

Changing Consumer Behaviour through Eco-efficient Services

An empirical study on Car Sharing in the Netherlands.

Ph.D. thesis of Rens Meijkamp
andrens@planet.nl

This shorted version of Rens Meijkamp's doctoral thesis has been prepared in cooperation with the author for posting and free international distribution on the @World CarShare Consortium at <http://www.ecoplan.org/carshare>. The full thesis is available in a printed paperback version for US \$25. The print version has 330 pages with an extensive list of references and summaries in English and Dutch.

Orders to the author at andrens@planet.nl

Comments and discussion invited on the @World CarShare discussion forum. The email address for comments is Carsharing@egroups.com

SUMMARY

This PhD thesis focuses on consumers and consumer behaviour in relation to environmental problems. It questions how consumer behaviour can be changed in order to reduce environmental effects. This study narrows down on one specific approach to change consumer behaviour, which is the development and (successful) market introduction of so-called Eco-efficient Services.

Through extensive empirical research in the Dutch field of Car Sharing services (an innovative mobility service) this approach is tested. Car Sharing services offer the flexible use of cars on a regular basis as an alternative for privately owned cars.

The PhD thesis is centred around the following three empirical research questions:

- A. What are the determinants of adoption of Car Sharing services?
- B. What are the determinants of the service quality perception of Car Sharing services?
- C. What are the changes in mobility behaviour?

The answers to these questions formed the input of an extensive analysis of the changes in environmental effects of the adoption of Car Sharing services. Besides this an estimation of the environmental potential of Car Sharing services in 2010 has been calculated.

This study closes with a reflection on the approach to change consumer behaviour through the development and (successful) market introduction of so-called Eco-efficient Services.

Contents

1 Introduction: changing consumer behaviour through “Eco-efficient Services”	1	
1.1 Environmental problems and consumer behaviour		1
1.2 Modelling environmental effects of consumer behaviour	4	
1.3 Intervention in consumption practice through innovative products and services		6
1.4 Consumption practice		9
1.5 Innovation strategies for reducing environmental impact	12	
1.6 Area of investigation: Car Sharing in the Netherlands		16
1.7 Specification of empirical research questions and method		19
1.8 The structure of this study		22
2 The concept of “Eco-efficient Services” as a potential innovation strategy for sustainable consumption	25	
2.1 Introduction		25
2.2 The “Steady-State Economy”	26	
2.3 The “Service Economy” versus the “Industrial Economy”	29	
2.4 The concept of “Eco-efficient Services”	34	
2.5 Environmental consequences of the concept of “Eco-efficient Services”	39	
2.6 Position on the concept of “Eco-efficient Services”		41
3 Car Sharing, a mobility service innovation in the Netherlands	43	
3.1 Introduction		43
3.2 Cost and benefits consumers		44
3.3 Market developments		48
3.4 Car Sharing and governmental policies	54	
3.5 Concluding remarks		58
4 Exploratory research on Car Sharing	61	
4.1 Introduction		61
4.2 Review of literature		62
4.3 Exploration by focus group studies		66
4.4 An exploratory survey in Leiden		69
4.5 Conclusions		72
5 Conceptual model	73	
5.1 Towards a conceptual model		73
5.1.1 The “Diffusion of Innovations-model by Rogers	74	
5.1.2 The various aspects of innovation diffusion research		75
5.1.3 Limitations of the innovation diffusion paradigm for our study	79	
5.1.4 Concluding remarks		82
5.2 Conceptual model for the adaption of Car Sharing		83
5.2.1 Theoretical perspectives on adoption: personal values and decision making		85
5.2.2 Theoretical perspectives on adoption: environmental attitudes		88
5.2.3 Theoretical perspectives on adoption: habitual behaviour	89	

versus deliberate choices		
5.2.4 Operationalisation of concepts	91	
5.3 Conceptual model for the service quality perception of Car Sharing services	94	
5.3.1 Theoretical perspectives	96	
5.3.2 Measuring service quality	101	
5.3.3 Operationalisations	104	
5.4 Conceptual model for changes in mobility behaviour	105	
5.4.1 Hypotheses	106	
5.4.2 Theoretical perspectives	107	
6 Research method	111	
6.1 Research method	111	
6.2 Questionnaire development	115	
6.3 Data collection and response	116	
6.4 Preliminary data processing	117	
6.5 The combination of eight subsamples	120	
6.6 Discussion and implications	128	
7 The adoption of Car Sharing services	129	
7.1 Motives for (non-)adoptions	129	
7.2 Exploration on determinants of (non-)adoption	131	
7.3 Habits, attitudes, intention and adoption	136	
7.4 Explaining attitude and intention towards Car Sharing	141	
7.5 Discussion on the adoption of Car Sharing	147	
8 Service quality perception of Car Sharing services	151	
8.1 Service quality and the intention of contract extension	151	
8.2 Measuring perceived performance of Car Sharing operations	152	
8.3 Explaining service quality perception by operational performance	157	
8.4 Multiple regression analysis on service quality	158	
8.5 Conclusions	161	
9 Changes in mobility behaviour	163	
9.1 Introduction	163	
9.2 Changes in car ownership	163	
9.3 Changes in behaviour		167
9.4 Searching for an explanation of changes in mobility behaviour	172	
9.5 Investigating in changes in mobility behaviour	177	
10 Changes in environmental effects	181	
10.1 Introduction		181
10.2 The method for the environmental assessment		182
10.3 Results of the environmental assessment	185	
10.3.1 Goal definition and scope	185	
10.3.2 The inventory	185	
10.3.3 The impact tables	188	
10.3.4 The environmental metabolism of Car Sharing services	190	

10.3.5	The integral environmental assessment of the adoption of Car Sharing services	191	
10.4	Conclusions		197
11	Conclusions and reflections	199	
11.1	Introduction		199
11.2	Discussion on the empirical research: the adoption of Car Sharing services	201	
11.2.1	Research results: the adoption decision on Car Sharing services	201	
11.2.2	Research results: the role of habitual behaviour in the adoption decision		203
11.2.3	Research results: the formation of an attitude towards Car Sharing	205	
11.2.4	Research results: the service quality perception of Car Sharing services		206
11.3	Conclusions: consumer research on Car Sharing services		208
11.3.1	The adoption decision on Car Sharing services	208	
11.3.2	The service quality perception of Car Sharing services	211	
11.4	Reflections on the consumer research		212
11.4.1	Reflections on the research method		212
11.4.2	Reflections on the applied theoretical framework	214	
11.5	Discussion and conclusions of the empirical research: the changes in environmental impact		217
11.5.1	Results of the environmental assessment of Car Sharing services	218	
11.5.2	Conclusions on the changes in environmental effects		219
11.5.3	Reflection on the results of the environmental assessment		221
11.5.4	Reflection on research method		223
11.6	The environmental potential of Car Sharing services in 2010		225
11.6.1	Car Sharing services in 2010: the assumptions	225	
11.6.2	The environmental metabolism of Car Sharing services in 2010	227	
11.6.3	The environmental potential of Car Sharing services in 2010		229
11.6.4	Conclusions		231
11.7	Reflection on the concept of Eco-efficient services		231
11.7.1	Car Sharing as a specific example of Eco-efficient Services		231
11.7.2	The value of the concept of Eco-efficient Services for Sustainable Development		234
12	Epilogue	237	
12.1	Recommendations for the field of Car Sharing services		237
12.2	Recommendations for the field of environmental management		240
12.3	Car Sharing service schemes today and in the future "Bewegingsruimte"		243
	Summary	247	
	Samenvatting	261	
	References		275
	Biographical note		297

Summary

1. Introduction

This thesis focuses on consumers and consumer behaviour in relation to environmental problems. It starts from the assumption that environmental problems are closely related to individual consumer behaviour, and that individual consumer behaviour is one of the major causes for the existing environmental problems.

Several studies argue that current consumption practices and consumer behaviour can not be called "sustainable", as defined by the United Nations World Commission on Environment and Development (WCED, 1987). Without substantial changes, in the long term these consumption practices present a serious threat to the environment and to society as a whole. In reaction to this general societal problem, the question arises how consumption behaviour could be changed in order to reduce its environmental impact.

In our study we narrowed down this general question by focusing on one specific approach to changing consumer behaviour in order to reduce environmental effects: It is assumed that consumer behaviour can be changed and be made less environmentally damaging through the development and successful market introduction of innovative products and services. In this approach, industry has a key-role to play. By means of innovative products and services it is possible to intervene in current unsustainable consumption practices and to provide alternatives to individual consumers. Changes in consumer behaviour can be realised through the adoption of innovative products and services that facilitate a new consumption practice.

The development of innovative products and services, which is also called an "innovation process", starts with an analysis of a consumption practice. A consumption practice can be understood as a kind of a transformation process in which various input factors are used for the production of certain utilities or useful end -results. The three major input factors by which consumers get the desired utilities are (1) products (hardware), (2) resources like energy and consumables and (3) their own consumption activities. In this conceptualisation, innovative activities are directed at rethinking and optimising the production of a certain utility or functionality to consumers by inventing new a consumption practice. The optimisation of a certain consumption practice ultimately results in an improvement of the environmental efficiency, which means that the same functionality is produced with less environmental effects.

For an assessment of the environmental effects of consumer behaviour, two major concepts are considered in this study. Using the equation of Ehrlich and Holdren (1971), we investigate the environmental metabolism of the product (system) that is used to produce a certain unit of service as well as the amount of units of service produced. The environmental metabolism refers to the environmental efficiency of the way a unit of service is produced in a certain consumption practice. The amount of units of service refers to the volume of consumption.

2. The concept of Eco-efficient Services

In this study we have chosen to investigate one particular approach at improving a consumption practice to reduce environmental effects. In theory, this approach results in a reduction in the environmental impact. This innovation strategy, called the Eco-efficient Services strategy, is defined as:

Eco-efficient Services are all kinds of commercial market offers aimed at fulfilling customer needs by selling the utilisation of a product(system) instead of providing just the hardware for these needs. Eco-efficient Services are services, related to any kind of hardware, in which some of the properties rights are kept by the supplier.

The Eco-efficient Services strategy is guided by the principle that it is the utilisation value of a product that has to be sold, instead of the product itself. Basically, this strategies rests on a different view of the (economic) value of products, also called “the economic paradigm of the Service Economy” (Giarini and Stahel, 1993). In the Service Economy, products are seen as entities that, when used, produce or help to produce certain units of service. It is these units of service that are assumed to be of value for consumers and not the products as such. Since the units of service accrue to people by the use of products, they are called the utilisation value of products. So, in the Service Economy the product is instrumental in providing what is desired by the customer. Therefore, not the product as such is to be sold, but the functionality of these products or their utilisation value in terms of units of service.

The Eco-efficient Services strategy further suggests that e.g. not the mere ownership of cars is of value for people, but the ability to use one for a certain period of time to cover a certain distance. Consistent with this assumption, the use of a car should be sold by (innovative) suppliers and bought by consumers.

The concept of Eco-efficient Services encompasses three different categories of solutions. They can be distinguished based on the extent to which property rights are handed over to the user of the products, and the extent to which a customer him/herself participates in the production of units of service. Seen from the perspective of the consumer, one of the basic characteristics of Eco-efficient Services is that a number of tasks and responsibilities related to the proper functioning and the operation of the products is out-sourced to external service suppliers. The following three categories of Eco-efficient Services were distinguished (Bierter, Stahel and Schmidt-Bleek, 1996):

1. Product-life-extension-services.
2. Product-use services.
3. Result services.

On theoretical grounds, various authors assume that the application of the Eco-efficient Services strategy will lead to the environmental optimisation of the production of the desired units of service (Giarini and Stahel, 1993; Manzini, 1994; Stahel, 1996; Bierter et al., 1996). This mechanism for reducing environmental impact is founded on the nature of the transaction between supply and demand, which is based on the utilisation value. When a supplier, in stead of merely selling the products, starts selling the utilisation value of products, he gets an economic interest in optimising – both economically and ecologically – the production of a unit of service. All costs, over the entire life cycle of the hardware involved in the production of the service, both in terms of material and energy consumption and investment and exploitation costs, directly influence the profit margin of the service supplier, which forms a strong incentive to optimise and reorganise the production of a unit of service. One of the important advantages of Eco-efficient Services is that instead of a conventional product-oriented optimisation, here a more product system -oriented optimisation is more

likely. A cost reduction and a reduction in the use of energy and material resources in any phase of the entire product life will be profitable, and not only in the production or the distribution phase, like in conventional situations. For each of the three categories within the Eco-efficient Services strategy the specific effects on the environmental optimisation were formulated.

3. The research problem

In this thesis the concept of Eco-efficient Services is seen as an interesting theoretical idea, which however still lacks empirical confirmation. For instance, the extent to which application of this strategy leads to a reduction of environmental impact has not been sufficiently proven or quantified. Our approach towards the concept of Eco-efficient Services is therefore that this strategy needs further testing in the empirical reality to establish its possibilities for changing consumer behaviour in order to reduce environmental effects.

Our two research questions refer to the theoretical nature of the concept of Eco-efficient Services on two aspects. The first research question relates to the *consumer acceptance* of Eco-efficient Services and examines the determinants of adoption. The second research question refers to the *environmental impact* of Eco-efficient Services and examines the changes in environmental effects as a result of the introduction of Eco-efficient Services.

4. The case of Car Sharing services

To answer these two questions we conducted an extensive field study. The empirical study has been performed in the field of Car Sharing services in the Netherlands. In the mid nineties several entrepreneurial activities had resulted in operational service schemes aimed at providing access to (regular) car use through various kinds of service arrangements. According to our definition, these innovative service arrangements could be interpreted as Eco-efficient Services: Car Sharing services provide access to a car and use of a car whenever needed, without the necessity to own a private car. The economic transaction between the customer and the service supplier is based on the utilisation value of the car in terms of the duration of car use and the distance travelled in the car. Car Sharing services started in 1994 with rather small-scale service systems, but have since their foundation extended their services to a larger urban area and more cities. Our empirical study was performed among four of the most innovative service schemes in the mid nineties, all of them not older than two years.

For the case of Car Sharing the two central research questions were transformed into three empirical research questions for a consumer research:

1a. What are the determinants of the adoption of Car Sharing by an individual consumer?
Before Car Sharing services can result in positive environmental effects, this alternative to the privately owned car must be adopted by individual consumers.

1b. What are the determinants of the service quality perception among experienced customers of Car Sharing systems?

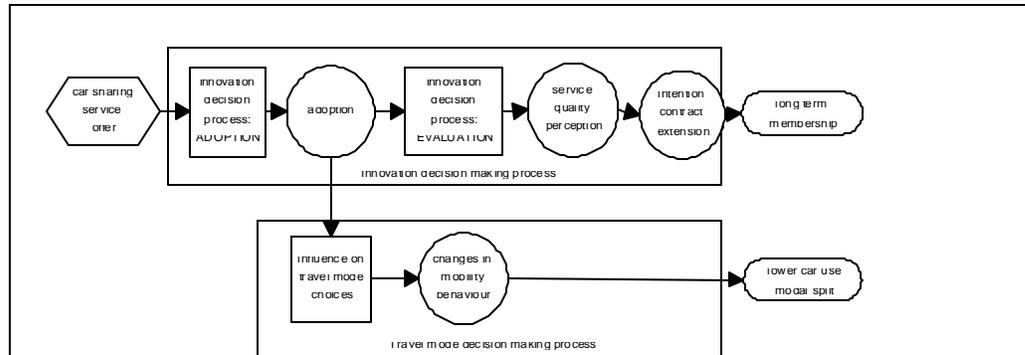
In order to represent a long-term alternative to the privately owned car, Car Sharing must be experienced as a high-quality service. A high service quality perception can be seen as a central precondition for customer retention.

2. What are the changes in mobility behaviour after adoption of Car Sharing?

For the environmental assessment of Car Sharing services, empirical data on the changes in mobility behaviour are indispensable. Mobility behaviour basically refers to the use of various means for transport, including the car.

5. The conceptual model

These research questions formed the basis for the consumer research among adopters and non-adopters of four different Car Sharing schemes in the Netherlands. They refer to three different decision making processes, as the consumer decision process model below illustrates. For any of the three dependent variables, the adoption of Car Sharing services, the service quality perception and the changes in mobility behaviour, specific conceptual models were developed that hypothesise how these three dependent variables could be explained. In the research, empirical evidence was gathered for the existence of the specified relationships.



6. Conclusions on the adoption of Car Sharing services

In order to answer our three empirical research questions a cross-sectional survey among four different Dutch Car Sharing service schemes, has been performed. The response on the survey contained 337 adopters and 809 non-adopters. Our exploratory research led to the following conclusions regarding the explanation of the adoption of Car Sharing services:

- a. The explanation of the adoption of Car Sharing services varies considerably among the various market segments. Especially the differences among those who owned a car before adoption and those who did not, are substantial. The most striking differences in the explanation are in the importance of the cost perception, or the importance of costs in travel mode decision making. Car owners in particular tend to be very cost conscious when adopting Car Sharing services and are motivated to adopt because of various negative experiences with private car ownership.
- b. Habitual behaviour is a barrier for the adoption of Car Sharing services. Habits in mobility behaviour prevent deliberate decisions with respect to travel modes. In a similar situation, past mobility behaviour is merely repeated without considering alternatives. This mechanism prevents a rational decision making process in which the pros and cons of Car Sharing services are weighed.
- c. In case of adoption of Car Sharing services the main motivation for adoption is economic savings. If consumers do not see an economic benefit in the choice for Car Sharing, the remaining motivating factors alone are insufficiently convincing to lead to adoption. Apart from economic savings, parking problems and extensive care and maintenance tasks are mentioned.
- d. Insight in the real costs of car use is an important boundary condition for the adoption of Car Sharing services. The perception of costs for car use is one of the most important determinants of adoption of Car Sharing services. Empirical evidence shows that those who have a good insight in all costs of car use and are willing to take all (fixed and variable) costs into account when making a travel mode decision, are far more likely to adopt Car Sharing services.
- e. For a broader consumer acceptance, Car Sharing services should have excellent accessibility. Easy access to cars must be provided at comfortable outlets that are

- near people's homes, otherwise positive attitudes and positive intentions will not be turned into adoption.
- f. For broader consumer acceptance, Car Sharing services must have a high service quality image. The decision to adopt of Car Sharing service strongly correlates with a high service quality perception of the service. Consumers are only willing to change their behaviour if they have confidence in the service organisation, and in its ability to provide decent mobility services at a reasonable price. Because consumers become dependent on the service organisation, they demand a professional commitment from it.
 - g. Only among former car owners is the value orientation of the adopters important for the adoption of Car Sharing services. We expected the value orientation of consumers to be very important in explaining the adoption of Car Sharing services. However, empirical evidence shows that only among the former car owners some explanatory value of the value orientation could be found. Adopters tend to associate cars less with values like freedom and welfare and more with their negative consequences. For the so-called substituters, these "anti-car values" clearly provide a strong motivation to change their behaviour.
 - h. The environmental attitudes have some explaining value in the adoption of Car Sharing services among former car owners. People who feel a personal responsibility to contribute to a cleaner environment are more likely to adopt. In the overall explanation however, this variable only seems to play a subordinate role. It seems fair to conclude that consumers do associate environmental values with Car Sharing services, but that these values have virtually no impact on the adoption decision.

