Copenhagen Carshare: Carsharing Technology Study

An Interactive Qualifying Project Report
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by

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ABSTRACT

This report concerns a project for the non-profit organization Copenhagen Carshare investigating issues relating to booking, billing, and car access. Presently the systems in use are insufficient for the needs of the management and rapidly growing membership. Extensive research and discussion with members, coordinators, and suppliers has analyzed commercial and custom development of wireless access systems and updated booking and billing software. The final recommendations present proposals to the carshare for integration of such technology into the carsharing process.

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1 INTRODUCTION

Copenhagen Carshare sponsored this project for the group to research and propose affordable technology for booking, billing, and car access for the non-profit organization, its members, and a potential network of carshares within Denmark. Currently, the system in place at Copenhagen Carshare is in many ways insufficient for the needs of the carshare, and change is necessary. The conclusions drawn by the group are based on extensive research and discussion; solutions are limited based on the timetable and budget of the organization. The final recommendations for new technology implementation are proposed as a resource for the carshare in anticipation of continuing growth.

Humans travel for many reasons: to get to work, to partake in business responsibilities, to run everyday errands, to travel on holiday, and often simply for enjoyment. However, the options for methods of transportation have evolved into a very wide and diverse field, providing people multiple options for travel. In many cities, public transportation is available, with buses, trains, and subways. Many people, especially in Denmark, ride bicycles for their short-range errands. However, sometimes public transportation or cycling is insufficient and it is then that people turn their interest to cars.

There are many options for how to use a car - one can rent a car, carpool with others, or purchase a personal car. Renting a car brings with it excessive hassle and cost each time a car is driven; in addition, the user must travel to the rental business. Carpooling works well when everyone has the same schedule and destination, such as transportation to work. However, this will most likely not satisfy all the travel needs of most individuals. Owning a car may bring the benefit of transportation freedom,

but it also carries with it many drawbacks. Purchasing a car can be exceedingly expensive, especially in Denmark where the taxes on such a luxury item are nearly 200 percent. Another option for having access to a car exists, however, and that is the carshare.

Carsharing is a system of shared access to a collection of motor vehicles, which is run by a central organization. Members of the association can sign up to use a car on an *as needed* basis. Picking up a fully maintained vehicle, users are unrestricted in the use of the car so long as it is returned to the same location in the same condition for the next member's reservation. For many programs the process is monitored and achieved through a key lock box or card swipe technology to control access to the cars, and a centralized server to oversee booking and billing, which communicates with the vehicles.

Most carsharing organizations are based on goals and ethics revolving around reducing car ownership, promoting environmentally friendly modes of transportation, and providing a less expensive alternative to car ownership. Reductions in traffic and parking, as well as, enhancement in pedestrian city atmosphere are beneficial side effects of carshare programs. The largest benefits to the user come from the economic savings and the accessibility to a vehicle where one might have been financially unable to own a car.

Some of the most commonly noted advantages of the carsharing concept are the environmental benefits. Carsharing among a group reduces the total number of cars in a given area and, with each less car on the road, there comes a reduction in air pollution. In addition to total car reduction, car usage also decreases as a result of carshares due to the increased benefit of using other transportation methods (Zipcar). Beyond the environmental benefits of decreased car usage is the lessening of many

civil burdens. These include fewer cars, resulting in less traffic congestion, less road maintenance, and a decreased need for parking facilities.

Furthermore, carsharing can help ease some ever-present economic issues. Road maintenance, signage and traffic lights, traffic police, and civil servants all contribute significantly to government spending in most cities and countries. Reduction in traffic congestion helps to reduce the need for all of these expenses. Purchasing new cars strains consumer cash flow as well, and many consumers who pay interest on a vehicle will end up paying much more than the value of the car, despite the drastic depreciation in the car's value over time. Businesses may also benefit from the reduction of cars due to carsharing programs through decreased strain on over-filled parking lots, decreased expense of employee parking, and reduced traffic flow, in addition to boosting the company's "environmental credentials" (National CarShare: Benefits).

Although the carshare concept has a large number of benefits, as with any form of transportation, it also brings disadvantages. Carsharing brings about equilibrium in transportation types, increases in pedestrian traffic, bicycle traffic, and public transportation could potentially stress the civil infrastructure. However, the greatest personal disadvantage for a carshare user is the lack of privacy and mild restriction by availability of vehicles. Despite these disadvantages, however, carshares are being established throughout the world with growing popularity.

Denmark has a relatively new, but nonetheless well-established, carsharing system across the country. This system includes large associations in Copenhagen, Århus, and Farum. Århus Delebilklub has been in service for more than six years and has shared its experience to assist in the establishment of Københavns Delebiler, the Copenhagen Carshare. Founded in May 2004, Copenhagen Carshare has divisions in

the districts of Østerbro, Vesterbro, Brønshøj, Bispebjerg and Nørrebro, sharing its location with the Copenhagen Environment and Energy Office in central Copenhagen (Copenhagen Carshare).

Copenhagen Carshare today, comprised of approximately one-hundred and fifty members and twenty-three cars located throughout Copenhagen, continues to grow in size and popularity. The organization began in order to reduce automobile dependency, promote linkage between all transportation modes, provide transportation for those without the means to maintain a private automobile, and to enhance the environmental and social setting of the surrounding urban neighborhoods. However, despite the economic and environmentally driven goals of the association, the need exists for technology and resources for a fully automated system.

Currently, the organization faces conflicts with booking, billing, and car access. The carshare's objectives include eliminating the use of key boxes and log books by its members. The organization's fast growth has created a need for an integrated form of technology to provide its members with dependable service and its management with time saving operations. In turn, the proposed technology will allow for a self controlled and well-organized business operation.

In order to unify the system and make allowances for appropriate updates, the team researched and proposed an integration of new technologies to achieve an efficient operation, while paralleling the agenda of the organization's vision for a timely change to its services. In addition, the chosen technologies have the ability to integrate into the existing operations of other carshares within Denmark, with a future goal to create a unified carsharing network throughout the country. The limited budget and resources imposed by the non-profit status of the Copenhagen Carshare constrained the possible solutions. However investigative research and consultation

with existing carshare organizations has brought about the methods for adapting and implementing existing technology. In addition, investigation into current carshare technology providers and developers has also provided viable solutions to meet the specific needs of Copenhagen Carshare and its partners.

2 BACKGROUND

In order for the group to define its project objectives, it was essential to first understand both the concept of carsharing and the organization for which this project was conducted. In the United States, given the fact that the establishment of carsharing is recent and limited, the team was only able to gain general insight into the operations and concepts of carsharing. A basic understanding of the cultural differences between the United States and Denmark also proved essential for establishing an understanding of the carshare's goals and purpose as well. From the background information gathered, the group gained an appreciation for the focus and work of such an environmentally conscious organization and country.

2.1 Copenhagen Carshare

Copenhagen Carshare was recently established in order to benefit both the citizens and environment of Copenhagen. The organization's mission is to reduce automobile dependency, promote linkage between all transportation modes, provide transportation for those without the means to maintain a private automobile, and to enhance the environmental and social integrity of the urban neighborhoods (Copenhagen Carshare: Background).

Beyond just this focus on Copenhagen, the carshare hopes to create a close collaboration of all carshare organizations within Denmark through a shared network. This collaboration would reduce total expenses and share practical experience in order to support the development of more comprehensive carsharing coverage. With a networked partnership, Danish carshares might also work together to influence politicians to agree on initiatives to improve the conditions of the shared car idea.

However, this network relies on each Danish carshare utilizing the same carsharing technology and process.

2.1.1 History

Building on Farum Carshare's experience and Århus Carsharing Club's six years of experience, Copenhagen Carshare was founded in May 2004. Today the organization has shared cars parked in five districts throughout the greater Copenhagen area, with nearly one-hundred and fifty members and twenty-three shared cars.

2.1.2 Organizational Structure

The organizational structure of Copenhagen Carshare relies on the dedication of its community. Community volunteers work to create an organization which benefits the environment, in a country with a growing desire to integrate the beneficial concept of carsharing.

The carshare consists of a Board of Directors, administration, carmasters, and members; each group contributing to the operation of the non-profit organization. The Board of Directors consists of five members and three alternates. At monthly meetings, which in general are open to all members, the Board discusses carshare issues and frequently makes financial and operational decisions. The majority of their responsibilities come at the annual meeting when elections are held and others involved in the carshare voice their opinions.

The administration of Copenhagen Carshare consists of the Director, Liselotte Ley and her assistant Henriette Christensen, who oversee the daily operations and membership enrollment for the carshare. In addition, responsibilities such as

communication with other Danish carshares, the media, and various other organizations fall under their jurisdiction.

The carmasters play an important role for the carshare. Currently, seven carmasters take responsibility for twenty-three cars, including performing monthly checks of the cars, washing and cleaning, arranging for both scheduled and unscheduled maintenance, and collecting and recording of the log books (Appendix P). In return the carmasters receive free membership to the carshare (Ley 3/23/05).

The role of membership founds the entire principal of the organization. Members join not only for financial savings but for support of an environmental cause. Membership voting at annual meetings influences the organization's administration and the Board, thereby contributing directly to the success and operation of the carshare.

2.2 Elements of Carsharing

The successful operation of a carshare relies on three main components: booking, billing, and car access. Without sufficient resources, such as technology, automated reservations, and key management, accurate billing and car usage are subject to misuse and error. Therefore, automated technologies used to manage the daily operations of carsharing organizations give convenience and structure to a 24-hour service (Shaheen, Carsharing 118).

2.2.1 Booking

Booking a reservation for a shared car is the first step in the carsharing process. The reservation process should be quick and easy to complete for the

members. Convenience and speed play a key role in the members' view of the carshare, requiring the booking process to be easy and user-friendly.

When members of Copenhagen Carshare need a car, they make reservations through the online booking system. A reservation can be for any amount of time but a cancellation on any reservation is subject to an additional fee (Copenhagen Carshare: Process).

2.2.2 Billing

While billing happens periodically, the events which lead to its effectiveness happen daily. Most carshare organizations bill their members monthly with membership, usage, and damage fees. For usage fees to be calculated properly, the distance driven by each member must be recorded for every trip.

Presently, Copenhagen Carshare relies on the members for recording information in the log book, including: car damage, reservation times, and odometer readings before and after each trip. Currently, this written log used by Copenhagen Carshare works on the honor system. Since the logs can be accessed by any member and require collection from each car every month, there are beneficial changes that can be made to the current billing system (Copenhagen Carshare: Process). Returned cars must be locked and in the same condition as they were when taken. Otherwise, the member is responsible for vacuuming and cleaning the car. Failure to do so results in a fine, and potential expulsion from the organization.

2.2.3 Car Access

Car access plays a crucial part in the carsharing process by ensuring hassle-free pick up of any car parked throughout the city. Once members reserve a car, they

must be able to access the car quickly and efficiently for their own convenience. Many carshare organizations use an electronic identification device mounted on the car windshield that reads member identification (ID) cards. In some cases, *all* members have access to *all* cars. In other organizations, the car remains locked unless the member has a reservation.

Once Copenhagen Carshare members complete a reservation, they must locate the key box that contains the keys for the car. In some circumstances, a note from the last user indicates where the car is parked if all the nearby spots were taken. This essentially gives every member 24-hour access to all cars, which has potential for problems (Copenhagen Carshare: Process).

2.3 Participatory Design

Participatory Design (PD) allowed for more effective research, investigation, and development into the group's proposal. The objective of the project, to integrate a technological solution into the existing carshare, effects the management and members of Copenhagen Carshare. To incorporate the different needs of those groups involved in the carshare the concepts of PD were drawn upon early in the group's research process in Copenhagen.

Participatory Design involves input and evaluation from multiple parties on the design and integration of technology into technical and managerial systems. Since different parties have varying technical and non-technical backgrounds, they assess differently the current carshare system as well as the benefits and consequences of the integration of new technologies. Parties considered to give input include membership, management, developers, and professionals in technical support (Kensing 20).

Through interviews and focus groups, the need became evident for all parties to play an active role in the discussion and decision-making process. The group came to the realization that viewing technology as simply a material thing limited development ideas. Rather, the group's recommendations would have to be a collection of "networks of people, practices, and technology" (CPSR). Important design and application process ideas would have to surface from the collaboration of each interview, focus group, and survey conducted.

The limited technology in use at the Copenhagen Carshare allowed the team to take an effective approach to PD. Ideas generated from the involved parties were "less constrained" by existing features in the carsharing process (Information and Design). Interview and focus group participants brought strong opinions and potential improvements for the current system, unbiased from more complex technologies.

While most forms of PD focus on the meeting of all of these groups at the same time to discuss issues, the project group felt this method would be impractical considering the large time commitment from each involved party.

2.4 Future Vision

Until recently the carsharing process utilized by Copenhagen Carshare proved sufficient for the newly established organization. However, the management sees a need for a change in the carsharing process given the continuously increasing membership. In order to continue timely and dependable operations some type of integrated technology must be incorporated in the current process.

Due to the growing size of the carshare and limited human resources, considerations for changes fell on an automated system. In turn, this would result in

the elimination of key boxes and log books. Limitations in the budget and available resources imposed by the non-profit status of the Copenhagen Carshare constrained a wide range of possible solutions.

3 METHODOLOGY

The purpose of this project is to propose to the non-profit organization, Copenhagen Carshare, an efficient technological update and solution to its current issues with booking, billing, and car access. This proposal involves the recommendation of the integration of various technologies with an economic analysis of each. The group utilized five research methods, in both the United States and Denmark, essential to achieving a solution suitable for both the management and members of the carshare: *interviews, a focus group, a member survey, observation of current system, and a cost assessment.*

3.1 Interviews

The interviews conducted in the United States were with experts in both the business and carsharing industry. In Denmark the group conducted interviews with administration from Copenhagen Carshare and other Danish carshares, carshare members, and IT professionals.

Interviews completed by the group were both by phone and in person. Questions for each interview were developed to have inoffensive and unbiased wording, with efficiency and straightforwardness in mind. Ordering of the questions was essential to create progression in both the complexity of the questions asked and with the familiarity of the interviewee.

3.2 Member Focus Group

Copenhagen Carshare requires that the proposal meet both the needs of its organization as well as its members. Therefore, the group conducted a focus group with four members of Copenhagen Carshare.

A focus group is a group interview with participants all having a stake in the issue. While the management of Copenhagen Carshare provided the group with organizational concerns and possible limitations, speaking with the members gave perspective into the pressing issues concerning the members as well as an evaluation of the existing process (Krueger 3). The group moderated the member's discussion to prevent participants from dominating the conversation and pressuring conformity in response.

3.3 Member Survey

The member survey was designed to allow the group to understand problems the members face as well as the members' opinions on the elimination and upgrade of parts of the carsharing system. Since all information concerning the organization is distributed by email and internet access is required to be a member, the group used email as a method by which to distribute the link to the online survey. The distribution of the member survey through proved to be beneficial for two reasons. First, emailing targeted a limited audience of only those who were members and allowed it to be non-confrontational in distribution. Second, it guaranteed that all members would receive the information. The group initially planned to post the member survey link through the online booking site. However, members with low usage might not see the website and would not have the opportunity to voice their concerns.

The group was fortunate enough to be able to target only the members of the carshare through the current set-up. This allowed the group to develop questions specific to the operation of Copenhagen Carshare. The questions were developed with timeliness in mind to induce as many replies as possible. Consequently, no free

response questions were used. Rather, a scaling technique was used to determine level of response for each question.

An open-ended section was included at the end of the survey for any considerations or concerns that might have been overlooked, which members felt they could not voice appropriately (Appendix G). An email accompanied the member survey in order for the group to re-introduce itself and the developments of the project.

3.4 Observation of Current System

The group traveled to the various key box locations to observe the ease of access and visibility of the boxes. The log books were located within the vehicle and studied for understanding the procedures to be expected of the members when completing the logs. Mock bookings were completed on the booking website, and ease of webpage navigation and setup was investigated.

3.5 Cost Assessment

A cost assessment was crucial for both the team's final proposal and Copenhagen Carshare's consideration of the recommendations. Special consideration was given because Copenhagen Carshare is a non-profit organization, and the technological solutions were analyzed and various possibilities were considered to meet the financial needs of the organization. Different scenarios for implementation were considered, giving the organization the choice of different cost levels and schedules based on the availability of funds.

4 RESULTS

The group has identified a number of possible solutions for the recommendation, including the commercially available Net Image "Smart Phone," Invers COCOS, and Eileo ZiboxLT, as well as the possibility of professional or student custom development. Following is a brief description of each.

4.1 Net Image "SmartPhone"

The Danish company which developed the booking system currently in use by Copenhagen Carshare has recently developed a new carsharing solution, the "SmartPhone" system. The core of this unit is a General Packet Radio Service, GPRS, enabled cell phone, placed in each car. Upon entering a shared car via traditional key box access system, the user dials the carshare server with a special cell phone software interface. The phone prompts the member to enter a specific member ID number and informs him as to whether he may drive the car. Before and after the trip, the odometer reading is entered into the phone. All the member information gets sent to the carshare's server where software compiles the data to generate billing (Kjer 4/19/05).

4.2 Invers

The oldest, most well known, and largest provider of carsharing technology in Europe is Invers, a German company, formerly specializing in fleet vehicle management. Inverse offers a full-featured "smart" key box system as well as a "Standalone" individual car access control system. The "Keymanager" key box uses smart card technology to limit access and communicates with the main server using a landline modem. The vehicles have electronics inside which record odometer readings and send the information to the key box to be compiled with access records.

The StandAlone individual car access system also uses smart card technology to limit car access by having a card reader just inside the windshield. Inside the car, members use a Personal Identification Number (PIN) to retrieve the vehicle key from a safe box. Hardware in the car records trip data and sends it to the main server using SMS (short message service) cell phone technology. Billing and booking software in conjunction with the server software are provided by Invers (Invers).

4.3 Eileo

A relatively new contender on the European carsharing technology market is the French Company, Eileo. Eileo offers individual car-based carsharing telematics products similar to those of Invers, but with low cost options. The product which the group investigated is the "ZiboxLT," a low cost version of the company's more full featured product, the ZiBox. ZiboxLT has a non-invasive installation, interfaces with the car's immobilizer system to prevent car theft, controls vehicle access via a smart card reader in the window, records distance driven, and communicates with the main server through a GPRS modem with SMS backup. All booking and billing software can be hosted by Eileo and bills are generated automatically. It is also possible for the carshare to host the server if so desired (Eileo).

4.4 Custom Development

The fourth solution, custom development of carsharing technology, would involve the creation of new booking and billing software as well as in-car telematics. "Telematics" refers to the combination of telecommunications and computing systems. The overall design requires keyless entry, controlled vehicle access, wireless communication with the carshare's server, data logging on distance traveled

by members, non-invasive installation, and an interface with new booking and automatic billing software. This development process relies on inexpensive or free development from either volunteers or new companies, complemented with a low-cost design for minimizing expenses.

4.5 Conclusion

Each of the above options offer Copenhagen Carshare various costs and timetables, depending on the urgency and complexity of the solution. The results of extensive research, interviews, a focus group, a member survey, and cost assessment culminate into the group's final recommendation.

5 DISCUSSION

This section contains an in depth look at the results of all research, observations, and discussions conducted by the group. In order to understand the drive for carsharing in Denmark the reader should be aware of the current issues and potential changes that exist for such a system.

5.1 Summary of Investigative Research

There were many methods utilized to determine the current process and future needs of Copenhagen Carshare. These included interviews, a focus group, and a survey with the management and members of the organization. Interviews were also conducted with others involved in carsharing, and IT professionals. While information from interviews and focus groups did not lend itself to statistical analysis their importance is quiet significant (Appendix E and Appendix F). The member survey provided the team with information that emphasized the need for an updated technology at Copenhagen Carshare (Appendix G).

Interviews

The administration of Copenhagen Carshare, Liselotte Ley and Henriette Christensen, were interviewed to give the group a better understanding of the issues seen from the management perspective (Appendix E). The two presented the following goals, which contributed to the group's final recommendation:

- Eliminate key boxes as a car access system
- Eliminate log books for recording billing information
- Communicate wirelessly between the cars and the office
- Install an ID reader in each car to control access
- Estimate budget as 10,000 DKK per car for technology upgrades
- Cooperate with Århus Delebilklub for development

Copenhagen Carshare's IT Consultant, Bjørn Dirchsen, was interviewed to establish his responsibilities for the organization and his capabilities as a technical

professional. His comments on the issues and concerns for future technology included the following (Appendix E):

- Provides computer maintenance, website and email hosting, and consultation on technical subjects
- Expects initial investment for development to be expensive
- Would be able to oversee the introduction of new technology
- Has hosting capabilities for booking and billing server
- Suggests a developer with prior experience to expedite the development
- Suggests a developer willing to work for appropriate price considering the relative simplicity of the project
- Warns that insurance company may not insure cars that are deemed insecure and theft prone

The Administrative Director of Hertz Carsharing Scandinavia, Alex Pedersen, provided the group a look into the operation of Hertz Carsharing in Denmark, by providing information on their current booking, billing, and car access system as well as economic suggestions (Appendix E). He addressed the group's questions with the following information:

- Carsharing technology at Hertz is from the German company, Invers
- Invers system requires complicated installation in the cars
- Largest overhead cost is monthly telephone plans
- Key boxes are economical when multiple cars are at one location
- Key boxes are used when cars are parked underground or in areas with bad cell phone reception
- Hertz suggests a possible partnership with Copenhagen Carshare
- Hertz has distribution rights for Invers products in Denmark

An IT Consultant and member of Copenhagen Carshare, Michael Zedler, provided information from a technical point of view for the project group (Appendix E). He addressed the group's questions and showed interest in future assistance for developing custom software and hardware:

- Suggested current booking system be made open source
- Suggested mapping abilities for each car location
- Volunteered to help in the development of the software especially in regards to the mapping abilities
- Suggested interfacing with PBS for online billing

- Volunteered to interview and assist in selecting potential developers

The head mechanic at Bekker Automobiler VW dealership, Kim Foldal, provided the group with knowledge about possible installation of in-car telematics systems. Foldal proved extremely helpful in confirming what was possible and what was presently impossible in terms of electronics installation (Appendix E). From this interview, the group was able to abandon some and confirm some ideas for possible recommendation to Copenhagen Carshare. The important points from Foldal follow:

- It is impractical to control power door locks and immobilizer through the OBD port
- It would be impractical to read the odometer through the OBD port
- The odometer signal can be read from a wire in the radio wiring harness
- The immobilizer system is extremely secure and difficult to modify because of modern wireless key transponders
- The car alarm will present a problem if the car is accessed without the use of a 'smart' key or wireless key fob

The director of Århus Delebilklub, Morten Franch, was interviewed to give the group a perspective from a well established carshare on his view of updating carsharing technology in Denmark (Morten 4/19/05). He brought up the following points (Appendix E):

- Needs justification for eliminating key boxes and log books based on cost
- Shows concern that Århus Delebilklub and Københavns Delebiler do not have the same growth patterns[1]
- Shows concern that Århus Delebilklub does not have the same immediate need for updated technology

The team met with the developer of the current booking system for Copenhagen Carshare, Hans Kjer of Net Image, to understand his contributions and

[1] Århus Delebilklub has been providing service for nearly seven years and currently has 170 members and 15 cars. However, Københavns Delebiler has been operating for only a year and has 150 members and 23 cars. Franch is concerned that since the organizations are not growing at the same pace they are not in need for the same updates immediately.

future role for the organization (Appendix E). He brought up the following points for consideration:

- Confirms that the current booking system would not be made available as open source
- Has developed a new booking system using a cell phone in each car referred to as the "Smart Phone" system
- Is interested in being involved in developing a new booking system for Copenhagen Carshare
- Specializes in user interface and is not a programmer

The Leasing Director of Europcar, Mads Munch, was interviewed to inquire about the possible installation of telematics systems in the leased vehicles and a possible financial agreement between Europcar and Copenhagen Carshare (Appendix E). He raised the following points:

- Confirmed that the proposed installations would be allowed by Europcar and covered by insurance
- Confirmed that insurance will cover the car key being stored in the car while parked
- Considered building the cost of the new system into the monthly lease price of each car
- Concerned with the unknown reliability of Eileo system, would like to see it working

Member Focus Group

The Member Focus Group provided the project group with an interactive insight into the current carsharing system from the user's point of view (Appendix E) and made numerous suggestions to make the system more user-friendly. The system should have the following:

- Ability to cancel reservations once reserved time has begun
- An easier booking system
- Booking by telephone as well as internet
- The removal of holiday cars from booking system once they are no longer available
- Contact information for reservations before and after current
- An overview and picture of each shared car

- Booking by location
- Booking by car
- Booking by time
- Maps and route planners for locating a reserved car
- Online billing
- A refined pricing system based on distance traveled
- Limited access to cars when not reserved

Member Survey

The member survey provided the project group with insight into the general attitudes of the Copenhagen Carshare members. The purpose of the survey was to better understand members' issues with the present system and to gauge comfort with proposed ideas for the future. The survey was conducted online and 35 out of a possible 150 responses were collected during a three day period (Appendix G). The majority of responses collected from the survey follow:

- Favored having a map of each car location in the booking system
- Showed little interest in an automated telephone booking
- Considered online bill paying very important
- Felt that monthly bills are difficult to read
- Favored keyless entry over the traditional key box system
- Favored limiting access to the cars based on reservation times
- Had minimal privacy concerns with the use of GPS in shared vehicles

5.2 Carsharing Process

The carsharing process is distinct for each business or organization; there is no one way to execute the methods used for running such an organization. For this reason, each carshare has its own unique protocol for running efficiently, depending on variables such as membership and fleet size. While this process is different for each carshare, it always involves both the management and members of the business or organization. Each party plays a distinct role in ensuring that the process continue to operate smoothly. However, it is important that the system assist the user with ease and eliminate unneeded complications.

The process utilized by Copenhagen Carshare proved to be adequate until recently. With the management looking into the future, it is apparent that the current process will not be sufficient for a continually growing membership. Therefore, the current system is in need of an upgrade of automated technology in order to reduce the work load of the Copenhagen Carshare staff.

5.2.1 Current Process: Copenhagen Carshare

Currently Copenhagen Carshare utilizes a primarily manual carsharing system. However the process is experienced differently for both the management and the members of the carshare.

5.2.1.1 Management

The management of Copenhagen Carshare oversees the daily operation of the carsharing process for the organization. It is responsible for maintaining the booking system, collecting and recording member usage data, and generating monthly bills.

Booking

The administration of Copenhagen Carshare has access to the "master" booking system. With this ability, it may look at all reservations that have been made as well as make certain cars unavailable for specific time periods.

Billing

The billing for the administration of Copenhagen Carshare involves more manual labor than the booking system. Each month the carmasters collect the log books which contain written information concerning the distance driven and use of the car for each reservation. Only after the carmasters transfer the data into a computer program can the accountant generate bills for each member from this information.

Car Access

The process of assuring car access for each member is time consuming and often a hassle for the administration of Copenhagen Carshare. Currently, the organization uses mounted key boxes at each shared location to store the keys to each car parked in the vicinity. The use of these boxes involves a lengthy process of finding locations and receiving approval to hang key boxes throughout the city. In addition, the management must strategically place new vehicles to optimize access for members based on demographics. This can be a challenge if key box locations are conditional on permission to hang a box.

5.2.1.2 Members

The members of Copenhagen Carshare partake in the carsharing process each time they use a shared car. The following walkthrough shows the typical process that a member would go through for booking, billing, and car access.

Booking

When members of Copenhagen Carshare need a car, they make reservations through the use of the online booking system. The member must enter either the date and time or the car they would like to reserve. The booking system then displays the options which meet their search criteria. A reservation can made be for any amount of time and a cancellation on any reservation is subject to an additional fee (Copenhagen Carshare: Process).

Billing

Members are billed based on the distance driven. While most larger carshares automatically log the members' distance driven electronically, Copenhagen Carshare's written log books rely on the honor system. Since any member can access

the logs and since the log books require collection from each car every month, there are certainly beneficial changes that can be made to the carshare's current billing system. Additionally, since returned cars must be in the same condition as when taken, members must, if necessary, clean the car to avoid incurring an extra charge (Copenhagen Carshare: Process).

Car Access

Once a Copenhagen Carshare member completes a reservation, he locates the car, usually within walking distance of his neighborhood. All members have keys to the key box which contains the keys for the vehicles. The member then finds this key box, to locate the keys for the cars parked nearby. Each key and car has a label with a name in order to identify the correct car. Inside the box, the member will find not only the key but, if all of the nearby spots were taken, a note from the last user indicating the car's location. This essentially gives every member 24-hour access to all cars, leaving the potential for complications (Copenhagen Carshare: Process).

Upon finding the car, the driver must check over the car for any noticeable damage as well as record in the car's log book his membership number, the time of pick-up, and the reading of the car's odometer. After completion of the trip, the driver must record the final odometer reading and park the car in a spot near the key box.

5.2.1.3 Issues

The issues related to the current carsharing process utilized by Copenhagen Carshare were established for the group through interviews with the management, and a focus group and survey conducted with the members of the carshare. Each party

had concerns with the current system and had already given thought into possible changes.

Management

The administration of Copenhagen Carshare gave immediate feedback to the group's proposal and provided some thoughts of its own. One of the main issues concerned the current use of key boxes and log books. The management highly dislikes the current process, wanting the elimination of both the key boxes and log books from the carsharing process.

The *first* concern was noticeably the issue of security since all members have a key to all key boxes. To date, this has not been a considerable issue. However, with plans to rapidly increase membership security could pose problems. Members could accidentally take the wrong keys when there are multiple cars at the same key box locations, since the identifying tags can fall off. *Second*, the lengthy process in finding and receiving approval to hang key boxes on walls throughout the city, produces problems. Having an identification and access control system placed in each car would allow flexibility in parking and car placement within Copenhagen (Ley 3/23/05).

The manual labor required for the use of log books is an unfavorable feature of the current process. Not only do members have to record their usage information, including distance driven and reservation times but each of these log books is collected monthly by the carmasters. The written information contained in each book must then be recorded manually into a computer program for an accountant to generate monthly bills for the members (Ley 3/23/05).

The elimination of the log books would be welcomed by the management for *two* reasons. *First*, the manual labor required for retrieval and recording of the log

book information would be an impossible chore once the membership reaches a certain level. Even at the present time the system is reaching its limit of being a practical solution for data retrieval and documentation.

Second, there have been a small number of occurrences when a certain reservation record was not recorded or was missing from the log book. If a system were introduced which used electronic data recording, this would eliminate the problem of missing information. Upon a car being accessed, the electronics would register both the starting odometer reading and time. At the end of the trip, the final distance and time would also be recorded. In addition, forgetfulness and dishonesty would no longer threaten the record keeping of the organization since billing information would already be stored in a computer. Billing would then be completed automatically and there would be no need for the carmasters to retrieve and enter the information by hand.

Members

The input of the members differed somewhat from that of the administration, since the members were not as well informed of the technology available specifically for carsharing. As regular users of the carshare, the members had their own thoughts and concerns regarding the carsharing process. The focus group and survey yielded the following information.

BOOKING

Ideas for more options and added features include allowing for multiple reservation types, flexible reservation cancellation including once the reservation has begun, removal of unused cars from the website, an overview of each car available, telephone booking, and mapping and route planning capabilities.

MULTIPLE RESERVATION TYPES

The members of Copenhagen Carshare feel that the booking system does not offer enough options for selecting an appropriate reservation. The current system requires a member to provide it with either date and time or car type. The members feel that it would be more helpful if they could book a car using three options: by car or car type, by date and time, and by location. This would allow members to book either by their personal needs or by car availability (Member Focus Group 4/5/05).

RESERVATION CANCELLATION

Members have requested the option of being able to cancel a reservation for a portion of the time they reserved the vehicle for, and also to be able to cancel once the reservation time has started. Members admit that they sometimes request a vehicle for a week knowing that they only need it for three or four days. This is done because their plans have not been confirmed and they like the flexibility of knowing a car is available for them any day they need. However, once their plans are established they would like the option of "freeing" up the car on the days they have no need for it. This would allow other members the opportunity to have access to that vehicle.

REMOVAL OF EXTRA CARS

The continual listing of the extra cars used for the holidays or high usage seasons, confuses and annoys some of the members. The extra cars remain on the booking site with an "unavailable" status. While they must remain in the booking system for billing purposes since a car must be in the system to be billed, member response, suggests that hiding the extra cars electronically when they are no longer available would be very helpful.

OVERVIEW OF EACH CAR

One point the members brought up in both the focus group and the open response to the survey was the importance of having an organized overview of each

car available. They would like to see a picture of each car as well as a description concerning seating, cargo space, and added features such as a trailer hitch.

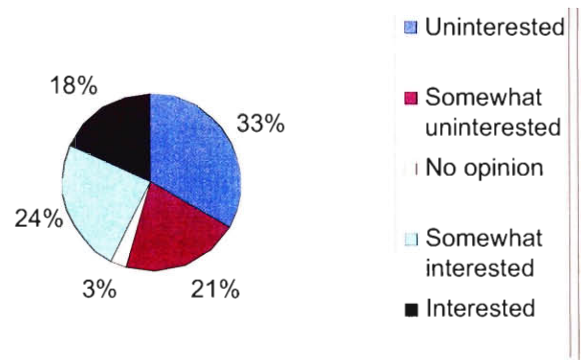
TELEPHONE BOOKING

The response given to the question of providing automated telephone booking differed greatly. The question was first asked to four members of the focus group. They all felt that it would be extremely convenient to have an option to book a car by telephone. The reason given was that if they were visiting with family and wanted to stay for dinner they would be able to call the booking system to inquire whether their reservation could be extended. All members present were in agreement, feeling that internet is not always readily available when they are in need of a quick reservation or extension (Member Focus Group).

