2.9.1   Aalborg – Car Sharing (9.1)

Measure Overview

Car sharing is at an early stage in Denmark with only a few car sharing clubs, none of which area in Aalborg. More of the grass root car sharing initiatives are taken over by commercial car rental companies. Therefore, in order to make it attractive for these companies to introduce car sharing in Aalborg, the Technical Department transferred part of its annual 450,000 km use of private car for business journeys to a car sharing initiative.

The car sharing scheme Hertz Delebilen was launched on the 6th of January 2004 with a single site for car sharing. In April 2004, 4 more sites were opened. Now there are a total of 7 car sharing sites and 11 cars. The number of members of Delebilen has been increasing since the launch and has now passed 200.

A system has been introduced which allows members to book the car via the Internet, telephone or via the Transport Information Centre on the new Public Transport terminal. Each member has their own smart card and PIN number, making it easy to use the cars. With this technology, the member cannot access the car if they have not booked. The system also records the distance and renting charges that are sent out with the member's bill and members can at all times see how much time is left on their booking and what the mileage is.

The Technical Department and Hertz have provided a scheme for members of the staff in the Technical Department. The cars are also available for other users during working hours. By this scheme the transportation is more sustainable.

As a marketing strategy, from October to December 2005 users of public transport in Aalborg with a monthly travel card could join the car sharing scheme for a reduced cost. From this marketing initiative, more potential car owners will join, postponing the purchase of a car and instead using a combination of Public Transport and car sharing.

Local Objectives

The objectives of the car sharing integrated package were to:
- Demonstrate and stimulate public interest in car sharing;
- Pave the way for car sharing as an alternative to purchase of the first/second car;
- Design a scheme that reflects user requirements;
- Implement a car sharing service covering up to 2-3 sites with 4-6 vehicles estimated to replace 15-35 privately owned cars;
- Evaluate the environmental impacts of car sharing.

The table below gives an overview of the local evaluation objectives set and how these relate to the overall VIVALDI objectives and targets.

NO	LOCAL OBJECTIVE	TARGET	CONTRIBUTION TO VIVALDI TARGET (S)
Aalborg IP – Car Sharing			
LO1	Appreciate user requirements in scheme design	Interview: • 200 potential users, • experienced service provider	Basis of LO2
LO2	Stimulate the market for car-sharing locally	Implement: • 2-3 car-sharing sites, • 4-6 shared vehicles	VT13: 5 new car sharing sites VT15: Replace 1,000 cars
LO3	Assess the environmental impacts of car sharing	Monitor: • behavioural impact	VT1 - 250 Clean Vehicles across the sites VT2 - Reduce energy use and CO_2 by 8% in demonstration area VT3 - Meet national air quality objectives

LO1 – Appreciate user requirements in scheme design
The Municipality of Aalborg carried out initial investigations into the potential user's attitude to car sharing during the Autumn 2002. The purpose was to decide the scale of the project by assessing the potential size and location of the car sharing sites.

A survey of 200 potential users took place to investigate attitudes to car sharing in general and the possibilities for modal shift at the car sharing sites. The results gave an indication about the highest acceptable distance between home and a car sharing site.

LO2 – Stimulate the market for car-sharing locally
Aalborg has implemented 7 Car Sharing Sites and introduced 11 shared vehicles as part of the VIVALDI project. This has exceeded the targets of 2-3 sites and 4-6 shared vehicles.

LO3 – Assess the environmental impacts of car sharing
The total fuel use for transportation in Aalborg has reduced by approximately 1 %. A total of 48,700 km was performed by the shared cars in the first year. The average journey was 52 km with a fuel consumption of 13.7 km/l. By selecting environmentally friendly cars Hertz Delebilen has managed to keep the specific energy consumption level at 2.4 MJ pr km. The average for the private vehicle fleet in Aalborg is 3.1 MJ/km. With a total of 149 members, of which 41% considered buying a car, the potential energy savings add up to about 2.860 GJ within the first year of car sharing. This is about 1% of the current energy consumption for transport in Aalborg.

Evaluation Results

Society - Acceptance and awareness (13 & 14)
Car sharing in Aalborg was launched together with the changes in public transport services. The idea was to use the awareness created by these changes to promote car sharing. One of the main benefits of this approach is the high responsiveness by the media. All major or minor events in relation to car sharing have been covered in the newspapers, on radio or on television.

If we look at how the participants in the current car sharing service actually got the information on the service the local media accounts for no less than 66%. It is interesting that the public meeting at the launch of the service only accounted for less than 5% of the members.

None of the respondents refer to dedicated marketing efforts as the information that has triggered their membership. In their comments to the survey some of the members expressed surprise at the limited marketing of car sharing in Aalborg.

The private partner, Hertz Delebilen, obviously has tried to balance the marketing efforts and not 'oversell' a service still in its early development phase. One of the main marketing efforts by Hertz has been directed towards business customers in order to get a broader customer base and a better balance between workday and weekend use of the vehicles. Perhaps the private customer segment has not been sufficiently catered for in this process.

Nevertheless a survey among users of public transport shows that about 26% of bus passengers and 17% of coach passengers are aware of the car-sharing scheme in Aalborg (see Figure 2.9.1-1). This is particularly interesting since it seems that public transport is the primary alternative to the use of a shared car (see below). Ahead of the launch of car sharing in Aalborg about 20% of both bus and coach passengers thought that car sharing could be a relevant option for them. Now that the service is in place the share among coach passengers has dropped to about 13% while a minor increase among bus passengers can be observed. Now about 21% of bus passengers do consider joining the car sharing scheme.