7. Conclusions on the service quality perception of Car Sharing services

With regard to the service quality perception we draw the following conclusions based on our research:

- a. The empirical research has shown that the service quality perception among current Car Sharing schemes is very good. On average, 90% of the adopters evaluate these service with "high" or "very high" service quality. This result can be interpreted as an indication that, at least among the adopters, Car Sharing can be a real alternative to a privately owned car.
- b. The service quality perception is an important predictor for the extension of the contract with the service organisation and thus for the market success of Car Sharing. Because of the solid correlation between the service quality perception and the intention to extend the contract in the following year, we can draw the conclusion that the service quality perception is an important predictor for the extension of the contract with the service organisation. This also implies that a high service quality is an important precondition for consumers to use Car Sharing as an alternative to the privately owned car.
- c. The service quality perception is mainly dependent on how the services are provided. In this study we have found empirical evidence for the fact that consumers evaluate the service quality mainly on HOW the services are provided. The content of the service (WHAT), which is the car itself, is far less important, assuming the car is in reasonable condition. So, a high service quality perception is realised through a service design aimed at a convenient service delivery for the consumer and a smoothly operating service organisation.
- d. Given the importance of the service performance in the overall service quality perception, it is essential to optimise the performance of the service organisation on six aspects. Based on our analysis, the following six dimensions of the performance of the service organisation were distinguished:
 - All service employees have to take the clients seriously and help them with their problems and questions. In other words, the employees have to show an empathetic attitude and behaviour.

- The clients should always feel that conditions are clear and that they can trust the organisation. This means that the employees and the entire organisation should do everything to give the customer reassurance.
 - The organisation must respond immediately and reliably to all questions and reservations at convenient opening hours. So, the organisation must be organised in such a way that the employees are able to show great responsiveness.
 - The visual appearance of the service organisation must be neat and attractive. All tangible elements should express the high quality character of the service organisation.
 - All transactions must be correct. This means that the charging and all other agreements are handled reliably.
 - The cars must be available at any time. This means 24 hours a day, even in weekends.
- e. The service quality perception is not only determined by the operational performance of the service organisation, but also by the characteristics of the service offer. Apart from factors related to the performance of the service organisation this study has shown that the price perception of the service and the evaluation of the distance to the outlet also have explaining value in the service quality perception. So, the extent to which people find the service expensive or not, as well as the extent to which cars are provided at a location convenient to them, influence people in their evaluation of the service quality.

8. Changes in mobility behaviour after the adoption of Car Sharing services

In response to the second empirical research question, the changes in mobility behaviour before and after adoption of Car Sharing services were established. These data are important for the overall environmental assessment of Car Sharing services. Because we could expect the entire mobility behaviour to change after the adoption of Car Sharing services, the changes in the use of different travel modes were established.

The change in car mileage before and after adoption is 33% for all adopters. There are however substantial differences between the various market segments. The change in car mileage is largest among those who substitute their private car for Car Sharing services (-65%).

* significance <i>p</i> < .05	average all adopters			
		Carless	car owner	
		average carless	substituter	second car driver
car mileage BEFORE	8.450	5.360	13.380	21.700
car mileage AFTER	5.660 * (-33%)	3.820 * (-29%)	4.730 * (-65%)	22.386 (+3%)

Table 1. Changes in car mileage per year, before and after the adoption of Car Sharing services

The change in the frequency of use (per week) of the various travel modes is substantial and varies over the three major market segments, which are the “carless”, the “substituters” and the “second car drivers”. The overall tendency is that trips by car (-43%) are substituted by the use of alternative travel modes. The number of trips per week by bicycle increases with

14%, trips by train with 36% and trips by bus with 28%. From our data we can also conclude that the total number of trips increases with 10% after the adoption of Car Sharing services.

* significance $p < .05$	Average Adopters			
		carless		car owner
		average carless	substituter	second car driver
car use	- 43%			
BEFORE	3,5	1,6	3,8	6,5
AFTER, of which by SHARED CAR	2,0 *	1,9	1,6 *	5,8
	1,9 *	1,2	1,5 *	0,5
cycle use	+14%			
BEFORE	14,3	15,1	11,6	14,5
AFTER	16,3	16,5	14,8 *	17,3
train use	+36%			
BEFORE	2,2	2,4	2,0	1,0
AFTER	3,0	3,0	3,5 *	1,4
bus use	+28%			
BEFORE	3,6	4,0	2,2	3,2
AFTER	4,6	4,8	4,2 *	4,0
total amount of trips	+10%			
BEFORE	23,6	23,1	19,6	25,2
AFTER	25,9	26,2	24,1	28,5

Table 2. Changes in frequencies of use per week of different travel modes, before and after the adoption of Car Sharing services

9. Conclusions on the changes in environmental effects of Car Sharing services

To answer the second research question, an integral environmental assessment was made of the changes in environmental effects after the adoption of Car Sharing services. To make this assessment, not only the changes in environmental efficiency of the different travel modes used for the entire mobility have to be considered, but also all changes in the entire mobility behaviour of the adopters.

Car Sharing services are treated in this study as a special travel mode with its own environmental efficiency per unit of service, which is a kilometre of transport by car. A special inventory was made to establish the integral environmental efficiency of Car Sharing services. In comparison to the average Dutch car the following conclusions were drawn regarding the environmental efficiency of Car Sharing services:

- the environmental impact of Car Sharing schemes in the production of a certain car mileage is an estimated 14% lower than the impact of the average Dutch car.
- the relative advantage of Car Sharing schemes mainly results from the use of relatively lightweight cars. The cars weigh about 22% less, which results in a higher fuel efficiency and a reduced contribution of the production of the car to the total environmental impact.

The integral assessment of the changes in environmental effects of Car Sharing services provides the answer to the second research question. These are the main results with respect to the changes in environmental effects as a result of the adoption of Car Sharing services:

- In a comparison between the total environmental impact of the adopters' mobility behaviour before and after adoption, a reduction of 21% was calculated, based on the Eco-Indicator method.
- The environmental impact of adopters of Car Sharing, as a result of their entire mobility behaviour is an estimated 40% lower than that of the average Dutch household.
- The total reduction in the amount of parking space needed (which equals the number of cars) was calculated at 44%. This percentage is realised by the adoption of Car Sharing. Per 1000 households these savings add up to an estimated 2038 m².
- The reduction in environmental impact varies substantially among the different market segments: The reduction in environmental impact is an estimated 14% among the carless and an estimated 48% among the substituters. Among the second car drivers the environmental impact increases by an estimated 6%.

On the basis of these research results, the following more general conclusions were drawn with regard to the changes in environmental effects after the adoption of Car Sharing services:

- The introduction of Car Sharing services leads to a reduction in environmental effects, which is the result of both improvements in the environmental efficiency per kilometer driven and changes in travel behaviour.
- The (changes in) environmental effects are mainly the result of (changes in) the use of fossil energy (fuel).
- The relative advantage of Car Sharing services over the privately owned car with respect to the environmental effects, is mainly the result of the use of relatively smaller cars.
- Of all the environmental impact categories, the largest reduction in environmental effects is achieved by the reduction in (parking) space.
- There is substantial variation in the changes in environmental impact among market segments (carless, substituters and second car drivers).
- The environmental assessment leads to the conclusion that the reduction of environmental effects can be explained by both behaviour-oriented factors and system-oriented factors.
- With regard to *behaviour-oriented factors*, the following factors can be distinguished:
 1. Car ownership is an important predictor of the relevant changes in mobility behaviour.
 2. The extent to which car trips are substituted by the use of alternative travel modes, that are more fuel efficient and less environmentally damaging.
 3. The substitution of car trips by the use of bicycles turns out to be extremely effective in reducing all environmental effects.
 4. The choice for the most fuel-efficient and the smallest car possible for a certain trip helps saving energy.
- With regard to *system-oriented factors*, the following factors can be distinguished:
 5. Implementation of the newest and most fuel efficient vehicles creates a relative advantage over the average privately owned car.
 6. Selection of the most energy-efficient and lightweight vehicles within a certain car class makes another additional contribution to the reduction of environmental effects.
- Car Sharing services do not entirely fit the assumptions put forward by the theoretical concept of Eco-efficient Services. This concept suggests that entrepreneurs gain an economic interest in the continuous improvement of a certain consumption practice towards a higher environmental efficiency. The only empirical observation that confirms this continuous improvement towards a higher environmental efficiency, is the fact that the various entrepreneurs always choose the most fuel-efficient cars. Life-extension of cars by maintenance and repair activities or upgrading of used cars is not common yet in current Car Sharing schemes.

10. The environmental potential of Car Sharing services in 2010

To estimate what contribution Car Sharing services could make to the reduction in environmental effects if these services were implemented on a large scale in the Netherlands, we extrapolated the current situation into the future. On the basis of several assumptions about the market penetration in 2010, the use of the different travel modes and the environmental impact of all travel modes, we calculated the potential to reduce the environmental effects. Our research data on the current situation were used as a reference.

Our calculations on the potential for a reduction in environmental effects have led to the following conclusions:

- Current Car Sharing schemes have great potential for improvement of their environmental metabolism: their environmental impact can be further reduced with 35%. The measures that need to be taken to achieve this result are far from challenging.
- The environmental potential of Car Sharing services in 2010 is large too. Based on the assumptions, a reduction of 30% in the total environmental impact was calculated. For the various impact categories similar reduction percentages were calculated, like a 31% reduction in CO₂ emissions.
- With respect to the changes in the number of cars and amount of parking space needed, our conclusion is that in 2010 the reduction rate (per 1000 households) will probably even be 65%. This reduction rate is mainly based on the assumption that the number of substituters will increase from 21% at present to 50% in the future. Expressed in square meters, the parking space reduction for 2010 is an estimated 7000 m² per 1000 households.
- Also the potential contribution of Car Sharing services in absolute terms cannot be neglected. Particularly with respect to the reduction in CO₂ emissions and the (parking)space required, Car Sharing services have such positive effects that their development deserves strong governmental support, both from central and local government.
- If the Car Sharing services develop according to our assumptions, these mobility services could become a very effective instrument for reducing CO₂ emissions. In line with the recent Dutch policy framework for the reduction of greenhouse gasses, called the "Uitvoeringsnota Klimaatbeleid" (VROM, 1999), Car Sharing services could contribute another 0,34 Mton reduction in CO₂ emissions to the 2,9 Mton reduction needed in 2010, which is 12%. Compared to all other policy measures, this would be a very important instrument.

11. How representative Car Sharing is for the concept of Eco-efficient Services

Car Sharing services were chosen as the subject of our empirical study because they were seen as a striking example of the theoretical concept of Eco-efficient Services. However, we concluded that the research results on this particular subject are difficult to generalise. There are too many variables involved to make a generalisation possible. The comparison with e.g. washing services as an alternative to the privately owned washing machine is difficult because these service involve quite a different service process and do not provide the products to consumers at all to deliver the desired endresults. Above all little emotional value is associated with a washing machine, compared to a car and the factor time or labour costs are quite another impact in the adoption decision making.

Despite the fact that Car Sharing must be treated as an isolated case, this study has nevertheless shed new light on the value of the concept of Eco-efficient Services. The experiences with Car Sharing in this study, have led to a couple of insights with regard to the value of the concept of Eco-efficient Services in a more general sense:

- This concept supports the analysis of the functional efficiency of a certain consumption practice. Through the identification of current inefficiencies, a specific consumption practice becomes problematic, which gives rise to improvements.
- The concept certainly helps to transform “life-cycle-thinking” into new business opportunities. Selling the utilisation value of products forces companies to incorporate all costs over the entire life cycle in the development of innovative solutions. It creates a business interest in more economically and environmentally efficient solutions.
- In addition, the concept of Eco-efficient Services provides a set of ideas of how extended producer responsibility (Lindhqvist, 1997) could be transformed into new business opportunities. Whereas extended producer responsibility is generally seen as a threat to linear business concepts, the concept of Eco-efficient Services illustrates how governmental interventions could be incorporated into business strategies and lead to new strategic advantages, e.g. in terms of stronger customer relationships.
- Our study on Car Sharing services has confirmed the central idea behind the concept of Eco-efficient Services that by selling the utilisation of products, the entire production-consumption system is improved and its functional efficiency increases. The extent to which improvement options are implemented is however largely dependent on the economic context. The prices of labour, energy, and material determine the extent to which innovative technological and organisational options are implemented.
- Focussing on the functional efficiency of a certain consumption practice and looking at the way in which a certain function is generated, stimulates a stronger market orientation of companies. To change a consumption practice successfully, one has to have a very clear idea of what customers really need.
- The concept of Eco-efficient Services is based on a very functional view on products. This concept assumes that products only provide functional outputs. In this functional output, product *use* is certainly essential, but the emotional values associated with product ownership and product use cannot be neglected in most domains of consumption. The fact that these emotional values associated with the product are neglected within the concept of Eco-efficient Services can be seen as an important limitation.

12. The value of the concept of Eco-efficient Services for Sustainable Development

The concept of Eco-efficient Services was introduced as a specific innovation strategy, by which industry could contribute to “Sustainable Development” (WCED, 1987). It was expected that as a result of the development and market introduction of innovative services, consumption behaviour could be changed, which would lead to a reduction in environmental effects. On the basis of this thesis on Car Sharing services, we discussed the value of the concept of Eco-efficient Services for Sustainable Development. We concluded that the value of this concept in the process of change towards Sustainable Development is only complementary and limited for various reasons:

- The concept of Eco-efficient Services is basically an innovation strategy by which the environmental efficiency of specific consumption practices can be enhanced. However, this represents only one relevant aspect of the total environmental impact. The concept of Eco-efficient Services is not aimed at influencing the volume of consumption, or the total amount of units of service. Changes in consumption behaviour that have a positive impact on the environmental effects are quite accidental; they are certainly not a general effect of Eco-efficient Services. So, this concept contributes only to Sustainable Development and Sustainable Consumption to the extent of providing more environmentally efficient consumption practices.
- The extent to which the concept of Eco-efficient Services contributes to the further optimisation of the environmental efficiency of consumption practices, is very likely to vary tremendously among the various marketsegments and over time. So, the positive effects from these services will vary from case to case. Since Car Sharing services provide an alternative to the privately owned car with only about 14% less environmental effects, it can

reasonably be expected that in other cases the increase in environmental efficiency will be much higher.

- Based on our study we conclude that it is very unlikely that Eco-efficient Services, as a specific kind of innovation in function fulfilment will ever result in an environmental improvement factor of 10, as has been suggested by several authors (Jansen and Vergragt, 1993; Vermeulen and Weterings, 1996; Brezet, 1997). If we assume, with Weterings and Opschoor (1992), that for a sustainable society the environmental efficiency of products and services must be improved with at least a factor 20, we have to conclude that the concept of Eco-efficient Services only has a limited role in the process of change towards Sustainable Development.
- So-called Eco-efficient Services have their own dynamics in the market. As we have seen in our study on Car Sharing, these services do not only function as an alternative to former consumption practices. Innovations always generate new markets and new types of behaviour. While Eco-efficient Services might provide more environmentally efficient alternatives for current consumption practices, it can not prevent from the development of new markets and therefore new sources of pollution.
- The context within which the development and introduction of Eco-efficient Services takes place is treated as a set of given boundary conditions. By treating the context as given, the concept of Eco-efficient Services does account for the possibility of change towards Sustainable Development resulting from changes in the context itself. In the process of change towards Sustainable Development it must not be forgotten that progress can also be made as a result of changes in the economic, social, cultural, legal and physical context.
- The concept of Eco-efficient Services takes a certain demand for granted and aims to provide just a more environmentally efficient alternative for this demand. It does not raise any questions at all regarding the justification of the demand for a certain functionality from an environmental point of view (see also SustainAbility, 1996). The absence of a criticism towards certain consumption practices can be seen as a limitation towards a more "sustainable" society.

13. The value of the concept of Eco-efficient Services for Sustainable Development

In the epilogue of this thesis a set of recommendations is provided for the field of Car Sharing services, as well as for the field of environmental management in general.

This thesis ends with a designers' perspective of the future. Based on study of the empirical reality in the nineties, a scenario was developed for the development of Car Sharing services in 2010. This is not meant as a prediction for the future, but as a 'grand design' that would inspire entrepreneurs and encourage co-operation between the various actors involved in the development of Car Sharing services.

-- end of summary --

11. Conclusions and reflections

11.1. Introduction

This thesis started from the assumption that macro environmental problems are directly related to individual consumer behaviour. It is the individual demand for products and services that finally leads to the aggregated environmental impact on the macro level. Many different studies argue, as shown in section 1.1., that current consumption practices and consumption behaviour can not be called "sustainable", as defined by United Nations World Commission on Environment and Development. Without any substantial changes these consumption practices presents serious threats to the environment and to human society at large. In reaction to this general societal problem it has been questioned how then consumption behaviour could be changed in order to reduce its environmental impact.

This general question is narrowed down here by focusing on one specific approach to change consumer behaviour in order to reduce the environmental effects: It is assumed that consumer behaviour can be changed and be made less environmental damaging through the development and successful market introduction of innovative products and services. In this approach industry has a key-role to play. By means of innovative products and services as a substitute for existing products and services, it is possible to intervene in current unsustainable consumption practices and to provide alternatives to individual consumers.

In this study we have chosen to focus on one particular innovation strategy, called the Eco-efficient Services strategy, which is defined as:

Eco-efficient Services are all kinds of commercial market offers aimed at fulfilling customer needs by selling the utilisation of a product(system) instead of providing just the hardware for these needs. Eco-efficient Services are services, related to any kind of hardware, of which some of the properties rights are kept by the supplier.

