed track services within the demonstration area generally provide step-free access from street to platforms and between platforms. Access to bus and coach stations is also step-free. Other facilities are more limited: one city offers signage designed to assist the visually impaired, and one offers inductive loop systems for people with hearing aids. Six cities offer public transport information in large print versions; two offer Braille and teletext facilities. Concessionary fare facilities for PRM are generally available. A nice service is offered in Tampere, which permits push-chair users to travel free.

The final set of questions related to facilities associated with taxi, private car and pedestrian movements. Four cities reported that some of their taxis are wheelchair accessible. Almost all cities provide specially reserved parking facilities for PRM, and dropped kerbs at pedestrian crossings are widely available. Tactile surfaces and audible signals were reported in only three cities.

Detailed accessibility survey

On the basis of the information obtained from the preliminary audit survey, a more detailed questionnaire was prepared and circulated to all cities in the CAPTURE consortium. The questions were asked under four headings :-

A. General Accessibility (all modes)
B. Organisation of Public Transport Services
 - Bus
 - Metro
 - Light Rapid Transit (LRT)
 - Suburban Rail
C. Design of Public Transport Services
 - Bus
 - Metro
 - Light Rapid Transit (LRT)
 - Suburban Rail
D. Other Modes
 - Special Bus services
 - Taxis
 - Private Cars
 - Walking

The section on general accessibility focused on matters of legislation, statutory advice and consultation procedures. Five of the seven countries reported various levels of national involvement in making provision for PRM. This varied from specific legislation to formal government reaction to pressure from organisations representing the interests of disabled people. Even more common are legislation and the imposition of regulations following initiatives by regional government. However, the most encouraging aspect of this short section of the survey was the fairly general indications of strong public interest in the problems of PRM and in exerting pressure to provide solutions. As a consequence the final specific question regarding plans or likely future developments elicited several suggestions in at least four countries that future regulation and co-ordination proposals were expected in the next few years.

In respect of the organisation of public transport services, the questions addressed issues relating to ownership, regulation, guidelines, subsidies, concessionary fares and staff training.

The ownership and operation of both buses and infrastructure rests generally with local authorities. Two cities reported private ownership of buses and one of passenger operations. Three cities carry out a form of mixed operation, although the nature of these arrangements was not clearly explained. Such limited regulation as exists is generally of the vehicle design (6 cities), although, perversely, Tampere, which does not regulate bus design, does have some regulations for ramps and elevators in terminals. The existence of guidelines was generally recorded both for buses and infrastructure (8 cities made explicit mention) and frequent reference was made to “best practice”. Several of the cities reported that local authorities provided subsidies for bus services, and in some cases of the infrastructure. Interestingly there was some variation of interpretation of what constitutes a subsidy. All but two cities reported the availability of concessionary fares for PRM. A lack of consistency is apparent, however, as between the provision of such fares for the physically disabled, sight impaired and elderly. Finally, although 7 cities reported some forms of staff awareness training it was at best partial and no guidelines for such training appear to exist at a national level. More locally based programmes do exist, as for example that developed by London Transport.

In those seven cities where Metro or LRT services exist, they are generally owned and operated by the local authorities (with some exceptions in UK). There were hardly any reports of regulations with respect to either vehicles or infrastructure, although several cities reported the existence of guidelines. Only two cities reported the availability of subsidies. All seven cities offer concessionary fares to PRM, with similar but inconsistent variation as for the bus services in terms of who was eligible. Only one city reported the existence of any form of disability awareness training.

Suburban rail services are provided for all but the smallest cities, and such services are owned and operated by central government, except in the UK. Very little regulation appears to exist, but there were several comments regarding guidelines and “best practice”. Concessionary fares are generally available as for the other modes. Again, there were no reports of staff training.

The section on the design of public transport services listed sets of facilities which might be provided for PRM and asked each city whether such facilities were provided. The facilities were divided into three groups :

- access to the vehicle;
- in-vehicle facilities;
- facilities at termini and / or information points.

The respondents were asked to provide information both about their own city and about the situation elsewhere in the country. Somewhat surprisingly, where country-wide information was offered it was very similar to that for the city itself. Whether this lack of variation reflects lack of nation-wide knowledge or is a genuine reflection of the situation is a question of some interest. The discussion which follows relates to ‘within city’ information.

