

0 Executive Summary

As part of a national plan developed in last years, the Public Transport Authority of North Denmark (Nordjyllands Trafikselskab NT) in collaboration with the City of Aalborg implemented the Travel Smart Card TCS in Aalborg including design and implementation of two new untested facilities:

- A fully integrated contactless Smart Card IT-system linked with the Bus PC infrastructure.
- A Travel Card Light solution to expand the use of electronic ticketing to public transport taxis.

New ticketing units have been installed in April 2011 and a test project with 45 buses has successfully been in operation since May 2011. An information campaign and introductory offers got 500 test users within the first month, with three alternatives: a personal, a family and an anonymous travel cards with different flexibility and discounts conditions. In September 2011, the measure has been extended to the 130 buses of Aalborg network (80 financed by ARCHIMEDES), integrating a necessary education campaign to drivers. In October 2011, a new marketing campaign has been implemented specially for young people and students.

NT will continue the work in 2012 with the Travel Card Light solution integrating public taxis and school buses and prepare an after evaluation when Travel Card users reach a satisfactory number. It was decided to postpone this task until ultimo 2012 / primo 2013, to ensure an optimal and smooth implementation, and roll out of the system by end 2012 when TCS will be in operation in 325 buses in the whole NT area. The current contract is bound to 2020, with a possible 5 years extension.

Evaluation 1) In testing time, a qualitative work with drivers and customers revealing the acceptance degree has been organised through 2 focus groups in November 2011 and April 2012. Online questionnaires about acceptance and incidences have been answered by 396 users in December 2011.

2) Data collection about use and incidences has been implemented in three periods: May16 -June 19 2011 (test time), August, 22-October, 30 2011 (Aalborg rollout) and November 2011 – October 2012.

3) Continuous data monitoring the service has been collected since the implementation. An after ARCHIMEDES quantitative evaluation campaign is linked to the regional rollout of the measure.

Key results:

Results are very satisfactory: In the first testing week in 45 buses in May 2011, 49 active journeys were registered with a total of 120 trips with the smart card. Five weeks later, there were 255 active journeys and 650 smart card trips. The first 500 test customers received a special offer to purchase the travel smart card, which was a big success.

The Travel Card system as a sales device for regular tickets obtained during the first 3 months a monthly sale of more than 500.000 DKK, approx. 1.000 daily tickets. In September 2011, the active Travel Card test users reached almost 375 passengers. In the end of October 2011 with 90 buses in the system, there were 638 active journeys and 820 smart card trips. From October 2011 to March 2012, the number of active Travel Card users increased from 500 to 3200 and the number of journeys within a week, increased from 2.000 to 16.000. In the same period there was a weekly sale of approx 35.000 cash tickets. In October 2012, there were yet 4400 active journeys, with 20.000 trips, compared to 36.000 cash tickets sold in the same period.

In an online survey in 2001 76,6% of the users stated that they were satisfied with the Travel Card; and 31.8% found that it would influence in a more often use of buses and public transport. The negative factor in this testing time was that 28,8 % of the passengers had experienced technical problems more than once. This figure has been decreasing ever since. 86,3% of the passengers were satisfied with the fare system: “the more you travel, the cheaper each trip gets”.

The system should encourage passengers to increase their use of public transport.

A Introduction

A1.1 Objectives

The measure objectives are:

(A) High level / longer term:

- To further develop an optimal and user-friendly environment for PT users and thereby counteract decreasing passenger number.

(B) Strategic level:

- To make use of public transport easier.
- To contribute to the image of public transport as a modern and convenient way to travel.

(C) Measure level:

- (1) To improve the working environment of the drivers. Handling of less cash will reduce the driver's risk of assaults and an integrated system will secure that the driver only has to respond to one system.
- (2) To increase the coverage and contribute of the travel card system by developing a "travel smart card" light version that can be used in public transport taxis or school buses, improving intermodality within PT system.
- (3) To facilitate the use of the whole PT system for PT current and future users.

A1.2 Target groups

The target group of this measure is:

- Present users of public transport: The smart card will make the payment of public transport easier.
- Potential users of public transport: The smart card will constitute a modern and easy way of paying for the use of public transport that will make trip chaining in public transport easier. Potentially the smart card can reduce the barrier constituted by different ticketing and pricing system.
- The bus drivers: The travel smart card will reduce the amount of cash the drivers have to handle and thus the risk of assaults.

The target area of this measure is:

- Regional

A2 Description

In this measure a smart travel card system - an innovative national project with a core system at the edge of the technological front line - was implemented in Aalborg. The core system and two new ground-breaking facilities were part of the demonstration in Aalborg.

The Public Transport Authority of North Denmark (Nordjyllands Trafikselskab (NT)) implemented the travel smart card in Aalborg including design and implementation of two new untested facilities as part of the ARCHIMEDES project:

- A fully integrated IT-system with the Bus PC infrastructure. ARCHIMEDES contributed to the design of this integrated system.
- A Travel Card Light solution to expand the use of electronic ticketing to public transport taxis. ARCHIMEDES contributed to the design of this light version system.

The project has been delayed due to contractual disagreements between the nationwide Travel Card organization and the supplier, out of ARCHIMEDES project influence.

Since December 2010, the project was back on track and a test project with 45 buses has successfully been in operation since May 2011. The ARCHIMEDES project contributed to the purchase of the ticketing units. Since the beginning in October 2011, all buses within the ARCHIMEDES CIVITAS Plus corridor were using the Travel Card System. It was decided to postpone one of the ARCHIMEDES elements (Travel Card Light solution) until ultimo 2012 / primo 2013, to ensure an optimal and smooth implementation and roll out of the system.

A3 Person in charge for evaluation of this measure

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Task	Measure leader
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B Measure implementation

B1 Innovative aspects

The innovative aspects of the measure are:

- **Use of new technology/ITS:** Development of a smart card system for payment of public transport – nationally.
- **New organisational arrangements or relationships:** Cooperation among all suppliers of public transport in Denmark – nationally. The system requires cooperation on standardisation of pricing and fare reference points.

B2 Planning of Research and Technology Development Tasks

Not relevant.

B3 Situation before CIVITAS

In previous years, efforts have been made to establish a national electronic ticketing system for public transport in Denmark. ARCHIMEDES project implemented this new system on buses operating in the CIVITAS Plus corridor between the city centre and the university at the south-eastern outskirts of the built-up area in Aalborg. The system replaces existing mechanical ticketing systems and builds on the bus computers that were implemented as part of the CIVITAS I VIVALDI project and therefore add value to previous European and local investments.

B4 Actual implementation of the measure

The measure was implemented in the following stages:

Stage 1: Design of the light-solution and planning of the implementation (*September 2008 – March 2011*)

The Public Transport Authority of North Denmark (NT) and ARCHIMEDES designed two new facilities as part of the ARCHIMEDES project: A fully integrated IT-system with the BusPC infrastructure and a Travel Card Light solution to expand the use of electronic ticketing to public transport taxis.

NT worked on promoting a national cooperation in relation to the light solution and prepared the implementation (preparation of data, requirement to the equipment in the buses etc.).

Stage 2: National coordination (*September 2008 – April 2011*)

The project has been delayed due to contractual disagreements between the nationwide Travel Card organization and the supplier. These were issues that the ARCHIMEDES project could not influence.

The measure has been coordinated with the organisation behind the development of the Danish Travel Card System.

Stage 3: Preparation and testing (*September 2008 - April 2011*)

Implementing a travel card system is a large and complex project. Together with the rest of the organisation at NT (planning department, sales, marketing and other groups) the working group has been involved in many activities concerning testing, preparing topology and fare data, preparing education and the introduction towards the customers.

Integration between the Bus Travel Card Unit and the Bus computer (delivering real time information and content to the onboard Infotainment system, measure AAL 69) have been finalized, accepted by NT at a factory test in France to be ready for use in the ARCHIMEDES demonstration. Work has been done on implementing and testing.

Installation of equipment in buses started in April 2011 - starting with the buses in the ARCHIMEDES corridor. Parallel to this work, wireless access points have been prepared for delivering and receiving data to and from the buses.

Stage 4: Test operation of the smart card system (October 2010 – September 2011)

It was intended to start the test operation in October 2010 - technically with the equipment in the buses and also towards the customers (bus passengers). The ARCHIMEDES project contributed to the purchase of the ticketing units. Everything was ready, but due to contractual disagreements between the nationwide Travel Card organization and the supplier the roll out of the system had to be temporarily stopped. In December 2010 the parties agreed to the contract and the planning of the system functionality and roll out could continue.

In the first week of May, a joint test (Danish Railways, NT, Travel Card East West) was conducted to ensure the technical reliability prior to starting the test operation. During the joint test, 26 test customers travelled more than 100 journeys with the travel smart card. The joint test included 7 local stations in order to allow transfers between the bus and train. The joint test was successful and the drivers were very positive towards the system. Technically there were only minor issues and fare- and topology data handling worked as intended.

The test operation started May 16, 2011. This day was marked with an information campaign and one of Aalborg's buses wearing a white polka-dotted coat (see figure 1). In the introductory phase, the busiest bus lines and train journeys were chosen to test the technology and collect customer experiences. The test project included 45 buses operating on bus line 2 (one of two main bus line's in the city of Aalborg) in the ARCHIMEDES corridor in order to be ready for full operation.



Figure 1: Marketing campaign on May 16, 2011

The first 500 test customers received a special offer to purchase the travel smart card (see figure 2). The offer was a big success and the 500 test customers were found within a month, which exceeded expectations.



- 200 kr. rejsepenge*
- 30 kr. introduktionsraba*
- Gavekort efter 25 rejser*
- Fremtidens billet - lige nu

Vær med til at prøvekøre Rejsekort i Nordjylland. Bestil fremtidens billet i dag i DSB Rejsebutik eller på 70 11 33 33. Læs mere på rejsekort.dk/nt



Figure 2: Introductory offer for the first 500 test customers

A complete connection with data from the central system and into the first bus was established in the beginning of September 2011. This meant that the system was ready to handle check in and check out and to sell tickets from the Travel Card System in the buses.

The Travel Card system is not only a chip-card for check-in/check-out but also a sales device for regular tickets. During the first 3 months there was a monthly sale of more than 500.000 DKK, which equals to almost 1.000 daily tickets. In September 2011, the numbers of test users was almost 375 passengers.

Integration between the Bus Travel Card Unit and the Bus Computer (delivering real-time information to the onboard Information system, measure AAL 69) was also a successful part of the test project. The bus driver logged into to the Travel Card system and all necessary information was delivered automatically to the bus computer, so the driver did not have to operate the bus computer. Prior to the start in June 2011, many different tests were made to ensure the integration and especially to handle situations if one of the two systems had an error. It was the intention to include the Travel Card Light solution as a part of the test project, but since the functionality of the solution was not satisfactory, NT decided to postpone it. A better version will be available ultimo 2012/primo 2013.

