MAIN

Model Application of Intelligent Public Transport Systems and Sustainable Mobility Policies in Ningbo

CONTRACT NUMBER: ASI/B7-30

Deliverable D2
User Needs and Requirements Analysis Report

Version 1.1

October 2004

Document control sheet

Project Name:	MAIN
Work Area:	Activity 2
Document title:	User Needs and Requirements Analysis Report
Document number:	D2
Electronic reference:	MAIN User Needs Report final for submission.doc
Main author(s) or editor(s):	Chris Wrathall (BPV)
Other author(s):	Norman James (TTR), Xiwen Zhang (BPV), Junchi Zhang (GIT)

Dissemination level: Public

Version history:

Version number	Date	Main author
0.1	07/06/2004	Chris Wrathall
0.2	17/06/2004	Chris Wrathall
0.3	23/06/2004	Chris Wrathall
0.4	06/07/2004	Chris Wrathall
0.5	13/07/04	Chris Wrathall
1.0	20/07/04	Chris Wrathall
1.1	14/10/04	Chris Wrathall

Circulation:

Recipient	Date of submission
Co-authors	7 June 2004
Co-authors	17 June 2004
Co-authors/Project members	23 June 2004
Co-authors	06 July 2004
Project members	13 July 2004
Peer Reviewers	20 July 2004

Approval / Peer-review:

Name	Date of approval

Project Co-ordinator:

Mr. Neil Scales
Merseytravel
24 Hatton Garden Liverpool L3 2AN

Tel: +44 151 330 1101 Fax: +44 151 236 2457
Email: neil.scales@merseytravel.gov.uk

Table of Contents

0 Abbreviations

0.1 Abbreviations

GDP	Gross Domestic Product
IPTS	Intelligent Public Transport Systems
ISDN	Integrated Services Digital Network
LAN	Local Area Network
NBGJ	Sate-owned company, responsible for Public transport service technologies in Ningbo
RMB	Chinese currency
SRRC	Short Range Radio Communication
WarN	Wide Area Radio Network
USD	United States Dollars

1 Introduction

This deliverable presents the results of Activity 2 of the MAIN Project. The MAIN project uses the experience of a group of European local authorities, transport companies and experts to assist the Chinese metropolis Ningbo to develop and validate a model implementation of sustainable mobility policies and intelligent public transport services (IPTS) and to disseminate this good practice to a great number of Chinese cities.

The overall objectives of the MAIN Project are to:

- stimulate enhancement of the urban social infrastructure in China with specific reference to transport systems and services
- develop and validate a model implementation of sustainable mobility policies and IPTS technologies that are based on European experience but suitable for widespread application in China
- foster the introduction of sustainable mobility policies and services in Chinese cities that will strengthen economic development in the cities without some of the adverse consequences that Western Europe has experienced.

Activity 2 (Analysis of User Needs) of the project aims to analyse and identify the specific needs of the city of Ningbo for applications of sustainable mobility policy and IPTS, and to specify the functional requirements for IPTS.

A methodology for achieving these aims has been developed and is described in Chapter 2 of this deliverable. In accordance with this methodology, project members have performed surveys and interviews and reviewed documents relating to local transport plans and provisions, in order to achieve the following:

- Identify existing transport policy and traffic management infrastructure and technologies in Ningbo;
- Define traffic related problems;
- Define user needs for sustainable mobility policies and IPTS.

The results relating to the first two of these objectives are reported in Chapter 3 of this report; the identified user needs are defined in Chapter 4.

In parallel with these activities, which focus on the local situation in Ningbo, current sustainable mobility policies and ITPS applications in Europe are being investigated in Activity 3 of the project. The result of the user needs analysis in Ningbo and the survey of good practice in Europe will be to develop a vision for sustainable mobility policies and transport systems in Ningbo and elsewhere in China. This vision is described in Chapter 5.

The results of the various surveys in China are presented in Chapter 6.

Further discussion of the survey results together with project partners has permitted the identification of a final set of functional requirements for the IPTS applications in the city of Ningbo. The functional requirement specification is presented in Chapter 7.

2 Methodology

2.1 Definition of users and user groups

The project description identifies the following target groups:
? Local transport authorities
? Public transport companies
? National and local politicians
? Equipment manufacturers and suppliers
? Public transport users
? General public.

The selected target groups are all stakeholders in defining and implementing sustainable mobility policies and IPTS for the following reasons:
? Local transport authorities are decision makers for the implementation of transport policy and transport system development strategies in individual Chinese cities;
? Public transport companies are the key stakeholders for public transport infrastructure and services in individual Chinese cities;
? National and local politicians are decision makers for defining transport policy objectives;
? Equipment manufacturers and suppliers are those developing, producing and providing transport management systems;
? Public transport users are the end users (passengers) of the public transport services. Their acceptance of public transport services is decisive for the success of the services and the related sustainable mobility policy;
? The general public is also a user of transport services. In addition, the living standard and quality of life of citizens is strongly influenced by the quality of transport services in cities.

The surveys carried out address each of the identified target groups, except the equipment manufacturers and suppliers and the general public. There are no plans to perform surveys among the latter target groups, as they will not be direct users of the MAIN products.

2.2 Methods for data collection

The following table provides an outline of the data collection methods used for the determination of user needs:

Survey type	Purpose	Target group	Size
On-site Interviews	Identify existing transport policy and traffic management infrastructure and technologies in Ningbo; Defining traffic related problems.	Ningbo transport authorities; Ningbo public transport companies.	4
On-site Interviews	Defining user needs for sustainable mobility policies and IPTS	Ningbo public transport company; Public transport users.	35 PT users
Questionnaire Survey	Defining user needs for sustainable mobility policies and IPTS	Public transport companies in other cities	26 (14 replies)
Reviewing relevant documents	Identify existing transport policy and traffic management infrastructure and technologies in Ningbo; Defining traffic related problems.	Ningbo transport authorities; Ningbo public transport companies.	Relevant plans discussed at project meetings and in interviews between project members

Table 2.1 Data collection methods used for the determination of user needs

A single bilingual (English and Chinese) questionnaire (or checklist) was developed for the surveys and interviews involving the authorities and public transport companies and the document review (see Annex A). This ensures the consistency of the survey as a whole and provides a sound basis for effective data processing and analysis. A separate questionnaire was used for interviewing public transport passengers (see Annex B).

The questionnaire/checklist for authorities and public transport companies was provided for interviewers and reviewers in both electronic and paper format to enable them to select an appropriate way for recording data either electronically or manually. All the data recorded manually has been converted to electronic format to enable automatic data processing and rapid analysis.

The surveys were carried out by GIT under the supervision of NBST. The original data recorded is maintained in the databases of GIT and TTR Ltd.

2.3 Time schedule

The final schedule for the planned surveys within Activity 2 was the following:

- 22 March – 3 April Agreement on the methodology, drafting of questionnaires
- 26 March – 10 April Preparation of questionnaires in Chinese
- 10-30 April Interviews of responsible local authorities and politicians in China
- 3 May - 10 June Survey among public transport users and operators in China

With respect to the original work plan this constitutes a delay of one month. The main reason for the delay was the time required for obtaining replies and feedback from the public transport companies.

3 Current situation in Ningbo

3.1 Current development plans and trends

Ningbo is located at the centre of China's coastline on the southern flank of the Yangtze River Delta, bordering on Shanghai and Hangzhou.

Ningbo is one of the Chinese cities that is opening up to the outside world. It is able to make its own development plans independently, as it enjoys the same rights as those of a provincial government in economic management. It is therefore a large city, entitled to formulate local laws and regulations, and a famous historic city with a rich cultural heritage. It covers an area of 9,365 sq.km and has a population of 5.46 million. The jurisdiction of Ningbo City encompasses two counties (Xiangshan and Ninghai), three county-level cities (Yuyao, Cixi and Fenghua) and six urban districts (Haishu, Jiangdong, Jiangbei, Zhenhai, Beilun and Yinzhou).

Ningbo port has become one of the most important ports in China. Its cargo handling capacity reached 185 million tonnes last year, ranking second among the ports in the mainland of China; and its container handling capacity amounted to 2,772,000 TEU.

Enjoying sound conditions for economic development, the social economy of Ningbo has been developed rapidly since opening up to the outside world. In 2003, the city GDP reached 176.99 billion RMB yuan, financial income reached 33 billion RMB yuan, public green land average 12.05 square meters per person, the average housing space for one person increased form 18 square meters. Nowadays, Ningbo has become an important industrial city and foreign trade port in east China, a key city and chemical industrial base in the Yangtze Delta and an economic centre of Zhejiang Province.

Ningbo has great development potential. By the year 2010, Ningbo will become a modern, international port city with a strong economy, advanced scientific and cultural sector; its citizens should enjoy a comfortable life style, fine social welfare and an excellent environment.

Ningbo is trying to improve its comprehensive strength and international competitiveness, to build an important manufacturing base in East China, and to become an important component of the international shipping and economic centre at the southern part of the Yangtze Delta. The per capita GDP will reach USD 6,000 by 2010 and USD 12,000 by 2020. To achieve these targets, efforts are being made to promote port construction, urbanisation, science and education and an ever greater openness towards the rest of the world. These broad objectives are at the heart of the city's "New Century Project", an all-embracing development project with specific focuses for development and construction in the "Four Zones, Three Parks, River, Lake, Port & Bridge". The "Four Zones" denotes the Ningbo Economic and Technical Development Zone, the Ningbo Free Trade Zone, the Daxie Island Development Zone and the Ningbo Export Processing Zone. Relying on the advantages of the port and openness policy, the "Four Zones" subproject focuses on developing harbour-based and new hi-tech industries, such as chemicals, steel, automobile and papermaking. The "Three Parks" refers to the Hi-Tech Park, the South Park and the North Park of Higher Education. They are being developed into the sci-tech base and education centre of the city. "River" refers to exploitation of the geographical position of Yongjiang, Fenghuajiang and Yaojiang rivers to build the "100-li Cultural Gallery of The Three Rivers". "Lake" refers to developing the Dongqian Lake into a national area for tourism and holidays. It will be be developed into a major recreational area of Ningbo, another "West Lake" in Zhejiang, and a good place for leisure and holidays for all the tourists from home and abroad. "Port" refers to developing Beilun port into a key port of international container trans-shipment and an important component of the international shipping centre of North-east Asia. "Bridge" refers

to construction of the sea-crossing over the Hangzhou Bay, enabling journeys from Ningbo to Shanghai to take less than 2 hours.

Three main national roads have recently been built in the city: the Ningbo part of the Ningbo-Jinghua highway, the western part of the orbital highway, and the traffic lane of Hangzhou Bay, which basically formed the "One circle, Five lane" highway network, allowing travel around the city in one hour.

With the increasing demand for public transport in the Ningbo region, particularly for those between the satellite towns on the one hand and the major city of Ningbo on the other hand, a light rail transport system has been planned. This will involve up to three major lines and three side lines, with a total length of 230 km and a network density of 1.2 km / km^2.

3.2 Public transport usage and predicted trends[1]

Nearly four million trips are made within the urban area of Ningbo every day. This figure is expected almost to double by 2020. To meet the new demand, public transport will need to increase its current capacity threefold by 2010. By 2020 the modal share of public transport (including rail) would need to be about 40% to ensure sustainable growth.

Table 3.1 provides a summary of expected trends. There is currently no rail transport within the city area of Ningbo, so the figures for 2003 and 2010 account for all surface public transport modes, including taxis. There are plans, however, to construct three to six rail links by 2020; hence, the figures for 2020 provide forecasts of the expected number of trips by all surface and rail public transport modes.

	2003	2010	2020	
			Higher (6 rail lines)	Lower (3 rail lines)
Number of trips per day	3,727,200	5,532,000	7,299,900	
Number of trips per day on public transport	652,700	1,770,000	3,169,900	2,909,500
Modal share (%)	17.51	32.00	43.42	39.86

Table 3.1 Predicted transport usage trends in the urban area of Ningbo

Table 3.2 shows how most of the public transport demand is expected to be met by mass transit systems. The construction of the new rail links by 2020, in particular, is expected to have a dramatic effect on the number of people travelling by public transport.

[1] The statistics and forecasts presented in this section are based on surveys and projections performed by the Ningbo Public Transport Company (NBGJ)

		2003	2010	2020 (6 new rail links)	2020 (3 new rail links)
Number of trips per day on public transport	Mass transit	591,000	1,683,000	3,055,000	2,757,100
	Taxi	61,700	87,000	114,900	152,400
	Total	652,700	1,770,000	3,169,900	2,909,500
Public transport modal share (%)	Mass transit	90.5	95.1	96.4	94.76
	Taxi	9.5	4.9	3.6	5.24

Table 3.2 Predicted public transport modal split between mass transit and taxis in the urban area of Ningbo

Currently public transport vehicles (buses) in Ningbo are able to transport about 364 passengers per day. This is low compared with other Chinese cities where, for example, the average daily capacity in Shenzhen is 406 passengers per vehicle per day and in Hong Kong it is 460 passengers per vehicle per day. The cities of Beijing and Shanghai have demonstrated the capability of achieving an average daily capacity of 1200 to 1300 passengers per vehicle per day. The target for Ningbo is therefore to achieve an average daily surface transportation capacity per vehicle of 600 to 700 passengers by 2020. This will be achieved by adjusting the lengths of service routes, increasing commercial speeds and service overtimes and vehicle capacities. Taxis will transport about 30 passengers per vehicle per day.

According to forecasts, there will be 3531 surface public transport vehicles in 2010 and 3870 vehicles in 2020; there will be 5080 taxis by 2020.

The highest proportion of public transport investment over the next twenty years will go into the development of Ningbo's rail service.

The following major works are planned for public transport over the next twenty years:

- Establishing the light rail public transport system
- Rationalising the public transport network, extending its coverage
- Establishing clearly layered public transport exchange stations (hubs)
- Completing road network facilities, enabling public transport priority
- Optimising the structure of public transport vehicles, upgrading the minibus system
- Introducing an advanced public transport management system
- Implementing a public transport vehicle regulation and certification procedure
- Defining governmental responsibility, strengthening the market management procedure

4 Needs of Chinese cities for sustainable mobility policies and services

4.1 Definition

Sustainable Mobility is part of the wider concept of sustainable development. Sustainable Development was summarised by the Brundtland Commission as *'A development that meets the needs of today without damaging the possibility of future generations to meet that need.'*

Sustainable mobility has been defined, by the World Business Council for Sustainable Development, as 'the ability to meet the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing any other essential human or ecological values today or in the future.'

Fundamentally it is important to decouple the concepts of mobility and economic development, this can be done by decreasing the indirect costs (time & financial) of the non-road modes and increasing the actual costs of road modes to reflect their real costs to society and on the environment. Mobility must still be allowed to assist economic growth, encourage social progress and stimulate environmental improvement.

4.2 Situation in Europe

Throughout Europe it has become increasingly apparent that mobility requirements cannot be met by continually expanding and extending the current type of transport provision. Future provision not only needs to offer the same level of mobility, but needs to do this more efficiently, more equitably and whilst causing less damage to the environment.

To have true sustainable mobility a level of mobility needs to be defined without the negative externalities, in essence:

- Congestion
- Lack of Adequate Infrastructure
- High accident rates
- Noise and air pollution.

The over-reliance on cars can have a negative affect on social cohesion; this is particularly in relation to the provision of local amenities. If a majority of the people in an area exercise high car usage local amenities begin to close as people fail to use them adequately. This means that those people without access to a car, typically the elderly, the infirm and poorer section of society, risk being more isolated from the wider community.

4.3 Congestion

Congestion is often seen as the problem rather than a symptom of lack of sustainability in the transport network. This means that congestion cannot be tackled alone, for example the idea that you can build your way out of congestion is not regarded as a solution, as it is likely that soon after any extra capacity has been added, it will be fully utilised.

This is where China has the advantage over Europe in that it has not yet got to this severe situation and can work toward maintaining its current modal split. To do this it is important

that investment is maintained in public transport and other modes, which do not detract from the environment, such as cycling or walking.

The promotion of soft measures can also help tackle congestion, these measures include:

- Car Sharing
- Homeworking or Teleworking
- Improvement of bus measures, such as lanes and real time information.
- Cycling Promotion.

The promotion of cycling in Europe is of great importance; with China having levels of cycling that can only be aspired to in Europe, it may not seem as a priority. It is important to remember that cycling is a very sustainable way to travel, it does not pollute, nor use very much road space and keeps the cyclist healthy. It is important that any policies brought in keep cycling an attractive option that all parts of government and other stakeholders are 'pulling in the same direction' and political support for cycling is maintained. It is also important to not only ensure retention of current cyclists but to keep attracting new cyclist too.

4.4 Lack of adequate infrastructure

Although infrastructure cannot be constantly expanded to meet demand, this would not be economically viable nor physically possible - it may be possible to make more efficient use of the infrastructure in a more efficient way. This could include the introduction of a road pricing structure to reduce the peaks in demand, so that the usage is more equally spread through out the day. It can also include measures to encourage people to use modes, which take up less road space and are less polluting such as use public transport networks or cycling and walking.

IPTS can also be used to increase the efficiency levels of the infrastructure that is already built, as IPTS can be used to improve control and improve enforcement, for example spreading demand and ensuring minimum standards of driving. This can lead to improvements in safety and the environment.

IPTS can also be used, as in the case of MAIN, to make public transport more attractive to users, which also increase the efficiency by increasing the utilisation of each service. As IPTS can also be used to provide additional route information, changes can be made to the network or pricing structure to match the need of those travelling. There are even IPTS that can be used to modify the engines workings when they enter certain areas or slow to certain speeds, thus limiting their emissions.

4.5 Noise and Air Pollution

The lack of sustainability in transport has led to various environmental negative externalities, which affect not only the users of transport but the all those who surround them.