The Eco-efficient Services strategy is guided by the principle that the utilisation value of a product needs to be sold, instead of the product itself. Basically this strategy rests on a different view of the (economic) value of products, also called by Giarini and Stahel (1993), the economic paradigm of the Service Economy. For example, the concept of the Eco-efficient Services strategy suggests that not the mere ownership of cars is of value for people, but the ability to use one for a certain period of time and for covering a certain distance. Consistent with this assumption, the use of a car should be sold by service suppliers.

On theoretical considerations it is assumed by various authors (Giarini and Stahel, 1993; Manzini, 1994; Stahel, 1996; Bierter e.a., 1996) that the application of the Eco-efficient Services strategy will lead to the optimisation of the production of the desired units of service. This mechanism leading to the reduction of environmental impacts would be the result of the nature of the transaction between supply and demand, which is based on the utilisation value. In contrast to selling merely the products, the supplier gets, when selling the utilisation value of products, an economic interest in optimising -both economically and ecologically- the production of a unit of service. All costs over the entire life cycle in terms of energy and material consumption as well as in terms of monetary costs for investments and exploitation costs put a direct load on the profit margin of the service supplier and will therefore become an incentive to the optimisation and the reorganisation of the production of a unit of service. One of the major advantages of Eco-efficient Services is that instead of a conventional

product-oriented optimisation, here a more product system oriented optimisation is more likely.

However, the starting point for this thesis is the conviction that the concept of Eco-efficient Services is far from a thoroughly tested theoretical idea. Only a couple of practical examples exist suggesting that Eco-efficient Services is more than just a theoretical idea. Our stance towards the concept of Eco-efficient Services is that this strategy needs to be tested in the empirical reality.

The two main empirical research questions that have been addressed in this thesis, aim to test the theoretical concept of Eco-efficient Services in the empirical reality on two aspects:

1. The first research question relates to the consumer acceptance of Eco-efficient Services and questions the determinants of the adoption.
2. And the second research question refers to the environmental impact of Eco-efficient Services and questions the changes in the environmental impact of the market introduction of Eco-efficient Services.

For answering these two questions we have set up an empirical study in the field of Car Sharing services in the Netherlands. During the mid nineties several entrepreneurial activities had led to various operational service schemes aimed at providing access to (regular) car use through various kinds of service arrangements. To our definition these innovative service arrangements could be interpreted as Eco-efficient Services: Car Sharing services are providing access to a car and the use of a car whenever necessary, without the need to own a private car. The economic transaction between the customer and the service supplier is based on the utilisation value of the car in terms of the duration of use and the distance driven by that car. Our empirical study has been performed among four of the most innovative service schemes.

This chapter will close this thesis with a discussion and conclusion on three levels of abstraction. First, we will discuss the results of our empirical study on Car Sharing in the Netherlands and draw some major conclusions for this specific case. Obviously, the focus will be on the two research questions, regarding the consumer acceptance and the changes in environmental effects. Above all we will sketch a future perspective of the environmental potential of Car Sharing services in 2010.

Second, we will reflect upon the value of the concept of Eco-efficient Services. Given the results of the empirical study on Car Sharing in the Netherlands, the practical relevance of the theoretical concept of Eco-efficient Services will be discussed and the implications for the wider theoretical framework of Eco-efficient Services will be formulated.

Third, we will reflect upon the value of the concept of Eco-efficient services in the light of Sustainable Development. The question is to what extent this concept is useful in realising Sustainable Development and Sustainable Consumption.

11.2. Discussion on the empirical research: the adoption of Car Sharing services

The first empirical research question regarding the determinants of adoption of Eco-efficient Services has been split up into two specific empirical research questions: (1) What are the determinants in the decision-making process for Car Sharing? And (2) What are the determinants of the service quality perception of Car Sharing services? It has been argued that the practical value of Car Sharing depends on the long-term consumer acceptance as an alternative option for a privately owned car and that for a long-term social acceptance not only the innovation must be adopted by consumers, but also that Car Sharing services must have a high perceived service quality, during all the service transactions over a longer period of

time. A high perceived service quality can be held as a precondition for the incorporation of the innovation in consumption behaviour in the long run. Both central elements of consumer acceptance (the adoption decision and the service quality perception) have been studied in our empirical research:

11.2.1. Research results: the adoption decision on Car Sharing services

To investigate the adoption decision we have specified a conceptual model with several hypotheses. In search of relevant determinants of adoption we have tested hypotheses 2 and 3. In testing these two hypotheses we have applied a behaviouristic approach in the analysis of the data set by comparing adopters with the non-adopters. So, in the first analysis no cognitive aspects of the decision making process have been taken into account. With respect to the nature of the decision making process, it has intrinsically been assumed that consumers evaluate on rational grounds in a deliberate and conscious process, which is common in innovation adoption theories.

Hypothesis 2. *Adopters differ from non-adopters on their individual characteristics, which include::*

- a. *their social demographic characteristics*
- b. *their personal characteristics/ attitudes*
- c. *their previous practice (with regard to mobility)*
- d. *their physical environment*

Hypothesis 3. *Adopters differ from non-adopters on their perception of the characteristics of the service scheme.*

Results of testing hypothesis 2

We have investigated the association between the various independent variables and the adoption decision instead of only testing whether adopters and non-adopters differ, which would satisfy for testing the hypotheses,. For marketing purposes, the strength of the correlation between each specific variable and the adoption decision is of particular interest. It reveals not only the distinction between two variables, but to a certain extent also its contribution to the explanation of the adoption.

Hypothesis 2 has only partially been accepted. Depending on which group of adopters is analysed (the entire population, the formerly car owning or the formerly carless people), a set of explaining variables has been found that correlate significantly with the adoption decision. Table 11.1. provides an overview of those variables that help distinguish adopters from non-adopters. A positive correlation coefficient means that with an increasing value of the explaining variable, the adoption of Car Sharing services is more likely.

	All respondents N= 1143	Carless N= 685	Car owners N= 458
Social-demographic characteristics			
Children		.15**	
Education	-.12*	-.16*	
Personal characteristics			
Perception car costs	.43**	.15	.29**
Cost involvement	.39**		.22**
Value: personal responsibility in environmental issues			.13**
Value: cars are symbols of freedom			-.19**
Value: conscious car use important			.12**
Value: technological perfection important	-.13**	-.15**	
Previous practice			
Car ownership before	-.14**		
Age former car			.19**
Total car mileage		.20**	
Mileage by rentals			.16**
Frequency of car use	-.12**	.11*	-.13**
Frequency of cycle use			-.10*
Frequency of car rental	.12**	.11	.10*
Commuting by car	-.12**		-.18**
Habit: never considering train use	-.13**		-.24**
Habit: familiar with car rental	.34**	.35**	.28**
Habit: never considering car versus public transport	-.31**	-.31**	-.28**
Habit: never considering car versus bicycle use	-.11**	-.19**	
Habit: used to combining trips		.15**	
Physical environment			
Distance to city centre			-.17**
Distance to train station			-.11**
Distance to car outlet	-.10**	-.10**	

significance: ** < .01, * < .05, correlations |r| < 0,1 not listed.

Table. 11.1. The determinants and their correlation coefficients with the adoption decision

results of testing hypothesis 3

With regard to the role of the perception of the service offer in the adoption decision making (hypothesis 3), it has been concluded that all measured variables contribute to the explanation of the adoption. Table 11.2. summarises the main results of testing hypothesis 3. Again a positive correlation coefficient means that the adoption of Car Sharing services is more likely when the value of the specific variable increases. Hypothesis 3 can therefore be accepted. Few differentiation between car owners and carless people can be made given the research results. All respondents showed modest association values with the cost perception of the service offer, the valuation of the distance to the car outlet, the quality perception and the basis on which costs are being compared.

	All respondents N= 1143	Carless N= 685	Car owners N= 458
Perception service offer			
Cost perception service	.23**	.28**	.15**
Valuation distance to the outlet	.23**	.19**	.27**
Quality perception service	.47**	.49**	.41**
Attitude towards Car Sharing	.29**	.22**	.35**
Cost reference	.17**	.27**	.14*
Cost comparison with rental	.18**	.15**	.19**

significance: ** < .01, * < .05, correlations |r| < 0,1 not listed.

Table. 11.2. The perception of the service offer in relation to of the adoption decision

To summarise the empirical results on the adoption decision, a conceptual model can be made, which shows the relevant determinants for the explanation of the adoption of Car Sharing. Figure 11.1. shows the empirical model with the nature of the relationship of each determinant with a positive adoption decision for all respondents, including both carowners and carless people.

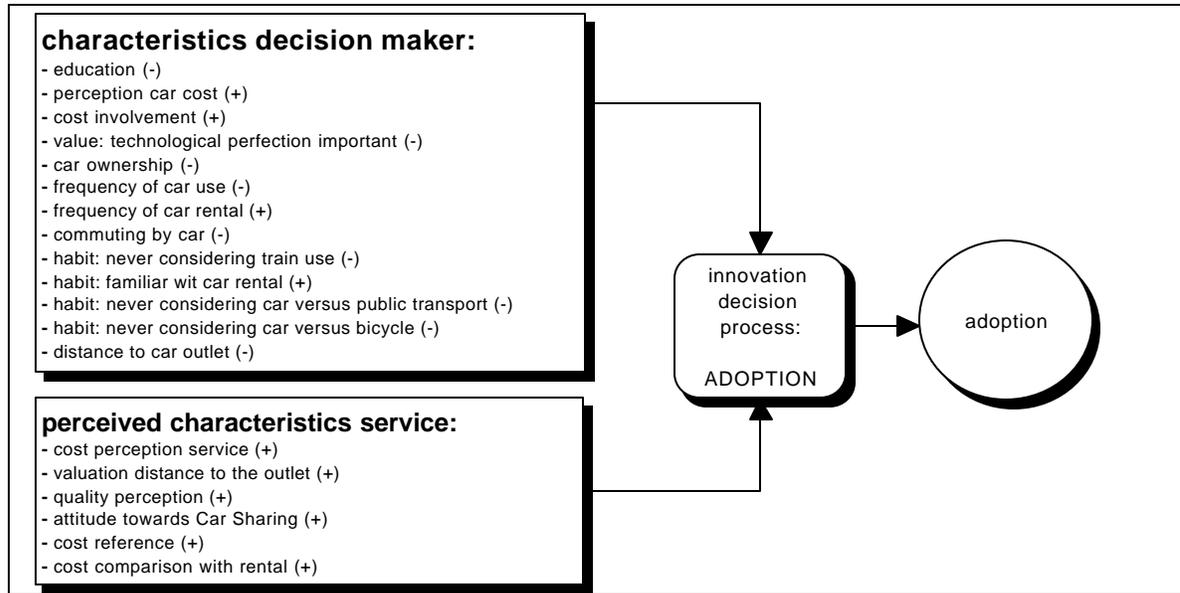


Figure 11.1. Improved conceptual model on adoption for all respondents

11.2.2. Research results: the role of habitual behaviour in the adoption decision

The testing of hypothesis 2 showed that past behaviour or the previous practices of consumers play an important role in the explanation of the adoption. These results clearly show that adopters can be distinguished from non-adopters on their past (mobility) behaviour. However these results raised new questions with regard to the implications. Past behaviour might either form indicators for deliberate reasons to adopt Car Sharing, or refer to the existence of habitual behaviour. In this thesis we found reason to assume that habits might play a role in the decision making process towards the adoption of Car Sharing, because of the highly repetitive nature of travel mode choices. We argued that in case of habitual behaviour, (non-)adoption is more likely to be explained by past behaviour than by deliberate choices.

In order to test the assumption that habits play an important role in the decision making process towards the adoption of Car Sharing services, we distinguished two different ways of explaining the (non-)adoption of Car Sharing. (Non-)adoption of Car Sharing may either be explained by a deliberate choice, in which all pros and cons are weighted. The innovation adoption and diffusion theory is entirely based upon the assumption that people make deliberate choices when deciding about the adoption of an innovation. Central in deliberate decision making is the idea (Ajzen and Fishbein, 1980) that people form attitudes and intentions about behavioural alternatives.

The alternative is that (non-)adoption is explained by habitual behaviour, which means that people do not make deliberate choices, but continue to follow previous practices based on simple heuristic principles or behavioural scripts.

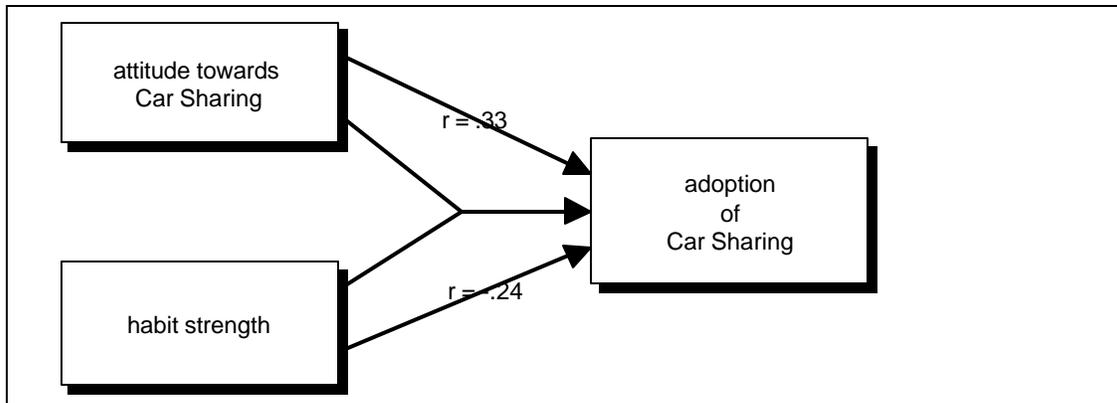


Figure 11.2. The influence of habit strength on the adoption of Car Sharing

Through the testing of the hypotheses 2b.III/IV/V, we have investigated the role of habitual behaviour in the adoption decision and the moderating effect of habitual behaviour on the predicting value of the Car Sharing attitudes on the adoption. Habitual behaviour has been operationalised (Meijkamp and Aarts, 1996) as habit strength, which is the extent to which people choose deliberately between the car and other travel modes, like public transport and the bicycle.

Through our analysis (figure 11.2.) we showed that habit strength influences the adoption negatively. With an increasing habit strength in travel mode choices, adoption of Car Sharing becomes less likely. As a consequence we may expect that the adopters are a highly selective group of consumers. They will be less habitual in their travel mode choices. For a further understanding of the adoption of Car Sharing, the (modest) mediating effect of habit on the attitude-intention-adoption process (the reasoned action), is also of importance. In case of a strong habit the relation between people's opinions and their intentions regarding Car Sharing play a less important role in the explanation of adoption, than in the case of a weak habit. That means that non-adoption could be explained differently than the adoption of Car Sharing. In case of adoption, it is very likely that people become a participant of such schemes, because they acknowledge the benefits of these systems for their situation. In case of non-adoption, instead of the negative opinion towards Car Sharing, habitual behaviour seems to play an important role. Merely the fact that people do not trade-off between Car Sharing and the private car, or between the private car and other travel modes, prevents them from building up an opinion about Car Sharing and thus from a deliberate, but negative or positive decision. In order to convince these people, it is important not only convince them in their reasoning, but foremost to break through their habits and stimulate them to make a deliberate decision about whether or not to adopt.

11.2.3. Research results: the formation of an attitude towards Car Sharing

Despite the fact that habits play a role in the adoption decision making, it can not be denied that people choose to adopt Car Sharing because they have developed a positive attitude towards Car Sharing services. Following the line of thought of Fishbein and Azjen (1975), the adoption of Car Sharing would primarily be based on a positive attitude towards this service. In extension to that, knowing which factors contribute to the Car Sharing attitude is essential for understanding the final adoption of Car Sharing.

In a multiple regression analysis we have selected the variables that explain most of the variation of the Car Sharing attitude for three population of non-adopters, which the entire sample, the carless people and the car owning people. In order to exclude the possibility that the attitude is based on experiences, instead of on an -a-priori- attitude formation, we excluded the adopters from our research sample and analysed the non-adopters. Table 11.3.

shows the overview of the Beta-coefficients of the regression analyses on the Car Sharing attitude and the R-square of the regression equation.

	All non-adopters (n= 280)		
		carless people (n= 126)	car owners (n= 99)
frequency of car use	.168		.228
estimations on savings	.179	.191	.122
quality perception	-.136	-.205	-.125
value: Car Sharing consistent	.186	.224	
price perception of the service	.149	.315	
value: flexibility in travelling	-.105		
evaluation distance to outlet	.106		.137
age	-.096	-.136	-.223
building year of the car	.091		
value: car is means for identity	-.078		
total amount of trips per week		-.117	-.183
willingness to act			.138
environmental consciousness			-.125
R Square	.2603	.2921	.2414

Notes: regression analysis with a stepwise entry with F-in = .20 and F-out = .25); cases with missing data pairwise excluded; a high positive score relates to a negative Car Sharing attitude

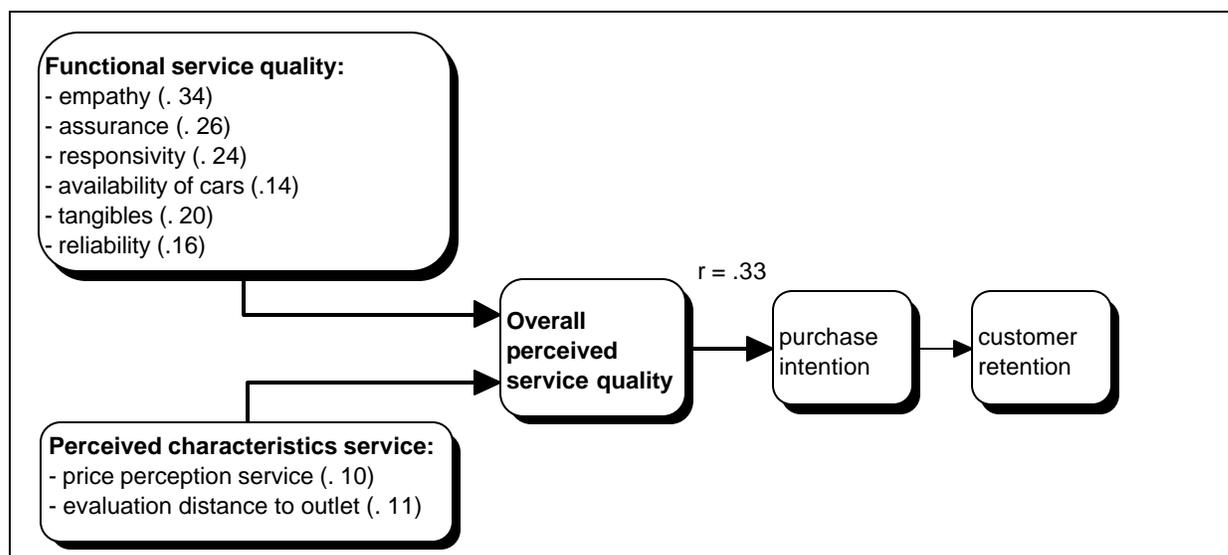
Table 11.3. Overview of Beta-coefficients of the regression analyses on the Car Sharing attitude

The regression analyses for the three samples have not resulted in one single regression equation, but in three sets of explaining variables (see table 11.3.), explaining 26%, 29% and 24% of the total variance for respectively the entire sample, the carless people and the car owning people.