Stage 5: Rollout of the smart card system in Aalborg (September 2011 – April 2012)

In September 2011, the installation, data and learning of 400 drivers were ready for the launch of the Travel Card in Aalborg. The smart card system was rolled out in the whole city of Aalborg in October 2011. This covers 135 buses including the 80 buses in the ARCHIMEDES corridor.

NT started up a new marketing campaign in October 2011 with young people and students as the target group.

On the website www.rejsekort.dk where the Travel Smart Card might be purchased,, the rollout for Aalborg was also announced (see figure 3).

The screenshot shows the homepage of the Danish Travel Card website. At the top, there is a navigation bar with links for 'Kontakt', 'Om Rejsekort A/S', 'Presse', and a search bar. Below this are three main menu items: 'Rejsekort og priser', 'Brug rejsekort', and 'Kundeservice'. The main content area is divided into several sections: 1. A map of Aalborg with a callout bubble stating 'Rejsekort er kommet til Nordjylland!' and text explaining that travel cards can be used on all city and metro buses in Aalborg, on DSB trains on the Hobro-Frederikshavn line, and on the Hirtshals-Skagensbanen. A 'Bestil kort' button is present. 2. A map titled 'Se hvor du kan bruge rejsekort' showing the Aalborg region. 3. A 'Bestil rejsekort' section with a '50 kr' badge and a 'Bestil' button. 4. A 'Beregn din pris' section with a 'Beregn din pris' button. 5. A 'Selvbetjening' section with icons for 'Tank-op', 'Spær kort', 'Overblik', and 'Mine rejser', and a 'Log ind' button. 6. A 'Nye vaner' section with a 'Check ud' button. 7. A 'Rejsekort i tal' section showing '58.993 Udstedte rejsekort' and '1.209.115 Antal rejser i alt' with a 'Pr. uge 42' note. 8. A 'Spørgsmål til kundeservice' section with a customer service representative image.

Figure 3: Screen dump of rejsekort.dk

From October 2011 to September 2012, the number of active Travel Card users increased from 500 to 3200 and the number of journeys increased from 2000 to 16000. In the same period there was a weekly sale of approximately 35.000 cash tickets.

These results were obtained once finished the kick off campaign with a special offer, where passengers got the travel smart card, almost for free. In this stage the passengers had to pay 50 DKK for the travel smart card.

In December 2011, an electronic survey was made on the web. NT and ARCHIMEDES asked the passengers about their experiences with the new Travel Cards and if the introduction of a Smart Card system, could increase their use of public transport.

Stage 6: Regional and national rollout of the smart card system (May 2012- January 2013)

The further regional and national rollout is not related to the ARCHIMEDES measure as such, but shall be mentioned here to provide a broader time perspective. The Travel Card was extended to the whole region in two steps, in May 2012 (42 buses) and again in October 2012 (148 buses). The nationwide rollout was also carried out in summer and fall 2012. By September 2012 the nationwide rollout was completed on train stations.

A small marketing campaign was performed in May 2012. NT has implemented another marketing campaign in October/November 2012, when the regional roll out is completed. The overall objective is to get more passengers to use the card instead of buying a ticket. In 2013 and 2014 the existing fare products will be removed so that that passengers can only choose between cash tickets and the Travel Card.

Stage 7: Implementation of the Travel Card Light solution (Dec 2012 – Feb 2013)

Besides implementing the Travel Card, the ARCHIMEDES project is focusing on integrating the IT-systems in the buses and working for the development of a Travel Card Light solution that should be used in public transport, taxis or school buses that will not be equipped with the normal travel card.

It was decided to postpone the Travel Card Light solution until 2012 to ensure an optimal and smooth implementation and roll out of the system.

The final Travel Card Light specification was completed in January 2012, for the new hardware, Motorola MC75A. The external blue tooth reader, developed specifically for the purpose of Travel Card Light solution and ticketing inspectors, is now available in a prototype.

NT will continue the work with the Travel Card Light solution and prepare the evaluation after-studies also after the finalisation of the ARCHIMEDES project when the numbers of Travel Card passengers have reached a satisfactory level.



Figure 4: The Travel Card Light Solution

On the picture above, the Travel Card Light Solution is shown. The Motorola MC75 A, placed in the printerunit, a Zebra RW4-PS, and the Card reader, from Höft & Wessel, at the right.

Measure title: **Travel Smart Card in Aalborg**

City: **Aalborg**

Project: **ARCHIMEDES**

Measure number: **8**

B5 Inter-relationships with other measures

The measure is related to other measures as follows:

Measure AAL 1 – Biofuels in Aalborg: In this measure there is a promotion campaign included (developed in task 2.1) which the travel smart card measure gives input to.

Measure AAL 69 - On-trip Bus Traveller Information in Aalborg: The integration between the Bus Travel Card Unit and the Bus computer deliver real time information and content to the onboard Infotainment system of measure AAL 69.

C Planning of Impact evaluation

C1 Measurement methodology

C1.1 Impacts and indicators

C1.1.0 Scope of the impact

The high level/longer term objective of this measure is to counteract the decreasing number of PT passengers by developing an optimal and user-friendly environment.

On the strategic level, the objectives are to make public transport easier and more modern and convenient way to travel. Furthermore, on the measure level the objectives are to improve the working environment of the drivers and to expand the system with a light version of travel smart card to be used in public transport taxis or school buses.

These objectives are reflected in the indicators chosen for this measure. First, the acceptance indicator is intended to give input on whether the users and the bus drivers perceive the travel smart card as an improvement of the service. Second, the number of tickets and the system reliability give knowledge about the system function as intended. Third, the overall modal split (number of passengers) reflects whether the changes also can be seen in the number of passengers.

C1.1.1 Selection of indicators

NO.	EVALUATION CATEGORY	EVALUATION SUB-CATEGORY	IMPACT	INDICATOR	DESCRIPTION	DATA /UNITS
	ECONOMY					
		Benefits	Number of tickets	Number of tickets	Number of tickets issued	No, quantitative, collected.
	SOCIETY					
14		Acceptance	Acceptance	Acceptance level	Two target groups: Drivers: Focus group interview of current acceptance of the measure Users: On line surveys of users of TSC (396 answers)	Index (%), qualitative, collected, focus group interview Index (%), quantitative, collected, online survey

Measure title:

Travel Smart Card in Aalborg

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NO.	EVALUATION CATEGORY	EVALUATION SUB-CATEGORY	IMPACT	INDICATOR	DESCRIPTION	DATA /UNITS
	TRANSPORT					
		Quality of Service	System reliability	Reliability of ticketing system	Number/percentage of down time/problems.	No and %, quantitative, collected, measurement
26		Transport System	Modal split	Average modal split-passengers	Percentage of passenger-km for each mode measured for a common package of PT related measures (Appendix A on Users of PT)	%, quantitative, derived

Indicator on "Number of Tickets" will still be available, however, since the project as described in section b4 will not include a full scale implementation in Denmark within the ARCHIMEDES project period the number of tickets issued cannot be seen alone, but should be related to the overall experiences with the system.

C1.1.2 Methods for evaluation of indicators

No.	INDICATOR	TARGET VALUE	Source of data and methods	Frequency of Data Collection
	Number of tickets		Data about the number of tickets issued over the travel card system has been continuously collected since the total implementation of the measure. These data can be compared with the number of tickets issued through the old system.	M33 and onwards.
14	Acceptance level		The driver's acceptance level has been collected through focus group interviews. The focus group interview was done in April 2012. 12 drivers participated in the focus group interview; 6 drivers who have used the system from October 2011 to April 2012, and 6 drivers who should take the system into use in May 2012. This was done to ensure a good basis for comparison. The passengers' satisfaction has been collected via an online survey made in December 2011. The survey was made among the users of the system in order to obtain knowledge on their experiences with the system. In total 396 respondents participated.	2 times, M39 and M44
	Reliability of ticketing system		Data on operation statistics are collected. Rejsekort A/S collects data about the reliability of the national travel smart card system in relation to the supplier's compliance with the service level agreement (SLA).	M33 and onwards.
26	Modal Average modal split-	Increased.	Data on number of passengers are collected. The after collection includes both passengers using the smart card and passenger using other payment	M13 and one in M39.

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No.	INDICATOR	TARGET VALUE	Source of data and methods	Frequency of Data Collection
	passengers		options. The collections are made as manual counts.	

Indicators on number of passengers have been covered by an overall analysis of the modal shift in the ARCHIMEDES corridor, developed across the measures, summarised in common Appendix A, attached to this MERT.

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C1.1.3 Planning of before and after data collection

EVALUATION TASK	INDICATORS INVOLVED	COMPLETED BY (DATE)	RESPONSIBLE ORGANISATION AND PERSON
Collection of the data about number of travel smart card tickets issued and operation statistics.	Focus on experiences with the system. Reliability of ticketing system.	From M38 and onwards	NT, Flemming Bundgaard.
Focus group interview about driver's and passenger's acceptance level.	Acceptance level.	M39_Dec 2011	NT, Flemming Bundgaard.
Collection of number of passengers.	Modal Average modal split - passengers	M39 and after implementation	NT, Flemming Bundgaard.
D12.2 Baseline and first results from data collection	All indicators	Month 34	
D12.3 Draft results template available	All indicators	Month 46	
D12.4 Final version of results template available	All indicators	Month 50	

C1.2 Establishing a baseline

The main focus is on acceptance and experiences with the new Travel Card system, and thus qualitative. A quantitative approach does not make sense as such, since the full rollout of the system in the region will first take place in October 2012, and the national rollout is first expected in 2013. In addition, the measure constitutes a new measure and therefore, there is no before data for the indicators linked directly to the travel smart card.

C1.3 Method for Business as usual scenario

Business as usual includes not establishing travel smart card system. However, the ticket system in the buses had to be renewed in some way. It is therefore not directly possible to use the historical data as the business as usual scenario. Construction of a business as usual scenario is therefore perceived neither possible nor relevant.

C2 Measure results

C2.1. BENEFITS – Economy - Number of tickets

The testing operation started with a pilot project containing 45 buses on bus line 2 (one the busiest bus lines in the city of Aalborg) starting May 16, 2011. The first 500 test customers received a special offer to purchase the travel smart card. The offer was a big success and the 500 test customers were found within a month, which exceeded expectations.

NT's goal was to sell 500 travel smart cards during the test operation and to register 300 active journeys (which means minimum one journey per week). This goal was reached – app. 650 travel smart cards were sold and there were 250 active journeys.