- Air pollution has a detrimental affect on health - not only can it increase levels of respiratory illnesses like asthma but in the longer term can discourage people from walking and cycling.
- Air pollution is made up from gases and chemicals, which are associated with the greenhouse affect, which in the longer term can lead to climate change.

- Air pollution can cause damage to physical structures, this can have a particular inimical affect on the cultural heritage of an urban area.
- Transport can also cause excessive noise, which can have a harmful affect on the sleep patterns of those and affect their productivity in the work place.

4.6 High Accident Rates

Over utilised urban areas can often be characterised by their high accident levels; this is of particular importance where there is an interface between different modes. It is therefore important that where infrastructure is modified or added to; to favour non-road modes, which all users of the infrastructure receive adequate instructions or training on how they are suppose to act with regards to these changes.

4.7 Application of the theory of Sustainable Mobility to other modes.

These theories can be applied to road related and non-passenger transportation. For example, for people travelling longer distances but under 400km the most sustainable mode is train rather than air or road. The transportation of goods is another area which can be made more sustainable principally by removing as much goods transportation as possible from the roads and revitalising the alternatives; this can be achieved by making more use of inter-modal routes and short sea shipping and the railways.

This will only happen with the active promotion of the non-road alternative. This should be done through a combination of incentives and disincentives, rather than purely by legislation alone. Any actions that are taken must be done bearing in mind the competitiveness of the area.

4.8 Ningbo

The level of motorisation is increasing steadily within Ningbo: already the major river crossing points suffer from congestion throughout the day, and many major roads and junctions within the centre suffer from congestion at peak hours. The Ningbo authorities are able to limit the number of licences issued annually for private motor cars, but it is generally felt that a level of motorisation will be reached in between 2 and 5 years which will bring dire environmental consequences and will put a strain on the city fabric. The time frame therefore represents the window of opportunity within which Ningbo may act in order to promote a swathe of sustainable mobility policies with a view to reducing the potential negative impacts of high levels of motorisation.

The major impacts which are feared with the increasing use of the private motor car relate to congestion, pollution, noise, nuisance and financial costs. The Ningbo authorities have invested much money and effort into transforming the city centre into a very attractive urban environmental with much greenery; no one wishes to see this attractive environment destroyed by the negative impacts of higher private car usage.

Ningbo is already planning sustainable mobility policies: one of the most resource intensive will be the planned construction of a network of 6 light rail lines which would complement the existing bus network operated by NBJG and would provide an attractive alternative to the private motor car, especially for radial journeys to and from the Ningbo city centre.

There is reason to believe that the explosion in the usage of private cars, and more importantly in the desire of the population to acquire and use private cars is replicated throughout China in all cities of over 1 million inhabitants. The challenge for MAIN is to develop in conjunction with the authorities in Ningbo a model for sustainable mobility implementation allied to the development and implementation of appropriate IPTS measures which can act as a paradigm for implementation throughout China. This model will draw upon the experience of the MAIN European partners, but also upon similar experience throughout he European Union, and it will complement, enhance and augment the moves towards the development of sustainable mobility policies already being developed and endorsed within Ningbo.

5 Vision for sustainable mobility policies and services

Overall aim of MAIN for Sustainable Mobility is:

"To foster the introduction of sustainable mobility policies and services in Chinese cities that will strengthen economic development in the cities without some of the adverse consequences that Western Europe has experienced."

A sustainable transport policy should

- Tackle problems caused by rising traffic volumes
- Encourage the use of environmentally friendly modes of transport

The vision is simply that the issues should be addressed by policy makers at national, regional and local level within a coherent framework. This requires action on:

1. Integration of services (Intermodality): how can private and public transport services be efficiently integrated to provide an efficient means of transportation which meets the needs of the user, satisfies the wishes of the stakeholders and minimise the negative impacts of unrestrained traffic growth ?

2. Demand management & Pricing: how can access to the highway network be limited in order to encourage the usage of sustainable modes of transport whilst satisfying the reasonable desires of the end user for mobility ?

3. Financing of transport improvements: what transport improvements, both to the highway network and to the public transport supply, will be able to best satisfy the desire for mobility whilst ensuring an environmentally sustainable urban fabric ?

4. Institutional issues: are there particular barriers to the development of an efficient and sustainable mobility policy which are reinforced through the institutional arrangements within Ningbo (and China) for the planning and provision of highway and public transport supply ? For example, would an appropriate model be to move towards one integrated transit authority for each city in China ?

5. Land use and mobility planning: how closely does current land use planning in Ningbo (and China) integrate with mobility planning. Can they be further integrated to ensure that the level of mobility required to access employment, services and leisure facilities may be minimised ? What conflicts might this bring about to the traditional urban planning policies within Ningbo (and other Chinese cities) ?

6. Improvement of public transport: in order to improve the model shift in favour of public transport it is necessary to improve the current public transport supply. This would include an improvement in the quality of public transport, but also an improvement in the perceived image of those services. Improvements to vehicles, infrastructure and information systems can all contribute to the raising of the image of the public transport supply making it a more attractive alternative to the private car

7. Advanced transport technologies:
   - Clean vehicle technologies, both for private cars and for public transit vehicles, can ensure that more people travel by sustainable modes and that fossil fuels are preserved whilst the environment suffers lower levels of pollution

- Alternative fuels: these fuels can provide an attractive alternative to existing fossil fuels as they are relatively easy to produce and have less serious and widescale impacts on the environment
- New vehicle concepts: light rail schemes, people movers and maglev systems can all have a role to play in the development of a sustainable and attractive public transport network which will attract new users and boost the modal shift in favour of public transport, not just because of restrictions placed upon the private car, but also owing to the positively enhanced image enjoyed by public transit which can act as an inducement to travel.

8. Soft measures – travel awareness, mobility management: expenditure in developing marketing and advertising campaigns, to explore and promote the benefits of travel by public transport from a health and environmental point of view, can also be of great significance in winning the hearts and minds of potential travellers and inducing them to travel by public transport. Integrated mobility management pulling together all forms of sustainable mobility for all journey purposes, and allied to the provision of ticketing and tourism services can also contribute to the improvement in the image of the public transport supply.

9. Tackling problems caused by freight transport: freight transport by road may be a major contributor to urban and inter-urban pollution. A range of policies may be envisaged to ensure that the damage caused by excessive freight transport by road may be reduced: this could include the development of alternative freight movements by rail or water, an improvement in the mechanical worthiness of the freight vehicles, integrated supply chain development to minimise the number and length of freight movements required by road.

10. Use of Intelligent Public Transport Systems (IPTS): these can bring a number of benefits by allowing transport operators to schedule and control their vehicle movements on a more informed basis, and also by allowing travellers to plan and undertake their journeys on a more informed basis than before. They can also be used to provide drivers with information, allowing them to avoid congestion and to utilise the road network in a more efficient and sustainable fashion. Examples of IPTS would include: real time information systems, management control systems, Variable Message Signs, vehicle scheduling systems etc

11. Physical Measures: physical restriction measures can also play an important part in developing sustainable mobility – these may reduce the road space available for the private car, develop new lanes for buses and taxis, reduce traffic speed or give over parts of the highway network to pedestrians and soft modes

12. Legal Measures: these can play a key role in ensuring that travellers are encouraged to use sustainable modes. These legal measures would include not only the imposition of legal barriers, for example, speed limits, but also the enforcement of these to ensure that car users face a penalty if they disregard legal measures which have been imposed in favour of public transport, with a view to encouraging sustainable mobility. An example from the UK is the widespread use of digital speed cameras to capture evidence for legal prosecution of motorists who violate imposed speed limits. Another example would be the fact that a bus lane serves little purpose if it is constantly blocked by parked or waiting cars – enforcement measures, to ensure that guilty motorists face an appropriate penalty, also have to be taken to ensure that the legal measure is successful.

13. Trip substitution: this is an interesting area which is being increasingly examined within the EU. It aims to tackle the desire for access and inclusion by providing local services and sustainable modes of transport to access those services, rather than

feeding an unrestrained desire for enhanced mobility. Teleworking and video-conferencing etc can also play an important part in this package.

Within MAIN we are aiming to develop a package of sustainable mobility measures which build upon:

- The needs of the Chinese authorities in Ningbo
- The experience of European partners within MAIN
- Experience drawn from elsewhere within the European Union
- Existing sustainable mobility policies being developed / implemented within Ningbo

This model for Sustainable Mobility within Ningbo will in turn act as a paradigm for sustainable mobility in cities of similar size and demographics throughout China.

The MAIN Vision being elaborated here will also include a series of (achievable) targets for the Ningbo authorities to achieve within the short (18 months), medium (5 years) and long (10 years) term. These will include:

- Modal shift
- Pollution
- Energy consumption
- Health
- Safety
- End User Satisfaction
- Etc.
- Etc.

6 IPTS survey results

6.1 Surveys of transport authorities and public transport companies

The interviews with local authorities and politicians in Ningbo and questionnaire survey among relevant Chinese public transport operators were carried out on the basis of the questionnaire in Annex A.

The following Ningbo Municipal authorities were interviewed in April 2004:
? Municipal Department of Science and Technology Commission (NBST)
? Municipal Department of Transport
? Municipal Department of Urban Planning
? Ningbo Public Transport company (NBGJ)

The public transport company survey was carried out in 26 Chinese cities, of which 12 cities (13 public transport companies) sent back their replies. These are the following:

- Ningbo
- Chongqin
- Kunming
- Dalian
- Xiamen
- Qingdao
- Shanghai
- Chengdu
- Guiyang
- Fuzhou
- Nanjing
- Shenyang

The results of the survey are summarised in the following sections.

6.1.1 Perceptions of current public transport services

Respondents claimed they were generally satisfied with the quality and efficiency of public transport services and the geographical coverage of the public transport network in their respective cities (Figs. 6-1 and 6-2).

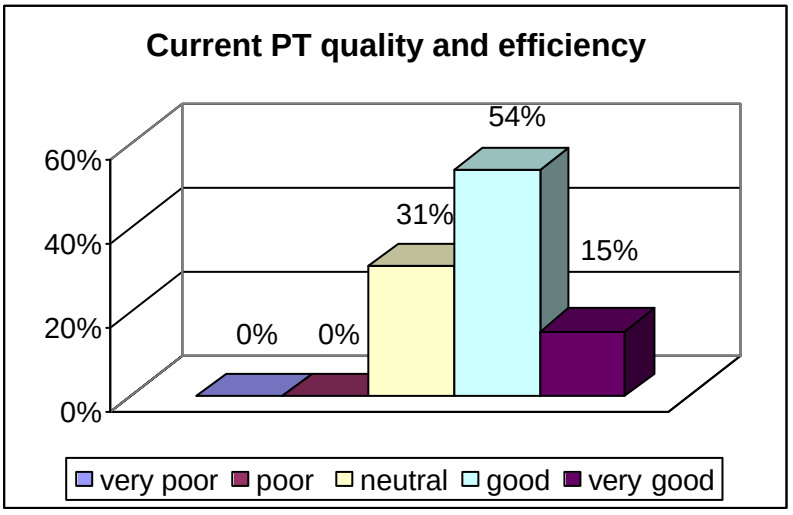

Fig. 6-1 Perceived quality and efficiency of the public transport service provided in respondents' cities (13 replies)

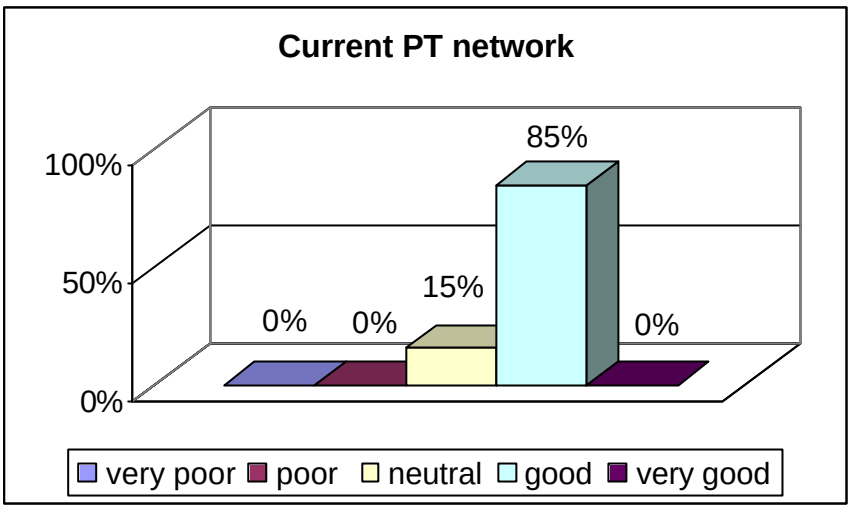

Fig. 6-2 Perceived adequacy of coverage of the public transport network in respondents' cities (13 replies)

Contrary to these general assertions, when respondents were asked to comment on specific aspects of their respective systems, their responses showed that certain factors contributing to the overall quality and efficiency of the systems could be improved. In particular, the following conclusions may be drawn:

- The level of integrated fleet management and resource sharing (Fig. 6-3) could be improved
- Some services are overcrowded (Fig. 6-4)
- Vehicle and driver scheduling could be improved (Figs. 6-5 and 6-6)
- Most of the public transport management systems in the survey were considered inadequate (Fig. 6-9).

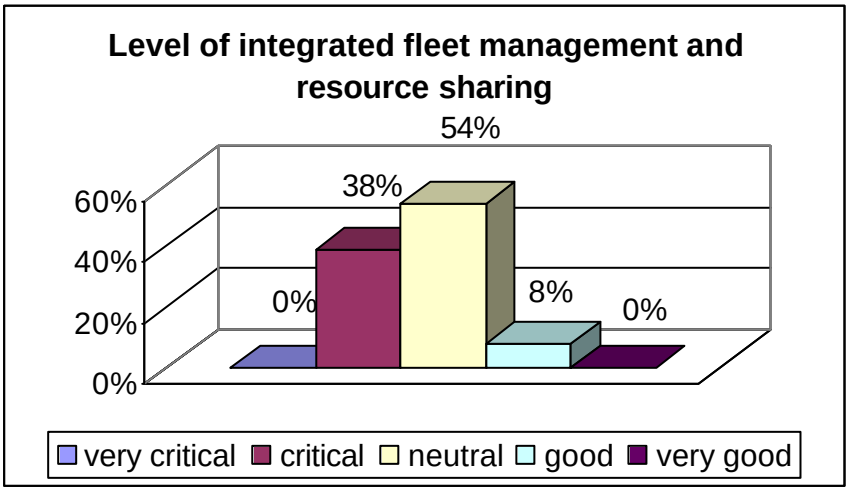

Fig. 6-3 Perceived level of integrated fleet management and resource sharing (13 replies)

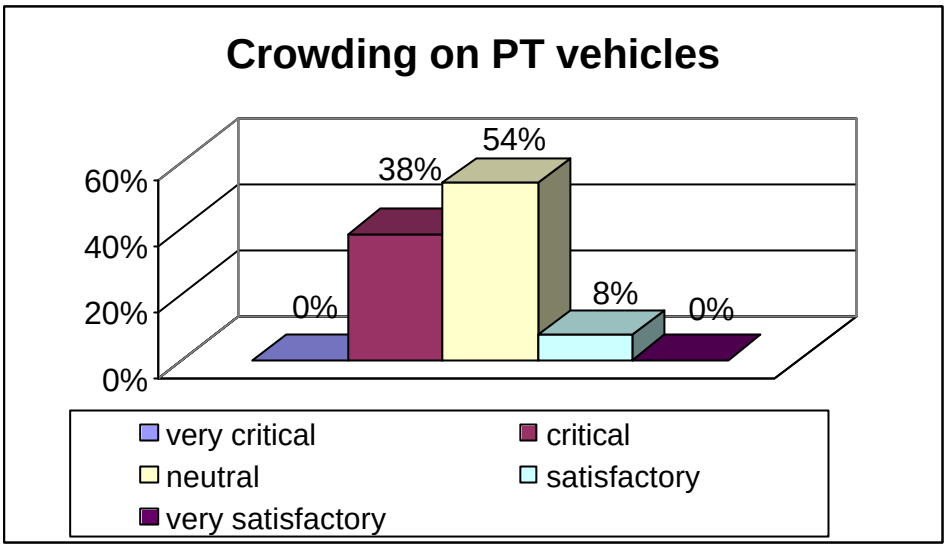

Fig. 6-4 Perceived overcrowding on public transport vehicles (13 replies)

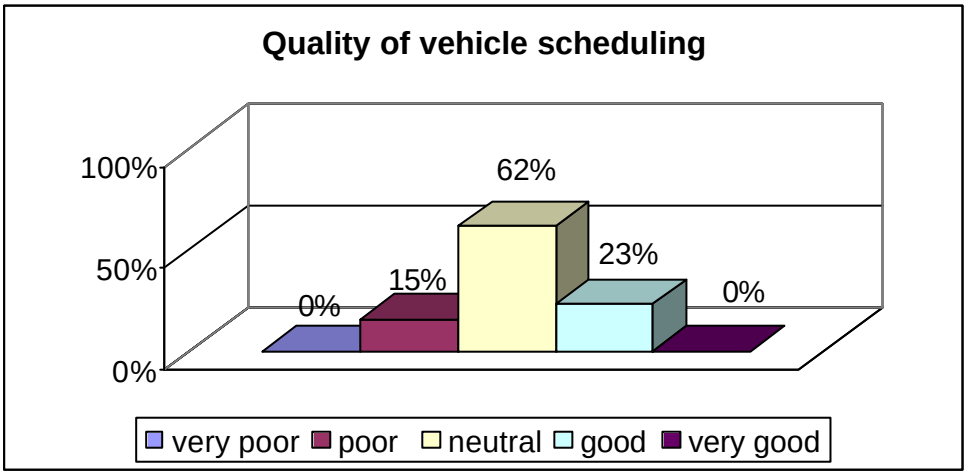

Fig. 6-5 Perceived quality of public transport vehicle scheduling (13 replies)

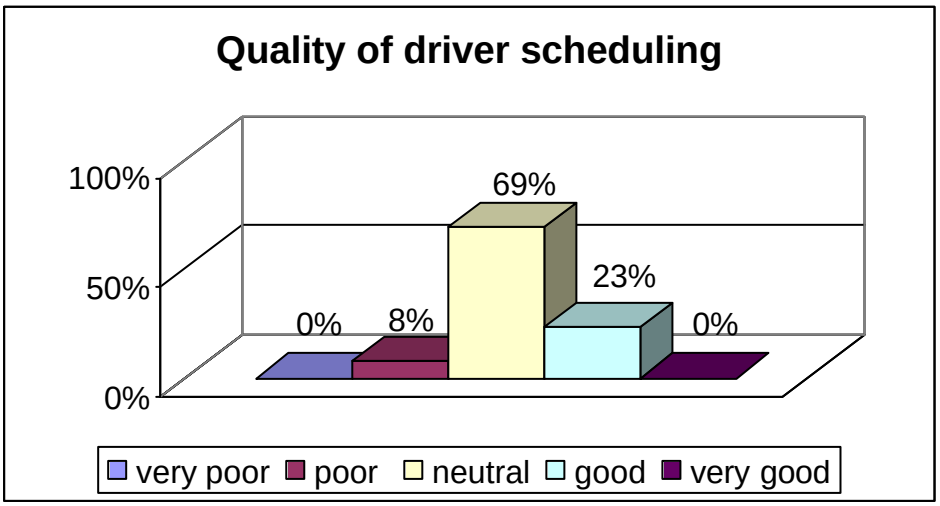

Fig. 6-6 Perceived quality of public transport driver scheduling (13 replies)

When respondents were asked whether they thought there was a requirement to optimise vehicle scheduling for their systems, all 13 replied that they thought there was (Fig. 6-7). Nearly as many respondents recognised a need to improve driver scheduling (Fig. 6-8).