11.2.4. Research results: the service quality perception of Car Sharing services

In order to explain the service quality perception of Car Sharing services as a predictor of the customer retention, a couple of hypotheses have been formulated. Through the empirical study, we have tested these hypothesised relations as specified in the conceptual model:

- Hypothesis 5.** The overall service quality has a positive impact on the intention of contract extension.
- Hypothesis 6a.** The functional service quality correlates positively with the overall service quality perception
- Hypothesis 6b.** The technical quality perception correlates positively with the overall service quality perception.
- Hypothesis 7.** The perceived characteristics of the service have an additional predictive value of the overall service quality perception, on top of the service performance.
- Hypothesis 8a.** The characteristics of the individual decision maker have an additional predictive value of the overall service quality perception, in addition to the service performance.
- Hypothesis 8b.** The mobility behaviour of the individual decision maker has an additional predictive value of the overall service quality perception, in addition to the service performance.
- Hypothesis 9.** The Car Sharing system contributes to the explanation of the overall service quality perception, on top of the service performance.



Note: values between brackets are Beta values of the multiple regression analysis

Figure 11.3. results of testing of the conceptual model for service quality perception

Figure 11.3. provides an overview of the results of testing the conceptual model for service quality perception. The testing leads to the following results:

- Service quality perception has a positive impact ($r = .33$) on the intention to extend the contract with the Car Sharing company, and thus with customer retention (hypothesis 5).
- For the functional service quality perception we found, based on a factor analysis, a six-factor solution, explaining 56% of the total variance. The dimensions of the functional service quality can be indicated with: “empathy”, “assurance”, responsiveness”, “availability of cars”, “tangibles” and “reliability”. All these dimensions have explaining power in the overall service quality perception (hypotheses 6a).
- For the technical service quality perception a three factor solution has been found, explaining 81% of the total variance. The technical service quality perception includes three different dimensions, which are: the “reliability of the car”, the “neatness of the car” and the “flexibility in car choice”. All these dimensions show a significant relationship with the overall service quality perception, except for “the neatness of the car” (hypotheses 6b).
- The computation of the intercorrelations between the dimensions of the two constructs shows that the functional and technical service quality perception are not at all independent constructs.
- The multiple regression analysis aimed at the explanation of the service quality perception shows that none of the dimensions of the technical service quality perception were included in the regression equation, but all dimensions of the functional service quality. Figure 11.3. shows the results of the multiple regression analysis and the beta coefficients of all variables that are included in the equation.
- As additional explaining variables for a high service quality perception two more variables have been found, which are the price perception of the service (.10) and the evaluation of the distance to the outlet (.11). That means that through an appropriate price structure of the service, that suggests low prices a higher service quality perception could be achieved, as well as through an appropriate distribution network with excellent locations. These results thus suggest that hypotheses H8a, H8b and H9 must be rejected. So the characteristics of the individual and his mobility behaviour, as well as the service system do not contribute to the explanation of the service quality perception. Only the functional quality perception (H6a) and some of the perceived characteristics (H7) explain the service quality perception.

11.3. Conclusions: the consumer research on Car Sharing services

In the previous section we have summarised the results of our empirical study on Car Sharing services in the Netherlands. We have shown our analysis of the relevant determinants of adoption and the service quality perception of Car Sharing services. However, the question remains what we can learn in a more general sense from these analyses, and what the main conclusions are that result from this study. In this section the major conclusions resulting from this empirical study will be presented for those concerning the adoption decision and the service quality perception.

11.3.1. the adoption decision on Car Sharing services

Before drawing the more general conclusions with regard to the adoption of Car Sharing services, it is important to recognise some basic characteristics of our study:

First it is important to note that the analyses provide only a rather static image of the adoption decision process. It seems to be as if all determinants are equally important at any stage in the adoption decision making process. This impression is illusory and is caused by our behaviouristic approach. This approach treats the adoption decision process as a black box and just wants to explain the behavioural responses.

Secondly it must also be noted that our sample consists of people that are more likely to adopt Car Sharing services than the average person. This is due to the selection of respondents. Only people that have shown interest in Car Sharing services, and that are entered into a certain decision making process with regard to the adoption of Car Sharing services, have been selected for our research. Thus the sample is very likely to have a pro-adoption bias.

Thirdly, our empirical research model is mainly of exploratory nature. Thus, the goal of this study was only to identify relevant explaining variables for the adoption decision.

What can now be concluded from the analyses?

- The explanation of the adoption of Car Sharing services differs considerably among the various market segments.

The results of our analyses show that it is difficult to explain the adoption of Car Sharing services with one common set of variables for all consumers. The distinction between former carless and former car owning households for example delivers two sets of explaining variables, that are only partially overlapping. The distinction in explanation is likely to be caused by the discrepancies in reference situations. Car owning households, considering to substitute their privately owned car for Car Sharing services respond to their experiences with car ownership with all its consequences. Carless households seek for opportunities to increase their access to car usage and to increase their opportunities for mobility. Most striking differences in the explanation are the importance of the cost perception, the cost involvement in travel mode decision making. Car owners tend to be very cost driven when adopting Car Sharing services and are motivated to adopt because of various negative experiences with private car ownership.

- Habitual behaviour prevents from a rational decision making

Given the results of the analysis on the determinants of adoption, it can be concluded that past (mobility) behaviour (or previous practices in Rogers' terminology) is very important in the explanation of the adoption of Car Sharing services. The importance of past behaviour (as a container concept of different variables) in the explanation of adoption might indicate a couple of relative advantages of Car Sharing services compared to the privately owned car. The fact that Car Sharing services provide substantial financial benefits at a low frequency of car usage can not be denied. However, the fact that past behaviour correlates with the adoption might also indicate the existence of habitual behaviour.

Based on empirical evidence, we conclude that habitual behaviour plays an important role in the explanation of the adoption decision. Habits in mobility behaviour prevent from deliberate decision making with respect to travel modes. Past mobility behaviour is just repeated in similar situations without considering alternatives. This mechanism prevents from a rational decision making with regard to the pros and cons of Car Sharing services for individuals. Thus, to convince those who have a habitual mobility behaviour, the first question is how habits can be broken through, and how people can be stimulated to consider Car Sharing as an alternative to the privately owned car.

- The economic savings are the major motivation for adoption of Car Sharing services

In case a deliberate decision is made regarding the adoption of Car Sharing services, one major motivation can be distinguished, which is the economic savings. If consumers do not receive economic benefits from their choice for Car Sharing, too little other motivating factors are left to adopt the service. Our study also suggests that economic savings are not the only motivations. Parking problems with a privately owned car, extensive care and maintenance tasks are two other -but less important- motivations.

- Insight in the real costs of car usage is an important boundary condition for adoption of Car Sharing services.

The perception of costs for car usage is one of the most important determinants of adoption of Car Sharing services. The costs for car usage consists to a large extent (62 to 81%, Consumentenbond, 1998) of fixed costs. Despite their large share in the total costs for car usage, the fixed costs are often neglected by consumers in the travel mode decision making. Empirical evidence shows that those who have a good insight in all costs for car usage and those who are willing to take all (fixed and variable) costs into account when making a travel mode decision, are far more likely to adopt Car Sharing services.

- The Car Sharing service should have an excellent accessibility for a broader consumer acceptance.

We also conclude from our analysis that an excellent accessibility of Car Sharing services is an important boundary condition for the adoption of Car Sharing services. The provision of cars at comfortable places nearby where people live and the easiness of access must be provided, otherwise positive attitudes and positive intentions will not be turned into adoption. Currently Car Sharing services are not (yet) widely available. The density of the distribution network and the availability of cars around the clock is certainly not always according to the consumers' preferences. Excellent accessibility is an important supply-side condition for market success.

- The Car Sharing service must have a high service quality image for a broader consumer acceptance.

The empirical analysis furthermore leads to the conclusion that the professionalisation of the sector is extremely important. The decision on the adoption of Car Sharing service strongly correlates with a high service quality perception of the service. Obviously consumers are only willing to change their behaviour if they have confidence in the service organisation, their ability to provide decent mobility services at a reasonable price. Consumers become dependent on a service organisation and require a professional commitment from the service organisation.

- The value orientation of the adopters is only among the former car owners of importance for the adoption of Car Sharing services.

On beforehand it was expected that the value orientation of consumers would be very important in the explanation of the adoption of Car Sharing services. Based on our empirical findings it can be concluded that this expectation is not entirely confirmed. Only among the former car owners some explaining value from the value orientation could be found. Adopters associate cars less with values of freedom and welfare and stronger with its negative consequences. Obviously, for the so-called substituters these "anti-car values" are one of the motivating forces to change their behaviour. The former carless, on contrary, can hardly be distinguished on their value orientation.

- The environmental attitudes have a little explaining value in the adoption of Car Sharing services only among former car owners.

Environmental attitudes only have little explaining value in the adoption of Car Sharing services among former car owners. Those who feel a personal responsibility to contribute to the environment are more likely to adopt. Seen from a broader perspective however this

explaining variable has only a subordinate role in the explanation. It is fair to conclude that consumers associate environmental values with Car Sharing services, but these values hardly have any impact on the adoption decision.

The adoption decision making process of Car Sharing services

Based on the conclusions above, regarding the determinants of adoption of Car Sharing services, also some conclusions on the adoption decision making process can be formulated:

First the nature of the adoption decision making process is dependent on the existence of habitual behaviour. In case of weak habits in mobility behaviour, which means that consumers are likely to consider various travel modes to travel somewhere, a process of rational decision making is followed. Rogers (1993) has modelled this process with the stages knowledge, persuasion, decision, implementation and confirmation. Our study has followed this line of thought and has found nothing but confirmation for this starting point among those who have made a deliberate decision on the adoption of Car Sharing services.

However, in case of a strong habitual mobility behaviour and little consideration about which travel mode to choose the adoption process must be modelled differently. Here, the decision as a result of a deliberate cognitive process, is not at all made. On the contrary, old mobility behaviour is continued and no deliberate decision is made whether to adopt Car Sharing or not. So, Car Sharing is rejected, while serious and deliberate considerations are absent.

In case of habitual behaviour it can be questioned whether habits are sustainable over time or can be broken through. Apart from our own study, also various other authors (Franke, 1998; Harms and Truffer, 1998) suggest that habitual mobility behaviour can be broken through. Our study reveals some empirical evidence for the idea that at specific moments in life people are willing to reconsider their situation with respect to mobility. When for example the old car has to be replaced, the costs for repair of the current car are very high, when people change from position or change their residence or when they get children, consumers have to rethink how to organise their transport. During these "moments of crisis" people are more open to changes in the way they organise their mobility. On these occasions Car Sharing services might become an option to consider for individuals. Obviously these services must be available nearby and must provide professional services at high quality and at reasonable prices. As soon as people are willing to reconsider the organisation of mobility behaviour fundamentally, they enter into the normal rational decision making process, that has been explored in our study. A similar mechanism was reported with respect to the adoption of high-efficiency central heating boilers (Brezet, 1994).

11.3.2. The service quality perception of Car Sharing services

With regard to the service quality perception we draw the following conclusions:

- The service quality perception of Car Sharing services is high among current schemes. The empirical research has shown that the service quality perception among current Car Sharing schemes is very good. On the average 90% of the adopters evaluate these services with high or very high service quality. This result can be interpreted as an indication for the fact that at least in some cases Car Sharing is a real alternative to a privately owned car.

- The service quality perception is an important predictor for the extension of the contract with the service organisation and thus for the market success of Car Sharing.

Due to the solid correlation between the service quality perception and the intention to extend the contract in the following year, the conclusion is drawn that the service quality perception is an important predictor for the extension of the contract with the service organisation. This also implies that a high service quality is an important precondition for consumers to use Car Sharing as an alternative to the privately owned car. So, the further professionalisation of the Car Sharing industry is the key to success for the concept of Car Sharing.

- The service quality perception is mainly dependent on how the services are delivered. In this study we have found empirical evidence for the fact that consumers evaluate the service quality mainly on HOW the services are delivered. The content of the service (WHAT), which is the car itself, is far less important, as soon the car is in reliable condition. These results have far reaching practical implications: In order to keep customers, a service organisation has to put all effort in maintaining the service delivery process constantly at a high quality level. Obviously consumers are relatively indifferent about the quality of the car. Instead, they want to be serviced smoothly. The way in which the distribution of cars is organised and operated is pivotal. Trying to be competitive on the kind of cars in your service system is certainly not a strategy that is recommended. On the contrary, a high service quality perception is realised through a service design aimed at a convenient service delivery for the consumer and a smoothly operating service organisation.

- To optimise service performance of Car Sharing services six major aspects are of importance

Given the importance of the service performance in the overall service quality perception, it is essential to optimise the performance of the service organisation. Based on our analysis the following six aspects in the performance of the service organisation are most important:

1. All service employees have to take the clients seriously and help them with their problems and questions. In other words, the employees have to show an empathetic attitude and behaviour.
2. The clients should always have the feeling that conditions are clear and that they can trust the organisation. That means that the employees and the entire organisation should do everything to provide assurance to the customer.
3. The organisation must respond immediately and reliably to all questions and reservations at convenient opening hours. So, the organisation must be organised in such a way that the employees are able to show great responsiveness.
4. The visual appearance of the service organisation must be neat and attractive. All tangibles elements should express the high quality character of the service organisation.
5. All transactions must be correct. That means that the charging and all other agreements are handled reliably.
6. The cars must be available at any time. That means 24 hours a day, even in the weekend.

- The service quality perception is not only determined by the operational performance of the service organisation, but also by the characteristics of the service offer.

Apart from factors related to the performance of the service organisation also other variables have an impact on the service quality perception. This study has shown that the price perception of the service and the evaluation of the distance to the outlet have explaining value in the service quality perception. So, the extent to which people find the service expensive or not, as well as the extent to which cars are provided at convenient places make people evaluate the service quality either more positive or negative. That implies that through an appropriate price structure of the service as well as through an appropriate distribution network with excellent locations a high service quality is generated. In return, customers will remain with the service organisation.

11.4. Reflections on the consumer research

11.4.1. Reflections on the research method

Every research project has its own dynamics and is performed in a different context. It is a myth to believe that a researcher is able to control all relevant variables and circumstances that influence the outcomes of a study. Especially in a field study in close collaboration with various entrepreneurs, their clients, and not to forget the Dutch Ministry of Transport, the research method must be designed by taking into account the boundary conditions and the practical restrictions of all parties involved. Therefore, it is valuable to reflect upon the research method and procedures and to relate these to the outcomes of a study.

One single questionnaire

All empirical data had to be collected through one single cross sectional study. The group of appropriate households that could be approached with a questionnaire, was rather limited in size and could only once be contacted. So, given the different research questions and the large variety of variables of interest, a rather long questionnaire was indispensable. However such long questionnaires do not stimulate a careful response and are also not in favour of large responses. Despite the extensive questionnaire our response was acceptably large and of good quality, with few missing data. In return, different questionnaires, addressing different kinds of research interests would have been preferred because then each subject could have

been dealt with more extensively. With respect to the perception of costs for transport, the perception of the service, the measurement of habitual behaviour, different background variables, etcetera, we were somewhat limited in the data that were available. If there would have been an opportunity to investigate specific aspects in more detail, like e.g. the perception of costs, we could have made a more in-depth analysis of these aspects.

Another disadvantage of cross-sectional surveys is that little iteration is possible. During the research process you come across new and highly relevant aspects and variables. The importance of e.g. habitual behaviour in explaining the adoption of Car Sharing is such an aspect.

operationalisation major concepts on theoretical grounds

Due to the fact that only one single measurement could be made among the group of households, few opportunities were left, but to specify core concepts on theoretical grounds. For an operationalisation, based on empirical validation no possibility was open. For the operationalisation of service quality perception e.g., we had to rely completely on general theoretical guidelines and very extensive measurement procedures. If a separate experiment on service quality perception for Car Sharing could have been performed, the measurement of this core concept could have been made much more efficient.

Above all, our results also show that theoretical concepts not always match with empirical reality. The distinction between technical and functional service quality perception might be plausible from a theoretical point of view. Our results show that these concepts are highly interdependent. Given the results of the focus group studies, we find it very remarkable that our analysis shows that the technical service quality is of minor importance for a high quality Car Sharing service. This result deserves further research, because both the empirical results from the exploratory research as well as intuition says that the quality of the car is of importance for the quality perception. If people were offered an old and dirty car for the same price, it is reasonable to expect a lower service quality perception.

Pro-innovation bias

In our study we have chosen to include only those households, that have either adopted Car Sharing, or have rejected the innovation after (little) consideration. All non-adopters were recruited from a database of people that ever showed interest in Car Sharing through a request for further information. This selectiveness of non-adopters might avoid problems caused by lack of knowledge about the innovation, but it also makes the research sample rather in favour of adoption. It is very likely that if the group of non-adopters would have randomly been selected from the general public the differences in determinants of adoption between adopters and non-adopters would have been more meaningful. There is however no reason to believe that there would be large differences in the explanation of the adoption of Car Sharing.