Facilities for bus access were generally good. Almost all cities provided good stop and vehicle labelling and low step heights, and several reported the use of stop edge markings. Only four offered a visual display of the next vehicle approaching. Bus facilities inside the vehicle are also generally good. Bell pushes and handrails are designed for easy use by PRM, and special seat allocation is common. Audible and visual information concerning the next stop was provided by several cities on some services. Most cities had wheelchair accessible vehicles available on some services. Almost all the cities offered good information content at bus stations/terminals, but only half attempted to offer it in a suitable form for PRM. Bus tickets are generally available for pre-purchase, but sadly only three cities reported the use of low level ticket machines. Special toilet facilities for PRM were generally provided.

With respect to fixed track services (LRT, Metro and suburban rail) the situation with regard to vehicle access is again generally good. Most cities offered clear vehicle labelling, easy door access and low step heights; platform edge markings were also fairly common. Surprisingly, few cities reported visual display of next vehicle approaching. It was also noticeable that facilities on suburban rail services were generally not as good as for Metro and LRT services, possibly reflecting the age of the systems. A similar pattern to that for buses emerges for in-vehicle and terminal facility provision. the comparatively limited provision of information displays on what are essentially larger and more dedicated vehicles is surprising. It is at the terminals that overall the number of negative responses is particularly disappointing. However it should be said that some cities have made excellent progress in this respect, while others make little provision.

The final section of the questionnaire dealt with “other modes” of transport. The first question was concerned with the provision of special bus services offering flexible door-to-door routing and scheduling for the exclusive use of PRM, normally with several passengers sharing one vehicle. The remaining questions were concerned with special facilities for taxi passengers, private car drivers and passengers, and pedestrians.

No fewer that 8 of the 11 cities reported offering special “Dial-a-Ride” type bus services for PRM as summarised in Table 6. These were with only one exception local authority owned and operated. In most cases there is a membership requirement which may or may not require medical evidence. There are usually restrictions on the use of the services, both in terms of the number and nature of the journeys. Work and medical (e.g. hospital visits) purposes are frequently prohibited, thus making clear an intended provision for leisure, shopping and personal business trips. Reported patronage varied from a few tens of passengers per month to 87,000 (!) and the proportion of wheelchair users from 4% to 90%. If this extraordinary range of reporting is correct, the area is clearly worthy of separate and more detailed study.

Naturally all cities reported taxi operations, and in practically all cases these are local authority controlled and regulated. Fleet sizes range from a hundred or so in small cities to 10-20,000 in the conurbations. Very few, except in the UK, are modified and/or wheelchair accessible. Limited subsidies are available in only a few cities. Car drivers and their passengers are generally given special assistance with parking - only one city did not offer reserved parking spaces. Some form of medical registration is required so that a badge or token may be displayed. Surprisingly, a few cities did not provide this facility at public transport terminals. Almost all cities made some provision to assist pedestrians and wheelchair users for those journeys and parts of journeys which cannot be undertaken by private car and public transport. The use of dropped kerbs was almost invariable and half of the cities used tactile warning surfaces. Almost all public buildings were reported as being accessible to wheelchair users.

Conclusions

The conclusions to the study are presented in Section 3 of this report. A more detailed record of the study is written up in the report “The CAPTURE Accessibility Report” by J.M. Clark and P.R.Oxley published by Cranfield University. Cranfield report 73.

APPENDIX THREE THE CAPTURE EVALUATION FRAMEWORK AND METHODOLOGY

The main aim of CAPTURE is to evaluate the effectiveness of the various physical measures in a variety of situations. The evaluation is based around the idea of common indicators which can be used in a variety of evaluation frameworks, due to the sometimes complementary, sometimes conflicting goals for evaluation in local, national, and international terms. Indicators are classified into the following rough groupings.

