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Changing consumer behaviour through Eco-efficient Services

An empirical study on Car Sharing in the Netherlands

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***Changing consumer behaviour through
Eco-efficient Services***

An empirical study on Car Sharing in the Netherlands

PROEFSCHRIFT

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In May 1993, as a newly graduated industrial designer, I started a journey of which I had no idea where it would lead me. As I had great enthusiasm and interest for the topics of both product innovation and the environmental effects of consumption, I thought that writing a thesis would be an appropriate next step in my development. I wanted to find out how innovative products and services could be used to influence consumer behaviour in such a way that the environmental effects of consumption would be reduced. I started out without a clear sense of direction. I set out to write a thesis without knowing what the thesis had to be about or what conducting research actually involved.

After seven years of hard work, the result now lies before you. I have reached my goal, which is an enormous relief. Nevertheless, I realise that especially the often difficult process of constructing this thesis now gives me the greatest satisfaction. I had to overcome a lot of obstacles and I succeeded. My work on this thesis gave me the opportunity to meet, and cooperate with, lots of different people. This personal contact and close co-operation with other people is what I have found most enriching.

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Utrecht, 26 March 2000

1 Introduction: Changing consumer behaviour through "Eco-efficient Services"

1.1 Environmental problems and consumer behaviour

Numerous studies by a variety of respectable institutes all over the world have reported on the deteriorating state of the world (RIVM, 1988, 1997; Weterings en Opschoor, 1992; Meadows, 1992; Brown, 1995; IPCC, 1995; Stanners ea., 1995; Seager, 1995). Over the past three decades, the impact of environmental changes on humanity has gradually become clear. Nowadays there is hardly any disagreement on whether these changes in the ecological system can be called a problem or not. The list of the environmental effects of the current economic development is long and covers all aspects of the ecological system. Many environmental researchers and environmental institutes (see e.g. Meadows ea. 1992) regard these environmental effects as very serious. Analysis has shown (Meadows, 1992) that the earth's carrying capacity (Opschoor and Weterings, 1992; Daly, 1996) will even become too small, especially in view of the likely increase in the world population and the expected growth of the world economy.

In 1987, the United Nations World Commission on Environment and Development (the WCED) responded to the growing environmental concerns and the increasing evidence of the seriousness of the situation with a report, "Our Common Future", that introduced the concept of "Sustainable Development". This report (also known as the Brundtland report) has put the relationship between economic development and the environmental problems high on the political agenda. Sustainable development was defined here as: "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The report stresses the long-term viability of a human society in which people's needs are satisfied.

Sustainable development is an umbrella concept that covers a number of key issues, such as fulfilling needs, enhancing the quality of life, improving resource efficiency and minimising waste, while taking a life cycle perspective and paying attention to the social equity dimension. For the WCED, sustainable development is founded on two conceptual pillars: first, the concept of needs, in particular the essential needs of the world's poor, "to which overriding priority should be given"; and second, the idea that the state of technology and social organisation impose certain "limits" on the environment's ability to meet present and future needs.

The WCED report sees a clear connection between environmental problems and consumption and production patterns: "In essence, sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technical development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations." (WCED, 1987). By using the concept of needs, the report introduced a new dimension to the discussion about consumption issues.

The focus on consumer behaviour was intensified at the 1992 Rio Earth Summit, where Agenda 21 was presented (UNCED, 1992). Agenda 21 states that "the major cause of the continued deterioration of the global environment is the unsustainable pattern of consumption and production, particularly in industrialised countries..." . Agenda 21 called on the developed countries to take the lead in promoting and achieving more sustainable consumption patterns and to continue making environmental improvements to the production of products and services. This study, however, will focus primarily on the issue of sustainable consumption.

Since the Earth Summit, governments, businesses, environmental organisations, and research institutes have worked at an international level to develop a shared understanding of what is required to achieve "sustainable consumption". The 1994 Oslo Symposium, hosted by the Norwegian Ministry of the Environment, produced this working definition of sustainable consumption: "the use of services and related products which respond to basic needs and bring a better life while minimising the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardise the needs of future generations" (MD, 1994).

One of the organisations, that has been involved in the development of such a shared understanding of sustainable consumption, is the International Organisation of Consumer Unions (the IOCU, 1993). It concluded that "to preserve the global ecosystem over the long term, consumption patterns must be sustainable. Many current wasteful consumption patterns of affluent consumers in the developed countries are not sustainable. (...) In a world with finite resources and environmental limits, consumers in the North will need to use less of the world's resources, so consumers in the South may claim their rightful share of the Earth's resources wealth. Consumption patterns in the North need to change so that consumer standards of living are maintained or improved, while less resources are used up and less waste and pollution are created."