Little variation over service schemes

The analysis of our data showed that the variation in service schemes does not contribute to the explanation of the adoption. However, in our research design only little variation in Car Sharing schemes could be created, both qualitatively and quantitatively. It can reasonably be questioned to what extent these four different schemes with only subtle differences in service concepts provide enough variation to test this hypothesis properly. More research is therefore recommended, especially among people that are able to choose from different service offers. It must also be taken into account that at the moment of research almost no competition existed among the four service schemes, because they were offered in quite different urban areas. So, the adopters were not left any choice between various service offers. It is reasonable to believe that in case of choice between various service offers some will be more convincing than others to substitute their car for Car Sharing. Specific research aimed at investigating the service system that is preferred over others, could throw a new light on the influence of the service scheme on the adoption decision.

Little insight in important background variables

Our study helps to distinguish adopters of Car Sharing services from non-adopters. The determinants of adoption also help marketing managers in specifying a marketing strategy in order to attract more customers. However, the incentives to change the way in which people fulfil their mobility needs have not become clear. Especially because habitual behaviour plays an important role in the (non-)adoption, specific events or occasions could be expected to be of importance. Changes in those background variables leading to adoption could not have been established. Qualitative empirical research could have revealed these kinds of variables.

Static over time

The collection of data has been performed in mid 1996. At that time the four different service schemes had been operational for not more than two years. The development of these new services was at that time (and still is) in a process of constant change and improvement. With respect to e.g. the implementation of information technology, the density of the distribution system, the price structure and the reservation system, all service schemes have gone through developments. Our research is therefore closely related to the service systems at that time.

However, we are convinced that the results still hold value for several reasons. First, our study is based on the analysis of the data over four different service schemes. So, the results refer to the concept of Car Sharing instead of to one specific Car Sharing scheme. Second, the development of has been directed at lifting barriers and enhancing the relative advantages for consumers. It can reasonably be expected that this development does not introduce essentially new problems for the adoption of Car Sharing, but on the contrary facilitates the adoption of the innovation.

11.4.2. Reflections on the applied theoretical framework

For both empirical research questions, regarding the adoption decision and the service quality perception two completely different theoretical perspectives have been used to study the case of Car Sharing. The value of these theoretical frameworks will be reflected upon below separately.

the adoption of Car Sharing services

Given our first research question and given the underlying research aim to develop measures to reduce the environmental impact of consumption through the market introduction of innovative products and services, the choice for Rogers' theoretical framework "Diffusion of Innovations" (1992) was quite obvious. His framework explains in more general terms how innovations find their way (or not) in society. A similar interest underlies our study with respect Car Sharing services, especially because we expected that these kind of innovative service could contribute to a reduction in environmental impact. The choice for this theoretical framework was furthermore quite obvious, because it helps defining measures to improve the adoption of innovation through either marketing oriented actions or through policy oriented measures.

Based on our experiences we find Rogers' framework applicable for the analysis of a broad variety of innovation adoption and diffusion problems. Also for the analysis of the analysis of Car Sharing services, this framework helps understanding the problems of adoption and diffusion. It provides not only structure for the analysis, but it also specifies a broad variety of factors that might affect the adoption and diffusion of specific innovations, like e.g. Car Sharing services. Our empirical results show that for a variety of variables we have found confirmation.

Despite the practical value of Rogers' framework, we also came across some limitations for our research purposes. Based on our experiences with the application of Rogers' framework we identify the following limitations:

- Although Rogers specifies a decision making process, which involves five different phases, little explanation is given with regard to the distinction of these phases in an empirical research process. It can be expected that each phase has its own important variables and intermediate results. In our experience Rogers' framework has its major value for making a behaviouristic analysis of decision making process. It does provide little help in opening the black box of the decision making process. Our analysis shows that through a combination of a behaviouristic analysis of the empirical data with an analysis of the cognitive aspects of the decision making process, the insight in the adoption of innovations can be extended.
- The innovation decision model incorporates the assumption that innovation adoption decisions are made deliberately. The decision process involves first knowledge about the innovation, followed by the formation of an attitude towards the innovations, which leads to a decision to adopt or to reject the innovation. Despite the fact that modelling innovations decision processes might be very helpful in understanding why people adopt an innovations, we find it to a certain extent also limited for understanding non-adoption. Our research shows that non-adoption is also partially explained by the fact that people do not actually consider the pros and cons of an innovation. If habitual behaviour is strong, people do not make a deliberate consideration. From a practical point of view understanding non-adoption is even more important than knowing why people change. According to our experience the innovation adoption theory should be modified in such a way that habitual behaviour becomes an integral part of the theory.
- Beforehand we identified the fact that motivational variables, like existing values and attitudes are not integrated in Rogers framework as a limitation for our study. The research results show that (domain-specific) values indeed have an additional explaining value in both the adoption decision and the Car Sharing attitude formation. Their statistical

importance must not be exaggerated, but their modest contribution is also influenced by our research design. In our research sample the group of non-adopters is highly selective, because they have shown interest in the new service on their own initiative. It can be expected that the explaining effect of motivational variables increases when the group of non-adopters is less selective.

- Rogers mentions in his conceptualisation of the innovation decision process four types of prior conditions that need to be fulfilled for adoption of innovations: (1) previous practice; (2) felt needs/ problems; (3) innovativeness and (4) norms of the social system. It does not become clear from his publication (1995) how these prior conditions can be met in order to facilitate adoption of innovations, or through which kind of mechanisms these prior conditions stimulate adoption of innovations. Especially with regard to previous practices we were puzzled how to interpret this theoretical concept.
- Although Rogers includes services in his definition of “innovations”, our study shows that his framework has lots to gain with the introduction of theoretical concepts from the area of service marketing. Especially with regard to the explanation of the implementation and confirmation stage of the innovation decision process a lot of additional clarification can be provided. Concepts like e.g. service quality perception, which are central in the evaluation process of services, throw a new light on the confirmation phase after the primary adoption of a service innovation.

the service quality perception

For the explanation of Rogers' confirmation phase, we have elaborated his conceptual model with concepts from service marketing theory. Zeithaml, Berry and Parasuraman (1996) have suggested a conceptual model that describes the relationship between service quality, as a result of the operational performance of service organisations, the behavioural intentions to remain or to defect from a certain service provider and the actual behaviour. In Rogers conceptualisation this would be indicated with continued adoption or confirmation. The general model for the behavioural consequences of service quality has been operationalised for Car Sharing services. For exploratory reasons we have extended the model with additional variables like some perceived characteristics, characteristics of the individual decision maker, the individual's mobility behaviour and the variation in Car Sharing schemes.

Given our practical experience with our conceptual model, we conclude that for a first empirical study this model was more than appropriate. With a multiple regression analysis a selection of most important variables could be made to explain the service quality perception. A large variety of variable can be excluded now for a further detailed modelling of the service quality perception. It is important to know that service quality perception is independent from the characteristics of the individual and his mobility behaviour. Above all we know that service quality perception does not differ among various service schemes. It must however also be admitted that a further detailed investigation is required on how to model service quality perception. The following limitations may be guiding for the remodelling of service quality perception:

- The technical and the functional service quality perception, as operationalised according to Parasuraman, Zeithaml and Berry (1988) turn out in the research results not to be independent concepts. On theoretical grounds (Grönroos, 1992) these two dimensions in service quality should be independent concepts. For analytical purposes it is very important to have highly independent concepts at ones disposal. Although both concepts have great face value, the empirical validity requires additional research.
- The instrument for measuring service quality perception called SERVPERF (see (Parasuraman, Zeithaml and Berry, 1988 and Cronin and Taylor, 1992) demands an extensive questionnaire with 34 items. Such an extensive instrument is not very efficient in the collection of data. Based on a further empirical research a more condensed measurement instrument should be developed. Especially for the monitoring of the

operational performance of a Car Sharing service organisations this is absolutely necessary.

- In the theoretical perspective of Grönroos (1992) the perceived characteristics of the service are not mentioned as determinants of service quality. Our exploratory studies however shows that especially the price perception of the service and the evaluation of the distance to the outlet have an additional explaining power. Both variables refer to characteristics that do not have anything to do with the operational service performance, but with the general service offer. Obviously the theory needs modification here.
- The theoretical framework of Grönroos (1992) does not provide a perspective of the relationship between the perceived service quality and the perceived price. Because the price perception of the service is extremely important in the adoption decision, it can be expected that in service quality perception the perceived price of the service also plays an important role. We conclude that a major limitation of Grönroos' framework is that too much attention is paid to service performance of the service organisation and too little to other explaining variables, related to the conceptualisation of the service itself.

11.5. Discussion and conclusions on the empirical research: the changes in environmental impact

The second research question concerns the changes in environmental impact due to the adoption of Car Sharing services. In the introduction of this thesis we have distinguished two important entities that determine the environmental effects, based on the equation of Ehrlich and Holdren (1971). These two elements are (1) the environmental efficiency of the system to produce units of service (the environmental metabolism) and (2) the (changes in) consumption behaviour in relation to these systems. Both are factors for the total environmental impact.

It has been concluded that for answering this research question two kinds of data are needed. First data on the changes in mobility behaviour due to the adoption of Car Sharing services are needed. Second an assessment of the environmental efficiency of the Car Sharing system is needed. This assessment, also called an LCA (Life Cycle Analysis), calculates the environmental impact per unit of service (a certain mileage by car).

To gather data with respect to the changes in mobility behaviour, we have performed for this thesis a large survey study among the adopters of four different Car Sharing schemes. Based on self-reported behaviour we gathered data with respect to the changes in mobility behaviour. Chapter 9 shows the results of this study

In addition to this empirical study, we made a simulation of the Car Sharing system in order to estimate the environmental impact per unit of service. This simulation has been supported by widely used software packages like SimaPro 3.0 (Pre Consultants, 1999) and IDEMAT (TU Delft, 1999). In chapter 10. this analysis is presented.

11.5.1. research results regarding the environmental assessment of Car Sharing services

For analytical purposes the environmental assessment, has been split up into two different assessments (see chapter 10). In both cases the changes in environmental impact have been calculated. The major results of these calculations are the following:

The assessment of the environmental metabolism of Car Sharing services

In the first assessment the privately owned car has been compared with Car Sharing schemes for a constant mileage over one year. The comparison shows that:

- the environmental impact of Car Sharing schemes in the production of a certain car mileage is an estimated 14% less, compared to the average Dutch car.

- the relative advantage of Car Sharing schemes results mainly from the use of relative light weighted cars. The weight is about 22% less, which results in a higher fuel efficiency and a reduced contribution of the production of the car in the total environmental impact.

The integral assessment of the changes in environmental effects of Car Sharing services

The integral assessment of the changes in environmental effects of Car Sharing services actually provides the answer to the second research question. Based on the assessment of the environmental efficiency of Car Sharing services and given our empirical data on the changes in mobility behaviour the overall changes in environmental impact is calculated.

These are the major research results:

- In a comparison of the total environmental impact of the adopters' mobility behaviour, before and after adoption, a reduction of 21% is calculated, based on the Eco-Indicator method.
- The reduction in environmental impact is verified with a second method, the EPS method. Expressed in EPS indicator-points the reduction in environmental impact is 27%.
- The environmental impact of adopters of Car Sharing, due to their entire mobility behaviour is an estimated 40% less than the average Dutch household.
- For any of the environmental impact categories a reduction is calculated. With respect to the changes on the greenhouse effect an average reduction of 21% is computed.
- The total reduction in amount of parking space needed (which equal the amount of cars) is calculated at 44%. This percentage is realised through the adoption of Car Sharing. Per 1000 households these savings add up to an estimated 2038 m².
- The reduction in environmental impact varies substantially among the different segments. The carless reduce their environmental impact with an estimated 14%, the substituters with 48%. Among the second car drivers the environmental impact increases with an estimated 6%.
- The environmental assessment shows that the reduction in environmental impact is mainly the result of (1) the reduction in car use, (2) the relatively modest increase in use of public transport and bicycle, (3) the reduction of environmental impact of car use through Car Sharing and (4) the fact that all alternative travel modes are more fuel efficient than the use of the car.

11.5.2. conclusions on the changes in environmental effects

Given the research results, as discussed above, a couple of more general conclusions can be drawn with regard to the changes in environmental effects after the adoption of Car Sharing services:

- The introduction of Car Sharing services leads to a reduction in environmental effects. As hypothesised, the introduction and adoption of Car Sharing services leads to a reduction in environmental effects. Expressed in so-called Eco-Indicator point, the reduction of environmental effects could be calculated at 22%. These calculations are based upon empirical data of current Car Sharing schemes and changes in mobility behaviour of the adopters of these schemes. The calculations are based on a life cycle perspective and an analysis of the entire Car Sharing system.

- The reduction in environmental effects is the result of both improvements in the environmental efficiency, as well as changes in behaviour.

The calculations of the environmental effects of the adoption show that the reduction in environmental effects is the result of both improvements in the environmental efficiency, as well as changes in behaviour. The analysis of the research results show that not only improvements in the environmental efficiency of the systems that provide mobility, but also the changes in mobility behaviour have a positive impact on the environmental effects.

- The (changes in) environmental effects are mainly the result of (changes in) fossil energy use.

The environmental assessment shows that the environmental effects are dominated by energy consuming processes. Transport demands a large input of energy resources through the use of fuel. All other processes are to a large extent of minor importance in the total environmental effects. Even the production, the maintenance and the disposal of the different vehicles does not contain more than 15% of the impacts per unit of service. So the major factor to reduce the environmental impact is the increase of the fuel efficiency of all transport means.

- The improvement of the environmental efficiency of Car Sharing services in comparison to the privately owned car does not comply with the expectations.

Various authors (Jansen and Vergragt, 1993; Vermeulen en Weterings, 1996; von Weizsäcker e.a., 1996; Fussler, 1996 and Brezet, 1997) expected great potential from innovative products and services to reduce the environmental effects. Car Sharing services is frequently mentioned as a concept with high potential. This concept has often been associated with environmental improvement factors of 4 or even 10, being an example of an innovation that further optimises the way in which a function is fulfilled. However, our study shows that these expectations of possible improvement rates might be too optimistic, at least at the short term. The expected potential for environmental improvements can certainly not be generalised.

- The relative advantage of Car Sharing services over the privately owned car with respect to the environmental effects, result mainly from the use of relatively small cars.

The environmental assessment supports the conclusion that the improvement of the environmental efficiency of Car Sharing services in comparison to the privately owned car is mainly the result of the fact that the service organisation run their schemes with relatively small cars in comparison to the average Dutch car. The weight of these cars is an estimated 22% less, whereas the fuel consumption is an estimated 24% less.

- Of all the environmental impact categories, is largest reduction in environmental effects can be found in the reduction of pressure on space.

Although the pressure on space is not included in the conventional impact categories (Heijungs, 1992), in the analysis of the various dimensions in the environmental effects, it can be treated as such. When comparing the these impact categories with respect to the reduction in environmental impact, the reduction percentage of the area of parking space needed (- 44%) exceeds the other reduction percentages. It can be concluded that Car Sharing is relatively very effective in saving space in urban areas.

- Car Sharing schemes are an effective instrument to reduce the greenhouse effect
In the current political context it is worth mentioning the effectiveness of Car Sharing schemes in reducing the greenhouse effect. With a reduction percentage of 21% in this impact category, Car Sharing can be seen as a new, but rather effective instrument in reducing CO₂ emissions, which is the main cause for the greenhouse effect.

- The variation in changes in environmental impact among market segments is substantial.
A more detailed analysis of the changes in the environmental impact show that the variation is large among the various market segments. Especially the group of adopters that substitute their car for Car Sharing service reduce their environmental impact with 48%. This variation provides a useful basis for a more selective policy on the adoption of Car Sharing services, both from the perspective of environmental policy, as well as from transport policy.

- The major factors that contribute to the reduction of environmental effects can be split up into behaviour oriented factors and system oriented factors.

The environmental assessment leads to the conclusion that the reduction of environmental effects can be explained by behaviour oriented factors and system oriented factors. With regard to *behaviour oriented factors*, the following factors can be distinguished:

1. Car ownership is an important predictor of the changes in mobility behaviour.
2. The extent to which car trips are substituted by the use of alternative travel modes, that are more fuel efficient and less environmentally damaging.
3. The substitution of car trips by the use of bicycles turns out to be extremely effective in reducing all environmental effects.
4. The choice for the most fuel-efficient and the smallest car possible for a certain trip helps saving energy.

With regard to *system oriented factors*, the following factors can be distinguished:

1. Through the implementation of the newest and most fuel efficient vehicles a relative advantage is created over the average car.
2. The selection of the most energy-efficient and light-weighted vehicles within a certain car class make another additional contribution to the reduction of environmental effects.

11.5.3. reflection on the results of the environmental assessment

In advance a set of assumptions with regard to the environmental effects have been formulated (see chapter 2). In response to the question "*How would the Eco-efficient Services approach affect the environmental effects?*" a variety of mechanisms that would affect the environmental effects of so-called Eco-efficient Services have been distinguished. As Car Sharing can be held as a specific example of the concept of Eco-efficient Services, it is valuable to reflect upon the assumptions in the light of our empirical results.

- The Eco-efficient Services approach will stimulate a continuous improvement of a consumption practice towards a higher environmental efficiency. This rather abstract assumption is based on the theoretical ideas with respect to the so-called "Service Economy" (Stahel, 1995). In the context of the Service Economy it is expected that producers who are being paid for the utilisation value of artefacts, get an economic interest in the optimisation of the functional efficiency. In the functional optimisation the consumption practice is adapted and improved with respect to the efficient delivery of units of service. This becomes visible in practice through the improvement of the entire service organisation, which results in a reduction of the use of resources in terms of hardware, time and money.

In the practice of Car Sharing only some weak empirical evidence for the existence of this mechanism could be found. The major reason for this might be the fact that Car Sharing schemes are still in an early phase of development, and above all their size is still small. Their first care is to up-scale the service organisation and to attract more clients. For the further optimisation of the existing schemes, major effort is invested in the implementation of new information technologies, that allow the electronic identification of clients, the exact registration of car usage and the possibilities for car fleet management. These measures are needed for a profitable service operation, but do hardly contribute to the functional efficiency from environmental point of view. In fact they allow for the use of less cars and service employees to operate the service, but they do not reduce the over-all environmental impact substantially.

Another reason for the conclusion that there is only a weak empirical evidence, is that currently all cars are operated to a maximum of 2 years in the service scheme. After a certain period of time the vehicles are being sold. So life-extension of cars, due to special repair and maintenance treatment is not happening, especially because issues of repair and maintenance become important after a couple of years.

The only observation that confirms the continuous improvement towards a higher environmental efficiency, is the fact that various entrepreneurs always choose those cars that are most fuel-efficient. In case of a price per kilometre, including petrol, this directly affects the profit margin.

