Measure title: **Changing parking behaviour in Aalborg**

City: **Aalborg** *Project:* **Archimedes** *Measure number:* **20**

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Summary

Through this measure the City of Aalborg has extended and improved the real-time Parking Information System on the parking network in the city centre. A Parking Information System designed to reduce unnecessary circulation by giving more targeted and more comprehensive information to parking searching drivers.

According to the initial Description of Work it was also planned to design and implement a revised parking charge structure, and thereby reduce long-time parking in the city centre. This would free parking spaces for short-term parking and thus reduce the parking-searching traffic. Due to political reasons this part of the measure could not be implemented within the ARCHIMEDES project period.

The old system providing parking information to drivers searching for parking, designed in the 90s, did not include all the new parking areas in the city centre and was technologically outdated. In the CIVITAS project a revision and redesign of the complete system have been done, in collaboration with the owners of private parking areas. The aim has been to avoid unnecessary kilometres driven in search for parking areas in the most congested areas of the city. This is achieved by informing the drivers about free parking spaces in the closest parking areas, avoiding through traffic in the city centre and saving time and fuel consumption.

Hence, a new and up-scaled Parking Information System has been implemented and is currently in operation. The results from the evaluation of the new Parking Information System can be summarised into the following conclusions:

- Awareness of the new Parking Information System among the users of the parking went up with 18% (14 pct point) from 78% to 92%, probably caused by the installation of more signs in the scheme, and the fact that the new system is more intuitively to understand.
- The proportion of users who found the new system made it easier to find a parking space increased by 27% (17pct. point) from 62% to 79%. Also the proportion, which used the Parking Information System increased with 34% (8 pct point) from 23% to 31%.
- Both with the old information system still working and after implementing the new Parking Information System, the information system made 18% of the users change their choice of car park. This is a relatively large proportion, indication that the parking Information system does have a significant effect on reducing search traffic and congestion around, and especially in, the parking areas.
- The parking occupation rate was reduced with 1/3 (20 pct point) from 61 to 41%. Primarily as an effect of an increase in the total number of available spaces. Any direct effect on the Parking Level due to the new Parking Information System cannot be documented, while the assessed usability and use among the users show a positive effect.
- The peak hour traffic level was slightly reduced after the Parking Information System was implemented. It is however, unclear which proportion of this reduction can be attributed to this measure. The average transportation time before arrival to a parking place was reduced by 19 sec per trip equivalent to a reduced transportation time-use of 9,978 hours and 233,000 less km driven per year.
- On the basis of the change in parking seeking driving, the CO_2 emission was reduced by 71 tons per year.

Overall, there has been a positive effect from the implementation of the new and up-scaled Parking Information System in Aalborg. A new and coherent Parking Information System seems

to have a positive effect on the parking-searching traffic flow in midsize cities. However, the following lessons learnt might be useful for other road authorities:

- It is important to allocate sufficient resources and in particular time to rethink the idea of the scheme. Else, it is difficult to change the basic ideas – ideas, which might have been suitable with the former parking pattern, but which are not practical today.
- The majority of the drivers had decided which car park they would use before they entered the city centre. For them, the information system is mainly used for validating that there is still available parking bays on the preferred car park.
- Finally, sufficient resources must be allocated after the full implementation of the Parking Information System to keep a high maintenance level.

A Introduction

A1.1 Objectives

The measure objectives are:

(A) High level / longer term:

- To reduce the use of the private car in sensitive areas of cities (i.e. CIVITAS Plus corridor) through economic signals.
- To achieve reduced congestion levels during peak hours.
- To achieve reduced emission of noise and air pollutants in sensitive areas.

(B) Strategic level:

- To reduce the traffic from cars searching for a free Parking space and hereby reduce the impact of this traffic on the environment.

(C) Measure level:

(1) To design and implement a revised parking charge structure, and thereby reducing long-time parking in the city centre. This will free parking spaces for short-term parking and thus reduce the traffic from cars searching for a free P space.

(2) To design and implement a revised Parking Information System and thus reduce the traffic from cars searching for a free parking space.

A1.2 Target groups

- Long time parking commuters. Often people that work in the city centre, and therefore are long time parkers.
- Regional level, visitors and tourists who drive to Aalborg and therefore need a parking space.

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A2 Description

According to the DoW it was planned to design and implement a revised parking charge structure, and thereby reducing long-time parking in the city centre. This would free parking spaces for short-term parking and thus reduce the parking-searching traffic. Due to political reasons this part of the measure could not be implemented within the ARCHIMEDES project period. Therefore this part of the measure will be omitted from the rest of this MLEP. However, a scientific review of how changed parking charge structure affects parking behaviour has been carried out. Hence, decision takers will have a basis to estimate the expected effect of a changed parking charge structure if it comes high on the political agenda again in the future.

The second part of the measure was to design and implement a revised Parking Information System. A parking guidance (P-guidance) system designed to reduce unnecessary circulation by giving more targeted and more comprehensive information to parking searching drivers.

The existing Parking Information System was implemented as part of the EU JUPITER-2 project (1996-1999) and has been of great use for the drivers since. In spite of technical renovation of the communication in 1999 and replacement of the displays in 2003, the system has become technologically outdated and both software and hardware needed to be renewed. But the more important point is that the city and the parking structure have developed over time making the information level inadequate. New big parking houses have been opened in or near the city centre, the new harbour front with a new Culture House and new Music Hall etc. have changed the traffic patterns and traffic level; some car parks have lost importance and others have been established, but could not be integrated into the old information system.

The main improvements with the new Parking Information System are:

1. The traffic through the city centre is reduced because the Parking Information System guides drivers to avoid the city centre during parking search,
2. More substantial parking areas are included in the Parking Information System. Hence the system gives more coherent information on the parking situation in and near the city centre,
3. The design and location of the Parking Information signs make the Parking Information System more intuitively,
4. The technology in the old system was obsolete and it became gradually more expensive and difficult to keep the old system running, and
5. Technologically it was difficult to connect the new car parks to the old system, while the new system is designed more open and includes all important car parks from the start and is open for any additional parking areas in the future.

As a consequence, the most basic terms for the new system were more or less given before starting the design process:

- Supporting a division of the city centre into new parking zones, making it possible to target the information on the Variable Message Signs (VMS) on the different approach roads, to give information only on the nearest parking zone and thus limiting the search traffic crossing the city centre.
- A technical expansion of the system to include all relevant major car parks in, and around, the city centre, both private and public.
- As a consequence, a physical expansion of the system to give dynamic information on more roads.
- Use of new technology, software and hardware.
- Giving information on alternative channels, such as the Internet and on mobile devices and, in accordance with the new ‘state of the art’ in the Intelligent Transport System (ITS)

society, the system should be able to 'Unlock the power of government data'. That is, the system should have a standardized data interface, open for all.

A3 Person in charge for evaluation of this measure

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B Measure implementation

B1 Innovative aspects

Innovative Aspects:

- Use of new technology/ITS. The parking system in Aalborg was quite old and it was therefore necessary to make an upgrade or replacement. The most recent technology was used and adapted to the new parking structure in Aalborg

B2 Planning of Research and Technology Development Tasks

Not relevant for this measure.

B3 Situation before CIVITAS

The Parking Information System was from the mid 1990's and needed a thorough review both technological and in terms of guidance strategy - especially due to the new parking situation along the waterfront, which has been revitalised.

B4 Actual implementation of the measure

The measure has been implemented in the following stages:

Stage 1: Identify the options *(15 September 2008 – 14 June 2009) - Finding out what is technological possible. A review of available systems for providing Parking Information was carried out. It was mainly based on literature reviews, scrutinising results presented at conferences and congresses in the area of urban traffic and mobility. Also networking with relevant experts in Denmark as well as across the EU was carried out.*

This review resulted in a broad knowledge within the area of Parking Information Systems and highlighted which solutions would be preferable within the project period.

Stage 2: Analyse the parking situation *(15 March 2009 – September 2010) – Analysis of the present parking situation, particularly where do people park and for how long.*

The analysis of the parking situation in Aalborg was mainly based on 3 sources:

1. *data from a central database containing parking registrations collected in recent years.,*
2. *the Parking Strategy for Aalborg Municipality, and work done in relation to the on-going work with the development of the Parking Action Plan for Aalborg, and*
3. *surveys and registration of car park use, conducted for this project.*

The Parking Action Plan is made on the basis of registrations and according to the set targets in the Parking Strategy from 2009. The Parking Action Plan analyses the parking situation in Aalborg City carefully, and highlights the future challenges regarding parking and parking-searching traffic, which the future Parking Information System will minimise.

Stage 3: Plan the new Parking Information System *(15 October 2009 – 14 September 2010) – Decide what system Aalborg needs. The old Parking Information System was based on the idea that the car parks in Aalborg City were located in 3 static zones. See Figure 1.*

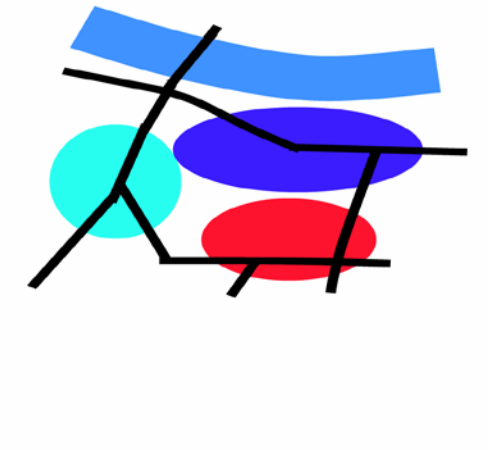

Figure 1: The principles of the old Parking Information System. The red, light blue and dark blue circles represent the 3 static parking zones. The black lines mark the overall road structure, while the light blue shape represents the fjord.

The signs and the structure of the system appeared to be increasingly obsolete. Also, in recent years the zones became unequal in size because the importance of the south-eastern zone (red) diminished over time, and in reality it only consisted of a single car park.

Significantly more car parks, both privately and publicly owned, should be included in the new Parking Information System. Cruising around in search for a parking spot is further discouraged when drivers are aware that the Parking Information System includes all parking spaces, including privately owned ones.