However, the same question in the Member Survey was met with a much different response. The question:

> How interested would you be in an automated phone reservation system? An automated phone system would be a system where someone could call a computer that would talk you through a reservation process

was asked through the online survey. The group expected that an overwhelming amount of members would favor an automated telephone booking system, given the ease it would bring to making a reservation. However, 33 percent were *"uninterested"* and 21 percent were *"somewhat uninterested"* in phone booking (Graph 1).



Graph 1: Interest in automated telephone reservations (Member Survey 4/28/05)

MAPS AND ROUTE PLANS

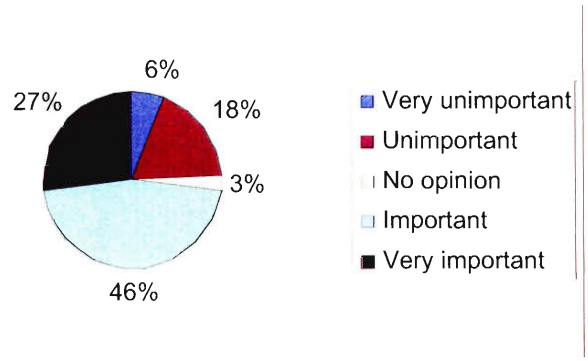
A concern of the focus group members was that they would like to see mapping capabilities present for each car location. This would include an online map with a pin pointed location of the parked vehicle as well as directions to the car via the public transportation system. The map of the car's location would be essential if an electronic system were placed in each individual car and the key boxes were eliminated, since each car would have a reserved parking spot rather than being parked within the vicinity of a visible key box.

This suggestion was discussed with both the current developer of the booking system and a member who is also an IT professional. The process of adding the links such as www.krak.dk (a Danish map website) and www.rejseplanen.dk (public transportation travel plans website) to the booking system would be relatively easy. However, the current provider of the carshare's booking system, indicated that such an upgrade in the booking system would be expensive (Kjer 4/19/05).

The question:

How important do you feel it is to have a map location of the vehicles available online when you are booking, such as one available on www.krak.dk?

was asked through the online survey. Seventy-three percent of the members who completed the survey saw the mapping capabilities as either *"important"* or *"very important"* (Graph 2).

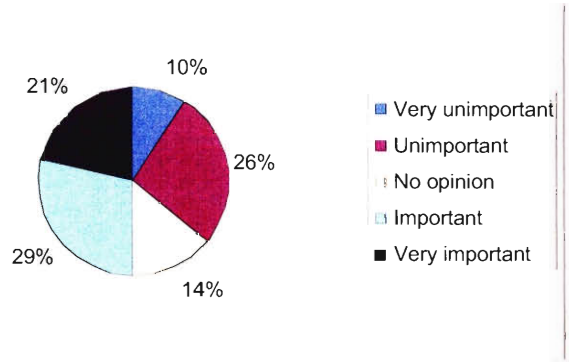


Graph 2: Importance of mapped locations (Member Focus Group 4/28/05)

The question:

How important do you feel it is to have directions to the locations of the cars on www.rejseplanen.dk?

was asked of the members through the online survey. While the members in attendance at the focus group favored such a link, the survey question was not met with great response once way or the other. The responses of *"important"* and *"unimportant"* occurred the most, with response rates of 29 percent and 26 percent, respectively. Also, 10 percent of the membership rated it as a *"very unimportant"* option (Graph 3). Consequently, this extra option should be made available only if the cost is minimal.



Graph 3: Importance of directions to car locations (Member Survey 4/28/05)

BILLING

Another important area for both the members and management of Copenhagen Carshare is the billing process. The group investigated a few issues seen by both members and management regarding billing.

ONLINE BILL PAYING

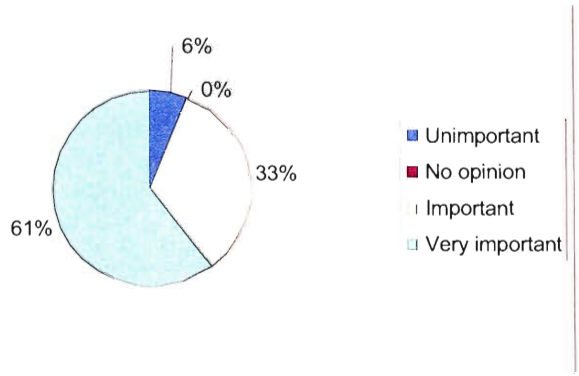
Members made it very clear that they would prefer online bill paying over the current paper based method. They would like Copenhagen Carshare to integrate with PBS, the Danish online bill paying system, in order to expedite their personal bill paying process.

The question:

Rate the importance of online bill paying, such as PBS?

was asked of the members through the online survey. The vast majority, 94 percent, of the members felt that it was either *"somewhat important"* or *"important"* to use online bill paying (Graph 4). One member went so far to leave a comment on the survey saying "*I rate the importance of automatic bill paying, like PBS, as VERY important.*" The bill paying process is considered time consuming and, at times,

frustrating as it presently exists. Each month members must go directly to the bank and transfer funds to the carsharing account (Member Focus Group 4/5/05).



Graph 4: Importance of online bill paying, PBS (Member Survey 4/28/05)

UNREADABLE BILLS

Currently the monthly bills are sent by mail and are considered by many to be nearly impossible to read. The text on the bill often overlaps, making the printed information unclear and jumbled. While online billing is preferred by the overwhelming majority, members would like to see the current process fixed immediately so that the bills are printed legibly.

CAR ACCESS

Car access is probably the most significant area in need of improvement at Copenhagen Carshare. The current key boxes are undesirable and a more advanced car access solution is anticipated.

KEY BOXES

The key boxes were much more of a concern for management than the members. However, there were still opinions in favor of eliminating the use of the key boxes for car access. The members feel that as the organization continues to

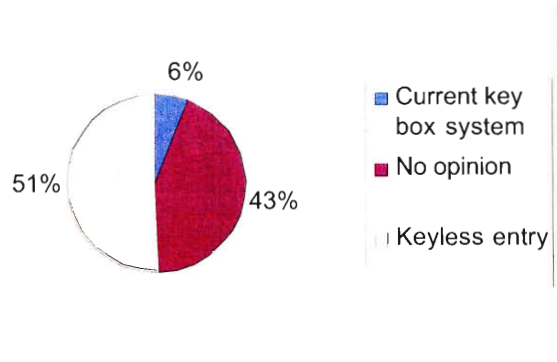
grow there will be a need to eliminate the manual aspects of the process. They understand that an automated system for each car would alleviate the work of the management and bring ease to the use of the cars.

Those in attendance at the focus group were in favor of the parking situation that would arise from using a telematics system in each car. Currently, the cars must be parked within sight of a key box in order to locate the reserved vehicle. Members feel that the key boxes are often difficult to find and nearly impossible to locate in the dark. With the elimination of the key boxes, it would be essential to have designated carsharing parking spots since there would no longer be a key box to "mark" the area. Therefore, given the fact that the key boxes are difficult to locate, the members favored the idea of having a permanent reserved parking spot to ease the search for a car.

The question:

> Which would you prefer more: the current key box system, *or* a system with keyless entry to the cars?

was asked of the members through the online survey. However, the response received was not as the group expected. The group felt that an overwhelming majority would be in favor of a keyless entry system. The response for *"keyless entry"* was almost matched with that of *"no opinion,"* resulting in 51 percent and 43 percent, respectively (Graph 5). The team considers the possibility that the responses are a result of the members not fully understanding the benefits of such a system, especially given that only six percent were specifically in favor of keeping the current system.



Graph 5: Desirability of current key box system vs. keyless entry (Member Survey 4/28/05)

LIMITED ACCESS

Members had mixed feelings about the ability of a new system to limit their access to the cars based on reservation times. Such as system would only allow a member with a reservation to get into the car during the reservation period. There are at least two reasons that limiting access is beneficial to the carshare organization. *First*, the current system theoretically gives all members access to all cars at all times since each member has a key to every key box in the city. While it has not been a common occurrence by any means, there is still a possibility for a car to be taken by someone without a reservation. *Second*, carshares in America have used this limited access feature in their systems to "lock out" members who either do not pay their bills or act irresponsibly while using the vehicles. If an emergency arose and a member needed to access the car at an unauthorized time, he would just need to contact the office and the car could be unlocked remotely.

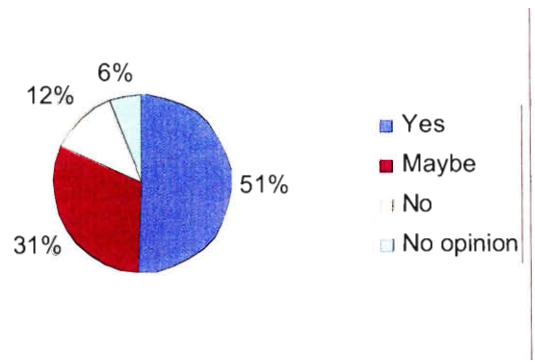
The response of the members from both the focus group and member survey were conflicting in views. However, they understood the benefits of such a feature. The members at the focus group did not see a significant problem with the current situation of being able to gain access any car when needed. An example was given

that sometimes members forget items in the car, such as glasses and bags, and go early the next day to retrieve them. They feel that it would be both a hassle to themselves and the management of the carshare if they were required to first call the office to gain car access. Currently, most members have trust in the organization and the other members given the small size of the carshare. However, they do realize that the organization is rapidly growing and will not always stay "close knit."

The question:

> Would you prefer a system where car access is limited to only the member who has reserved a designated time

was asked of the members through the online survey. The response was in favor of such a system with 51 percent answering *"yes"* and 31 percent answering *"maybe"* (Member Survey 4/28/05).



Graph 6: Opinions on limited car access (Member Survey 4/28/05)

5.2.2 Future Vision

One of the reasons many carsharing organizations are able to run efficient and smooth operations is through the use of modern technology offered specifically for this purpose. It is the intention of the group's proposal and recommendation that Copenhagen Carshare integrate this technology into their process in order to achieve a smooth running, automated system.

Technology integration in carshare programs has become widely prevalent in European and American carshare programs. These technologies have added to the ease with which members can access cars and billing information, and have allowed the organizations to track and maintain their vehicles more efficiently. Members may access the booking system by either telephone or internet. Servers send confirmation emails to the users, and reservation data is sent to the car's onboard computer system via a wireless transmitter. When the member arrives, he simply swipes the smart card in front of the card reader in the window and the car confirms the reservation. If the user has a reservation, the car will unlock all doors and the ignition. After the trip, the usage data is recorded and bills are generated automatically. Below is an image showing the automated carsharing process of Zipcar, a large United States carshare.

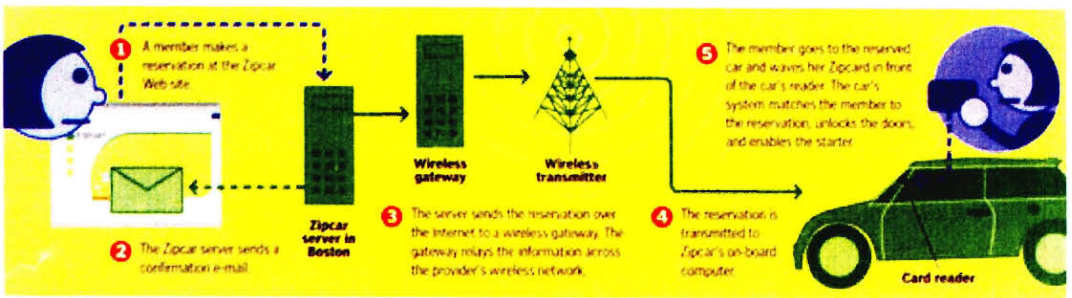


Figure 1: Automated carsharing process (Zipcar)

5.3 Carsharing Technology

When investigating the design of telematics and software systems for an integrated carsharing system, the group had to consider how the car communicates, gathers data, and controls access, as well as the various features and considerations of the server and software. The following overview gives a simplified discussion of the technologies, and the sections following discuss the areas which were investigated in depth, either because of their current use in carsharing technology, cost effectiveness, or unique characteristics.

5.3.1 Technology Overview

In modern carsharing telematics systems, communication between the car and the carshare is achieved through the use of cell phone technology. Newer cell phones have the option of General Packet Radio Service (GPRS), which allows users to access the internet and send emails. In fact, cell phones with GPRS are more like mini-computers than they are phones, because of their internet interface through the cellular phone system. In-car electronics can use GPRS to send and receive information from a main computer at the carshare through the use of cell phone services.

The Global Positioning System (GPS), is another technology which the group investigated for possible use in the carsharing electronics. GPS is a system where satellites, combined with electronics, can determine an object's position anywhere on the earth. This system can be used for security, such as locating a missing car, or for determining the distance traveled by the car.

Originally thought was given to using the OnBoard Diagnostics (OBD), port to gather distance data as well as control the door locks and ignition system. This port exists in all cars somewhere under the dashboard and is used by mechanics to "talk" to the car's computer. Some in-car computers Controller Area Network bus (CANbus), which uses two wires to transmit data to and from many of the electronic components in the car. The group hoped that this system could be used with the OBD port to gain access to the door locks, immobilization system, and odometer. However most cars do not yet have CANbus available for connection, and even in those that do, there are too many complications to justify attempting its use in the face of simpler solutions. Alternatively, behind the radio in almost every new car there exists a wire

that transmits data on the speed of the car. This information can easily be converted into the distance traveled.

Immobilizer systems exist in nearly all new cars. In most keys there is a small electronic device which contains an identification number. When the key is put into the ignition, a reader confirms the identification number so that even if someone had duplicate keys, without the chip they could not drive the car. Because members may occasionally need to enter the car but not drive it, and for safety reasons, immobilizers should be used to control functionality to the ignition system of a car.

"Key fobs" are the small keychain remote access devices that come with newer cars. They normally allow the user to lock and unlock the car, as well as turn on and off the car alarm. For convenience and ease in development the key fobs for the vehicles could be taken apart and installed in the telematics system to control the door locks.

Smart cards are credit card shaped devices that can store and process data and are often used for access control. Small chips on the cards keep ID numbers much like a password. When a card reader reads a smart card it receives this ID number and determines whether the person is allowed to gain access. Encryption capabilities make smart cards safer than classic magnetic strip cards, as on a credit card. The reason that smart cards work so well for a carshare comes from the ability to read the cards wirelessly. A reader in the car inside the windshield can read the member's card outside. Because the reader cross references a list of acceptable ID numbers for access from memory, this memory can be constantly changed to control access.

Microcontrollers are small devices that act similarly to a computer processor. Much like a brain, they organize or translate all the data being collected in the car, and coordinate its return to the carshare. The in-car electronics rely on many separate

devices and standards, but can be organized by connecting all the components to a central microcontroller. Different electronic devices can be used to ensure that access is controlled, data is gathered, and communication is possible. However design considerations stemming from the complexity of the systems and cost of development must be taken into account to optimize the solution for the carshare.

Aside from the telematics system in the cars, there will also be a central server which communicates with the cars to transfer booking and billing information. Using GPRS, this server can contact the cars over the internet, while also being equipped with a hardware GSM modem to facilitate the transfer of data by SMS in the event of a low GPRS signal. The server also hosts the carshare and booking website and collects the billing information. Careful thought must be given to making the booking software on the server user-friendly for both the carshare management and members.

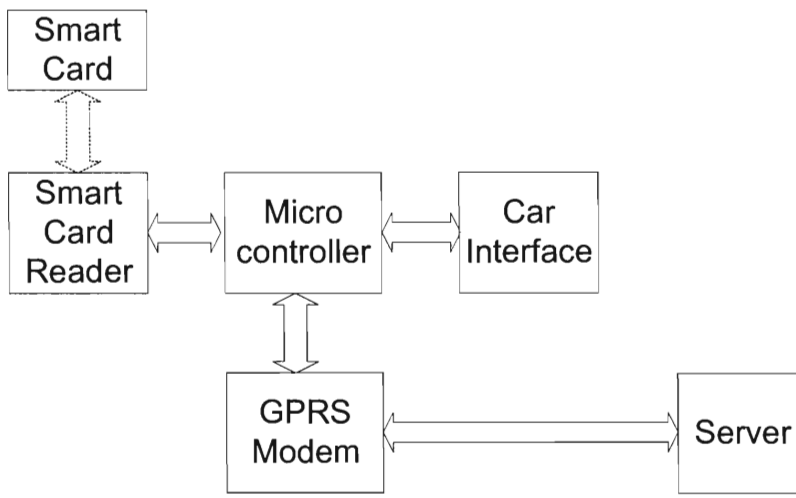


Figure 2: Telematics System Block Diagram

5.3.2 Hardware

In this section, the technologies under investigation for use in a carsharing telematics system are discussed in depth. For a more general overview, please refer to the previous section.

5.3.2.1 GPRS

General Packet Radio Service is a relatively new cell phone standard which allows for data transmission over cell phone networks, and is an improvement to the Global System for Mobile communications (GSM) cell phone standard. These standards are used extensively throughout Europe and increasingly in the United States (GSM World: What is GPRS). Coverage in Denmark should not be an issue.

Most modern carsharing systems are built around a GPRS modem to facilitate the transfer of booking and billing information between the main server and the individual cars. This allows reservation data to be sent to the cars to control vehicle access, as well as allowing trip data and billing information to be sent back to the server after the trip is over. Additionally, communication with the cars gives the carshare management the ability to give new members car access instantly or block problematic members, for example.

There are two main options for purchasing GPRS modems for use in electronic devices. One known as a "module" is just the modem itself, typically designed for printed circuit board mounting, solder connections, and "internal" communication connectors. The other option is to purchase a GPRS "terminal" which is built around the module but also includes a Subscriber Identity Module (SIM) reader, standard "external" serial port connector, power and antenna jacks, and a case. Most terminals can be powered directly off of a 12 volt source such as a car electrical system. Note that an inexpensive external antenna is required.

Subscriber Identity Module, or SIM, is a type of smart card used in cell phones to store a user's phone number, address book, and text messages. The SIMs necessary for carsharing GPRS systems such as Eileo's are Machine to Machine (M2M) cards with 1-5 MB of data transfer per month (Eileo email 4/7/05). GPRS service currently costs approximately 8 DKK per MB which would mean a maximum of 40 DKK per month per car to use GPRS (Dirchsen email 4/11/05). A desirable feature of GPRS data calls is that in addition to having a phone number that can be dialed, the GPRS modem also has an IP address and therefore can have data sent to it as if it were on the internet, greatly simplifying the computer-GPRS interface on the server end. Note that it would be wise to still have a hardware GSM modem attached to the server for SMS backup when GPRS signal is low. Although real world data transfer speeds are much lower than the 171.2 kbps theoretical maximum, the speeds are much greater than is necessary for the carsharing application (GSM World: What is GPRS).

The external serial data port usually used on modems and other devices to communicate is called RS232 (also referred to as V.24) and the connecter is a standard DB9. The modems can typically be controlled through this port using common European Telecommunications Standards Institute (ETSI) compatible AT commands (Dahmen). This makes it a fairly easy job to communicate between a microcontroller and the modem in the car.

Finally, it is very important to consider the electrical power requirements of the GPRS modem because in order to receive information from the main server, the modem must be on and working at all times, even when the car is off and the alternator is not producing any power. Most of the modems the group has investigated have a high peak power draw (~ 1 Amp at 12V) while transmitting data,

but also have a fairly low power draw (~ a few milliamps at 12V) while in idle mode. Further electrical considerations are discussed in this chapter (Electrical Considerations 5.3.2.6).

5.3.2.2 GPS

Global Positioning System, GPS, can be used to track a vehicle's position across the globe. This satellite based service is provided for free by the United States government. The most relevant application of GPS to carsharing is for locating shared cars at any time anywhere, in the event that a car were stolen or not returned on time. It could also be useful to pinpoint a car on a city map so that a user could easily find where the car is parked, and distance information could also be gathered through GPS. GPS would not be very difficult to implement electronically, as there are many GPRS modems available which have GPS built in as well for an additional cost. The main disadvantage of GPS technology is that some members may be uncomfortable that someone at the carshare would always know exactly where the member was at all times. This is seen by some as a nice security feature and by others as a breach of privacy and would have to be taken into account before considering the use of GPS for Copenhagen Carshare. Member responses to a survey question along these lines provided no strong opinions either way.

5.3.2.3 Access Control Devices

Since one of the largest issues with carsharing is car access, methods by which to limit access play a key role in the design of a more efficient carsharing system. Many types of access control devices exist which can be adapted for use within a carshare system. However the designs should stress the ability to identify each

member individually, allow access without invasive installation into a vehicle, be secure to prevent theft, and be an economic solution.

Smart Cards

Smart cards, though resembling credit cards in appearance, are actually small microprocessors. They are becoming the next generation of security for applications like credit cards, information storage and management, and access control. Embedded Integrated Circuit Chips, or ICCs, serve as microcontrollers, or mini-computers, and are what make the cards "smart." Memory stored on the card can be processed in the ICC, which also contains a chip operating system, communication software, and encryption algorithms. The ability to process and protect the information on the smart card makes smart cards a safe and useful tool for access control applications.

There are three major classifications of smart cards: Memory-only, Wired Logic, and Secure Microcontroller (Holcombe 18). Memory-only ICC cards have no processing ability and mirror the function of magnetic stripe cards, such as traditional credit cards. Wired Logic ICC cards have predetermined algorithms built into the structure of the chip on the card. Finally, Secure Microcontroller ICC cards have a microprocessor, an operating system, and memory, giving the card the ability to store and change the processes affecting the data on the card (CardWerk).

Both the Secure Microcontroller ICC and the Wired Logic ICC smart cards have the desired abilities to safely and effectively work as access control devices for a carshare because of their ability to encrypt, and to store the necessary amount of data. However the Wired Logic ICC cards are not commonly available. Memory-only ICC cards should not be considered because of their inability to protect the data on the card. Considering the many features on the Secure Microcontroller ICC cards,

reasonable cost, and commercial availability, Secure Microcontroller ICC cards prove to be the optimal choice of smart card for the carsharing application.

Readers

Interfacing with the card holds benefits over other memory storage and access control devices since both contact and contact-less interfaces exist. With contact interfaces the card exchanges data with a card reader via a conductive surface on the card. Radio frequency waves send data for the contact-less versions, within a proximity to the reader up to one meter, but generally within 10 centimeters (Holcombe 22). Hybrid and Dual-Interface cards exist which contain both methods of data transfer, either with two separate chips with one for each method, or both methods connected to the same chip, respectively. The card readers supply the necessary electricity to the card for the data transfer through induction. In general the card readers and writers are small, about the size of a Personal Data Assistant, or PDA, and are commonly wall mounted for door access, or are designed for desktop usage. Direct-wiring, USB, serial port, and PCMCIA, are among the interface connections available for these devices.

Smart card readers are simply intermediaries between the smart card and a host server. The host server is a computer such as "a PC, a network device, or a stand-alone access control device" that processes the information sent from the card, and generates a response (Holcombe 20). Two types of intermediary systems exist, transparent and standalone. With transparent smart card readers, the reader requires an input from the host server for any signaling between the card and the reader to take place. The reader only powers the card, and pulls the unprocessed data from its memory. Standalone readers have the ability to initialize the cards, and to process the data before sending it to the host server.

Transparent readers are relatively inexpensive and easily adaptable because they do not perform any processing functions as these are all executed by software on the host server. Standalone readers have generic methods to retrieve information built into the hardware and are normally more expensive. When determining which to use, one needs to consider the potential need for future upgrades or changes, and the development versus hardware costs. Flexibility in the system can be important to the carshare in the future should a need arise to change the type of information retrieval. Transparent readers will require increased development costs but decreased hardware costs, which might be beneficial considering the potential to get extremely inexpensive, if not free, development. However, standalone readers can read many commonly used, and standardized interfaces, and would probably have the ability to read any interfaces the carshare would consider. The increase in hardware price associated with the standalone readers brings about a significant improvement in development time and costs. In the end, the developers must weigh the importance of flexibility, time, hardware costs, and development costs.

Reasons for Usage

Smart card technology, though relatively new, is economic and reliable, the desired traits of any access control system for a carshare. The contact-less accessibility allows for a smart card reader to stay safely within a shared car and allows for non-invasive installation of a reader within a car. Memory storage space permits every member to have an ID number, an important function for limiting car access and determining member identity. Most importantly, however, smart cards allow for secure access control by allowing encryption algorithms to protect the ID numbers on the cards and by providing billions of potential ID numbers. Smart cards also have some convenience options since they provide enough data storage space for

other information, such as personal member information, to be stored on the card. Fortunately, since smart card technology is so new, and it is a vast improvement over older access control devices, it should not soon be outdated.

An additional consideration in using smart cards comes from a potential future relationship of Copenhagen Carshare with HUR, the Copenhagen Transit Authority. HUR currently plans to look into the development of an integration of the different modes of transportation in Copenhagen under one smart card system. Carsharing is being considered as one of the types of transportation. By using a flexible, transparent smart card reader the carshare should be able to adapt should HUR choose a different smart card system.

5.3.2.4 Microcontrollers

The "brain" of the in-car electronics will be a small microcontroller. Raw speed and processing power are not very important in the carsharing application. Rather focus should be put on serial communication to external devices and low power consumption. The microcontroller should also either carry enough flash memory to store temporary reservation, user, and trip data, or have external memory available. Most modern microcontrollers carry between 512 bytes and 16 kilobytes.

Power consumption for most modern microcontrollers is generally very low, at around 1-5 mA at 1 MHz at 5V. RS232 serial communication for a GPRS modem or smart card reader necessitates one or more USARTs (Universal Synchronous Asynchronous Receiver/Transmitters) which can be found in most microcontrollers.

While central to the in-car telematics system, the choice of a specific microcontroller is up to the engineer as there are many available which could function well. There are many suitable chips on the market such as Motorola MC, Microchip

PIC, and Atmel AVR. If an interface with a car's CANbus is to be used, both Atmel and Microchip provide a line of chips with onboard CAN controllers.[2]

5.3.2.5 Car interface

One of the key areas of any carsharing electronic device is the interface to the automobile electrical system. Through this, the electronics receive electrical power, read information about distance traveled, control the door locks, and possibly control the car immobilizer system. Originally, the group hoped to propose a system with completely non-invasive installation in the cars, but in talking with VW mechanic Kim Foldal, it was readily apparent that this is not easily feasible.

OBD and CANbus

The group's original plan called for the electronics receiving power, accessing car odometer readings, and controlling door locks through the OBD port using CANbus. CANbus has in recent years been used more and more to control electrical devices in cars and other industrial applications, using simple digital serial communication over a two wire bus. The advantage of using CAN in cars is a significant reduction in weight of the wiring harness of the vehicle, and that through CAN, it is possible to access the vehicle's main computer to retrieve information and control devices. The group originally looked into CAN and OBD because there would be no hardwiring of carsharing electronics necessary, as there would only be one plug-in connection.

The group's plans were somewhat thwarted, when it was learned from Foldal that only the newer VWs and a few other cars even have CANbus accessible in the OBD port, and even then it would not be practical to control the car in this way. For example, while the power door locks can easily be controlled through the CAN

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[2] Information gathered from the commercial websites of Atmel, Microchip, and Motorola.

connection, the car must be turned on to gain access to the car computer and accomplish this action. Once a connection has been established, the car may be switched off but will "go to sleep" 30 minutes later and no longer be under external control. Clearly this is not a feasible way of controlling the door locks. Furthermore, while the distance driven may be retrieved from the CANbus (if present at the OBD), a much simpler way is to simply record odometer pulses from an easily accessible wire going to the car radio (for speed-dependent volume control). In this same wiring harness an unswitched power wire can be found. While this method does require connecting directly to the car's wiring harness, there would be no effect on the car and the invasiveness of the installation would be very minimal (Foldal 4/18/05).

Key Immobilizers

The mechanic also provided the group with some very important information regarding modern car keys, immobilizers, and alarms. In addition to wireless lock/unlock key fobs, all modern cars have 'smart' keys with a wireless electronic identification device embedded in the plastic handle. The immobilizer system will not allow the car to start if this device is not present. Traditionally, cars have required the key to be in the ignition, but a new generation of cars are arriving with "keyless entry," which simply requires the key (with electronic ID) to be somewhere in or near the car and not necessarily in the ignition. With the traditional system, if the door of the car is mechanically unlocked without using the wireless key fob, the alarm will go off if the key is not placed in the ignition within 30 seconds. This would make controlling the power door locks impractical through a hardwired connection (in addition to the excessive hassle of directly modifying the wiring harness) and thus necessitates a more complicated method for door control (Foldal 4/18/05).

Door Lock Control

The discussion with the mechanic spawned the idea of modifying the wireless key fob for permanent installation in the carsharing electronics. In this way, the power door locks could easily be controlled simply through the vehicle's existing transponder system, eliminating the need for serious invasive installation beyond a few wire connections for power and odometer readings (Foldal 4/18/05). The alarm would also be disabled when the doors were unlocked by the key fob. Building the key transponders into the carsharing electronics would be very easy, but alternatively, inexpensive. Microcontrollers exist which would enable a custom wireless transmitter to be built to transmit the door lock/unlock code at the correct frequency.

5.3.2.6 Electrical Considerations

It is important to consider the electrical power requirements of the entire in-car electronics system, because some components of the system must remain active at all times, even when the car is off and the alternator is not producing any electricity. The risk here is that if the car is parked and not running for a long enough time, the electronics could potentially drain the battery to the point that there would not be enough energy left in the battery to start the car. The most worrisome components in this case are the smart card reader and the GPRS modem. However, employing a low power or cycled mode for the system would save battery power when the engine is off, and it would also be simple to make the electronics send a "low battery" warning to the main server if there were a risk of the battery dying.

After researching the power requirements of the various components, the group was able to put together a very rough estimate of the power requirements of a basic system (Appendix U). The peak current requirements will probably be

approximately 0.3 to 1.5A (3.5 – 18W), although this is no concern since the time period is negligible when the car is off, and power is readily available when the car is on. The more significant area is the nominal power draw when the car is off.

Depending on the specific components selected and the specific circuit design, the best and worst case nominal current draw of the complete system should be 25 to 115 mA at 12VDC (0.3 – 1.4W), *assuming no low power mode.* This is equivalent to 0.6 – 2.75Ah per day. Assuming an minimum of 40 Ah for an automotive battery (at 25A – the battery will have much greater capacity at lower current draws), this would give a maximum parked car time of 15-66 (worst-best case) days, although at the end of this period the battery would probably be to low to start the car. It is unlikely that the nominal power requirements would be as bad as this worst case, since the components and circuit can be designed to minimize power consumption and extend the period of time the car can be parked. Of course, in the carsharing application the cars are used almost everyday so this should not be too great an issue.

The greatest power requirements are those of the smart card reader, since it must remain active at all times in order to read a member's card. One technique which could be used to save power is to cycle the reader on and off with a particular duty cycle. That is, the reader could be turned on for one second, then off for one second (50 percent duty cycle) which would use about half the power as continuously running the reader. The problem with this is that a member would have to keep his smart card near the reader for as long as two seconds for it to be read. However this should not pose a large problem. In conclusion, the basic calculations performed here are not terribly accurate and include a large range of powers and currents. In the final design, components should be selected for the lowest power consumption to reduce the risk of discharging the battery excessively (Appendix U).

5.3.3 Software

The following section discusses the features and attributes which the group feels are important for a carsharing booking system, and how some may be implemented into new software.

5.3.3.1 User interface

The booking and billing system of Copenhagen Carshare must be both simple and effective for use by its members. It is common that websites are designed from the designer's perspective rather than for the needs of the everyday user (Hobart). However, by applying a carefully designed graphic user interface (GUI), ease can be added to the user's navigation through the website with the computer's graphic capabilities (Graphical User Interface).

Many user interfaces for websites exist. However the use of graphic icons and menus can bring simplicity to a website since they can simplify navigation to mouse use only (Hobart). The drawbacks of a keyboard come from a lack of standardization, for example in entering a time of day for a reservation. If an individual would like to reserve a car at four o'clock in the afternoon should they enter; 4p.m., 4:00, or 16:00? This confusion can be avoided by having a drop down menu displaying times for all 24-hours of the day, for example.

The use of GUIs allow a program interface to take full advantage of the computer's graphic ability. This makes the website user-friendly since graphical representations are immediately identifiable by users, regardless of their technical capabilities (Graphical User Interface). Overall, designers must remember that a user needs to use something quickly and easily in order to get their tasks completed. Alan

Cooper, the "father of visual basics", reminds the designer to "imagine users as very intelligent but very busy" (Roe).

Minor changes to the layout, loading, and consistency of a webpage have dramatic effects on the usability and friendliness of any website. Placement and layout of icons, fields, and information is critical for trouble-free navigation. Symmetry used in the placement of fields, informational boxes, and buttons improves page layout. In addition, important information should be placed in the upper left of the page while the least important information should be in the lower right (Hobart).

In order for the user to navigate quickly without returning through superfluous pages, a navigation toolbar should remain on the "parent page," a portion of the page which never changes, ensuring accessibility at all times. This navigation toolbar should contain a hierarchy of options for the user to effortlessly use the booking and billing system when reserving a shared car (Hobart).

Confusion often arises when entire webpages are redrawn on the monitor for only a small change of displayed data somewhere on the page. An update should take place on a "whole-screen" basis only when the user has confirmed that all fields have been filled (Hobart). In addition, user-entered field information should be stored and redisplayed when a user leaves and returns to a page, for the efficient implementation of minor changes. Reloading should also not take place on the parent page if possible to avoid suspicion that an external page, that is a page outside of the website, is being loaded.

Visual consistency plays a key role in the user's ability to establish comfort with a website. Word choice and usage should be characterized by uniformity. For example, a carshare's booking system when referencing a "car," "automobile," or "vehicle," should always use the same word, not all three at various times. Other

visual signals such as navigation icons, color schemes, and text formats should also remain constant from page to page. It is important that the basic design be decided at the beginning of the design process since it may be time consuming and costly to correct later (Hobart).

If not to promote consistency, one should avoid the use of pop-up dialogue boxes to prevent disorder. Pop-up boxes often distract the user and block information displayed on the page (Roe). For example, a pop-up calendar could block availability dates on the window below.