- The amount of products that are needed at a specific moment for fulfilling the market needs will substantially be reduced due to the enhanced service efficiency of these products.

Inherent to the nature of the service, Car Sharing indeed leads to a reduction in the amount of vehicles needed at a certain moment to provide a group of consumers with mobility by car. However, our study shows that the number of vehicles is largely dependent on the composition of the group of adopters and whether the adopters substitute their car for Car Sharing. The study shows that the reduced number of cars leads to a reduction (-44%) in the amount of space needed.

Only because of the fact that the total car mileage is reduced with 33%, the number of cars needed over the entire life cycle is reduced with a similar percentage. Otherwise the number of cars does not contribute to changes in environmental effect. The environmental effects are depending on the actual use of the car and not on the availability. The major reason for this is that the factor time does not play any role in the conventional LCA methods.

- In a pooling system a faster replacement of products is possible. This implies that always the newest and most environmentally efficient models can be implemented. Old and inferior models will rapidly disappear because of the relative short product lifetime.

The effect of a faster replacement of products, compared to the situation in which people own a car, certainly has a positive effect on the environmental assessment. Obviously this effect is stronger in times of rapid innovation and market introduction of new and more fuel-efficient technologies. This effect becomes apparent, when the differences in average age of cars are compared. The average Dutch car is about 7,2 years old (CBS, 1995), whereas the cars in a Car Sharing scheme have an average age of 1 year to a maximum! With a constant improvement of the fuel efficiency, Car Sharing schemes are always more than six year ahead with respect to the application of the new technology.

- The shorter economic pay-back period presents a smaller economic risk, which facilitates relatively more expensive investments in superior technology.

There is no empirical evidence for this mechanism. So the effect on the reduction of the environmental impact can be neglected at the moment.

- Since products are returned from their service life to waste much faster, the time span between assembly and disassembly becomes smaller. This increases the possibilities and profitability of high level reuse of products, the reuse of parts and subassemblies, apart from the recycling of materials.

For this mechanism no empirical evidence is found either. As Car Sharing schemes are still rather small, compared to the entire Dutch market, no advantages of economies of scale are available. Above all, at the moment all cars used in Car Sharing schemes, are sold to the private market after 1 to 2 years of usage. So, no collective end-of-life treatment is possible.

- Product-use services prevent individuals from being bound by certain economic investments. The flexibility of product-use services in the choice for a specific consumption technology will lead to a more frequent use of more environmentally efficient options.

The idea behind this assumption is that in case of individual product usage and ownership, the investment in products stimulates, for reasons of decreasing marginal costs to use only that specific product. The investment prevents from a flexibility in choice of consumptive options for a specific need.

Although our empirical study does not provide the data to confirm the existence of this mechanism, it is very likely that in the case of Car Sharing services this mechanism exists. Our study suggests that Car Sharing makes people less habitual in their travel mode decisions. It is likely that, as a result, people more often choose for alternative travel modes. It can however be doubted whether this is because of the higher environmental efficiency. We assume that especially economic reasons or other practical reasons lead to the choice for alternative travel modes.

11.5.4. reflection on research method

According to our experiences the application of the LCA method and following the guidelines of SETAC have been very helpful in performing the environmental assessment. Through its life-cycle approach, as well as its integrated product- systems approach the method provides insight in the major factors that determine the total environmental impact and the major impact categories. Above all, the results of the LCA show clearly the multidimensional character of environmental effects.

However, the results of the LCA study can only be evaluated in the context of this method. The LCA methodology is basically a simulation of the empirical reality. For the analysis of products and processes estimations on the environmental performance of the different specific processes are being used. In other words, LCA studies are in essences an approximation of the empirical reality with regard to their environmental performance. Thus, the results of an LCA can not be interpreted as an absolute environmental profile. Its value can mainly be found in the comparison of Car Sharing with alternatives and in the quantification of the changes in environmental effects after the adoption of Car Sharing. In any case, the quality of the results of a simulation depends on the quality of the data that are used as the input for the analysis. The data that are used for the analysis concern both data on changes in mobility behaviour as well as data on the environmental effects of various processes. It is important to note that the data on mobility behaviour are our own empirical data. The other data are derived from reliable sources. The following remarks can be made with respect to the quality of the data and the quality of the results:

data collection: behavioural changes

The data with respect to the changes in behaviour are collected through self-reported behaviour. The respondents have been asked to estimate their carmileage before and after adoption, as well as their frequency of use of all travel modes, before and after adoption. In order to get data on (changes in) mobility behaviour this is the second best method. A longitudinal study, based on frequent reports would have been preferred, if there would have been no financial or time restriction for our study. However in the domain of transportation research our method is frequently used. Especially because we are mainly interested in changes in mobility behaviour, we hold this method for more than appropriate.

data collection: the Car Sharing schemes

Our environmental assessment is strictly limited to current Car Sharing schemes. With the further development of these service systems and a further professionalisation of the service organisations the environmental consequences will certainly change. On the one hand this might be due to the fact that quite different groups of users are reached and convinced, which might result in quite different behavioural effects of Car Sharing schemes in the future. On the other hand also through adaptations in the service system the environmental metabolism might change. Only based on assumptions with regard to these changes, some predictions can be made with respect to the environmental impact of future Car Sharing systems.

The environmental assessment is based on assumptions that represent the current Dutch Car Sharing schemes. As shown in chapter 3. a variety of Car Sharing schemes can be distinguished. When the operational differences of these services are compared with the

assumptions used, we conclude that this variety will hardly influence the environmental effects. It can be concluded that the major factor that influences the variation in environmental effects is the composition of the car fleet with respect to the size of the cars. As we have seen in the environmental analysis, the fuel consumption has a strong impact in the environmental effects.

environmental assessment

The environmental assessment is aimed at comparing the environmental metabolism of an average private car with Car Sharing. Both are solutions to get mobility by car. This comparison is however based on a functional approach. Both options are similar in a functional sense, but differ on a variety of other characteristics, like e.g. the psycho-social consequences or the set of associated values. We conclude that the uni-dimensional character of the environmental assessment (based on a functional unit) does not entirely represent a multi-dimensional reality in consumption.

causality

The research results show in a descriptive way that mobility behaviour has changed after the adoption of Car Sharing. With these results it has also been calculated that the environmental effects are reduced after the adoption of Car Sharing. The question now arises to what extent these changes in mobility behaviour, and in environmental effects successively, can be attributed to the adoption of Car Sharing. It can be questioned to what extent a causal relationship exists between these changes in behaviour and the nature of such a Car Sharing scheme?

Based on our research method, we must conclude that the causal relationship can not be proved. Although this relationship is most likely to exist, other possible (partial) explanations can not be excluded. In order to prove the causality of the relationship, quite a different research design is required, including a reference group and a proper controlling for a large variety of determinants of an individual's mobility behaviour. The environmental assessment, based on the reported changes in mobility behaviour, therefore underlies the *ceteris paribus* condition and can not be treated as a clear cause-effect analysis.

11.6. The environmental potential of Car Sharing services in 2010

Currently the number of participants in Car Sharing schemes is growing, but the market penetration is still small. Therefore these services represent at the moment nothing more than a niche market. However based on the growing support from local governments, the increasing investments of the entrepreneurs, the increasing professionalisation of the service organisations and the positive experiences currently in cities like Amsterdam, Rotterdam and Utrecht, it can be reasonably expected that Car Sharing services will gain in market share.

The question then arises to what extent Car Sharing service could contribute to the environmental policy aims. The results on the environmental assessment of the current situation suggest that an important contribution to the reduction of CO₂ emissions and energy use can be expected if Car Sharing reaches a substantial market penetration. Such a positive perspective would further stimulate all efforts of central and local governments. To assess the merits of a large scale implementation of Car Sharing the environmental potential of Car Sharing services in the future has been calculated below, taking the year 2010 as an appropriate milestone.

11.6.1. Car Sharing services in 2010: the assumptions

In order to calculate the environmental potential of Car Sharing services in 2010, we have made a couple of assumption with respect to four major factors:

1. the market penetration of Car Sharing schemes in 2010
2. the use of the different travel modes in 2010
3. the environmental impact of the use of all travel modes in 2010
4. the environmental metabolism of Car Sharing services in 2010

assumptions on the market penetration of Car Sharing schemes in 2010

With regard to the market penetration we assume the following situation in 2010:

- In 2010 there are an estimated 400.000 participating households in Car Sharing schemes
- The share of the various user groups has changed to respectively 30%, 50% and 20% for “carless”, the “substituters” and the “second cardrivers”.

Table 11.4. below shows the number of households and the division over the various user groups.

	Composition population in 1999	Composition population in 2010	Number of Dutch households in 1999 (in million)	Market penetration in 2010 (%)	Estimated number of participating households in 2010
carless	71 %	30 %	1,5	8 %	120.000
substituters	21 %	50 %	4,0	5 %	200.000
second cardrivers	9 %	20 %	1,0	8 %	80.000
Total	100 %	100 %	6,5	6,2 %	400.000

Table 11.4. Market penetration of Car Sharing services in 2010

The assumptions with regard to the size and the composition of the Car Sharing population are based on extrapolations of current market experiences. Currently the carless represent the largest user group; they are most easily to be convinced on the short term, but the number of carless household from which new customers can be attracted, is relatively small. The group of one car owning households, from which potentially substituters can be attracted, is relatively large. This group represents on the long term the largest subpopulation although they are currently most difficult to attract. For the substituters Car Sharing offers the largest financial benefits. This group needs a long adoption time and demands excellent service facilities. Because this target group is by far the largest, it is likely to become the most important user group.

The number of households is a conservative estimation, based on current values (CBS, 1998). Foreign studies arrive a similar estimations. Baum and Pesch (1994) have estimated the market potential of Car Sharing in Germany at 3% of the population and the Federal Swiss Governments estimates the market potential, based on a recent study of Muheim (1998) at even 9%. Our estimation fits well to these values.

assumptions on the use of the different travel modes in 2010

The use of the different travel modes is essential for the total environmental effects. The following assumptions are used in our calculations:

- For the assessment only the use of motorised travels modes will be taken into account.
- The level of reference is calculated with the assumption that the adopters in 2010 have a similar travel behaviour as the current adopters from our study. Obviously the changed composition of the group of users, which has large implications for mobility behaviour, has been taken into account.
- The changes in mobility behaviour in 2010 are similar to those of the current adopters. The differentiation in behavioural changes among the three user groups is used in the calculation.

So the general assumption in our calculation is that the nature and the volume of the changes in behaviour do not differ from those we have measured in current Car Sharing schemes. The data with respect to (the changes in) mobility behaviour are taken from our empirical study.

assumptions on the environmental impact of the use of all travel modes in 2010

In the environmental assessment we take into account the use of all motorised travel modes. These are the assumptions with respect the environmental impact of these travel modes in 2010:

- The environmental impact of the train and the bus per unit of service does not change, compared to the current situation.
- Given the estimations of the car industry (Automotive Engineering International, 1998) the average fuel consumption in 2010 can be estimated at 4 l/ 100 km, which means an average reduction in fuel use of 33%. It is assumed that various feasible improvements and innovative technologies are entirely implemented in 2010.
- The average age of the car increase from 7,82 years to an estimated 9,65 years. This estimation is based on the extrapolation of the improvements over the last 15 years (CBS, 1998). Therefore it is assumed that the improvement of the fuel efficiency of the average Dutch car scores is not more than 28%.

As a result of the assumptions above, the calculations on the environmental effects of future Car Sharing schemes will mainly have their value in a relative sense. The change in environmental effects however is exactly our main interest.

assumptions on the environmental metabolism of Car Sharing services in 2010

Current Car Sharing systems are still in development. It can not be expected that in 2010 the Car Sharing schemes remain unchanged. Various trends and developments are likely to have an impact on the organisation and the content of the service. For entrepreneurs there is not only a need for further economic optimisation but also for further improvements of the service to the needs of the consumer. Various measures and reorganisations will lead to a more optimised service organisation and a more efficient use of resources and cars. Based on a qualified guess it can be estimated what the potential for improvement is with respect to the environmental effects of Car Sharing services per unit of service. In comparison to the current Car Sharing schemes it can be assumed that the following changes and improvements will be realised in 2010:

- Given the current experience with Car Sharing services over time, it is possible to enhance the utilisation efficiency even further up to 1 car for 20 contracts. This can be realised through changes in mobility behaviour of the adopters over a couple of years and through measures aimed at the reduction of non-productive time.
- Given the economic interests of the entrepreneur to reduce the fuel consumption, the most fuel efficient car, available at the market, will be chosen.
- It can be expected that the fuel consumption is further reduced with an estimated 5%, due to the introduction of feed-back mechanisms with respect to fuel consumption. Current car computers are already measuring fuel consumption of individual drivers. Through feed-back and rewards for an efficient driving style on the monthly bill, participants can be stimulated to use the car fuel-efficient. This effect can be further enhance when so-called econometers are installed in all cars. Bongard (1990) even concludes, based on empirical research, that a reduction of fuel use due to the adaptation of driving behaviour, of more than 10% is feasible. We stick to our conservative estimation.
- In 2010 the life of the car, expressed in mileage, will be increased with an estimated 20%. Through an increase of the economy of scale it will become more profitable to keep cars longer in the service system. Maintenance and repair will not be out-sourced anymore. As life-extension of the car directly affects the economic results, more effort is put in maintenance and repair, leading to an extended product-life.

11.6.2. the environmental metabolism of Car Sharing services in 2010

Car Sharing schemes will be quite different in 2010 from the current ones, and so their environmental metabolism of Car Sharing services. First it can be assessed what the potential for environmental improvement of Car Sharing service in 2010 is, based on the

functional unit, which is defined as the provision of mobility by car for one household over one year. The analysis is made for the average carmileage in a Car Sharing scheme.

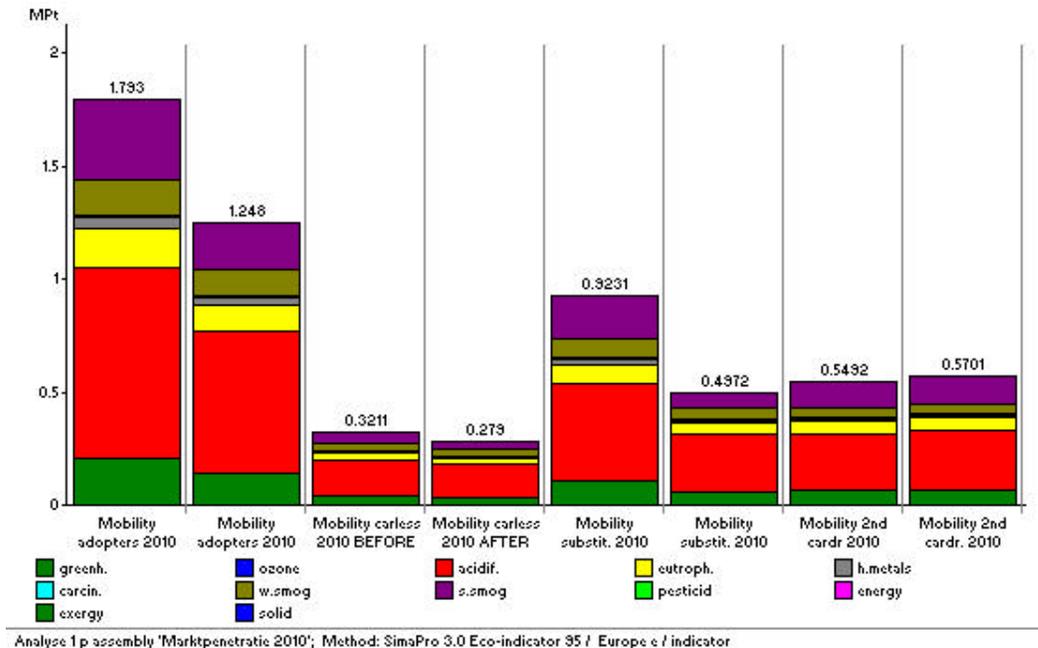


Figure 11.4. The comparison of environmental impact of Car Sharing, now and in 2010

Figure 11.4. shows the comparison of the current average private car, the current Car Sharing scheme and a possible Car Sharing scheme in 2010. They are compared on the basis of the average yearly use of a current Car Sharing scheme. For each of these three options also the impact due to the average use and the production of the vehicle is shown. Compared to current Car Sharing schemes, a possible Car Sharing scheme has an estimated potential for improvement of 35%. The largest share of this potential for improvement comes from the assumed increase of the fuel efficiency of 33%, due to more fuel-efficient vehicles and a more efficient driving style. The increase of the life of the car becomes visible through the reduced impact for the production of the car, from 43 to 33,3 μ Pt (-33%).

Related to the average current Dutch car the environmental impact of a future Car Sharing scheme is an estimated 44% lower at a constant mileage. It must however be noticed that the average Dutch car in 2010 will also become more fuel-efficient. On the other hand Car Sharing schemes will have a comparative advantages of always using the latest technology and thus the most fuel-efficient technology. Car that are used as private car will only disappear from the market after an average of 10 to 15 years.

Based on the assumption that the composition of the group of adopters changes substantially, an estimation can be made with respect to the changes in the amount of cars needed for the provision of mobility and thus for the changes in the amount of (parking) space required. For this estimation it is estimated that the group of adopters will consist for 30% of former carless people, for 50% of “substituters” and for 20% of second “cardrivers”. Figure 11.5. below shows the results of the calculations.