The concept of "sustainable consumption" in fact suggests that current consumption patterns in the North must change fundamentally. This is easier said than done, particularly since it is almost completely unclear what "sustainable consumption" will mean in practice. For instance, the question still remains what kind of concrete products and services are needed to help people consume more sustainable in the future. The analysis of many documents on "sustainable development" and "sustainable consumption" seems to justify the conclusion that these concepts need to be further operationalised.

Recently, various authors (see e.g. Schmidheiny, 1992; Fussler, 1996; Brezet, 1997; Cramer, 1994, 1995, 1996, 1997; Hart, 1997; and Weijnen, 1997; von Weizsäcker *et al.*, 1997) have picked up this question and have argued that environmental problems can only be addressed properly through substantial changes in product development and consumption: "Sustainable development requires radical improvements in products and services. They must provide customer satisfaction with much lower levels of environmental impact." (Fussler, 1996). Their arguments are based on the assumption that innovative products and services can change consumer behaviour, while maintaining customer satisfaction and

reducing environmental effects. Some companies have already followed this approach. They have started innovation processes that have resulted in innovative products and services which do less environmental damage than their former products. These companies have developed such innovative products and services not only because they are environmentally less damaging, but also because they are highly competitive in the marketplace. Many environmental scientists see such innovation processes as a very promising approach to achieving "sustainable consumption".

This approach differs from approaches followed in the past (see e.g. Vlek and Michon, 1992; Midden and Bartels, 1994; Tertoolen, 1994; Steg, 1996). In the past, approaches were often defined from a governmental perspective, as it was assumed that changing consumer behaviour was mainly the government's responsibility. Consumer behaviour was influenced through governmental actions (Vlek and Michon, 1992), through either structural strategies or cognitivemotivational strategies. In contrast, changing consumer behaviour through the development and introduction of innovative products and services is primarily businessorientated, and leaves the government only a limited role. Companies voluntarily choose to develop new products and services that help reducing environmental effects because they expect new business opportunities. The latter approach could therefore be seen as a new way of changing consumer behaviour to reduce its environmental effects. This new approach will form the starting point for this study.

Research objective

In this study we will focus on how consumer behaviour can be changed in order to substantially reduce the environmental effects, and, more specifically, on how individual consumer behaviour can be changed through the development and market introduction of innovative products and services. We assume that to change individual consumer behaviour and so reduce the environmental effects of consumption, we need to develop a clear understanding of the determinants that rule individual consumer behaviour.

This choice of the perspective of the individual consumer is consistent with the analyses made by several social scientists. Among others, Vlek (1997), Midden (1993, 1995) and Spaargaren (1995) argued for a redefinition of the current environmental problems in terms of a consumer behavioural problem. They argue that individual consumers can be seen as the source of all environmental problems, since it is the individual demand for products and services that ultimately, on an aggregated level, produces environmental effects.

This study aims to add to the understanding of how innovative products and services might affect consumer behaviour in relation to its environmental effects. The importance of this increased understanding is partly academic and partly related to the development of appropriate policy measures to bring sustainable consumption a little closer. Two elements can be distinguished here, which are (1) creating a better understanding of the way in which innovations affect consumer behaviour and its resulting environmental impact and (2) developing an appropriate environmental policy that tries to influence consumer behaviour through specific technological innovations. In the past, both these elements have not been very well developed and have not been studied extensively.

1.2 Modelling environmental effects of consumer behaviour

Because this study focuses on the relationship between consumer behaviour and the resulting environmental effects, it is essential to model this relationship. For this purpose it is especially important to describe how innovative products and services could contribute to a further reduction of the environmental effects of consumer behaviour.

One existing model that seems to be very useful here is a wellknown equation that was first formulated by Ehrlich and Holdren (1971). Various authors have already used it, albeit for different purposes (see e.g. Opschoor and Weterings, 1992 of Vlek, 1995). Considered from a materials flow perspective, the total environmental impact (or environmental effects) of production and consumption (EI) can be expressed by the product of the world population (P), the amount of units of service (US), and the environmental metabolism (EM) of those systems that produce units of service.

$$EI = P \times US \times EM$$

P: Population

The number of inhabitants of the earth is certainly one of the major contributing factors in environmental pollution. The size of the population is an important multiplier in the total environmental impact of the economy. In the context of innovation and design, however, it is not a factor that can be influenced.

US: Units of Service

The number of inhabitants of the earth is certainly one of the major contributing factors in environmental pollution. The size of the population is an important multiplier in the total environmental impact of the economy. In the context of innovation and design, however, it is not a factor that can be influenced.