The new system uses variable areas to inform the driver about available parking spaces depending on the location. The information is restricted to the nearest car parks to avoid unnecessary traffic crossing the city centre, where most pedestrians are; e.g. if a driver comes from south looking for parking possibilities in the central part of city, he will be presented with a different number of available spaces in the central part of the city, than if he come from east – i.e. specifically only those located in the southern part of the city centre.

As it is very difficult to put a sharp limit between the parking zones included in the overall parking areas, variable zones makes the Parking Information System more intuitive and easy for parking-searching drivers to use. Figure 2 shows the car parks, together with the established and planned information signs included in the new Parking Information System.

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Figure 2: Map indicating the placement of the signs in the new Parking Information System. The green areas are present or future car parks. The blue dots are signs that will be established now, while the red dots marks planned signs to be established in the future

As the final output from this stage, a set of tender materials was compiled.The tender material described the total system to be delivered:

- *In total 65 displays on 38 signs of which 32 were to be dynamic and 6 to be passive.*
- *Two master controllers / servers, situated at two different places in the city, mirrored and each able to control and run the complete information system.*
- *Communication lines between all units, using more different technological solutions depending on the local conditions.*
- *Software, for running the information system. Database for dynamic and static data, and user software for central maintenance of all static data. As an extension, user software allowing each private car park to maintain static data on own car park.*
- *Data integration to a number of private car parks. More different solutions for the different parks.*
- *Statistical module*
- *As a part of Measure 9 'Modernising Travel Information in Aalborg' a webservice putting static and dynamical parking data at disposal for all external information systems as Internet display, SMS services and APPs.*

The complete redesign of the Parking Information System appeared to be more time consuming than expected. In particular, the zoning, that is the position of the signs and which car parks that should be represented on each variable sign, caused a lot of complicated, although fruitful,

discussion. However, without this procedure it might have been difficult to reach a sufficiently user-friendly and intuitive Parking Information System.

The process also included a Baseline study with the purpose of evaluating the effect of the final decided Parking Information System. The Baseline study included surveys, traffic counts, parking counts, and data retrievals from parking databases. The periods for data collection were chosen so that any changes in driving and parking behaviour due to weather, holidays etc. would be minimized compared to the planned after study period.

Stage 4: Tender of the new system. *(14 September 2010 –May 2011).The supplier of the new system was found via a competitive tender among 6 potential suppliers. The tender was judged following a '**most economically advantageous tender'** (MEAT) process. The selection was done based on the bidder's total weighted score on these criteria:*

1. *Price (40 %).*
2. *Functionality and quality (30 %).*
3. *Design and aesthetics (15 %).*
4. *Staffing and implementation (15 %).*

The competitive tendering was carried out in two steps. Each offer's scores for items 2-4 were decided and published before the price information was opened, thus making sure that a low / high price would not influence the score for item 2-4. This process guaranteed that the price would only influence the result with the decided 40%.

The tendering resulted in three bids of which the most economically advantageous bid was selected.

Stage 5: Implementing the new Parking Information System. *(May 2011 – April 2012) After selecting the supplier implementation of the Parking Information System started.*

As a result of the postponed tendering[1] it was planned for the Parking Information System signs to be installed in the period August – October 2011. However, as a result of a delay from the Italian supplier of the signs, the implementation was foreseen to be delayed by a further two months so that operation would start in the middle of December 2011. As the signs and foundations from the old system had to be removed before the foundation to the new system could be laid, this would cause a period of approximately one month without any active Parking Information System. Furthermore any likely delays in the implementation would prolong this period. A long period during Christmas sales without an active Parking Information System in the city centre was not acceptable. As a result it was decided that the implementation of the signs had to be postponed to January-February 2012. Instead the freed time was used to design and develop the database and software solution.

During and after the installations, tests on the network and the databases were carried out. The Parking Information System was in operation by the end of April 2012.

Dynamic displays:

65 LED displays were mounted on 38 signs, and further 6 signs with static information were installed. This was a major extension compared to the previous system, and included possibilities for supporting new planned car parks. Figure 3 and 4 show dynamic Parking Information System signs in operation.

[1] See section D1 Deviations from the original plan and D2.1 Barriers.

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Figure 3: Dynamical sign in the periphery of the city centre showing free parking spaces in two different parking zones of the city centre.

Controllers: *Master Controllers were installed in two different places in the city, mirrored and each able to control and run the complete information system. Figure 5 and 6 show examples of the back office access to monitor and maintenance the Parking Information System.*

Software: *Based on an existing product the supplier modified and extended the software to fulfill the requirements in the tender material.*

Figure 4: Dynamic sign, showing free parking spaces. All three car parks that these signs information on, are privately owned.

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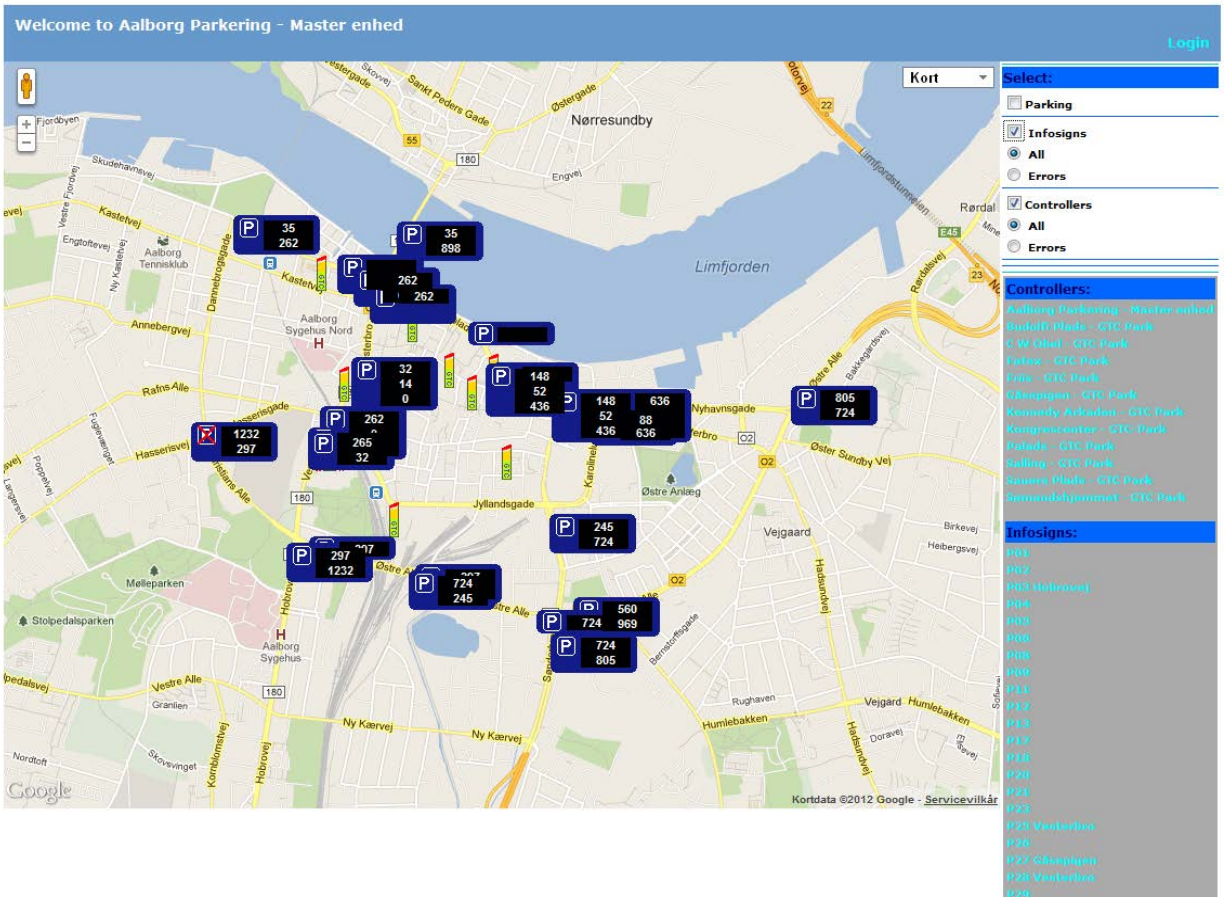

Figure 5: Example of operators System Supervision Screen in the back offices system.