Figure 2.9.1-1 Potential members of the car sharing scheme among users of Public Transport
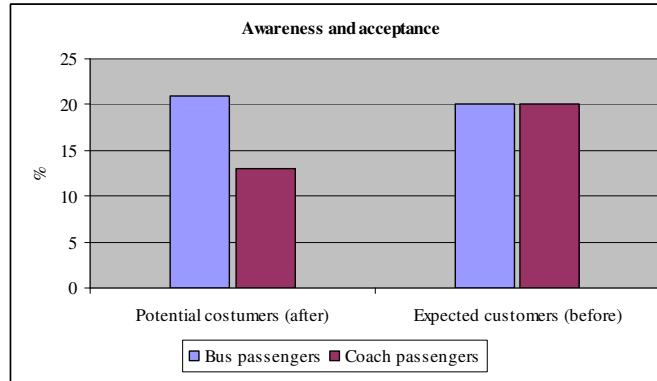
The decline among coach passengers indicates a better knowledge of the concept of car sharing. Realistically, joining an Aalborg car sharing scheme while living in neighbouring municipalities 10-15 km away from the nearest car sharing site can only be useful to a few people.

Those using the car sharing service are generally happy with it. There are comments regarding the current fleet of vehicles indicating that they do not fully cover user needs. Availability of a child seat and larger capacity - both in terms of passengers and luggage - are some of the main issues raised. If car sharing is supposed to establish itself as a 'transition mode' for young families clearly these demands must be taken seriously. Consequently a van is now included in the fleet.

Utilisation

Utilisation has risen since the beginning of the scheme. The number of members has doubled during the last year and more positive, the total use has tripled, see Figure 2.9.1-2.

In general the car sharing scheme has risen both in terms of usage and number of members. Its potential is probably bigger than the existing scheme and if it grows further it may have a measurable influence on the level of congestion and emissions.

**Figure 2.9.1-2 Development in Car sharing members and mileage**
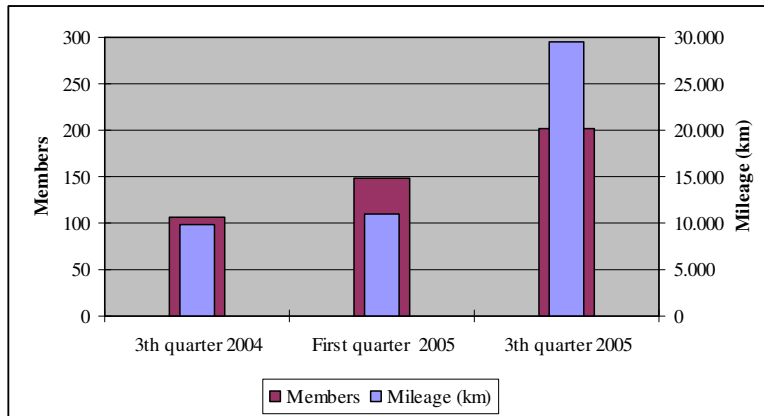
The gender distribution among users of car sharing is shown below. The proportion of female users has grown sharp and is now approximately 40 %.

Figure 2.9.1-3 The gender distribution among Car sharing users
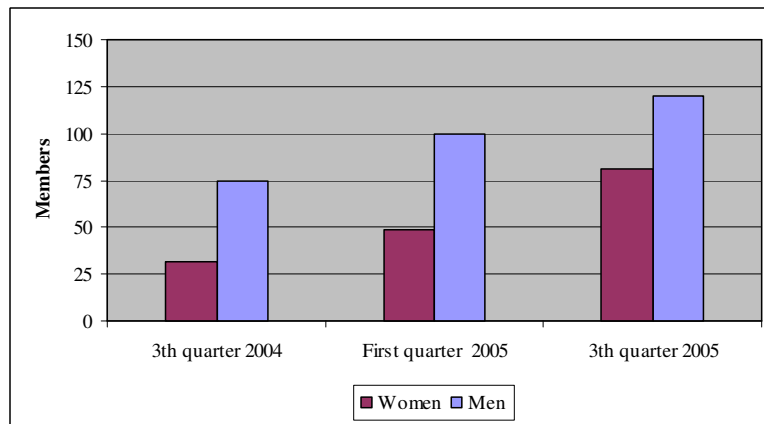
The age distribution among users of car sharing is shown in Figure 2.9.1-4. It is remarkable that the proportion of young people has grown and now constitutes approximately one third of the users. It indicates that the scheme enables users to postpone purchasing their first car, which was a major reason for establishing the scheme.

Figure 2.9.1-4 The age distribution among car sharing users
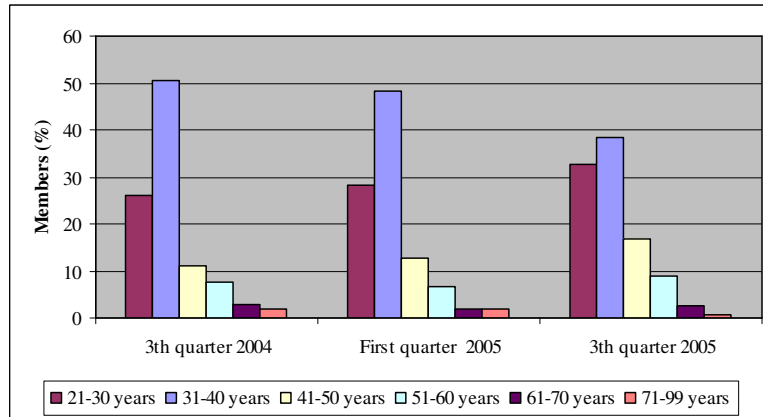

Accessibility and security

The users of car sharing in Aalborg were asked to assess five features characterising the current service in Aalborg. The availability of cars and the distance to the nearest car sharing site came out with a high score both on importance and satisfaction. The Internet based booking system and the smart card key system clearly contribute to make car sharing more easily accessible. These features receive positive comments from the users.