- Transport efficiency
- Changes to travel patterns and behaviour
- Safety
- Impacts on the local economy
- Impacts on persons with reduced mobility
- Energy and environment

These broad aims are covered by a programme of data collection which includes the following survey types:

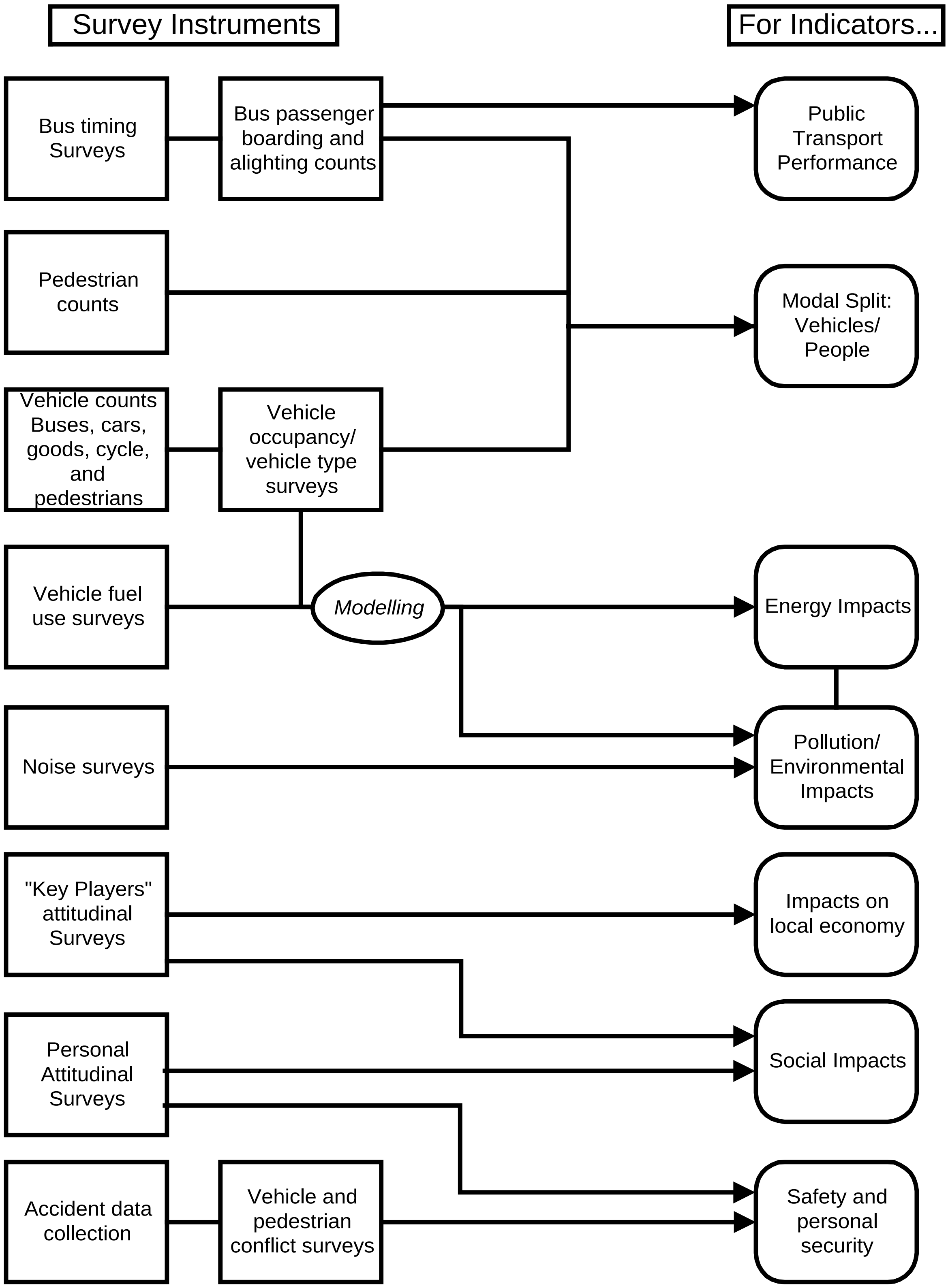
- On board surveys of vehicle speeds, bus patronage;
- Traffic counts (by different types, including pedal cycles, and pedestrian), including recording of car occupancy;
- Personal interviews (with members of the public, with stratified samples to ensure minimum sample sizes for various social groups);
- Personal interviews with key players (local authorities, interest groups, shopkeepers etc.);
- Data on accidents for city;
- National data on engine sizes and fuel type (to combine with data on vehicle flows and speeds for energy and environmental monitoring);
- Noise meter surveys.