The Travel Card system is not only a chip-card for check-in/check-out but also a sales device for regular tickets. During the first 3 months there was a monthly sale of more than 500.000 DKK, which equals to almost 1.000 daily tickets. In September 2011, the numbers of active Travel Card test users were almost 375 passengers.

Altogether 597 travel smart cards were issued in the first five weeks of the testing operation (see figure 4). NT has issued 329 travel smart cards, and DSB has issued 268. There are three different kinds of travel smart cards:

- A personal travel that provides the maximum discount, but where only the card holder can use it.
- A flex travel card flex that can be shared by family and friends.
- An anonymous travel card.

In October 2011, the smart card system was rolled out in further 90 buses. Now 135 buses were in operation with smart card system, including the 80 buses in the ARCHIMEDES corridor. From October 2011 to March 2012, the number of active Travel Card users increased from 500 to 3200 and the number of journeys, within a week, increased from 2000 to 16000. In the same period there was a weekly sale of approx 35.000 cash tickets.

The following data in section C2.1 is collected for the periods of May, 16 – June, 19 2011 (week 20 – 24) and August, 22 – October, 30 2011(week 34 – 43) and November 2011 – March 2012 (week 45 – 12).

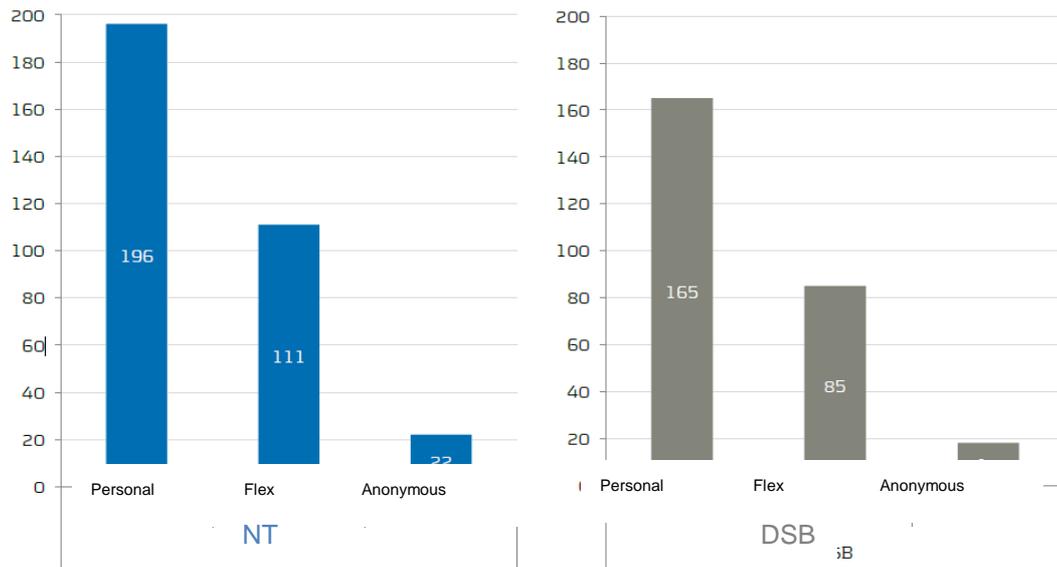


Figure 5: Number of issued Travel Smart Cards during the first 5 weeks

In the first week, 49 active journeys (cards with at least one journey within a week) were registered (see figure 6). The same week, a total of 120 trips were registered with the smart card (see figure 10). Five weeks later, there were 255 active journeys and 850 smart card trips.

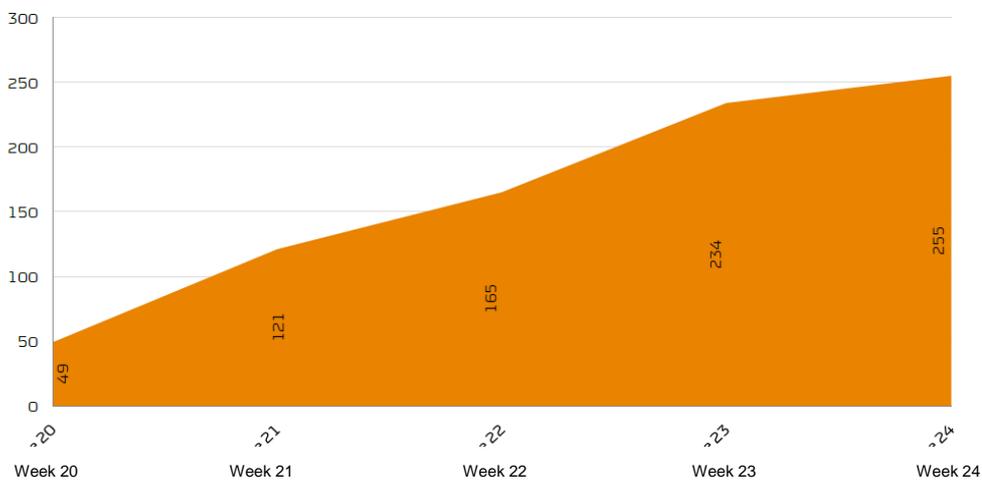


Figure 6: Active journeys week 20-24 2011 (travel smart cards with minimum one journey per week)

In the last week of August 2011 (week34), there were registered 213 active journeys (see figure 7). The same week, a total of 750 trips were registered with the smart card (see figure 11). In the end of October 2011 (week 43), there were 638 active journeys and 820 smart card trips.

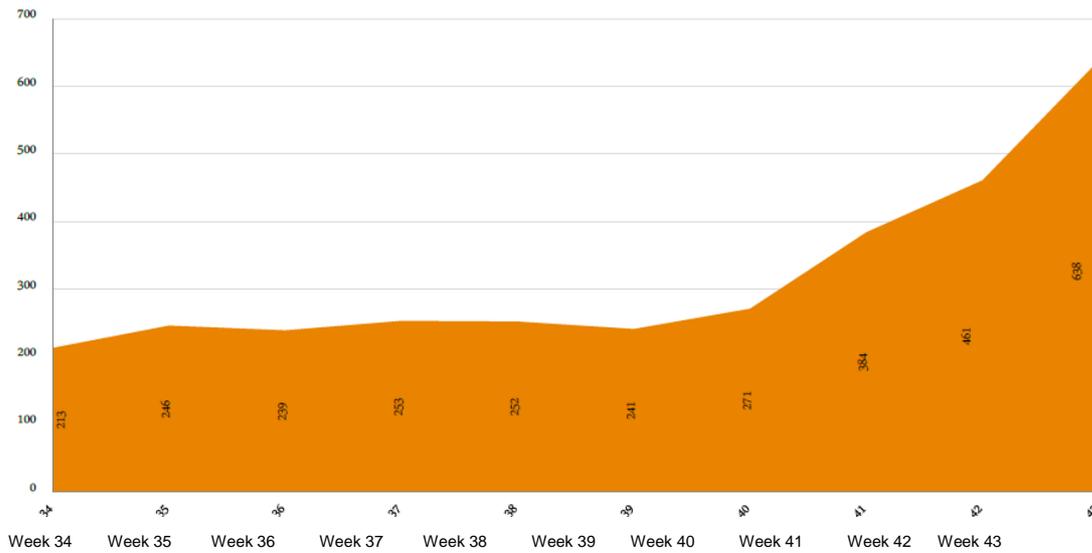


Figure 7: Active journeys week 34-43 2011 (travel smart cards with minimum one journey per week)

When launching the travel card in all Aalborg in October 2011, there were approx 900 active journeys. Week 12, 2012, the number of active journeys had increased to 3200 (see figure 8). In the same period, the total number of trip, increased from 4000 in week 12, to 16.000 in week 10 2012 (see figure 12)

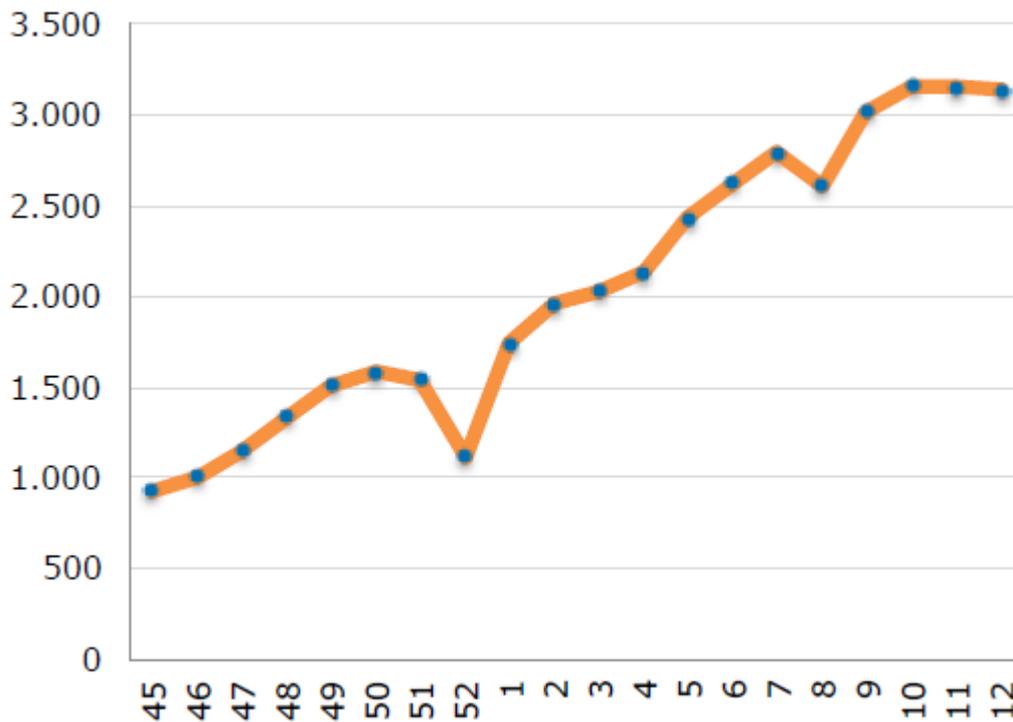


Figure 8: Active journeys week 45 (2011) – 12 (2012) (travel smart cards with minimum one journey per week)

The number of active journeys increased from 3200 in week 21, 2012 to 4400 in week 40, 2012 (figure 9). In the same period, the total number of trip, increased from 14.000, to 20.000 (see figure 13)