Feedback from both the management and members of Copenhagen Carshare concludes that the current booking and billing system needs improvement. The interface issues raised by both parties concerned navigation, and fields not storing entered data. While the member survey concluded that most members find the system satisfactory, the focus group confirmed that the interface, not the functionality, needs improvement.

Booking System

A well designed booking system should be both user-friendly and intuitive. The members feel that the current booking system could be done in a "smarter" way (Member Focus Group 4/5/05). Through the analysis of the current booking system, recommendations for a new system have been established.

Currently, the booking system only allows the member to reserve a car by date, time, and certain car type. The members feel that it would be more helpful if they were given multiple options by which to book a car. In general users should be able to reserve through three strategies: by car or car type, by time, and by location.

This allows members to access cars efficiently by need, whether it be type of car, or availability.

Reserving by car type allows members to constrain searches for available vehicles of the desired type or style, such as a van or station car. Some members might prefer not to drive a certain size or type of vehicle. Additionally, members familiar with certain vehicles may wish to choose to reserve a vehicle which they already are familiar with. Currently the names which reference the vehicles are confusing and long. By giving each car a unique name, for example "Lucy Lupo," familiarity can be established with vehicles. This promotes the establishment of a visual relationship with the cars. Also when making a reservation by car type it is important that the members be able to understand the size and capabilities of each car available through the carshare. Therefore, the website should display pictures of each car available as well as a description of seating and cargo space. This graphical image would allow the members to immediately understand the difference between a VW Lupo and a VW Caddy, for example.

There are many common calendar setups for reservation by time. However ease and comprehension play important roles in the decision. Currently, the system requires users to input the vehicle they wish to use and the times they wish to use it. Reserving by time should be separate from reserving by vehicle, since usage can be independent of car type. Both long term reservations and short term reservations have to be supported effectively by the system and add difficulty to the design. Interactive calendars allow for members to avoid using long drop down menus. One should use a design that starts on a macro level and works down; for example, users select from a monthly calendar the days which their reservation will include. For the selected start and end days the user will then select the hour that the reservation will start and end.

By using location searches users will be able to more effectively reserve vehicles even if they don't often reserve from a certain area. The system should require no need of familiarity with car location such that any new user can navigate as fast as an old user. A member could then reserve a car from a friend's house without already knowing the closest carshare car site or needing to find it in person.

To complement this system, and to eliminate the need for familiarity with car locations there are two interactive features that can be added to the website in order to increase the usability for the members. Cars can be displayed on printable maps upon the user's request, and directions to car locations can be incorporated into the reservation process. Maps of car locations can be added by simply including the krak.dk (a Danish map website) and rejseplanen.dk (public transportation travel plans website) links to the Copenhagen Carshare website. This would save the users time in planning their own trip to the vehicle locations and make cars attractive for those users who are not familiar with the entire fleet by understanding their accessibility. Another consideration might be to list the closest gas station location for each shared car. Note that there would be fees associated with links to these websites.

Members have requested the option of being able to cancel a reservation for a portion of the time they reserved the vehicle for and, also, once the reservation time has started. For example, if Member A books a car from Monday at 11:00a.m. through Friday until 8:00p.m. he currently can not cancel his reservation starting after the start time on Monday morning. The members would like to be able to cancel reservations for two reasons. First, if the car is no longer needed they would like it to be available to other members of the carshare.

Second, a member suggested that, when booking a car in advance for an entire week, he often only needs to use the car for three days of the five. Once he decides

which days he is in need of the car he would like to be able to "free up" the car for another member for the other two days of that week (Member Focus Group 4/5/05). Allowing the members the option to cancel a reservation once the reservation time has begun will allow the member to save money and will benefit other members of the carshare by making unused resources available again. However, in order to insure that members do not abuse their ability to cancel at anytime, fees for canceling should still be imposed.

Another area of confusion for the members stems from the continual listing of extra cars in the booking system. These extra cars are used periodically throughout the year during high demand times such as holidays and the summer season. While the cars are listed they have an "unavailable" status. They must remain in the booking system for billing purposes since a car can not be billed if it is not in the system. However, based on member response, hiding the extra cars when they are no longer available would be a needed feature in the new booking system.

An additional point that arose during the focus group with members of the carshare was that they would like the booking system to display more information for current reservations. They feel it would be useful to have or be able to access contact information for members who have reserved the car both before and after their own reservation. This would have the potential of eliminating confusion when the car can not be parked within a visible distance of the key box or it would allow members to inform the next reservation that a car has been dropped off earlier than expected. However from a management perspective, there is a large issue with this request, member privacy. Members have a right to keep their privacy in regards to contact information and rental habits. While the carshare promotes member interaction and involvement in the organization, it must always consider confidentiality.

Billing System

The current billing system requires improvement in three areas to create a user-friendly and efficient system: pricing structure, billing appearance and dispatching, and online billing.

The pricing structure within the billing system is not consistent and forces the user to manipulate their reservation in order to achieve a fair price for the hours needed. For example, a member can reserve a "stor bil," or large family car, for five hours and pay 100 DKK. However, a member can reserve the same car for 6-hours and pay only 50 DKK (Københavns Delebiler Booking). It is important that the billing system be consistent.

The billing information that is received each month is confusing for the members. The focus group discussion indicated that the printed bills are often hard to read since the text is overlapping and disorderly (Member Focus Group 4/5/05). Considering the carshare's environmental policy and the prerequisite of all members having internet, it seems practical, if not essential, to consider online billing. Members would also like to see the kilometers they have driven to date, as well as the fees paid. This would allow each member to determine personal cost effectiveness of the carshare versus personal car ownership (Member Focus Group 4/5/05).

A final consideration for the billing system is that the members would like to use online billing to pay their monthly bills. The members at the focus group feel comfortable with online bill paying and believe it is much more convenient in terms of time savings (Member Focus Group 4/5/05).

5.3.3.2 Development

When developing new software there is always the debate of whether to choose open or closed source. It is important to investigate and understand the advantages and disadvantages of both classes of software, in addition to the reason for creating either classification.

Open Source

Open source is a form of software that allows users access to the original source code from which a computer program is compiled. This access along with a license allows programmers to read, use, redistribute, and modify the source code in the hopes that the software will evolve over time (Open Source).

First it is important to understand the reasons for producing open source software. Motivation arises from the passion for making software that can positively contribute to those who can either not afford commercial software, or for those who do not like being dependent on a company (Grant).

The advantages of open source software can be evident to even the most non-technical user. With countless programmers being able to access and modify the program, extra features can be added and errors can be fixed without having to wait for original software publisher to release a newly improved version ("Open Source Software"). This can allow for programs to not only be developed and modified with amazing speed but customized for individual use. It has been found that the evolution of open source software is superior and quicker than software developed with the traditional closed model (Open Source). In addition, this type of "peer review" is found to be more reliable since contributions and verifications in the programming community are open to both amateurs and professionals ("Open Source Software").

In addition to speedy improvements there is a large advantage in the price of open source software given that it is often very inexpensive and, sometimes, even free. However, the main advantage lies in the power of the consumer. Software that is open source creates competition and provides options and independence to the consumer. "In an Open source world nobody gets to hold you, the customer, to ransom" (Cox).

A disadvantage to using open source software is that it comes with no warranty or guarantee. Therefore, if it does not work, there can be no legal action taken towards an individual or a company (Grant).

Closed Source

Closed source refers to programs that do not have a distributed source code. This makes the software practically impossible to modify since only the binary version will be distributed to the customer. The source code is protected as a "trade secret" of the company that created it. Today closed source software dominates what is produced in the commercial industry (Closed Source).

The benefits for developing closed source software are very different from that of open source. The main incentive for the developer is that he can sell his product and achieve monetary growth. This is because once software is created it can be distributed and copied as many times as needed with little added materials and effort. In addition, when purchasing closed source software one receives assurance that the product will perform as advertised and not malfunction (Grant). Along with the program comes quality documentation and support.

A disadvantage to having a closed source system is that an organization becomes dependent on its software provider. The software developer can, without

warning, increase its prices and make it difficult for an organization to refuse an expensive upgrade (Cox).

There has been an ongoing discussion on whether the booking system of Copenhagen Carshare should be open or closed source. Through interviews with IT professionals and current providers the group discovered the concerns involved in having the booking system be either open or closed source. The professionals which contributed most to this continuing dialogue were both a member and an IT professional, Michael Zedler, and the current provider of the booking system for Copenhagen Carshare, Hans Kjer of Net Image.

Zedler was interviewed by the group concerning his interest in working on developing a new booking system for the carshare. Within the last few months he has been in contact with Kjer concerning the current booking system. He has proposed that it should be available as open source, and if it were he would like to contribute to its ongoing development (Zedler 4/12/05). However Kjer has declined, as of yet, to offer the current system as open source. He does not see how he could maintain a profit for his company (Kjer 4/19/05).

If software were to be custom developed for Copenhagen Carshare it is suggested an open source system is created. There are three reasons for this suggestion: free contribution from the community, independence from a software provider, and standardization of carsharing software in Denmark.

Despite the niche market for carsharing specific software, the global growth of carsharing has resulted in interest in open source software for non-profit carshares. For the carshare itself, Zedler was very interested in contributing his IT professional experience to a booking system for Copenhagen Carshare and also has the capability to find other competent developers willing to participate. He has also given a good

amount of thought to what he would like to see in a new booking system. As both a professional programmer and a member of the carshare, his input would be extremely valuable in developing a new system.

Currently Copenhagen Carshare relies on Net Image's booking system, and recently ordered an update to the software to help handle the demands of the increasing growth of the organization. With any closed source system the carshare depends on the schedule and price charged by the vendor. If there were to be a new system developed two suggestions would be made. *First*, the project should include open source coding in order to allow for continual updates by both interested professionals and members, at added no cost. *Second*, a common business strategy should be utilized and that is to put the project out to bid. This would ensure the lowest development cost for Copenhagen Carshare. Independence from a closed source system or commercial institution could be a safer and more cost effective investment for the carshare.

Due to the desire to standardize carsharing across Denmark, one must consider input from all the carsharing organizations. What better way to receive contributions than by having an open source software system? Each carshare, regardless of size, can help contribute in the creation of the design and functionality. Additionally, if professional consultation is used, the price can be split amongst all the organizations.

However, "closed source software is created to satisfy the need in the market" (Grant). The booking systems of Elieo and Invers were developed specifically for carsharing needs. Since software is already readily available creating a new booking system may not be in the best interests of Copenhagen Carshare in terms of development cost and schedule.

A closed source system developed by one individual or company, would take both time and money. This would also require that the carshare continue their dependence on a developer. If the booking system were to be developed as open source this would also require a large amount of development time. Zedler would like to give his professional experience. However given the cause of the organization he would not want monetary payments in return (Zedler 4/12/05). Therefore, this project would be completed in his spare time. Given the current growth of the organization it would be impossible to follow such a time table.

Enterprise Resource Planning

Enterprise Resource Planning (ERP) involves the integration of all software functions of an organization into a single computer system. By integrating the software into one system, users have only one interface system to learn, and no inter-program stability issues arise. More specifically, Copenhagen Carshare would have a program that would serve as both a booking and billing program. If they were indeed separate programs they would need to be updated separately from each other in order to share important information. However, ERP would allow a new member to be entered into both the booking and billing system at the same time with no updates required.

The disadvantage of ERP in general is that it takes time to establish within a company or organization. This is because the way business is conducted and the way workers work is all changed because of the capabilities of programs that are fully integrated. However, this should not pose a problem for Copenhagen Carshare given the size of the organization. With very few employees to consider, integration of the software should take no additional time compared to any other new software. In

addition, with its ability to integrate customer, booking, and billing information the time savings in the end will be worth the establishment of the a program which has ERP (Koch).

5.4 Major options

Through extensive research and investigation, the group has considered four possible options for the recommendation of upgrading the existing technology used by Copenhagen Carshare. The major options vary in cost, complexity, features, and feasibility including: *Net Image "SmartPhone," Invers, Eileo, and custom development.*

5.4.1 Net Image "SmartPhone"

The Danish company which developed the booking system currently in use by Copenhagen Carshare has developed a new carsharing solution, the "SmartPhone" system. The core of this system is a GPRS enabled cell phone which is placed in each car, with custom software installed for the booking and billing system. Upon entering a shared car via a traditional key box access system, the user keys in his member number on the cell phone. The booking system then confirms the reservation and informs the user of his status. If the user does not have a reservation, the cell phone will inform the user that they are not authorized to use the vehicle. After using the car, the authorized member enters into the cell phone the distance driven (can be automated with use of GPS) and the data is sent back to the billing system. In this setup, the booking software is similar to the current version, but upgraded with new features and improvements in order to interface with the cell phone (Kjer 4/19/05).

5.4.1.1 Advantages and Disadvantages

The advantages of this system are that the cell phones can easily be moved from car to car with no electrical wiring or complicated installation necessary. Given that extra cars are used during high demand times, it is desirable to have a system which can be moved freely with ease. In addition, the cost of the system would be relatively low compared to some of the higher-tech solutions. The system also offers features such as the ability to make or change reservations from the car, through use of the "SmartPhone."

The main disadvantage of this option, is that it still relies on key boxes and, therefore, there is no member access control to the vehicles, leaving the same security and unreserved use issues as before. Furthermore, the user must still enter the distance driven on the cell phone manually (unless it is equipped with GPS), which is the second main reason that the group believes that this "SmartPhone" system is *not* appropriate as the main technology solution for Copenhagen Carshare. However a similar, perhaps simpler, cell phone system could be useful for extra cars during busy seasons.

5.4.1.2 Cost

While the group was unable to extract an exact price quote from Kjer, founder of Net Image, it did learn that the price for approximately 15 cars was roughly 50,000 DKK. This price includes the cost of the phones and the booking and billing software (Kjer 4/19/05).

5.4.2 Invers

The oldest, most well known, and largest provider of carsharing technology in Europe is Invers, a German company formerly focused on company fleet vehicle management. Inverse offers "COCOSoft" booking and billing software, a full-featured "Keymanager" electronic key box system, as well as a "Standalone" individual car access control system. Today Invers products are in use by around 70 carshares, including Hertz Carsharing Denmark, (Carsharing Network) and an estimated 130,000 end users around the world (Invers: About Us).

Software

COCOSoft software for the Windows operating system provides online and/or cell phone booking, automated billing, and all associated tasks and touts a "user-friendly" multi-language interface, although after observing the systems use, the group does not entirely believe this claim. The software is designed to be used in conjunction with Invers' in-car hardware. The software contains five parts:

CocoBoss - A database of customers and vehicles

CocoBook - Booking manager for the organizers

CocoBill - Billing

CocoWeb - Internet booking for customers

CocoWap - Cell phone booking for customers

Additionally, the software handles booking of accessories, such as bike racks or trailer hitches, blocking of reservations during maintenance periods, periodic reservations, and automated billing (Invers: Products: Software).

Keymanager

Another system offered by Invers, which is not of much interest to Copenhagen Carshare but is still worth mentioning, is the "Keymanager." This package is aimed more at centralized fleet or carpool use, and this modern key box system uses an electronically controlled key box with a small board computer in each car. Booking information is sent electronically to the key box, which only releases keys to a particular car to the person who has booked it at that time. Secure access to the keys is gained through smart card ID, and identity is verified in the car. Trip data is logged onboard, and is transferred to the central server from the key box rather than the car, using a "smart" key fob to communicate with the car's board computer (Invers: Products: Keymanager). This key box based access system saves some money by eliminating the need for GSM or GPRS modems in the cars. In addition, it is an economic choice over individual car ID systems where multiple cars are parked within the same area. However, the system still requires a complex installation (Pedersen 4/13/05).

Standalone

The COCOS Standalone system is meant to be a complete system for controlled vehicle access and data logging. It consists of a board computer which is installed in place of the car radio, a GSM communication system which "talks" with the company's software, and a smart card reader for individually controlled vehicle access. After making a reservation, a member need only hold his smart card near the reader for a few seconds to unlock the car. The member additionally has a PIN, which is used for identification inside the car to retrieve the key from the locked holder which is located in the car's glove box. Onboard data logging provides information for billing which is automatically sent to the main server at the end of the booked

period. The in-car hardware includes a built in GSM cell phone and radio. Invers claims to have designed the Standalone system to be compatible with any car with power door locks, although the installation is quite complicated (Invers: Products: Standalone).

5.4.2.2 Advantages and Disadvantages

While the company Invers and its products are well-established, well proven, and functional, the group feels that Invers' products will *not* be appropriate or desirable for Copenhagen Carshare. First to consider are the excessive and complex installation requirements. When the group met with the Administrative Director of Hertz Carsharing Scandinavia, Pedersen, he mentioned how Hertz had run into some trouble getting Invers' system installed in many of their cars, particularly a Volvo station wagon which had been at the mechanic for over a week (Pedersen 4/13/05). Even when the installation went smoothly, it was still quite complex, time consuming, and expensive and wiring diagrams for each vehicle were required from the manufacturer. Furthermore, in the opinion of the team Invers' products are over featured and over complicated for the needs of the carshare. This, of course, is reflected in the cost of the systems.

The group observed the Invers booking, billing, and management software. While functional and full-featured, the group felt that the system was excessively complicated and not very "user-friendly" from the management point of view. Finally, Hertz has been trying to persuade Copenhagen Carshare to form a partnership. Since the companies follow different missions, the administration of the Copenhagen Carshare has made it clear that a partnership would be resisted.

However, it has been discovered that Hertz owns the rights for distributing the Invers system in Denmark (Pedersen 4/13/05).

5.4.2.3 Cost

Despite having contacted Invers many times beginning in January 2005, both as students from WPI and representatives of Copenhagen Carshare, the team has been unable to get any sort of price quote from Invers. However, the company did invite the management of Copenhagen Carshare to a one-day, 800 workshop, in Germany. From speaking with other carshares in the United States, it is the understanding of the group that Invers' products are very expensive and perhaps more suitable for large corporate fleet use. Furthermore, Hertz Carsharing has the distribution rights for Invers products in Denmark, so Copenhagen Carshare would be forced to purchase the products through Hertz if this option were chosen (Pedersen 4/13/05). Of course, in addition to the cost of purchasing or leasing the hardware and software, there would also be the usual usage fees for the server and GSM communication. Invers offers very complete, proven hardware and software, but it is probably not a good fit with the needs and resources of Copenhagen Carshare.

5.4.3 Eileo

A relatively new contender on the European Carsharing technology market is the French Company, Eileo. Eileo offers individual car based carsharing products similar to those of Invers, but at a lower cost and with a claimed far less invasive installation. The product which the group has investigated most fully for the use of Copenhagen Carshare is the ZiboxLT, a low cost version of the company's more full featured product, the ZiBox. ZiboxLT has a minimal installation, interfaces with the

car's immobilizer system, controls vehicle access via a smart card reader in the window, records distance driven, and communicates with the main server through a GPRS modem with SMS backup. All booking and billing software is hosted by Eileo and bills are generated automatically, although it would be possible for the carshare to host the server if so desired (Eileo: ZiboxLT).

Eileo offers four main products, the Zenon internet booking and billing server, ZiBox GPRS car radio/computer, ZiboxLT, a low-cost embedded car computer, and Zelec, a system with options for sharing electric vehicles (Eileo: Technology).

Software

The Zenon server is in many ways similar to the software offered by Invers: it allows easy online booking, communicates with in-car hardware, and generates bills automatically once a month. However, it appears that Eileo's software is better organized and more user-friendly for the management than Invers'. Eileo uses what it calls a "Tribal" system, where it "organizes people in a community…which facilitates the sharing of resources. Drivers, passengers, cars & parking lots are affiliate to a Tribe" (Eileo: Zenon). This could be useful for organizing carsharing in Denmark with "tribes" in Farum, Århus, and Copenhagen, for example.

Zibox

Eileo's equivalent to Invers' "Standalone" system is the "Zibox" embedded GPRS enabled car computer/radio. While the Zibox is most likely not appropriate for the Copenhagen Carshare, it is worth mentioning. The system includes a large dashboard-mounted color LCD, which can display text to guide the user of the car through the process and also can display trip data and fees. Like the Invers system, Zibox also includes a hands-free GSM cell phone for communication to the central office and an RDS radio. A clever money saving measure that Eileo has built into the

Zibox is wireless communication while parked using WiFi (IEEE 802.11b) wireless data transfer to avoid the transmission expenses associated with GPRS, which is used during the trip. WiFi communicates to a local base station as opposed to a satellite. The car computer can be personalized to the organization purchasing the system and also to each user, storing favorite radio stations and other personal preferences. The user interface is a large color touch-screen and the total system also includes the smart card reader and car radio/computer (Eileo: Zibox).

ZiboxLT

The ZiboxLT is a lower cost, lesser featured, simple version of the regular Zibox. Despite being an "economy" package, ZiboxLT is still based around a GPRS modem to facilitate reservation and trip data transfer between itself and the main computer. A handy feature of this system is the ability to gain car access not only through a contactless smart card, but also with a cell phone call or text message to the vehicle's board computer. The user interface consists of only two buttons, one of which activates an optional built-in phone and the other which the user presses to end his trip. The ZiboxLT system is made up of just one discretely installed box and the card reader (Eileo: ZiboxLT). Installation consists of only a few wired connections behind the car radio and a slight modification of the key to make use of the existing wireless transponder system (Eileo email 4/11/05). GPS tracking is an option for both the Zibox and ZiboxLT systems.

5.4.3.2 Advantages and Disadvantages

Eileo, founded in 2002, is a carsharing technology business with a vision. Its stated mission is to "improve mobility, reduce car costs, and save oxygen" (Eileo: Vision). A quick glance at the company website will reveal that this organization has

a strong environmental ethic, and even offers an integrated hardware/software package specifically for electric vehicle fleet use. Eileo has also made extensive use of open source software to reduce costs and build upon existing, well proven, software. With this in mind, while Eileo's products are very appealing, affordable, and seem to be well suited to the needs of Copenhagen Carshare, it must be taken into consideration that the company is relatively new and does not have the same level of experience and customer base of a company like Invers. Were Eileo's ZiboxLT option chosen, Copenhagen Carshare would be the first non-French user of the company's products and there would be about three days of work to translate the system into Danish (Eileo email 4/25/05). Before the group can recommend this option it would be advisable to observe and test the system in France.

5.4.3.3 Cost and Usage Options

Eileo offers three main options for the use of their products:

> The *first* option is to simply purchase the in-car hardware outright and pay for the use of their remotely hosted server, or host the server locally. There are initial setup, training, and installation costs, as well as a monthly fee to be paid to Eileo for the use of their server facilities and of course a small monthly charge for the use of GPRS (Eileo email 4/7/05).
>
> The *second* option is to rent the hardware from Eileo on a per month per car basis, while still paying other fees for installation and setup, and monthly fees for the use of their server and GPRS. There is also a refundable deposit required for each rented unit and a three-year contract (Eileo email 4/18/05).

> The *third* option makes it possible to use Eileo's products for a one to three month trial period, with the electronics installed in two of the organization's shared cars. At the end of the trial, if Copenhagen Carshare chooses to use the product, they simply outfit the rest of the cars and the system is fully in place (Eileo email 4/25/05).

Since customers of Eileo may choose between Eileo's server or an independent server, different pricing exists depending on the option chosen. The following chart shows Eileo's prices for the server, and the different hardware options.

Eileo Server		
INSTALLATION COSTS		
Server Set-up	750	
Server Training	350	
2-days local support	600	
Server	1250	
PER CAR COSTS		
Zi-box Unite	800	
Smart Card Reader	90	
Hands-free GSM	120	
Pre-cabled	45	
Roof GPS-GSM Antenna	70	
20 Smart Cards	0	
est. Installation	140	
Shipping Costs estimate	30	
GPS	80	
PER MEMBER COSTS		
Smart Card	3.5	
MONTHLY COSTS		
car	40	kr.
Server cost per car	29	

Independent Server		
INSTALLATION COSTS		
Server Set-up	0	
Server Training	350	
2-days local support	600	
Remote Installation	3900	
PER CAR COSTS		
Zi-box Unite	800	
Smart Card Reader	90	
Hands-free GSM		
Pre-cabled		
Roof GPS-GSM Antenna		
20 Smart Cards		
est. Installation		
Shipping Costs estimate		
GPS		
PER MEMBER COSTS		
Smart Card	3.5	
MONTHLY COSTS		
Server Monthly Costs	50	
car	40	kr.
License per car	23	

Table 1: Eileo ZiboxLT Cost Breakdown

Eileo is a strong contender for the recommendation to Copenhagen Carshare. The product seems to be a good match with the needs and resources of the carshare. However, an actual demonstration of the product and its reliability needs to be pursued before any investment should be considered.

5.4.4 Custom Development

The fourth solution the group has investigated is the custom development of carsharing technology for Copenhagen Carshare. This would involve the creation of new booking and billing software as well as in-car hardware.

5.4.4.1 *Advantages and Disadvantages*

The advantage of this solution is that the technology is developed specifically to meet the needs of the carshare, and would therefore be easily customized and be developed in Denmark and in the Danish language. In some respects though, it may not make sense to "reinvent the wheel" here as there are already technology solutions which could work. However, custom development is still a strong option for Copenhagen Carshare as it provides the most possibilities and potentially the lowest cost.

5.4.4.2 *Overall System*

Using the following general components, the group envisions developing a system similar to, but simpler than, the products offered by Invers and Eileo, with smart card based access control, wireless communication with the cars for reservation data, and automated billing. Keeping the electronics and software as simple as possible will reduce costs, complexity, and chances for error, as well as maximize the number of potential developers by not limiting the product with esoteric technologies and components. The components of a custom developed system can be broken down into two main categories: server and software, and in-car hardware.

5.4.4.3 *Server and Software*

Any carsharing system relies heavily on a central server to handle booking and billing. The group's plan involves a server which can communicate with the GPRS modems in the cars via the internet rather than a hardware modem, but also includes a GSM modem to make use of SMS as backup when the GPRS signal is too low. The server must have great enough bandwidth and system capabilities to handle all

member reservations, communication with the cars, and billing calculations (Software 5.3.3).

5.4.4.4 In-Car Hardware

The group has researched many options for in-car telematics, and after careful consideration of the options, the main components of the envisioned electronics have been investigated to provide reliable, secure, and affordable car access control and data logging (Hardware 5.3.2).

GPRS Modem: A GPRS modem, or "terminal," allows wireless communication between each car and the main booking and billing server. This allows the automatic transfer of reservation and billing information. There is an option to use a GPRS/GPS combination modem as well, if GPS services are desired. SMS can be used as a backup when the GPRS service is weak.

Smart card Reader: A smart card reader placed in the windshield of each car allows carefully controlled secure member access to each vehicle.

Microcontroller: A microcontroller serves as the central "brain" of the system, communicating with all other components and performing the necessary digital logic.

Car Interface: Through the car interface, the system receives uninterrupted battery power in order to operate even when the car is turned off. Additionally, through this interface, the system controls the power door locks, records distance driven, and potentially immobilizes the car.

Security

It is important to keep security and reliability in mind when developing these products. One important aspect to consider is the necessity of immobilizing a parked share car, such that if a car were broken into it could not be driven except by a member. The major companies such as Invers and Eileo accomplish this feat with complicated wiring and wireless communication with the car, respectively. If custom hardware were to be developed for Copenhagen Carshare, it would be necessary to create a similar immobilizer setup, or have the keys locked in a box within the car, which only the members could unlock.

Reliability

Another important consideration is the reliability of the software and hardware. The automotive environment is one of the harshest and most demanding on any electronic device due to vibrations and large temperature swings, although carsharing electronics benefit from being mounted inside the cabin. The electronics in the car must be able to withstand these and other potential problems such that the system is reliable on a daily basis as well as being functional for many years. It is also important that the system be able to handle a low battery situation without malfunctioning or becoming damaged. It would be simple to have the system send a low battery warning to the carshare office far enough ahead of time to prevent any potential problems. Achieving very good reliability requires a lengthy development and testing period which the carshare would most likely not have available.

Timeframe

It is very important to consider the timeframe of new product development; design, testing, and production of new products, especially hardware, can take a much

longer time and cost much more than expected. Full-featured and proven products require years of development, which would not be consistent with the timeframe if the carshare were it to develop its own technology.

Examples of the design process which can take significantly longer than expected include researching components in more depth, coding and debugging software, prototyping and testing hardware, finalization of design, and production. For the number of units which would be required by Copenhagen Carshare, especially if Århus or Farum Carshares joined in the development process, it would probably be impractical to build each unit by hand once the design was finalized. This equates to additional waiting time while production is beginning and further problems are resolved.

5.4.4.5 Development Costs

There are three main costs associated with the development and use of a custom system: one time development costs, per-car electronics and installation costs, and monthly usage costs. Custom development has the possibility of either being extremely expensive or inexpensive, since none of the costs are set in advance. The cost of the individual components is certainly quite varied, as new products are always appearing on the market, prices change, and the developer has the choice of buying high end or low end components. This, of course, comes with the potential tradeoff of quality versus cost. A project such as this has the possibility of costing far more than expected if problems occur during the design and testing, on the other hand, if all goes well, the development costs could be fairly low. The costs also depend greatly on the timeframe.

Developers

The area of greatest potential savings is in the labor of developing the system. One option would be to use developers who are capable of a project like this and who are amenable to the carsharing cause and who may donate some of their labor or provide a reduced rate. Another option the group considered was having the system developed by university engineering students. An example of this would be to use WPI students completing a Major Qualifying Project (MQP) during their senior year[3]. Yet another option, which would take a longer time, would be to present this project to an online developers' forum to see if people would be willing to contribute a little bit to the project for the challenge and fun of working on something new. While the feasibility of these last two options are undetermined, they would be worth considering.

Production Costs

One other area which could contain hidden costs is the production of the units. The number of units required is relatively small, but more than could be easily built by hand. This would suggest having the electronics built by an outside manufacturer, and because of the small number of boards these one-time production costs would be likely more significant.

Server and GPRS Usage Costs

In addition to the cost of developing the necessary hardware and software, there will also be costs associated with the hosting of a web server and the use of GPRS. Fees for someone outside the carshare to host the server should not be

[3] An MQP is a senior-year project required for completion by all Worcester Polytechnic Institute students. The project must be completed within the students' field of study.

excessively more than they are currently, although they may be somewhat higher due to increased bandwidth and complexity. GPRS service currently costs approximately 8 DKK/MB which would mean a maximum of 40 DKK/month/car to use GPRS (Dirchsen 3/31/05).

5.5 Europcar

The car rental company, Europcar, is a global provider of mobility services. Currently, it operates 2,650 locations around the world and has partnerships with airlines, railways, hotels, automobile clubs, and road-side assistance services (Europcar: Our Company).

5.5.1 Current Contract

Copenhagen Carshare leases all of its vehicles from Europcar for two reasons. First, if the organization were to purchase its own cars, the insurance costs would be too high. However, the insurance costs for a leased rental car are more cost-effective for the non-profit association. Secondly, the organization must replace each car every three years to achieve their environmental goal so it is financially beneficial to lease the cars rather than to purchase them. Based on the agreement with Europcar each vehicle can only be serviced at an authorized dealer (Ley 3/23/05).

The relationship of Copenhagen Carshare and Europcar is extremely beneficial for the carshare, even in addition to the financially feasible agreement for leased vehicles. In the past, Europcar has been able to provide the carshare with many resources despite the carshare's lack of funds. For instance, each shared car was in need of a trailer hitch and Europcar paid for the purchasing and installation of each hitch. The cost of the project was then built into the monthly leasing price for

each vehicle. This allowed the organization to have immediately needed resources without having the immediate budget.

5.5.2 Proposed Contract

The group spoke with the leasing director of Europcar, Mads Munch, to discuss the possibilities of installing telematics in the cars and further funding. Given Munch's faith in such an environmentally driven organization, he became interested in providing assistance to such a project. The details of installing a system from the carsharing technology company, Eileo, were discussed and approximate costs were quoted. Munch was immediately interested in continuing to provide Copenhagen Carshare with the necessary resources, through an addition to the current lease agreement. The options were discussed and need to be looked into further by both Munch and Ley.

At the time of the interview, Eileo had provided the group with two options for acquiring their system. As discussed previously, the system could be either purchased or leased for three or more years from Eileo. The possibility of having Europcar purchase the system was discussed. For either option it was thought that Europcar could front the initial fees and build the cost into the current lease agreement (Appendix E).

If the system were purchased or leased then it would be desirable for Europcar to pay the initial set up fees and hardware costs. This would leave Copenhagen Carshare the responsibility of paying the monthly fees for the server. The cost that was initially fronted by Europcar would then be included in the monthly leasing fee and would be paid off completely in three years.

If the system were purchased, Copenhagen Carshare would essentially own all of the equipment at the end of the three years. At this time the Eileo fees would be removed from the leasing price and Copenhagen Carshare would only need to continue to pay the server fees directly to Eileo. However, if the system were leased, these monthly hardware costs would not disappear and Copenhagen Carshare would continue to pay the lease price to Europcar and a server fee to Eileo for as long as the equipment lease was in place (Munch 4/20/05).

5.5.3 Concerns

During the discussion with Munch, two concerns were raised regarding both Eileo and carsharing technology, in general. *First*, Munch was concerned about the reliability of Eileo's products. Given its new presence in the carsharing technology industry he was very persistent in ensuring the satisfaction of the system by other users. Munch asked the group to contact other organizations using the current system to gauge their feelings concerning its operation.

Consequently, an organization was contacted regarding the use and installation of the Eileo system. Autocomm, a carshare in Bordeaux, France, has currently been using the Eileo system for four-months in two shared cars. The Director, Hervé Dugény, is extremely pleased with the system and the organization has experienced no problems as of yet. However, it is important to note that Autocomm goes not pay for the system, rather they act as a showcase for Eileo products.