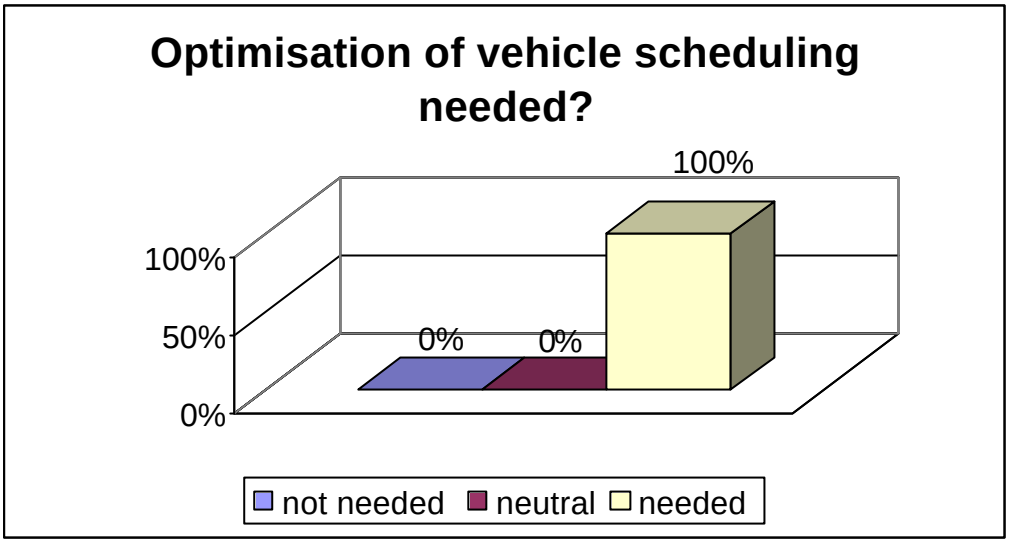

Fig. 6-7 Perceived requirement to optimise public transport vehicle scheduling (13 replies)

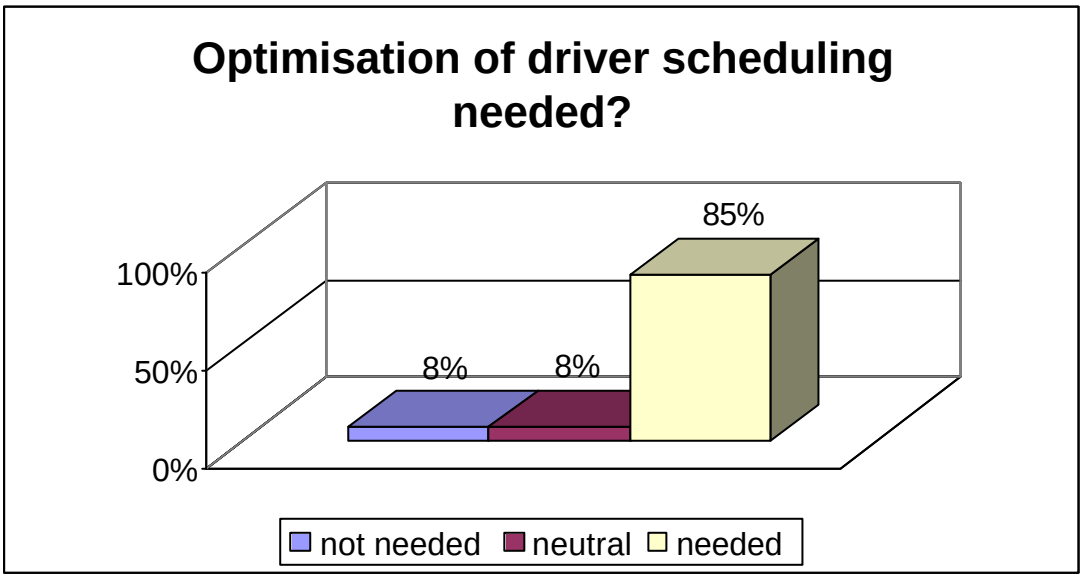

Fig. 6-8 Perceived requirement to optimise public transport driver scheduling (13 replies)

A high majority of respondents declared that their public transport system did not have an adequate management system, providing automatic recording, analysis and presentation functions (Fig. 6-9).

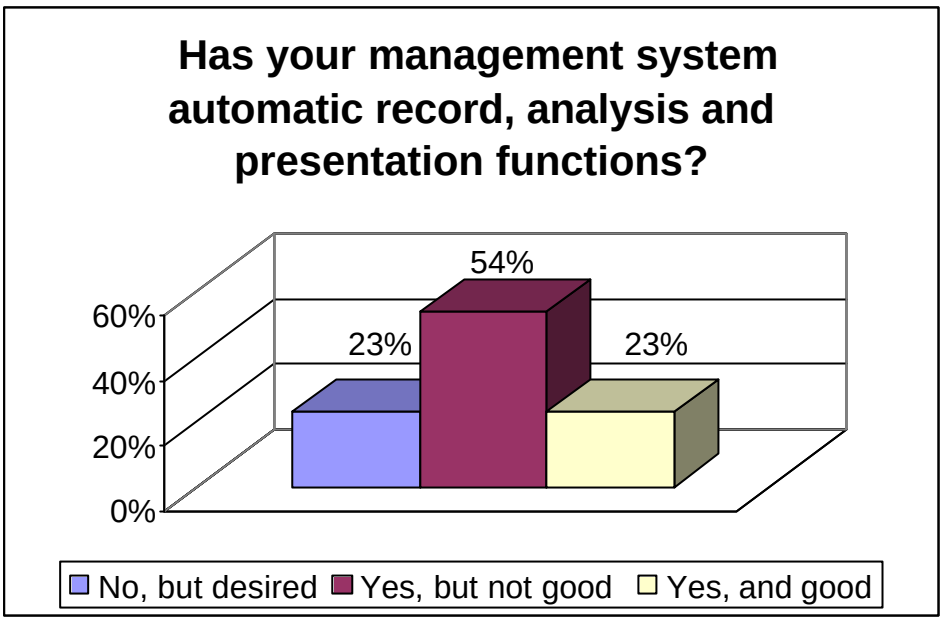

Fig. 6-9 Adequacy of public transport management system (13 replies)

Only one respondent expressed any concern over the quality of the bus stops (Fig. 6-10).

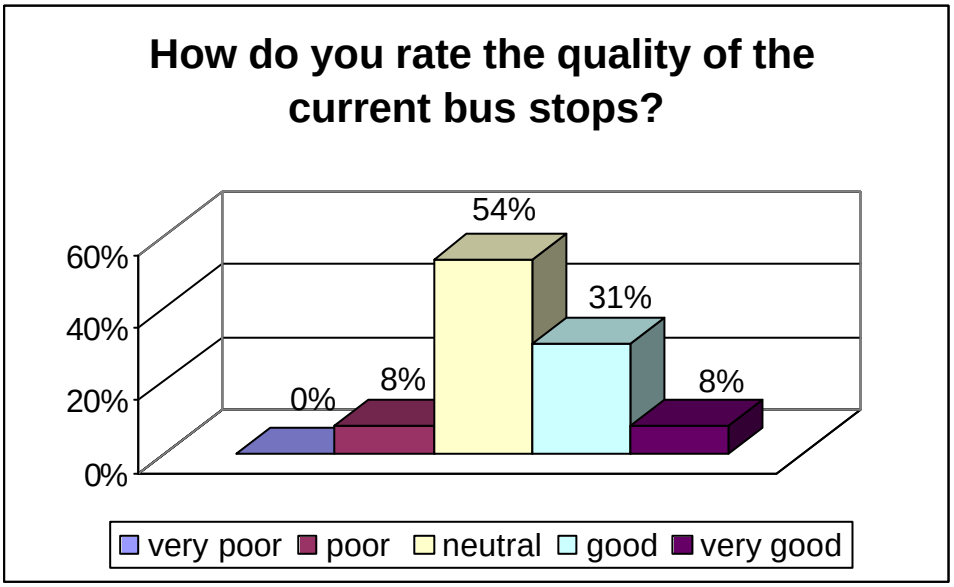

Fig. 6-10 Perceived quality of public transport stops (13 replies)

6.1.2 Current features of services

Over half the public transport systems investigated in the survey were equipped with GPS (Fig. 6-11), albeit on a limited scale.

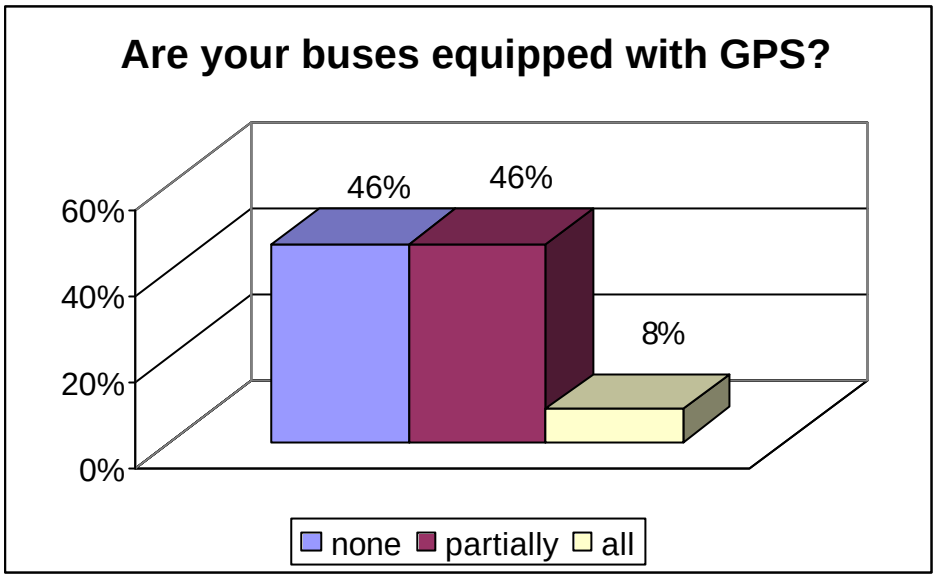

Fig. 6-11 Extent of GPS implementation among surveyed public transport systems (13 replies)

All the systems in the survey featured voice announcements of next stops (Fig. 6-12), though in some cases, implementation concerns only part of the vehicle fleet.

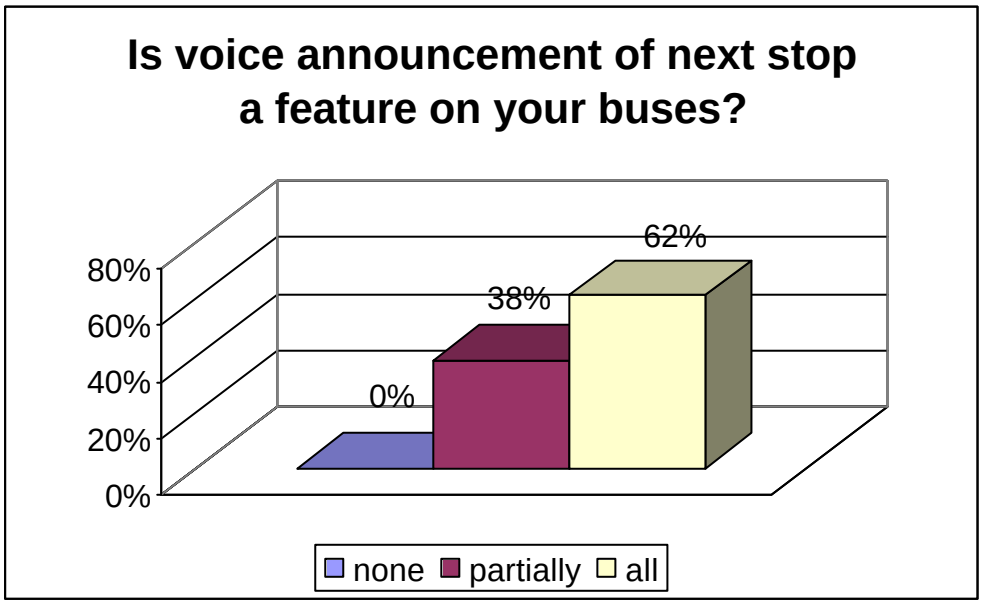

Fig. 6-12 Extent of next stop announcement implementation among surveyed public transport systems (13 replies)

Eleven of the public transport operators involved in the survey use smart cards for electronic ticketing in parallel with a conventional ticketing system (payment on board in cash with emission of paper tickets). One respondent claimed that his/her system used smart cards exclusively. One respondent failed to answer the question. (Fig. 6-13).

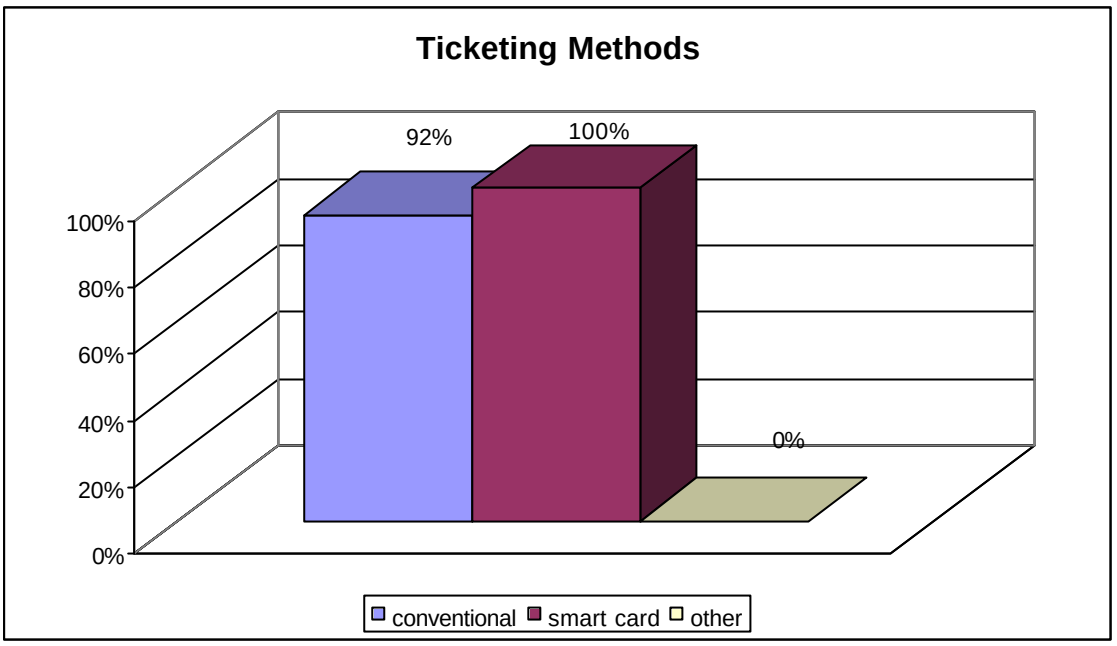

Fig. 6-13 Ticketing methods used among surveyed public transport systems (12 respondents could each give up to three replies)

Most of the systems do not have any communication system implemented between vehicles and a control centre (Fig. 6-14).