From a commercial point of view there is a delicate balance between getting satisfactory revenues from each shared vehicle and securing a sufficient amount of shared vehicles and car sharing sites. In Aalborg Hertz has recognised the importance of being close to the customers and providing a sufficient amount of vehicles and this is appreciated by the users. It was the decision of Hertz to up-scale the scheme to its current size and this has contributed to a positive image of the service.

The average distance between the home of the users and the nearest car sharing site in Aalborg is 2.9 km but for more than 60% of the users it is less than 1.5 km.

Figure 2.9.1-5 User responses on 5 indicators in relation to the car sharing service in Aalborg

1) Availability of cars	2) Distance to car-sharing site	3) Maintenance of shared cars
4) Variety of shared cars	5) Cost of use	
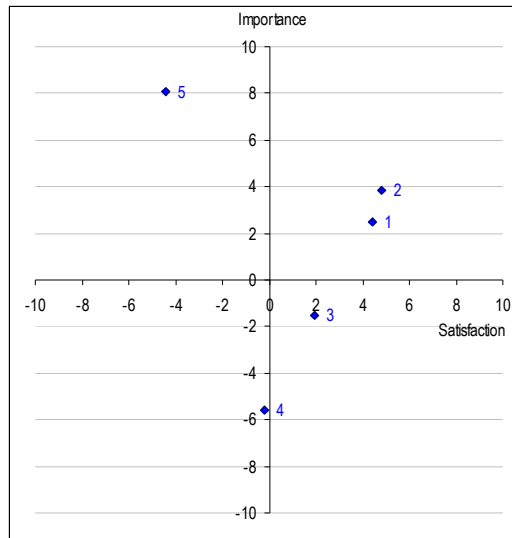
The main 'problem' in relation to the current car sharing service in Aalborg is the cost of use. More than 50% of the users find that a change in costs (lower rates per kilometre/hour) would make car sharing more attractive to them. Some suggest the introduction of corporate programmes rewarding dedicated use of car sharing.

It does seem as though it is difficult to fully understand the price structure of car sharing and to 'place it' between other alternatives such as public transport, taxi, car rental, car ownership etc. It is not likely that the costs of car sharing can be reduced significantly if it is to be an economically viable service. Therefore efforts must be made to explain the price structure and to increase transparency of the costs of other modes.

Transport - User perception
As shown in Figure 2.9.1-5 the costs of car sharing play an important role in users' perception of car sharing. But even though the cost is a real issue the availability of car sharing has had a positive impact on their urge to buy a car. The share of those planning to purchase a car has dropped notably due to the availability of the car sharing scheme.

Table 2.9.1-1 Plans for car purchase among users of car sharing scheme before and after the service was launched based on a 2-3 year perspective

	Share of members before	Share of members after
Considered purchasing a car	41%	22% [1]

1)   If car sharing ceases to exist in Aalborg a further 37% plans to purchase a car.

The role of car sharing as a 'transitional mode' before purchasing a first car is to some extent expressed by the growth in the number of persons considering buying a car if the car sharing service ceased to exist. From a situation before where 41% considered buying a car the figure is now 59%.

Since about 37% of the respondents are willing to remain car sharing users this is clear evidence of a positive perception of the current service.

Impact on transport

Some of the main problems created by car transport in the cities are related to rush-hour traffic between home and the workplace. Short car trips where the catalytic converters do not reach their working temperature, low vehicle occupancy rates and congestion problems characterise the traffic situation in may cities morning and evening.

If we take a look at how the shared cars are used in Aalborg we get an impression of how car sharing can contribute to reducing these problems.

Most of the current members of car sharing in Aalborg make use of the shared car less than once a week. The average figures for households in Denmark are between 2.5-5.0 trips per day with the lowest figures for inner city apartments where we find the current user group of car sharing in Aalborg. Hence, car usage levels are about 1/20 of those of the average city resident.

One of the main reasons is that a shared car is only rarely used in home-workplace journeys. Only 12% of car sharing members have used the shared car on the way to work. Shopping and leisure trips are the main areas of use.

This is also reflected in the average occupancy rates reported by the users. On an average there are 1.93 persons in a shared car. This is notably higher than the average in home-workplace trips which according to a national survey from 2001 is about 1.21 persons per vehicle in the morning and 1.48 persons per vehicle in the afternoon (The Danish Road Directorate, 2002, "Personer pr bil"). It is even slightly higher than the national average at weekends (1.87 persons per vehicle).

By taking the car away from the individual household and placing it in a car sharing service it does seem that there is less car traffic and a more efficient use of the vehicles on the roads.

The trips in a shared car typically replace either public transport journeys (46%) or other forms on individualised motorised transport (e.g taxi, rental car etc.). A total of 39% of car sharing users would have used the latter option.