*Second*ly, Munch was more in favor of leasing the system directly from Eileo. The group agreed that technology is always changing and the possibility of having a better system in three years is highly probable. Therefore, if the system were leased it

could then be turned in at the end of the three years and replaced by a newly updated system. In addition, it was also realized that more and more technology is being built directly into new vehicles. Therefore, in three years when a new vehicle is leased it could potentially have some electronics needed for carsharing as standard components, possibly making custom development a bit easier and affordable.

5.6 Extra cars

One area of carsharing logistics which must be considered when investigating new booking and access systems is the necessity to have a greater number of cars during busy times such as Easter, Christmas, and the summer season. These "extra cars" present a problem since they are only provided for use temporarily from Europcar, and are not permanent fixtures of the carshare fleet. This means that any electronic access system which is semi-permanently installed in the permanent cars would have to be installed in the extra cars as well, or another solution must be used.

It would be impractical for the carshare to pay for the installation of electronics in the cars if the usage is only temporary, and it would also be excessively expensive to own all of the extra equipment if it were only used part time. This will become less and less of an issue as the carshare expands: in the United States, the large carshares have enough cars that they do no need to supply extra cars during the busy seasons. While the Copenhagen Carshare still faces this issue, the group has several possible solutions in mind.

The simplest option for the extra cars is to use paper log books for recording distance traveled by each member, and have the members using the extra cars use an existing key box or pick up the keys from the carshare office. The group discussed with Ley is the possibility of having the extra cars be used by members who are

reserving the car for a longer period of time, in order to keep the paper work and key swapping to a minimum. This solution would incur practically no additional expense for the organization, and the small amount of user data could be entered into the billing software manually as it currently is.

Another possibility would be to use Net Image's "SmartPhone" system (or a similar cell phone based system) for the extra cars. This would still require the members using the extra cars to record their distance driven on the phone, as well as to use a key box or pick up the keys from the carshare office. Given the expense and extra hassle of using this system and its associated booking software, it does not present any major benefits over the first, simplest option, and would only prove practical if the permanent cars were also using the "SmartPhone" system

A third option exists, although it may be quite unlikely given the small need for extra cars in any given year. If a commercially developed system were to be installed into the cars it would be advised that a few extra systems be purchased in case one malfunctions and a quick replacement is needed. Therefore, the group would suggest that additional extra systems be purchased and used for both emergency repairs and extra cars. Given that the Eileo system requires a fairly non-invasive installation, the electronic equipment could be swapped in and out of the extra cars with relative ease and little time. This option may be unlikely in the near future given the funds needed to purchase extra systems that go without use most of the year. However, it would be worth discussing with Europcar to see if it would finically fund additional systems for both back-ups and extra cars. The price of such an option could be worked into the leasing price and Copenhagen Carshare would be billed over time rather.

A final option the group has considered is using Copenhagen Carshare's partnership with Europcar to provide the extra cars directly to the members. Through statistical records kept by the organization it has been found that most of the extra cars used during the holidays are reserved for at least one week's use. Therefore, cars could be picked up and returned to the Europcar office directly, while maintaining the same pricing scheme as used by the carshare. This option would not involve a key box. However a log book or other system would have to be used to record distance traveled.

5.7 Cost Assessment

Copenhagen Carshare's non-profit status and limited budget makes the major expenditures required for technology integration a crucial issue. In addition to the cost evaluation, expenditure risk also plays a large role in the decision. Consideration to the costs of the four major options is given. However focus is given to Eileo's options because of feasibility and flexibility in the costs.

5.7.1 Eileo Overview

The Eileo ZiboxLT has the potential to fit within the budget of the Copenhagen Carshare. Although when purchasing the system large upfront costs make the investment seem impractical, Europcar could potentially lease the systems to the carshare. Customization of the ZiboxLT is available and allows the carshare to make an economically streamlined product choice by purchasing only those features necessary. Eileo offers two major options for pricing when purchasing the server system. Server space may be rented from Eileo's servers directly, or customers may

provide their own server. Additionally, the hardware may be purchased or rented and there is an appealing option for a trial period.

5.7.2 Purchasing Eileo ZIboxLT

Pricing for purchasing the ZiboxLT includes one-time upfront costs for service and training, the car hardware, and server software. In addition there are monthly fees for both the server and GPRS cell phone service. Depending on the server services the customer chooses there may also be annual software fees. Installation costs for the hardware depend on the mechanic the carshare uses.

Twenty smart cards are provided with each ZiboxLT system purchased. Although extra smart cards can also be purchased. The company will also customize the smart card reader and smart cards depending on the standard the carshare desired to use.

Eileo offers a few customization options for extra hardware. Choices like the hands-free GSM and GPS systems focus on safety and security, while the pre-cabling and roof antenna serve to improve service and installation. The group recommends the purchase of the offered roof antenna, to improve reliability of GPRS communication when members are in rural areas, and pre-cabling for decreased installation time. The price of GPS is relatively low and inclusion should be considered depending on the needs and desires of the carshare.

Eileo Server

The Eileo server option in comparison to the independent server is cheaper for lower vehicle capacity carshares and brings with it a reduced upfront cost. However

the large upfront costs of purchasing the hardware from Eileo serves to be a large obstacle in considering this option.

INSTALLATION COSTS		use option		For 25 cars
Server Set-up	750			750.00
Server Training	350			350.00
2-days local support	600			600.00
Server	1250			1250.00
			One-time costs	2950.00
PER CAR COSTS				
Zi-box Unite	800			20000.00
Smart Card Reader	90			2250.00
Hands-free GSM	120	no		0.00
Pre-cabled	45	yes		1125.00
Roof GPS-GSM Antenna	70	yes		1750.00
20 Smart Cards	0			0.00
est. Installation	140	no		0.00
Shipping Costs estimate	30			750.00
GPS	80	no		0.00
Total	1035		For all cars hardware costs	25875.00
MONTHLY COSTS				
GPRS (local provider) per car	40 kr.			135.14
Server cost per car	29			725.00
			Per Month Costs	860.14
			Total costs per year	10321.62
			Total costs per month	860.14
			Total one-time costs	28825.00
			Total costs	39146.62

Table 2: ZiboxLT with Eileo Server, Cost for 25 Cars

Independent Server

INSTALLATION COSTS		Use Option		For 25 Cars
Server Set-up	0			0.00
Server Training	350			350.00
2-days local support	600			600.00
Remote Installation	3900			3900.00
			One-time costs	4850.00
PER CAR COSTS				
Zi-box Unite	800			20000.00
Smart Card Reader	90			2250.00
Hands-free GSM	120	no		0.00
Pre-cabled	45			1125.00
Roof GPS-GSM Antenna	70			1750.00
20 Smart Cards	0			0.00
est. Installation	140	no		0.00
Shipping Costs estimate	30			750.00
GPS	80	no		0.00
Total	1035		For all cars hardware costs	25875.00
PER YEAR				
Remote Maintenance	1200			1200.00
			Per Year costs	1200.00
MONTHLY COSTS				
Server Monthly Costs	50			50.00
GPRS (local provider) per car	40 kr.			135.14
License per car	23			575.00
			Per Month Costs	760.14
			Total costs per year	10321.62
			Total costs per month	860.14
			Total one-time costs	30725.00
			Total costs	32685.14

Table 3: ZiboxLT with Independent Server, Cost for 25 Cars

If a customer uses an independent server the upfront costs increase, an annual server fee is added, and a software license fee is charged for every car. Despite Eileo's large increase in cost associated with the use of an independent server, the carshare can eventually save money if its vehicle capacity, in a conservative estimate, exceeds thirty cars, and affordable server space is found. Even with these savings though, the carshare cannot currently afford the large upfront costs of the hardware.

In addition one must also consider the hassle of using an independent server, as running a server *can* be time and cost intensive should something prove problematic.

5.7.3 ZiboxLT and Europcar Leasing

Since Europcar currently leases vehicles to Copenhagen Carshare, the group investigated having Europcar purchase the ZiboxLT and lease it to the carshare. One potential option includes lease of the hardware from Europcar with the intent of completely purchasing the hardware after three years. This eliminates the high upfront costs that prevent the purchase of the ZiboxLT system. In addition by using Europcar as a leaser, the carshare has the potential to reach an economically sustainable solution by actually purchasing the system over time versus renting the system. The breakdown of the two server options including the lease fees from Europcar are below.

Eileo Server

INSTALLATION COSTS		Use Option		For 25 Cars
Server Set-up	750			750.00
Server Training	350			350.00
2-days local support	600			600.00
Server	1250			1250.00
			One-time costs	2950.00
MONTHLY COSTS				
GPRS (local provider) per car	40 kr.			135.14
GPS Monthly Cost	0	no		0.00
Server cost per car	29			725.00
Europcar Fee Estimate*	215 kr.			726.35
			Per Month Costs	860.14
			Total costs per year	10321.62
			Total costs per month	860.14
			Total one-time costs	2950.00
			Total costs	29021.62

*Determined by taking the hardware cost per vehicle divided by 36 months

Table 4: ZiboxLT Lease from Europcar with Eileo Server, Cost for 25 cars

Independent Server

INSTALLATION COSTS		Use Option		For 25 Cars
Server Set-up	0			0.00
Server Training	350			350.00
2-days local support	600			600.00
Remote Installation	3900			3900.00
			One-time costs	4850.00
PER YEAR				
Remote Maintenance	1200			1200.00
			Per Year costs	1200.00
MONTHLY COSTS				
GPRS (local provider)	40 kr.	per car		135.14
GPS Monthly Cost	0	per car no		0.00
Server Monthly Cost	50	per car		50.00
Europcar Fee Estimate*	215 kr.	per car		726.35
License	23	per car		575.00
			Per Month Costs	1486.49
			Total costs per year	19037.84
			Total costs per month	1586.49
			Total one-time costs	4850.00
			Total costs	23887.84

*Determined by taking the hardware cost per vehicle divided by 36 months

Table 5: ZiboxLT Lease from Europcar with Independent Server, Cost for 25 cars

5.7.4 Eileo Renting

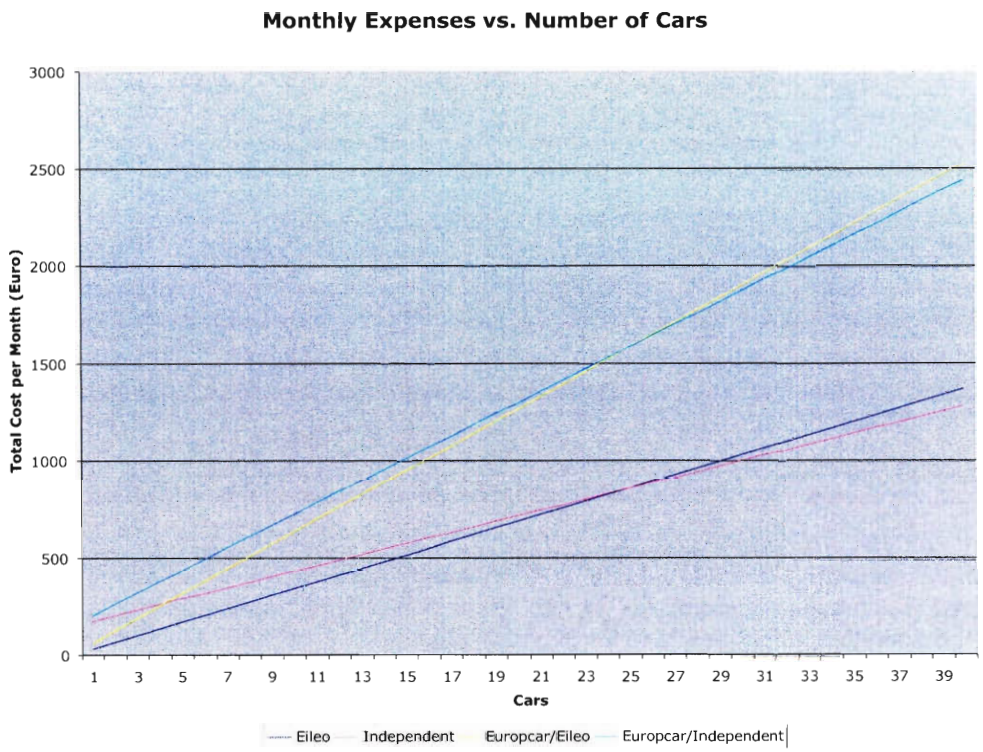
In addition to selling the ZiboxLT, Eileo offers rental services for their products. The ZiboxLT can be rented under a three-year contract, with a one-year trial period. This option can also be used by the carshare to make the system affordable. This plan has both low upfront costs and relatively low monthly fees. However the carshare will never reach a sustainable economic solution by relying on the rental services of Eileo. While renting for three years might be a temporary solution, the expenses accrued from renting the system during that time is equal to the expenses had the carshare purchased the system.

INSTALLATION COSTS		Use Option		For 25 Cars
Server Set-up	750			750.00
Server Training	350			350.00
2-days local support	600			600.00
Server	1250			1250.00
			One-time costs	2950.00
MONTHLY COSTS				
GPRS (local provider) per car	40 kr.			54.05
GPS Monthly Cost per car	15	no		0.00
Eileo rental fee per car, including server	50			500.00
			Per Month Costs	554.05
			Total costs per year	6648.65
			Total costs per month	554.05
			Total one-time costs	2950.00
			Total costs	9598.65

Table 6: ZiboxLT Rental from Eileo, Cost for 25 Cars

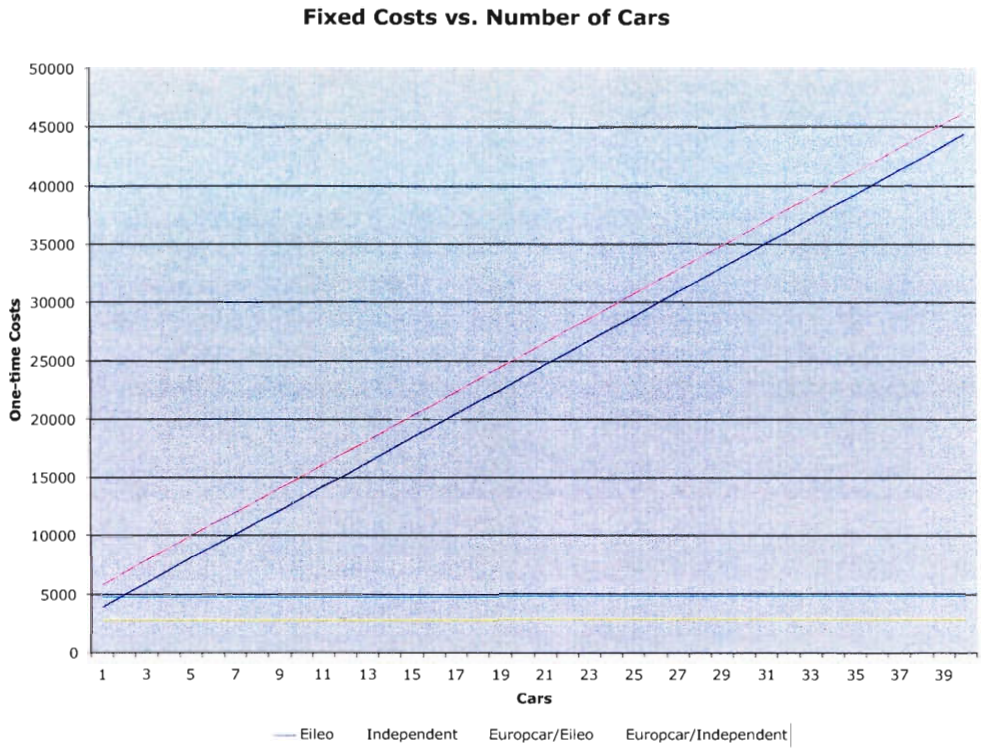
5.7.5 Comparison

The many options available, using the Eileo system of course, have their own advantages and disadvantages. Balance must be found between upfront costs and affordable yearly expenses. The following graphs compare the total expenditure after three years, so that considerations can be made for long term investment. The graph, *Monthly Expenses versus Number of Cars*, demonstrates the large difference in monthly expenditure between renting and purchasing. At roughly twenty-six vehicles it becomes economical to invest in the Independent server option.



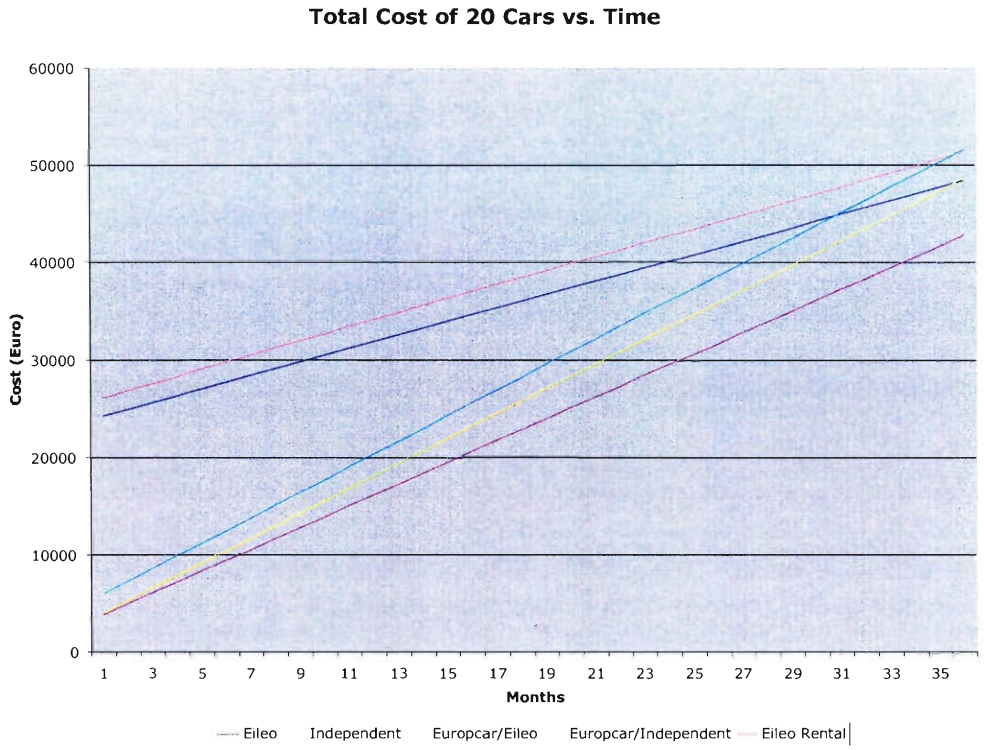
Graph 7: Eileo System, Monthly Expenses vs. Number of Cars

In comparison, the following graph, *Fixed Costs versus Number of Cars*, shows the one-time hardware and software investments. The larger monthly expenses from renting are balanced by a single fixed cost investment. While conceivably this investment is eventually paid, the leasing option spreads the expenditure over the three-year payment period.



Graph 8: Eileo System, Fixed Costs vs. Number of Cars

However to give an idea of expenses over time the following graph, *Total Cost of 20 Cars versus Time*, compares the total expenditure over three years for all five systems. The same expenses are accrued after the three-year period if purchasing or renting the system. The graph illustrates the feasibility of investing in the Eileo system by using Europcar as a leaser, through the visualization of the large difference in initial investments and total investments after the three years.



Graph 9: Eileo System, Total Cost of 20 Cars vs. Time

Since the carshare constantly increases in membership and therefore vehicle ownership the need for continuing hardware investment exists. To compare expenditures with both cars and time allows insight into the long term investment costs (Appendix R).

5.7.6 Invers

The carshare can not actually purchase the StandAlone system from Invers directly. Hertz Delebilen purchased the rights to distribution of the system within Denmark and Scandinavia. The Administrative Director at Hertz Delebilen, Pedersen, offered to sell the Invers system, complete with installation to Copenhagen Carshare. No analysis of this system was completed since it is an overall *less appropriate solution* that costs more than its competitors.

5.7.7 Net Image "Smart Phone"

The developer of the Smart Phone system, Hans Kjer of Net Image, did not provide the group with an estimate on price. However hardware costs should be low because of simplicity and commercial availability of GPRS cell phones at a discount price when purchased in conjunction with a cell phone plan. Software development costs are completely unknown. An old quote of 50,000 DKK for the system including hardware existed. However, Kjer asserts that the new price will be lower. Because of the current state of the software and Kjer position as a middle man and not a developer, it seems practical to *avoid* this solution.

5.7.8 Custom Development

Perhaps the most difficult possibility to estimate the cost for is custom development, since there are so many variables. This estimate would be better carried out by a professional developer than by the project group, since the professional developer would be aware of what it would actually cost, including all of the various details.

Zedler was contacted in order to supply the group with a rough estimate for development costs. The group supplied Zedler with a carshare technology development outline (Appendix V), in order to establish an overview of those development processes necessary to develop new carshare technology. He was able to come up with a *rough* estimate of 500,000 DKK for the entire development (Appendix W). However, it is important to note he stressed this estimate to be rough and there would exist room for error as high as 50 percent. Also one can outsource

development to the "far east, which can cut the total costs by 25-40 percent" (Zedler email 5/6/05).

6 RECOMMENDATIONS

The final result of the research and investigation conducted over the last four months has culminated to this recommendation to Copenhagen Carshare. Due to the growth of the carshare from a small community of members to a large politically influential organization, there exists a definite need to update the technology in use for booking, billing, and car access control from the current key box and logbook based system. Through careful research, interviews, and discussions, the group feels confident that it has collected appropriate information to make a solid, well-based recommendation. The discussion on the options least appropriate for the carshare comes first, followed by two options better suited to the needs of the organization.

6.1 Less Appropriate Options

Two options the group researched, Net Image's "SmartPhone" system and the products offered by Invers, *fail* to meet the needs of Copenhagen Carshare. Financial, functionality, and timeliness issues determined considerations of both systems.

6.1.1 Net Image

Net Image's "SmartPhone" system neglects to satisfy one of the main objectives of this project, the removal of the insecure and problematic key box car access system. Furthermore, the integration of distance driven data recording in this system is user dependent rather than automated. User dependency plagues this system by not providing any user access limits. Overall the system fails to *guarantee* any results and provides few advantages over the current system.

6.1.2 Invers

Cost and complexity of installation make Invers' products a poor choice for Copenhagen Carshare. The major factor in the decision was that Hertz Delebilen owns the rights in Denmark to the Invers system. Copenhagen Carshare risks dependency on the for-profit company, in addition to Hertz's contrasting profit oriented goals. This aside, the Invers systems do not meet the needs of Europcar for non-invasive installation, also the system has no capabilities for use in temporary or "extra cars" because of this complex installation. Higher costs compared to commercial competitors with similar or superior products settles the decision to *reject* the Invers systems.

6.2 More Appropriate Options

Both Eileo's ZiboxLT system and custom development have viability for the carshare. Though contrasting greatly, the two plans each have their own relevance, despite different financial plans, community effects, and timelines.

6.2.1 Eileo

After careful consideration, the group believes that Eileo's ZiboxLT hardware, and Zenon software match the needs of the carshare very well. Quick implementation, combined with an affordable price, reinforce this option's feasibility. By taking advantage of Europcar's potential leasing option, the carshare can afford to invest in the system now without the need of significant upfront costs. Furthermore, this option eliminates the hassle of working with developers, and lengthy development time. Were the carshare to use Eileo's products, further investigation into reliability and a trial of their product would need to be completed.

6.2.2 Custom Development

The custom development of hardware and software for Copenhagen Carshare brings feasibility, cost effectiveness, customization, commercialization, and community involvement. For these reasons, custom development also matches the needs of the carshare. By building upon open source software, inexpensive software development can be possible by involving volunteers from the Danish and carshare communities. The trade-off of a lengthy development process creates some reservations in considering this option. However, the final product will match the needs of the carshare with the opportunity of marketing the product to other carshare organizations. On the whole, custom development's cost effectiveness, considering the budget of the carshare, ensures its consideration as a solution.

6.3 Final Recommendation

The group's final recommendation is for the carshare to further investigate Eileo's products and conduct a trial period on two of its cars. The option of a one to three month, two-car trial allows for a low-risk, offers real world evaluation of the system. If Copenhagen Carshare benefits from the system, the remainder of the fleet could be outfitted, but if the products failed to meet expectations, only minimal financial loss would result. Upon dissatisfaction with Eileo, further exploration into custom development could follow. Armed with the knowledge gained from the Eileo trial, the carshare could refine the needs and expectations for its personalized system. It is the group's hope that through this recommendation, Copenhagen Carshare will choose, implement, and enjoy a modern booking, billing, and access system for the

rapidly growing organization to be successful for many years to come as carsharing expands in Denmark.

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8 APPENDICES

Appendix A: Glossary of Technical Terms

Access System: A system in place in a carshare to control who is able to operate a shared car

AT Commands: Stands for "ATtention" commands, a name drawn from the commonly used commands for controlling all types of modems. For more information see the European Telecommunications Standards Institute (ETSI) website

Board Computer: A small computer or microcontroller installed in a car to control access and log user data

CANbus: Controller Area Network bus, used in cars for data transfer between different in-car electronics

Electric Vehicle: A car or other vehicle which is powered electrically instead of by an internal combustion engine

GPS: Global Positioning System, can be used to track a vehicle's position

GPRS: General Packet Radio Service, a relatively new standard which is an improvement to the GSM cell phone standard and is used to transmit data over cell phone networks (GSM World: What is GPRS?)

GSM: Global System for Mobile communications, a cell phone standard used extensively throughout Europe and increasingly in the United States (GSM World: What is GPRS)

GUI: Graphical User Interface

Hybrid Electric Vehicle: A car or other vehicle which utilizes a combination of electric and internal combustion engine propulsion

ICC: Integrated Circuit Chip, a type of extremely small microprocessor used in smart cards

IP Address: Internet protocol address, a unique address for each device on the internet

Key Box or Key Lock Box: A locked box which contains the keys to one or more shared cars, usually located in close proximity to the parking facility

Key Fob: A small keychain accessory normally referring to a car door remote control, which can include electronics such as an RFID, digital memory, or wireless transmitter

LCD: Liquid Crystal Display, flat display such as those used by laptop computer screens

Microcontroller: A small integrated circuit with the capability to process and store data as well as communicate with and control other devices

OBD: OnBoard Diagnostic port, a connection available in all modern cars for the purpose of communicating with the main car computer

Open Source: publicly available software that may be based off of other publicly available software, and is open for modification and customization

PCMCIA: Personal Computer Memory Card International Association, which creates standards for digital peripheral devices. (Or, more realistically, "People Can't Memorize Computer Industry Acronyms")

RDS: Radio data stream, a method of transmitting information about the radio station within the actual audio

Serial Port: A common type of computer to computer connection for transferring data in a serial fashion

Server: A central computer which can communicate with many others

SIM: Subscriber Identity Module, a type of smart card used in cell phones to store a user's phone number, address book, and text messages.

Smart card: Contactless SmartCards are somewhat similar to RFIDs, but are more expensive and also more secure, having the additional capacity to store and process data including an ID number (Smartcard Alliance)

SMS: Short Message Service, a 160 character per message data transfer method between cell phones

Telematics: A system with integrated computing and telecommunication

USB: Universal Serial Bus, a very common type of modern serial port

WiFi: A common name for the IEEE 802.11 wireless standard for computer related data transfer

Appendix B: Contact List

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Appendix C: Emails Corespondance

From: Arnaud Lejeune, Carsharing Manager Eileo SAS
Date: April 7, 2005 to April 25, 2005

From: "Arnaud Lejeune" <arnaud.lejeune@eileo.com> [+]
To: "'WPI'" <wpi@kobenhavnsdelebiler.dk> [+]
Cc: <h.b@eileo.com> [+]
Subject: RE : RE : RE : RE : RE : RE : Product Inquiry
Date: Mon, 25 Apr 2005 10:24:26 +0200

Dear Seth,

I'm glad to hear you are interested in our solution.

Our server is currently available in French and English.
If you choose our solution, we could work together to translate it in Danish - As texts are in separate files, it will take about 3 full days of translation.

We can setup for you a short-test - 1 month, up to 3 month - with 2 of your vehicles.
This test will include server setup and access (in english) and vehicle installation.

This short-test will alow you to see, for a small cost, the system in real working condition with two of your vehicles and some of your members.

The price to set-up the short-test is 1450 ex vat. It includes all our support to make this test a success.
After the short-test, if you chose to continue, this cost will be deducted of the price of the service.
That means this short-test is free if you confirm you choose our solution.

Unfortunately, we do not have literature in Danish yet. We are finalizing or English documentation for the 1st of June.

Please do not hesitate to ask me for further details,

Bests regards,
Arnaud.

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Paris Cyber Village
204, rue de Crimée
75019 Paris
France
tel : +33 1 55 26 42 61
fax : +33 1 55 26 42 03

From: "Arnaud Lejeune" <arnaud.lejeune@eileo.com> [+]
To: "'WPI'" <wpi@kobenhavnsdelebiler.dk> [+]
Subject: RE : RE : RE : RE : RE : Product Inquiry

Date: Thu, 21 Apr 2005 12:02:59 +0200

Hello Seth,

Thank you for your questions.
The renting mode does not include initial server and training fees. I will work to provide you with the quote.

The one year test period is a shorter term engagement, that allow you to test in live before to engage for 36 months.
At the end of the test, you will be able to :
* end the service and return EILEO's ZiboxLT and accessories. In this case EILEO keep the 300 deposit.
* continue the service for 36 month. At the end of this time, if the components are in good shape, we return the deposit to you.

Our server is communicating to the vehicles through internet. The embedded GPRS of Zibox directly connect to internet.
There are GSM modem's attach to a second server to assume SMS backup, SMS maintenance, and RING notifications.

Congratulation for your car-sharing growth !

Best regards,
Arnaud

From: "Arnaud Lejeune" <arnaud.lejeune@eileo.com> [+]
To: "'WPI'" <wpi@kobenhavnsdelebiler.dk> [+]
Subject: RE : RE : RE : RE : Product Inquiry
Date: Mon, 18 Apr 2005 18:57:44 +0200

Dear Seth,

CAN bus is used in some projects involving car manufacturer.
It is illegal to use CAN bus without car manufacturer approval.

Odometer sensor is an option. It depends of each vehicle. We may read this information from the dashboard electronic.

Source power : we connect ZiboxLT to the car-radio power line. It does not take the place of the car-radio : you can still listen to your car-radio. ZiboxLT is usually hidden behind the dashboard.

Key : the driver use to the mechanical part of the original key. With the mechanical part of the key, he can not start the car, still there is no transponder inside.
The original transponder is shielded into the ZiboxLT. It is impossible to unmount it or to try to start the car without the authorized smartcard.

GPRS is perfect for vehicle tracking and 'machine to machine' communication.
I do not know your GPRS prices in Denmark, but in France 'GPRS Only' sim cards are very less expensive than GSM cards.
For **SMS** solution, if you consider you need at least 3 SMS per trip (1 for booking, 1 for 'begin of use', 1 for 'end of the trip / report), it finnaly cost more when you have activity. If you want to track the car, it drammaticly cost more!

We use GPRS exchange with SMS backup when the GPRS signal is too low.

Right know, there is no place in Denmark where you could see our solution. Hope you will be the first !

In france you may call Autocomm (small begining bordeaux car-sharing) :

Hervé Dugény - Director - 00 33 05.40.120.172

Finally, **our whole solution is available in renting mode** :

50 / month / vehicle for ZiboxLT renting and Zenon use (with a 300 guaranty deposit per ZiboxLT installed)
+15 / month / vehicle for GPS maps and SMS alerts with vehicle address.

Handsfree option is a fix +120 per vehicle at installation.

renting mode is a 36 month engagement.
However, renting mode can start by a **one year test-period**.

Hope i answered your questions.
I'am available if you look for further assistance.

Kind regards,
Arnaud.

From: "Arnaud Lejeune" <arnaud.lejeune@eileo.com> [+]
To: "'wpi -eng studiegruppe'" <wpi@kobenhavnsdelebiler.dk> [+]
Subject: RE : RE : RE : Product Inquiry
Date: Mon, 11 Apr 2005 15:52:02 +0200

Hello,

Here are our answers...Hope they will help you !

Best regards,

Arnaud.

--
> Is there any car manufacturer or specific vehicle with which ZiboxLT is incompatible? We are using VW,

> Toyota, and Skoda cars.

ZiboxLT is compatible with any type of car with remonte key and transponder immobilizer. Any recent car from the year 2000 should be ok.

> What exactly do you mean by 'non-destructive' installation? Our concern stems from how you control the power doors if you only listen to the CAN bus passively.

We do not connect to the CAN bus. We integrate the Key remote control in ZiboxLT. There is no connection to the car as the only component we have to unmount is the key.

> We are also wondering if you could tell us more about the anti-car jacking feature. Are you locking the ignition?

Our patent allows wireless communication to the native transponder system of the vehicle. It is the most secured system on the market - and the main reason of our Research partnership with Renault.

It has the ability to virtually disable the key transponder. Doing so, the car can not start again, even if one unmounts the telematic system.

It is compatible with any car with native transponder (100 percent of new cars on the market)

In regards to the SmartCards, must we purchase only your SmartCards, or are they compatible with other brands? In the near future we hope to use the SmartCards for purposes other than just car access and need to know if they can be integrated into these other systems. Also is a SmartCard writer needed for creating your own cards?

We have partnership with main dealers on the market :

* HID (world leader for access control in buildings) either in 125khz and 13.56Mhz

* MIFARE (13.56Mhz)

* CALYPSO (13.56Mhz)

the smartcard are white on both sides by default. We may deliver you with customized smartcards.

Our preferred smartcards are HID iClass, secured, low cost and low consumption.

We may listen to your whishes to integrate other technologies of smartcard readers.

What happens if a member forgets to press the 'trip done' button at the end of a reservation period?

1- he is still in "renting" mode and as to pay this.

2- back to home, he may end his trip from the website

3- the logistic staff may end the trip from the website

4- the next bookin on this car will be automaticaly transposed to another car, regarding the next driver's preferences.