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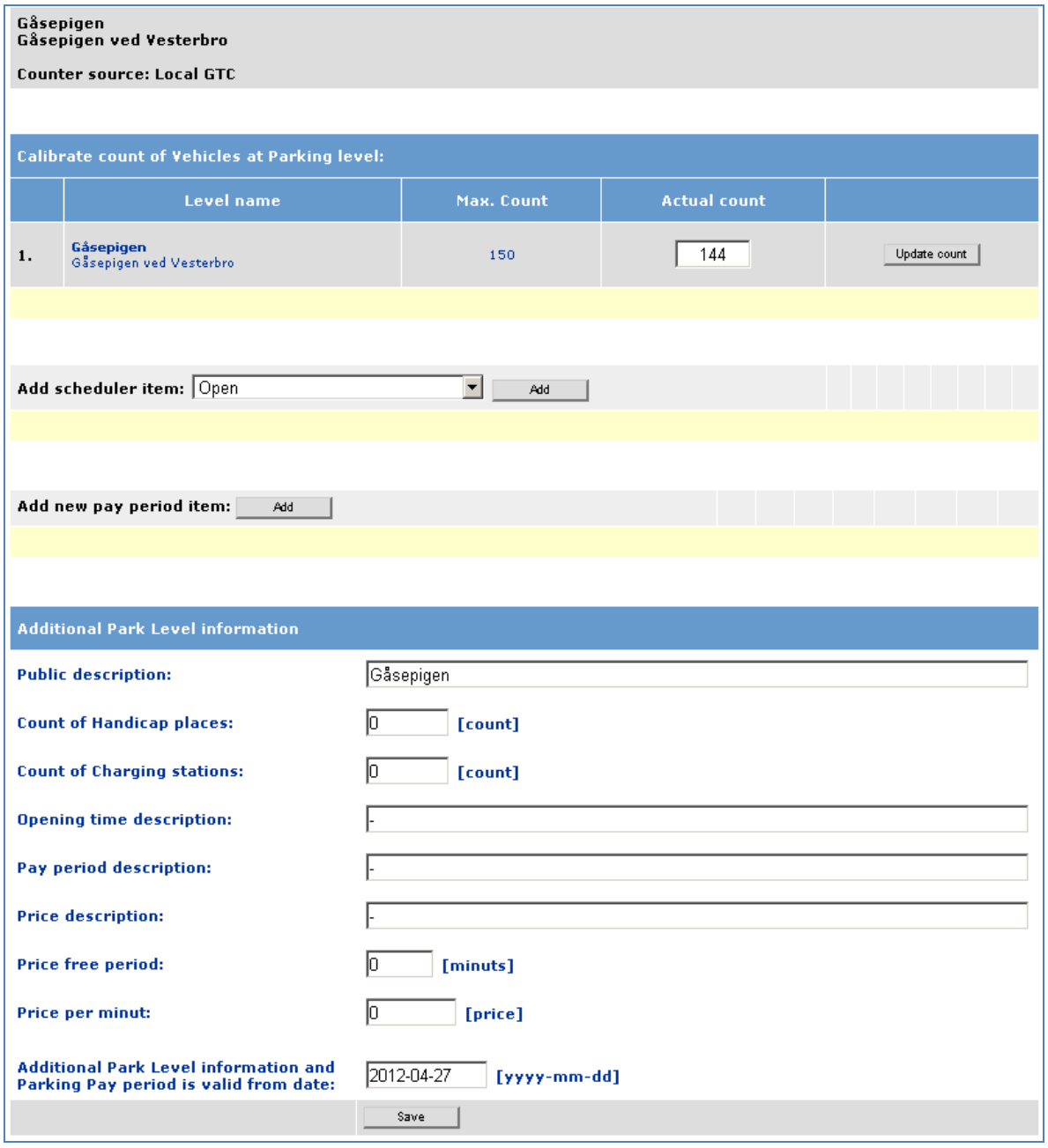


Figure 6: Example of screen dialog for entering data in the back offices system.

Data interface:

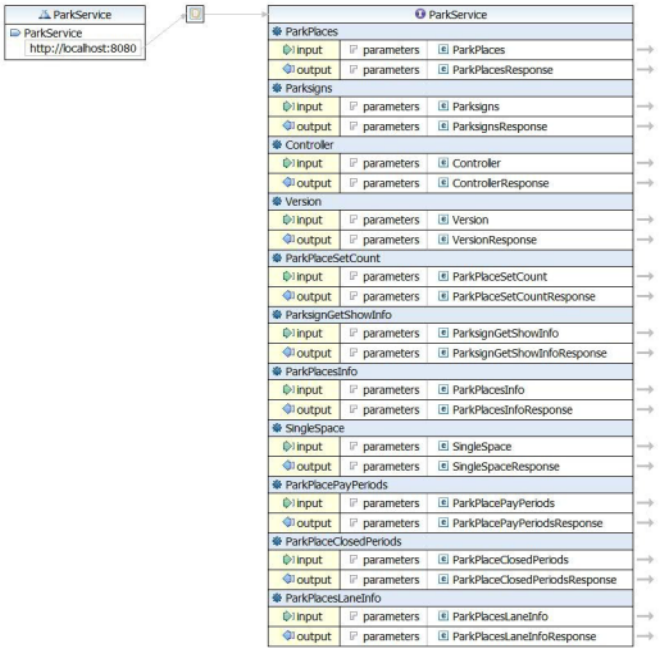
As a part of ARCHIMEDES Measure 9 'Modernising Travel Information in Aalborg' a web services interface has been developed.

The purpose of the interfaces is to make all parking data, static and dynamic, publicly available for all potential users, and thus make it possible for everyone to use these parking data to create information services to the public, via the internet or as apps.

This approach is in accordance with 'state of the art' in ITS, and is supporting Obamas New Digital Government Strategy.

2 Webservice ParkService

Webservicen ParkService består en række servicekald:



Figur 1 ParkService

Følgende services er tilgængelige:

1. **ParkPlaces**
   Information om antal ledige pladser for et givent parkeringsområde.

2. **Parksigns**
   Liste over aktive henvisningstavler der er i systemet.
   Med information om visning og status.

3. **Controller**
   Information om GTC Park controller

4. **Version**
   Liste med tilgængelig services
   Versionsnummer og udgivelse for hver service.

Figure 7: Example of page from the public web service description.

The presentation of free parking spaces and the prognosis for free parking spaces in the next hours, on the Measure 9 'Modernising Travel Information in Aalborg' Traffic Information Internet site (www.trafikken.dk/nordjylland) has been redeveloped to use the open web service interface as data source. Figure 7 shows an example of the open web interface and figure 8 shows the public available Parking Information on the Internet.

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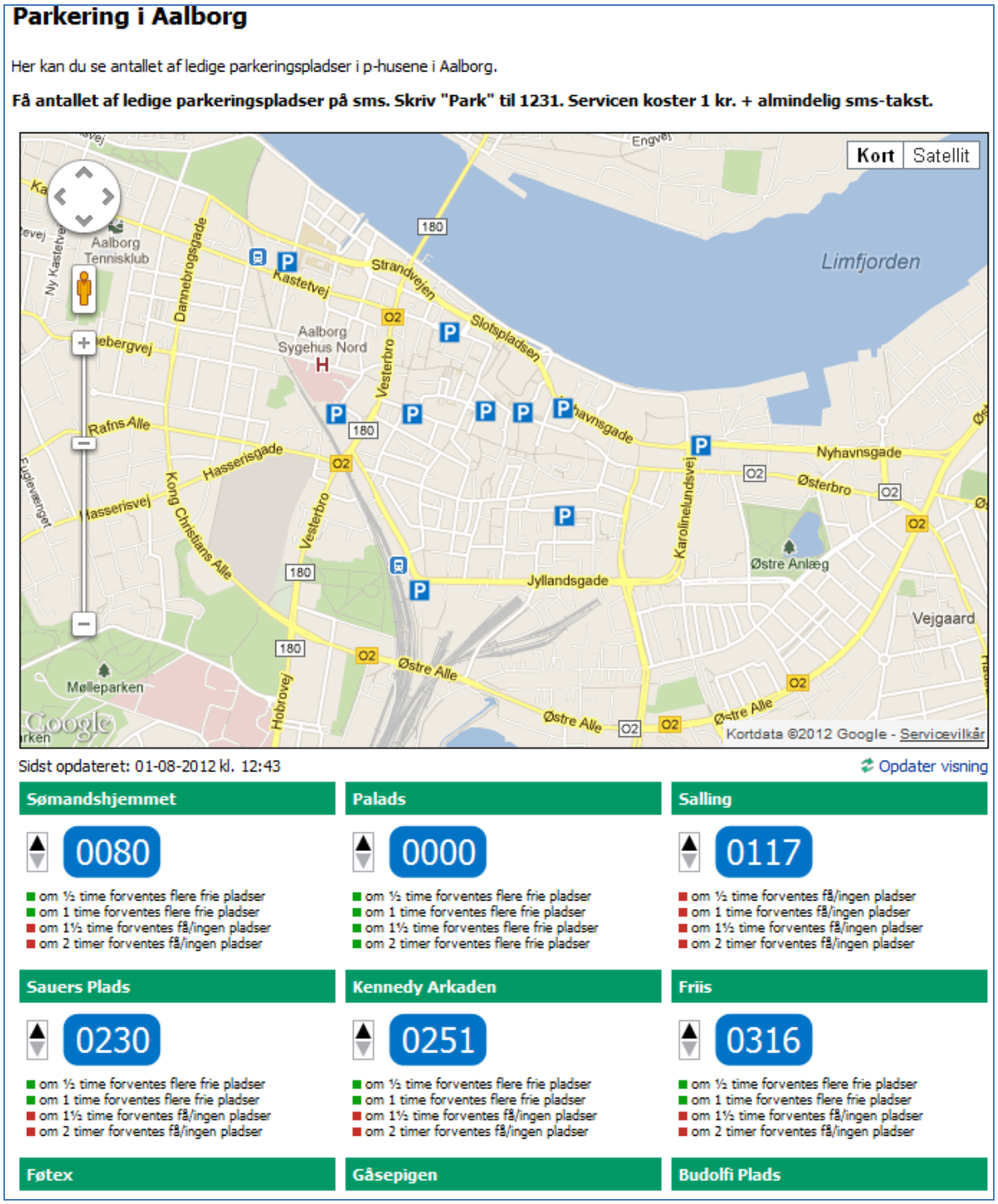

Figure 8: Internet presentation of free parking spaces and the prognosis for free parking spaces.

Besides this, the University and more private companies have started to develop APPs, which use the web service. Together with the updated web interfaces these APPs will facilitate more easy access to information on the parking situation.

Stage 6: Operation of the new Parking Information System. *(April 2012 and onwards)*

The new Parking Information System has been in operation from late April 2012 and onwards.

After passing the Site Acceptance Test with some minor errors and outstanding issues, according to normal practice, the Operational Test Period was started. During this period most of the outstandings from the Site Acceptance Test have been solved.

The Operational Test ran without major problems.

In the same period data collection for the after study, with the purpose to evaluate the effect of the new Parking Information System, has been done. Evaluation has been based on surveys, traffic counts, parking counts, and retrievals from databases. The after study is based on data collected in the summer 2012, but outside the holiday period.(Data collection in the holiday period were avoided to make sure that the traffic pattern and Parking searching traffic does not differ from the situation when baseline data were collected.)

B5 Inter-relationships with other measures

The presentation of free parking spaces and the prognosis for free parking spaces in the next hours, on the Measure 9 'Modernising Travel Information in Aalborg' Traffic Information Internet site (www.trafikken.dk/nordjylland) has been redeveloped to use the open web service interface as data source.