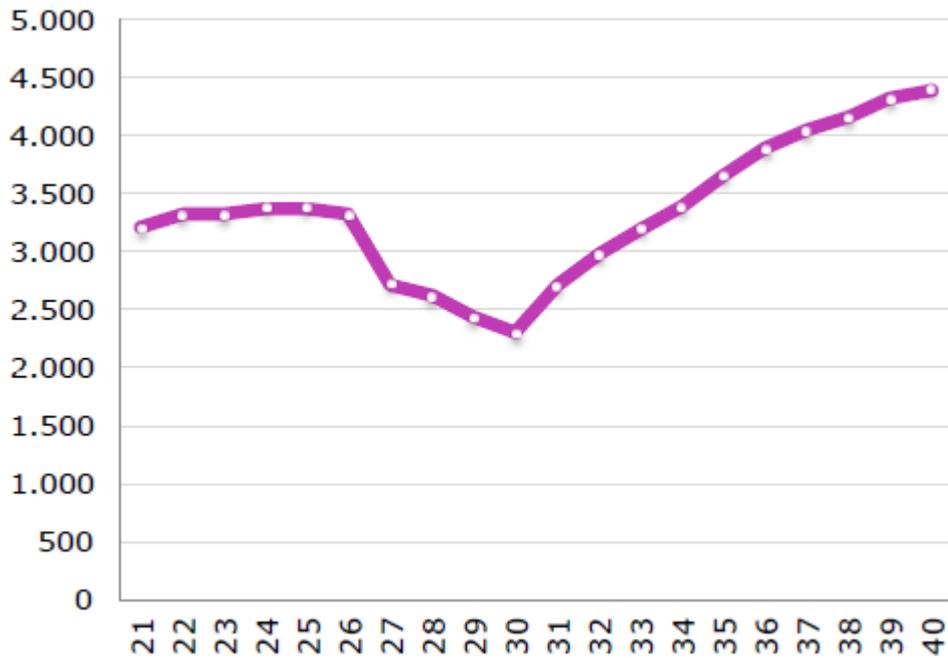


Figure 9: Active journeys week 21 (2012) – 40 (2012) (travel smart cards with minimum one journey per week)

There were 1-5% missed check-outs during the first five weeks of testing operation (see figure 10). Missed check-outs are calculated like this: Number of missed check-outs divided by total number of journeys.

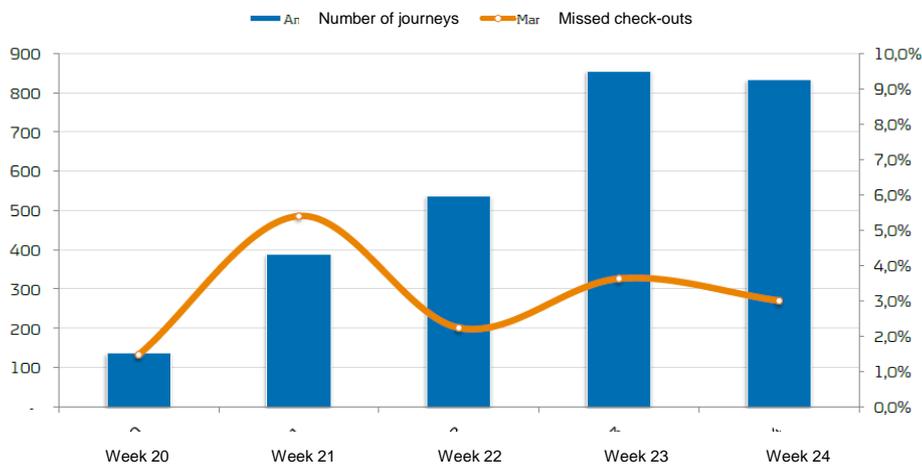


Figure 10: Number of journeys versus missed check-outs in % per week (week 20 – 24 2011)

In August – October 2011, there were 1-3% missed check-outs (see figure 11).

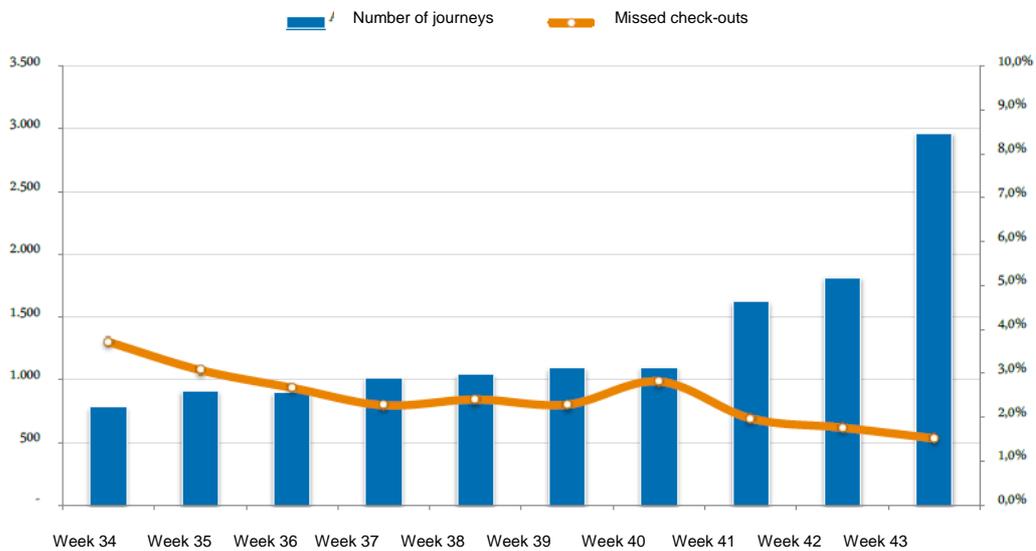


Figure 11: Number of journeys versus missed check-outs in % per week (week 34 – 43) 2011

In November 2011 – March 2012, there were 0,7-2% missed check-outs (see figure 12).

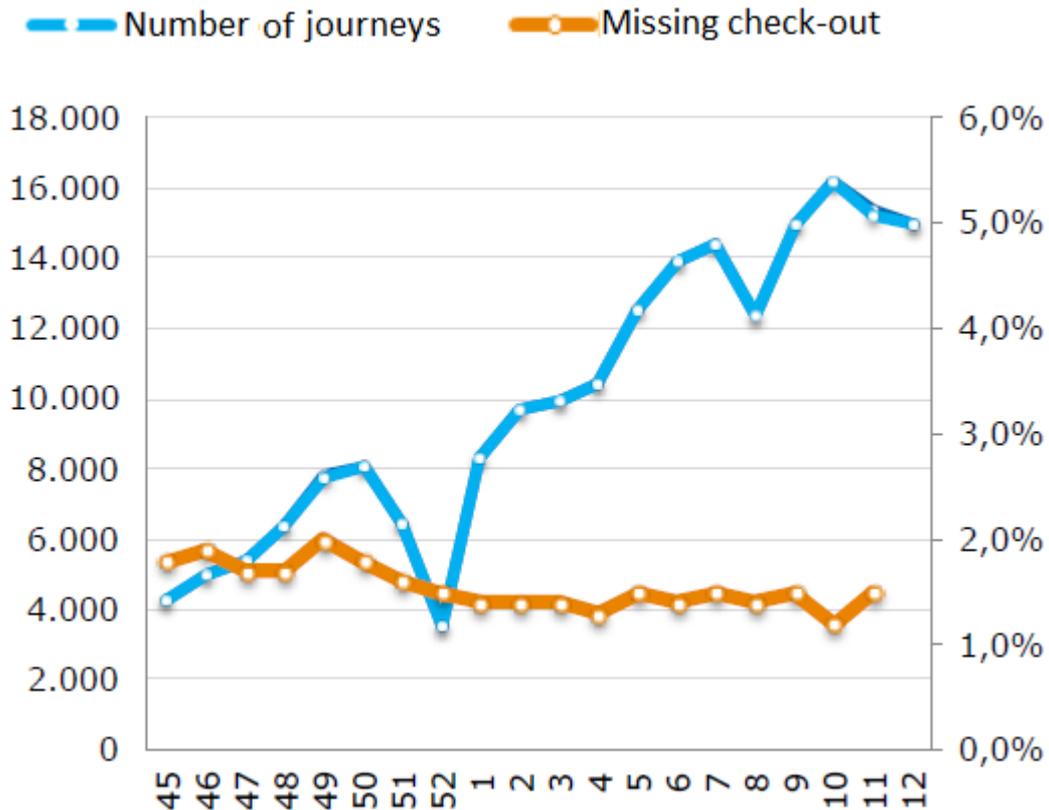


Figure 12: Number of journeys versus missed check-outs in % per week (week 45, 2011 – 12, 2012)

In May 2012 – September 2012, there were 1-1,7% missed check-outs (see figure 13).

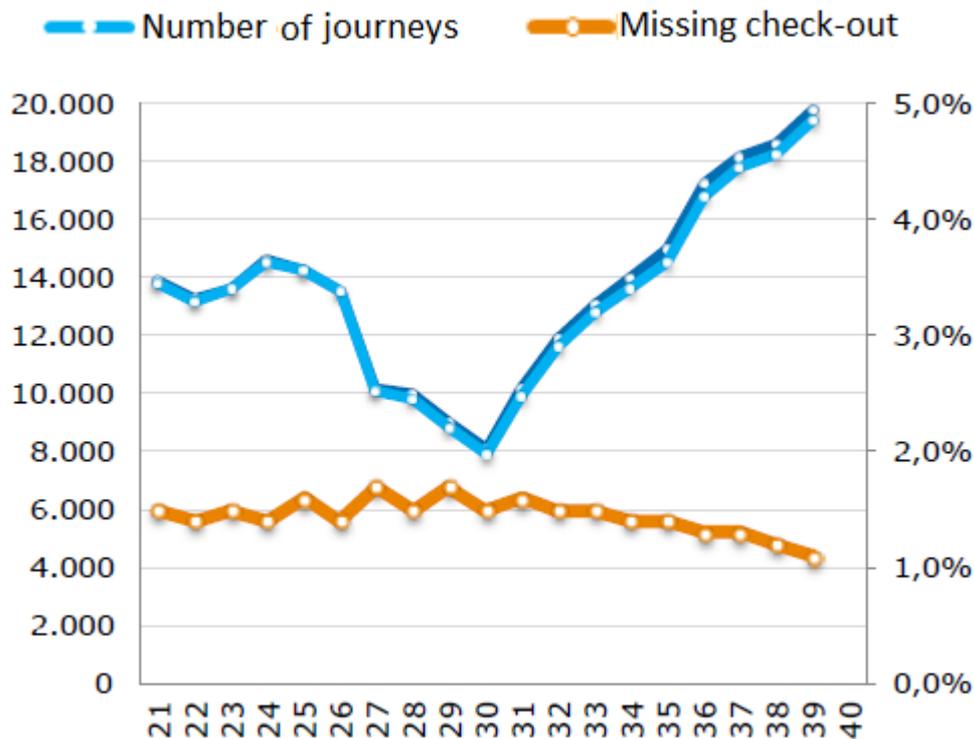


Figure 13: Number of journeys versus missed check-outs in % per week (week 21, 2012 – 40, 2012)

In connection with the introduction of travel cards to new passengers, the proportion of missing check out is higher for a while. When the passengers have used the system for a period, they will become accustomed to the new principle and the proportion of missing check-out is reduced thereafter. In the NT, we have spent a lot of resources to provide passengers detailed information about remembering to make the check out. Among other via stickers on the bus doors and through information on the bus info screens (measure AAL 69). This has not been done in a similar level in Zealand, in connection with the introduction of the travel card, which can be seen by the higher percentage of passengers who do not make the check out, in these buses.