If we did not want the GPS option now, but wanted it a year from now, would it be possible to add the GPS hardware to units we purchased that don't have it?

The GPS hardware have to be installed from our factory.

However, the GPS service may be subcribe on demand.

> During busy times like Easter and Christmas, we rent extra cars for the carshare. How do you usually recommend we handle this situation using your products?

You may add the rental vehicle to the booking interface.

> If we choose to use your server, what is your server's uptime percentage?

we have a 99,95 percent of uptime. That means our server may be done for maintenance task (updates) about 21 minutes / month.

> Could you please clarify the pricing for the Zenon server, when it is hosted by you compared to when it is hosted by us?

Hosted by EILEO: 29€ / month / vehicle.

Hosted by you : 3900€ (remote installation) + 1200 € / year (remote maintenance for server updates) + 23€ / month / vehicle (licence for use) .

> Could we see a price quote (per car) which includes all of the other options on the ZiboxLT? It would be helpful to see it displayed in one-time setup costs as well as per-car per month.

i will work on it.

> What are approximate shipping costs?

about 30€ per unit for DHL. // for the whole package, we may take it with us (train or plane) if we come to visit you or to install.

> Unfortunately we could not download the Product PDF for the ZiboxLT from your website, so could you please email us the file?

We are sorry, the PDF you tried to download is currently not available. We are making a newer one and i will send it to you when it will be released.

From: "Arnaud Lejeune" <alejeune@eileo.com> [+]
To: "'wpi -eng studiegruppe'" <wpi@kobenhavnsdelebiler.dk> [+]
Cc: <h.b@eileo.com> [+]
Subject: RE : RE : Product Inquiry
Date: Thu, 7 Apr 2005 13:22:20 +0200

Dear Seth,

Thank you for your enquiry and congratulation for your carshare organization !

Eileo aims to support carsharing, providing the bests products, quality and support.

For your car-sharing service, our best product line is ZENON and ZIBOX-LT
ZENON is a rich online car-sharing server, for booking, accounting, billing, staff management, customer relation management, with email and SMS alerts...)
ZIBOX-LT is a car-embedded GPS-GPRS computer to perfom access control to the car and automatic report of trip datas (km, hours, ..)

We can provide a fully automatic CarSharing system :
- Access to the global CarSharing server 'Zenon' (from Internet Explorer, no installation needed).
- In-car embedded computer 'ZiboxLT' .
- Contactless smartcards for access control 'HIDtm'
- Communication solution between the server and the cars (GPRS).

This is a very competitive and powerfull solution. Prices really depend of your needs.

Exemple for one vehicle (EXWORK, ex VAT)
* Embedded ZIBOX-LT starts at 800 / unit. Options are :
  SmartCard Reader : 90
  Hands-free GSM : 120
  Pre-cabled (easy, quick and secured mounting) : 45
  Roof GPS-GSM antenna : 70 (for best GPS reception and GPRS link)
  We provide every unit with 20 smart cards. We may provide more cards : 3,5 / card.
* Installation in the vehicle usually costs 140 . It is quick (1h-2h), simple and non-destructive. It can be done by a car-radio installer.
  However, EILEO's staff as to be there for the first installation and first start-up.
* Software access with full options, hosting and support, is 750 for set-up, 350 for training, then 29 / month / vehicle.

For your 15 vehicles, the average total cost is :

	price* / unit	**quantities**	**total**
Hardware Equipement****	1 005	15	15 075
ZiboxLT	800	15	
Smartcard Reader	90	15	
pre-cabled	45	15	
roof antenna	70	15	
Server	1 240	1	1 240
Setup	750	1	

Training	350	1		
In-car Installation				
Installation	140	15	2 100	
2 days local support	600	1	600	
TOTAL INVESTMENT			**19 015**	
Server monthly fee***	29	15	435	to EILEO
GPRS communication**	10	15	150	to your GSM local operator
TOTAL MONTHLY CHARGE			**585**	

* This prices does not includes shipping, taxes.

** The GPRS communication fees depends on your local operator prices : you have to ask your local operator for "machine to machine" GPRS sim cards (1 to 5 MByte / month), with SMS ability (we use SMS for GPRS backup).

*** This price covers standard Zenon server Licence, Hosting, daily Backup, and EILEO's support. GPS localization in optional and cost +15 / vehicle / month. It allows vehicle retrieving and EILEO's innovation "free surface parking"

**** Hardware is provided with one year guaranty.

Our solution is available righ now, with delivery in 15 days.
We may also follow your needs with custom developpements or services.

Zelec system is dedicated to electric cars. It prevents electric cars that have 'loading memory' battery technology (nickel cadnium) from damages. It handles loading cycles and logisics consideration (bookings, previsionnal km).
For more recent electric vehicle (Li-Ion...), Zelec is not usefull as you may charge the battery at any time.
For best use of Zelec, we have to connect the battery-sensor of the vehicle to Zibox-LT.

Please tell me more about your project, your organization (i tried to read your website / any english version ?) and your growth opportunities so we would better understand your needs.
Do not hesitate to contact me for any questions.
I whish you success in your project !

Best regards from Paris,

Arnaud Lejeune.
Car-Sharing Manager.

EILEO SAS
www.eileo.com

From: Bjørn Dirchsen, IT Consultant for Copenhagen Carshare
Date: Monday April 11, 2005

From: Bjørn Dirchsen <bjoern@netsolutions.dk> [+]
To: "WPI" <wpi@kobenhavnsdelebiler.dk> [+]
Subject: Re: GPRS and server questions
Date: Mon, 11 Apr 2005 22:48:37 +0200

Hi Jaron, Caitlin & Seth.

First, the hosting of the carshareon.
I could not find anything on their homepage that suggests that it could be run on other servers than theirs. They wrote a lot about their Open source based system, but that does not imply anything (apart from a complex installation, I gues...). I'm convinced that it runs on Linux (at least, that's what the homepage says). But if you can find out if there is a price for buying their system and updates when they find bugs etc. in it, it would be interessesting. I'm, sure that I can do a much better price than Eileo - but still, it's hard to say when I dont' really know what the system consists of.
The price for the communication from the cars to the server is very low. 1Mb of GPRS data traffic costs approx DKK 8,- so a max of DKK 40 per car/month should do it. As I understand, the cars connects via GPRS and NOT via SMS. GPRS is data communcation and SMS are just small packets of information. SMS'es can be transmitted via either GSM or GPRS. If they transmit data via SMS it would be best to have a "free -SMS" subscription in addition to the GPRS subscription. I think the price is approx DKK 200/car for a free-SMS subscription.
I'm flattered by Liselotte's never-ending confidence in me, but I don't really have someone at hand to do the installation. I know a person that works with cars off time, I can ask if he wants to participate.
That's all for now please write again if you have questions!

KR., Bjørn

Appendix D: English Translation of Københavns Delebiler Website

Transcription of Copenhagen Carshare Website
http://www.kobenhavnsdelebiler.dk/
Translated from Danish to English by Professor Peder Pedersen on Jan. 28, 2005

Audio File 1

Background
"baggrund"

The first share car program started in Switzerland in the middle of 1940s. It was a good way to share the limited resources available due to the limitations of the war. Today, Denmark has a well established carshare system which among others includes agreements with public transportation companies and a well distributed network of shared cars over the whole country. Today it makes a lot of sense to take the carshare idea further. Private car ownership is one of the most expensive investments that a family can make given that cars in Denmark are roughly three times the cost they are in the United States. Today there are share car organizations all over the whole world including Denmark. In Denmark there are carshare organizations in Århus, and Farum and the Copenhagen area. From a personal economical view, the carshare concept has a special meaning in a country like Denmark which has some of the world's highest fees on ownership of cars. From a societal point of view, it helps lessen the traffic and improve the environment. The sizes of the Danish share car organizations vary a lot. Some share car organizations consist of 4 to 5 families who share a single car, like in Iceland. While, other carshares consist of 100 members who have shared access to 10 to 15 cars. It is the goal of the Copenhagen Carshare (CCS) that there will be created a close collaborations over all the organizations within Denmark. In that way we can reduce the total expenses and we can share our experiences. We can also work together to influence politicians to agree on initiatives which will improve the conditions of the share car idea.

What is a share car? (04:15)
"hvader en delebil"

In a carshare association a number of people, get together, to share the fixed expenses that are associated with having a car. Thereby they save a lot of money as a share car person in comparison with ownership of one's own car. As a private owner of one's own car one pays a very high price, just to have the car standing without use most of the day. The shared car is parked close to your place of residence and in Copenhagen townships there is a free parking license for share cars which thereby are free from the two hour restrictions in the Bridge Quarters, a certain area of Copenhagen. Close to the parking of a shared car is a key box which all members have access to. In the key box hang the keys for the cars. You pay only, beside a monthly fee, for the number of kilometers and the period of time when you're using the car. As members it is not necessary to have personal auto insurance. The insurance for the cars is included in the fee and the membership prices. The cars have liability insurance up to 4,000k ($8,000). When you have the need of a car you can very simply and easily make

reservations on the association's home page. You can reserve as much as you want to, but be aware that it costs money to cancel a reservation. The closer to the time a reservation the cancellation takes place, the higher the fee that has to be paid for the cancellation. The cancellation fee prevents that there are over-reservations where members choose a lot of times just to be safe, when they in reality don't need a car. If there is a great need for a SC in a given area, it is in and of itself assigned that there is need for placing still another car there. Depending on the parking possibilities CCS can place a new car just in the course of a couple of weeks. CCS will along the way extend the number of available cars in greater Copenhagen so that the members of the association can get access to shared cars (SC) over all of the greater Copenhagen area **(08:21)**. CCS has a possibility to rent extra cars in high season periods such as summer and Christmas holidays. The CCS takes care of frequent check and cleaning of all the cars. You have to take care always to bring the car back in good and clean condition after use. Beside that you have to be 23 years of age and have a valid driver's license.

Economy (9:40)
"økonomi"

According to FDM (Danish AAA) it costs 3-4,000k ($500-800) a month to own a small car personally. With CCS it costs 125k ($30) a month in fees. Beside that, comes your expenses for the drive itself. With driving a SC you pay, beside the fee, only for the time and distance you are driving. For SC there are the fixed fees low in comparison to the expenses which are connected with the use of the car, price/km and hour. For private car ownership the condition is the opposite. A rule of thumb says that membership in a SC association is an economically good solution for those who drive between 1,000 and 15,000 km a year. A SC is not a suitable means of transportation for those who have the need for daily commute to and from work by car. Another condition which affects the economy is the expenses that are associated with getting rid of one's own car when one joins a SC association **(11:40)**. A car owner who wishes to get rid of his own car and replaces it with a SC has, depending on the condition of the car, two possibilities – either to sell the car or junk it. The last is connected with expenses and what pertains to the sale of a used car is often that the price is far lower if the sale is not combined with the purchase of a new car. In other words, can getting rid of one's own car and choose a share car in short term contain an increase expense in comparison with buying a new car. BUT! The calculation has to be compared to the expenses that are saved by joining a SC association in form of low fixed expenses **(13:13)**. If you don't need a daily car and you have the possibility of shifting to public transportation or bicycle then there is no doubt that much money can be saved by becoming a SC driver.

Environment (14:00)
"miljø"

The SC ownership contributes to a better environment and healthier urban life. The extent that people get rid of their own car and instead choose to become a member of the SC there will be fewer cars on the street. In practice can one SC replace between 4 and 5 ordinary privately owned cars. Fewer cars in the city means less traffic, fewer parking places which can be used for green areas, etc. On a longer term perspective, does it also give the city the possibility to plan car-free areas with smaller areas for

driving. Fewer cars also means that the pollution is lower and since the cars of CCS are replaced every two to three years, these cars fulfill the new standards for fuel economy and emissions. A SC is utilized to a far greater extent than most of the privately owed cars. It is not uncommon for a privately owned car to not be used 18-20 hours per 24 hours which is a definite waste of resources. Numbers from abroad show that members of SC associations reduce their driving need about 30 percent. The fixed expenses (insurance, annual fees, depreciation, etc) with private car ownership is by far the greatest and even the driven km are not experienced as expensive but with a SC it is opposite. Due to the low fixed expenses but higher km and time-use fees will a share car member drive fewer km annually and in that way protect the environment significantly. A member of a SC organization will choose to avoid the unnecessary car trips and experiences from SC activities have shown that the members at the same time contribute to increased utilization of public transportation because more trips which were previously carried out in one's own car are now done by other ways of transport. Finally, there are only on average 1.3 persons in each privately owned car while the number for SCs is two.

Question and Answer (FAQ) (18:15)
"spørgsmål og svar"

Am I obligated to drive a certain amount in SCs?
No! It is up to you how much or little you will use a SC.

Is there an upper limit for how long a time I can have a SC?
No, you decided yourself for how long a period you wish to have the car.

What if all the cars are away over xmas?
If you plan ahead of time, the CCS has the ability to get a hold of extra cars in a high-load period such as Christmas and summer vacation.

Does price/km include or not include gasoline?
The price does include gasoline. That means you will know ahead of time exactly how much your bill will be.

How far in advance can you book a car?
You can book a car up to a year ahead of time.

What if the previous user didn't deliver the car back in time?
Call immediately to CCS who will try to solve your problem.

What if the car is left dirty by the previous user?
It is a necessity in order for the SC organization to work well that the members show consideration for its other and treat the cars nicely. If you experience that a member does not fulfill this expectation, you should write it on the [driver's log]. That member will first of all get an extra fee. If this is repeater, CCS will call and have a talk with a particular member **(20:50).** In a most extreme consequence can such lack of care result in that a member will be excluded from the association.

What equipment is in the car?
In all the cars there is a [detailed map of Copenhagen]. For longer trips there is a

possibility to borrow a roadmap of Denmark or a Europe map from CCS. On most of the cars there is a hitch for trailers, also for bicycle carries up to two bicycles as well as a [running light] according to the laws. Beside that there is a possibility to borrow a roof carrier from CCS. Other equipment the members have to take care of.

Is one allowed to smoke in the cars?
NO! All cars are no smoking cars.

What does it mean, the different membership types?
See explanation under "Membership Types." **(22:12)**

Audio File 2

Membership Types and Prices (00:20)
"medlemstyper og priser"

Copenhagen Carshare has the following membership categories.
Ordinært medlem (ordinary membership)
Indmeldelsesgebyr: 4000 DKK (Sign up fee)
Kontingent pr. måned: 195 DKK (monthly fee)

Ordinary member will have all the rights in CCS including booking right, driving right, voting right at an annual meeting. The right to bring in an additional member (spouse) to their ordinary membership. So the family would only have to pay for one and the family can use it.
Tillægsmedlem (additional member)

Indmeldelsesgebyr: 500 DKK (sign up fee)

Kontingent pr. måned: 50 DKK (monthly fee)
Only be established in connection with an ordinary membership with the same address. That person will have the same rights as an ordinary member. This is for a roommate, significant other, etc.

Firmamedlemskab (Corporate Membership)
Companies and institutions can establish up to 4 additional memberships for company/association use with an ordinary membership.

Gæstemedlem (Guest Member)
100 DKK pr. uge, max 4 på hinanden følgende uger (100 DKK per week, maximum four consecutive weeks)
Should only be established to drive a share car over a limited period, 1 to 4 weeks. It does not have booking rights and voting rights. Can only be established in connection with an ordinary member or additional member who are then financially responsible for the guest member. A guest member is only allowed to drive the associations car when and ordinary or additional member is present in the car.

When you need to use a car (05:30)

"når du skal bruge en bil"
Picking up the car: When your booking period starts you can go and pick up your booked car. Check carefully that you are picking up the right car. The name of the car should be obvious from a sticker on the instrument panel of the car which can be seen from the outside. The car is parked in its reserved parking spot. Near it is a key box to which you have the key. Here in the key box you find the car key and the gasoline card. The name of the car is on both the key and the gasoline card. If the car is not parked in the reserved place check then if the key is in the key cabinet. If the key is there, the car is probably just near by. Check then if there is a note in the key cabinet indicating the cars placement. Be very careful to take the right key. It is particularly important in the summer when there are several cars at the same station/pick up place. Before you drive away you should insure that the car does not have any damages, etc. which have not been noted on the "problem" list of the car. You should also fill our the first part of the "driving sheet" with membership number, time of picking it up, and reading of the odometer. After that you are ready to drive and may use the car as you wish during the period of time that you have reserved it for.

(08:27) REMEMBER If the car, against the rules, is delivered back dirty, not locked, and with sufficient gasoline (which is _ of a tank), or of the like then report this information in writing on the "driving sheet" under the category *notes*.

Smoking: It is not permitted to smoke in the cars.

Animals: can only be brought in the car with an animal transport box. After use of the car you must vacuum and clean it out.

Gasoline: the cars you lead free octane 95 and the car should always be brought back with at least a quarter filled tanks. Remember that the gasoline can be refunded only after previous agreement with CCS. (if you didn't use the gas card and paid yourself you must have an agreement for reimbursement.) You should therefore use the gas card whenever possible.

Driving: You must drive according to the traffic rules.

Bicycle Light: If you have a bicycle carrier on the back of the car you must have a light on the arm of the carrier. It is required by law. The arm should be kept in an aluminum box in the luggage compartment when not in use.

Theft: To prevent break-in and vandalism against the cars you ought to remove all visible item of value from inside the car before you leave it.

Bringing the car back: if you cannot bring the car back at the agreed upon time you must contact CCS as quickly as possible. If you are not able to park it back in its reserved spot near the sign and key box you must write/draw the place where you parked the car instead. And put the note in the key box. The car must be brought back at the very latest when the booking period expires. (00:12:34) it should be returned with at least a quarter of a tank of gas and you yourself must make sure that no damages have been incurred and leaving it in a nice and drivable condition for the next share car driver. You then fill out the "driver's notes" and place the car key and

notes back into the key box.

Payment: **(13:09)** once a month you will receive a bill on your car use and membership fee. From the bill you can see each booking with what car you have used, what time you booked it, how long you have used it for, and how many kilometers you have driven.

Appendix E: Interview Synopses

Frank Noonan: WPI Management Professor
Date: Tuesday February 8, 2005
Location: WPI

How does the "newsvendor problem" pertain to carsharing?
The "newsvendor problem" is the daily issue faced by newspaper vendors. They must decide in advance how newspapers and magazines to stock each day. To relate this concept to a carshare, a carshare organization must decide in advance of reservation were fleet placement should be throughout a city. In addition, they must decide how many cars to place at each car station.

With cars parked throughout the city how can we optimize the availability of cars to the members/users?
The term "yield management" is commonly used in the airline industry. It is standard for an airline to overbook a flight because there is a probability that everyone with a will not show, referred to as probability model on demand. However, the rules of statistics will not come into play with a small non-profit car organization. Therefore, the organization should become as cost effective as possible and provide the maximum convenience to fleet placement.

How can a change in managerial operations benefit the service provided by a carshare?
Successful service is the product of a productive managerial operation. In order to provide successful service management must analyze the different customer groups spread throughout the city. This will allow the organization to make correct allocation of vehicles based on past customer usage. In addition, it is important to understand peak times for the organization. This involves the consideration of differential pricing and increased resources during daily peak times and holidays.

How would one go about suggesting and eventually implementing managerial change of current operations?
It is important to show an organization exactly how they have been doing what they are doing. Then as part of your proposal, you must show them how to use resources in the best possible way. For your situation, it is important to understand however that you will most likely be dealing with limited resources, given the non-profit status, and a lack of control in a self-supported process, with cars being parked throughout a city with no central location to oversee the entire process. it is important to not only propose technology but analyze its effects and possibilities on paper.

Brian Kusler: IT Director of City CarShare
Date: Thursday February 10, 2005
Location: IGSD Office by telephone

How does your access system work currently? Planned changes?
City CarShare (CCS) uses RFID key fobs with readers in the windshield of each car. User data is logged and saved onboard until it is recovered manually via serial port. The boards were developed for CCS and interface with ignition, fuel injection, door locks etc. CCS has car stereo technicians do the installation since they are already familiar with car electric systems.

CCS wants to add GPRS capability to their boards (about $140 add on per car) so that they can talk to the cars directly from the office. Reliability of boards is pretty good, although some problems do show up in the field. Most issues with members.

What is the open source reservation system you use?
EngineGreen worked with CCS to develop the booking system which was based on existing open source software. EngineGreen is now selling the newest version of their software. EngineGreen hosts server. Important to keep tech support close to home.

City CarShare helped get Philly Carshare up and running. Are they set up in a similar fashion to City Carshare (using same tech, etc)?
Yes, Philly is using CCS's tech.

Since City CarShare is a non-profit organization, would they consider sharing any IP to other non-profit carshares?
Yes, but non-profit only. CCS wants to "productize" their boards with full written support and installation documents etc. The problem is tech support, especially if stuff goes overseas.

Field work performed by members of their own organization as well as outside contractors paid by the hour. Big problem with customers leaving the lights on so battery dies and access system goes with it. Want to be able to send an SMS text message or GPRS etc warning of battery status.

Would it be possible to estimate the cost of designing and implementing your complete system for our sponsor?
<< $1,000 reader, board, ignition disable etc. Will get back to us by e-mail.

Stephen Oakley: Zipcar, VP of the Zipcar Experience

Date: Wednesday February 16, 2005
Location: IGSD Office by telephone

What are the most common issues that you experience with customers pertaining to booking issues?
The biggest issue is availability. The company has online and phone booking systems as well as pre-automated booking systems. Though there are no real complaints about the booking system there are problems on the customers end. Zipcar tries to address the issue of availability by ensuring that customers don't become accustom to using only one car. Customers will use only one car and when it is booked will choose not to book any car even if one close by is free. Zipcar tries to fix this issue by providing the availability of the 5 closest cars and by allowing customers to choose by location so that they can easily access cars by their work or any other location they desire. Because the 5 car availability can have similar problems to the customer's fixation on one car Zipcar added a search where customers can see what cars are available for the times that they want.

What issues do you face in regards to car access?
There are a few issues they face with car access. One is the user interface. Customers who are accustomed to card swipes are used to ones powered by AC, like building access cards. Since DC powers the card swipes for the car, most people are impatient and swipe the card too fast.
The second factor is customers leave car electronics running, whether it be the overhead dome light, or keys in the ignition. This results in the battery dying and thus the next customer will not be able to access the car.

What do you do in those emergencies?
We can do a couple of things. Most often we simply move the customer to the next car, which is normally; parked next to the one they had access too. Zipcar will also send out a cab to take the customer to the closest car if necessary. At this point someone is sent from Zipcar to fix the battery.
The third issue Zipcar faces with car access is related to the fact that each member has a unique card. Often times members will end up with a card that isn't there's and will try and get access to the car. This normally happens when, for example a member loses a card and they receive a replacement, but then find their old card and try and use it for access. Zipcar can actively reassign the cards, so members can read off the number for the card they are using and Zipcar can reassign that card to them giving them access to the car.

What factors do you use to determine optimal car placement?
There are a couple of dimensions that Zipcar uses. First there is the marketing standpoint. Is the location clean, well lit, and well trafficked. They look at the ease of access. They also like spaces that are close to main roads. They also have to look at mixing the usage type for each location. There needs to be a mix of business and residential use for each vehicle so that the usage can be optimized. They like to have a car, which is contracted with a larger institution. For example they might put a car next to a condominium complex for its residents to use.

Do you have cars that are specific to an individual institution?
There are only a few cars, which are specific to an individual population. Cars on lets say Wellesley campus are available to anyone in the Wellesley area not just students.

In general and for expansion to new areas what ratio do you try and keep between cars and the number of members?
It is difficult to put a rule of thumb on the ratio since one car might be heavily used while another receives only low usage. Normally Zipcar looks at the utilization levels of a car and when they get high enough decide to add a second car to that area. In some places there is simply high membership for occasional use, so the car is not utilized often, while in other places members will use a car three times a week.

What demographics have you found to be most interested in using a carshare?
Zipcar realizes that they are attractive to a green consumer so they try and reduce the stereotype that carsharing is simply a green activity. There was much concern that Zipcar would come across as a green company, which is not there policy at all, so they fought that image from their startup. There is a lot of usage from the 25, high educated, high income demographic because they tend to be early adopter of new technologies and ideas, they tend to be urban dwellers and they don't mind taking risks. There is also an odd group in there 40s and 50s who adopt the carshare, perhaps because they are well established and their kids have left. There is a niche demographic of young families in need of a second car. There is of course some bias to web users because of the need for access to the Internet.

So you recommend always having the phone option?
They underestimated the use of the phone service. Unlike most carshares they added the phone service later after the carshare was settled as opposed to having an automated phone service from the beginning like most carshares. The percent of phone reservations has increased dramatically.

Liselotte Ley: Project Sponsor, Director of Copenhagen Carshare

Date: Wednesday March 23, 2005
Location: Copenhagen Carshare Office

How many members and cars do you currently have?
We currently have 115 ordinary members and 23 additional members making a total of 138 members as of today (Wed. March 23, 2005). Today we are adding 2 cars for a total of 15 cars (Wed. March 23, 2005).

How many locations do you have, and what are their names?
There are 9 locations within 5 districts within Greater Copenhagen, Nørrebro, Østerbro, Vesterbro, Brønshøj, and Bispebjerg.

How many key boxes do you have?
We have a key box at each location for a total of 9 key boxes. We are planning on adding two additional key boxes in the next 2 weeks.

What do you see as the disadvantage to having a key box access system?
There are many disadvantages to using a key box. First is the issue of safety. All members have keys to all of the key boxes. It is also a process for finding and having approval from the city for attaching the boxes. There is also a risk of a member taking the wrong key and keys are not necessarily identifiable because tags often fall off. With an ID system in each car it will allow for flexibility in parking and car placement.

Do you have a preference for the user interface for the cars? i.e. electronic key box, ID reader on each car
We would like to get rid of the key boxes and log books. It would be ideal to have an ID reader on each car.

Will Europcar allow hardware to be installed in the cars Copenhagen Carshare leases?
Yes, they will let them install electronics.

How important is it for the car to be able to communicate with the office?
Not essential but it would be very nice.

How do you currently maintain the cars?
Based on the agreement we have with the leasing company (Europcar) we can only take cars to authorized dealers, Volkswagen and Toyota. For each 15,000 km that are the cars are driven they are taken to the authorized dealership for a full check-up. The VW are serviced in Copenhagen at Bekker Delebil and the Toyotas are serviced in Farum.
The carmasters are responsible for other basic maintenance and cleaning. We are going to start making penalties for members for basic car maintenance. We are going to discus the position and responsibility of the carmasters of the annual member meeting in May. We need to be stricter with them and their responsibilities.

What is given in return for these services in terms of monetary amounts and free membership?
Carmasters are given access to shared cars in return for a waived monthly fee. There are 5 carmasters however one of the carmasters is taking car of 10 cars. They check the cars once

a month.

Would you consider becoming a partner with a local mechanic and eliminating the position of the carmasters?
According to the leasing agreement we must used a mechanic at an authorized dealer. Also, we can not eliminate the position of the carmaster because they clean the cars.

What is your current budget?
We currently have no working budget. However, a new automated system would free up 50 DKK per member per month from accounting and billing services. Also, Århus is waiting on your project and will have some funds available. We think that we could offer 10,000 DKK per car for updated technology. We are planning to do fundraising with Århus.

How much of the budget is used for accounting and billing purposes?
We spend 50 DKK per member each month for an accounting fee.

If distance and billing information could be stored in the car would you be willing to use a system that requires manual retrieval with a laptop once a month?
This would be an acceptable method but not preferred. This might be an option for cars that are added at the holidays like Easter and Christmas.

Do you have relationships with carshares outside of Denmark?
No we do not however we would like to. The man from HUR, Tonny, is looking into Sweden and Switzerland.

What are your goals for the future in terms of adding members and cars?
We currently do not have any goals in terms of set numbers and timelines. I would like to be able to sit down to form actual goals however numbers are constantly changing and there is no time right now to stop and do that. However, studies have shown that there are 100,000 potential members in Copenhagen that would be interested in joining a carshare. Also, according to
HUR the growth of Copenhagen Carshare mimics that of other European carshares.

If our proposal meets your financial needs how soon would you want to implement the system?
Immediately and the people from the Århus Delebiler are also interested financially in your project.

Do you know what technology provider Hertz Carshare is currently using?
Hertz claims to have developed their own hardware and software. However, I think you should talk with them.

Would members be willing to have an increase in membership prices in order to have an update in technology?
No, they recently received an increase in their monthly billing. However, I think you should ask their opinion at the focus group.

What specific services does Bjørn Dirchsen provide for Copenhagen Carshare?

Bjørn is in charge of our e-mail system, internet services, homepage, and is a technical consultant to our organization consultant. I do not believe that he is a developer.

Do you know of anyone who is a developer?
Hans has developed our current booking system and is working on a new cell phone that can be put into any car, you will have to speak with him about his new invention. There is also a new member, Michael Zedler, that is helping Hans develop some stuff.

How much do his services cost? Is there an hourly fee or a flat fee?
Bjørn works for us a minimum of 10 hours a month minimum. We pay him by the hour but he gives us a special fee.

Would he be able to develop hardware and software for updated technology?
Bjørn would probably not be able to develop anything.

How much would Copenhagen Carshare be willing to spend on each car for updated technology?
We would be able to give approximately 10,000 Kr per car for updated technology.

Why do you lease the cars instead of buying them?
The leasing model made the most sense in terms of insurance costs. It was not realistic for an insurance company to insure cars that are owned and used by multiple members.

Would you be willing to allow advertisements to be put on shared vehicles in order to gain extra funding?
We have considered this idea and there has been much debate. We will be discussing it further at the annual meeting however members have told us that they would feel uncomfortable if they drove a car covered in advertisements to a funeral, business meeting, or any other important event.

Bjørn Dirchsen: IT Consultant for Copenhagen Carshare

Date: Thursday March 31, 2005
Location: Copenhagen Carshare Office

What is your educational and professional background?
He graduated from the University of Copenhagen, and has been an IT Professional for 10 years

What does your company specialize in?
He owns NETsolutions, which provides servers, consultation, and hardware and software products.

What services do you provide to Copenhagen Carshare?
He provides basic IT services, including computer maintenance, hosting the website and e-mail, and providing consultation on technical subjects.

What are your opinions on the technologies available for carsharing?
He liked the suggestions present in the report, but had no particular bias on any available technologies.

Do you have any estimate of development costs for in-car hardware?
He believes the initial investment will be expensive, but had no specific monetary value.

Do you have any estimate of development costs for new booking and billing software?
Not right now

Would you be able to oversee the introduction of a new booking, billing, and car access system?
Though it isn't one of his areas of expertise, he would be able to oversee the introduction of the technology.

Could your company host the booking and billing server?
His company has the capability of hosting the servers.

Could you give us any leads on potential software and hardware developers for this project?
Though he didn't have a specific name, he recommended that the developer have similar experience to expedite the development. The key to finding a developer, he said, was to look for someone willing to develop the technology for a reasonable price, since the project is fairly easy.

Other Comments:
He warned that insurance companies might not be willing to provide insurance for cars with the electronic access system, unless they deemed the anti-theft system safe.

Michael Zedeler: Copenhagen Carshare Member

Date: Tuesday April 12, 2005
Location: Copenhagen Carshare

What is your educational and professional background?
Currently he is writing his Master's Thesis for Computer Science.

What does your company specialize in?
IT Consulting, with various industries and projects.

What problems do you see with the current booking and billing system from an IT point of view?
His concern was that the current booking system would not work under greater loads once the membership increases. Concern arose over whether two members could make the same reservation simultaneously.

Have you been in contact with Hans Kjer concerning his current system?
He had been in contact with Hans Kjer and has been trying to persuade him to publish his booking system as open source. However, Hans Kjer has not yet done so.

What features would you add if it were open source?
He would like to see mapping abilities for the locations of each car. It is free in Denmark and very simple to add to any site. A member's address could even be added so that the system could be semi-automatic. He believes that the software should be interfaced with PBS to allow for online bill paying. Also, I would like to see a "chat room" set up that would allow members to read or post repairs or issues certain cars have had. The management of Copenhagen Carshare could then update the dialogue with how and when the car was repaired.

What have you developed thus far?
Nothing.

What time frame would you have for developing these extra features?
No comment.

If a whole new booking system was to be developed what do you estimate its costs to be?
No comment.

Would you or a contact you know be interested in helping with its development?
He said he would be interested in assisting with new development of a booking and billing system. However, because of the non-profit status of the carshare he would rather volunteer time in helping to develop the software then be paid for his professional services. He also had a contact for a hardware developer and a website which is a listing of inexpensive, Danish, start-up developers whose services would be within the price range of the carshare. With this in mind he volunteered to interview potential developers to find the most capable one for the carshare.

Alex Pedersen: Administrative Director, Hertz Delebilen

Date: Wednesday April 13, 2005
Location: Hertz Delebilen

How long as Hertz been running a carshare in Copenhagen?
Hertz began operating the in the carshare industry in 1998.

As a car rental company what advantages did you see in joining the carshare industry?
Honestly, if Hertz had done an analysis first of joining this industry they probably would not have done it. Car rental people are very different from carsharing people. Car rental people enjoy seeing those who are renting the vehicles and they do not like the idea of a car not be cleaned between each use. Therefore, Hertz operates their rental and carsharing as two different families or businesses.

How many members do you have?
Hertz has 1,700 members.

How many cars do you have?
Currently Hertz has 62 cars and by next week they will have 67. They ordered 5 more VW Cabrios, they are very popular with their customers.

Do you offer larger cars for shared use such as Sport Utility Vehicles?
Hertz offers vans and Volvo station wagons. They recently started offering a 9-seater mini-bus which is wheel chair accessible.

Do you have other locations within Denmark besides Copenhagen?
Yes, Hertz has locations in Copenhagen, Hellerup, Odense, Aalborg, Kastrup Lufthavn (Copenhagen Airport), Albertslund, Høje Taastrup, Roskilde, Esbjerg, and Allborg Lufthavn (Aalborg Airport).

Do you have other locations within Europe?
No, Hertz only operates carshares within Denmark.