These figures are not surprising when we look at the purpose of trips. The main use of the shared car is in relation to leisure trips (e.g. family visits) and shopping. Work related trips only account for 15% of the trips. The price structure of car sharing seems to make it less attractive for vacation trips, as only 8% have made use of the shared car for this purpose.

Based on the above it does seem that car sharing can be a useful add-on to public transport and may assist in securing the customer base in daily transport by offering a quality service for specific purposes.

Environmental impacts

Within the first year of car sharing in Aalborg the shared cars were used for a total of 48,700 km. The average journey was 52 km with a fuel consumption of 13.7 km/l. By selecting environmentally friendly cars Hertz Delebilen has managed to keep the specific energy consumption level at 2.4 MJ pr km. The average for the private vehicle fleet in Aalborg is 3.1 MJ/km.

The shared cars also substitute non-motorised trips. Obviously these trips do not have an average length of 52 km. About 90% of all bicycle trips in the major cities in Denmark are less than 6 km.

Based on these figures and on the stated use of other modes had the car sharing service not existed it is possible to estimate the environmental impact of car sharing (see Table 2.9.1-2.).

Table 2.9.1-2 Energy savings due to the environmental friendliness of the shared car fleet.

	Annual mileage	Share of trips	Energy consumption
If done by other private car	22.081	39%	68,921 MJ/year
Done by shared car	22.081	39%	52,986 MJ/year
Saved			15,935 MJ/year

The results in Table 2.9.1-2 are only the direct impact of the current car sharing service. Providing the car sharing service had not existed some of the current users would have purchased their own car. Since each car purchased is likely to result in 15,000 new vehicle kilometres we can add about 47,000 MJ/year per saved vehicle to the above.

With a total of 149 members of which 41% considered buying a car the potential energy savings add up to about 2.860 GJ within the first year of car sharing. This is about 1% of the current energy consumption for transport in Aalborg.

This more than compensates for the increase in energy consumption occurring from the transfer of bicycle and public transport journeys to shared cars. In Table 2.9.1-3 an estimate of this increase is given.

Table 2.9.1-3 Increase in energy consumption due to transfer of journeys from bicycles and public transport

	Annual mileage	Share of trips	Energy consumption
Consumption due to transfer of PT trips	25,921	46%	62,201 MJ/year
Consumption due to motorisation of bicycle trips	711	15%	1,706 MJ/year
Total increase			63,907 MJ/year

Economy (1 & 2)
The private-public partnership agreement between Hertz Delebilen and Aalborg Kommune enables Aalborg to follow developments in membership and turnover in the car sharing project. However, in order to protect the commercial interests of Hertz Delebilen, an agreement has been made not to publish turnover figures externally.

Process Evaluation

Within the first year of car sharing in Aalborg it has not been possible to fully meet the economic targets for the service set by the private operator. This is due to a lower number of memberships and a lower mileage per member than budgeted for. Yet still the private operator considers the Aalborg car sharing scheme a success, and believes that the service will be economically viable.

The process of developing car sharing in Aalborg has benefited largely from the experiences of the professional operator Hertz Delebilen and the in-depth knowledge of the city and its citizens at the Technical Department. Hertz Delebilen was able to set up a service with state of the art technologies and Aalborg was able to identify those sites most likely to become successful car sharing sites.

Clearly the involvement of Aalborg Kommune is one of the main reasons why the service is now in place. If the Technical Department had not engaged itself in screening the potentials and creating awareness by using the service the increase in car sharing would have been much slower. Now not only Aalborg but also Esbjerg - another major city outside the Copenhagen area - has a car sharing service.

Throughout the project a close dialogue has been kept between the two partners in the private -public partnership enabling the continuous positive development of the service. Ideas and proposals have been discussed and transformed into adjustments or expansions of the service.

Hertz Delebilen recognises that the amount of effort required to follow up on the service periodically has exceeded their capabilities. As car sharing in Aalborg will continue beyond VIVALDI Hertz Delebilen has consequently increased the amount of staff. It is expected that this will enable an increased focus on individual marketing of the service.

Conclusion

At the end of the VIVALDI project, the car sharing scheme will be continued. The scheme has been increasing continually since its launch one and a half years ago. The 7 existing car sharing sites around the City of Aalborg may be up-scaled to include a few more. It could for example include the two largest shopping malls in the suburban area or a few other densely populated areas in the city that could be potential car sharing sites. However, it depends on the economics of the scheme, as the Municipality of Aalborg will not be a partner in the scheme after the end of the VIVALDI project. Nevertheless the Municipality of Aalborg will continue to be a member of the scheme. Finally, the measure will be further integrated with future projects with the aim of improving the environment in the urban areas.

2.9.2   Aalborg – Bus Priority and RTPI (12.3)

Measure Overview

Before the VIVALDI project, Bus Priority and AVL (Automatic Vehicle Location) were only operated on three bus lines in Aalborg. A total of 28 signalised intersections were then fitted to enable bus priority. AVL was not fitted to coaches, so consequently regional buses were caught in traffic in Aalborg. The coach terminal in the city was

planned for redevelopment to be completed in 2003. It was considered important to reduce space needed for the terminal area in order to reduce walking distances and to open the area for other urban activities including offices and shops - activities that were expected to increase the demand for public transport. That required flexible platforms with Real Time Passenger Information (RTPI). In order to free the city centre of buses heading for the coach terminal, a shortcut was made from the ring road system. This added further value to the new facility.

The RTPI came into operation in August 2004 and the Bus Priority in January 2005. In total, 209 buses are now fitted with bus computers and they are connected to a mobility centre which operates the RTPI system. Around the city there are 32 signs with RTPI placed at the most important bus stops and at the four local railway stations in Aalborg.