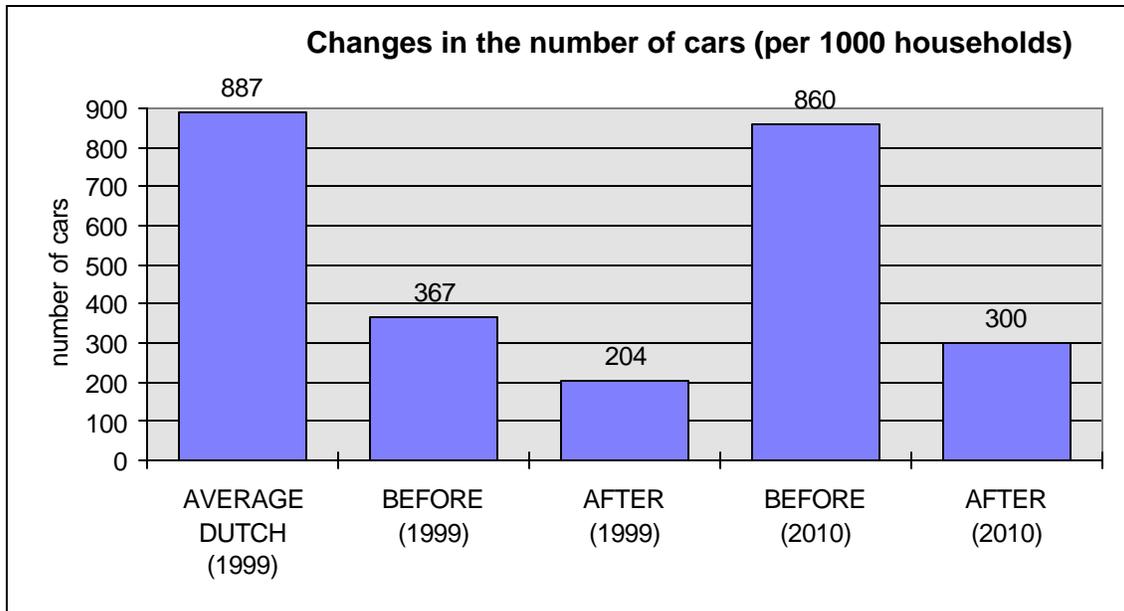


Figure 11.5. Changes in the amount of cars, in 1999 and in 2010 (per 1000 households)

It can be concluded that in 2010 for every 1000 households an estimated number of 300 parking places are required, which is about 3750 m². Compared to the situation before adoption (in 2010) this means a reduction of an estimated 65%. Expressed in square meters, the reduction is an estimated 7000 m² per 1000 households. In comparison to the situation after adoption in 1999, however, the amount of parking space needed per 1000 households increases with 47%. This is the effect of the relative strong increase of the share of “second cardrivers”. They all still own (at least) one car and have a subscription to a Car Sharing organisation in addition.

11.6.3. The environmental potential of Car Sharing services in 2010

Given the environmental metabolism of Car Sharing services in 2010, as calculated above, and the other assumption made, the environmental potential of Car Sharing services in 2010 can be calculated. The calculation has been made for the entire user group of 400.000 households. In the figure below (figure 11.6.) the results of our calculations are shown. The environmental impact is expressed in terms of Eco-Indicator points. For any of the three user groups a calculation is made of the potential changes in environmental impact. The figure shows the amount of Eco-Indicator point of the assumed mobility behaviour before and after adoption of Car Sharing services.

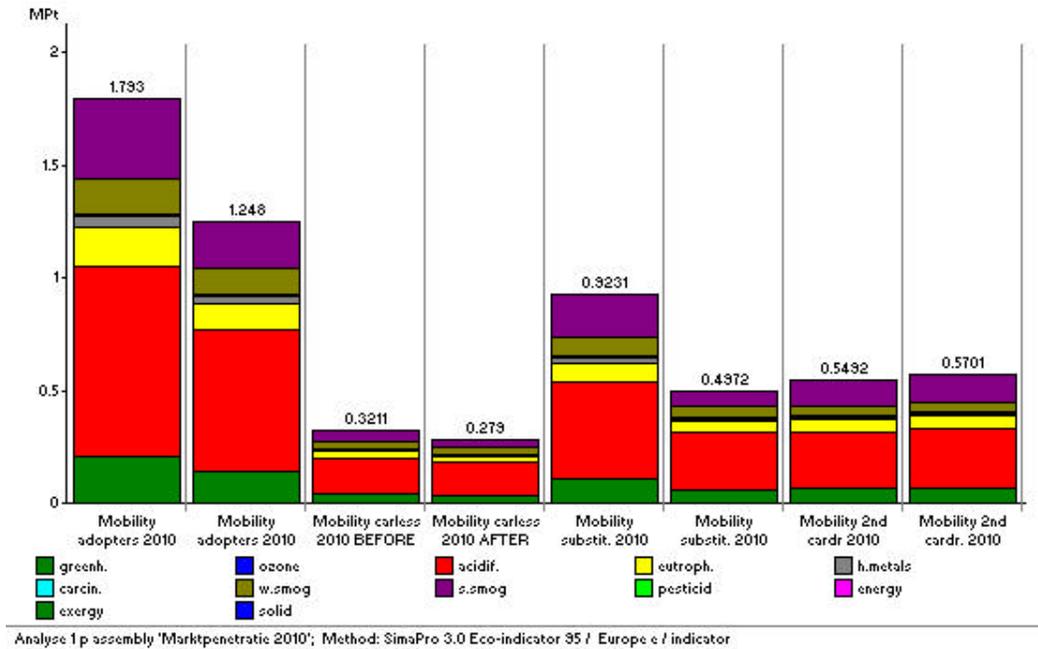


Figure 11.6. The environmental potential of Car Sharing services in 2010 (400.000 households)

The calculations show the following results:

- These 400.000 households could reduce their environmental impact due to mobility with an estimated 30%. For the “carless” this percentage is only 13% and for the “substituters” 46%. However the environmental impact of the second cardrivers increases with an estimated 5%.
- Both in an absolute as well as in an relative sense the substituters is the most interesting group from an environmental point of view.
- These households could save an estimated 0,34 Mton of CO₂ emissions (31%) and an estimated 2420 tons of SO₂ emissions (26%).
- The energy use could be reduced from an estimated 17,8 GJ to 13,6 GJ (24%). So, the amount of (fossil) energy saved can be estimated at 4,2 GJ.
- The reduction in the number of cars, which equals the amount of parking spaces, can be also calculated. In the environmental assessment of a Car Sharing system, we concluded that per 1000 households an estimated number or 300 cars could be saved. Based on this value the reduction in number of cars for the group of 400.000 households can be calculated at 120.000 parking places. This takes an area of about 1,5 million square metres or 150 hectare.

As there are no clear policy aims for the year 2010 with respect to emissions and energy use, it is not possible to calculate to what extent Car Sharing could contribute to environmental policy goals. However these results suggest that Car Sharing services definitely could make a positive contribution to future environmental policy goals.

11.6.4. Conclusions

To estimate what the contribution of Car Sharing services to the reduction of environmental effects could be if these services would be implemented at a large scale in the Netherlands, we made an extrapolation of the current situation into the future. Based on several assumptions about the market penetration in 2010, the use of the different travel modes and the environmental impact of all travel modes, we calculated the environmental reduction potential. Our research data on the current situation were taken as a reliable reference. The

calculations on the estimated potential for reduction of environmental effects has led to the following conclusions:

- The potential for improvement of the environmental metabolism of current Car Sharing schemes is large. The environmental impact of an average use of Car Sharing services can be further reduced with an additional 35%. The measures that need to be taken to achieve this result are far from challenging.
- The environmental potential of Car Sharing services in 2010 is large too. Based on the assumptions a reduction in environmental impact of 30% has been calculated. For the various impact categories similar reduction percentages are calculated, like for example a reduction in CO₂ emissions of 31%.
- With respect to the changes in the number of cars and parking space needed the conclusion is that in 2010 it is likely that the reduction rate (per 1000 households) is even 65%. This large reduction rate is mainly based on the assumption that the number of substituters will increase from 21% at present to 50% in the future. Expressed in square meters, the reduction for 2010 is an estimated 7000 m² per 1000 households.
- Also in absolute terms the potential contribution of Car Sharing services can not be neglected. In particular with respect to the reduction of CO₂ emissions and the (parking)space required, Car Sharing service have such positive effects that this development (further) deserves a strong governmental support, both from central governments as well as from local governments.
- If the development of Car Sharing services evolves according to the assumptions, these mobility services could represent a very effective instrument in the reduction of CO₂ emissions. Based on the very recent Dutch policy framework for the reduction of greenhouse gasses, called the "Uitvoeringsnota Klimaatbeleid" (VROM, 1999), Car Sharing services could contribute another 0,34 Mton reduction in CO₂ emissions to the needed 2,9 Mton in 2010, which is 12%. Compared to all other policy measures, this would be a very important contributing instrument.

11.7. Reflections on the concept of Eco-efficient services

11.7.1. Car Sharing as a specific example of Eco-efficient Services

In an early stage of this study, Car Sharing services have been chosen as the subject of our empirical study. Car Sharing is held a striking example of the theoretical concept of Eco-efficient Services. This case has provided an interesting field for our empirical investigations on this concept. Seen from a higher abstraction level, it can now be questioned to what extent the results of our study on Car Sharing service are representative for the entire concept of Eco-efficient Services. In the discussion of the concept of Eco-efficient Services we have distinguished three categories of services: (1) product-life-extension-services; (2) product-use-services and (3) result-services. To what extent could the results on Car Sharing services be generalised to all these three categories of services? And what have we learned from our study on Car Sharing services for the development of Eco-efficient Services in general?

The generalisation of research results

With regard to the possibility to generalise the research results on Car Sharing services, we can not be very pretentious. There are just too many differences among the services of the three categories of Eco-efficient Services, that it is very hard to generalise from only one study on one particular case, whether it concerns the adoption of services, the service quality perception or the changes in consumption behaviour after the adoption of the new service. The differences among the Eco-efficient Services that make the generalisation difficult are the following:

- the extent to which the properties rights are handed over to customers
- the mechanisms that lead to improvements in environmental efficiency
- the organisation of the service delivery process
- the variation in actors involved in the entire product chain
- the nature of the end user
- the extent to which emotional values are associated with the ownership of a product
- the extent to which consumers are involved in the consumption practice themselves
- the extent to which the use of products requires expertise or experience
- the investments that are related to the ownership of goods
- the cost structure of product use
- the extent to which a certain product requires maintenance and repair costs
- the extent to which financial risks are involved over the life cycle
- the transaction costs for transferring the goods to customers
- the extent to which alternative consumption practices available

All these differences make the diversity among the Eco-efficient Services too large, to generalise the empirical findings of Car Sharing services. Every case can be seen as a case on its own, with its own problems of market adoption and implications for the environmental effects.

The value of the concept of Eco-efficient Services

Despite the fact that Car Sharing must be treated as a case on its own, it can not be denied that this study has thrown a new light on the value of the concept of Eco-efficient Services. The experiences with Car Sharing in this study, have led to a couple of insights with regard to the value of the concept of Eco-efficient Services in a more general sense:

- This concept supports the analysis of the functional efficiency of a certain consumption practice. Through the identification of current inefficiencies a specific consumption practice becomes problematic. At the same time the concept suggests different possible solutions to optimise the functional efficiency. It is very productive in innovation processes to identify problems in consumption in order to focus the activities in development. Above all this approach is very much designers-like and reflects their design activities (Dorst, 1997).
- The concept certainly helps to transform “life-cycle-thinking” into new business opportunities. Not only from environmental point of view, but also from business economic point of view, the optimisation of all costs over the entire life cycle is essential to create more efficient solutions for the market. Selling the utilisation value of products forces companies to internalise all costs over the entire life cycle in the development of innovative solutions. It creates a business interest in more economically and environmentally efficient solutions.
- In addition to that, the concept of Eco-efficient Services provides a set of ideas of how an extended producer responsibility (OECD, 1997) can be transformed into new business opportunities. Whereas extended producer responsibilities is generally seen as a threat to linear business concepts, the concept of Eco-efficient Services illustrates how such governmental interventions could be incorporated into business market policies and lead to new strategic advantages e.g. in terms of stronger customer relationships.
- Our study on Car Sharing services has confirmed the central idea underlying the concept of Eco-efficient Services that through selling the utilisation of products, the functional efficiency increases through improvements in the entire product system. However the extent to which improvement options are implemented is largely dependent on the economic context. The price structure of labour, energy and material costs actually determines to what extent innovative technological and organisational options are implemented.
- Through the focus on the functional efficiency of a certain consumption practice, while taking into account the entire way in which certain functions are generated, a stronger market orientation of companies is stimulated. In order to change a consumption practice successfully one has to have a very clear and valid idea on what customers really need.
- The concept of Eco-efficient Services is based on a very functional conception of products. This concept assumes that products only deliver functional outputs. These functional output of product usage is certainly essential, but the emotional values associated with product use can not be neglected in most domains of consumption. The neglectance of emotional values associated can be held as an important limitation of the concept of Eco-efficient Services.

Lessons from Car Sharing for the understanding of the concept of Eco-efficient Services

In addition to these more general valuable properties of the concept of Eco-efficient Services, also a couple of more specific lessons can be drawn. Because of the fact that the empirical results on Car Sharing services can not be generalised, we prefer to formulate these lessons in terms of hypotheses. The hypotheses might serve as guidelines for further research on this subject:

- Eco-efficient Services can be well treated as normal innovations when studying their adoption and diffusion. Based on our study on Car Sharing, we conclude that there is strong evidence that the adoption and diffusion of Eco-efficient Services does not differ fundamentally from other kind of innovations.
- The relative advantages as perceived by the consumer, are essential for the adoption of Eco-efficient Services.

- The perception of fixed and variable costs have an important impact on the adoption of Eco-efficient Services. If there is no insight in the entire life-cycle costs among the consumers, and especially in all variable costs over the service life of the product, Eco-efficient Services will meet little acceptance in the market.
- The environmental attitude only plays a subordinated role in the adoption decision of Eco-efficient Services.
- Consumers only give up the ownership of goods and buy services instead, when the transaction costs, both in terms of time and money are relatively low. That also implies that these services must be easily available wherever and whenever needed.
- For the adoption of Eco-efficient Services these services must be well organised, reliable and convenient. In other words, the service organisation must provide high quality services..
- Changes in consumption behaviour after the adoption of Eco-efficient Services are difficult to explain and vary substantially over various market segments.
- A great habit strength prevents from the adoption of Eco-efficient Services.

11.7.2. The value of the concept of Eco-efficient Services for Sustainable Development

In the introduction of this thesis, the concept of Eco-efficient Services has been introduced as a specific innovation strategy, through which industry could contribute to “Sustainable Development” (WCED, 1987). As a result of the development and market introduction of innovative services, it was expected that consumption behaviour would change and result in a reduction of environmental effects. Based on our experiences with Car Sharing services, it can now be questioned what the value of the concept of Eco-efficient Services is for Sustainable Development.

We conclude from our study on Car Sharing services in the Netherlands that the concept of Eco-efficient Services certainly has a value in the process of change towards Sustainable Development and Sustainable Consumption. However, the value of this concept in the process of change is only complementary and limited for various reasons:

- The concept of Eco-efficient Services is basically an innovation strategy through which the environmental efficiency of specific consumption practices can be enhanced. It merges the economic interests of companies with a societal interest to reduce the environmental impact of production and consumption. That results in a further optimisation of certain consumption practices with respect to its environmental efficiency. However, this represents only one relevant aspect responsible for the total environmental impact. The concept of Eco-efficient Services is not aimed at influencing the volume of consumption, or the amount of units of service. Changes in consumption behaviour that have a positive impact on the environmental effects are quite accidental and certainly not a general effect of Eco-efficient Services. So, this concept contributes only to Sustainable Development and Sustainable Consumption to the extent of providing more environmentally efficient consumption practices.
- The extent to which the concept of Eco-efficient Services contributes to the further optimisation of the environmental efficiency of consumption practices, is very likely to vary tremendously among the various markets and over time. So, the positive effects from these services differ from case to case. Whereas Car Sharing services provide an alternative to the privately owned car with only about 14% less environmental effects, it can reasonably be expected that in other cases the increase in environmental efficiency is much higher (see e.g. Goedkoop e.a., 1999)
- Eco-efficient Services on itself won't lead to a “sustainable” society. This innovation strategy only provides concrete ideas of how the environmental efficiency of consumption

practices could be enhanced and how industry could create new businesses to help this bring about. The extent to which these kinds of services might contribute to the reduction in environmental effects must not be overestimated. It has been suggested (Jansen and Vergragt, 1993; Vermeulen and Weterings, 1996; Brezet, 1997) that innovations in function fulfilment would lead to a factor 10 reduction of the environmental effects per unit of service. Based on our study we conclude that it is very unlikely that Eco-efficient Service, as a specific kind of innovation in function fulfilment results ever in such improvement factors. If we assume with Opschoor and Weterings (1992) that for a sustainable society the environmental efficiency of products and services must be improved with at least a factor 20, than it is obvious that the concept of Eco-efficient Services has only a limited role in the process of change towards Sustainable Development.

- So-called Eco-efficient Services have their own dynamics on the market. As we have seen in our study on Car Sharing, these services do not only function as an alternative to former consumption practices. Innovations also generate new markets and new types of behaviour. While Eco-efficient Services might provide more environmentally efficient alternatives to current consumption practices, it can not prevent from the development of new markets and therefore of new sources of pollution.
- The context within which the development and introduction of Eco-efficient Services takes place is treated as a set of given boundary conditions. By treating the context as a given one, the concept of Eco-efficient Services does not take into account the possibilities for changes towards Sustainable Development that result from changes in the context itself. In the process of change towards Sustainable Development it must not be forgotten that due to changes in the economic, social, cultural, legal and physical context also beneficial steps forward can be made.
- The concept of Eco-efficient Services takes a certain demand for granted and aims to provide just a more environmentally efficient alternative for this demand. It does not raise any questions at all regarding the justification of the demand for a certain functionality from an environmental point of view (see also SustainAbility, 1996). The absence of a criticism towards certain consumption practices can be held as a limitation towards a more "sustainable" society.

12. Epilogue

The end of a long study like this is in any sense arbitrary. In the process of research so many questions are only raised and not answered. But to finish such a study, it is absolutely necessary to narrow down and to keep focused. However, in the last section one inevitably arrives at the conclusion that the research efforts are only first attempts to a better understanding of the concept of Eco-efficient Services and that, fortunately, the development of Car Sharing services in the world outside have only begun. To provide others the opportunity to start where this thesis ends and to help practitioners with insights generated through this study, I would like to formulate a couple of recommendations. It underlines my hope this study is an inspiring source for new projects, studies, entrepreneurial activities and policy initiatives.