What are the membership costs?
We have two different membership levels. Level A is for members who drive shared cars more frequently. They pay a monthly fee of 300 DKK per household and pay a lower fee per kilometer. Level C is for members who drive shared cars less frequently. They pay no monthly fee however the pay a higher fee per kilometer.

What services do you provide to your members (gas cards, maintenance, reserved parking, etc.)?
Hertz provides its members a gas card, monthly maintenance, and clearly marked reserved parking.

In terms of attracting members, do you think you have an advantage over Copenhagen Carshare? Why?

Some say yes and some say no. Those who are members of Copenhagen Carshare want to make a difference in the environment and their community. The question each member must ask themselves is how involved do you want to be.

Do you have members that join just to drive luxury cars?
Hertz has members that join because they are in need of a van. And Pedersen knows for a fact that some members joined when Hertz purchased the VW Cabrio. It gives them the chance to drive a car that is not practical enough for them to personally purchase.

What technologies does Hertz currently use for the carshare?
Hertz uses a German product, Invers, both their Standalone and Keymanager systems. The reason they use both is because it is cheaper to use the Keymanager if there are multiple cars parked in the same area. For instance, Hertz has eight cars parked at the office so the key box contains all of the keys. A Keymanager is also needed for cars parked in a garage since GPS can not be received. A huge cost of this system is the telephone line. Hertz pays a monthly subscription for each box to TDC (Telephone Company).

Does Invers host your booking and billing server?
No, Hertz has its own server.

Have you had problems with the current technology you are using?
They have had some problems with the telephone lines but other than that no.

Did Hertz develop them and do you plan to develop them further?
No.

Liselotte has told us that you have made her an offer to partner with Hertz Carshare. What does this offer entail?
Copenhagen Carshare would essentially be "outsourcing" their duties while maintaining their own identity and membership base. Hertz would create them their own booking and billing system however we would support it on our server. Hertz would also clean their cars once a week and allow them to partner with our other carshare locations in Denmark. Hertz believes that both carshares have a common goal is that is to "grow

Hans Kjer: Developer of Current Booking System

Date: Tuesday April 19, 2005
Location: Århus Delebilklub

What is your background with regards to software and hardware development?
Hans has a B.A. in communications and music. He is not a programmer, he specializes in interface. He currently owes his own company, Net Image.

Would you consider making your booking system open source?
Hans has been asked before by IT professionals that are members of Copenhagen Carshare to make his system open source. However, he sees this as impossible since he does not see how he could earn money with an open source booking system.

Would you be interested in working on a new booking and billing system?
Hans would be interested in working on a new system. He has already developed a new concept using a cell phone which was discussed a bit later.

Would you be capable of hosting a new booking system, one that is either custom developed or commercial?
He would be able to do this however he can not estimate a price since he buys space on another server that is not his own. However he claims to be able to provide a server such that if we used the independent server option that the costs would be lower than Eileo's.

How does your cell phone system work?
Han's cell phone system is referred to as "Smart Phone." The system works by installing a regular cell phone with GPRS capabilities into the carshare cars. The phone software would be modified to create a program specific to the carsharing process. The member after gaining access to the car via a key box system, would enter their member ID number into the phone and the current odometer reading. The phone would inform the member whether they are in the correct vehicle, and if they are reserved for the current time. After the member completes the trip he or she can input the new odometer reading to complete the process.

Morten Franch: Director of Århus Delebilklub

Date: Tuesday April 19, 2005
Location: Århus Delebilklub

How many members and cars do you currently have?
Århus Delebiler has been operating for over six years and currently has roughly 170 members and 15 cars. There are about 23 cars in the summer since more are demanded during this season.

How do you feel about key boxes and log books?
Morten feels that it would be convenient to get rid of key boxes and log books, but stresses that his costs would have to be less or the same for him to really justify it.

What problems have you had with the current system?
Currently the carsharing club has about two or three occurrences a year when unreserved cars are taken. There have also been two occurrences where a former member kept the key to the key boxes and was still using the cars.

What do you think about Han's "Smart Phone" solution?
Morten has a major issue with Han's "Smart Phone" system. The system does not force any member to input the odometer and member ID number information. It seemed that he had serious reservations about spending money on the system, as he couldn't see it being worth the monetary investment.

How important is it for the car to be able to communicate wirelessly with the office?
Morten's biggest priority was cost. Regardless of how the system worked, the system had to be cheaper. He did however like the option of wireless communication with the office.

If distance and billing information could be stored in the car would you be willing to use a system that requires manual retrieval with a laptop once a month?
This system was not preferred since he would have to hire a carmaster with the appropriate technical knowledge.

What are your goals for the future in terms of adding members and cars?
Morten's tight budget, and inability to really advertise the carshare leaves him to the conclusion that the carshare has reached a plateau in terms of members and cars. At this point it seems he is looking for sustainable business solutions.

Would Århus Delebil be interested in updating their current carsharing technology with recommendations from our final proposal?
Morten believes that if we create an economic solution, and we present an appropriate solution to the issue of having summer month vehicles that it would most likely be considered.

If our proposal meets your financial needs how soon would you want to implement the system?

Because the Århus Delebil has limited cash flow, and capital he does not foresee being able to implement the system soon. However if Europcar would purchase and lease the systems to the Århus Delebil Morten believes that it could be implemented much sooner.

How much would Århus Delebil be willing to spend on each car for updated technology?
No money to spend at this time.

Kim Foldal: Shop Coordinator, Bent Bekker Volkswagon Automobile Dealership

Date: Monday, April 18, 2005
Location: Bent Bekker Dealership

Can the power doors be controlled through the OBDII port?
Yes, but only as a test procedure

How can someone lock the engine through the OBDII port to disable car ignition?
Not practical

Can we lock the ignition and then remove this system and keep it locked?
No longer applicable

Is the power provided through the OBDII always available, ignition or battery?
Yes, the power is always available

Approximatly what size fuse is on the OBDII power connector?
At least 5 amps which is plenty for this application. Again, no longer applicable

How would you recommend we access the odometer reading from the car?
He recommended that the group use a wire available in the wiring harness for the car radio. The wire carries the odometer pulses to the radio (for speed-dependent volume control) as an active square wave

How would you recommend we retrieve the check engine light?
Not addressed

Does the car send a low battery flag when the car is off?
No longer necessary. Battery voltage can be read by the Microcontroller

Do VW's have keyless Immobilizers?
Only the Touareg has a keyless immobilizer

Mads Munch: Europcar

Date: Wednesday April 20, 2005
Location: Europcar Car Rental

Can electronics be installed in Europcar cars that are leased by Copenhagen Carshare?
Yes, the electronics that the group's project would consist of can be installed into the cars. There is not an issue with doing so or insurance terms.

Can Europcar install electronics in the shared cars or would VW have to do it?
Depending on the level of work needed either Europcar's mechanics or a contractor will be used to install the electronics. Either way Europcar will responsible for installation.

Could this fee be built into the leasing fee for Copenhagen Carshare?
Yes, fees in the past have already been built into the leasing price paid by Copenhagen Carshare. Recently, Europcar purchased and installed trailer hitches for Copenhagen Carshare and built the price of the equipment and labor into their monthly lease price. The Carshare can choose to either pay a small monthly fee indefinitely or pay a larger monthly fee for a set time period, wherein after that date they will have paid for that particular hardware system.

If the car key was altered would the insurance still be valid?
Depends on the system

Is it acceptable to store the key in the car in terms of insurance?
Yes. Mad's believes there is no problem with this since Hertz stores the car keys in their shared vehicles using the Invers system.

Would Europcar be able to rent the systems to Copenhagen Carshare?
The cost of such a system was discussed at great length. Estimated prices for the Eileo Zibox LT were quoted, using information sent to the group from the company. It was made clear that there was an initial fee for purchasing the system and that there were additional fees for hardware for each shared car. In addition, the option of renting the system exists and the option was discussed. Mad's said that Europcar would be able to purchase the system and distributed it into the lease for each car for Copenhagen Carshare per month. In conversation Mad's made noted points in terms of the reliability of the company for their electronics development as well as a need for finding a carshare that currently uses the system itself. He believes that the true test of the potential of this system is to see it working in a real carsharing situation. He asked that the project group return to him with further contact information for the company, Eileo. He was invited to the group's final presentation and asked for a copy of their final proposal report.

Appendix F: Focus Group Results

Members in Attendance: ***Jon Bendtsen, bendtsen@diku.dk***
Mette Kirchhof, Jensen Mette_kj@tdcadsl.dk
Kim Skytte, kim.g@abl1926.dk
Søren Nedergaard, nedergaard@itu.dk

Focus Group Duration: 95 minutes
Date: Tuesday April 5, 2005
Location: Copenhagen Carshare Office

What problems you have had in the past with booking and how has Copenhagen Carshare dealt with it?

A member can not delete the booking once the booking time has started. For example if the car has been booked for an entire week and you realize that you only need 3 of the 5 days then you should be able to free up the car for those 2 days that you will not need it.

The entire booking system is not user-friendly. All of the interaction that needs to be done could be done in a smarter way.

Remove the cars from the website that are only Easter cars when it is not Easter.

Members understand that this booking system will not work once the membership grows.

They would like to see online who has booked the car before them including contact information. So that if the car is not there or they can't find it then they can call the person with the reservation before them.

Members would like to book by phone. If they take the car for the afternoon they would like to be able to call in to see if the car is available in order to continue their reservation. They would be comfortable with automated telephone booking.

From the administration end the members (Kim) would like to have generated statistics about use by each member. The carshare would then be able to foresee busy times when more cars will need to be brought in.

What features would you like to see in a new booking system that would be more convenient for you?

Want an overview of all the cars that are available with pictures.

Want to be able to book with different methods: by car size, date, and location.

Members would like to partner with dgs.dk so that maps could be immediately displayed showing the location of a shared car.

Also I would like to integrate with rejseplanen.dk, so it is possible to get a suggestion of how to get to (and from) the place where the cars are parked, using public transport. rejseplanen.dk allows this.

Members would like a calendar displayed when booking a car.

What problems you have had in the past with billing and how has Copenhagen Carshare dealt with it?

The bills are hard to read, the printed text is messed up.

Automated billing will cut down on all of the labor work that is required.

The part that calculates booking prices is flawed. If I decide to book a car for 5 hours, I am charged 75 kroner even though the price for 6 hours is 50 kroner. The booking system should charge the cheapest possible price without altering the pickup and drop off times (leaving the booking to last 5 hours in my example).

Would you like your billing information to be sent differently?

All members in attendance would like to do bill paying online with a credit card (PBS).

They would like the billing/pricing system to be clearly laid out. Some have a hard time understanding how their charges have been accumulated.

Integrate with PBS.

What problems you have had in the past with car access and how has Copenhagen Carshare dealt with it?

People think they have booked a car in the system and they actually didn't but they still took the car. However, someone made an actual reservation for the car.

Members also forget what day it is and take a car on Tuesday thinking it is Wednesday. The members believe that this occurrence will become more prevalent as the membership grows.

Yes. I'd like to integrate the booking system with SMS, so it is possible to access certain functions by sending SMS to a specified number. The functions I have in mind are:

* Request extension of current booking.
* Get phone number of person who had car just before and just after a given booking.
* Write log (to avoid paperwork).
* And maybe also just booking a car from scratch.

How do you feel about every member having access to key boxes and cars at all times?

They do not feel that there is a threat to their security.

One concern was that a couple has only one key, making it very inconvenient. However, they feel with a lot of member there will be issues.

Are there any specific changes you would like to see in the system in terms of booking, billing, and car access that we have not discussed?

The key boxes are hard to find. They are in favor of reserved parking spots.

Want to be able to contact the carmasters about the cars they are responsible for. They would like the carmasters to have a posted email.

How do you feel about the current prices for the service you receive?

Paying by kilometers is not the best system. It is very expense to drive the car a long distance. They would like to see a different pricing scheme (differential rates), some suggestions included:

Have "peak" and "off peak" times when the charge per kilometer is less during "off peak" hours at night. Also make a price distinction between weekdays and weekends.

As a member drives more and more kilometers in the same trip the kilometer charges continues to decrease. Example 0-120 km costs 5kr/km, 120-240 km costs 3kr/km, etc.

The members want a "fair" pricing system that accurately reflects the use of the cars by the members. They do not want a pricing scheme that charges by the hour, they do not believe it is flexible enough since they would feel in a rush.

They see a lower fare at other car rental companies such as Hertz.

Consider pre-paid monthly usage that could be drawn from an account each time the cars are used. Online billing would allow members to view usage and charges daily. They suggested that a pre-paid system could be cheaper by offering a deal for those who put money up front right away.

If new technology was integrated into the cars would you feel more comfortable with a demonstration or an informational write-up?

It seems that it would be beneficial to have demonstration of how to access the car with a smart card. These findings are based on a members experience with smart cards and Zipcars recommendation through a phone interview.

Would you feel comfortable accessing a card with an ID card and having the key in the car?

Some of the members would like it so that every member can access the car at all times with their card and have the ignition remained locked once a non-reserved member accesses the car.

However, they feel that locking out members that do not have a reservation would add a safety feature.

Overall it seemed like the members were uncomfortable having the keys in the car. They are worried that the key would be left visible. Therefore, there must be an agreement in the member contract about placement of the key.

Do you have any concerns with using GPS tracking in terms of privacy?

No.

Yes, but I am willing to accept it, given that the system is designed carefully (Micheal Zedler, email).

From our presentation would you be in favor of our current proposal?
They were welcoming of our initial proposal. Many of their own thoughts paralleled our current findings.

The members were overall concerned with the reliability of the system.

Research the reliability of system as well as Zipcar's experience.

Do you have personal contacts that would be able to assist with the development of software and hardware?

Handouts were passed around outlining the project in addition to contact information. We are expecting continued contact with information.

Members suggested using the same technology that HUR is developing for linking transportation through a smart card system. They believe HUR as a public system will offer assistance to their non-profit organization.

Appendix G: Member Survey

Københavns Delebiler: Technology Survey

How long have you been a member of the Københavns Delebiler?

☐ Less than 1 month ☐ 4 months or less ☐ 8 months or less ☐ 12 months or less

Would you have bought a car if Københavns Delebiler was not available?

☐ Yes, a new car ☐ Yes, an old car ☐ No ☐ No, I sold my car ☐ Don't know

How would you rate the ease of booking for the online reservation system?

☐ Very Easy ☐ Easy ☐ Moderate ☐ Difficult ☐ Very Difficult

How would you rate the ease of locating the carshare vehicles?

☐ Very Easy ☐ Easy ☐ Moderate ☐ Difficult ☐ Very Difficult

From how many locations of key boxes do you commonly reserve vehicles?

☐ One location ☐ Two locations ☐ Three locations ☐ Four locations ☐ More than four locations

Would you reserve vehicles at more key box locations if they were easier to find?

☐ Yes ☐ Maybe ☐ No ☐ No opinion

How often do you reserve a vehicle?

☐ Once a month ☐ Twice a month ☐ Once a week ☐ Twice a week ☐ More than twice a week

Would you reserve more often if the reservation system were easier to use?

☐ Yes ☐ Maybe ☐ No ☐ No opinion

How often has the car been unavailable or missing when you had a reservation?

☐ Never ☐ Almost never ☐ Occasionally ☐ Frequently ☐ Almost always

How interested would you be in an automated phone reservation system? (An automated phone system would be a system where someone could call a computer that would talk you through a reservation process.)

☐ Uninterested ☐ Somewhat uninterested ☐ No opinion ☐ Somewhat interested ☐ Interested

How important do you feel it is to have a map location of the vehicles available online when you are booking? (such as one available on www.krak.dk)

☐ Very unimportant ☐ Unimportant ☐ No opinion ☐ Important ☐ Very important

How important do you feel it is to have directions to the locations of the cars on www.rejseplanen.dk?

☐ Very unimportant ☐ Unimportant ☐ No opinion ☐ Important ☐ Very important

Which would you prefer more: the current key box system, OR a system with keyless entry to the cars

☐ Current key box system ☐ No opinion ☐ Keyless entry

How secure do you feel the current system is with every member having a key for every key box?

☐ Very unsecure ☐ Unsecure ☐ No opinion ☐ Secure ☐ Very secure

Would you prefer a system where car access is limited to only the member who has reserved a designated time?

☐ Yes ☐ Maybe ☐ No ☐ No opinion

Have you ever been in need of emergency maintenance while using a shared car?

☐ Yes ☐ No

Do you own your own cellular phone?

☐ Yes ☐ No

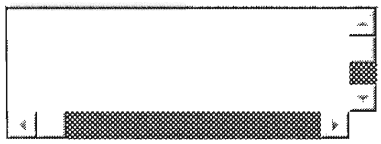
How would you rate your comfort level if the location of the car was known at all times using a Global Positioning System (GPS) device in the vehicle? (GPS is an electronic device which informs you of your location anywhere in the world)

☐ Uncomfortable ☐ Somewhat uncomfortable ☐ No opinion ☐ Somewhat comfortable ☐ Comfortable

Rate the importance of online bill paying, such as PBS?

☐ Unimportant ☐ Somewhat unimportant ☐ No opinion ☐ Somewhat important ☐ Important

If you have any other concerns or issues with booking, car access, and billing please feel free to comment below:



Appendix H: Member Survey Results

Københavns Delebiler: Technology Survey

1 How long have you been a member of the Københavns Delebiler?

Less than 1 month	0.00%
4 months or less	27.27%
8 months or less	33.33%
12 months or less	39.39%

2 Would you have bought a car if Københavns Delebiler was not available?

Yes, a new car	0.00%
Yes, an old car	51.61%
No	32.26%
No, I sold my car	9.68%
Don't know	6.45%

3 How would you rate the ease of booking for the online reservation system?

Very Easy	12.12%
Easy	48.48%
Moderate	30.30%
Difficult	9.09%
Very Difficult	0.00%

4 How would you rate the ease of locating the carshare vehicles?

Very Easy	21.88%
Easy	31.25%
Moderate	31.25%
Difficult	12.50%
Very Difficult	3.13%

5 From how many locations of key boxes do you commonly reserve vehicles?

One location	9.38%
Two locations	34.38%
Three locations	37.50%
Four locations	9.38%
More than four locations	9.38%

6 Would you reserve vehicles at more key box locations if they were easier to find?

Yes	6.25%
Maybe	18.75%

No	71.88%
No opinion	3.13%

7 How often do you reserve a vehicle?

Once a month	24.24%
Twice a month	45.45%
Once a week	15.15%
Twice a week	9.09%
More than twice a week	6.06%

8 Would you reserve more often if the reservation system were easier to use?

Yes	3.03%
Maybe	15.15%
No	78.79%
No opinion	3.03%

9 How often has the car been unavailable or missing when you had a reservation?

Never	59.38%
Almost never	31.25%
Occasionally	6.25%
Frequently	3.13%
Almost always	0.00%

10 How interested would you be in an automated phone reservation system? (An automated phone system would be a system where someone could call a computer that would talk you through a reservation process.)

Uninterested	33.33%
Somewhat uninterested	21.21%
No opinion	3.03%
Somewhat interested	24.24%
Interested	18.18%

11 How important do you feel it is to have a map location of the vehicles available online when you are booking? (Such as one available on www.krak.dk)

Very unimportant	6.06%
Unimportant	18.18%
No opinion	3.03%
Important	45.45%
Very important	27.27%

12 How important do you feel it is to have directions to the locations of the cars on www.rejseplanen.dk?

Very unimportant	12.12%
Unimportant	33.33%
No opinion	18.18%
Important	36.36%
Very important	0.00%

13 Which would you prefer more: the current key box system, OR a system with keyless entry to the cars

Current key box system	6.25%
No opinion	43.75%
Keyless entry	50.00%

14 How secure do you feel the current system is with every member having a key for every key box?

Very unsecure	9.09%
Unsecure	24.24%
No opinion	21.21%
Secure	42.42%
Very secure	3.03%

15 Would you prefer a system where car access is limited to only the member who has reserved a designated time?

Yes	50.00%
Maybe	31.25%
No	12.50%
No opinion	6.25%

16 Have you ever been in need of emergency maintenance while using a shared car?

Yes	9.38%
No	90.63%

17 Do you own your own cellular phone?

Yes	87.88%
No	12.12%

18 How would you rate your comfort level if the location of the car was known at all times using a Global Positioning System (GPS) device in the vehicle? (GPS is an electronic device which informs you of your location anywhere in the world)

Uncomfortable	9.09%
Somewhat uncomfortable	12.12%
No opinion	33.33%
Somewhat comfortable	15.15%
Comfortable	30.30%

19

Rate the importance of online bill paying, such as PBS?

Unimportant	0.00%
Somewhat unimportant	6.06%
No opinion	0.00%
Somewhat important	33.33%
Important	60.61%

Appendix I: History of Carsharing

Carsharing began in Europe during World War II. While it was not an organized service or business, it began in order to share the limited resources available to the citizens of the countries at war (Copenhagen Carshare). However, the phenomenon of carsharing has grown into beneficial organizations and expanding corporations in both Europe and the United States within the last thirty years.

Europe

Europeans have been enjoying the benefits of carshares since the late 1980's. Early carshares were normally informal and relied on volunteers and the generosity and consideration of their members. Booking systems were run where "each car had an administrator whom members could call to book a trip. They would retrieve the car key from a safe deposit box near the car. Each member had a key that opened all deposit boxes. After each trip they returned the car and noted in the board book the distance and time of their journey" (Hockerts).

These humble beginnings originated in Switzerland in 1987 with what would become the birth of the modern day carshare. Two separate companies, the ATG, AutoTeilet Genossenschaft, and ShareCom, were formed with both ecological and economic benefits in mind. The overwhelming success of the carshares resulted in near doubling in size annually. In 1991, the BFE, Swiss Federal Energy Office, began Energie2000, a plan to promote energy efficiency and renewability. The VCS, Verkehrs-club der Schweiz, "Switzerland's 'green' traffic club, began to systematically support car-sharing" and "proposed car-sharing as one of the projects funded under the program and offered to act as project manager between the BFE and the two co-operatives." In 1988, the two original carshares merged to

create Mobility CarSharing, one of the largest European carshare conglomerates today (Hockerts).

Today, Europe has some of the most extensive coverage of carshare programs worldwide. Major carshare corporations such as European Carshare and Mobility CarSharing, cover parts of Italy, Switzerland, Germany, Norway and France. However, the carshare craze has gone as far as Jerusalem and Singapore (Car Sharing Network).

United States and Canada

While Europe is responsible for the first carsharing concept, Canada and the United States have since placed themselves on the carsharing road map. Today there are nine carsharing organizations currently operating in North America. In 1983, the first carsharing experience, Mobility Enterprise, ran as a field-test as part of a research program for Purdue University for three years. Later in 1983 STAR, Short-Term Auto Rental, another research project, operated in San Francisco until March of 1985. STAR offered over 9,000 residents of an apartment complex the access to shared vehicles for ranging reservation lengths (Shaheen, Carsharing 120).

The first and oldest organized carshare in North America began in 1994 in Quebec City, Canada as a non-profit organization. Entrepreneur Benoit Robert founded the cooperative Auto-Com. Today Robert is the founder and chief administrator of the merged for-profit company, CommunAuto Inc. The company operates as the largest carsharing company in both Montreal and Quebec City with nearly 1,300 customers, over 80 vehicles, and 40 locations (Robert 3).

The concept of carsharing began in the United States in Portland, Oregon with CarSharing Portland Inc. which began service in March of 1998 (Brook 2). Today three carsharing organizations account for 95 percent of the membership in the United

States. These companies dominate both the west and east coast with two for-profit businesses, Flexcar and Zipcar, and one non-profit organization, City CarShare (Shaheen, Technologies 2).

Flexcar's motto, "why buy when you can borrow," sums up the American version of the carsharing concept. The company, founded in 1999, is the "nation's oldest and largest car-sharing company." Flexcar grew from community support and currently offers service in five states and over twenty metropolitan areas (Flexcar: Company).

Another leading carshare company in the United States directly took its inspiration from the popularity of the existing idea in Europe. One of Zipcar's co-founders, Antje Danielson, first encountered the concept of carsharing while vacationing in Berlin, Germany. She observed that individuals could drive cars by the hour for their various needs (Zipcar: About Us). Danielson returned from her trip and immediately shared the idea with Robin Chase, Zipcar's other co-founder. Chase saw promise in the idea; however, market research showed that "Americans don't like to share" (McMillan).

Therefore, the women sought to Americanize the carshare concept by utilizing wireless technology to streamline the process. Their goal was to use technology to meet the needs and values of their customers while complementing other forms of transportation within the community (Zipcar: Mission). The company began in Boston, Massachusetts in 2000, providing a fleet of cars distributed throughout the city. Currently, Zipcar operates in Boston, New York City and Washington D.C. with plans to expand nationally (Zipcar: About Us).

City CarShare, a non-profit organization based on the west coast of the US, began its service in March of 2001. Executive director, Elizabeth Sullivan, "hoped

[it] would have 500 members by the end of the first year, but [it] reached 500 in three months" (Minton 1). At the end of its first year in service, City CarShare had over 1,500 members and 70 vehicles (City CarShare: About). Most recently, City CarShare helped establish and continues to support Philly Carshare in Philadelphia, Pennsylvania.

Like Zipcar, the idea for City CarShare started because of the fast growing success of the concept in Europe. However, the transportation activists, environmental organizers, and urban planners, who started the organization, decided to form as a non-profit carshare. They felt this would allow them "to build an organization that would be capable of surviving economic ups and downs, while staying focused on a mission." With their passion for a positive change, City CarShare collaborated within the community in order to create a well-built and long-lasting organization (City CarShare: About).

Appendix J: Business Classification

The choice of a business classification as profit or non-profit is a difficult decision for most establishing companies and services. Different benefits and penalties exist for each classification. The classification decision is frequently determined by the personal beliefs of the founders and the motivation for which the business was first created (Brook 2). Below is a discussion of these classification types.

Profit

Profit is the financial gain a company experiences by providing services and equipment for a target group. For-profit companies are commercially driven and compete financially based on their level of profit. However, companies that seek profit have an early period in which they are continuously operating in the red. It takes time for assets to build and for start-up costs to be paid back. For instance, Zipcar is a commercial for-profit company established in 1999; it just recently emerged from the red and cut a profit in 2004 (Zipcar Representative).

Non-profit

A non-profit association by definition is an organization existing to serve a social or political need. It is important to note that a non-profit organization does not provide for the final solution; rather it assists by effectively, efficiently, and responsibly improving upon a social issue (Bryson 26-27). With this said, it is important not to underestimate the power of a non-profit organization. Some individuals in the corporate world view those in the field as "unsophisticated, inefficient, unaccountable, and poorly paid" (Gelatt vii). However, non-profit associations are the quiet and powerful force bringing about change in society through individual support (Drucker 3).

With a limited amount of assets, it is important that a non-profit establish relationships with others in the business world to collaborate both resources and information. It is beneficial for a non-profit to take advantage of its customers' good will and devotion towards a change.

Appendix K: Automobile Statistics in Denmark

Denmark's heavy taxation system on motor vehicles has long affected the country's automobile consumerism. Despite the costs, however, the Danish still have significant automobile infrastructure and rely on cars as a viable source of transportation. With over 1.9 million registered household vehicles, and about 5.4 million residents, Denmark has only .35 cars per person, in contrast with, 0.7 cars per person in the United States or .505 cars per person in Germany (Kiss). Only 54.7 percent of families in Denmark own cars, and only 10.3 percent own two or more cars. Corporate automobile numbers near 1.8 million, with only 5,721 taxis in the country. In general, cars in Denmark are relatively old at an average age of 9.1 years, and in 2003 only 96,501 new (both corporate and household) cars were registered (Statistics). Household Danish vehicles traveled 38,854 million kilometers in 2003, making an average of about 20,500 kilometers per vehicle (Statistics).

The low numbers of vehicles can be easily explained by the Danish Taxation system for motor vehicles. The Danes charge a car registration tax of 180 percent of the value of the car. However, because of the VAT (value-added-tax) the value of the car is inflated by 25 percent and the car registration tax applies after the price change. In addition to the registration tax, Danish drivers must also pay a fee for their driving license and number plates of about 1,200 DKK (Car in Denmark). There also exists an owner duty, which taxes the citizen based on the fuel efficiency of the car. This environmental policy is doubly enforced with a Green or Ecological tax. Carbon dioxide and energy usage are taxed, in addition to sulphur content in the fuel (A Shared Future). Third-party insurance for the vehicle is compulsory by the government but is not exclusive to car ownership.

Appendix L: Benefits of Carsharing

Carsharing provides many advantages for its members, the city, and the environment. The mission statement of the Copenhagen Carshare is promoting carsharing in order to improve the environment and reduce the cost of using a car for specific needs. This is consistent with the mission statement of City CarShare: "City CarShare is a non-profit organization whose mission is to promote carsharing as a means to reduce automobile dependence and to enhance the environmental and social integrity of our urban neighborhoods and planet" (City CarShare: About). Most of the benefits provided by carsharing can be grouped into three categories, economics, environment, and urban planning.

Economic Benefits

The main economic benefit brought about by carsharing is reduced transportation expenses for the organization's members. "As a private owner of one's own car one pays a very high price, just to have the car standing without use most hours of the day" (Copenhagen Carshare: What is a Carshare?). Owning a personal car is very expensive, with very high fixed costs associated with purchase, registration, inspection, insurance, disposal, and parking. Carsharing replaces these very high fixed costs with a much lower yearly and/or monthly fee, but a somewhat larger operating cost. "Typically, the fixed costs of a privately owned medium-class car amount to 40,000-50,000 DKK annually and the variable costs lie between 0.90-1.10 DKK per km. In contrast, the fixed costs of a shared car amount to 2,000-4,000 DKK annually and the variable costs lie between 3.00-4.00 DKK per km" (A Shared Future). Clearly, carsharing works best for people who do not require daily car use, and according to the Copenhagen Carshare, "membership in a carshare association is an economically good solution for those who drive between 1,000 and 15,000 km a

year. Carsharing is not a suitable means of transportation for those who have the need for daily use to commute to and from work by car" (Copenhagen Carshare: Economy). Additionally, such "hidden" expenses as gas taxes, emissions taxes, and maintenance costs are included within the carshare membership fees. Besides just saving members money, a carshare also reduces the headache of paperwork. The value of a personal car, despite very high purchase costs, depreciates quickly. This is not a concern with a carshare since members are not financially responsible for the cars. Furthermore, "in Copenhagen townships there is a free parking license for shared cars" (Copenhagen Carshare: What is a Carshare?). Although they may seem minor, parking fees add up over time. All of these savings allow people without the financial means to purchase a car on their own, the ability to access a reliable and clean car when they need one, or simply bring about more affordable transportation for everyone.

Environmental Benefits

The economic benefits provided by carsharing are paralleled by an equally significant array of environmental benefits. One of the main factors is that through carsharing, "car usage of individuals is reduced by as much as 50 percent. Because people have to pay the full cost of using the car each time they drive, they choose to drive only when it makes economic sense" (Zipcar: Green Benefits). Also, "in practice one shared car can replace between 4 and 5 ordinary privately owned cars" (Copenhagen Carshare: Environment). This reduction in driving and number of cars results in vast environmental benefits. The obvious ones are, of course, reduced gasoline consumption and emissions. Furthermore, fewer cars on the road results in less traffic congestion which is a cause of excessive emissions. "Urban freeway congestion costs are estimated to average 6-9¢ under moderate congestion (50 mph),

and 37¢ when congestion is heavy (traffic flows at less than 40 mph)" (Evaluating Carsharing Benefits 6). Additionally, many people who own cars own one that meets their most demanding needs, making the vehicle excessive for most of its use. Through use of a carshare, people can drive smaller, more economic cars, but also have access to a different vehicle when they need one.

Finally, another interesting facet of carsharing is the possibility of the use of alternatively powered cars. Existing carshares in the US and Europe have made use of natural gas, battery electric, and hybrid electric vehicles. These offer efficiency, cleanliness, and renewability of resources, themes that embody many of the same principles and interests as these organizations' members. In general, they are only used within a city, and indeed, many carshares have alternative cars in their fleets. The Seattle Electric Vehicle Association recently partnered with Flexcar, a Seattle based carshare company, to give membership discounts to electric vehicle owners who drive an electric for short range errands in the city but sometimes need a longer range car for other trips. Additionally, Flexcar is offering battery charging opportunities at some of its parking locations (Seattle Electric Vehicle Association). Finally, there are hybrid electric vehicles on the market which combine some of the efficiency of electric vehicles with the common convenience and long range of conventional gasoline powered vehicles. "Hybrid vehicles offer 2-3 times the energy efficiency of a comparable gasoline-only car, and have ranges of about 600 miles on a tank of gas" (Coalition for Clean Air). Carsharing is an excellent application of alternative energy in transportation.

Infrastructure Benefits

While the mission of carsharing focuses on environmental and economic benefits, there is also an impact on the infrastructure of an urban city. Carsharing

overall reduces the number of cars on the road, provides additional space for urban planning, and promotes the use of alternative modes of transportations.

From an analysis of Zipcar's carsharing process, as mentioned above, it has been found that "car usage of individuals is reduced by as much as 50 percent" (Zipcar: Green Benefits). While the environmental benefits are obvious, a decrease in the number of cars on the road reduces traffic congestion and competition for limited parking. It is interesting to note that transportation activists and urban planners established the non-profit organization, City CarShare (City CarShare: About).

Since some urban planners have taken active roles in establishing and promoting carshares, it is evident that carsharing benefits a community by freeing up additional space in an urban setting. With a reduction of automobile dependency and a reduced number of cars in the infrastructure of a city, it is possible for urban space to free up "for uses other than parking lots" and spaces. This in turn allows for further creation and maintenance of ecological space within a city (City CarShare: About).

The concept of carsharing also promotes the use of alternative transportation modes within an urban area. Individual car ownership promotes excessive car use in order for the owner to get the most from a car he is financially committed to because of incurred maintenance and insurance costs. Since members of a carshare organization do not own their cars, the incentive to drive is removed or significantly reduced (Zipcar: How).