The number of intersections with Bus Priority has increased. There are now 51 intersections with this technology, compared to 28 previously. An after study on the impact of Bus Priority was made. In a corridor with 8 signalised intersections all fitted with Bus Priority the buses on an average saved up to 4% of their total travel time. This is quite remarkable considering that only buses delayed for more than 3 minutes actually gain priority.

The results are that the users of PT can now be informed about delays and irregularities at the central bus stops and furthermore can expect a 4% reduction in travel time in competition with private cars.

Local Objectives

The objectives of the telematics integrated package of measures were to:
- Integrate public transport services in one unified system
- Promote public transport as a "modern" means of transportation
- Ensure reliable PT services throughout the day
- Provide easy access to travel information
- Pave the way for future ITS services in public transport (e.g. electronic ticketing, widespread RTPI)
- Improve the working climate for drivers and user satisfaction

The table below gives an overview of the local evaluation objectives set and how these relate to the overall VIVALDI objectives and targets.

NO	LOCAL OBJECTIVE	TARGET	CONTRIBUTION TO VIVALDI TARGET (S)
Aalborg IP – Public Transport Improvements by use of ITS			
LO4	Integrate all PT services in one system	Implement: • new PT network structure • integrated info-systems	VT9: Increase patronage by 20%
LO5	Increase reliability of PT services and perceived waiting time	Implement: • 20 bus priority units, • 188 bus computers • RTPI at interchange facilities.	VT22: RTPI on quality corr. VT23: Increase use of PT-info
LO6	Change the decrease in PT passenger numbers	Achieve: • 2-3% more PT passengers • 2% lager modal share	VT9: Increase patronage VT1 - 250 Clean Vehicles across the sites VT2 - Reduce energy use and CO_2

			by 8% in demonstration area VT3 - Meet national air quality objectives
LO7	Promote PT as a modern means of transportation and increase satisfaction	Implement and achieve: • services reflecting demand • red. perceived waiting time	VT9: Increase patronage

LO4 & LO5 - Integrate all PT services in one system and increase the reliability of PT services and perceived waiting time.

To achieve the above objectives Aalborg has introduced the following advanced ITS systems:
• Bus computers on 209 buses
• Real time passenger information (RTPI) displays at 32 locations
• Bus priority based at 23 intersections

All 3 targets have been met and exceeded by an additional 31 bus computers, 28 RTPI displays and 3 bus priority locations.

LO6 & LO7 – Change (reverse) the decrease in PT passenger numbers and promote PT as a modern means of transportation and increase user satisfaction.

The effectiveness of the PT measures implemented in Aalborg was evaluated by conducting a before and after survey of 1,260 passengers and 127 bus drivers. The results showed that there was a slight decrease in the frequency of public transport use (bus and coach) of -5% and -3% respectively. Possible explanations for this are addressed in the measure level evaluation below.

There was a difference in the perceived regularity of buses among bus and coach passengers. Both users of buses and coaches felt that there has been a reduction in the frequency of delays. The perceived reduction in delays for buses reduced from 39% to 30 % and for coaches from 26% to 24 %.

The project has also shown that the public is aware of the new opportunities. The self-service information kiosk placed at the terminal facility demonstrates this with 24,000 pages being activated monthly at the terminal with itineraries and schedules as key searches.

Evaluation Results

Society - Acceptance and awareness (13 & 14)
The timing of the VIVALDI activities in Aalborg co-ordinated with a major transformation of the entire public transport system has drawn the attention of the public. It is however interesting to observe that there has been a distinction between the critical voices raised against the new structure and increased fare levels in public transport and the positive acceptance of the new ITS in public transport.

Two primary reasons can be identified:
• A dedicated effort towards the media and the public explaining what could be expected from the ITS at what time; and

- The fact that the systems at the time they were rolled out proved fairly stable and reliable due to extensive development and testing phases.

Clearly in a situation with public transport in the spotlight, a failure would have been a major drawback with long-term impacts on the image of public transport.

The public is well aware of the new opportunities. The self-service information kiosk placed at the terminal facility demonstrates this. On a monthly basis 24,000 pages are activated at the terminal with itineraries and schedules as key searches.

It is very positive that this service which is the least visible of the ITS initiatives in Aalborg has been noticed and accepted by the users. A survey showed that 46% of those not using public transport in Aalborg did know of the travel planning tool that is accessible on the self service terminal and via the Internet.

Another indication of the level of awareness is the informal comments received by the project members - e.g. 'how come the signs were shut down yesterday evening?', 'how does it work?', 'are all the signs replaced?' etc. Although the equipment is fairly discrete in its design the strategy of placing the VMS outside the bus shelters has made VIVALDI visible, and it draws the attention of those passing even if they are sitting in their car.

Accessibility and security
A key element of the new public transport system is the new terminal facility for buses and coaches controlled by advanced ITS. In order to monitor how the new layout and the new services were received by the users 16 indicators were analysed before and after restructuring the area.

Although the new terminal facility itself is not a VIVALDI measure, the telematics systems introduced in VIVALDI are indispensable measures in achieving the layout.

Figure 2.9.2-1 User responses on 16 indicators before (blue) and after (red) the changes at the bus terminal. Response from users of coaches to the left and for urban bus lines to the right.