12.1. Recommendations for the field of Car Sharing services

Recommendations for Car Sharing entrepreneurs

From our study a couple of recommendations can be derived that may be useful for Car Sharing entrepreneurs to increase the competitiveness of their service and its success in the market:

- The accessibility of Car Sharing services must be excellent to convince the broader public to adopt Car Sharing as an alternative to private car ownership. That implies that a high density distribution network is indispensable, where cars are available 24 hours a day.
- Car Sharing users are using for their mobility quite intensively alternative travel modes, apart from a car. Therefore the integration of Car Sharing services with public transport services into an integral package of mobility services fits to the demand of the users.
- Car Sharing schemes are mainly attractive for short individual trips and not for longer periods of use, like long weekends and holidays. So, the further integration of short-term rental and long-term rental into one service packages can be recommended.
- The information and communication technology is the enabling technology of Car Sharing services and should therefore be given highest priority in the further development of these services. The application this technology enhances both the reliability of the service and facilitates the efficient allocation and transaction of cars.
- To keep customers over a longer time, a smoothly organised service delivery where clear service standard are held, are essential. In the organisation of the service delivery process the aspects “empathy”, “assurance”, “responsivity”, “image of tangibles”, “reliability” and the “availability of cars” are the core aspects to enhance the service quality perception.
- In order to break through habitual behaviour, it is recommended to increase the trialability of the service. Providing the opportunity to potential clients to try at low costs the functionality of the service scheme will certainly have a convincing effect on consumers to adopt Car Sharing.
- The marketing communication should be focused on those moments in life where people make strategic decisions with regard to residence and mobility or reconsider their current choices. At these occasions Car Sharing must be available and become one of the options in the decision making process.
- A transparent cost structure of Car Sharing services is needed to convince people to adopt Car Sharing services. In order to prove the relative advantages of these services for the individuals however not only a transparent cost structure is needed, but also a realistic comparison with all costs of the privately owned car. In the communication it must be stressed over again what a the real costs of a privately owned car are.

recommendations for (transport) policy

This study has shown that Car Sharing service contributes to transport policy and environmental policy aims. It has been concluded that this development deserves further

governmental involvement. These are the recommendations to (Dutch) policy makers to stimulate to further development of Car Sharing services:

- An important incentive for success is a very restrictive parking policy in urban areas. High parking prices and a great pressure on scarce parking space are important encouraging factors for consumers to adopt Car Sharing services. Local governments have many policy instruments to create the right boundary conditions in this respect.
- The large fixed costs of car ownership provide the economic incentive for Car Sharing services, because sharing these costs with others bring the economic advantages for consumers. Through the continuation of the taxation of car ownership the central government could maintain these economic incentives.
- An important boundary condition for entrepreneurs to run their Car Sharing services is the availability of special parking facilities in the urban area. Local governments should provide excellent parking facilities in public space.
- Spatial planning in cities should take into account the demand for special parking places at railways stations, park and ride stations and other strategic locations in cities. It is recommended to develop specific guidelines for local governments on how to integrate Car Sharing schemes in new town planning and in existing urban areas.
- Car Sharing services will only flourish in an urban environment where alternative travel modes are easily available. So, a further development of public transport services through local governments will help providing a favourable context for Car Sharing services. It is recommended to stimulate the integration of both type of mobility services.
- In order to improve the quality of Car Sharing services, it is recommended to stimulate and facilitate specific projects of Car Sharing organisations, like e.g. the implementation of new solutions with respect to information technology.
- In order to stimulate the environmental potential of Car Sharing services it is important to develop a selective stimulation policy. Only those companies that make a serious and high quality market offer and that offer highly flexible services should benefit from governmental support.
- It is further recommended to stimulate the use of highly fuel efficient vehicles in Car Sharing schemes. That would further increase the environmental potential.
- The environmental analysis of Car Sharing services shows that stimulating the use of bikes instead of cars or public transport is extremely effective in reducing environmental effects.

Recommendations for further research on Car Sharing services

This study on Car Sharing services has created much more insight in the issues related to consumer behaviour and the environmental effects related to the use of these kinds of services. Despite all, a large variety of questions still remain open. But after this study we know better to formulate relevant research questions. For further research we recommend the following research questions:

On the *adoption of Car Sharing services* we distinguish the following research questions:

- What is the nature of the decision making process?
- Which kind of variables are important in which phase of the decision making process?
- What are the incentives to break through old habits and to adopt Car Sharing services?
- What is the role of background variables in the decision making process?
- How could the perception of car costs (both fixed and variable costs) be explained?
- How could the perception of car costs be influenced in order to convince consumers to adopt Car Sharing services?
- How does the attitude towards Car Sharing services change over time, after the adoption?

On the *diffusion of Car Sharing services* we distinguish the following research questions:

- What are the dynamics in adopters groups over time?
- What is the influence of governmental communication on the attitudes towards Car Sharing?

- What is the impact of free publicity on the attitudes towards Car Sharing?
- What is the role of the social environment in breaking through habitual behaviour and the large scale adoption of Car Sharing?

With respect to the *service concept* we distinguish the following research questions:

- Which Car Sharing service would be the most convincing one for consumers to adopt Car Sharing as an alternative to the privately owned car?
- What are the preferences with regard to the service concepts among various market segments?

With respect to the *service quality perception* we distinguish the following research questions:

- What are the criteria for high quality services from a consumer perspective?
- Is service quality perception an appropriate explaining variable for the customer retention?
- What is the role of perceived characteristics in the explanation of service quality perception?
- What is the empirical relevance of the distinction between the technical and the functional service quality perception?

With respect to the *changes in mobility behaviour* we distinguish the following research questions:

- How can the changes in mobility behaviour be explained?
- What is the influence of the service concept on the changes in mobility behaviour?
- How could the changes in mobility behaviour be optimised from environmental perspective?
- What are the dynamics in mobility behaviour over time?
- How could changes in mobility behaviour over time be explained?

12.2. Recommendations for the field of environmental management

recommendations for industry

Although the concept of Eco-efficient Services is not entirely tested yet, this approach can be recommended as an interesting source of inspiration for new innovation opportunities for industry. Based on the literature and the experiences with Car Sharing services it seems to be an approach that leads not only to environmentally efficient alternatives, but also to strategic advantages in terms of stronger customer relationships, more added value and an alternative to competition based on price setting or product quality. This approach is particularly challenging for industry because it puts the focus on the development of an infrastructure for the delivery of services. The concept of Eco-efficient Services is recommended because of the opportunity to develop a competitive advantage over others with respect to service quality instead of mainly on technological superiority or product price. Quite recently e.g. Electrolux has started an experiment with 7000 households in the context of the "Smart Home project". Electrolux offers these households free washing machines and only bills the usage of the machines ("pay per wash"). Free service on the machine is included in the offer. After 1.000 cycles, households can decide whether to replace or upgrade the machine. "Pay per wash" is the first of several products and services for the Smart Home that Electrolux is expected to release on the market in the coming years, according to Michael Treschow, President and CEO of Electrolux at the launch of the Smart Home project.

recommendations for policy making on environmental management

The case of Car Sharing shows that the development of new consumption practices requires a long trajectory in which many fundamental and practical problems have to be overcome. Above all this case shows that only through the extensive experimentation in a real-life setting such new consumption practices, supported by new product and service systems, can be realised. Many practical problems can not be foreseen before starting the experimentation. Consumer acceptance can not properly be investigated without a real-life experiment and the social, economic and environmental effects can not be reliably established. So it is recommended to public authorities to support much more extensively the experimentation with new consumption practices in order to bring about the needed changes in society towards sustainable development.

A second recommendation for policy making on environmental management is to stimulate the environmental optimisation of product systems through a policy on extended producer responsibility. Through an extended producer responsibility for products after their useful life, industry will be faced with the end-of-life consequences. In order to realise "reverse distribution", a new relationship with consumers is needed, based on a shift in property rights. Above all the extended producer responsibility puts a large incentive on the internalisation of all costs in the redesign and reorganisation of product systems. In the context of an effective policy on extended producer responsibility, industry is more likely to reconsider its strategic marketing strategy, to develop a service infrastructure to recover used products and to optimise the utilisation of products, probably through the use of elements from concept of Eco-efficient Services.

Recommendations for further research on the concept of Eco-efficient Services

On a couple of issues we recommend further research on the concept of Eco-efficient Services:

- First it is unclear what the value of this concept is for the development of profitable market strategies and what kind of strategic advantages and disadvantages might be linked to this concept.
- Currently little insight exists how Eco-efficient Services could be best developed. If this concept further proves its value, there is certainly a need in industry for specific methods to develop these kinds of services. It has become clear from our case study that especially the development of new service organisations and the integration of information technology in those service organisations represent important aspects of new methods for the development of Eco-efficient Services.
- This study has fed the idea that the application of the concept of Eco-efficient Services will certainly not be successful in any product category. If success is defined in three dimensions (market success, commercial success and environmental beneficial) it can be questioned which product related or product use related factors determine the potential for an integral success on these three aspects.
- It is very plausible to assume that the context within which Eco-efficient Services exist is very important for their success. Further research is needed to identify those factors that facilitate the development of these kind of innovations and that make them flourish in the market.
- In this study a first attempt has been made to unfold the relationship between Eco-efficient Services and their environmental effects. Currently little insight exists with respect to a more generalised image of what the environmental potential of Eco-efficient Services is and what kind of factors are responsible for the contribution to improvements in environmental effects.
- In extension to the last research topic also the relationship between the economic development through Eco-efficient Services and the environmental effects is interesting. Economic development aims to add value to economic activities. It can be questioned whether the concept of Eco-efficient services helps to disconnect economic growth from the growth in environmental effects.

Recommendations for designers and design education

Our study has been set up in design context in which designers try to integrate environment requirements in product development. For those involved the area of environmental product development we have a couple of recommendations:

- Designers need to have a clear image of what the problems are to which they have to respond. Often these problems are defined in quite conventional terms, based on problematic aspects of existing solutions. Based on our study it also seems valuable to redefine problems entirely and to question existing solutions on a conceptual level. As designers have the capability to create images of entirely new solutions in advance, they are able to assess a redefinition of what customers need. In general it is recommended to designers to critically question a given design task, and to do research on the nature of the solutions that need to be developed. Especially with respect to sustainable solutions there is a need for unconventional solutions.
- A source for inspiration for designers when analysing the design task is a deep analysis of the efficiency of product use. In order to arrive at the conclusion that certain products are very inefficient in use, one has to have images of how things could be better organised or be optimised. The analysis of current inefficiencies in consumption is very much related to the ability of designers to create new solutions. So, it is recommended to assess current consumption practices from a future perspective, in which completely new solutions exist.

- Our study has shown that when integrating environmental requirements in product development it can be very useful not to rely only on technological improvements of products. The case of Car Sharing services shows that through a reorganisation of the entire product chain, interesting new opportunities are created that are not primarily based on technological improvements. It is recommended to designers to take into account the opportunities for improvement that result from the development of product related services. Both from commercial as well as from environmental point of view the integration of service aspects in product development are in most cases beneficial and in many case even indispensable.
- Finally it is recommended to designers in their efforts to reduce the environmental impact of consumption, to take into account the possible rebound effects from new solutions. In the assessment of various design solutions it is important to assess on beforehand the possibilities for undesired effects in terms of consumption behaviour. In many cases these rebound effects have also negative environmental effects.
- It is recommended to those responsible for design education to create more awareness among students for the aspects mentioned above. Especially the implications of the growing importance of services in our current economy definitely need further attention in design education. Increasingly more products are depending on service systems in order to deliver their functionality to the users. Not only to make products more fit to the requirements of service systems, but also to be able to develop in an integrated manner new product-service systems, new impulses to design education are needed through which different skills and knowledge are taught to students. It is recommended to develop a new course focussing on service development in society and service aspects in design. The possible environmental benefits should be seen as one of the aspects of service development.

12.3. Car Sharing service schemes: from here into the future

Scientific research on social issues is rather conservative: it generally reflects upon the currently existing reality or even on past times that are gone. Design, in contrast, helps create a new reality. It projects ideas into the future and translates abstract ideas into realistic plans of how such a new reality could be created. Design is constructive and creative, which makes it a very attractive activity to designers.

In my own development I have left my profession as a design engineer and have developed research skills, especially in the social sciences. However, as a social scientist, I can not forget about my own roots. For me it is impossible to do research without having an idea about how new knowledge could contribute to design processes or other processes of changes. So in my case I was, during the entire research process, constantly sharpening my vision, based on the insights generated through research, on how Car Sharing services should be developed into the future.

These quite natural activities finally led to a presentation of a future vision for Car Sharing services. Together with Jelle Zijlstra, a professional designer in Rotterdam, I made a “grant design” of how Car Sharing services could be further developed into a large scale service network and be integrated in the Dutch urban fabric. It was send as a contribution to a national contest, organised by the foundation for Car Sharing in the Netherlands together with NIROV. Our plan was called “Bewegingsruimte” (“space to move”) and was awarded with the first price of Dfl. 35.000,=. It seems to me that presenting our plan “Bewegingsruimte” is an appropriate way for me to finish this research project, because it translates the results form research into a design for the future.

“Bewegingsruimte”

a scenario for the development of Car Sharing services in the Netherlands.

The service offer for the consumer

The nature of service offer for the consumer is the major success factor for an innovative service system. The service offer must appeal to the needs of individual consumers and must provide relative advantages to the existing solutions.

For the ideal Car Sharing service the following characteristics are important:

1. Cars must be available 24 hours a day just around the corner. So a highly dense network of distribution points is needed to convince consumers to adopt Car Sharing services.
2. The distribution of cars must be realised through an entirely automated system that identifies the user, provides the cars, registers the usage of the car and makes up the invoice.
3. The cars are distributed from special parking places in public areas.
4. Cars must be available with and without reservation in order to provide room for flexibility as well as reliability.
5. At the distribution point various kinds of cars must be available for different kinds of trips.
6. Apart from Car Sharing services for short trips less than 24 hours, also long long-term arrangements must be easily available under the same umbrella.
7. In addition to Car Sharing services other mobility services, like train and local transport, must be integrated in the service package.
8. Car Sharing services should operate in a national network of service suppliers that enable to get services at city.

The vision for a future mobility system in 2010

Car Sharing service should evolve into a nation wide network of mobility services. The existence of a large network has an additional value in itself: if Car Sharing services are widely available this represents a interesting extra advantage over the situation that only locally services are offered.

The future vision for a Car Sharing system in 2010 is based on two four elements:

1. A customer becomes member of the entire mobility system, which includes the availability of a car nearby home, the opportunity to get a car at any city where the network is represented and special travel conditions for the use of public transport.
2. The mobility system consists of different cells that all individually sell out one single brand. All individual cells one common proposition for every customer at any city.
3. The network consists of different local service suppliers that are responsible for the smooth operation of the services locally.
4. The future mobility system consists of three different scales: Small, Medium and Large.

The SMALL scale provides services directly in the living areas of cities, just around the corner where the customers live. The reach of the SMALL scale is 200 to 300 metres. If customers live further away from the distribution point, a new distribution point has to be created. At these points a couple of cars (about 5) are available. The cars are meant for rather short trips. No choice in type of cars is offered at the SMALL scale.

The MEDIUM scale represents a buffer stock for an entire city district, in which a large amount of SMALL scale distribution points are available. The MEDIUM scale provides for all the customers from that particular district a large choice of different type of cars. Above all, for long-term use (more than two days) customers receive their cars from these distribution

points. The location of the MEDIUM scale is at the district gates nearby local facilities, like shopping centres of bus stations and has a reach of about 2 kilometres. The LARGE scale is a high-tech distribution centre for cars nearby large public transport centres and railways station. The cars from this distribution points are available for any customer from the entire Car Sharing organisation. The location of the LARGE distribution centre enables the combination of long-distance public transport use and short distance car usage. Because of the scarcity of parking space nearby railway stations, it is the idea to install entirely automated parking houses.

How to get there?

The vision for the future mobility system is ambitious, but the ideas below on the realisation may turn this vision into a plausible future perspective. The trajectory for the introduction and further development of Car Sharing services can be sketched as follows. Current developments already point in a similar path of development:

To start from now, a brand manager has to invest in the further development of a Car Sharing brand, that can be implemented anywhere. At the core of the service concept is a efficient and reliable software and hardware system that enables the automated and flexible distribution of cars at any location. Besides this, the brand manager has to invest in the familiarity of the service brand and a basic interest in Car Sharing services. Meanwhile at a small scale practical experiences have to be made with Car Sharing services in practice. Through the market communication about the positive experiences in practice a latent market demand has to be built up more widely.

In order to upscale from local experiments with the introduction at a larger scale, it is necessary to built up a network of local service suppliers that operate the Car Sharing services and maintain the fleet and the contacts with the customers. Through the creation of a franchise concept that enables local entrepreneurs to operate Car Sharing services and to benefit from a strong brand in the market, local outlets are created. These outlets are not only an integral part of a large network of service suppliers, but also represent interesting new local business that could not have been created by individual business units. All knowledge and technology is developed centrally in order to facilitate local entrepreneurs. Every local entrepreneur has to create a public-private partnership with local governments to create special parking places in public space and with local public transport corporations in order to create added value through the integration of public transport services in the service offer.

To introduce the entire mobility service a set of stepping stones into the future can be projected:

2000 First the SMALL scale must be further developed and introduced in the market. By far this scale is the most important in the entire mobility system.

2003 If there is a certain diffusion of Car Sharing service through the wide-spread availability of SMALL scale units, it becomes attractive to develop the LARGE scale facilities at railway stations and other large transport facilities. Through the availability of the LARGE scale facilities, customers get the opportunities to rent a cars at different locations, as easy as at their own SMALL scale location.

2005 With the growing economy of scale, it becomes attractive to develop the MEDIUM scale, where a buffer stock is created and from where long-term rental is organised. At any city district where demand is large, such buffer facilities might become necessary. These MEDIUM scale facilities might become focal points in local business activities and provide facilities for e.g. teleworking or local distribution centres for E-commerce.

2010 In 2010, finally, the LARGE scale facilities will have turned into important business centres within urban areas. Integrated with the facilities for the Car Sharing corporation, these locations offer different kind of facilities for businesses and employees, like e.g. teleworking centres and outlets for a large variety of other kinds of services.

In 2010 a new kind of car is introduced in the Car Sharing system. This car is made especially for the service system and excels in fuel efficiency and durability.

To conclude

Grand designs like “Bewegingsruimte” are in most cases not a correct prediction of the future. Our grand design is not meant as a prediction for the future, but as a realistic sources of inspiration for entrepreneurs. The function of these kinds of designs can generally be found in their ability to fuel entrepreneurship and co-operation between different actors. If this thesis, and in extension to that, this design for a future mobility system helps generating essential impulse in society to develop Car Sharing services into a widely available service system, I am more than satisfied.