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C Planning of Impact evaluation

C1 Measurement methodology

C1.1 Impact and indicators

C1.1.0 Scoop of the impact

The new Parking Information System will give visitors and citizens in Aalborg a better guidance of where to park, and thereby contribute to less parking seeking traffic in the city centre. Less parking seeking traffic will make less pollution and congestion in the city centre. The new Parking Information System will also include new parking areas away from sensitive areas.

C1.1.1 Selection of indicators

NO.	EVALUATION CATEGORY	EVALUATION SUB-CATEGORY	IMPACT	INDICATOR	DESCRIPTION	DATA /UNITS
	SOCIETY					
13		**Acceptance**	Awareness	Awareness level	Awareness of the policies/measures	Index (%), quantitative, collected, survey
14			Acceptance	Acceptance level	Attitude survey of current acceptance of the measure	Index (%), quantitative, collected, survey
		ASSESSMENT OF RENEWED PARKING INFORMATION SYSTEM	Assessment	Assessment level	User assessment of renewed Parking Guides Info.	Index (%), quantitative, collected, survey
	TRANSPORT					
			Parking Level	Parking behaviour - peak	Occupancy rates Changed parking search	Index (%), quantitative, collected, survey Occupancy rates on parking areas
21		**Transport System**	Traffic Levels	Traffic flow by vehicle type - peak	Average vehicles per hour by vehicle type - peak	Veh. per hour, quantitative, measured Quantitative, collected, survey

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NO.	EVALUATION CATEGORY	EVALUATION SUB-CATEGORY	IMPACT	INDICATOR	DESCRIPTION	DATA /UNITS
22				Traffic flow by vehicle type - off peak	Average vehicles per hour by vehicle type – off peak	Veh. per hour, quantitative, measured Quantitative, collected, survey

Indicator 22 "Traffic flow – off peak" has been taken out of the final evaluation, because analysis indicated that it is not likely that changes in the parking information system will have an effect on the traffic off peak.

C1.1.2 Methods for evaluation of indicators

No.	INDICATOR	TARGET VALUE	Source of data and methods	Frequency of Data Collection[2]
13	Awareness level		A survey including 1,040 users of three selected central parking areas was made as data collection for the Baseline study. It included stop-interviews in which the users of the parking areas were asked about various topics regarding their selection of the particular car park. Each interview took 1-2 minutes. Student helpers carried out the interviews. Baseline data were collected in the periods August 25 to September 2nd in 2010 on Tuesday, Wednesday and Thursday afternoons. However, to make sure sufficient survey data were available, additional data were collected in the end of March – beginning of April 2011. The additional data were collected on one car park, to increase the strength of the data. These answers are included in the 1,040 answers. Subsequently the data were analysed in spread sheets. In June 2012 an After survey with 603 users of the same selected car park was carried out. This time for After data collection was selected to be sure that any running-in problems of the Parking Information System were solved and at the same time before the general change in the traffic pattern due to summer holiday traffic affects the results. Hence, 651 and	2 times

[2] Most types of data were collected twice. One time before the implementation of the Parking Information System, and one time after it was in operation. These two data sets are named *'Baseline'* and *'After'*.

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No.	INDICATOR	TARGET VALUE	Source of data and methods	Frequency of Data Collection[2]
			603 users of the selected parking place answered the survey in Baseline and the After study, respectively. Regarding the awareness level, the users of the car park were asked about their awareness of the old Parking Information System and if they used it.	
14	Acceptance level	To reduce the use of the private car in sensitive areas of cities (i.e. CIVITAS Plus corridor) through economic signals. To achieve reduced emission of noise and air pollutants in sensitive areas.	A survey included 1,040 users of three selected central car park were made as data collection for the Baseline study. It included stop-interviews in which the users of the car park were asked about various topics regarding their selection of the particular car park. Each interview took 1-2 minutes. Student helpers carried out the interviews. Baseline data were collected in the periods August 25 to 2 September 2010 on Tuesday, Wednesday and Thursday afternoons. However, to make sure sufficient survey data are available, additional data were collected in the end of March – beginning of April 2011. The additional data were collected on one car park, to increase the strength of the data. These answers are included in the 1,040 answers. Subsequently the data were analysed in spread sheets. In June 2012 an After survey including 603 users of one selected car park was carried out. The data collection was concentrated in the same location as in April 2011 to increase the reliability regarding traffic level analyses. This time for After data collection was selected to be sure that any running-in problems of the Parking Information System were solved and at the same time before the general change in the traffic pattern due to summer holiday traffic affects the results. Hence, 651 and 603 users of the selected parking place answered the survey in Baseline and the After study, respectively. Regarding acceptance level the users were asked if they used the Parking Information System and if they found that the Parking Information System made it easier to find an available parking space.	2 times
	Parking level	To reduce the use of the private car in sensitive areas of cities (i.e. CIVITAS Plus corridor) through economic	Data used to measure the effect on the Parking Level are based on field registrations. Analysis on Baseline and After data from a central parking database was meant to be used as additional results to underpin the reliability of the found results. However, this database was revised during the first half part of 2012, and no data were available for the After period. Results based on this data source are therefore omitted from the analyses.	2 times

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No.	INDICATOR	TARGET VALUE	Source of data and methods	Frequency of Data Collection[2]
		signals. To achieve reduced congestion levels during peak hours.	Data from manual parking counts in the Eastern part of the city centre has been collected. Baseline data were collected in the periods March - September 2010, on selected Tuesday, Wednesday and Thursdays. Student helpers carried out the manual counts with 30 minutes intervals in the period 14.30 – 16.30 on selected days (afternoon peak hours). The After registrations were carried out in an identical way and were carried out 22 – 24 May 2012 A survey included 1,040 users of three selected central car park were made as data collection for the Baseline study. It included stop-interviews in which the users of the parking areas were asked about various topics regarding their selection of the particular car park. Each interview took 1-2 minutes. Student helpers carried out the interviews. Baseline data were collected in the periods August 25 to 2 September 2010 on Tuesday, Wednesday and Thursday afternoons. However, to make sure sufficient survey data are available, additional data were collected in the end of March – beginning of April 2011. The additional data were collected on one car park, to increase the strength of the data. These answers are included in the 1,040 answers. Subsequently the data were analysed in spread sheets. In June 2012 an After survey including 603 users of the same car park was carried out. The data collection was concentrated in the same location as in April 2011 to increase the reliability regarding traffic level analyses. This time for After data collection was selected to be sure that any running-in problems of the Parking Information System were solved and at the same time before the general change in the traffic pattern due to summer holiday traffic affects the results. Hence, 651 and 603 users of the selected parking place answered the survey in Baseline and the After study, respectively. Regarding Parking level manual parking counts from the Baseline period and the After period were collected to register the changed use of the parking areas in question. Regarding the survey data a number of questions address the effect on the parking level: The users were asked where they planned to park before they reached the parking area. Hence it can be measured how many drivers that change their destination during their transport – reasonable caused by the Parking Information System. Also, they were asked if they know the Parking Information System in Aalborg, and if they	

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No.	INDICATOR	TARGET VALUE	Source of data and methods	Frequency of Data Collection[2]
			use it to select a parking area with available parking spaces. These questions together show the effect of the Parking Information System.	
	Assessment level	To reduce the use of the private car in sensitive areas of cities (i.e. CIVITAS Plus corridor) through economic signals.	In the After survey 603 users of a central car park were asked about the new Parking Information system and how they assess it compared to the old one. The After study was carried out in June 2012.	1 time
21	Traffic Level	To achieve reduced congestion levels during peak hours	Data used to measure the effect on the Traffic Level in the peak periods were based on retrievals from measurement database and added supplementary traffic counts at 5 different main routes into the city centre. The traffic counts and output from the measurement database were made for one week late August/early September 2010. Due to malicious damage on the counting station on one measuring route in the city centre only data from 4 supplementary traffic counts were included in the Baseline study. The After study was carried out in 24 – 31 August 2012. The After study was similar with the Baseline study, but only 4 supplementary traffic counts was included. The reasons for this late time of the After study are these: Due to the use of external providers of traffic counts, the counts have to be ordered some weeks before they are planned to be carried out. Hence, when the Parking Information System was in operation and the running-in problems shown terminated it was not possible to get traffic counts before the end of June, e.g. virtually in the summer holiday season. Beside the traffic counts, derived results on the basis of the surveys are used to estimate the effects on Traffic Level. In the survey, the users of the selected car park were asked about their time departure before arrival to the parking place and from which postcode (and neighbourhood if the postcode was for the central Aalborg) they departed. On the basis of changes in transportation time, an estimate on the changed distance driven could be made. Changed transportation time from a large number of drivers started out from same location indicates an effect from the Parking Information System. Moreover, on basis of the changed Traffic Level, the effect on CO_2 emission has due to the new Parking Information System.	2 times

C1.1.2 Planning of before and after data collection

EVALUATION TASK	INDICATORS INVOLVED	COMPLETED BY (DATE)	RESPONSIBLE ORGANISATION AND PERSON
Baseline data collection	13, 14, 21, 22	M 25 (M 32)[3]	City of Aalborg, Niels Agerholm
Collection of after data	13, 14, 21, 22	M 46 - M48[4]	City of Aalborg, Niels Agerholm
D12.2 Baseline and first results from data collection	All indicators	Month 34	
D12.3 Draft results template available	All indicators	Month 48	
D12.4 Final version of results template available	All indicators	Month 49	

[3] Additional 'Baseline' data were collected in M32.
[4] Additional 'After' traffic counts were carried out in M48.

C1.2 Establishing a baseline

To establish a baseline, a number of data sets were selected. The selected data were: retrieval from measurement database, supplementary traffic counts, retrieval from the parking database, surveys and field registrations on parking behaviour.

Before data were collected in a survey which included 1,040 users of 3 selected central car park. The survey included 1-2' stop-interviews in which the users of the car parks were asked about various topics regarding their selection of the particular parking area.

Data were collected in the periods August 25th to September 2nd 2010 on Tuesday, Wednesday and Thursday afternoons. After careful reviews on these data, it was found that data were more fluctuating than expected, and to make sure sufficient survey data were available, additional data were collected in the end of March – beginning of April 2011. The additional data were collected on one of the three car parks, to increase the strength of the data. To make sure that sufficient reliable results could be extracted it was therefore decided to make the analyses based on data from the later selected car park only. Afterwards the data were analysed further.