1) Transfer distance bus-train	2) Transfer distance coach- bus	3) Transfer distance bus-car	4) Transfer distance bus-taxi
5) Transfer distance bus-bike	6) Parking / kiss & ride facilities	7) Bicycle parking facilities	8) Indoor facilities
9) Outdoor facilities	10) Bus regularity	11) Information on service	12) Information on schedules
13) Information on itineraries	14) Perceived safety and security	15) Ease of perception of terminal	16) Visual impression
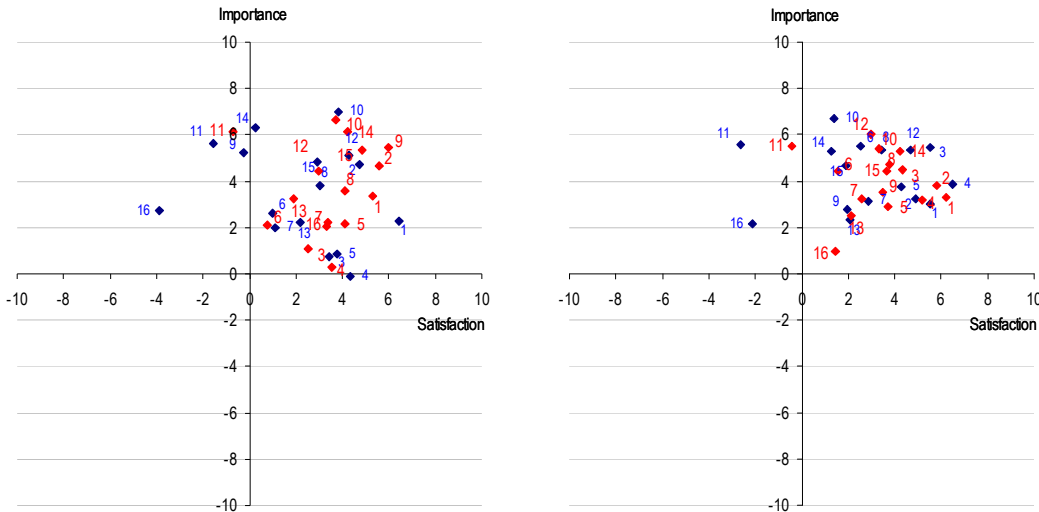
The overall picture shows a positive development in user satisfaction. On average, satisfaction amongst the users of urban bus lines is 0.62 points higher after the introduction of the new terminal facility. Amongst users of coaches, the development is even more positive with a 1.25 point higher level of satisfaction.

If we look at the accessibility of the new terminal facility the general impression is that conditions have worsened in relation to accessibility by car and taxis. It is true that private cars are not allowed to enter the terminal facility. However, they are allowed to visit the parking facility at the terminal building - with elevators leading to the terminal - providing they pay the parking fee.

What we are really seeing is that the willingness to pay for parking when bringing somebody to the terminal facility is limited. This has a rather unfortunate consequence. A number of cars disregard the no entry signs and thereby cause problems for the bus drivers. This is a key issue currently being discussed with the police.

In spite of the problems with cars entering the area, the users now feel much safer at the terminal facility. The score on safety is 3.0-4.0 points higher after the reconstruction.

A common feature among both coach and urban bus line users is that they have not quite got used to the lack of timetables at the bus stops now fitted with real time passenger information. However, the users of coaches do not attach the same importance to the availability of schedules in the after situation - maybe because some of them use the self-service information kiosk or the ticket sales office instead. However, both user groups generally experience better information on the service due to the variable message signs.

In terms of bus regularity the perception is different among coach and bus passengers. While bus passengers report an improvement (1.6 points higher average score) coach passengers report a minor deterioration (0.1 point lower score). There is no obvious reason for these differences as the same priority systems have been implemented for buses and coaches.

Figure 2.9.2-2 Driver responses on 16 indicators before (blue) and after (red) the changes at the bus terminal.

| 1) Ability to keep schedules off peak	2) Ability to keep schedules in peak	3) Ability to inform on schedule	4) Ability to inform on oth. sch.
5) Ability to inform on transfers	6) Ability to send alarm	7) Cash payment option in buses	8) Bus access to terminal
9) Private car access to terminal	10) Taxi access to terminal	11) Bicycle access to terminal	12) Terminal layout for buses
13) Pedestrian traffic in terminal	14) Perceived safety and security	15) Ease of perception of terminal	16) Visual impression
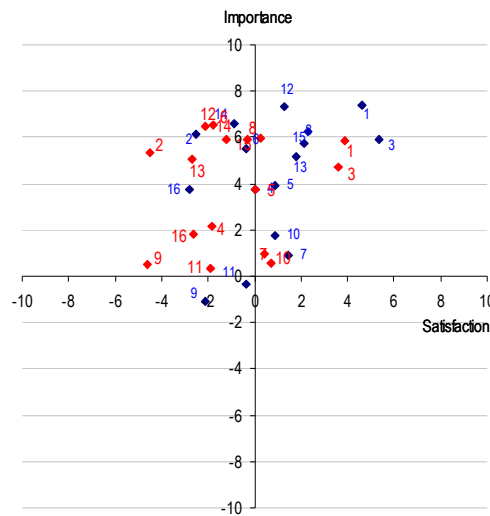
Figure 2.9.2-2 show the results of a similar survey among bus drivers. Unfortunately the survey results are characterised by a lack of interest by the drivers in the before study which only 28 drivers answered and a general discontent in the after situation leading to a negative assessment of all indicators even if they have not changed or indeed improved.