The 4 graphs below (figure 14, 15, 16 and 17) shows the number of sold tickets in cash versus the number of bus journeys with a travel card in North Jutland per week. The graph shows the increase of journeys with the travel smart card. The expansion level of selling cash tickets is as expected. It was the same level, as with the older cash ticket equipment, that the Travel Card System replaced.

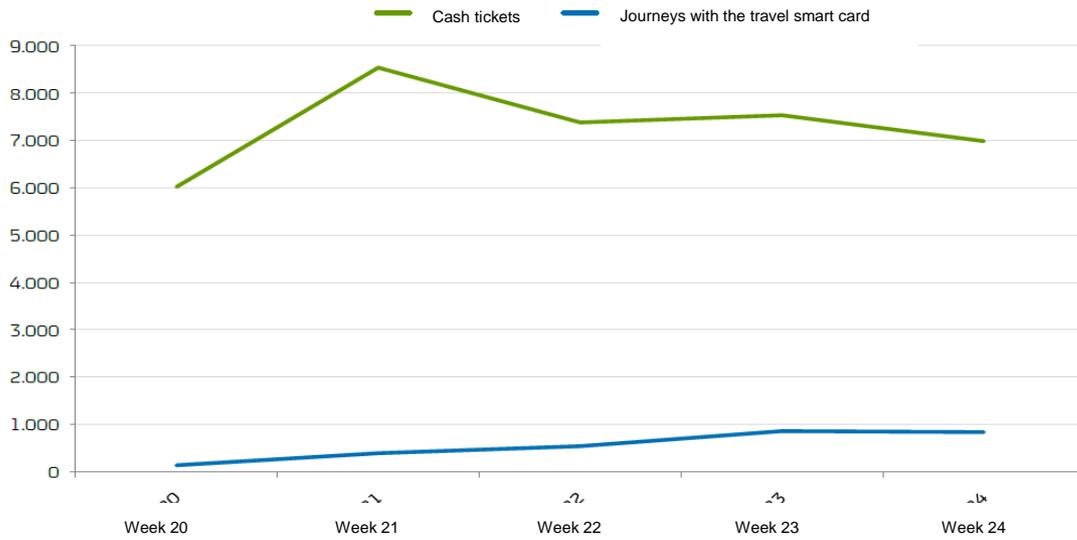


Figure 14: Number of sold cash tickets versus number of journeys with the travel smart card (week 20 – 24, 2011)

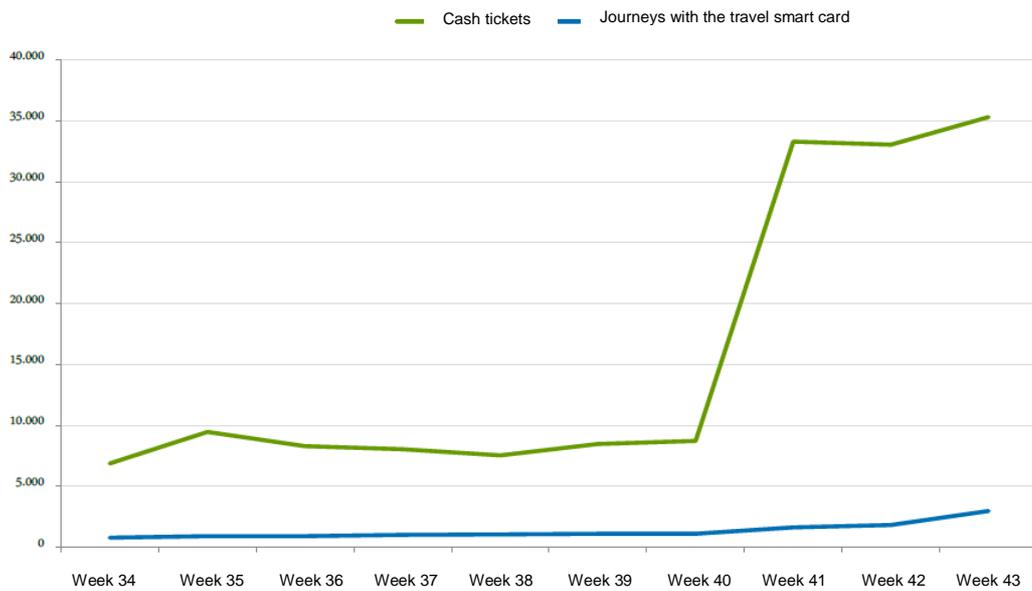


Figure 85: Number of sold cash tickets versus number of journeys with the travel smart card (week 34 – 43, 2011)

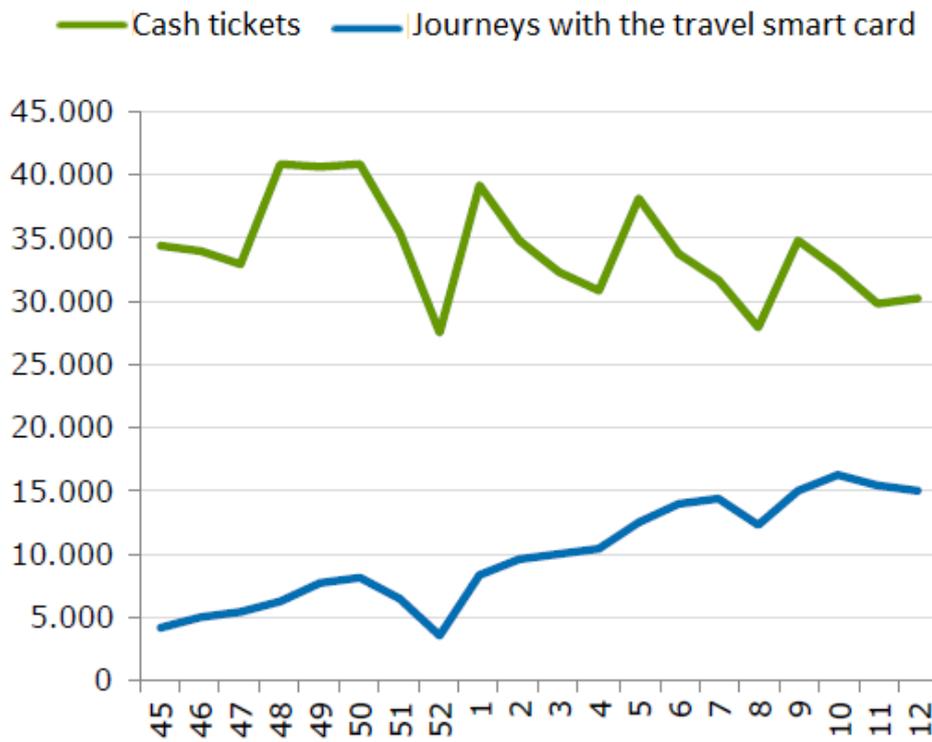


Figure 96: Number of sold cash tickets versus number of journeys with the travel smart card (week 45 2011 – 12 2012)

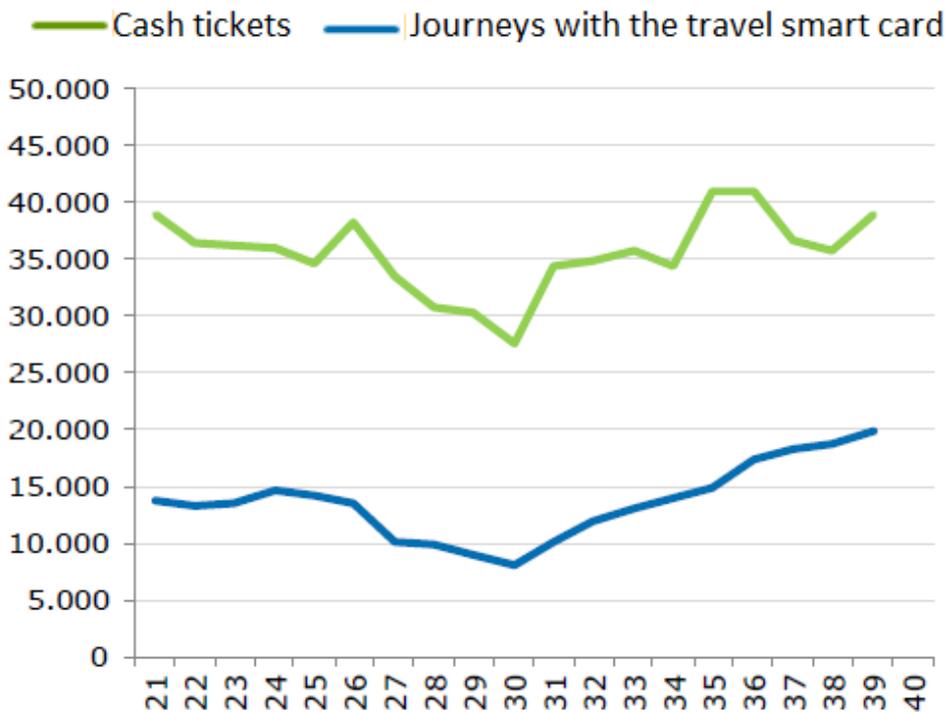


Figure 17: Number of sold cash tickets versus number of journeys with the travel smart card (week 21 – 40, 2012)
 Number of tickets during the rollout of the smart card system in Aalborg, will be followed continuously also after the finalisation of the ARCHIMEDES project.

Table C.2.1.1 Economy – Number of tickets

Indicator	Before (date)	B-a-U (date)	After (from M39 and onwards)	Difference: After – Before	Difference: After – B-a-U
Number of tickets			<p>In September 2011, the active Travel Card test users reached almost 375 passengers. In the end of October 2011 with 90 buses in the system, there were 638 active journeys and 820 smart card trips.</p> <p>From October 2011 to March 2012, the number of active Travel Card users increased from 500 to 3200 and the number of journeys within a week, increased from 2000 to 16.000. In the same period there was a weekly sale of approx 35.000 cash tickets. In October 2012, there were yet 4400 active journeys, with 20.000 trips, compared to 36.000 cash tickets sold in the same period.</p>		

C2.2. SOCIETY - Acceptance level

Customer survey

In December 2011, an electronic survey was made on the web. NT and ARCHIMEDES asked the passengers about their experiences with the new Travel Card. 396 customers responded. Figure 14 shows the age of the respondents.