In June 2012 an After survey including 603 users of one selected car park was carried out. The data collection was concentrated in the same location as in April 2011 to increase the validity for the traffic level analyses. The period for After data collection was chosen to make sure that any running-in problems of the Parking Information System were solved and to avoid the general change in the traffic pattern due to summer holiday traffic.

Hence, 651 and 603 users of the same selected car park answered the survey in Baseline and the After study, respectively.

Ideally, the surveys among the users of the parking areas should have been carried out at the same time of the year. However, this was not an option due to late implementation of the Parking Information System, as this would have resulted in a significant conflict with the time frame of the ARCHIMEDES project. Additionally, it shall be noted that the differences in traffic pattern between the periods are very limited.

The Danish Road Directorate uses a general model handling the variations in traffic volume and type over the year. The model distinguishes between 7 types of driving in private cars: commuting, local, regional, remote, and three levels of holiday traffic. As the data were collected outside the holiday periods, only the first four types of traffic are of relevance. The survey data shows that less than 1 % is remote traffic. In baseline and after the implementation the local traffic consisted of 36% and 37%, respectively. The rest of the traffic was regional. To measure the effect on time use only local trips are used and according to the National model, the maximum variance in the local traffic as well as commuting traffic volume is 4%. Since the variation in traffic type as well as proportion is negligible, no effect due to the time variation of the data collection is expected.

The drivers were asked about their home postcode and the postcode where the actual trip was initiated. As the purpose of the enquiries was to identify the parking search behaviour of the existing road users, no socio-economic data to disclose the composition of this group were included. For this reason it is not possible to evaluate if any difference in the behaviour should be a result of difference in the composition of the response groups. However, three factors indicate that the before and after data are directly comparable: 1: The proportion of regional/local initiation of the trip was virtually identical before and after the implementation; 2: Virtually the same proportion of drivers changed their target parking area before the trip was initiated; and 3: Data were collected in exactly the same time periods of the weeks before and after.

Together with general knowledge from the Parking Strategy for Aalborg Municipality, and work in relation to the development of the Parking Action Plan for Aalborg these results establish the baseline for the measure. The description of the establishing of baseline is made for the four levels: awareness,

acceptance, parking, and traffic. Several of the collected data sets/surveys reasonably cover more than one of the levels and are therefore used more than once to form the baseline levels when appropriate.

Table C.1.2: Status on collected data.

Indicator	Before	After
Parking Level	(16 – 18 March 2010, 25 Aug – 9 Sep 2010 + 29 Mar – 6 Apr 2011)	(22-24 May 2012, 6-27 June 2012)
21 Traffic Level	(25 Aug – 9 Sep 2010 + 29 Mar – 6 Apr 2011)	(6-27 June 2012 24 -31 August 2012)
13 Awareness Level	(25 Aug – 9 Sep 2010 + 29 Mar – 6 Apr 2011)	(6-27 June 2012)
14 Acceptance Level	(25 Aug – 9 Sep 2010 + 29 Mar – 6 Apr 2011)	(6-27 June 2012)
Assessment Level	NA	(6-27 June 2012)

Awareness

The awareness level was measured in the survey. The users were asked if they knew that there was a Parking Information System.

It was the assumption that the establishment of a more comprehensive Parking Information System would result in a bigger proportion of the users of car parks being aware of it. Also, it was the assumption that a more intuitively and easy understandable system would lead to more road users using it. Moreover, the proportion of drivers who changes their destination for parking before they arrives to the car park is assumed to indicate the awareness of the measure.

Acceptance

Within the same survey, the acceptance level has been addressed. The users have been asked if they used the Parking Information System and if they found, that it made it easier to find an available parking space.

The hypothesis was that a more comprehensive Parking Information System would result in a bigger proportion of the users of car parks using the Parking Information System. Also, it was the assumption that more users would find it easier to use the information from the new Parking Information System. Hence the acceptance level could be measured on the basis of answers to these questions.

Parking

Analysis on before data from a central parking database together with data from manual parking counts in the Eastern half of the city centre has formed the baseline for the parking level. The car parks in Eastern part of the city are selected because they have a lower occupancy rate than the central Western car parks. Hence, the changes in occupancy rates due to a new Parking Information System would probable be more measurable here.

The above mentioned survey asked about various topics regarding their selection of the particular car park. The users were asked where they planned to park, before they reached the car park. Hence it could be measured how many drivers changed their destination during their itinerary – reasonably caused by the Parking Information System. Also, they were asked if they know the Parking Information System in Aalborg, and if they used it to choose a car park with available spaces. The answers to these questions, together with the parking counts and the retrievals from the parking database, form the baseline of the parking level.

It seams reasonable to think that these results, which form the baseline for the parking level, would change due to the new Parking Information System. The evaluation after the implementation of the old Parking Information System showed that a proportion of drivers changed their destination due to the received information. Also it was the assumption that the new Parking Information System would increase the occupancy rate on the car parks with dynamic Parking Information, because the users are informed on the available parking spaces.

Traffic

Traffic data is used to measure the traffic on East-West bound roads, which normally carries a lot of parking-searching traffic. The locations were selected because the best possibilities to measure the effect were here. In the city centre the North-south bound roads are only very few and they are arterial roads, where any overall effect from the measure most reasonable will be immeasurable.

The average transportation time from departure to the parking place, the proportion of drivers who select a new parking place as target, and the effect on the traffic flow on selected road segments form the baseline Traffic Level.

C1.3 Methods for Business as Usual scenario

With the current Parking Information System, the parking searching traffic would continue to increase in the future as the current system is not open for adding in new parking areas. Besides, within a few years the existing system would become very difficult to maintain due to an obsolete technical system. Or it might even be impossible to keep the system running because replacement items would not be available.

Hence, besides the expected increased parking-searching traffic due to traffic growth in general, a technical obsolete Parking Information System might cease to operate over time and thereby result in further congestion. Hence B-a-U would result in decreased accessibility and more congestion, tailbacks etc. and therefore is in reality not an applicable approach in the long term.

C2 Measure results

C2.1 Transport

This subsection includes the two indicators Parking Level and Traffic Level (21). As the effects in the Business-as-Usual scenario cannot be foreseen in quantitative units further considerations are not included in this section. An overall approach to B-a-U scenario is available in section C1.3.

Data from the survey was used. Road users who parked their car where immediately after parking asked a few questions regarding parking and the Parking Information System. The users were asked if the final chosen car park was another than the first decided. Changes from the first chosen parking area to the destination parking area indicate that the parking behaviour has been affected by information from the Parking Information System.

Both with the old information system still working and after implementing the new Parking Information System, 18% of the users changed their choice of car park. See table C2.1.1. This is a relatively large proportion, indication that the parking Information system does have a significant effect on reducing search traffic and congestion around, and especially in, the parking areas. The result also indicates that a significant proportion of the users have made up their mind before the trip was initiated, and primarily uses the system when approaching the city, to ensure that there is still available parking bays in the chosen parking area.

The proportion changing choice of parking area is depended on the amount of free bays in the areas; the benefit of a parking information system is thus increasing with increasing shortage of available parking bays – increasing traffic level in the city centre.

Table C2.1.1: The proportion of users, who changed their target car park during the trip. Before and after implementation of the new Parking Information System.

Parking Level	Before	B-a-U	After	Difference: After –Before	Difference: After – B-a-U
No effect	82%	NA	82%	0%	NA
Changed destination	18%	NA	18%	0%	NA

Data used to measure any effect on the parking level are manual collected registrations on the car parks in the eastern part of the city centre. The studied part of the parking spaces includes approximately 22% of all public available parking spaces inside the ring road, Østre Alle, in Aalborg. The areas in which the registrations were made are part of the ARCHIMEDES Corridor.

Baseline data were collected in March to August 2010 and the After data in May 2012. The main result is that the number of parked cars decreased slightly while the parking occupancy rate decreased significant as a consequence of an expansion in the number of parking spaces in the area.

In Baseline 1,596 parking spaces were available in the eastern part of Aalborg City. This figure changed to 2,189 while the Parking Information System was being implemented. The increase of 593 parking spaces (37%) were the combined effect of the number of non-restricted parking spaces going down with 78 (100% reduction) and the payment parking going up with 671 parking spaces (65%). Only very limited changes occurred to the number of time-restricted parking spaces. This significant increase in the number of available payment spaces in the study area is in line with the ambitions in the parking strategy of Aalborg. See table C2.1.2.

Table C2.1.2: The development in available parking spaces in the Eastern part of Aalborg City. Baseline and After.

Parking Level (No. of available spaces)	Baseline	B-a-U	After	Difference: After – Baseline	Difference: After – B-a-U
Payment	1.041	NA	1.721	680	NA
Time restriction, ≤30 min.	333	NA	327	-6	NA
Time restriction, >30 min.	144	NA	141	-3	NA
No restrictions	78	NA	0	-78	NA
Total	1.596	NA	2.189	593	NA

Between the two registrations, the number of occupied parking spaces was reduced by 60 (6%) in the area. It indicates a minor decrease in the parking occupation. However, as the non-restricted spaces were turned into payment spaces, a significant part of the decreased number of parked cars is expected to have moved to surrounding spaces outside the study area without restrictions (the spaces that turned from unrestricted to payment spaces are located in the outskirt of the study area, that is close to the unrestricted spaces outsides the area).

The significant increased number of parking spaces resulted in a reduction in parking occupation rate from 61% to 41%, mainly because the occupancy rate of the payment spaces went down from 51% to 33%. The occupancy rate on the time-restricted spaces was only slightly reduced. Other factors than the new Parking Information System may have affected the parking behaviour. The general financial crises, a competitive area with malls in the southern suburban areas with an almost unlimited number of free parking bays, and not least the removal of the unrestricted parking spaces and increased number of payment spaces in the area, have also contributed to the change in the parking behaviour. See table C2.1.3.

Table C2.1.3 The change in number and proportion of occupied parking spaces in the Eastern part of Aalborg City. Baseline and After.