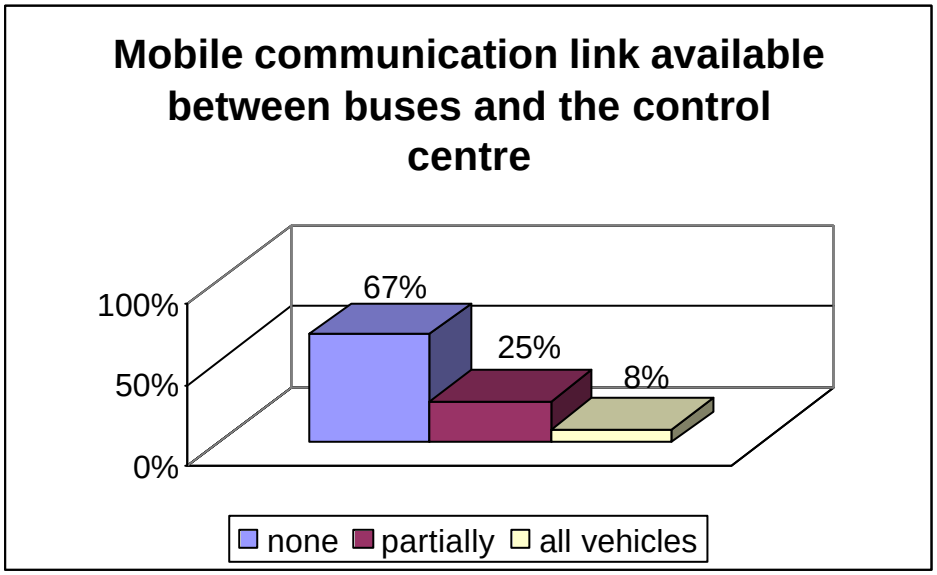

Fig. 6-14 Availability of a communication link between vehicles and the control centre among surveyed public transport systems (12 replies)

When asked which communication technologies are currently in use, four respondents stated that GPRS is currently being used, three that their system uses a private radio network and one replied that a wireless LAN is being used; the other systems in the survey do not use any communication technology (Fig. 6-15).

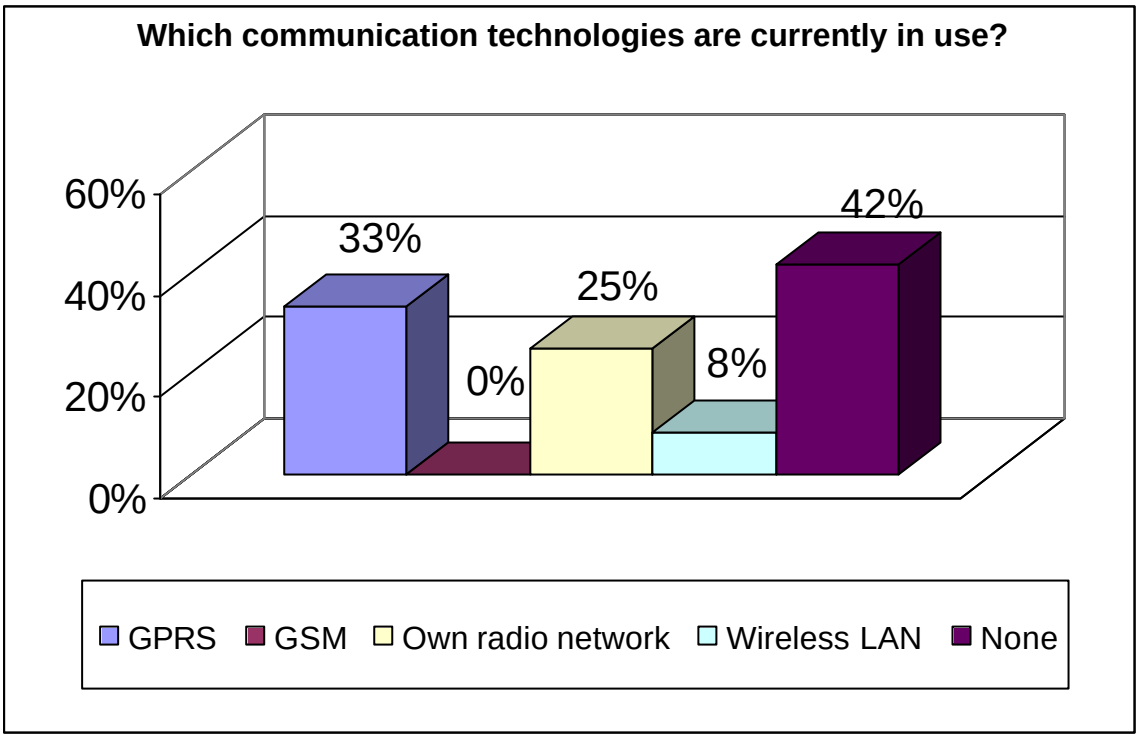

Fig. 6-15 Communication technologies currently in use among surveyed public transport systems (12 respondents; one respondent uses both GPRS and their own radio network)

6.1.3 Identified requirements for IPTS

Apart from vehicle and driver scheduling optimisation, mentioned in Subsection 6.1.1 above (see Figs. 6-7 and 6-8), respondents identified several other IPTS system requirements as well.

Basic real-time fleet monitoring data, relating to vehicle location and the number of passengers on board a vehicle at a given time, is considered to be of paramount importance by all or most respondents, but also information relating to general traffic conditions and emergency calls, fee collection data and video surveillance output is considered important by most of the respondents (Fig. 6-16).

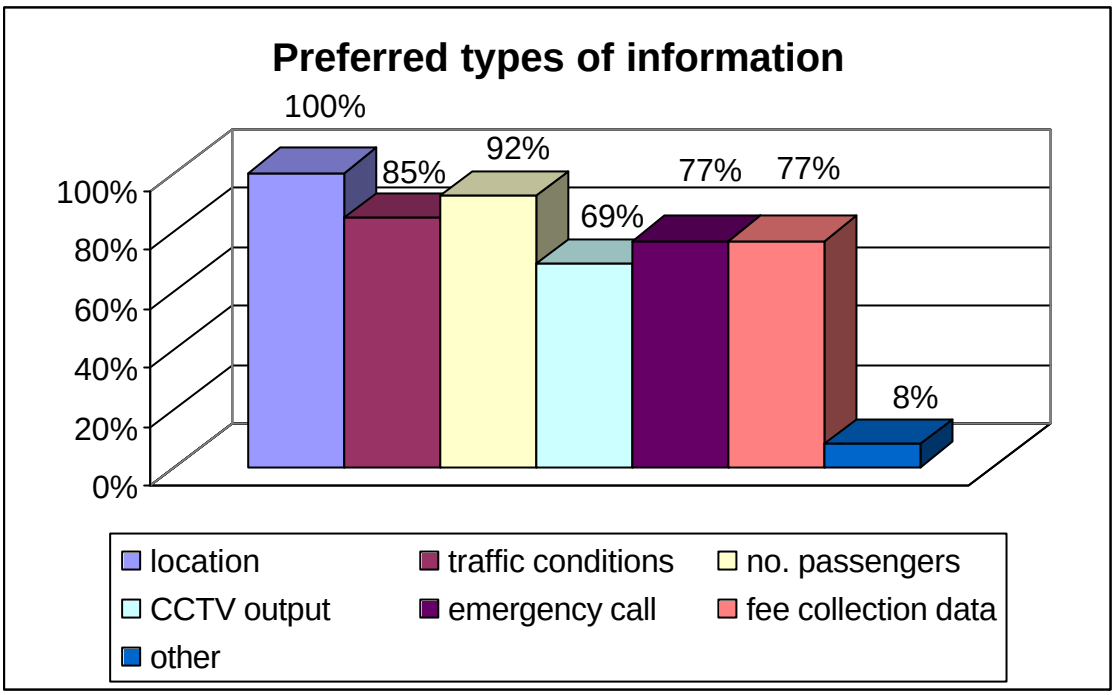

Fig. 6-16 Most important information from vehicle to control centre (13 respondents identified as many information types as they wished)

Where there is a requirement for video surveillance, all respondents agree that interchange points are the more critical areas. Respondents did not all agree, however, over whether it is more important to have these systems on board the vehicles or at stops (Fig. 6-17).

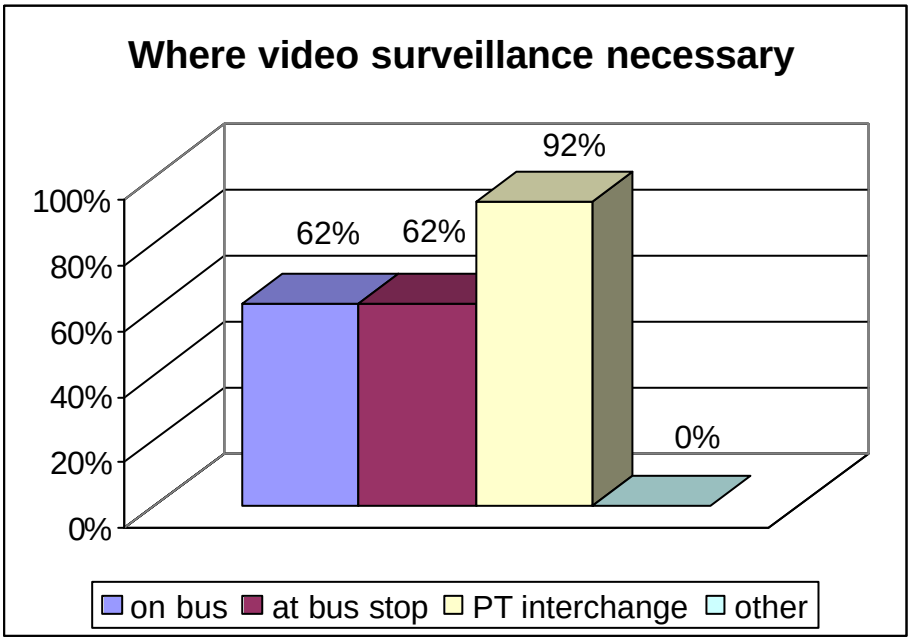

Fig. 6-17 Most important locations for video surveillance systems (13 respondents each identified up to three locations)

A high majority of respondents identified the need for passenger counters (Fig. 6-18)

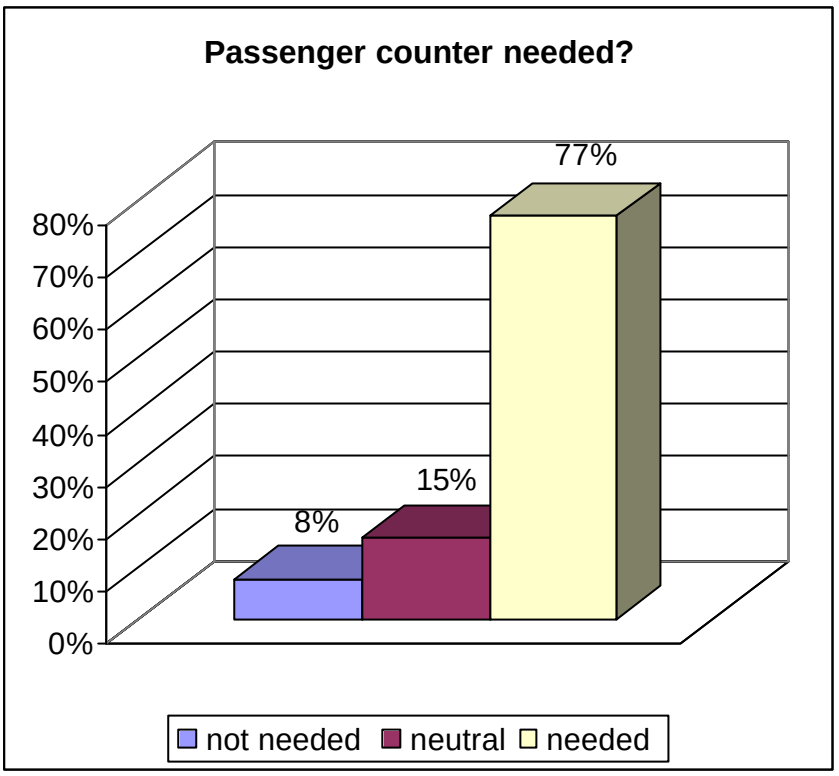

Fig. 6-18 Need for passenger counters among surveyed public transport systems (13 replies)

A clear ranking of information for pre-trip planning emerged from the survey. The type of information required for this purpose, in order of stated importance, was the following (Fig. 6-19):

- Best route
- Travel time
- Sightseeing information
- Trip cost

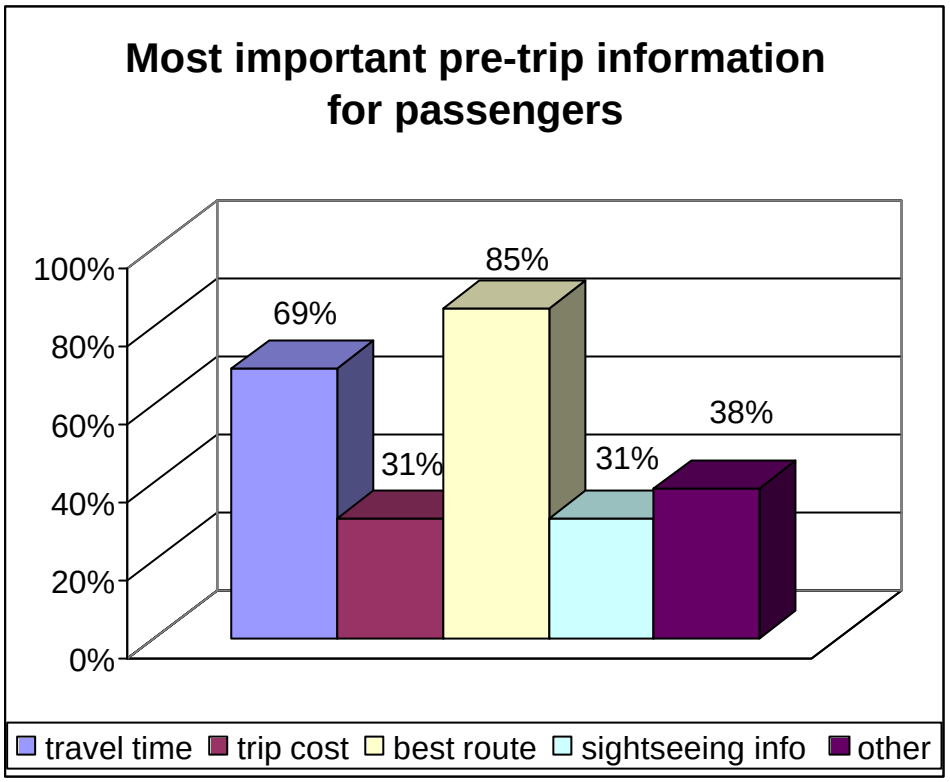

Fig. 6-19 Most important pre-trip information (13 respondents each identified as many information types as they wished)

The survey results also showed a ranking of preferred locations for providing public transport information to the public. The identified locations, in order of stated importance, were the following (Fig. 6-20):

- At stops
- On board the vehicles
- At railway stations or on PCs or mobile devices
- At airports
- At ports

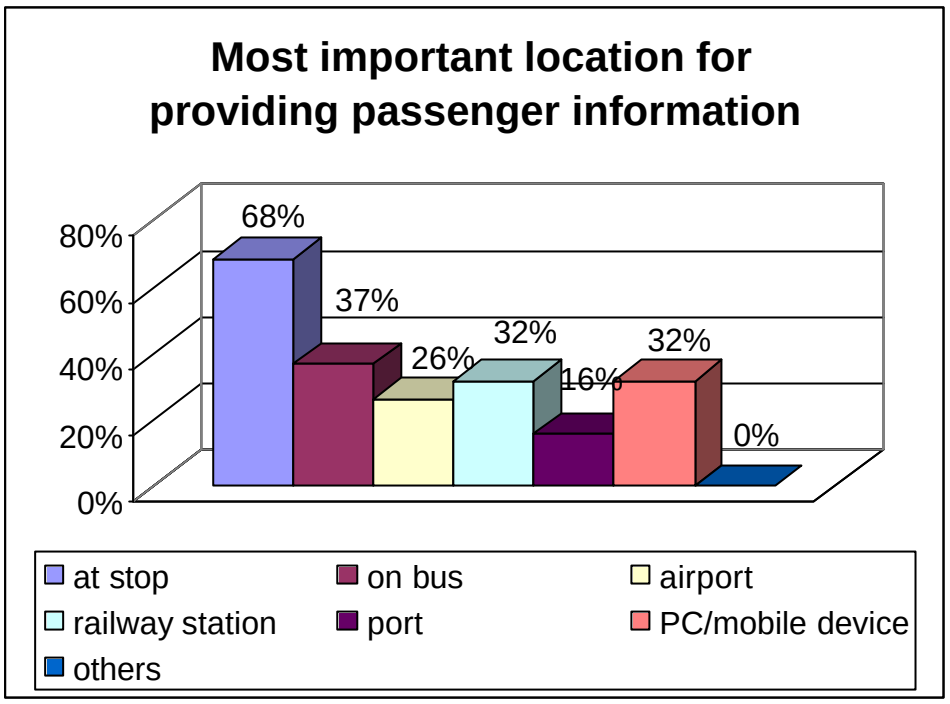

Fig. 6-20 Best locations for providing public transport information (13 respondents could each identify as many location points as they wished)

Respondents were asked to state the type of information they thought should be provided at public transport stops. Again, it is possible to observe a ranking of the most important information to be provided at these locations, as follows (Fig. 6-21):

- Start and end times of service
- Arrival times of vehicles at the stops and service routes
- Location of vehicles
- Information on fares
- Weather or traffic information and advertising