There is an ongoing dialogue between Nordjyllands Trafikselskab and the bus drivers in order to clarify the real problems and their reasons.

Table 2.9.2-1 Drivers satisfaction in relation to new service opportunities (range -10 to +10)

	Score before[1]	Score after
Ability to see the schedule and real time of other buses	5.2	5.2
Ability to get priority when delayed	5.5	7.4
Ability of providing answers on itineraries and schedules	-2.5	-0.8

[1]   For the first two subjects the score before represent the drivers expectations in relation to the new ITS system. For the third subject it represents their actual ability in the before situation.

The drivers were also asked about some of the opportunities offered by the new systems. It seems that the systems once they were in place have contributed to an increased level of satisfaction among the drivers. Their expectations in relation to the ability of getting information on other bus lines have been fulfilled or even better, and although the drivers are not yet satisfied with their ability to provide answers on

itineraries and schedules there has been a notable improvement. Some drivers find that it takes to long to find the information. This is likely to change as they get more experienced with the system but obviously opportunities for system improvements will also be examined.

According to the drivers the bus passengers do now have confidence in the real-time passenger information. This has had a positive impact on their attitude. They seem more relaxed boarding the buses, and even if the bus is delayed they do not seem to register the delay simply because they only refer to the real time information and not to the schedules. This contributes to an improved working environment for the bus drivers.

Transport – User perception
A key aspect in the evaluation of the VIVALDI ITS measures in Aalborg is of course the extent to which they have in fact changed transport or the perception of public transport.

As mentioned in the above there was a difference in the perceived regularity of buses among bus and coach passengers. This was examined in more detail in the survey. As it appears from Table 2.9.2-2, both users of buses and coaches have felt that there has been a reduction in the frequency of delays. But again buses come out better than coaches. Coach passengers even report a minor increase in the frequency of delays causing conflicts with personal arrangements.

Table 2.9.2-2 Calculated average the reported delays based on three levels (daily, weekly or monthly)

	Percentage of workdays with delays before	Percentage of workdays with delays after
Frequency of delayed buses	39%	30%
Frequency of delayed coaches	26%	24%
Frequency of bus delays affecting personal arrangements	13%	10%
Frequency of coach delays affecting personal arrangements	10%	11%

One of the reasons for the difference between buses and coaches may be the introduction of the Metro bus system. Previously, regional buses did not take up passengers within the built up area. Since this is not the case with the new Metro bus system, obviously the risk of delayed coaches due to inner city boardings has increased.

Therefore, it is not surprising that coach passengers report an increase in average perceived delays of 20 seconds (from 311 sec. to 331 sec.) once the buses are delayed. It could be so that the availability of bus priority is only partially able to compensate for time losses due to inner city boardings.

However, if we look at the urban bus lines there has not been a change in the way the buses operate, and therefore the results of the survey among these passengers perhaps better demonstrates the impacts of bus priority and real time passenger information.

On urban bus lines, the passengers report an average decrease in average perceived delays of 24 sec. (from 313 sec. to 289 sec.) once the buses are delayed. This is equivalent to an 8% reduction in perceived waiting times.

Impacts on buses

A separate study on the impact of bus priority has been made. In a corridor with eight signalised intersections all fitted with bus priority, the buses on average saved up to 4% of their total travel time. This is quite remarkable considering that only buses delayed more than 3 minutes actually gain priority.

Based on the study a rough estimate of the impact of the entire bus priority system is a daily travel time saving of about 4 minutes per bus passing each of the 51 signals with bus priority, or a total of 17 hours saved per day.

When looking into the surveys among users of public transport, there is a difference in the frequency by which they use the buses before and after the implementation of the new structure and the ITS measures in VIVALDI.

Table 2.9.2-3 Calculated average frequency in PT usage by passengers

	Percentage of workdays before	Percentage of workdays after
Frequency of bus use	72%	67%
Frequency of coach use	71%	68%

The simple and negative answer explaining this development could be the loss of part of the 'customers by force'. Such a loss is most likely to result in either an increase in trips by low cost modes i.e. bicycles or cancelling of trips. With the increase in fuel prices during the last year it is unlikely that this user group would have increased car trips significantly.

The positive interpretation of the results is that the availability of RTPI, the higher frequency of buses in key corridors and improved planning tools has opened public transport towards other users. The fact that you do not really need to know the schedules in advance due to the high frequencies in the rush hour and the information on when to expect the next arrival has made public transport less complicated. Hence, a new group of less frequent users is now seeing public transport as an alternative for them.

Perhaps these features are especially appealing to the male customer group as the surveys show an increasing share of male customers rising from 25% to 28% on urban bus lines and from 33% to 35% on coaches.

Local impacts on traffic and safety

It was foreseen that the number of pedestrian crossings near the terminal facility would increase due to the new functions at the terminal building (cinema, offices and shops). One of the key factors is that the Arcade through the terminal building followed the axis of the old boulevard. This is a problem as it was not possible to fit in a signalised pedestrian crossing at this point. It simply would not leave sufficient space for the bus stops. Therefore an increase in illegal crossings was likely to occur.

Both of the above expectations have come true. The total amount of pedestrian crossings in the period between 12 AM and 5PM has gone up from 150 per hour to 500 per hour. In the same period illegal crossings have increased from 13% to 17% of the

total amount of crossings. However, from video recordings it does appear as though those crossing outside the signalised intersections are well aware of the risk and more cautious. It was only at the signalised crossings that "near accidents" did occur - mainly because of pedestrians or cyclists ignoring the red light.