Parking Level	Available Parking spaces		Number of occupied spaces			Proportion of available spaces occupied	
	Baseline	After	Baseline	After	Difference	Baseline	After
Payment	1,041	1,721	529	571	42	51%	33%
Time restriction, ≤30 min.	333	327	283	251	-32	85%	77%
Time restriction, >30 min.	144	141	90	85	-6	63%	60%
No restrictions	78	0	65	0	-65	83%	-
Total	1,596	2,189	966	907	-60	61%	41%

Based on the change in parking space occupancy rate in the study area it is not possible to show any effect on the parking level due to the new Parking Information System compared to a situation, where the old system was still running. However, the proportion of users, who use the Parking Information System as well as those who finds that it made it easier to park, increased after the new Parking Information System was implemented. These are elaborated on in section C2.2.

The effect on the Traffic Level due to the new Parking Information System is studied on the basis of two approaches. Based on traffic counts on selected east-west-going road sections where any effect on the traffic level most probably is seen and based on the derived effect on users of transport time extracted from the user survey.

The Baseline traffic counts were carried out in one week in the end of August 2010 and the similar After traffic counts were carried out in the end of August 2012. The structure of the counting does not allow dividing the results for the afternoon peak hour traffic into separate weekdays. Therefore the average traffic volumes for the afternoon peak hour traffic from Monday to Friday in each of the two periods are used. See table C2.1.4.

Table C2.1.4 The afternoon peak hour traffic on selected East-West going midblocks, Baseline and After.

21 Traffic Level (peak hour traffic)	Before	B-a-U	After	Difference: After –Before	Difference: After – B-a-U
Danmarksgade	417 vehicles	NA	494 vehicles	77 vehicles	NA
Prinsensgade	599 vehicles	NA	559 vehicles	-40 vehicles	NA
Algade	390 vehicles	NA	303 vehicles	-87 vehicles	NA
Vingårdsgade	375 vehicles	NA	392 vehicles	17 vehicles	NA
Total	1.781 vehicles	NA	1.748 vehicles	-33 vehicles	NA

The difference in traffic volumes on the selected east-west-going central streets in the city centre in Baseline compared to After the implementation is modest. The effect differ somewhat with two streets having reductions and two the opposite. In total the traffic volume has decreased from 1.781 to 1.748 (-1,9%). To the extent that this change is not only a random variation, some of the reduction is reasonable caused by the new Parking Information System, but some of the reduction can also be a consequence of the improved traffic management on the ringroad Østre Alle implemented through ARCHIMEDES Measure 70. It is not clear, which part of the effect is caused by the revised Parking Information System, but the results are in line with the general purpose of less traffic in the city centre.

In the survey, the 1,254 (651 in Baseline and 603 After) users of the car park were asked for their departure time and departure postcode (and a more specific neighbourhood if the postcode was for the

central Aalborg). Based on difference in transportation time between Baseline and After, an estimate on the changed distance driven can be made.

The two surveys resulted in 77 different postcodes and nine neighbourhoods. The majority of those were only departed by one or few users. Hence the focus was on the postcodes/neighbourhoods with most users. Only those with more than 20 records in Baseline as well as in the After registration are included in the analyses.

A part of the drivers have errands or did not drive the direct route to the parking activity, while other drivers drove directly to the parking place, because it was the target for the trip set before departure. Therefore it makes no sense to include neither all time driven nor the average time driven in the results. Instead the average of the 10% and 25% percentiles of the time driven is used to measure the time driven to the car park. Dense traffic as in the city centre has a low average speed, therefore an average of 20 km/h is selected to recalculate the change of transportation time to change in distance driven. The effect on transportation time from the areas with most trips included appears in table C2.1.5.

Table C2.1.5: The change in transportation time prior to arrival on a central parking place distributed on neighbourhoods and total, Baseline and After (minutes).

Traffic Level - peak (21) (mm.ss)	Sample size	Baseline	B-a-U	After	Difference: After – Baseline	Difference: After – B-a-U
Frejlev	29	12.47	NA	12.55	0.08	NA
Gug	36	10.49	NA	10.29	-0.20	NA
Aalborg East	36	13.04	NA	14.42	1.38	NA
Nørresundby	61	07.49	NA	08.38	0.49	NA
Hasseris	40	07.17	NA	06.23	-0.53	NA
Vestbyen	34	07.56	NA	06.08	-1.48	NA
City Centre	86	07.04	NA	05.51	-1.13	NA
Total (Weighted)	322	08.56	NA	08.37	-0.19	NA

The average transportation time per trip decreased by 19 sec. after the Parking Information System went into operation. Despite significant difference in the size of effects, most of the results indicate a reduced transportation time.

During the implementation of the Parking Information System but before the After registration, the railway connection across the Limfjord was interrupted by a cargo ship hitting the bridge. This resulted in the train traffic being replaced with extra bus traffic over the road bridge, which might have affected the travel time from North negative. Later studies have shown that a significant change of modal share from Public Transportation to private cars has followed due to the damaged railway bridge. Together with the increased number of buses crossing the bridge, this could explain the increased transportation time from Nørresundby - across the Limfjord from North.

From East / South, the improved Adaptive Traffic Signal Control System on the ring road (Measure 70) might have affected the transportation positive. The transport time for trips from Gug (south-east) is in accordance with such a hypothesis, while the trip time for Aalborg East show just the opposite.

The transportation time from the nearest western neighbourhoods Hasseris, Vestbyen, and in particular from the City Centre, indicates an explicit reduced transportation time. It is notable that driving from these nearest neighbourhoods is faster after the implementation, and this shows that the transportation time to the car park has been affected positively locally. Most likely the same effect is present for the more remote neighbourhoods, but here other factors blur the results.

The relatively low number of included users (when distributed on post codes) might result in some uncertainties. Despite these uncertainties the overall pattern shows a reduced transportation time, and it is a fair conclusion that the Parking Information System results in reduced transportation time due to less parking searching traffic.

A rough estimate of the total effect from the Parking Information System is made. Aalborg Municipality has each year some 1.25 million payments for parking inside the ring road, Østre Alle. Also the municipality manages 65% of the total number of public available parking spaces in Aalborg, while the rest of these are privately managed, but public available. Under assumption that the use and number of transactions per parking space is identical for both private and public managed car parks there will be approximately 1.92 million parking per year on payment parking spaces inside the ring road. As the Parking Information System only addresses payment car parks, and almost all payment car parks are included in the system, this number also represent the number of affected trip. . Hence a estimation shows that the implementation of the Parking Information System in Aalborg results in approximately 9,978 less hours of driving and 233,284 less km driving each year. See table C2.1.6.

Table C2.1.6: The effect on transportation time and distance driven per year in Aalborg. Baseline and After.

Traffic Level - peak (21)	Difference: After –Baseline	Note
Transportation time (Weighted) (mm.ss)	-00.19	
Distance driven (Weighted) (m)	-122	Average speed 20 km/h
Total Transportation time (hours)	-9,978	1.92 million parkings/year
Total Distance driven (km)	-233,284	0.122 km extra per parking

An important objective in the ARCHIMEDES project is to reduce fuel consumption and hence CO_2 emission. The new Parking Information System affects the traffic as indicated above with a reduced distance driven during parking search as the result.

To estimate the change in CO_2 emission the official model developed by the Danish Ministry of Transport, TEMA2010 is used. In the model it is possible to estimate a number of emission types for different mode of transport and different types of traffic.

TEMA2010 operates on some pre-defined parameters. The model used is tuned as good as possible to the traffic in question. It is assumed that parking searching traffic is carried out with a speed of 20 km/h due to many decelerations. This assumption can be questioned. However, on Østre Alle the total average speed in the afternoon peak period differs from 25km/h to 32 km/h depending on the direction and on if the Adaptive Traffic Signal Control System is activated (Measure 70). The Adaptive Traffic Signal Control System covers the arterial ring road and significant parts of the parking searching traffic will be on the smaller and more congested streets with lower average speed.

It is assumed that the driving is carried out in middle-size cars and with a distribution between diesel- and petrol-based cars as the national distribution in the period 2010 to 2012. As an average it is assumed that the cars meet the EURO IV standard. As the average age of the Danish cars is quite high it can be questioned if a EURO IV standard is the most suitable emission level to select, but the level is choosen as the older emission level (EURO IV) is estimated to be to low.

Based on these figures, the estimated reduced CO_2 emission per parking is calculated to 37g and the total reduced amount per year in Aalborg to 71 tons. See table C2.1.7.

Table C2.1.7 Some important parametres used in the TEMA2010 model and the effect from the Parking Information System on CO_2 emission.

Emission Level		
Model choices		
	Diesel	Petrol
EURO norm	IV	IV
Engine size	<2,000 cc	1,400-2,000 cc
Proportion	23%	77%
g CO_2/km	233	324
Average g CO_2/km (weighted)	303	
Estimated emission effects		
After-Baseline g CO_2/parking	-37	
After-Baseline tons CO_2/year	-71	

C2.2 Society

This subsection includes the three indicators: Awareness Level (13), Acceptance Level (14), and Assessment Level. As the effects in the Business-as-Usual scenario can not be foreseen in quantitative units further considerations are not included in this section. An overall approach to B-a-U scenario is available in section C1.3.

Data concerning the Awareness and the Acceptance level were mainly collected in the late summer 2010 and supplemented by data collected in the spring 2011 as described in section C1.2. Because the Assessment Level will be based on the new Parking Information System no data were collected as Baseline data. The data collections for the After study were carried out in the June 2012. See table C1.2.

The level of awareness is measured in the survey. The users of the car park were asked if they knew that there was a Parking Information System. In Baseline 78% were aware of the Parking Information System while this number increased to 92% after the new Parking Information System was implemented. The increased awareness is mainly explained by the fact that the Parking Information System includes more parking areas and more VMS and hence a more frequent presentation of Parking Information for the drivers. To some degree information in medias and information from the municipality might have contributed to the increased awareness. Moreover, it might be due to the fact that the system is now more intuitively and easy understandable and more drivers therefore use – and remember - it. See table C2.2.1.

Table C2.2.1: The proportion of users who were aware of the Parking Information System. Baseline and After.