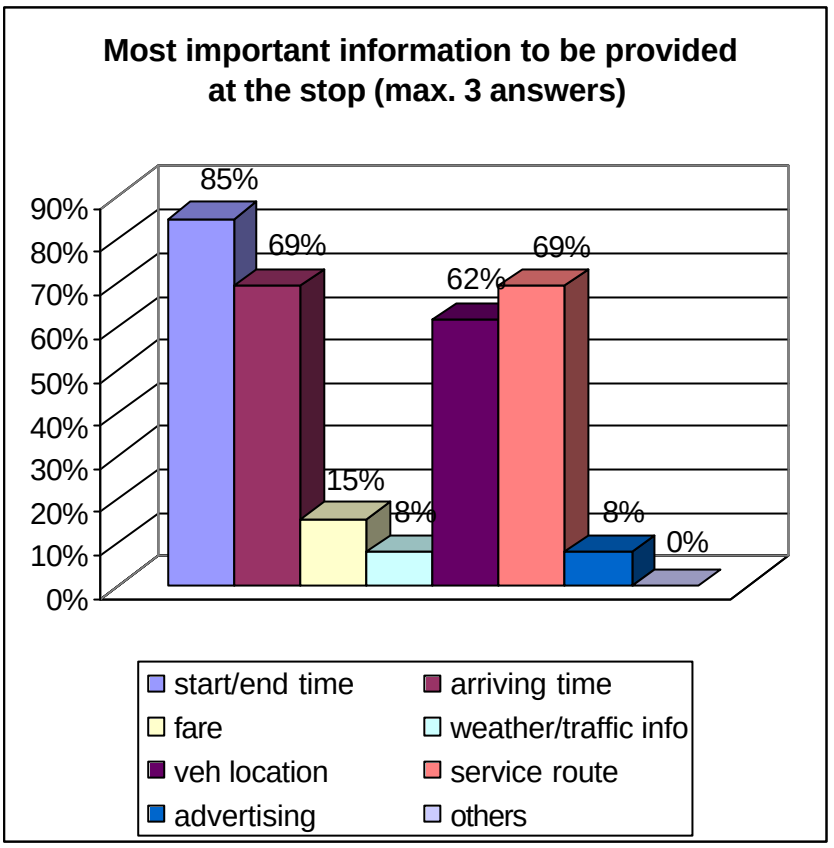

Fig. 6-21 Most important information to be provided at public transport stops (respondents identified up to three information types)

The following three most important types of information to be provided on board vehicles were identified (Fig. 6-22):

- Identification of next stop
- Destination
- Travel time
- Price
- Route length

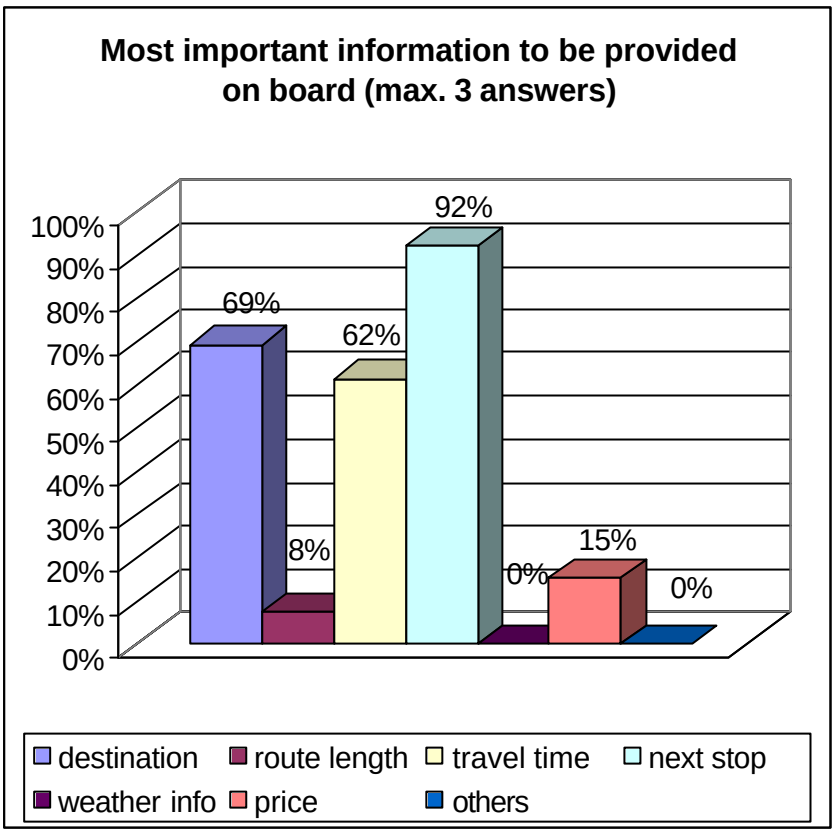

Fig. 6-22 Most important on-board information (12 respondents identified up to three information types)

All the respondents identified a need for large interchange hubs in their cities (Fig. 6-23).

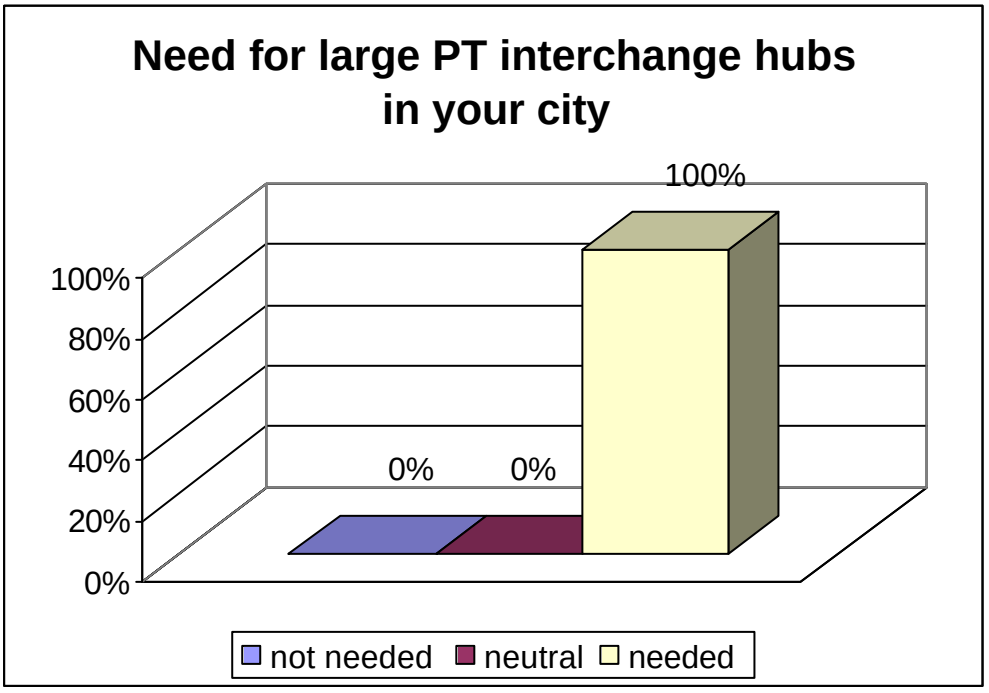

Fig. 6-23 Need for large public transport interchange hubs among surveyed public transport systems (13 replies)

6.2 End user surveys

A random sample of 35 commuters was interviewed in order to understand how they perceived the current public transport services in Ningbo and how they could be improved. The results of the interviews are summarised in the following sections.

6.2.1 Current PT services

The majority of respondents were non-committal in their overall assessment of the quality and efficiency of the public transport service operating in their city (Ningbo). A sizeable minority stated they thought the current services were 'good', while a smaller, but nonetheless significant, minority rated the service 'poor' to 'very poor' (Fig. 6-24).

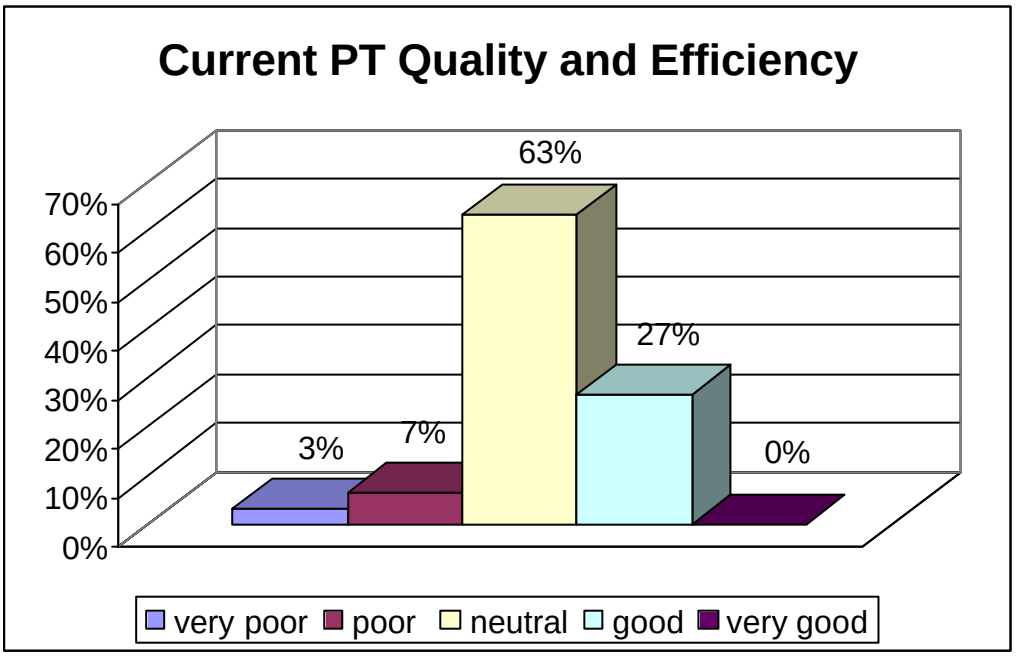

Fig. 6-24 Passengers' perceived quality and efficiency of the public transport service provided in Ningbo (30 replies)

Just over half the people interviewed considered the current network offered sufficient coverage of the local area; a sizeable minority were non-committal and only one respondent was unhappy about current coverage (Fig. 6-25).

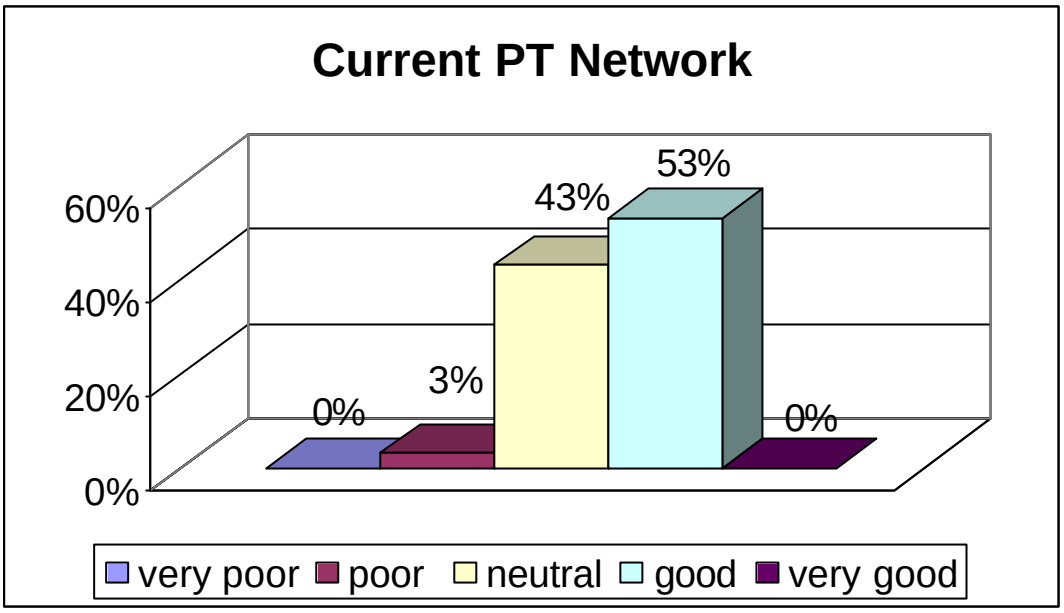

Fig. 6-25 Passengers' perceived adequacy of coverage of the public transport network in Ningbo (30 replies)

40% of the sample identified overcrowding on Ningbo's public transport network to be 'critical or 'very critical' (Fig. 6-26).

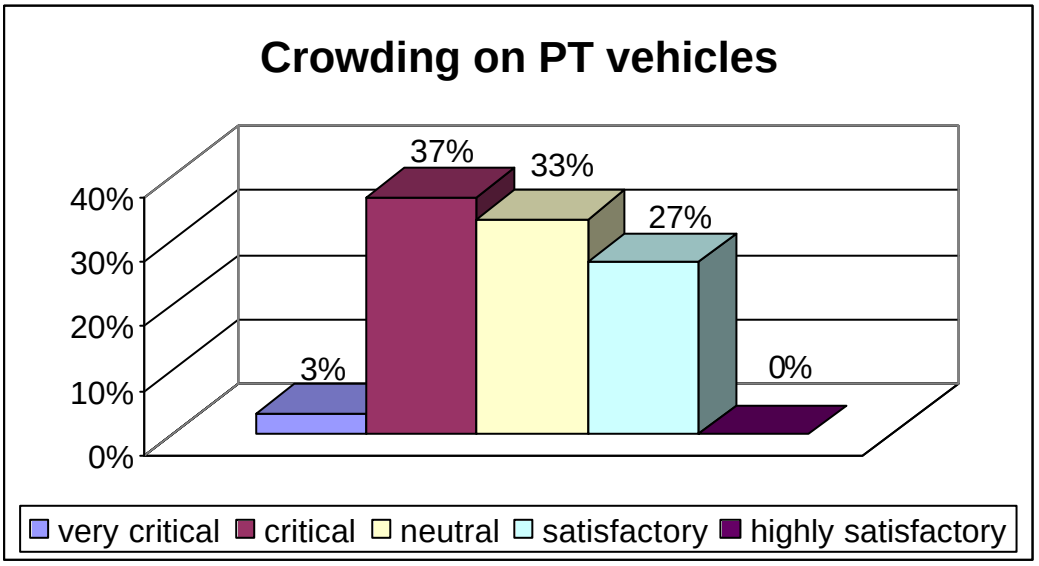

Fig. 6-26 Passengers' perceived overcrowding on public transport vehicles in Ningbo (30 replies)

The majority of the sample make at least one connection change in the course of their journey between home and work (Fig. 6-27).

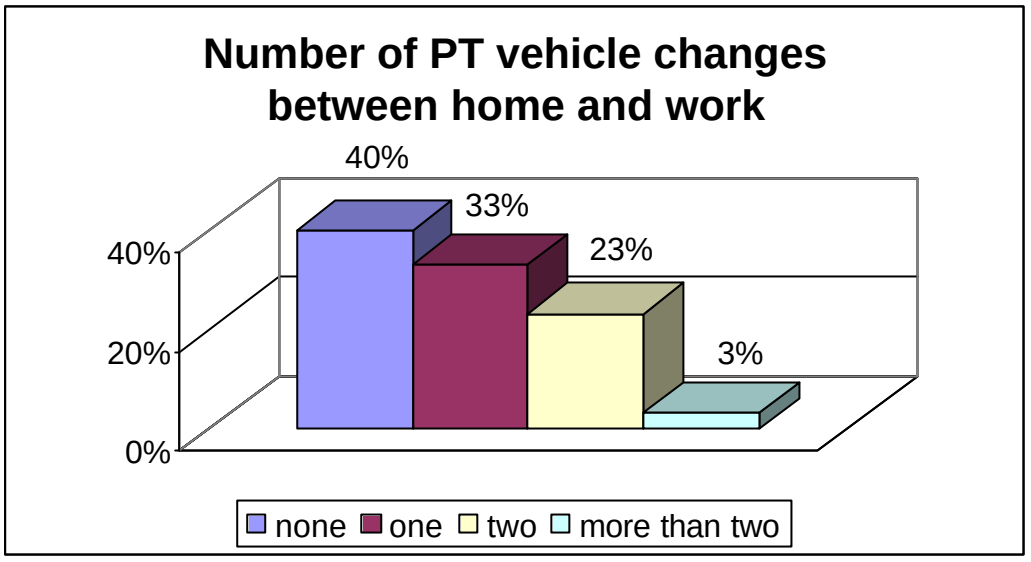

Fig. 6-27 Number of connection changes in the course of a commuter journey in Ningbo (30 replies)

Only a small number of respondents claimed to be satisfied with the scheduling of public transport services (Fig. 6-28).

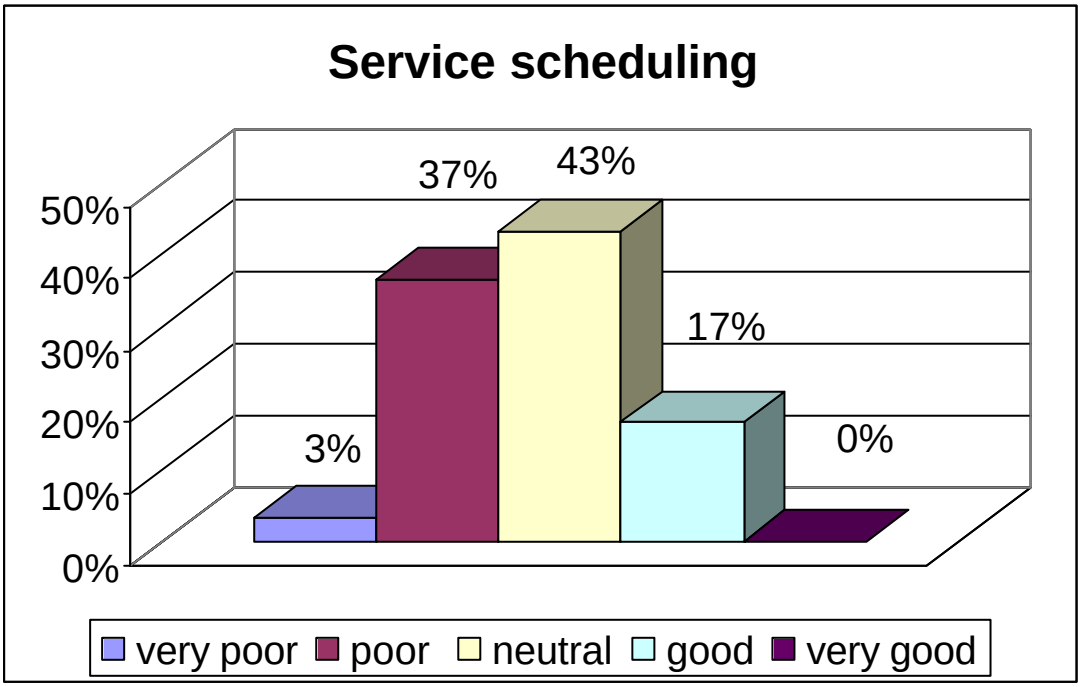

Fig. 6-28 Passengers' perceptions of public transport service scheduling in Ningbo (30 replies)

We can only surmise the causes for users' dissatisfaction with the scheduling of services. Here are some possible reasons:

- the arrival times of vehicles are unpredictable, causing long waiting times at stops
- there is an uneven distribution of passenger loads among vehicles, leading to overcrowding
- there is poor synchronisation between services, leading to long waiting times for connections.