When a member pays incremental costs for transportation, he soon realizes the actual cost of each trip made. This economical realization forces the individual to not only evaluate the importance of the trip but also think of alternative modes of

transportation, which can be utilized. These alternative modes include walking, biking, trains, buses, taxies, and carpooling (City CarShare: About).

While carsharing is for the majority a beneficial concept, there are a few disadvantages carsharing has on a city's infrastructure. An increase in alternative forms of transportation could stress the infrastructure. Public transportation companies might need to expand in order to accommodate the increased use of their service. This expansion could put a financial burden on both the consumer and the transportation company with increased fares and a need for more equipment and workers.

Appendix M: Carsharing Management

While technology integration can help to improve the workings of a carshare, it is also worth considering management techniques that could be utilized to further improve the organizational structure of the association. These will involve analyzing current business models, strategic car placement, and the elements of carsharing.

Carshare Business Models

The major factors affecting carshare business models are the pricing and fees, the size of the organization and the member to vehicle ratio. Commonly proposed fee structures use a combination of the following fee types (Scott 31):

application fee
membership deposit
first hour charge
per hour fee
per mile fee
charges for each reservation
differentiated membership levels
annual membership levels
monthly membership levels
family membership levels

A combination of these fees allows for more efficient and fair billing for members. If billing on a monthly basis is too high, then it will punish low usage users. Likewise, if fees for hourly usage are too high, then short distance use members will be penalized. For this reason, billing is determined using a combination of many of these fee types.

Carshares, like many other businesses, have a critical size after which financial sustainability is possible. The minimum size needed to cover costs is approximately 40 vehicles and 600 members (McLaughlin). However, to reach this level the appropriate member to car ratio must exist. One model suggests that at "150 members there will be 20 vehicles, and at 600 members, 48 vehicles" (Scott 37). The

reason comes from availability of vehicles. Early in the process in order to ensure that members will be able to book a vehicle, more cars are needed per member. Later on because member usage stays on average the same and more total cars are available, fewer are needed per person to have the same assurance of availability.

Operations Management

Operations management is the design, the operation, and improvement of the systems that creates the carshares' services. The study of operations managements is essential to the optimization of a carshare because of the importance of allocating vehicles to members efficiently, and the limited resources including capital and human resources, available to most carshare organizations.

The largest concern for any carshare is locational and informational transformation. This refers to the locations of the carshares' cars and the information that must be collected for proper billing, booking and maintenance of the vehicles. The location of the cars directly affects the member's ability to access the vehicle and therefore take advantage of the service. This concept doubly applies to carshares since the vehicle location changes during both usage and allocation. Information gathering and quality must be optimized for proper and timely billing.

Process flow refers to the tasks or actions that must be taken for a service or good to be accessed. In carshares, the efficiency of the process flow plays a large role in how the organization operates on a whole and the members' satisfaction with the service. Appendix Q shows the process flow chart for an average carshare. It identifies the steps a member follows in order to access a vehicle. Highlighted issues in the process include the possibilities that a car is not available upon arrival, a car needs maintenance and will not function, and a member returns the car late. These issues affect the process efficiency of most carshares.

Carshares in general have operations that are difficult to manage because of the variability in cycle time, the time between the completion of car trips, utilization, and the ratio of the time that a car is being used to the time it is available. On the daily basis, car usage has peaks and lows based on factors such as work and sleep cycles. If one looks at usage on the weekly basis, the service is utilized differently on the weekend. On an annual level there are fluctuations because of holidays and weather. In general, it can be difficult to predict the cycle time, since the members' reasons for using the carshare vary widely (Noonan).

The objective of analyzing operations management for carshares comes from the inherent need of any organization to enhance its service. The end goal is the improvement in the quality, flexibility, speed, and price of the service.

Fleet Placement

Carsharing depends greatly on the strategic placement of cars in order to optimize the use of each vehicle while providing easy access to the greatest number of members. It would not be ideal to place cars in areas which are not conducive to the carsharing process. Since carsharing is essentially a self-supported network, it is important that car placement be targeted towards an existing high-density neighborhood with reliable transit links.

Therefore, carsharing relies on more than just cars; it is important for an organization to understand city demographics and membership usage patterns. In addition, information pertaining to urban planning and city transportation is critical in making car placement decisions. The utilization of demographics allows an organization to continue with reliable service while effectively planning for future growth. Through analysis of current usage patterns and member surveys, target areas with large demand can be determined to properly redistribute cars for optimal use.

Having shared cars parked throughout a city requires management to consider both parking and accessibility of the area. Carsharing requires reserved parking spots at car stations in order for members to pick-up and drop off cars with ease. Therefore, the available space and related costs need evaluation to determine the most favorable number of cars placed at any given station.

The objective of City CarShare is "to locate vehicles in dense, transit-rich neighborhoods" in the city of San Francisco (Shaheen, Carsharing 120). Members of carsharing organizations rely on other forms of transportation to pick-up their reserved cars. Therefore, the placement of car stations must be a reasonable distance from bus and subway stations. A study done in Portland, Oregon in 1997 suggests that members should have no more than a five minute walk to the station at which they plan to pick-up a car (Scott 10).

Stephen Oakley, VP of the Zipcar Experience, says that Zipcar bases optimal car placement on three principles; marketing, ease of access, and mix of usage. First, Zipcar only places carsharing stations in clean, well-lit areas where traffic volumes are high. This placement ensures an attractive look for the business as well as easy marketing with city dwellers passing by marked shared cars daily. Second, shared cars are placed usually on the main roads avoiding the heart of the city since congested traffic will require more time to navigate oneself out. Therefore, cars are parked both at parking garage exits and near highway onramps. Finally, a mix of usage is essential for optimizing the use of a car each day. Therefore, there must be a balance of both potential business and residential use in an area, increasing the probability that a car will be shared continuously throughout the day and meeting the needs of both groups (Oakley).

Appendix N: Carshare Process Flow Chart

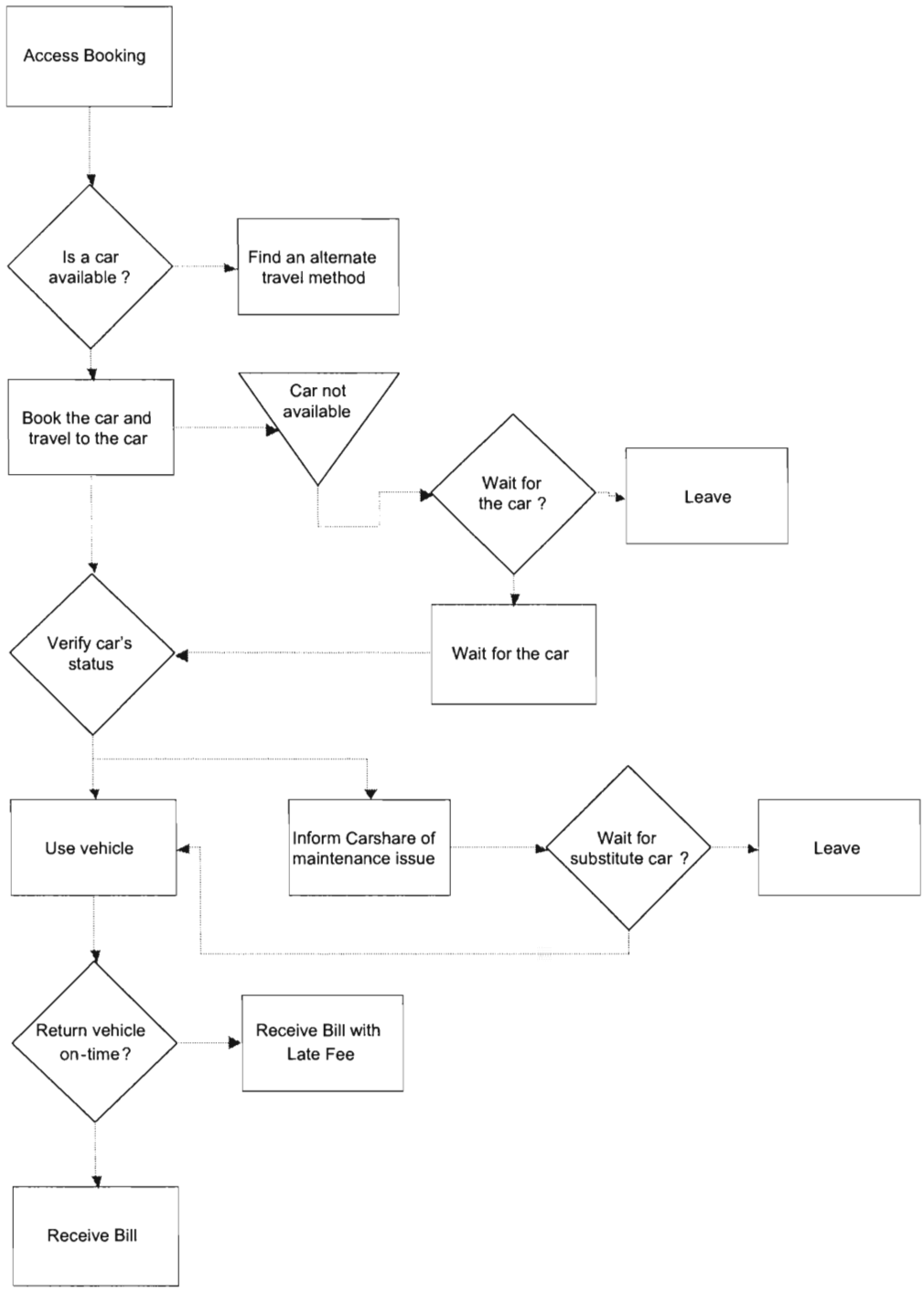


Figure 3: Carshare Process Flow Chart

Appendix O: Copenhagen Carshare Membership

Copenhagen Carshare began service in May 2004 and currently consists of five locations in Østerbro, Vesterbro, Brønshøj, Bispebjerg and Nørrebro. All of the locations are within the greater Copenhagen area, allowing the association to share collective resources (Copenhagen Carshare). It is a non-profit organization consisting of one-hundred and fifty members and twenty-six cars within Copenhagen.

There are four different membership types offered by Copenhagen Carshare. One may purchase an ordinary membership, an additional membership, a corporate membership or a guest membership. The Ordinært medlem, or ordinary membership, entitles the member to have all member rights in Copenhagen Carshare. He is given booking rights, voting rights at annual member meetings and the right to add an additional membership for his spouse. This addition to the membership requires that the family only pay once for a shared usage.

The Tillægsmedlem, or additional membership, can only be established in conjunction with an ordinary membership. The member with this membership would reside at the same address as the ordinary member and receive the same rights.

A Firmamedlemskab, or corporate membership, allows companies and institutions to purchase an ordinary membership with up to four additional memberships for personnel affiliated with the company or institution. This membership allows a company to provide its workers with a fleet of "company cars" at a significantly reduced price.

Finally, the Gæstemedlem, or guest membership, provides for those who require the access of a car for a limited period of one to four weeks. The membership does not entitle the bearer to booking or voting rights. In addition, the membership must be in connection with an ordinary or additional member who is financially

responsible for the guest. The guest member is only allowed to drive if an ordinary or additional member is present in the shared car (Copenhagen Carshare: Memberships and Cost).

Membership Types	Sign-up Fee*		Monthly Fee*		Weekly Fee*	
Ordinært medlem (Ordinary Membership)	4000 kr	$700.00	195 kr	$35.00	-	-
Tillægsmedlem (Additional Membership)	500 kr	$90.00	50 kr	$10.00	-	-
Gæstemedlem (Guest Membership)	-	-	-	-	100 kr	$18.00

*Converted using the Universal Currency Converter

Table 7: Copenhagen Carshare Membership Types and Fees (Copenhagen Carshare)

Appendix P: Copenhagen Carshare Carmasters

Carmaster-ordning

Der tilknyttes en car master pr. bil. Some vederlag fritages car masteren for månedlig kontingentbetaling.

En car master indvilger i at påtage sig følgende opgaver:

1) Månedligt check af bilen, der indbefatter:
    a. Bilnklys og andre lygter
    b. Bremser
    c. Horn
    d. Vinduesvisker
    e. Dæskestand
    f. Reservehjul
    g. Advarselstrekant
    h. Registrering af eventuelle ridser, skrammer samt fejl og mangler ved bilen i.ø.

2) Vask og rengøring af bilen en gang om månedsopgørelsen (jfr. Medlemsvilkår 8.3)

3) Når bilen skal til serviceeftersyn og andre eventuelle værkstedsbesøg sørger car master herfor efter nærmere aftale med Københavns Delebiler

4) Indsamling af køresedler og indtastning af data
    a. Indsamle køresedler fra bilen inden den 1. i hver måned
    b. Aflæning af gennemsnitligt benzinforbrug
    c. Indtaste oplysninger fra køresedlen + gennemsnitligt benzinforbrug i regneark en gang om måneden (pr. den 1.) og indsende oplysningerne pr. mail til Københavns Delebiler

Car master fungerer som kontaktperson for foreningens medlemmer i forbindelse med eventuelle spørgsmål og/eller problemer med bilen

Carmaster Agreement

There is one carmaster for each car. The carmaster does not have to pay a monthly membership fee in return for their services.

A carmaster is responsible for the following tasks:

1. Perform and a monthly check of the car, including:
    a. Directional and other lights
    b. Brakes
    c. Horn
    d. Windshield wipers
    e. Tire pressure
    f. Car fluids
    g. Spare tire
    h. Triangle emergency reflector
    i. Record damage, missing car items, or recent mechanical problems

2. Wash and clean the car once a month.
    If a member returns a car that has not been cleaned the carmaster will take care of the washing and vacuuming of the car. However, the member will be charged an additional 100 kroner on their monthly bill (according to paragraph 8.3 of the member agreement)

3. The carmaster makes arrangements with Copenhagen Carshare when cars need both scheduled and unscheduled maintenance.

4. Collection and recording of log books
    a. Carmasters will collect log books from the car(s) they are responsible for before the first of every month
    b. Carmasters will calculate the average amount of gas purchased in a month
    c. Carmasters will record the information from the log book and the average spending of gas per month (on the first of the month) and to send the information by mail to Copenhagen Carshare

5. If you have any problems or questions with the car the carmaster is the organizations contact person

Appendix Q: MEGA El-Bil "MultiTruck," General Comments and Observations

Seth Murray, Jaron Kuppers
28 April, 2005

Copenhagen Carshare is considering adding to its fleet a small battery powered electric vehicle called the MultiTruck, made by the French company MEGA. The appeal of this vehicle is that it has no exhaust emissions, and it is very efficient in its use of energy since the batteries can be recharged from renewable 'green' energy sources such as solar and wind power. MEGA claims an energy use of the vehicle of 100 Wh/km, which is quite efficient. While electric vehicles are generally not suitable for long distance driving due to the limited energy storage abilities of batteries, they are very well suited to short-range use within cities.

The vehicle is small, with a wheelbase of 2050 mm, a length of 2980mm, a width of 1530mm, and a height of 1800mm, and is available in a variety of configurations including a pick up, drop side, van, tipper, or plain chassis cab. The vehicle has a rated payload of 435 kg with 3 cubic meters of cargo space. The two seat lightweight truck has an aluminum frame with a plastic body and includes all the usual features of a regular car, including seat belts, head lights/brake lights, windshield wipers, heater, radio, etc. Driving the vehicle is very easy, it is just like driving a car except it does not need to be started, just switched on. There is no shifting necessary other than a forward/reverse selector. The brakes are not power assisted, which may surprise a driver who is used to power assisted brakes, but they work well and are not difficult to operate. An additional energy saving measure is the use of "regenerative braking," where energy is put back into the batteries when the vehicle is slowing down. This also helps to extend the life of the brake pads.

The electric version of the MEGA truck is powered by a 48V, 4 kW separately excited Direct Current (DC) motor, which quickly propels the vehicle up to approximately 45 kilometers per hour – perfect for in-city driving. The only concern with this motor is that, like most DC motors, it uses brushes which require periodic replacement, although very infrequently. The motor and electronics driving the motor are made by General Electric, which is a very good name in motors and drives, and has been outfitting golf cars with very similar drive trains for a very long time. Drive systems very similar to the one used in the MEGA are in use in almost all electric golf cars today and are quite reliable and safe.

The MEGA is available with either 8 or 12 Exide sealed, maintenance free lead acid batteries which come with a full two year warrantee. Because of the already limited range of battery powered vehicles, especially in cold weather, the 8 battery version should not even be considered unless the vehicle's exact usage requirements are known to be short-range only. Only the 12 battery version is available from the Dansk Autoimport A/S, and has a claimed driving range of 55-100 km per charge. Charging is done through an onboard "smart" charger and battery management system, to extend the life of the batteries. The charger is fully automatic, runs from a standard 230V, 16A electrical outlet, and takes 7-9 hours for a full recharge. Unlike NiCad batteries, lead acid batteries do not require that they be fully discharged before charging; in fact, this can damage them if it is done too often or the batteries are discharged too low.

The biggest concern with any battery powered vehicle is of course the battery life. If they are not cared for, lead acid batteries may only last approximately two years before needing replacement, however, the MEGA vehicle's battery management system will keep the batteries healthy if the charger is plugged in when the vehicle is

not in use. If so the batteries should last at least 3-4 years before needing replacement, and potentially longer depending on the usage requirements of the carshare. Even Replacing the batteries every 3-4 years should not be excessively expensive, however.

One concern with this vehicle is its newness in Denmark and therefore the lack of shops which could perform maintenance on the vehicle if necessary. However, the automobile dealership which is importing the MEGA vehicle is also setting up a maintenance network, so nearby service should be available if necessary. One advantage of electric vehicles is that they generally require very little maintenance: there is no oil to change and no coolant to check, for example.

Another concern with the MEGA is its safety. There was text in the vehicle manual from the manufacturer which hinted towards the vehicle not being classified as a normal motor vehicle. Because of this it has been exempt from certain safety inspections, such as crash tests. The light plastic frame, while efficient, leaves concern as to its structural integrity in a crash. The low frame leaves little support for an impact from a vehicle with a frame taller than the MEGA. However, since the vehicle is staying only in the city, any accidents should be only minor low speed collisions. In addition, the batteries will be helpful in rear collisions because of their size and weight. Further inquiry into the safety of the vehicle is recommended.

In conclusion, the MEGA MultiTruck appears to be well built and despite a few concerns, could be a valuable and environmentally friendly addition to the cars of Copenhagen Carshare.

Appendix R: Eileo ZiboxLT Acquirement Method Expenditure Comparison

The following tables display the full expenses of the 5 solutions using Eileo's ZiboxLT hardware and Zenon server. The graphs compare the costs of the different systems. In addition analysis on the cost of each system by comparing time and vehicle quantity is present. Interactive spreadsheets can be found on the included Compact Disc. Each spreadsheet allows for updates of vehicle quantity, membership number and length of payment time. The comparison spreadsheet contains the same graphs as below, but allows for changes in membership number, vehicle number and payment time as well.

One should note the focus on long-term investment, and total expenditure. Since the total investment over-time is nearly the same for each option, an option with low initial investment but higher monthly investment should be considered. Also it is important to remember that with the renting option, after the three years considered in this cost assessment no hardware will be owned by the carshare, whereas with the other options there is or after the three years will be ownership of the systems.

Cost Comparison

# of Cars: 20 Exchange rate:
Members: 400 7.40
of Months: 50 Dkr./1 Euro

INSTALLATION COSTS		
Eileo	2950.00	21830 kr.
Independent	4850.00	35890 kr.
Europcar Eileo	2950.00	21830 kr.
Europcar Independent	4850.00	35890 kr.
Eileo Rental	2950.00	21830 kr.

PER CAR COSTS*		
Eileo	1035.00	7659 kr.
Independent	1035.00	7659 kr.
Europcar Eileo	0.00	0 kr.
Europcar Independent	0.00	0 kr.
Eileo Rental	0.00	0 kr.

*Make sure that the same options are checked

PER MEMBER COSTS		
Eileo	0.00	0 kr.
Independent	0.00	0 kr.
Europcar Eileo	0.00	0 kr.
Europcar Independent	0.00	0 kr.
Eileo Rental	0.00	0 kr.

PER YEAR		
Eileo	0.00	0 kr.
Independent	1200.00	8880 kr.
Europcar Eileo	0.00	0 kr.
Europcar Independent	1200.00	8880 kr.
Eileo Rental	0.00	0 kr.

MONTHLY COSTS		
Eileo	688.11	5092 kr.
Independent	618.11	4574 kr.
Europcar Eileo	1269.19	9392 kr.
Europcar Independent	1199.19	8874 kr.
Eileo Rental	1108.11	8200 kr.

Total costs per year		
Eileo	8257.30	61104.00 kr.
Independent	8617.30	63768.00 kr.
Europcar Eileo	15230.27	112704.00 kr.
Europcar Independent	15590.27	115368.00 kr.
Eileo Rental	13297.30	98400.00 kr.

Total costs per month		
Eileo	688.11	5092.00 kr.
Independent	718.11	5314.00 kr.
Europcar Eileo	1269.19	9392.00 kr.
Europcar Independent	1299.19	9614.00 kr.
Eileo Rental	1108.11	8200.00 kr.

Total one-time costs		
Eileo	23650.00	175010.00 kr.
Independent	25550.00	189070.00 kr.
Europcar Eileo	2950.00	21830.00 kr.
Europcar Independent	4850.00	35890.00 kr.
Eileo Rental	2950.00	21830.00 kr.

Total costs over time**		
Eileo	58055.41	429610.00 kr.
Independent	61455.41	454770.00 kr.
Europcar Eileo	66409.46	491430.00 kr.
Europcar Independent	69809.46	516590.00 kr.
Eileo Rental	58355.41	431830.00 kr.

**Total Cost over X months (excluding member costs), Input above

Table 8: Eileo ZiboxLT Cost Options Comparison Table

Pricing			optional: yes/no		# of Cars: 10 Exchange rate: # Members: ## 7.40 # of Months: 12 Dkr./1 Euro	
INSTALLATION COSTS						
Server Set-up	750				750.00	5550.00
Server Training	350				350.00	2590.00
2-days local support	600				600.00	4440.00
Server	1250				1250.00	9250.00
				One-time costs	2950.00	21830.00 kr.
PER CAR COSTS						
Zi-box Unite	800	per car			8000.00	59200.00
Smart Card Reader	90	per car			900.00	6660.00
Hands-free GSM	120	per car	no		0.00	0.00
Pre-cabled	45	per car	yes		450.00	3330.00
Roof GPS-GSM Antenna	70	per car	yes		700.00	5180.00
20 Smart Cards	0	per car			0.00	0.00
est. Installation	140	per car	no		0.00	0.00
Shipping Costs estimate	30	per car			300.00	2220.00
GPS	80	per car	no		0.00	0.00
				For all cars hardware co	10350.00	76590.00 kr.
				Per car hardware costs	1035.00	7659.00 kr.
PER MEMBER COSTS						
Smart Card	3.5	extra cards:		0	0.00	0.00
		needed cards:		0		
				Per Member costs	0.00	0.00 kr.
MONTHLY COSTS						
GPRS (local provider)*	40 kr.	per car			54.05	400.00
GPS Monthly Cost	0	per car	no		0.00	0.00
Server cost per car	29	per car			290.00	2146.00
				Per Month Costs	344.05	2546.00 kr.
				Total costs per year	4128.65	30552.00 kr.
*Estimate given to us by Bjørn Dirchsen				Total costs per month	344.05	2546.00 kr.
				Total one-time costs	13300.00	98420.00 kr.
				Total costs	17428.65	128972.00 kr.

Table 9: Purchase from Eileo with Eileo Server

Pricing			optional: yes/no		# of Cars: 10 # Members: 200 # of Months: 12	Exchange rate: 7.40 Dkr./1 Euro
INSTALLATION COSTS						
Server Set-up	0				0.00	0.00
Server Training	350				350.00	2590.00
2-days local support	600				600.00	4440.00
Remote Installation	3900				3900.00	28860.00
				One-time costs	4850.00	35890.00 kr.
PER CAR COSTS						
Zi-box Unite	800	per car			8000.00	59200.00
Smart Card Reader	90	per car			900.00	6660.00
Hands-free GSM	120	per car	no		0.00	0.00
Pre-cabled	45	per car			450.00	3330.00
Roof GPS-GSM Antenna	70	per car			700.00	5180.00
20 Smart Cards	0	per car			0.00	0.00
est. Installation	140	per car	no		0.00	0.00
Shipping Costs estimate	30	per car			300.00	2220.00
GPS	80	per car	no		0.00	0.00
				For all cars hardware co	10350.00	76590.00 kr.
				Per car hardware costs	1035.00	7659.00 kr.
PER MEMBER COSTS						
Smart Card	3.5	extra cards:		0	0.00	0.00
		needed cards:		0		
				Per Member costs	0.00	0.00 kr.
PER YEAR						
Remote Maintenance	1200				1200.00	8880.00
				Per Year costs	1200.00	8880.00 kr.
MONTHLY COSTS						
Server Monthly Costs	50				50.00	370.00
GPRS (local provider)	40 kr.	per car			54.05	400.00
GPS Monthly Cost	15	per car	no		0.00	0.00
License	23	per car			230.00	1702.00
				Per Month Costs	334.05	2472.00 kr.
				Total costs per year	5208.65	38544.00 kr.
*Estimate given to us by Bjøm Dirchsen				Total costs per month	434.05	3212.00 kr.
				Total one-time costs	15200.00	112480.00 kr.
				Total costs	16734.05	123832.00 kr.

Table 10: Purchase from Eileo with Independent Server

Pricing			optional: yes/no		# of Cars: 20 # Members: 200 # of Months: 12	Exchange rate: 7.40 Dkr./1 Euro	
INSTALLATION COSTS							
Server Set-up	750				750.00	5550.00	
Server Training	350				350.00	2590.00	
2-days local support	600				600.00	4440.00	
Server	1250				1250.00	9250.00	
				One-time costs	2950.00	21830.00	kr.
PER MEMBER COSTS							
Smart Card	3.5	extra cards:		200	0.00	0.00	
		needed cards:		0			
				Per Member costs	0.00	0.00	kr.
PER YEAR							
Remote Maintenance	0				0.00	0.00	
				Per Year costs	0.00	0.00	kr.
MONTHLY COSTS							
GPRS (local provider)*	40 kr.	per car			108.11	800.00	
GPS Monthly Cost	0	per car	no		0.00	0.00	
Server cost per car	29	per car			580.00	78.38	
Europcar Fee Estimate**	215 kr.	per car			581.08	4300.00	
				Per Month Costs	688.11	5092.00	kr.

**Determined by taking the hardware cost per vehicle divided by 36 months

*Estimate given to us by Bjørn Dirchsen

Total costs per year	8257.30		61104.00	kr.
Total costs per month	688.11		5092.00	kr.
Total one-time costs	2950.00		21830.00	kr.
Total costs	11207.30		82934.00	kr.

Table 11: Europcar Leasing with Eileo Server

Pricing			optional: yes/no		# of Cars: 20 # Members: 200 # of Months: 12	Exchange rate: 7.40 Dkr./1 Euro
INSTALLATION COSTS						
Server Set-up	0				0.00	0.00
Server Training	350				350.00	2590.00
2-days local support	600				600.00	4440.00
Remote Installation	3900				3900.00	28860.00
				One-time costs	4850.00	35890.00 kr.
PER MEMBER COSTS						
Smart Card	3.5	extra cards:		200	0.00	0.00
		needed cards:		0		
				Per Member costs	0.00	0.00 kr.
PER YEAR						
Remote Maintenance	1200				1200.00	8880.00
				Per Year costs	1200.00	8880.00 kr.
MONTHLY COSTS						
GPRS (local provider)	40 kr.	per month per car			108.11	800.00
GPS Monthly Cost	0	per month per car	no		0.00	0.00
Server Monthly Cost	50	per month			50.00	6.76
Europcar Fee Estimate*	215 kr.	per month per car			581.08	4300.00
License	23	per month per car			460.00	3404.00
				Per Month Costs	1199.19	8874.00 kr.
				Total costs per year	15590.27	115368.00 kr.
				Total costs per month	1299.19	9614.00 kr.
				Total one-time costs	4850.00	35890.00 kr.
				Total costs	20440.27	151258.00 kr.

*Estimate given to us by Bjørn Dirchsen

**Determined by taking the hardware cost per vehicle divided by 36 months

Table 12: Europcar Leasing with Independent Server

Pricing			optional: yes/no		# of Cars: 20 # Members: 200 # of Months: 12	Exchange rate: 7.40 Dkr./1 Euro	
INSTALLATION COSTS							
Server Set-up	750				750.00	5550.00	
Server Training	350				350.00	2590.00	
2-days local support	600				600.00	4440.00	
Server	1250				1250.00	9250.00	
				One-time costs	2950.00	21830.00	kr.
PER MEMBER COSTS							
Smart Card	3.5	extra cards:		0	0.00	0.00	
		needed cards:		0			
				Per Member costs	0.00	0.00	kr.
MONTHLY COSTS							
GPRS (local provider)	40	kr. per month per car			108.11	800.00	kr.
GPS Monthly Cost	0	per month per car	no		0.00	0.00	
Eileo rental fee, including server	50	per month per car			1000.00	7400.00	
				Per Month Costs	1108.11	8200.00	kr.
				Total costs per year	13297.30	98400.00	kr.
				Total costs per month	1108.11	8200.00	kr.
				Total one-time costs	2950.00	21830.00	kr.
				Total costs	16247.30	120230.00	kr.