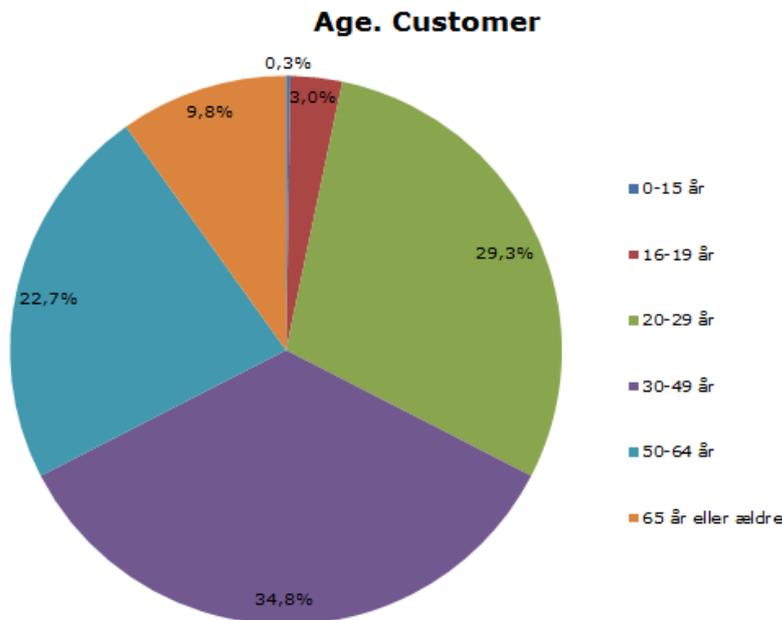


Figure 18: Age of respondents

The survey showed that 76,6 % of the passengers were either satisfied or very satisfied with their travel smart cards. Only 12,0 % of the passengers were not satisfied with their travel smart card.

The survey also showed, that 31,8 % of the passengers replied that the introduction of travel cards will get them to use public transport more often. NT and the ARCHIMEDES project were pleased with this result, because this indicate, that introducing at travel smart card, could get more passengers or get the existing passengers to travel more.

28,8 % of the passengers have experienced technical problems more than once, by using the travel card. 43,5 % of the users has never experienced technical problems. The fact that almost one third, of the passengers, have experienced technical problems more than once, indicate that something needs to be explored. Is there actually a lot of technical problem, or is it the drivers and customers using of the system, that fails?

86,3 % of the passengers were satisfied with the fare system; “the more you travel, the cheaper each trip gets”. The system should encourage the passengers to increase their use of public transport.

Overall, NT and ARCHIMEDES were quiet satisfied with the results of the survey. In a coming survey, we will go deeper in to the fact, that one third experienced technical problems more than once.

Drivers: Focus group interview

In April 2012 a focus group interview, was carried out. NT and Archimedes wanted to investigate the driver’s acceptance of the travel card system. Are they satisfied with the system? Does it live up to their expectations? Has the new system changed their daily work? How does it affect their working environment?

12 drivers participated in the focus group interview; 6 drivers who have used the system from October 2011 to April 2012, and 6 drivers who should take the system into use in May 2012. This was done to ensure a good basis for comparison.

The drivers who do not have experience with the travel card system, expects that the ticketing process will be more simple and a lot faster than with the old ticketing system. They hope that the travel card will be a success and is in advance positive about the new ideas. They also expect that they through education, will be well trained in using the new ticketing system.

These expectations are confirmed by the drivers who have experience worked with the travel card system. The drivers who have received training and have tried to work with the new system, confirms that it has become easier for them. The new system is faster than they are used to and is easier to use. They no longer need to have tickets in there bag. In addition, the system also has the advantage that they do not have to have a big cash amount in the drivers bag, as they are used to. This reduces the risk of assault.

Drivers are also happy with the system reliability and the low number of errors on the system. Technical error occurs significantly less than the drivers have been accustomed to with the old system. It can take up to three months between the experiencing of the system fails. Generally, the drivers are happy with the system and the use of it. The drivers are satisfied with the training they received, before taking the system into use. All drivers participated in a one day training in travel card system.

Some drivers would like the system to be able to sync via GPS and not only via WLAN at the bus garage. This would make the updating of the system more flexible.

Finally, some drivers point out, that the light from the travel card screen and validators in the bus, can bother the drivers’ view, when it is dark. In addition, the location of the driver’s screen is not optimally placed in all buses.

All in all, the drivers are quite satisfied with the travel card system and feel, that it is easy to use and are happy, that it reduced the amount of cash in the bus.

Table C.2.2.1 Society results

Indicator	Before (date)	B-a-U (date)	After (M39, M44)	Difference: After – Before	Difference: After – B- a-U
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<p>No.14: Acceptance</p>			<p>The survey showed that 76,6 % of the passengers were either satisfied or very satisfied with their travel smart cards. Only 12,0 % of the passengers were not satisfied with their travel smart card.</p> <p>The survey also showed that 28,8 % of the passengers had experienced technical problems more than once. 43,5 % has never experienced technical problems.</p> <p>In addition, the survey showed that 86,3 % of the passengers were satisfied with the fare system.</p> <p>The drivers are quite satisfied with the travel card system and feel, that it is easy to use and are happy, that it reduced the amount of cash in the bus. Drivers experience system failures rarely (down to only 4 pr. year)</p>		
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C2.3. TRANSPORT - Reliability of ticketing system

Joint test DSB, NT and Travel Card East West

In the first week of May 2011 Danish Railways (DSB), the Public Transport Authority of North Denmark (NT) and Travel Card East West conducted a joint test of travel card system in North Jutland. The joint test included 7 local stations in order to allow transfers between the bus and train.

26 test customers travelled more than 100 journeys with the travel smart card during 3 days. They switched continuously between the bus and train, and often forgot both checking in and out along the way. They exited and run some errands, entered at other places than they had exited, and behaved altogether like real travellers. Still in the end, when the buses returned to the garage and train stations had transferred their data from the Check-In and Check-Out pedestals, the system was able to figure out the correct price for trips in northern Jutland.

The equipment was turned on and the drivers were educated how to use the system, the same week as the test took place. The drivers were very positive towards the system.

The test showed that there were still some minor technical issues with some of the readers, but fortunately these issues could be solved. Technically these were only minor issues and fare- and topology data handling worked as intended. In the end, the joint test succeeded in being ready for the test operation on May 16 2011.

Before the roll put in October 2011, in further 90 buses, a similar test, was not conducted. The Pilot from May 2011 to October 2011 had shown, that the system and fare- and topology data was on a high level, and NT was satisfied with quality of operation experience, that was obtained. Therefore NT conducted a test in September 2011, with special focus on bus equipment, whether it was stable enough to go into operation. The test showed that the 90 buses were ready to go into operation on schedule, 10th of October 2011. Again before the roll out of 42 buses in April 2012 and the 148 buses in October 2012, NT conducted a test, with special focus on the equipment, to make sure, that the buses was ready for operation.

Reliability during the test operation (May 2011 – July 2012)

A complete connection with data from the central system and into the first bus was established in the beginning of May 2011. This meant that the system was ready to handle check in and check out and to sell tickets from the Travel Card System in the buses.

Integration between the Bus Travel Card Unit and the Bus Computer (delivering real-time information to the onboard Information system, measure AAL 69) was a successful part of the test project. The bus driver logged into to the Travel Card system and all necessary information's were delivered automatically to the bus computer,

so the driver didn't have to operate the bus computer. Prior to the start in June 2011, many different tests were made to ensure the integration and especially to handle situations if one of the two systems had an error.

The two graphs below (figure 19 and 20) shows the data on operation statistics, showing the reliability of the national travel smart card system in relation to the supplier's compliance with the SLA (service level agreement). The graph show, that the validators and the other decentral equipment meet the requirements.

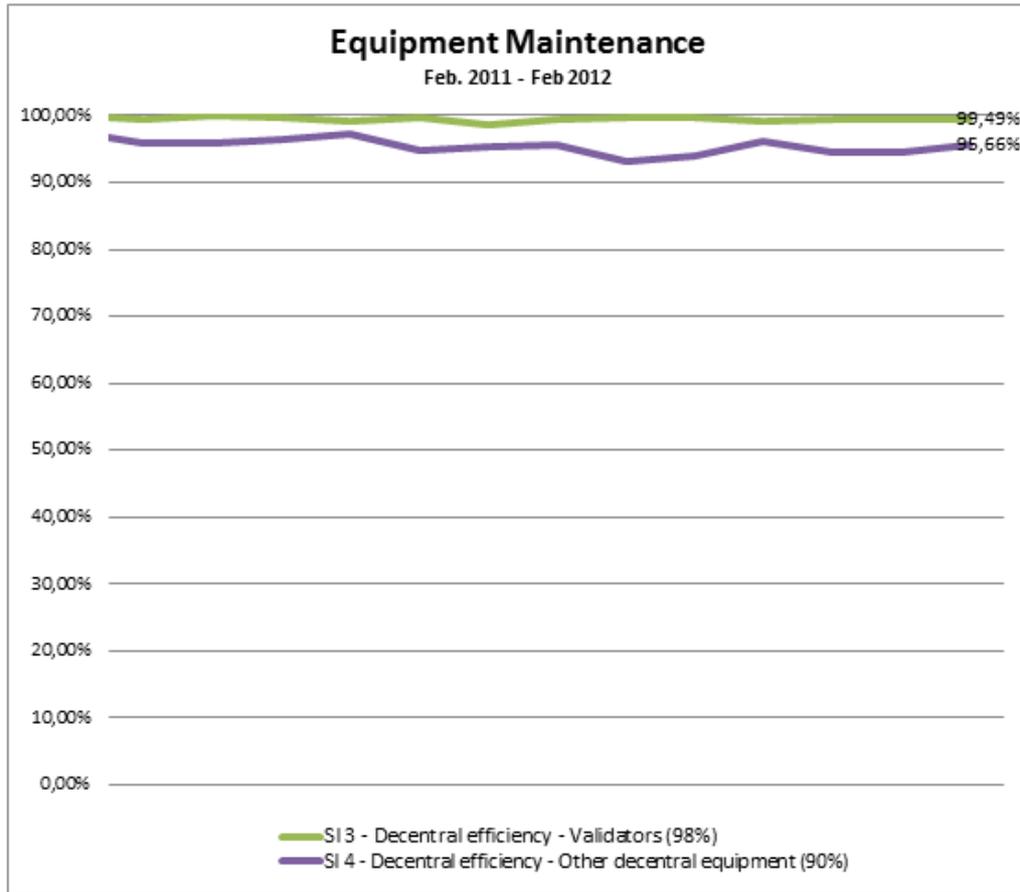


Figure 10: Equipment maintenance (Feb 2011 – Feb 2012)