It would be interesting to investigate the reasons for dissatisfaction among passengers on this point, in order to find out how best to solve the problem.

Despite the shortcomings of the public transport service in Ningbo, the majority of the sample declared they were generally satisfied with the service, though a high percentage (27%) said the service did not meet their requirements (Fig. 6-29).

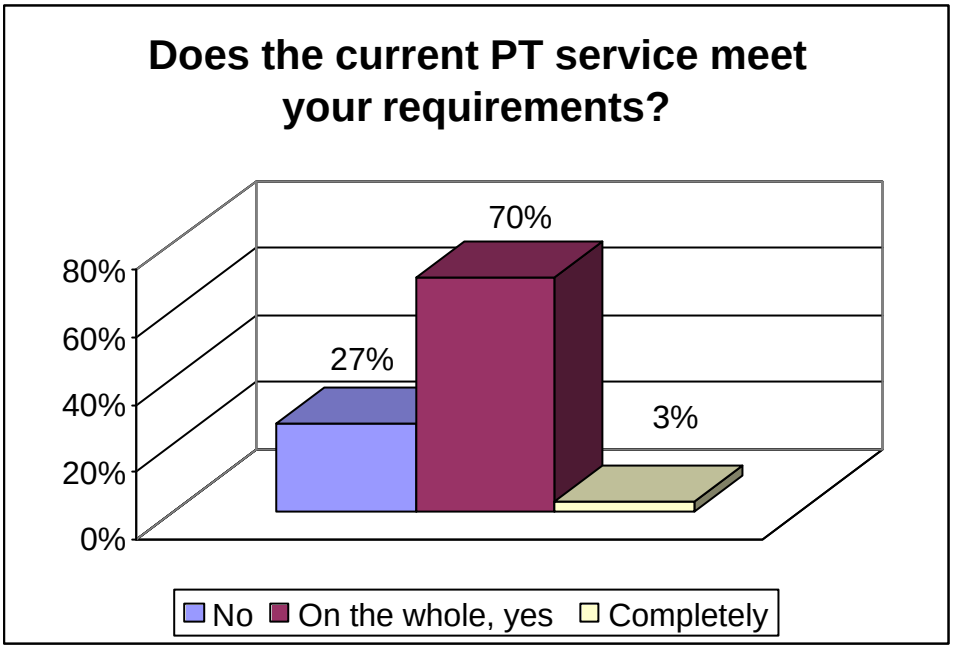

Fig. 6-29 Passengers' satisfaction with the public transport service in Ningbo (30 replies)

The majority of the sample made no comment about the quality of information provided at stops. We may infer from this that the majority did not identify a need for this information. A sizeable minority (23%), however, described the quality of information at stops as 'poor' (Fig 6-30).

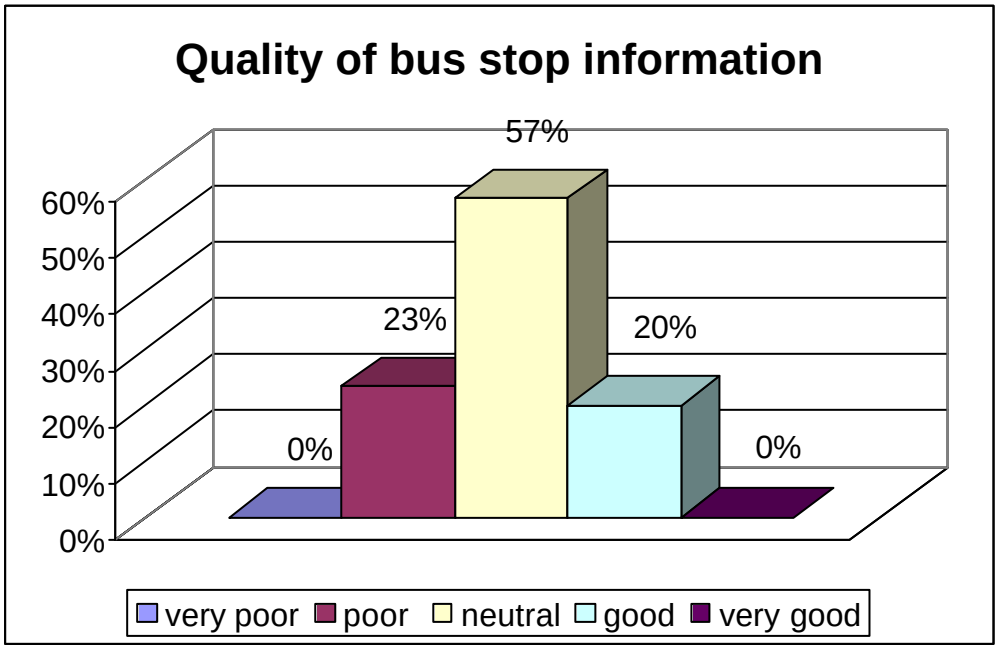

Fig. 6-30 Passengers' perceptions of the quality of information provided at public transport stops in Ningbo (30 replies)

A small minority of the sample recognised a need to improve the quality of public transport stops (Fig. 6-31).

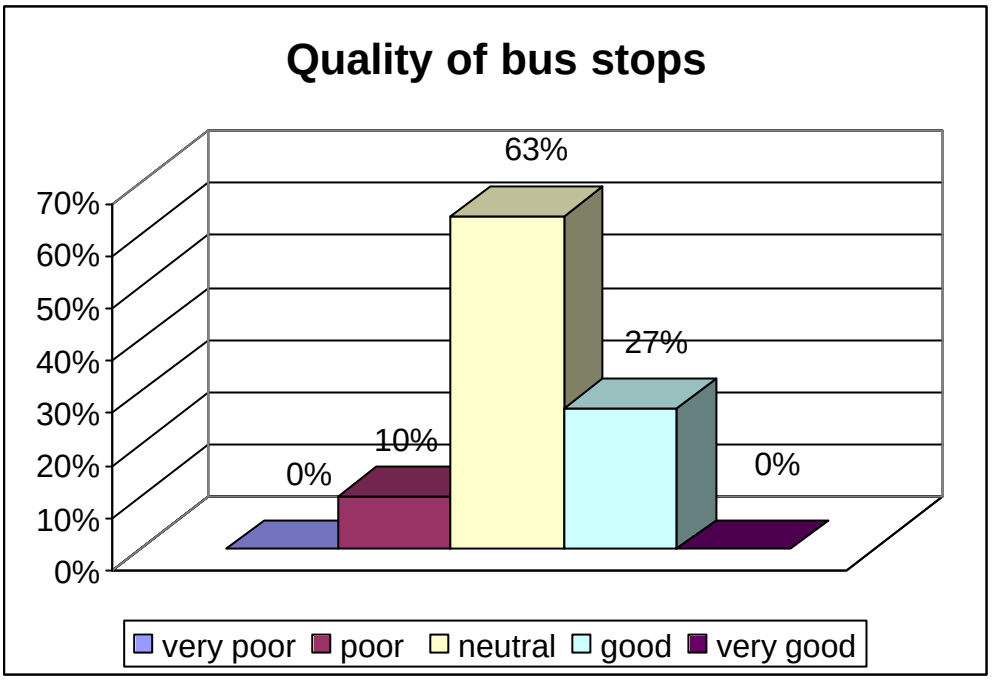

Fig. 6-31 Passengers' perceptions of the quality of public transport stops in Ningbo (30 replies)

6.2.2 Perceived requirements

When asked where they thought video cameras should be placed to improve personal safety and security, the majority answered they should be placed at public transport stops, while significant minorities indicated they should be placed on board vehicles and at main public transport interchange points (Fig. 6-33).

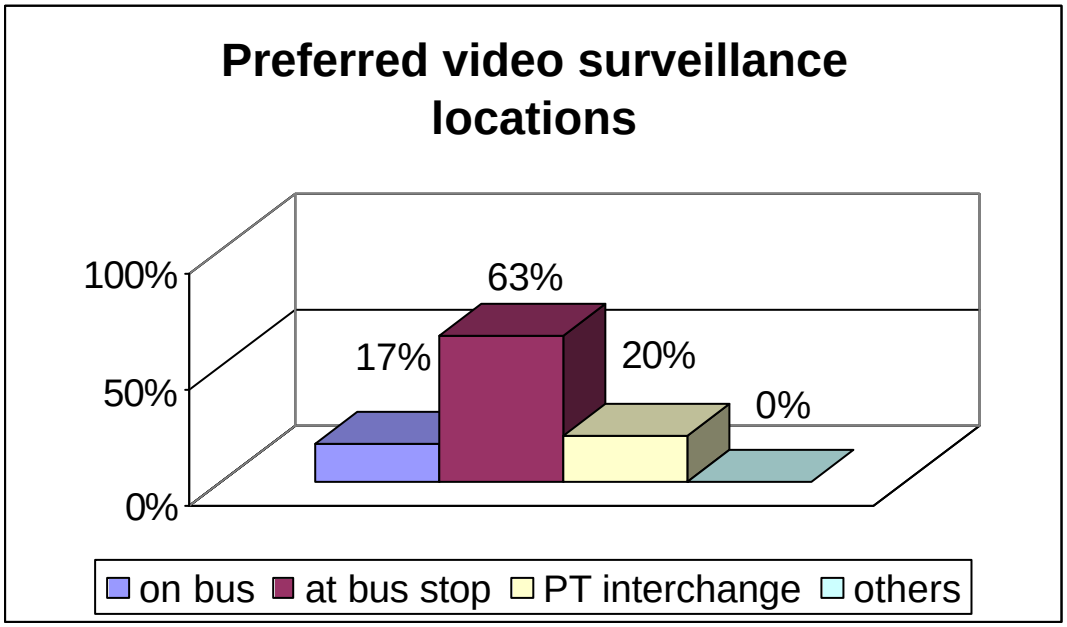

Fig. 6-32 Passengers' preferred locations for video surveillance systems in Ningbo (30 replies)

The interviewees were asked to state which three types of information they thought would be most useful for public transport passengers. The following ranking of information resulted from their answers (Fig. 6-34):

- Travel time
- Best route
- Sightseeing information

Only a small part of the sample (4 persons) indicated trip costs as important information.

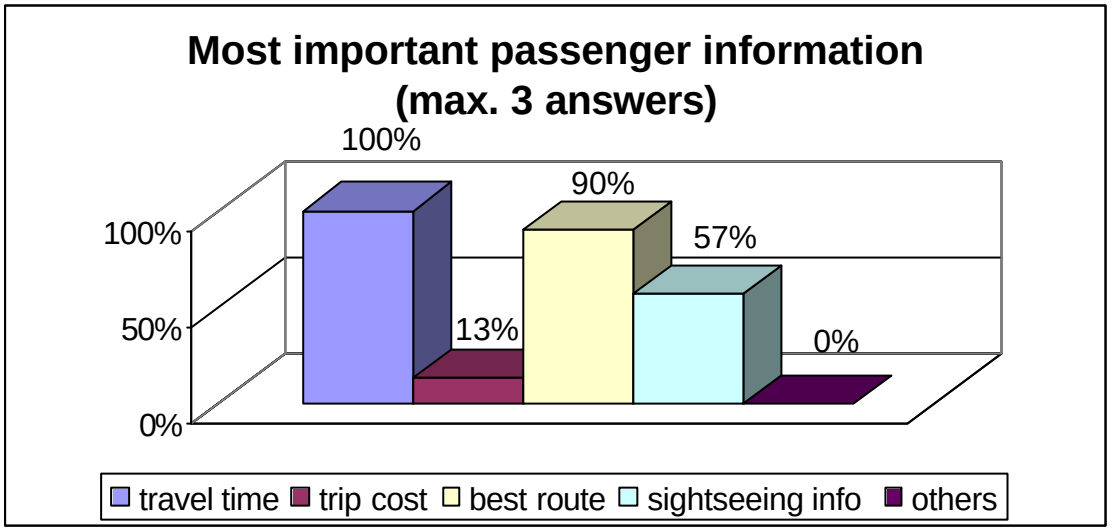

Fig. 6-33 Preferred information types for passengers Ningbo's public transport system

A ranking of preferred locations for providing passenger information (Fig. 6-35) also emerged from the results of the survey. It is as follows:

- At stops and on board vehicles
- At railway stations
- Via the PC or a mobile device

Only one or two people thought it was important to provide information at the airport or port.

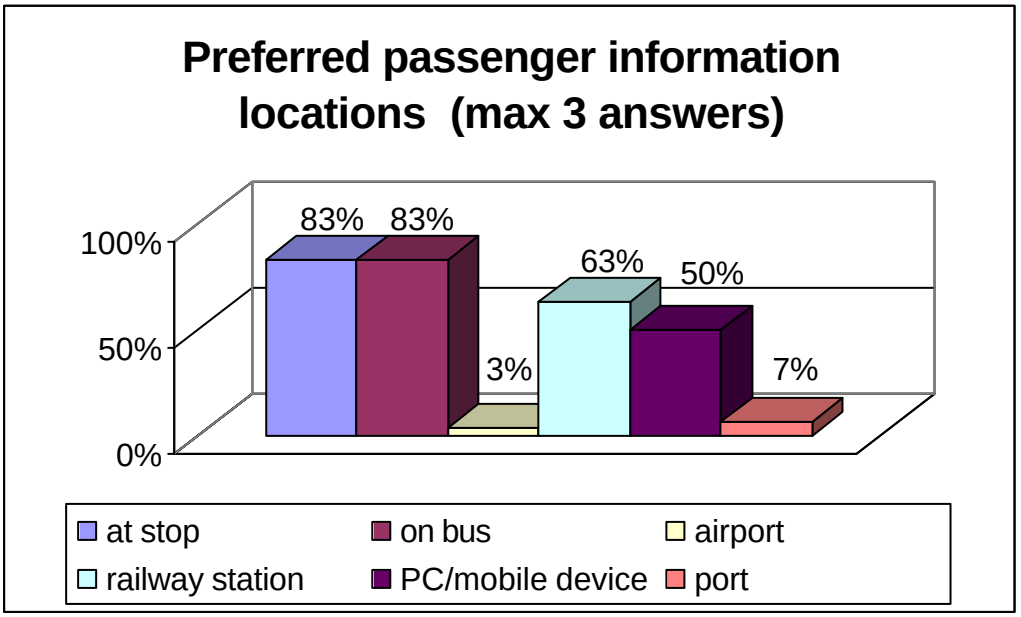

Fig. 6-34 Passengers' preferred locations for passenger information terminals in Ningbo

Respondents were asked to state the type of information they thought should be provided at public transport stops. Again, it is possible to observe a ranking of the most important information to be provided at these locations, as follows (Fig. 6-35):

- Daily start or end times of service
- Service routes
- Location of vehicles
- Arrival times of vehicles at the stops

Only one or two people identified traffic information and advertising as required information at public transport stops.

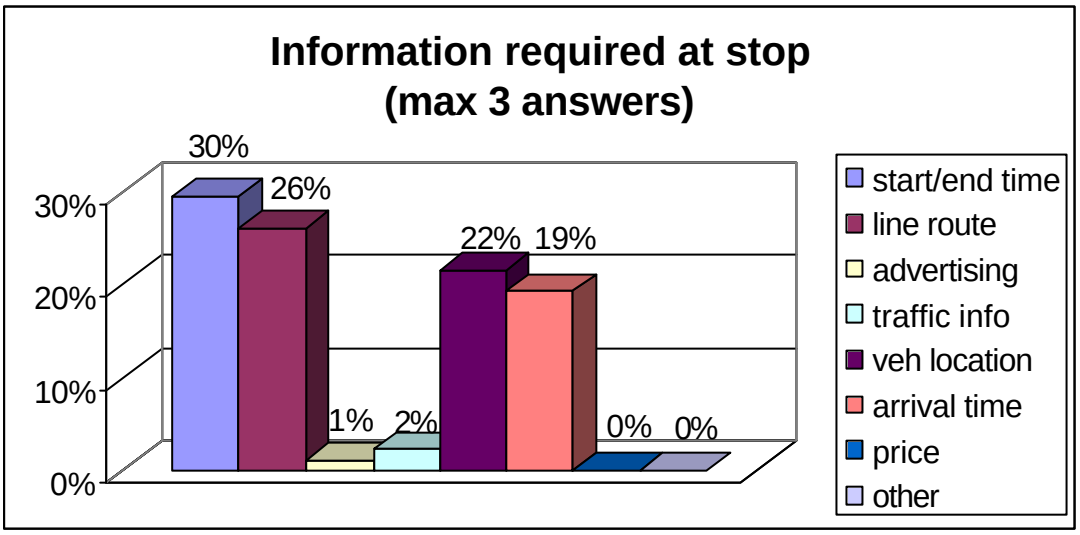

Fig. 6-35 Preferred information for passengers at public transport stops

The following four most important types of information to be provided on board vehicles were identified (Fig. 6-36):

- Direction
- Travel time and identification of next stop
- Weather information

A few people also identified route length and price as useful information to be provided on board.