Table 13: Eileo Rental

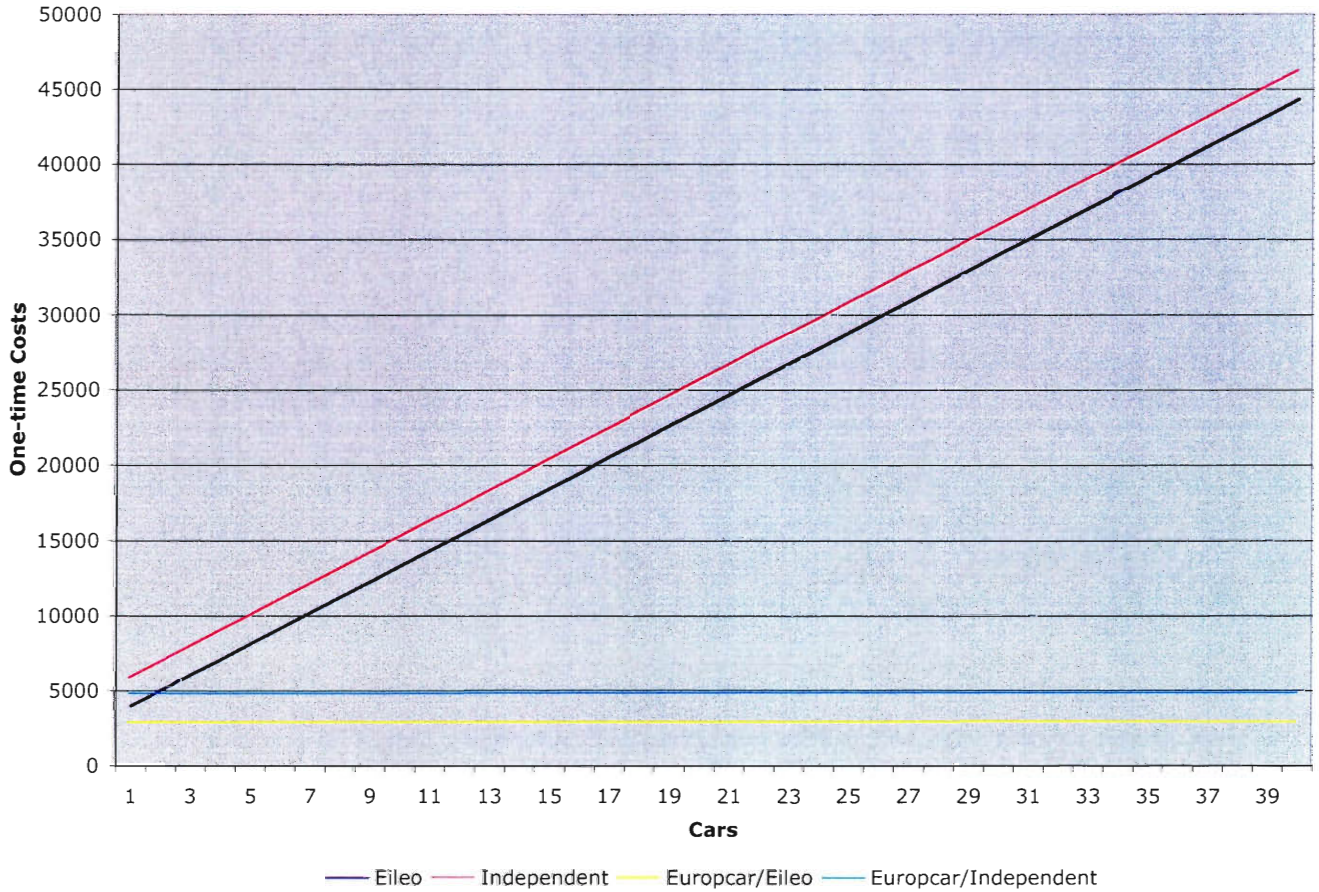


Figure 4: Fixed Costs vs. Number of Cars

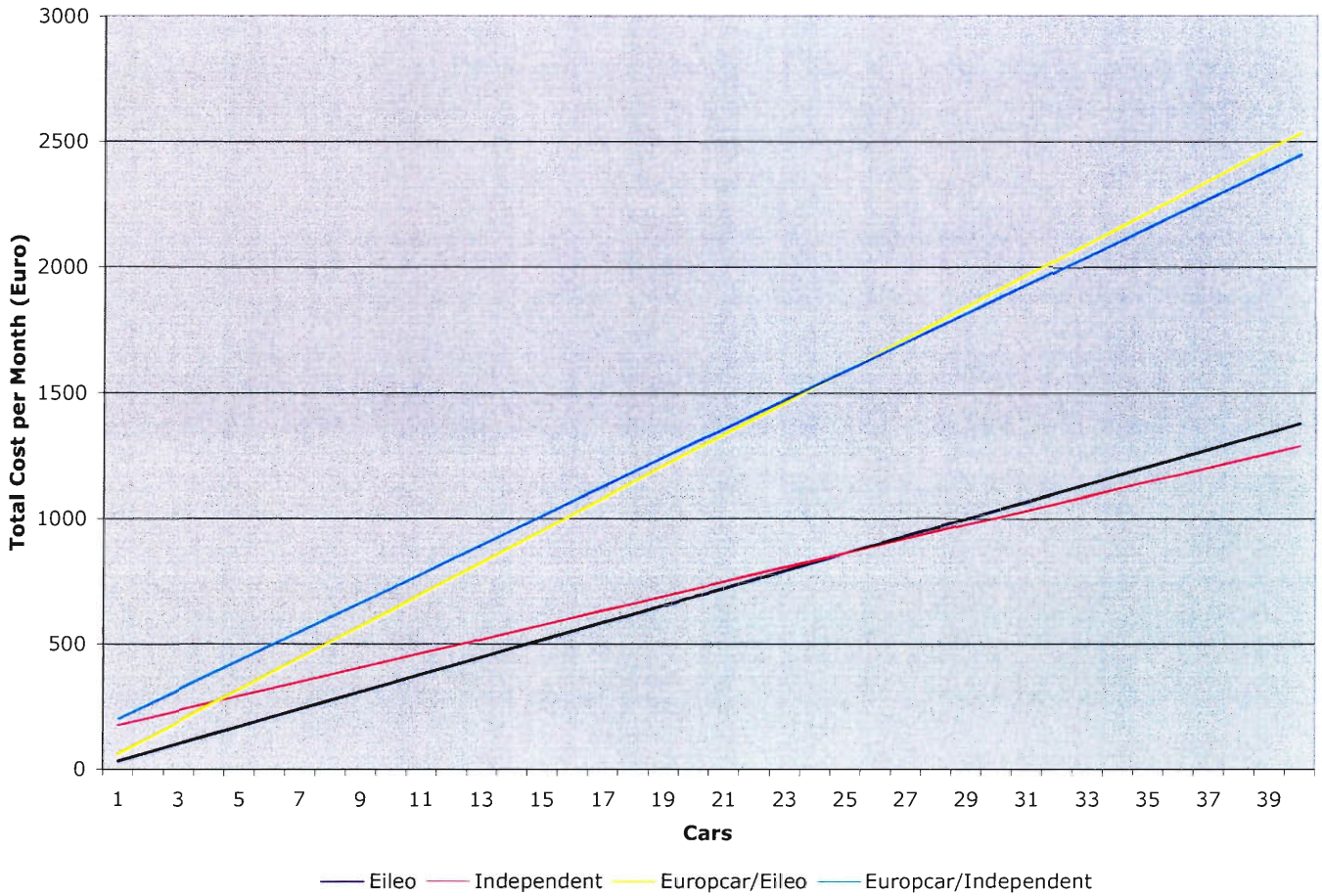


Figure 5: Monthly Expenses vs. Number of Cars

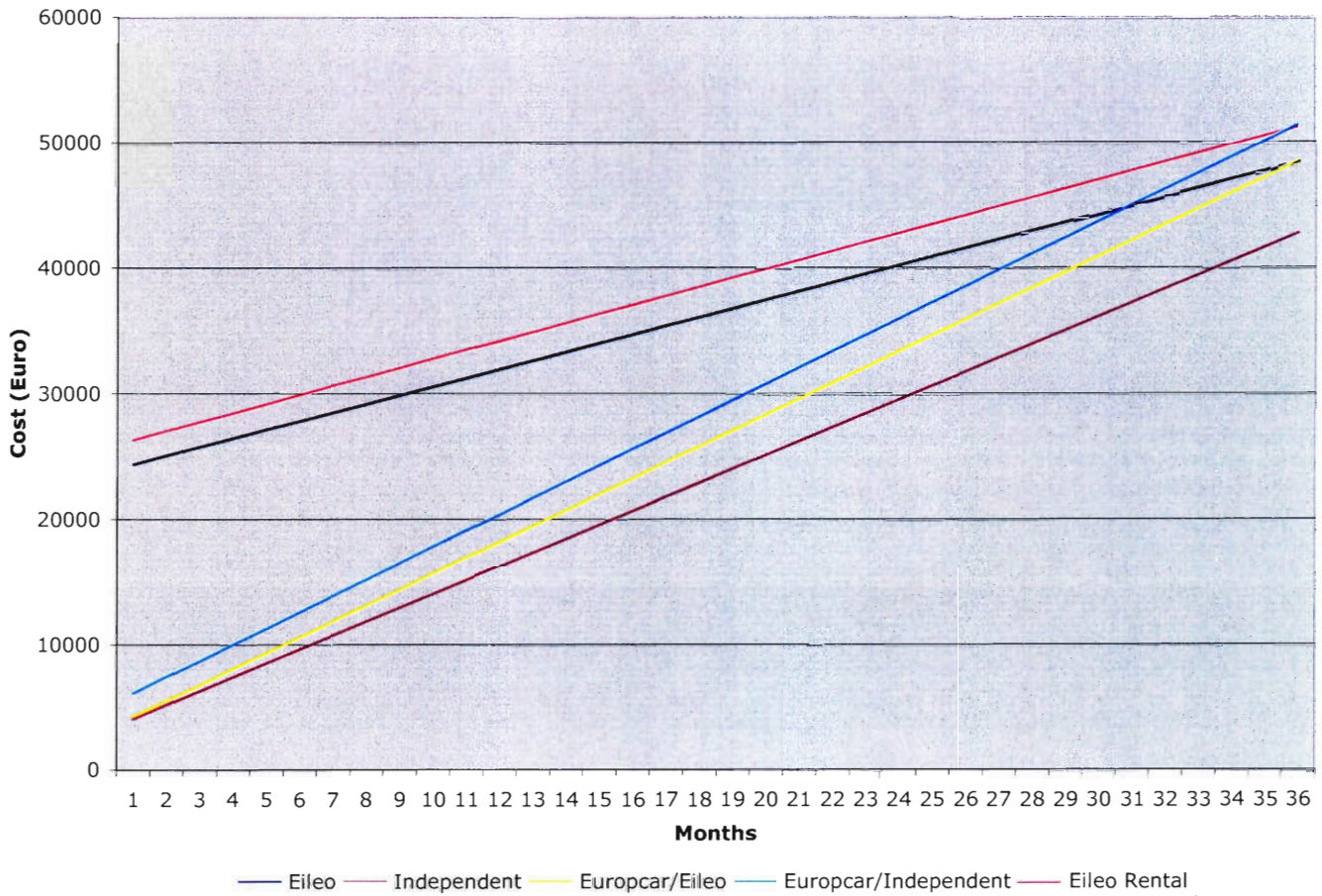


Figure 6: Total Cost of 20 Cars vs. Times

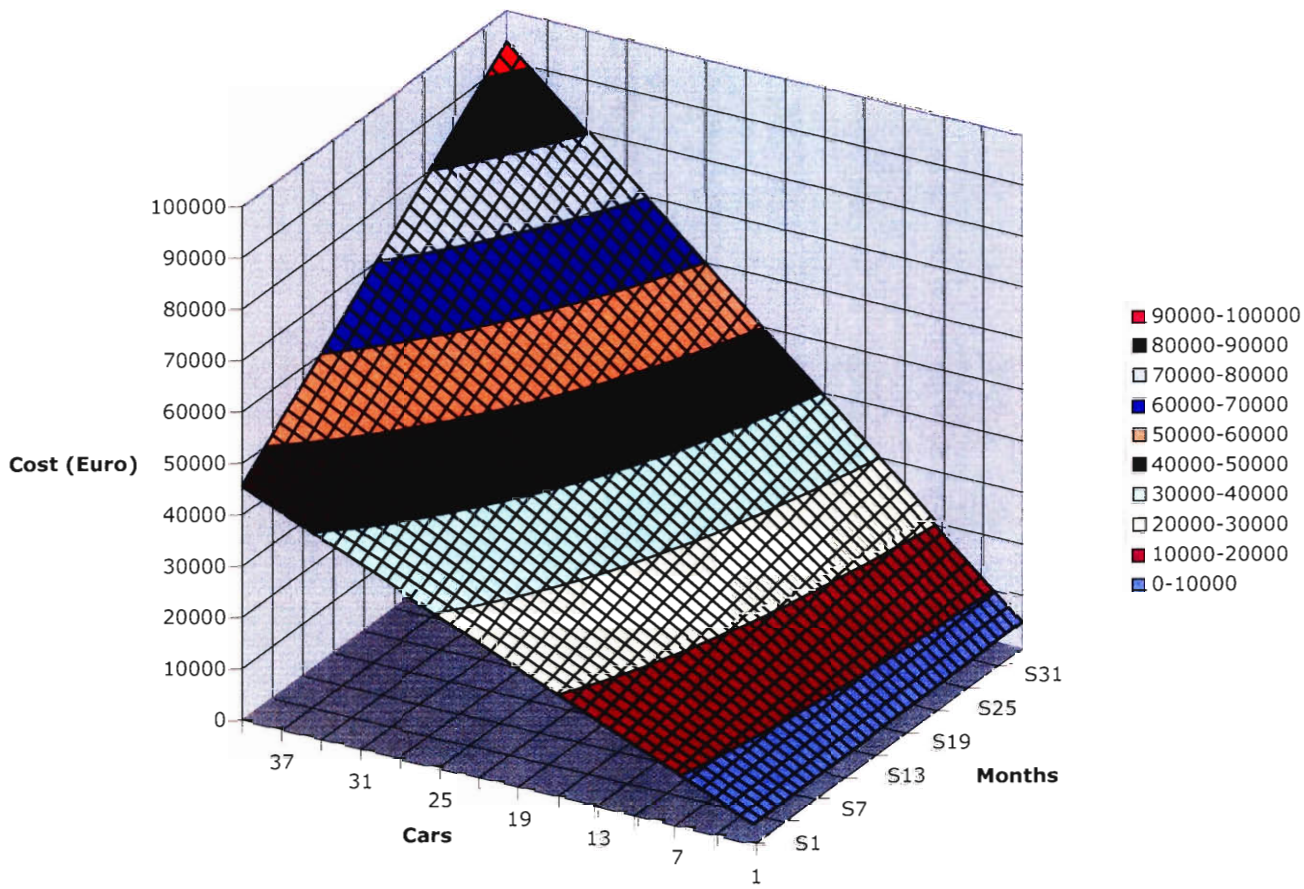


Figure 7: Purchase from Eileo with Eileo Server, Cost vs. Months and Cars

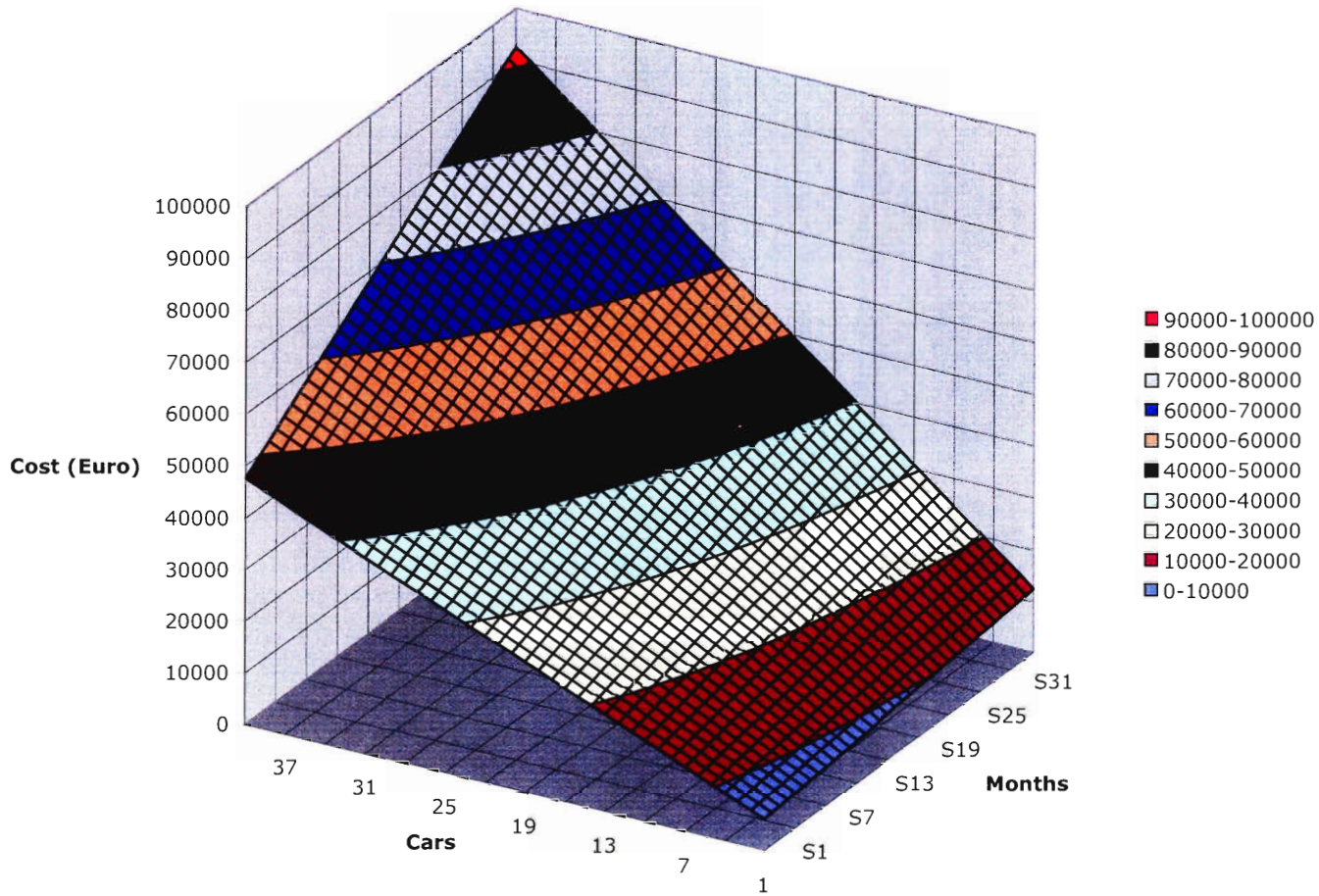


Figure 8: Purchase from Eileo with Independent Server, Cost vs. Months and Cars

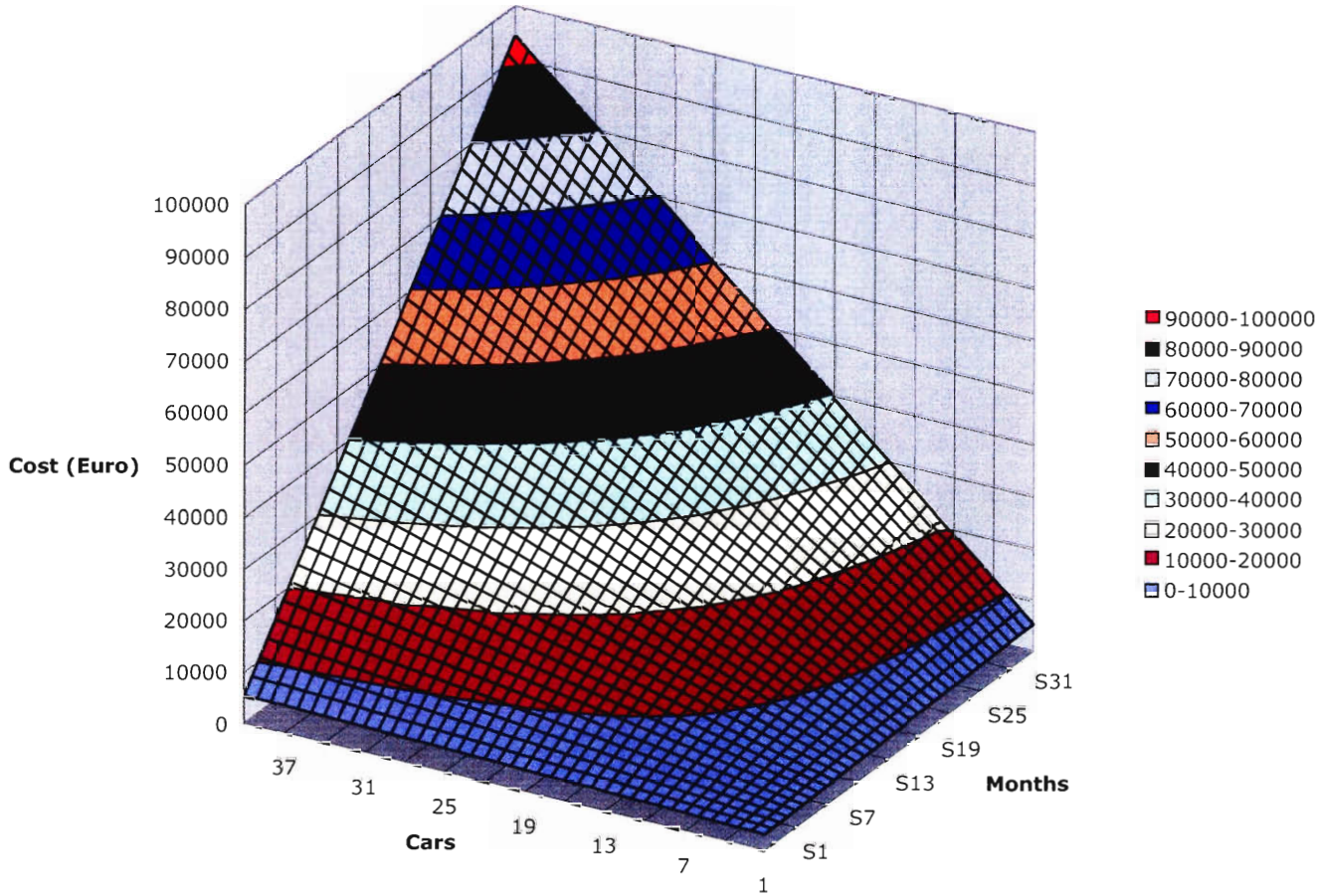


Figure 9: Europcar Leasing with Eileo Server, Cost vs. Months and Cars

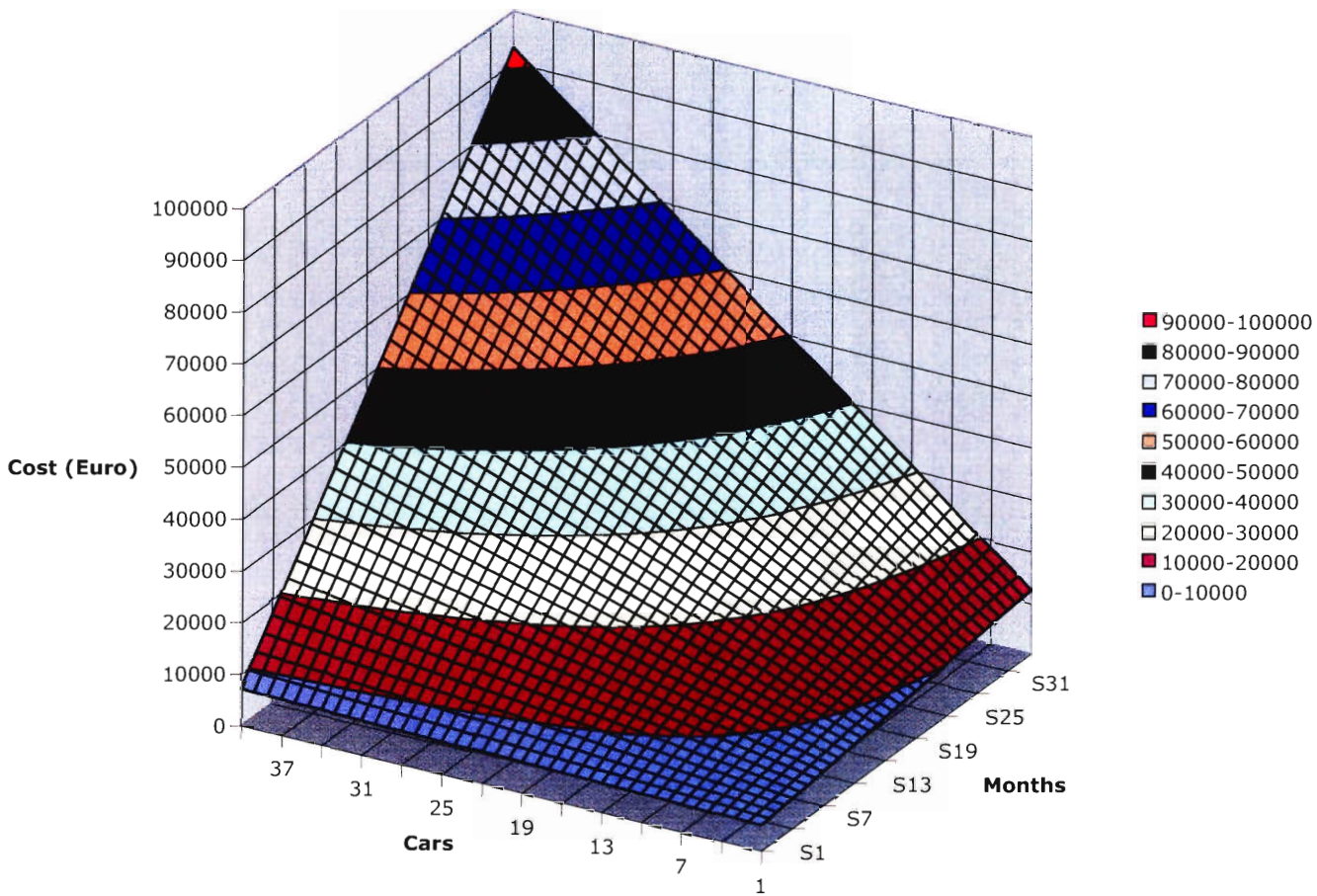


Figure 10: Europcar Leasing with Independent Server, Cost vs. Months and Cars

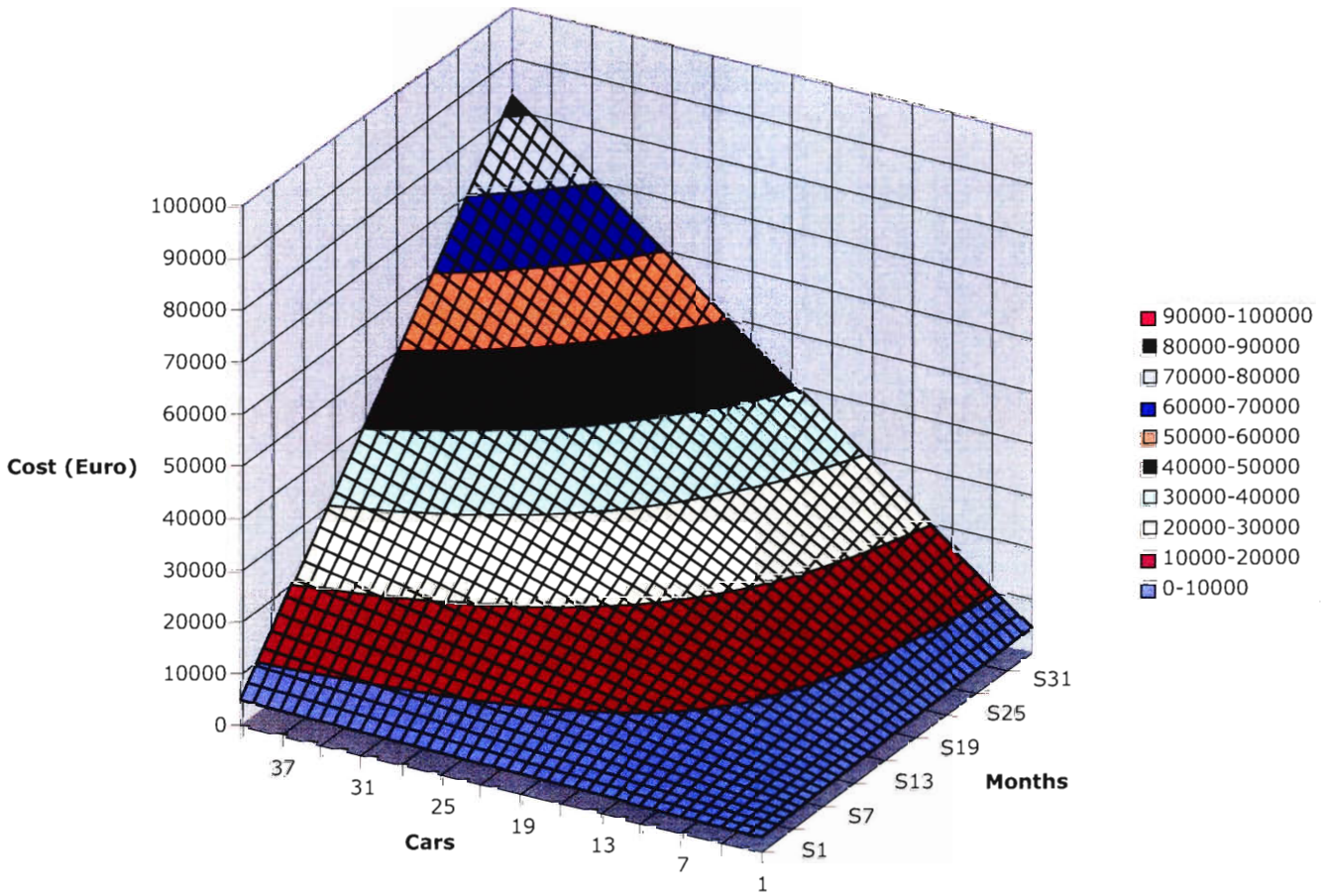


Figure 11: Eileo Rental

Appendix S: GPRS Modem Prices

GPRS Modems

Manufacturer	Model	Current Peak/Idle	Features	Cost (Euro)	Seller
TeamSharp SpaceTech Inc	GM-22	250/3 mA at 12V	triband, AT commands	53	TeamSharp
Tecomm	TEC-MC388-S	1A/? At 12V	dual band, RS232 or USB	133	Conigma
Wireless Integrated Technologies	WIT GPRS	1.8A/? at 5.5V	dual band, RS232 or USB, AT, incl. Antenna	140	WIT
Round Solutions	**TER-GX101S**	150/8 mA at 12V	dual band, RS232 serial	150	Round Solutions
a2b Communication	RCM20	1500/30 mA at 12V	triband, RS232 serial, AT commands	290	a2b
Siemens	**MC35iT**	unspecified	dual band, RS232, AT commands	130	Conigma
				142	WDM
				212	Mobile Data Direct
				212	TDC
				230	Klinkmann
				250	Sequoia Technology
				262	Mobile Data Solutions
GPRS Module (NOT terminal)					
Round Solutions	GM862-GPRS	"low"	dual band, serial, AT commands, built in SIM reader	85	

Table 14: GPRS Modem Prices

Appendix T: Smart Card Prices

Company	Product Name	Price	Transmit Freq.	Input Volt.	Current Typical	Peak		Proximity
Indala	FlexSmart		13.56 Mhz	9-16 DC	20mA	75mA		6.35 cm
HID Corporation	iClass R10 Reader	$95	13.56 Mhz	10-16 DC	80mA	300mA	@12V	7.6 cm
HID Corporation	ThinLine II	$110	125 kHz	5-16 DC	30mA	100mA	@5V	12.5 cm
HID Corporation	iClass R40 Reader		13.56 Mhz	10-16 DC	80mA	260mA	@12V	5 cm
RF IDeas Inc.	AIR ID Playback	$225	13.56 Mhz	5 DC				7.6 cm

Product Name	Outputs:	Wiegand	Serial	ABA Track 2	Clock-&-data
FlexSmart		x	x	x	
iClass R10 Reader		x			
ThinLine II		x			x
iClass R40 Reader		x			
AIR ID Playback			x		

Table 15: Smart Card Prices

Appendix U: Electrical Requirements

Approximate Electrical Requirements for Custom Electronics

Component	Peak Current at 12V (mA)	Nominal Current at 12V (mA)
GPRS Modem	250-1500	3-30
Smart Cart Reader	75-300	20-80
Microprocessor with 5V regulator	8-10	1-2
external USARTs, memory, etc	5-10	1-2
approximate totals (mA):	340-1820	25-115
approximate totals (W):	3.5 – 18	0.3 - 1.4

Battery life:
25-115 mA * 24 hours = 0.6 - 2.75 Ah/day
Assume 40 Ah battery, = 15-66 days

approximate calculations assume a linear voltage regulator for microprocessor and no 'idle mode'

Table 16: Electrical Requirements

Appendix V: Carshare Development Technology Function Outline

The following outline looks at the required functions of custom developed software and hardware. Though it is currently in its first stages of drafting, the purpose of its creation was to allow Michael Zedeler to determine a price estimate based off its contents.

CAR

- Card Reader (user's card sends encrypted ID number to processor)
  - Confirm access with processor to enter
  - Confirm access with processor to drive
- Key fob
  - Processor sends message to unlock doors
  - Processor sends message to lock doors
- GPRS modem
  - Server pushes data (data type ?)
    - Access Control (user ID numbers and corresponding access times)
    - Clock set?
  - Server pulls data (contacts server to pull data)
    - Access data (time stamped ID number)
    - Distance data (by user)
- Odometer (outputs square wave pulses)
  - Processor converts pulses to distance traveled
- Processor
  - Talk to the Key fob, GPRS modem, Card Reader, and Odometer
  - Confirms access and sends message via Key fob
  - Converts odometer data

SERVER

- Internet database
  - Import data file from ERP Software
- Car GPRS modems
  - Server pushes data to the cars' GPRS modem
  - Server pulls data from the cars' GPRS modem

INTERNET INTERFACE

- Non-user
  - General Information
    - View membership information
    - View car types and locations (map from krak.dk ?)
    - View prices by car class
- Ordinary User

- General Information
  - View membership information
  - View prices by car class
  - View car types and locations (map from krak.dk ?)
- Booking
  - Book a car
    - Book by car type (input type of car)
      - View list of cars
      - See car map and estimated bill (user inputs estimated travel distance)
    - Book by user's location (input address)
      - View cars at closest locations
      - See car map and estimated bill
    - Book by time available (input start and end time)
      - View cars available at times
      - See car map and estimated bill
  - View current bookings
  - View past bookings
  - Unbook (input segment of time to unbook, or unbook entire time)
  - Export data file to ERP Software (contains user access data for each vehicle)
- Billing
  - View prices by car class
  - View current bill
  - View old bills
  - Pay current bill (data is sent to ERP system)

➢ Administrator
- Cars
  - Add
  - Modify
  - Delete
- Members
  - Add
  - Modify
  - Delete
  - Lock out user's access
- Booking
  - View bookings
    - By member
    - By car
- Accounting
  - Modify user bill
  - Export CSV-file for import in ERP system (contains bills: by user, by car)
- Statistics
  - Export CSV-file for import in ERP system (contains user general information, car general information, car odometer, reservation history: by car, by times, by user)

- ERP SOFTWARE

  - User Interface
    - Accounting
      - Carshare overview
      - Current capital
      - Expenses
      - Revenue
    - User
      - View
      - Modify
      - Print/email
      - Export to PBS
    - Statistics
      - Car
        - Overall usage
        - User usage
      - User
        - Usage history
        - Cancellation history
        - Miscellaneous survey data
      - Fuel
        - Overall usage
        - Consumption by car
    - Billing
      - Modify bill format
      - View bills by user
      - View bill discrepancies
      - Export data file to the website (bill information for the members)
      - Send bill information through email

  - Non-user Tasks
    - Determine time sensitivity of updated booking data
      - Export data file for use by the server (contains data on user access)
      - Save data for next file transfer
    - Import data from cars (access data and odometer data)

    - Billing
      - Import data
        - Import data from cars via server (access data and odometer data)
        - Import data from internet (reservation data)
      - Process
        - Process car data, and compare to reservation data
        - Determine bill discrepancies

      - PBS
        - Import data from internet (bill information)
        - Format and forward information to PBS

Appendix W: Estimated Custom Development Costs

Task					Function points	Notes
Car mounted systems						
	Card reader				?	
	Key FOB				?	
	Modem				?	
	Odometer				?	
	Software					
		Base system			9	
		Read card			1	
		Lock/unlock doors			1	
		Exchange messages with server			3	
		Read distance traveled			1	
Internet server						
	CMS					
		Base system			9	
		Graphical design			9	
		Static pages				
			Membership informaton		1	
			Car types		1	
			Prices		1	
	Booking system					
		Base system			9	
		Booking				
			Search for available slots		9	Filters, grouping and sorting can be based on type, location, availability and others
				Choose filters		
				Choose grouping		
				Choose sorting		
				Choose output format		
		View bookings			3	
			Current			
			Past			
			By car			
		Unbook			3	Letting the user unbook time intervals will lead to unexpected results and are discouraged
		Billing				
			View bills		1	
			Pay bills		9	
		Administration				
			Cars		3	
				Add		
				Modify		
				Delete		
			Members		3	
				Add		
				Modify		
				Delete		
				Lock user		
			Locations		3	I propose we use locations for car placements.
				Add		
				Modify		
				Delete		
		Accounting				I propose we use the ERP system to de the accounting
			Generate bill files for ERP system		3	
			Import bills from ERP system		3	
			Generate payment files for ERP system		3	
			Import payment status from ERP system		3	
Backoffice ERP system						This is a standard off-the-shelf ERP system, such as Navision, maconomy or the like. No adjustments or customization is planned.
Function points total					91	

Table 17: Estimated Custom Development Costs