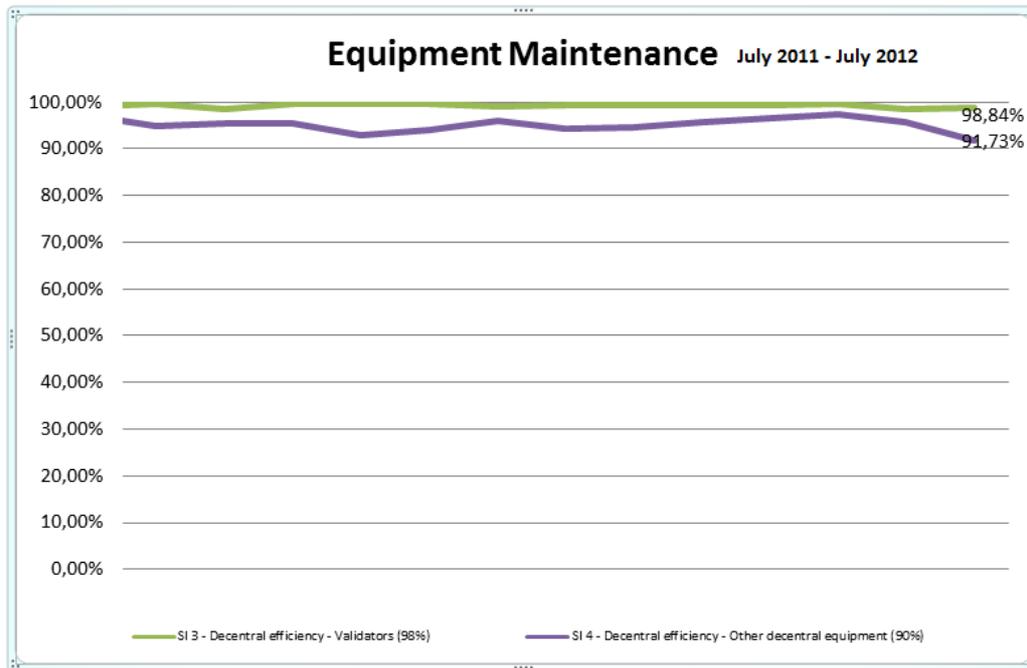


Figure 20: Equipment maintenance (July 2011 – July 2012)

Table C.2.3.1 Transport results

Indicator	Before (date)	B-a-U (date)	After (M39 and onwards)	Difference: After – Before	Difference: After – B-a-U
Reliability of ticketing system			Data on operation statistics shows that the reliability of the national travel smart card system complies with the SLA (service level agreement). The decentral efficiency is in the SLA set to 98% and 90% for the validators and other decentral equipment respectively.		

C2.4. TRANSPORT - Average modal split-passengers

Changes in modal split have been measured within the effects of the package of measures related with this is reported in appendix A.

C3 Achievement of quantifiable targets and objectives

No.	Target	Rating
1	High level / longer term: To further develop an optimal and user-friendly environment for PT users and thereby counteract decreasing passenger number	**
2	Strategic level: To make use of public transport easier.	***

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3	Strategic level: To contribute to the image of public transport as a modern and convenient way to travel.	**
4	Measure level: To improve the working environment of the drivers. Handling of less cash will reduce the driver's risk of assaults and an integrated system will secure that the driver only has to respond to one system.	***
5	Measure level: To increase the coverage and contribute of the travel card system by developing a "travel smart card" light version that can be used in public transport taxis or school buses, improving intermodality within PT system.	O / *
6	Measure level: To facilitate the use of the whole PT system for PT current and future users.	**
NA = Not Assessed O = Not Achieved * = Substantially achieved (at least 50%) ** = Achieved in full *** = Exceeded		

C4 Upscaling of results

The Travel Smart Card is not just implemented in the 80 buses operating in the CIVITAS Plus corridor between the city centre and the university. By October 2012, 325 buses in Northern Jutland have got the system installed. NT is planning to install the system in approx. 35-45 extra buses in within the first half of 2013.

The travel smart card "light version" will be implemented in approximately 100 buses in NT, within the first few months of 2013.

A further up-scaling in NT is after the implementation of the Travel Card light version, not possible, because all buses will have one of the two Travel Card solutions installed. .

C5 Appraisal of evaluation approach

Using an electronic survey on the web, as NT and ARCHIMEDES did, seems to be a good method, when measuring the passenger's acceptance of the system. A lot of passengers responded, and the feedback was overall positive. By using this method for measuring the passengers' acceptance level, some details and important information can get lost. This information might have been visible if another method had been used, e.g. a focus group interview. By using the electronic survey, the information is more in general.

The focus group interview was a good method when the drivers' acceptance of the system is to be investigated. By using this method we got the possibility to go in to details with some parts of the system. As an example, details regarding the training of the drivers, details regarding the placement of the equipment in the bus and whether or not the drivers are satisfied with the reliability of the system, have been collected. All this information was analysed and used to ensure that the coming bus driver training is at high level and to ensure that the placement of the equipment in the bus, is as optimal as possible for the drivers.

To answer the question concerning the possible increase of the number of users of public transportation and modal split changes, counting of passengers was planned.. Several initiatives are implemented in the Archimedes corridor and it can be difficult to determine what influence one initiative have compared with the others. At the same time, other factors may have influence in both positive and negative direction. For this measure the overall positive feedback from the passengers confirms that the Travel Smart Card makes the ticketing situation easier for the passengers. Changes in modal split have been measured within the effects of the package of measures related with this (measure 1, 8, 9, 68 and 69) is reported in appendix A.

C6 Summary of evaluation results

The online passenger survey, with 396 users' answers, showed that approximately 75 % of the passengers were either satisfied or very satisfied with their travel smart cards. Only 12,0 % of the passengers were not satisfied with their travel smart card.

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The survey also showed, that 31,8 % of the passengers replied that the introduction of travel cards will get them to use public transport more often.

The focus group interview showed that the drivers are satisfied with the new ticketing system. It is easier to use, the reliability is better than they expected and the amount of cash in the bus is reduced.

Indicators on number of passengers will be covered by an overall analysis of the modal shift in the ARCHIMEDES corridor, developed across the measures. This is included in appendix A.

C7 Future activities relating to the measure

As described under C4, NT is planning to install the Travel Smart Card system in additional 35-45 buses.

The Travel Card Light solution has to be implemented as planned in about 100 buses from December 2012 to February 2013. From October 2012 and 4-5 months ahead, the national campaign will be conducted. This should lead to a significant proportion of passengers that will begin using the Travel Smart Card.

As part of the negotiations in the autumn of 2010, when the national travel card project was delayed, Rejsekort A/S and the supplier East-West agreed, that a number of functionalities will be delivered in coming version updates. One of the functionalities, the season pass, will be delivered from the beginning of 2014. A large proportion of passengers will therefore stay on the old season pass until 2014 and therefore shift to the Travel Card season pass in 2014.

D Process Evaluation Findings

D.0 Focused measure

X	0	No focussed measure
	1	Most important reason
	2	Second most important reason
	3	Third most important reason

D1 Deviations from the original plan

The national Travel Card Project was delayed due to contractual disagreements between the nationwide Travel Card organization and the supplier. These were issues that the ARCHIMEDES project could not influence. So, the Pilot has been delayed in Aalborg in approximately seven months. Since December 2010 the project was back on track and a pilot project has successfully been in operating since May 2011.

It was decided to postpone the Travel Card Light solution until 2012 to ensure an optimal and smooth implementation and roll out of the system. The final Travel Card Light specification was completed in January 2012, for the new hardware. The new Travel Card Light Solution will instead be implemented from December 2012 to February 2013.

D2 Barriers and drivers

D2.1 Barriers

Preparation phase

Barrier – (Technological/Planning) When integrating two IT systems, it is a necessity that a thorough specification with clear indications of responsibility is made. With the integration between NTs BusPC and Travel Card Unit, it was therefore important that the specification was as precise as possible. The success or failure of the integration depends on the reliability of both the two system separately and the reliability of the integration.

Implementation phase

Barrier 2 – (Organisational) The Travel Card system is quite complex. And the organisational setup is likewise quite complex, with a lot of parties involved. When introducing a third party supplier in an already complex system structure, problems can occur. When two different suppliers work together, and a problem occurs along the way, there is a risk, that it will be the customer's responsibility (in this case NT) to debug and find the way through a given fault. Therefore, it is of great importance constantly to be involved in the process.

Operation phase

Barrier 3 – (Involvement) The driver is of great importance, when implementing new IT systems “out in the field”. It is difficult for the Traffic Company to be on top of the situation, because it is not possible to monitor the operation from an office. Therefore it is a good idea if some drivers can be a sort of ambassadors. These ambassadors can of great help when operation starts and when the system is updated. Driver support and desire for the system to work is essential for the system to work optimally.

Barrier 4 – (Technological) When introducing a new IT system, there will be a number of drivers who feel uncomfortable with the new technology. Especially among the older drivers we experience skepticism towards the system. This is attempted addressed through a training in the use of the system. But the drivers, who are not comfortable with the use of the new technology, will not be visible before start of operation. Therefore, it is at this stage important to distinguish between system failures and errors caused by the driver when the system error is reported.

D2.2 Drivers

Preparation phase

Driver 1 – (Involvement/Organisational) It is important to involve the drivers as early as possible and give them the information they need. They are key persons. At the same time, it is also important, that the drivers - and all the other partners, stakeholders, suppliers, e.g., are aware of the responsibility between the different parts of the system.

Implementation phase

Driver 2 – (Planning/Involvement) NT involved a number of drivers in the process of the physical placement of the monitor and printer in the buses. It was very important to get the drivers involved in the process and in this way gain their acceptance and thereby give them ownership of the project. Therefore, we used extra time on this, in connection with the installation of buses for the pilot in May 2011. In connection with the rollout of travel cards in 2012, we have not involved drivers in the same way as in 2011, since we have made use of the experience gained from 2011. This has probably proved to be a bad choice. The equipment is located in the same way as the buses from 2011 - but we have this time not achieved the level of involvement and ownership of the system from the drivers, as we did in 2011.

Operation phase

No drivers experienced.