13 Awareness Level	Baseline	B-a-U	After	Difference: After – Baseline	Difference: After – B-a-U
No (%)	22%	NA	8%	-14%	NA
Yes (%)	78%	NA	92%	14%	NA

Data collection regarding the acceptance level was carried out in the same survey as for the awareness level. The proportion of users, who found that the Parking Information System makes it easier to find a vacant parking space was 62% in Baseline and increased by 27% (17 percentage point) to 79% after the new Parking Information System came in operation. It means that there is as well a high

acceptance of the new Parking Information System and a significant increase in acceptance level between the old and the new system. See Table C2.2.2.

Table C2.2.2: The proportion of users who found that the Parking Information System makes it easier to find a parking place. Baseline and After.

14 Acceptance Level	Baseline	B-a-U	After	Difference: After – Baseline	Difference: After – B-a-U
No	38%	NA	21%	-17%	NA
Yes	62%	NA	79%	17%	NA

The use of the Parking Information System also increased. See table C2.2.3. In Baseline the proportion was 23% but it increased with 34% (8 percentage point) to 31% after the new Parking Information System came in operation.

Despite the significant increased level of use, the Parking Information System is still only used by about 1/3 of the users. It can be explained by the fact that virtually all the users were from the region, and approximately 40% of all the users parks in the city centre once a week or more frequent. As a consequence 82% of the users had decided to park on a particular car park even before arriving to the city centre. These users 'only' uses the Parking Information System to validate that there is free parking bays in the preferred car park when approaching the city centre. If this more or less unconscious use of the information system is included in the answers as 'use of the information system' in Table C2.2.3 could be called in question.

Table C2.2.3: The proportion of users who used the Parking Information System. Baseline and After.

14 Acceptance Level	Baseline	B-a-U	After	Difference: After – Baseline	Difference: After – B-a-U
No	77%	NA	69%	-8%	NA
Yes	23%	NA	31%	8%	NA

Despite the general more positive attitude to the new Parking Information System, it should be noted, that many users found the Parking Information System less reliable than desired. The most common complain is lack of reliability from the Parking Information System – probably because the data collection to the evaluation of the system had to take place while the system was still in the operational test phase.

The Assessment Level is addressed regarding the After study only, and consists of the users' assessment of any change in quality of the Parking Information System. The users of the selected central car parks were asked if they had recognized that a new Parking Information System was in operation. Different to the general awareness of the Parking Information System, which was high – especially after the new Parking Information System came into operation; only 15% stated that they had recognized that a ***new*** Parking Information System was in operation. Also, only a minority of these drivers found that they could assess, if the new Parking Information System worked better than the old one. However, all drivers, who assessed it, found that the new Parking Information System worked as good as or better than the old system did. See table C2.2.4.

Table C2.2.4: The users' assessment of the new Parking Information System. After only.

Assessment Level	Proportion (%)
Much better	4
Somewhat better	4
Stayed the same	16

Somewhat worse	0
Much worse	0

Approximately one in three of the assessments showed a better Parking Information System with the new system compared to the old one. Moreover, indirectly the increased use and awareness of the new Parking Information System indicates a positive assessment despite that many users were not able to assess any improvements of the system. All things being equal, the users assess an increased level of service from the new Parking Information System compared to the old one.

One of the reasons that only a minor part of the road users were able to state that they had recognized that a new system were in operation, probably were that the old system was replaced before any technical malfunctions started to show to the users. On the other hand, the new system gave information on more signs and for more car parks, giving a general more positive attitude to the new Parking Information System.

C3 Achievement of quantifiable targets and objectives

No.	Target	Rating
1	To design and implement a revised parking charge structure, and thereby reducing long-time parking in the city centre. This will free parking spaces for short-term parking and thus reduce the traffic from cars searching for a free Parking space.	**NA**
2	To design and implement a revised Parking Information System and thus reduce the traffic from cars searching for a free Parking space.	******

NA = Not Assessed O = Not Achieved * = Substantially achieved (at least 50%)
**** = Achieved in full *** = Exceeded**

C4 Up scaling of results

With this measure completed, the entire city centre is covered and up scaling is therefore not that relevant. But more private owned car parks could be added to the system if new car parks are established. Also, over time the big shopping mall 'City Syd' located in a southern suburb of Aalborg could be either connected to the system or a parallel subsystem could be implemented.

C5 Appraisal of evaluation approach

As a consequence of the delayed implementation of the Parking Information System, collecting of data for the Baseline and the After study could not be done at the same time of the year. However it is reasonable to expect, that there will be only limited variation in the general traffic and parking pattern between the selected periods for the data collection. Both are in periods of the year without snow to affect the results. Also, both are carefully selected to avoid summer holiday as well as bank holidays of which there are a number in the spring.

The original surveys which were planned to be carried out in three car parks in the city centre, were changed to only one, and an additional Baseline survey was made. The original idea was to study the effect of the new Parking Information System in three various sites of the city centre. They were selected because any bias due to unforeseen local conditions, which would affect the results, could be handled in a suitable way. It turned out, that the departure localities of the drivers were much more variable than expected – hence the planned estimation of any effect on travel time from the drivers' departure localities was not workable. Also, it was found that there was a high correlation between most answers in the three sites – e.g. almost the same proportion of drivers in the three locations had decided where to park before the trip started. I.e. it seemed reasonable that reliable results could be collected from one locality only. At the same time the restriction to one parking site only, caused that the results regarding transportation time became much more reliable. Hence, nothing indicates that this change compared to the planned surveys affected the reliability of the survey – more reasonable the opposite.

C6 Summary of evaluation results

In Aalborg the development had made it necessary to rethink and renew the Parking Information System. New big parking houses had been opened in or near the city centre, the new harbour front with a new Culture House and new Music Hall etc. had changed the traffic patterns and traffic level, and the need for a Parking Information System using the most recent technology that limited the traffic flows through the city centre had appeared. Hence a new and up-scaled Parking Information System was implemented and is currently in operation. The results from the evaluation of the new Parking Information System can be summarised into the following conclusions:

- Awareness of the new Parking Information System among the users of the car park went up with 18% (14 pct point) from 78% to 92%. This is probable caused by the installation of more signs in the scheme, and the fact that the new system is more intuitively to understand.
- The proportion of users who found that the Parking Information System made it easier to find a parking space increased by 27% (17pct. Point) from 62% to 79%. Also the proportion, which used the Parking Information System increased with 34% (8 pct point) from 23% to 31%. Both results show that the Acceptance Level increased after implementation of the new Parking Information System.
- Both with the old information system still working and after implementing the new Parking Information System, 18% of the users changed their choice of car park based on information form the information system. This is a relatively large proportion, indication that the parking Information system does have a significant effect on reducing search traffic and congestion around, and especially in, the parking areas.
- The parking occupation rate was reduced with 1/3 (20 pct point) from 61 to 41%. Primarily as an effect of an increase in the total number of available spaces. Any direct effect on the Parking Level due to the new Parking Information System cannot be documented, while the assessed usability and use among the users show a positive effect.
- The peak hour traffic level was slightly reduced after the Parking Information System was implemented. It is, however unclear which proportion of this reduction can be attributed to this measure. The average transportation time before arrival to a parking place was reduced by 19 sec. per trip. It is equivalent to a reduced transportation time-use of 9,978 hours and 233,000 less km driven per year in Aalborg City.
- A majority of the users could not assess if the new Parking Information System results in better information than the old one did. However, those who assess it found it at the same level or better than the old one. This lack of ability to give a positive conscious assessment of the information level is somehow counteracted by an increase of 27% in the numbers of users who found that the Parking Information System made it easier to find a parking space.
- On the basis of the change in parking seeking driving, the CO_2 emission was reduced by 71 tons per year in Aalborg City.

Changing parking behaviour in Aalborg

City: **Aalborg** *Project:* **ARCHIMEDES** *Measure number:* **20**

C7 Future activities relating to the measure

The Parking Information System includes the entire city centre and can therefore not be up-scaled geographically. However, more private owned car park could be added to the system if interest for this occurs. Also, over time the big shopping mall 'City Syd' located in a southern suburb of Aalborg could be connected to the system. It might, however take several years before it will be a requirement as there still are more than enough available parking spaces in this area.

D Process Evaluation Findings

This measure is not a focus measure.

D1 Deviations from the original plan

- **Postponement of implementation of revised parking charge structure.** According to the DoW it was planned to design and implement a revised parking charge structure, and thereby reduce long-time parking in the city centre. Due to political reasons (side effect of national tax stop) this part of the measure could not be implemented within the ARCHIMEDES project period.
- **Deviations from original expected time schedule.** The internal time schedule for this measure has been postponed several times, and the final implementation date is late in the project period compared to the original expectations. As explained in section D2.1 Barriers the reasons for the postponed time schedule, was due to more factors: Side effects of the economical uncertainty on the construction of the Music Hall. A time consuming zoning process done in three phases and the fact that the Italian subcontractor for signs was two months delayed, which resulted in a similar delay in the implementation process. As a consequence of this last delay the prospect of not having a Parking Information System during the Christmas sales led to the postponement of the start of the physical installation until after Christmas 2011 – and then the casting was hit by the winter weather.

D2 Barriers, drivers and activities

D2.1. Barriers

Preparation phase

- **Political / strategic / financial.** ***Planning and financial uncertainty related to the new Music Hall.*** Besides the drivers described in section **A2 Description,** an important premise for redesigning the Parking Information System was the anticipated change in traffic and parking behaviour as the result of the construction of a new Music Hall at the old Harbour Front in the centre of the city. Shortly after signing the ARCHIMEDES contract, an uncertainty on the construction of the Music Hall arose. The prices from the tender did not match the expected budget figures. This uncertainty led to an order to suspend working on a new Parking Information System, until a solution on the Music Hall problem was found.
  This new situation, concerning needs and economy, resulted in a request to re-evaluate if a new Parking Information System was needed, or if the task should be redefined to a renovation of the existing system. After a period of stand still, the Music Hall's financial problems were solved, and the process of planning and designing a new Parking Information System, could restart.
- **Planning. / Political.** ***Finding a compromise between the technical and the political considerations.*** One of the key elements in designing the new information system was deciding on the zoning of the city. Dividing the city into logical zones and deciding which car parks should be referred on which signs. The second part of this problematic topic was to find a political compromise between reducing traffic by only giving targeted information to drivers on nearest car parks, and satisfying the anticipated politically supported interest from the City Centre's commercial association in giving broad information on all available parking spaces. This originates from the association's competition with the big shopping mall 'City Syd' located in a southern suburb of Aalborg. There was also politically supported interest from the owners of individual car parks in being presented on signs in *all parts of the city* (which

conflicted with the technical interests) to draw customers to the shopping centre associated with their particular car park.