Figure A3.1 shows how these surveys are used to collect data for indicators.

The aim is to collect information and indicators to allow for structured analyses such as cost-benefit analysis, and other forms of multi criteria analysis, while allowing the freedom for many kinds of assessment.

A full evaluation plan for CAPTURE is available on request to ttr_oxford@compuserve.com.

Figure A3.1 - The CAPTURE Surveys; Their uses and Roles



APPENDIX FOUR THE CAPTURE SURVEYS CARRIED OUT IN EACH CITY

Appendix Three describes the evaluation methodology and the types of surveys required for different methods of calculating indicators. In this appendix we list the surveys carried out in each city (Table 1.4.1).

Table 1.4.1: Surveys carried out in each city

SURVEY TYPE	Bre	Buc				Cop	GM	Lon	Mad	Myt	Orv	Rom	Tam	Vit
		1a	*1b*	*2*	*3*									
Vehicle timing and speed surveys														
On board bus timing		•		•		•	•	•					•	•
Automated bus timing	•					•								
Recording buses from roadside								•	•					
In car journey timing						•	•	•		•			•	
Vehicle speed surveys									•			•		
Patronage Surveys														
At stop bus boarding survey							•		•			•		
On board boarding and alighting survey		•		•					•				•	
Ticket sales bus patronage							•	•		•	•			
Bus counts														
Automated vehicle counts						•								
Manual counts of numbers of buses									•					
Vehicle count surveys														
Automatic vehicle counts (unclass)	•					•		•			•			•
Auto semi-classified vehicle counts									•					
Video recording of vehicles									•					
Classified vehicle counts	•	•	•	•			•	•			•	•	•	•
Car occupancy	•						•		•	•			•	
O/D survey of vehicles														•
Queue length surveys								•						
Car park occupancy surveys						•					•			
Cycle counts						•								
Cycle parking surveys						•								
Pedestrian counts								•		•	•	•		•

Table 1.4.1(continued): Surveys carried out in each city

SURVEY TYPE	Bre	Buc				Cop	GM	Lon	Mad	Myt	Orv	Rom	Tam	Vit
		1a	*1b*	*2*	*3*									
Interviews with the public														
Bus stop personal interviews							•						•	
On board interviews						•								
Roadside driver interviews (postal return)						•								
Cyclist interviews (postal return)														
In-street public interviews	•			•	•					•	•	•	•	•
At home (face or telephone) interviews		•							•			•		
Key person interviews														
Interviews with local authority officers	•	•	•				•							
Interviews with bus drivers						•								
Interviews with shopkeepers						•	•			•	•	•		
Energy surveys (or by calculation)														
Vehicle fuel consumption records	•	•		•									•	
Energy consumption (modelling)	•					•	•	•						
Safety surveys														
Accident data		•	•	•	•	•	•	•	•				•	•
Other surveys														
Accessibility audit							•							
Noise meter surveys		•		•				•				•		
Emissions monitoring	•	•		•				•					•	

APPENDIX FIVE LIST OF CAPTURE PROJECT REPORTS

TITLE	DELIVERABLE NO
Project Evaluation Plan	Deliverable 1
Pan European Survey - Results of a survey of physical transport policy measures in 90 cities throughout Europe	Deliverable 2
Design of physical measures in the CAPTURE test sites	Deliverable 3
First Year Project Progress Report (not publicly available)	Deliverable 4
Implementation of measures in the CAPTURE test sites	Deliverable 5
Second Year Project Progress Report (not publicly available)	Deliverable 6
CAPTURE Demonstration Conduct	Deliverable 7
The effectiveness of physical transport policy measures: The results of 11 city demonstrations (This Report)	Deliverable 8
Results, Recommendations and Conclusions	Deliverable 9
Report of the CAPTURE / OPIUM joint conference - Brussels - January 26th and 27th 1999	Deliverable 10

Copies of the publicly available reports are available from:

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