D.2.3 Activities

Preparation phase

Activity 1 – (Technological/Planning) Development of precise specification in order to integrate the NTs BusPC and Travel Card Unit.

Activity 2 – (Involvement/Organisational) Planning of involvement of the drivers in the implementation phase in 2011.

Implementation phase

Activity 3 – (Organisational) Constantly involvement in the process in order to secure that the cooperation between the suppliers is kept on track.

Activity 4 – (Planning/Involvement) Involvement of drivers in relation to the installation in order to gain their acceptance and ownership.

Operation phase

Activity 5 – (Planning/Involvement) Involvement of drivers through training courses and appointment of ambassadors among the drivers in order to gain their acceptance and create ownership.

D3 Participation of stakeholders

D.3.1. Measure Partners

- **NT, Public Transport Authority of North Denmark** - Responsible of the planning and implementation of the measure.
- **City of Aalborg** – Represented in the working group related to the measure.

D.3.2 Stakeholders

- **Other suppliers of public transport in Denmark** – Cooperation about standardisation of pricing system and fare referencing points.

- **Rejsekort A/S** – Rejsekort A/S is the national company, owned by the Public Transport Authorities in Denmark, that has got the contract with the supplier of the Travel Card system and is responsible for establishment and operation of an electronic ticketing system for all public transport in Denmark.
- **East-West** – East_West is the supplier of the Travel Card System in Denmark.
- **FARA** – The supplier of the Buscomputer and responsible for the travel card integration with the Buscomputer.

D4 Recommendations

D.4.1 Recommendations: measure replication

Recommendation 1 - Electronic ticketing is a necessity for public transport. The process of tendering, choosing a supplier, specification of the system and subsequent implementation of the system, can be a long process, with the possibility that the system itself may be outdated when it is operational. It is therefore important to ensure the opportunity for continuous adjustments and acquisitions in the contract with the supplier, so that the system satisfies drivers and customers when you use it.

Recommendation 2 - An important prerequisite for a successful project is the collection of good and valid data. It is important to have a clear strategy for this work and with more and more systems who are interdependent, it is important that data is collected and maintained in one place. When errors in the data is found, it is important that these is changed as soon as possible. In this way the customers and the drivers experience, that the Public Transport Authority respond to their feedback.

Recommendation 3 - It is always recommendable to start small. It is important to start with a pilot. Partly in order to gain experience in a small part of the system, in this case with a few buses and drivers, but also to gain experience, with a few customers using the system. After a period with good system performance, a larger number of customers can be introduced to the system.

D.4.2 Recommendations: process (related to barrier-, driver- and action fields)

Recommendation 4 – When multiple suppliers are involved, it is important to have a clear specification and clear allocation of responsibilities, both in the development phase and in the operational phase. NT has experienced this in connection with the introduction of integration between travel card and BusPC.

Recommendation 5 - Involvement of drivers is a key point. It is very important to have ambassadors out in the bus, which both provide feedback on system updates, changes and overall operation. But also because drivers are the first step towards the customer. They are the first sales employee in the system, that the customers meet. Involvement and ownership is a key point, as well as a thorough training in the use of the system.

Appendix A

ARCHIMEDES corridor - Number of passengers from 2009 to 2011

For the part of the ARCHIMEDES corridor in the region of the University the modal split impact of ARCHIMEDES is expected to be: 2-4% less use of car among the students and employee reference groups; 1% annual increase in public transport use; and a 5% increase in cycling.

In order to investigate these objectives, two counts of bus passengers have been completed. This document will summarize the results of these counts and across measures conclude on the effects of ARCHIMEDES on the use of public transport. In the ARCHIMEDES project five measures directly linked to public transport have been implemented:

- Measure 1: Biofuels in Aalborg
- Measure 8: Travel Smart Card in Aalborg
- Measure 9: Modernising Travel Information in Aalborg
- Measure 68: Pre-trip & On-trip Mobile Phone Information
- Measure 69: On-trip Bus Traveller Information in Aalborg

Methodology

The passenger counts have been carried out before and after all measures were implemented. The first counting was made in the period 26 October to 8 November 2009 while the second counting was made in the period 9 November to 20 November 2011. All passengers entering and exiting the buses were counted manually at every bus stop for every second or third departure during daytime.

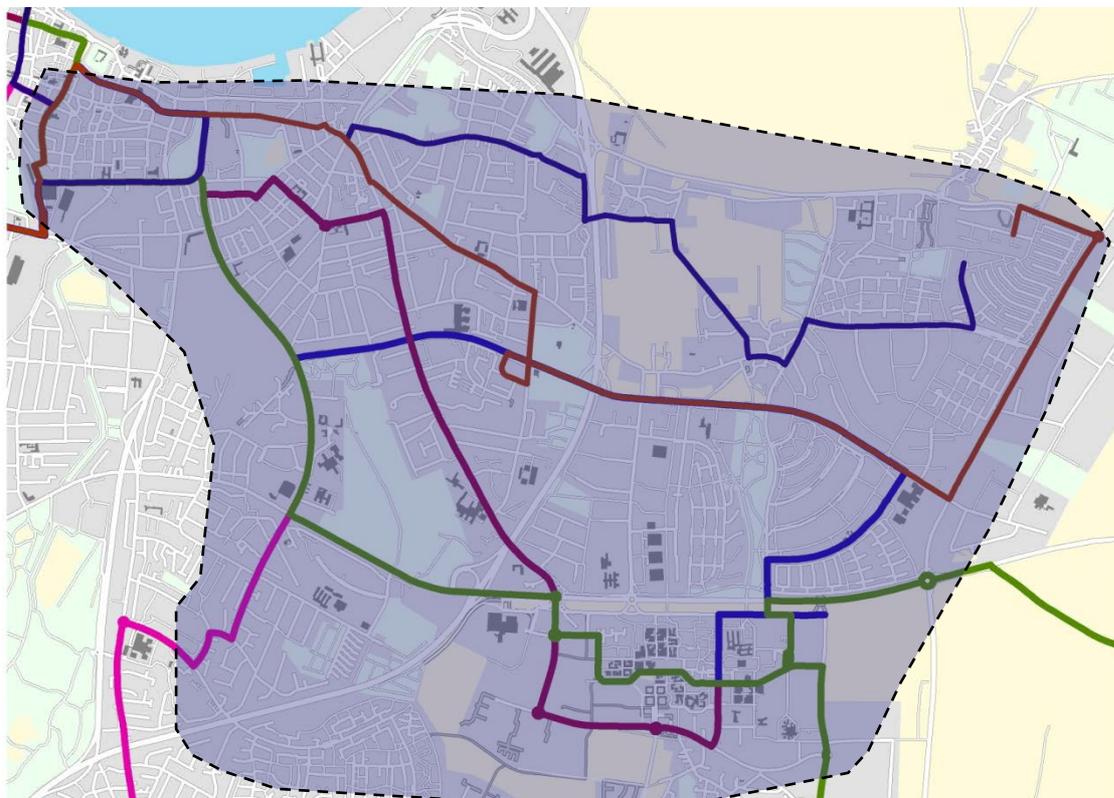


Figure A.1 Bus lines within CIVITAS corridor

The following bus lines are included in this analysis: Bus line 2, 11, 12, 14, 15 and 17. On the map the counting area within the ARCHIMEDES corridor is marked together with the bus lines going through the corridor.

The operational level has been almost the same throughout the period apart from the number of extra buses used.

Results

The overall result shows that there has been an increase of 6.2 % in the number of passengers from 2009 to 2011.

There has been an increase in the number of passengers on all bus lines except bus line 2. An explanation for this might be that during rush hour there was a larger number of extra buses in 2011 than in 2009 and therefore the number of passengers that use the normal buses are spread out to more buses. We have not counted the number of passengers using the extra buses, but based on experiences a plausible estimate is that the number of passengers in average is 30 pr. extra bus. When including this number of passengers from the number of extra buses in both periods there have been an increase of 6.2 % in the number of passengers in the corridor.

	2009	2011	Change in %
Line 2	15,483	13,624	-13.6
Ekstra buses	1,200	3,450	
Line 11	5,258	5,469	3.9
Line 12	7,455	7,766	4.0
Line 14	5,996	6,513	7.9
Line 15	4,727	4,809	1.7
Line 17	5,464	6,767	19.3
Total	45,584	48,399	6.2

Table A.1 Compared results of counts 2009-2011

Appraisal of Evaluation Method

The counts include both entering and exiting passengers, in order to make sure that all passengers are counted. This could be a source of error if there had been a significant change in the way the passengers travel in or across the corridor from 2009 to 2011. We have no indication of such a change.

Counting passengers is a resource demanding task if you do not have an automated system. As we do not have unlimited resources, we had to limit the number of trips and the period of time that we counted. We have counted every second or third trip and calculated the total number from these. The passengers are not necessarily evenly distributed between the different trips, and this could also be a source of error. As the counted trips are randomly chosen based on which trips the counters could reach, there should be no such systematic error.

The two periods in which we have counted are not exactly the same, but they are so close that we don't think this has a significant influence on the result.

In addition to these sources of errors there are a number of externalities that also could influence the result.

The weather is an important factor in Denmark, because a lot of the bus passengers choose to walk or ride their bike when the weather is fine, but when the weather is cold or rainy they use the bus. We have only counted the passengers over a relatively short period of time, and if there have been more cold or rainy days one year than the other, this will affect the result. If we should compensate for that it would require a lot more counting.

One of the other measures in the corridor is improved bicycle lanes from the city centre to the university. This can also affect the number of passengers that use the bus, if they choose to ride bicycle instead of the bus. This is of course a good thing, but it will affect the number of passengers that use the buses.

Establishing a baseline for comparison

The only passenger counting system we have in Aalborg is an old, simple automatic system that only detect entering passengers but not where, when or on which bus line. Counting from this system indicates that there has been an increase in the total number of passengers in the buses on 7.5% for the whole network. The results of the passenger count in the ARCHIMEDES corridor and this number is not comparable since they are made in two

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very different ways and with different purpose, but they can give an indication of a positive development in the whole city.

The Public Transport related measures that have been implemented on the bus lines in the corridor have later been extended outside the corridor by the PT authorities, and is supposed to have same positive effect outside the corridor as in the ARCHIMEDES corridor. Therefore it is not possible to establish a genuine 'business as usual situation' for documenting the positive effect in the corridor.

Conclusion

Compared to the number of passengers in 2011 to 2009 the numbers have risen by 6.2% or 3.1% a year. This is well above the goal of 1% a year.

Trying to use the numbers of passengers on the rest of the network as a 'business as usual' is not possible, partly due to differences in the counting methods, partly due to the fact that the ARCHIMEDES improvements done in the corridor, later is extended to the rest of the system.