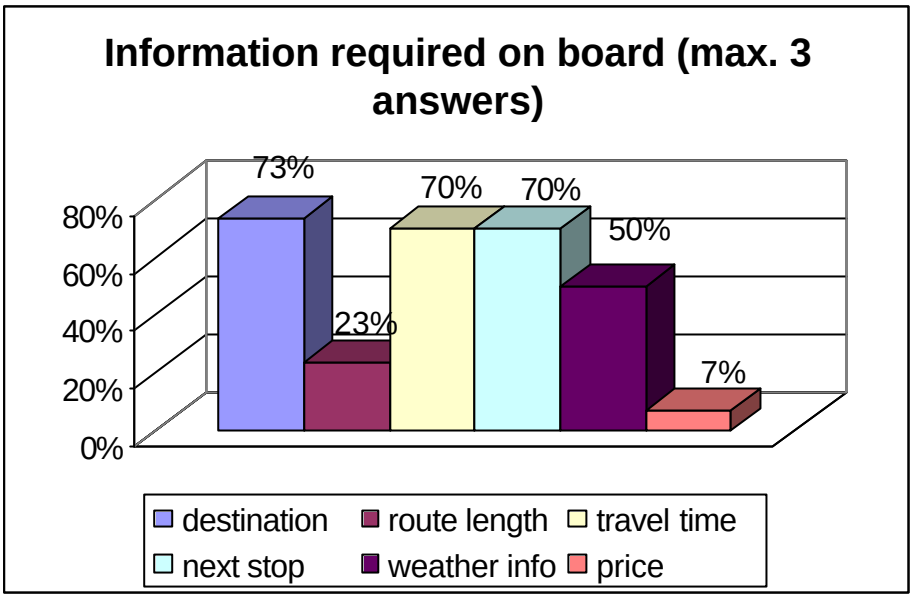

Fig. 6-36 Preferred information for passengers on board public transport vehicles

A sizeable minority (37%) of the sample recognised the need for large interchange hubs in the city (Fig. 6-37).

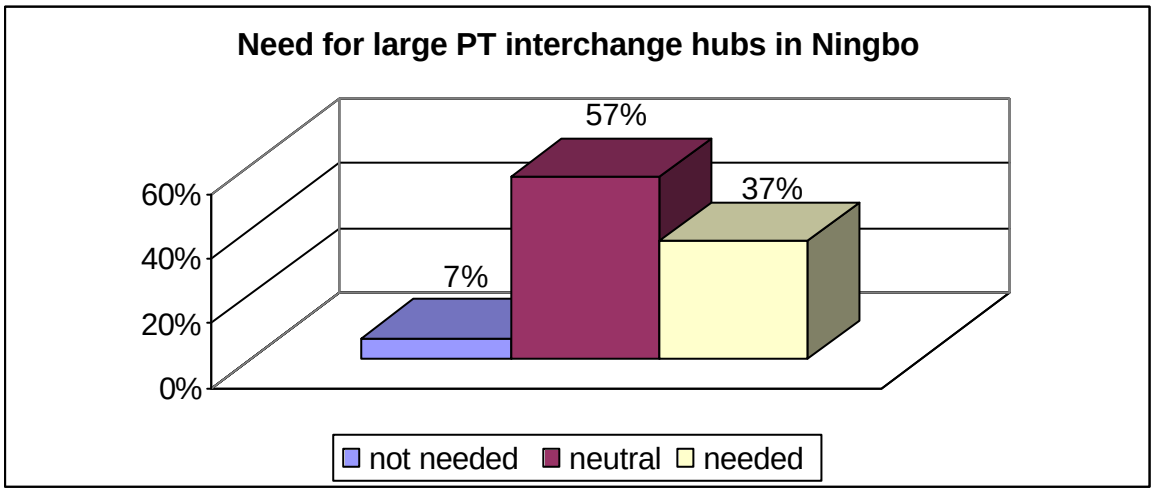

Fig. 6-37 Need for large public transport interchange hubs according to commuters (30 replies)

More than two-thirds of the sample expressed a preference for using smart cards over other means for accessing the transport network (Fig. 6-38).

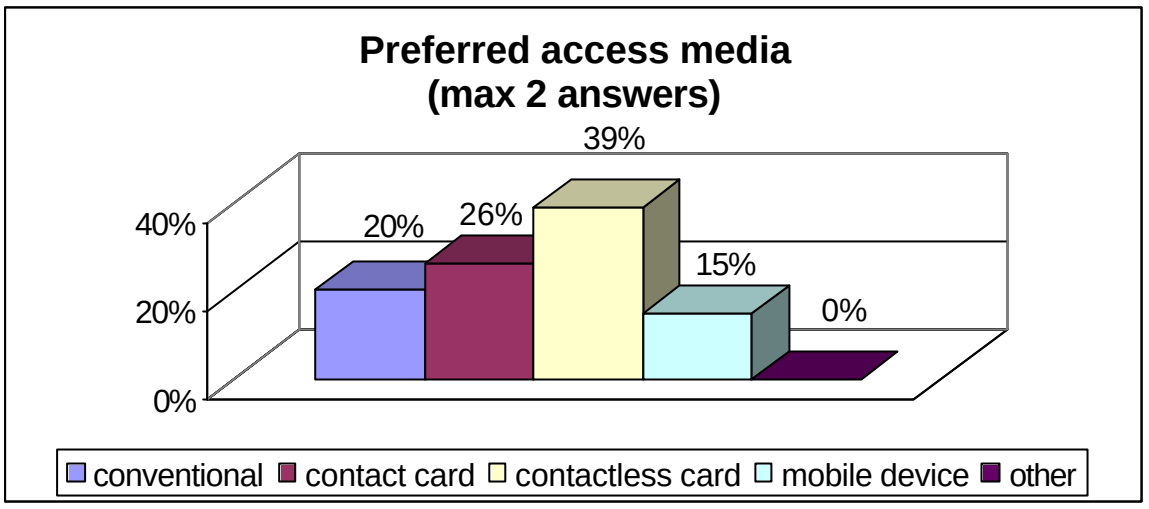

Fig. 6-38 Preferred access media

6.3 Interview with NBGJ

Project members interviewed a manager in NBGJ's planning department in order to understand the priority requirements of the company for IPTS. The notes and conclusions from this interview are provided in Annex C. The following priority requirements are noted:

- The control centre should be able to:
  - Communicate with each vehicle in the fleet
  - Monitor the position of each vehicle
  - Monitor the status of vehicles
  - Monitor the status of peripheral equipment
  - Store historical data
  - Manage the dispatching of messages to/from the vehicles
  - Interface with other ITS systems
  - Provide optimal driver and vehicle scheduling
  - Manage the passenger information system
  - Elaborate an assessment of the quality and efficiency of the public transport service
  - Provide reporting functions
  - Maintain peripheral equipment
- Each vehicle in the public transport fleet should be able to:
  - Monitor passenger flows and calculate when the vehicle is overcrowded
  - Check its own status
  - Register its position in the network
  - Communicate with a control centre in real time
  - Announce the next stop
  - Send an emergency call to the control centre
- The system should include fixed peripheral devices that are able to perform the following functions, as appropriate:
  - Data uploading/downloading and storage
  - Display of real-time information at bus stops
  - interfacing with the traffic light control system

  The fixed peripheral units should conform with the provisions of TC 278 / WG3, regarding devices and visualisation methods. They should run on DOS (in room

version) and their applications should be developed modularly and be written entirely in C++.

- Communication between components in the system should be by means of a communication network having the following characteristics:
  - perfect integration of intelligent units
  - integration of the following communication dedicated sub-networks:
    - LAN – Local Area Network - at the control centre level
    - Wireless LAN at control centre level
    - WArN – Wide Area radio Network - for mobile units
    - SRRC – Short Range Radio Communication - for mobile units
    - ISDN – Integrated Services Digital Network - for distributed fixed units
  - regardless of the network technology used to physically connect the various computers, TCP/IP should be used as the extended network communication protocol, providing the rules for the exchange of messages and specifying how to handle abnormal situations
  - The WArN can be both a PMR radio system as well as the GSM – SMS cellular network.

6.4 Conclusions

From the results of the surveys and the interview with NBGJ a first list of user needs can be established as the basis for elaborating the functional requirements for the Ningbo IPTS architecture.

The following user needs emerge from the public transport company survey:

- Improved integrated fleet management and resource sharing
- Reduced overcrowding on vehicles
- Optimised vehicle scheduling
- Optimised driver scheduling
- Improved management system, including automatic recording, analysis and presentation functions
- Availability in real time of fleet monitoring data, relating to vehicle location and the number of passengers on board a vehicle at a given time
- Availability of information relating to general traffic conditions
- Availability of emergency call facility
- Availability of fee collection data
- Availability of video surveillance data
- Operation of a video surveillance system, especially at interchange points
- Availability of the following pre-trip information for travellers: best routes, travel times, sightseeing information, trip costs
- Availability of information terminals at stops, on board vehicles, at railway stations, via the PC or a mobile device, at airports and at ports
- Availability of the following traveller information at stops: service start/end times, vehicle arrival times, service routes, locations of vehicles, information on fares, weather and traffic information, advertising
- Availability of the following traveller information on board vehicles: identification of next stop, direction, travel times, price, route length
- Introduction of large public transport interchange hubs.

The following user needs emerge from the end user survey:

- Reduced overcrowding on vehicles
- Improved service scheduling
- Improved quality of information available at stops
- Improved quality of stops
- Operation of a video surveillance system, especially at stops
- Availability of the following information for travellers: travel times, best routes, sightseeing information, trip costs
- Availability of information terminal at stops, on board vehicles, at railway stations, via the PC or a mobile device
- Availability of the following traveller information at stops: start/end times (what's this), service routes, locations of vehicles, vehicle arrival times
- Availability of the following traveller information on board vehicles: direction, travel times, identification of next stop, weather information
- Introduction of large public transport interchange hubs.

The two lists may be combined to form the following **superset of user needs**, that accounts for all the user needs identified in both surveys:

- Improved integrated fleet management and resource sharing
- Reduced overcrowding on vehicles
- Optimised vehicle scheduling
- Optimised driver scheduling
- Improved quality of stops
- Improved management system, including automatic recording, analysis and presentation functions
- Availability in real time of fleet monitoring data, relating to vehicle location and the number of passengers on board a vehicle at a given time
- Availability of information relating to general traffic conditions
- Availability of emergency call facility
- Availability of fee collection data
- Availability of video surveillance data
- Operation of a video surveillance system, especially at interchange points and stops
- Improved quality of information available at stops
- Availability of the following pre-trip information for travellers: travel times, best routes, sightseeing information, trip costs*
- Availability of information terminals at stops, on board vehicles, at railway stations, via the PC or a mobile device, at the airport and port*
- Availability of the following traveller information at stops: start/end times, service routes, locations of vehicles, vehicle arrival times, advertising, information on fares, weather and traffic information*
- Availability of the following traveller information on board vehicles: direction, travel times, identification of next stop, weather information, price, route length *
- Introduction of large public transport interchange hubs.

* Wherever there is a difference in the ranking of preferences between the two surveys, the ranking emerging from the end user survey is given in the above list.

Finally, it is possible to check to what extent the priority requirements identified in the interviews with NBGJ correspond with the needs identified in the superset above. This correspondence is demonstrated in the following chapter.

7 Functional requirements for IPTS

7.1 Overview

The functional requirements emerging from the user needs analysis are presented in two different ways in this chapter:

- Firstly, a table is presented showing the correspondence between each of the user needs identified from the surveys (and listed in the superset of user needs in section 6.4 above) with the functional requirements emerging from the interviews with NBGJ
- Secondly, the same superset of user needs is compared with the user needs identified in the KAREN/FRAME framework.

The principal aim of the first table is to ensure that the IPTS architecture for Ningbo is adequately defined to cover the identified user needs.

The second table will facilitate a comparison with IPTS systems in Europe that have also been defined using the KAREN /FRAME framework.

7.2 Identified user needs vs. identified functional requirements

Identified Need	Corresponding functional requirements identified by NBGJ
Improved integrated fleet management and resource sharing	Control centre: o Communicating with each vehicle in the fleet o Monitoring the position of each vehicle o Monitoring the status of vehicles and peripheral equipment o Storing historical data o Managing the dispatching of messages to/from the vehicles o Interfacing with other ITS systems o Providing optimal driver and vehicle scheduling o Managing the passenger information system o Elaborating an assessment of the quality and efficiency of the public transport service o Providing reporting functions o Maintaining peripheral equipment Communication network: o Control centre LAN o WArN o SRRC
Reduced overcrowding on vehicles	Control centre: o Communicating with each vehicle in the fleet o Monitoring the status of vehicles and peripheral equipment o Managing the dispatching of messages to/from the vehicles In-vehicle system: o Monitoring passenger flows and calculating when the vehicle is overcrowded o Communicating with control centre in real time Communication network: o WArN

Identified Need	Corresponding functional requirements identified by NBGJ
Optimised vehicle scheduling	Control centre: o Communicating with each vehicle in the fleet o Monitoring the position of each vehicle o Monitoring the status of vehicles and peripheral equipment o Storing historical data o Managing the dispatching of messages to/from the vehicles o Interfacing with other ITS systems o Providing optimal driver and vehicle scheduling o Elaborating an assessment of the quality and efficiency of the public transport service In-vehicle system: o Monitoring passenger flows and calculating when the vehicle is overcrowded o Checking vehicle status o Registering vehicle position in the network o Communicating with control centre in real time Communication network: o Control centre LAN o WArN o SRRC
Optimised driver scheduling	Control centre: o Monitoring the position of each vehicle o Providing optimal driver and vehicle scheduling o Elaborating an assessment of the quality and efficiency of the public transport service Communication network: o Control centre LAN o WArN
Improved quality of stops	Control centre: o Monitoring the status of peripheral equipment

Identified Need	Corresponding functional requirements identified by NBGJ
	o Managing the passenger information system o Elaborating an assessment of the quality and efficiency of the public transport service o Maintaining peripheral equipment Fixed peripheral devices: o Data uploading/downloading and storage o Display of real-time information at bus stops Communication network: o ISDN
Improved management system, including automatic recording, analysis and presentation functions	Control centre: o Communicating with each vehicle in the fleet o Monitoring the position of each vehicle o Monitoring the status of vehicles and peripheral equipment o Storing historical data o Managing the dispatching of messages to/from the vehicles o Elaborating an assessment of the quality and efficiency of the public transport service o Providing reporting functions o Maintaining peripheral equipment In-vehicle system: o Monitoring passenger flows and calculating when the vehicle is overcrowded o Checking vehicle status o Registering vehicle position in the network o Communicating with control centre in real time Communication network: o Control centre LAN o WArN o SRRC
Availability in real time of fleet	Control centre:

Identified Need	Corresponding functional requirements identified by NBGJ
monitoring data, relating to vehicle location and the number of passengers on board a vehicle at a given time	o Communicating with each vehicle in the fleet o Monitoring the position of each vehicle o Monitoring the status of vehicles and peripheral equipment o Managing the dispatching of messages to/from the vehicles o Elaborating an assessment of the quality and efficiency of the public transport service o Providing reporting functions o Maintaining peripheral equipment In-vehicle system: o Monitoring passenger flows and calculating when the vehicle is overcrowded o Checking vehicle status o Registering vehicle position in the network o Communicating with control centre in real time Communication network: o Control centre LAN o WArN o SRRC
Availability of information relating to general traffic conditions	No specific functional requirements have been defined so far, though fulfilment of the data monitoring requirements (vehicle location, travel speed) and vehicle/centre communication requirements would provide the data and communication pre-requisites for fulfilling this need.
Availability of emergency call facility	Control centre: o Communicating with each vehicle in the fleet o Monitoring the position of each vehicle o Monitoring the status of vehicles and peripheral equipment o Managing the dispatching of messages to/from the vehicles o Interfacing with other ITS systems In-vehicle system: o Monitoring passenger flows o Checking vehicle status

Identified Need	Corresponding functional requirements identified by NBGJ
	o Registering vehicle position in the network o Communicating with control centre in real time o Sending an emergency call to the control centre Communication network: o Control centre LAN o WArN
Availability of fee collection data	No functional requirements identified
Availability of video surveillance data	No functional requirements identified
Operation of a video surveillance system, especially at interchange points and stops	No functional requirements identified
Improved quality of information available at stops	Control centre: o Managing the passenger information system Fixed peripheral devices: o Data uploading/downloading and storage o Display of real-time information at bus stops Communication network: o ISDN
Availability of the following pre-trip information for travellers: travel times, best routes, sightseeing information, trip costs	Control centre: o Managing the passenger information system Fixed peripheral devices: o Data uploading/downloading and storage o Display of real-time information at bus stops Communication network: o ISDN

Identified Need	Corresponding functional requirements identified by NBGJ
	o WArN
Availability of information at stops, on board vehicles, at railway stations, via the PC or a mobile device, at the airport and port	Control centre: o Managing the passenger information system Fixed peripheral devices: o Data uploading/downloading and storage o Display of real-time information at bus stops Communication network: o ISDN o WArN
Availability of the following traveller information at stops: start/end times, service routes, locations of vehicles, vehicle arrival times, advertising	Control centre: o Managing the passenger information system Fixed peripheral devices: o Data uploading/downloading and storage o Display of real-time information at bus stops Communication network: o ISDN
Availability of the following traveller information on board vehicles: direction, travel times, identification of next stop, weather information	Control centre: o Communicating with each vehicle in the fleet o Monitoring the position of each vehicle o Managing the dispatching of messages to/from the vehicles o Interfacing with other ITS systems o Managing the passenger information system In-vehicle system: o Registering vehicle position in the network o Communicating with control centre in real time o Announcing the next stop

Identified Need	Corresponding functional requirements identified by NBGJ
	Communication network: o WArN
Introduction of large public transport interchange hubs.	Control centre: o Communicating with each vehicle in the fleet o Monitoring the position of each vehicle o Monitoring the status of vehicles and peripheral equipment o Storing historical data o Managing the dispatching of messages to/from the vehicles o Interfacing with other ITS systems o Providing optimal driver and vehicle scheduling o Managing the passenger information system Fixed peripheral devices: o Data uploading/downloading and storage o Display of real-time information at bus stops Communication network: o ISDN