In the end this zoning process was done in three phases. First the employee in the municipality responsible for parking, made up a model for new zones based on the city's official parking strategy. Secondly an assistant professor in Traffic Planning from the university made a new suggestion based on the former, modified after some more theoretical reflections. This work was carried out in close cooperation with the employees in the municipality. The proposal of the revised Parking Information System was modified in the city to make it politically acceptable and based on this a consultancy transformed the model into an operational description in the tender material.

This process – where the same work was more or less done three or four times – was time consuming, but as described in *Stage 3: Plan the new Parking Information System,* worth the effort.

Implementation phase

- **Planning.** ***Time consuming tender process.*** The supply of the system was tendered out. Compiling the tender material was a complicated and time-consuming process. As already described, offers were received from 3 different companies and the company offering the most economically advantageous bid was selected.
- **Political / Technical.** ***Supplier lack of ability to deliver on time and need to reschedule due to Christmas shopping.*** During the implementation process the selected supplier had some general problems complying with the agreed time schedule and at one point in time, he had to inform the city that his subcontractor for signs in Italy was two months delayed, which resulted in a similar delay in the implementation process. As described previously, the prospect of not having a Parking Information System during the Christmas sales led to the postponement of the start of the physical installation until after Christmas 2011.

Operation phase

- **Problem related**. ***Making the car drivers utilise the system.*** Evaluation shows, that the majority of the drivers have decided which parking place to use before they enter the area where the Parking Information System is implemented. If the full potential of the Parking Information System shall be reached; more of these drivers must follow the information from the Parking Information System. All things being equal this change in behaviour will not occur as long as there is enough free parking slots on the parking places being decided in advance.

D2.2. DRIVERS

Preparation and implementation phase*:*

- **Political / strategic:** ***Political focus on sustainability and environment***. On society level the general development has raised the need for a revised Parking Information System. Increase in the number of cars and constantly increasing concentration of private and public owned functions in the city centre have increased the need for ITS solutions as e.g. Parking Information System to address the challenges in the form of more and more congestion and parking-searching traffic.

  On the strategic level, cities are increasingly in competition with each other. This means that Aalborg e.g. has to offer local environment in the city, which is as good as can be found in other cities of the comparable size.

On the other hand, as described under 'barriers' it can be a challenge for a city like Aalborg to put up very strict reductions in the assess ability of cars in the city centre. A strong resistance can be expected from the City Centre's commercial association and the parts of the general public, which historically have been reserved towards significant reduced access for private owned cars to the city centre.

- **Technological:** ***The need for a renewed system.*** The existing Parking Information System was increasingly obsolete. Consequently a work on strategic level was initiated to ensure sufficient acceptance of the need of a revised Parking Information System.

  At the same time the redevelopment of the new harbour front including the construction the new Music Hall accentuated the need for a new Parking guiding system.

- **Organizational, Involvement / communication:** ***Cooperation with private car park owners.*** As described in section D3.2 the fruitful cooperation with private car park owners contributed to the success of the Parking information system. The success was contingent on a non-compulsory cooperation, where the private car park owners agreed to deliver real-time parking data to the system in return for being a part of the information system.

D.2.3. Activities

Preparation phase

- **Planning:** ***Focus on designing a logical and coherent zoning structure*****.** Focus was allocated to compiling a clear strategy for parking and parking information. The city was divided into zones and it was decided where to show information on which zones, to avoid cars being guided to cross the city centre. At the same time the commercial and political interests in the zonings had to be handled.

Preparation and implementation phase

- **Organizational:** ***Focus on cooperation with private car park owners*****.** A reliable information system shall include all relevant car parks. If only a subset is included – E.g. only public owned car parks – the drivers will not act according to the information provided, but will start circulating in the city centre searching for a possible free space in one of the private car parks. The inclusion of all car parks, regardless ownership etc. is therefore critical. Focus was thus allocated to securing a good cooperation with owners of private car parks.

Implementation phase

- **Planning:** ***Focus on good adherence to time schedule.*** The employees in the municipality worked close together with the supplier and the consultants involved, ensuring the fastest possible progress towards the implementation of the Parking Information System. During the implementation of the Parking Information System, the employees from the municipality followed the contractor's work thorough to detect any unforeseen delays and to handle them in the best available way. Problems, which appeared, were addressed as soon as possible, and solutions were found.

- **Planning:** ***Postponement of implementation to avoid not having a parking information system during Christmas Shopping.*** When the suppliers time schedule became delayed, the physical implementation process was postponed (including the demolishing of the old system) to avoid congestion in the city centre from not having a parking information system during Christmas shopping.

D3 Participation

D.3.1 Measure partners

Below are a brief description of all project partners and their level of involvement in the measure:

The City of Aalborg being the leading partner in the project has been responsible for the planning and implementation of the project. This includes responsibility for design of the system, cooperation with stakeholders, tender, project management and financing the major part of the system (The part not financed by the CIVITAS project).

Aalborg University: Principle participant. An assistant professor from Aalborg University has been responsible for the data collection, analyse and evaluation of this measure.

D.3.2 Stakeholders

- **Private car park owners :** One of the important premises for a well functioning Parking Information System is that it includes all relevant car parks. If only a subset is included – E.g. only public owned car parks – the drivers will not act according to the information provided, but will start circulating in the city centre searching for a possible free space in one of the private car parks. The inclusion of all car parks, regardless ownership etc. was therefore critical. A full cowering system would give more reliable information than a system, which only included a minor part of the parking places in the city centre.

  In Aalborg there is an old tradition for Public-Private partnership, or cooperation. In the old Parking Information System from 1995, information for four of the nine included car parks was for privately owned car parks. But in the meantime more private car parks had been established, and it had not been possible to include them the information system, for various technical reasons as the physical design and placement of the signs and the design of the system itself. Such integration has been demanded from both road users and from the companies behind the car parks as also described in B4.

  Thus it was an important task to include all relevant private car parks in the new system. On the one hand this required that the technological solution was designed to handle these private car parks in terms of open interfaces to the different systems in the car parks delivering dynamical data on the parking occupancy rate, and the integration of these car parks into the different signs in the city. On the other hand it required an ongoing communication and cooperation process with the owners of these car parks to agree:

  1. that it was advantageous to include information on the private car parks in the public system,
  2. the technical solution for exchanging data between the private data collection system and the public information system (and how a private data collection system should be established, if it did not exist previously)
  3. the possible financial issue between the parties for the private business being exposed on the public information system.

  This communication mostly took place as a continuation of the existing channels between the city and the private companies.

  At project start-up a meeting was held with all relevant interested parties among the companies running the private car parks, to present the plans, to create understanding for the importance of integrating the private car parks in the common information system, and to initiate the debate on technical and economical solutions.

Later, bilateral meetings were held between the Project Managers from the City and from the supplier, and each car park.

In a good dialogue decisions were made on financial and technical matters.

It was agreed, that each car park had the technical and financial responsibility for sensors and systems inside its own car park, and for delivering the data into an agreed interface. Besides the initial costs for setting up this part of the system – and possible maintenance costs it – the participation in the information system is free of charge.

Most companies were very positive to this model. At the time of finalizing the implementation, the status is that the owner of one small car park has chosen not to participate based on a balancing of implementation cost compared to expected benefit given that it is situated in the periphery of the city centre, and a second car park is not yet delivering dynamic data due to lack of focus from the company behind the car park – the downside of a non-compulsory cooperation.

D4 Recommendations

D.4.1 Recommendations: measure replication

- **A replication of the project in other cities is recommended.** Overall there has been a positive effect from implementing the new and up-scaled Parking Information System in Aalborg. A new and coherent Parking Information System seems to have positive effect on the parking-searching traffic flow in midsize cities. ***A replication of the project is recommended for cities of same size or larger, without a Parking information system***.
- **A clear strategy for parking and parking information is required.** One of the important premises for a well functioning Parking Information System is that it is based on a clear strategy for parking and parking information. The city has to be divided into zones and targeted information have to be shown on each sign, to avoid cars being guided to cross the city centre – where the majority of pedestrians are – on their route to a free Parking lot.
- **The system shall include all relevant car parks.** Another important premise is that the system shall include all relevant car parks. If only a subset is included – E.g. only public owned car parks – the drivers will not act according to the information provided, but will start circulating in the city centre searching for a possible free space in one of the private car parks. The inclusion of all car parks, regardless of ownership etc. is therefore critical.
- **The technological solution has to be designed to handle dynamical data from the different systems**. If the system shall be able to include data from all relevant car parks, it is required that the technological solution is being designed to handle dynamical data input from a range of different data systems in the private car parks, in terms of open interfaces.
- **The system has to be technically reliable, trustworthy and transparent**. The system is only working, and the search traffic minimized if the users rely on the guidance from the Parking Information System. The system has to be technically reliable and the model behind the calculation and communication of number of free parking lots has to be trustworthy and transparent.
- **Lack of maintenance will result in unreliable feedback to the users.** Sufficient resources must be allocated after the full implementation of the Parking Information System to keep a high maintenance level. This is crucial as problems with maintenance in most cases will result

in less reliable feedback to the users, and subsequently less trust in, and use of the Parking Information System.

D.4.2 Recommendations: process

- **The system shall include all relevant car parks – include private car park owners.** An important premise is that the system shall include all relevant car parks. If only a subset is included – E.g. only public owned car parks – the drivers will not act according to the information provided, but will start circulating in the city centre searching for a possible free space in one of the private car parks. This requires that focus is allocated to an ongoing communication and cooperation process with the owners of these car parks.