In a five year period ahead of the opening of the new terminal there were on average 2.6 accidents per year on J.F. Kennedys Plads in front of the terminal, of which 1.6 lead to personal injury. Since the opening of the new terminal in 2004 a total of 2.4 accidents per year have occurred, of which 1.6 caused personal injury. Before, pedestrians were included in 30% of the accidents while the figure now is about 50%.

It is likely that the growth in pedestrian accidents is to some extent related to the increase in pedestrian traffic and the after period is really too short to determine whether there is a safety problem. However, the growth appears significant and it is therefore important to monitor the accident rate in the area in future years.

Car traffic levels around the terminal facility have not changed as much as pedestrian traffic. The only differences are seen in Jyllandsgade to the east of the terminal where traffic has decreased by about 500 vehicles per day between 2002 and 2004. The main explanation is the re-routing of coaches to the new short cut between the terminal facility and the outer ring road Østre Allé. As a parking facility at the new terminal facility is also connected to Østre Allé it is not surprising that traffic levels here have gone up by about 1,300 vehicles per day in the same period.

The creation of the short cut between Østre Allé and the terminal has contributed to minimising the conflicts between motorised traffic and pedestrians on the 'city side' of the terminal. The main drawback of this solution is that it opens for car traffic illegally making a shortcut through the terminal facility. Unfortunately, some car drivers find this option too attractive, and even though it is only a few vehicles daily this hazardous behaviour does cause unnecessary and dangerous conflicts with buses.

Economy
As mentioned in the above the evaluation of bus priority indicates daily travel time savings of 17 hours per day. The delays primarily occur during rush hours where a large proportion of the passengers are either on their way to or returning from work and where the occupancy rates in the buses are at their peak.

The Danish Ministry of Transport suggests that the value of delay time in this situation is DKK 118 per hour ~ 15.75€ (MoT, 2004, Nøgletalskatalog til brug for samfundsøkonomiske analyser på transportområdet). Assuming 30-40 passengers occupy the buses the value of daily time savings due to bus priority can be estimated to 8,000-10,700€ per day.

To the extent that these time savings can also be converted into savings in schedules there is not only a benefit for the passengers but also for Nordjyllands Trafikselskab and Aalborg Kommune. Currently, the cost of one bus-hour is about DKK 427 ~ 57€, so the two project partners in VIVALDI will potentially save up to 740-970€ per day due to bus priority.

If these costs are compared to the daily costs of running the mobile communication between central servers, buses, signs and signals - currently about 155€ per day - it is obvious that a benefit of such an initiative has to come mainly from securing or expanding the customer base rather than increasing efficiency.

Process Evaluation

Process evaluation in VIVALDI has been ongoing throughout the project period. There has been a continuous dialogue between key stakeholders - politicians, technicians, operators and users - to keep the project on track. Processes and approaches have continuously been adapted whenever the situation required it.

A project like VIVALDI realised in a municipal or county organisation like the Technical Department and Nordjyllands Trafikselskab demands solid political support. Key drivers in the process of getting this support are the clear need for the project in Aalborg, the funding opportunities, the chances of success and the opportunity to become in the forefront of sustainable transport at National and European level.

The launch of CIVITAS coincided with the plans to restructure public transport and a private initiative of revitalising the terminal area. Due to its tight timescale, funding opportunity and focus on forefront technologies, CIVITAS proved to be an efficient incentive. This is acknowledged by politicians as well as technicians in Aalborg. It helped to set and reach the targets.

However, targets, political backup and funding do not necessarily create a success. The successful completion of the ITS in VIVALDI is closely related to:
• The decision to join forces with Greater Copenhagen Transport
• The capability to effectively take charge of the project
• A common commitment to succeed by project partners, consultants and suppliers

It is important to emphasise the large scale of such a complicated project, in order to attract the quality of suppliers that are able to manage its development professionally. In this case a national partner was found while in previous projects Aalborg has benefited from European contacts (e.g. in relation to investments in environmentally friendly vehicles).

We are convinced that without the dedicated effort and time spent by the ITS experts within the project team, the project would not have been successfully completed within time and budget. The resources needed were underestimated at the outset but an immediate response from the regional administration once this became apparent meant that resources were not a problem locally.

The distribution of roles between partners, consultants and suppliers not only secured the successful completion of the project; it also built up knowledge and the feeling of ownership within the organisation of Aalborg Kommune and Nordjyllands Trafikselskab. This has significant importance now that all the systems are in regular operation.

The apparent discontent among bus drivers does indicate problems in relation to the design of the terminal facility that have not been fully recognised or addressed. To

some extent this can be due to the agreements made in relation to the public-private partnership when designig the terminal facility.

There was a conflict between commercial interests in maximising building opportunities and the achievement of an optimal layout of the terminal facility and the access ramps. Having the options on land acquisitions the private partner to some extent determined the layout of the PT terminal facility. Placing the responsibility of the design of access ramps with the private partner created a design process not sufficiently co-ordinated with the 'ground-requirements' for the terminal facility.

Although these problems are external to VIVALDI they have played a key role in the bus drivers' assessment of the VIVALDI measures. The lesson learnt is that it is important to manage all aspects of a project.

Conclusions

When the VIVALDI project finishes the Telematics will continue. Moreover, it is planned that RTPI should be implemented in other parts of the city to improve the service level in the remaining part of the PT route network. Finally the measure will be further integrated with future projects to improve the environment in the urban area.