Table 7-1 Correspondence between the user needs identified in the surveys and the functional requirements identified in the NBGJ interviews

7.3 Identified user needs vs. user needs of the KAREN/FRAME framework architecture

User needs resulting from MAIN survey	KAREN/FRAME user needs		
	Code	**Definition**	**User Need Set**
Improved integrated fleet management and resource sharing	10.1.0.3	The system shall be able to assist PT operators in planning for the optimum use of existing resources to meet the demand.	Public Transport Management - General
Reduced overcrowding on vehicles	10.1.2.1	The system shall be able to receive information about the identity, location, status and occupancy all vehicles in the fleet in real time.	Public Transport Management - Monitoring
Optimised vehicle scheduling	10.1.1.1	The system shall be able to produce optimum vehicle schedules that consider many issues, e.g. links, points, day types, vehicle types, demand types, time bands, limits based on demand etc.	Public Transport Management - Scheduling
Optimised driver scheduling	10.1.1.2	The system shall be able to produce optimum driver schedules.	Public Transport Management - Scheduling
Improved quality of stops	N/A	**Note:** There is no KAREN/FRAME equivalent identified.	Related to: On-trip Information – Traveller Interaction
Improved management system, including automatic recording, analysis and presentation functions	10.1.0.4	The system shall be able to analyse records of usage and operational data, and passenger surveys, to assist in the planning process.	Public Transport Management - General
Availability in real time of fleet monitoring data, relating to vehicle location and the number of passengers on board a vehicle at a given time	10.1.2.1	The system shall be able to receive information about the identity, location, status and occupancy all vehicles in the fleet in real time.	Public Transport Management - Monitoring

User needs resulting from MAIN survey	KAREN/FRAME user needs		
	Code	**Definition**	**User Need Set**
Availability of information relating to general traffic conditions	7.1.1.1	The system shall be able to monitor sections of the road network to provide the current traffic conditions (e.g. flows, occupancies, speed and travel times etc.) as real time data.	Traffic Control - Monitoring
Availability of emergency call facility	5.1.0.1	The system shall be able to make a 'May Day' call.	Emergency Notification and Personal Security
	5.1.0.2	The system shall be able to detect that the vehicle has been involved in an accident, identify its location, and initiate a 'May Day' call automatically.	Emergency Notification and Personal Security
	5.1.0.4	The system shall be able to give the driver an immediate acknowledgement to his/her emergency call, i.e. to indicate that assistance is on the way.	Emergency Notification and Personal Security
	5.1.0.5	The system shall be able to identify the driver / vehicle making an emergency call.	Emergency Notification and Personal Security
	5.1.0.6	The system shall be able to provide two-way data and/or voice communications between the vehicle and the emergency control centre.	Emergency Notification and Personal Security
	5.1.0.8	The system shall be able to minimise the response time for rescuing drivers who have requested assistance from the emergency services, e.g. breakdown, medical emergency, accident etc.	Emergency Notification and Personal Security
Availability of fee collection data	N/A	**Note:** There is no KAREN/FRAME equivalent identified.	New set required for Electronic Ticketing

User needs resulting from MAIN survey	KAREN/FRAME user needs		
	Code	**Definition**	**User Need Set**
Operation of a video surveillance system, especially at interchange points and stops (Availability of video surveillance data)	10.5.0.1	The system shall monitor for, and collect evidence on, illegal activities in various locations, e.g. car parks, PT facilities, PT vehicles, etc.	Public Travel Security
	10.5.0.2	The system shall be able to provide two-way data and voice communication between PT vehicles and a central location.	Public Travel Security
	10.5.0.3	The system shall summon assistance when requested by drivers, or other travellers, e.g. after disorderly behaviour amongst certain passengers.	Public Travel Security
Improved quality of information available at stops	10.4.2.1	The system shall provide service information which is legible, understandable and capable of being assimilated very quickly by all travellers, including those with special needs.	On-trip Public Transport Information – Traveller Interaction
	10.4.2.2	The system shall provide information in the native language at the output location, and/or from a user selected choice of other appropriate foreign languages, when applicable.	On-trip Public Transport Information – Traveller Interaction
Availability of the following pre-trip information for travellers: travel times, best routes, sightseeing information, trip costs	10.1.4.1	The system shall be able to inform travellers about PT operations, e.g. travel times, delays, fares etc.	Public Transport Management – Information Handling
	10.1.4.2	The system shall be able to provide information about PT services to the travellers either on-board the PT vehicle, or before the journey.	Public Transport Management – Information Handling

User needs resulting from MAIN survey	KAREN/FRAME user needs		
	Code	**Definition**	**User Need Set**
	10.1.4.4	The system shall be able to provide information that is relevant to travellers with special needs, e.g. obstacles, manually operated doors, manual payment systems, restrictions for guide dogs, etc.	Public Transport Management – Information Handling
Availability of information terminals at stops, on board vehicles, at railway stations, via the PC or a mobile device, at the airport and port	10.4.1.2	The system shall be able to provide general (dynamic) PT information, personal safety information, as well as the arrival times of next vehicles, delays, etc. at mode interchanges, e.g. bus stops, in metro, railway or bus stations, etc.	On-trip Public Transport Information – Information Handling
Availability of the following traveller information at stops: start/end times, service routes, locations of vehicles, vehicle arrival times, advertising	10.4.1.2	As above.	On-trip Public Transport Information – Information Handling
	10.4.1.3	The system shall be able to provide information that is relevant to travellers with special needs, e.g. obstacles, manually operated doors, restrictions for guide dogs and/or push chairs, etc.	On-trip Public Transport Information – Information Handling
Availability of the following traveller information on board vehicles: direction, travel times, identification of next stop, weather information	10.4.0.1	The system shall be able to inform travellers about all PT operations, e.g. bus, rail, metro, air, taxi, car pooling etc.	On-trip Public Transport Information
	10.4.1.1	The system shall be able to provide in-vehicle general (dynamic) PT information, as well as the arrival time at, and name of, next stop for this vehicle.	On-trip Public Transport Information – Information Handling
Introduction of large public transport interchange hubs.		**Note:** There is no KAREN/FRAME equivalent identified.	Related to: Public Transport Management - General

Table 7.1 Correspondence between user needs identified from surveys and KAREN/FRAME set of user needs

7.4 User need categories

The following set of user need categories can be identified from the right-hand column of Table 7.1:

- Public Transport Management - General
- Public Transport Management - Monitoring
- Public Transport Management - Scheduling
- Traffic Control - Monitoring
- Emergency Notification and Personal Security
- Public Travel Security
- Electronic Ticketing
- Public Transport Management – Information Handling
- On-trip Public Transport Information - General
- On-trip Public Transport Information – Traveller Interaction
- On-trip Public Transport Information – Information Handling

7.5 Functional categories

The above user need categories can be grouped under the following broader functional categories:

Operations Management:

- Public Transport Management - General
- Public Transport Management - Monitoring
- Public Transport Management - Scheduling
- Traffic Control - Monitoring

Safety and Security:

- Emergency Notification and Personal Security
- Public Travel Security

Electronic Ticketing

Public Transport Information

- Public Transport Management – Information Handling
- On-trip Public Transport Information - General
- On-trip Public Transport Information – Traveller Interaction
- On-trip Public Transport Information – Information Handling

These functional categories will provide the basis for defining the IPTS specification for Ningbo. They will also be used for defining the Evaluation Framework for the MAIN project, in particular for defining the expected impacts of the system.

Annex A Questionnaire for the PT authority and PT company surveys

Questionnaire
For Public Transport Company Survey

Issued by Global IST Technology Co Ltd
Phone: 0574-86829078

1 Current Public Transport Service

Please mark your choice below.

1.1 Current public transport service quality and efficiency

very poor ? poor ? neutral ? good ? very good ?

1.2 Current public transport network coverage

very poor ? poor ? neutral ? good ? very good ?

1.3 Level of integrated fleet management and resource sharing

very critical ? critical? neutral ? good ? very good ?

1.4 Degree of occupation in the public transport vehicles

very critical ? critical? neutral ? good ? very good ?

1.5 Your view of bus dispatching quality

very poor ? poor ? neutral ? good ? very good ?

1.6 Does the current public transport service meet your requirements ?

No ? Basically ? Completely ?

1.7 Are your buses equipped with GPS ?

None ? Partially ? All ?

1.8 Is voice announcement of next stop equipped on your buses ?

None ? Partially ? All ?

1.9 Has your management system automatic record, analysis and presentation functions ?

Not but wished ? Yes, but not good ? Yes and they are good ?

1.10 Are you happy with the current bus stop ?

very poor ? poor ? neutral ? good ? very good ?

1.11 Methods for fee collection

Cash ? smart card ? others ?

1.12 Mobile communication link available between buses and the control centre

None ? Partially ? All ?

1.13 Which communication technologies are currently in use ?

GPRS ? GSM ? Own radio network ?

Wireless LAN ? No ?

2. Requirements for the Future Public Transport Service

2.1 Optimisation of bus dispatching needed ?

not needed ? neutral ? needed ?

2.2 Optimisation of bus driver dispatching needed ?

not needed ? neutral ? needed ?

2.3 Most important information to be sent by bus to the Centre

veh. Location ? running cond ? passenger no ?
CCTV output ? alarm ? fee collection ?

2.4 Where video monitoring necessary ?

On bus ? at stop ? at interchange ? others ?

2.5 Passenger counter needed?

not needed ? neutral ? needed ?

2.6 Most important pre-trip information for passengers

travel time ? trip cost ? best route ?
sightseeing ? others ?

2.7 Most important location for providing passenger information

at stop ? on bus ? airport ? railway station ?
PC/mobile ? port ? others ?

2.8 Three most important information to be provided at the Stop ?

operating time ? arriving time ? Fee ? Weather/Traffic Info ?
traffic info ? veh location ? line route ?
advertising ? price ?

2.9 Three most important information to be provided on bus

direction ? line length ? travel time ? next stop ?
weather info ? price ? others ?

2.10 Need for large Public Transport interchange stations

yes ? no ? neutral ?

Annex B Questionnaire for the end user surveys

Questionnaire
For IPTS User Needs Survey

Issued by Global IST Technology Co Ltd
Phone: 0574-86829078

1 Current Public Transport Service

Please mark your choice below.

1.1 Current public transport service quality and efficiency

very poor ? poor ? neutral ? good ? very good ?

1.2 Current public transport network coverage

very poor ? poor ? neutral ? good ? very good ?

1.3 Degree of occupation in the public transport vehicles

very critical ? critical? neutral ? good ? very good ?

1.4 Number of necessary changes from home to working station

0 ? 1 ? 2 ? >2 ?

1.5 Your view of bus dispatching quality

very poor ? poor ? neutral ? good ? very good ?

1.6 Does the current public transport service meet your requirements ?
No ? basically ? Completely ?

1.7 Are you happy with the current bus stop information service ?
very poor ? poor ? neutral ? good ?
very good ?

1.8 Are you happy with the bus stop construction ?

very poor ? poor ? neutral ? good ?
very good ?

2. Requirements for the Future Public Transport Service

2.1 Most important information for operators

Veh. Location ? operation condition ? passenger no ? traffic condition?

2.2 Passenger counter needed?

not needed ? neutral ? needed ?

2.3 Where video monitoring necessary ?

On bus ? at stop ? at interchange ? others ?

2.4 Three most important information for you

travel time ? trip cost ? best route ?
sightseeing ? others ?

2.5 Three most important locations for providing passenger information

at stop ? on bus ? airport ? railway station ?
PC/mobile ? port ? others ?

2.6 Three most important information to be provided at the Stop ?

operating time ? line route ? advertising ? traffic info ?
veh location ? arriving time ? advertising ? prince ?

2.7 Three most important information to be provided on bus

direction ? line length ? travel time ? next stop ?
weather info ? price ? others ?

2.8 Need for large Public Transport interchange stations

not needed ? neutral ? needed ?

2.9 Two preferred payment forms

cash contact card contactless card
mobile device others

Annex C Summary of NBJG's requirements for IPTS (draft)

1.1 On-board system

1.1.1 On-board system structure

On-board system involve telematics host computer, information screen, information inquire terminal, electrical charge, balance inspect, passenger flux inspect, vehicle status information, image collection etc.

1.1.2 Telematics host computer function

1.1.2.1 GPS position function

It can obtain GPS information, and provide vehicle position information in real time, to monitor and control in real time.

1.1.2.2 Announcement function

1. use the keyboard announce the station by hand.
2. automatic announcement
3. voice announcement output
4. LED,LCD display in words

1.1.2.3 Keyboard operation function

The system provide the button and infrared remote control keyboard special for the drivers.

As below functions:

1. use the keyboard announce the station by hand.
2. use the keyboard send the vehicle information to the center.
3. use the keyboard send the alarm information to the center.
4. use the keyboard send the congestion information to the center.
5. use the keyboard send the malfunction information to the center.

1.1.2.4 Telematics host computer receive the date and software

1.1.2.5 Update the terminal's files and programs from the control center

1.1.2.6 Receive the message from the control center

Receive the message from the control center,display on LCD to driver.

1.1.2.7 Data send function

- Adopt China Mobile GPRS or Unicom CDMA to contact with control center.
- Send the vehicle state up-to –date in timing, send cycle 1~30S.It can adjust from control center
- Send the information collected by peripheral equipment in timing, cycle 5S~30S.
- Read the toll data from IC card, send to the control center, cycle 10S~30S.

1.1.2.8 Inquiry function

1.1.2.9 Note function

1.1.2.10 Peripheral equipment connectors

1.1.2.11 Identify malfunction

When the telematics computer doesn't work, it can display on the lamp.

1.1.3.1 Electric safety request

- Power: DC 7V ~ 40V, in especial condition, it provide special prepositive power.
- Voltage: 1500V, 50Hz pass is OK.

1.1.3.2 Electromagnetic interference request

According to GB/T17626 series standard 2 grade.

1.1.3.3 Environment adaptability

- Under (DC 40V,50?),(-40?,DC 7V),(40?,90%humidity),it should be ok.
- Pass the rain test.
- Pass the resist rust test
- Pass the resist dust test

1.1.3.4 Physical structure adaptability OK

1.1.3.5 Keep working 340 hours

1.2 Data center service sub-system

1.2.1 System structure

Involve: multimedia brand service, on-board computer service, message center, another system connector.

1.2.2 System function

This system is the main part of IPTS, it will be responsible for data receiving, sending ,calculation ,saving.

1.2.2.1 On-board computer service

Keep communication with control center.

1.2.2.2 Station card service

Display the information from the on-board computer and advertisement.

1.2.2.3 Message center

It can note the message sending-time, sender, receiver etc.

1.2.2.4 Connectors to another system

The connector can send the data to another system.

1.3 Scheduler service sub-system

This system is the hardcore in IPTS system, it will improve the public transport intelligence. It will increase the level of public traffic management, increase the service quality of public traffic.

1.3.1 Structure of Scheduler service sub-system

Scheduler service sub-system involve intelligent public traffic optimization system and intelligent public traffic scheduler monitor system.

1.3.2 Function of scheduler service sub-system

1.3.2.1 Line optimization

This system can increase the public traffic vehicles work efficiency after analyse the data, take full advantage of infrastructure traffic.

1.3.2.2 Dispatching optimization

This system can auto make the schedule daily sheet according to the driver information, vehicles information etc.

1.3.2.3 Simulation dispatching

This system provide simulation dispatching to the user.

1.3.2.4 Monitoring and scheduler in real time

The control center can receive the data from the bus, know everything happened on the road, and order the driver how to do with accident.

1.4 Intelligent scheduler mode

1.4.1 Original scheduler mode

- traveling plan can not be implemented.
- badly in time
- scheduler work hard by handwork
- examination non-standardization
- anything man-made in scheduler
- can not deeply in analysing scheduler data

1.4.2 Principle of intelligent scheduler mode

- traveling scheduler will be more flexible.
- According to the data from vehicles in real time,manage the traveling well.
- reduce the public traffic scheduler people by computer auto-scheduler.
- be more standardization.
- more particular examination for driver.
- improve the maximal benefit of company.

1.5 Service information sub-system

The system provide adequate information about traveling to travellers before their journey or on their journey. Including:

- information system before their journey
- information from bus stop
- synthetically passengers information system

1.6 Network management sub-system

1.6.1 Function

1.6.1.1 Equipment status information in real time

For example: IP address, on-board terminal position etc.

- tele-maintenance
- tele-debugging
- tele-configuration files
- equipment operation log

1.7 Public traffic intelligent evaluation sub-system

1.8 Report form sub-system

The system provides statistical data, auto-make and print report forms daily.

Network communication

The communication network that provides for the exchange of information between the various components of the system are fixed or mobile (at the main level or distributed over the territory). The communication network is created in such a way as to have the perfect integration of intelligent units and communication dedicated sub-networks: LAN – Local Area

Network, at the control centre level; Wireless La, at control centre level" - WarN – Wide Area radio Network, mobile units; SRRC – Short Range Radio Communication, mobile units; ISDN - Integrate Data Network, distributed fixed units. On this extended network communication protocol TCP/IP is adopted. The protocol discusses the rules for the exchange of messages, and specifies how to handle abnormal situations.
In this case without regard to the network technology used to physically connect the various computers. The Wide Area radio Network can be both a PMR radio system as well as the GSM – SMS cellular network.

Fixed Peripheral Devices

The infrastructures present on the ground are the following: warehouse data loading/downloading units, "smart" bus stop displays, information displays, interface units for the traffic-light control system. These specific ground infrastructures are designed to perform specific practical functions while unattended. More specifically, underneath their structural appearance, the system units are built upon the same technologies adopted for the mobile apparatuses. In those specific cases regarding devices and visualisation methods, it referred to the provisions of TC278.WG3, specifically the part relating to: "Passive passenger information on the ground." The standard operating system DOS (in room version) was used for the software. The applications, developed modularly, are all written entirely in C++ language. As previously mentioned, the units are connected with TCP/IP protocol.