US: Units of Service

The second entity in the equation is "units of service". It refers to the total package of units of service that an average individual consumes. Units of service are expressed in terms of the useful or functional results of the use of certain products, like driving a car, watching a TV set, or washing clothes in a washing machine. Practical examples of units of service are: 1 kilometre of transport by car, 1 hour of watching television or the cleaning of 1 kilogram of clothes. These units of service directly relate to the extent to which consumers use certain products or technical systems.

All technical systems, which also include simple products, can be seen as production facilities of units of service over their lifetime. Consumer products must also be regarded as (simple) technical systems. The reason for building these technical systems is directly related to their capability of producing units of service. The unit of service is a measure for the functionality or utility of product systems.

It is quite essential to note here that the concept of "product", "artefact" or any kind of "hardware" is absent in this equation. Only the extent to which utility is derived from a product is considered important. Artefacts are merely treated as one of the input factors in

the production process of the units of utility or units of service. Artefacts are considered as only instrumental in consumption.

The quantity of units of service in the consumption process is directly related to consumer behaviour, i.e. to the extent to which products and technical systems are used by consumers. Any intervention in the consumption of units of service should therefore be based on the determinants that regulate consumer behaviour.

EM: Environmental metabolism

The environmental metabolism can be understood as a characterisation of a product or technical system, applied to the production of units of service. It is in fact a multidimensional characterisation of all the environmental effects that result from the production of a unit of service. In the production of a unit of service various input factors like energy and natural resources are transformed into a useful unit of service, together with its non-product output (Reijnders, 1998).

Ayres (1989) introduced the term "industrial metabolism", comparing industrial systems with living organisms (see also e.g. Cramer and Quakernaat, 1993). Living organisms transform certain materials into other kinds of materials. Through inflow, transformation and emission of materials, the organism can exist and fulfil its function. Industrial systems and even specific products can be interpreted as organisms that absorb materials and transform them into other kinds of materials. Ayers shows that the production of some kinds of useful output also implies the creation of (non-useful) waste. Above all, he shows that metabolisms that generate a certain useful output can vary in efficiency. His concept of "industrial metabolism" implies two questions: (1) to what extent is the waste stream environmentally damaging and (2) to what extent is the metabolism efficient?

The term environmental metabolism expresses the different kinds of environmental effects per unit of service. These effects might either be related to the amount of material input per unit of service or to the non-product output per unit of service. For both the input related and the output related environmental effects, a more or less quantitative indicator has been developed. The MIPS-indicator (Schmidt-Bleek, 1994) indicates the Mass Input (of natural resources) per Unit of Service, and the LCA (SETAC, 1993; Heijungs ea., 1992) provides a set of indicators for the environmental impact of the non-product output, classified in a number of effect scores. However, there is still a lot of discussion on the relative value of both approaches (see e.g. Reijnders, 1998; Cramer, 1999).

Although the term environmental metabolism has mainly been used in the context of the analysis of flows of materials in the industrial society, we also find it a useful concept for the analysis of the metabolism of a particular product or product system. The environmental metabolism refers to the environmental efficiency with which a unit of service can be produced. In general, environmental efficiency varies considerably between different brands and products in different price brackets. Of course, the environmental efficiency also depends upon the way in which a certain unit of service is produced.

Environmental efficiency is sometimes also called "eco-efficiency" (Schmidheiny, 1992). However, this term not only involves environmental issues, but also economic aspects. Schmidheiny defines "eco-efficiency" as *"the delivery of competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing ecological impacts and resources intensity, through the life cycle, to a level at least in line with the earth's estimated carrying capacity"*.

For reasons of clarity we will stick to the term environmental efficiency, which is defined as the extent to which a product or technological system is able to produce the desired units of service with the least environmental effects. This definition could serve as an – abstract – overall criterion for all innovative and engineering activities aiming to optimise the environmental efficiency of the production of units of service.

Concluding remarks

In response to the equation as discussed above, various concluding remarks can be made:

- Although the equation has generally been used for the analysis of macro-economic developments like the effects of the growth of the world population, it is also valuable for the analysis of specific cases: The equation shows that there are two major components that contribute to the total environmental effect: the first is consumer behaviour, exemplified by the amount of units of service that are consumed and the second is the technical system used to produce units of service. In other words: not only the volume of consumption, but also the kind of products and services consumers use to fulfil their needs matters in the analysis of the environmental effects.
- In search of ways to reduce the environmental effects, we can basically choose to regulate two entities: either individual consumer behaviour or the technical systems which produce the units of service. It is crucially important to distinguish between these two entities, since they require completely different measures to be influenced in order to reduce the environmental impact.
- The equation clarifies the difference between environmental effects (or environmental impact) and the concept of environmental efficiency. Environmental effects are the result of both consumer behaviour and the environmental metabolism of a technical system, whereas environmental efficiency indicates the efficiency of the environmental metabolism. This environmental metabolism is a property of a technical system that transforms materials into useful units of service as well as waste streams that cause environmental effects. The environmental efficiency can be enhanced by improving the technical system. Such improvements finally lead to new marketable entities: innovative products and services that are offered to the market.
- The equation will be used as an analytical framework for assessing changes in the overall environmental effects. The equation suggests that to assess the changes in the overall environmental effects two major components must be analysed: changes in the environmental efficiency and changes in the units of service as consumed by individuals.

1.3 Intervention in consumption practice through innovative products and services

Improving the environmental metabolism of a technical system entails a process of innovation. The result of such a process is that the environmental efficiency of the technical system through which a certain unit of service is produced, is increased. As already indicated in section 1.1., many authors have argued that this approach could be very effective in changing consumer behaviour in order to reduce the environmental effects of consumption. The underlying idea is that once consumers start to use innovative products and services

with a higher environmental efficiency, the environmental effects of their consumption behaviour will be reduced. Innovative products and services therefore function as interventions in the existing consumption practice.

Many authors (see e.g. Manzini, 1990, 1992, 1993, 1994, 1997; Schmidheiny, 1992; Cramer, 1993, 1994, 1995, 1996, 1997, 1999; Fussler, 1996; Hart, 1997; von Weizsäcker *et al.*, 1997) discuss the idea to intervene in current consumption practice by developing and introducing innovative products and services. This is often seen as a challenge to industry because it requires completely new solutions for fulfilling customer needs. Solutions that not only have to be more environmentally efficient but also have to be competitive in the consumer market.

One of the key publications that represents this approach is "Factor Four" (von Weizsäcker *et al.*, 1996). "Factor Four" has one central message, which is that "resource productivity can and should grow fourfold" and that "the amount of wealth extracted from one unit of natural resources can quadruple". "Factor Four" is clearly a plea for "technological progress" based on a substantial increase in "resource productivity" and offers a variety of technological innovations to illustrate the viability of this idea. The possibilities of an increase in resource productivity are illustrated through a variety of examples of technological innovations in energy consumption, use of material, and transport. The term resource productivity must be understood as an indicator for the environmental metabolism based on resource input.

Most authors (Schmidheiny, 1992; Fussler, 1996; von Weizsäcker *et al.*, 1997; Cramer, 1997) argue that through the introduction of innovative products and services not only the environmental effects can be reduced, but often substantial competitive advantage can be gained as well. Von Weizsäcker *et al.* (1997), for instance, argue that an increase in the resource productivity can be realised at negative costs. This is profitable for businesses and can even be beneficial for countries in terms of international competitiveness. They therefore conclude that the direction of technological progress should be changed not only "for moral reasons, but also for material reasons" (von Weizsäcker *et al.*, 1997).

Conceptual model with general research questions

The discussion about the role of innovative products and services in changing consumer behaviour to reduce environmental effects, gives rise to a variety of research questions. We find two implicit assumptions in the literature worth questioning:

1. First of all, it is assumed that the individual consumer accepts the more environmentally efficient products and services and then uses them as a substitute for former solutions.
2. Secondly, it is expected that the overall environmental effects of a new consumption practice, based on the use of innovative and more environmentally efficient products and services, are substantially lower than those of the current consumption practice.

In this study we want to question these two underlying assumptions for several reasons:

- One of the core ideas of the approach is that through the development and market introduction of more environmentally efficient products and services, a new consumption practice can be created. Through the introduction on the market of these innovative products and services, consumers are offered alternatives that might facilitate a new

consumption practice. However, it can be questioned whether more environmentally efficient products and services also appeal to customer needs. If such innovations do not appeal to customer needs, they will fail in the market and therefore also fail in realising a reduction of environmental effects. Thus, a better understanding of the factors that determine the adoption of innovations is definitely needed.

- In the literature it is also assumed that innovative products and services substitute the old ones and that, because of the higher environmental efficiency of these new products and services, the environmental effects will be substantially lower. Although it can not be denied that, to a certain extent, innovations substitute old solutions, research shows that, in practice, most innovations also create completely new markets. Such a development certainly has also adverse effects on the environmental impact. We conclude that the reduction of environmental effects is highly dependable on the actual motives the consumer has for adopting the new product, i.e. whether the product is substitutive or additional.
- The literature also gives an overview of the behavioural consequences of innovative products and services in the daily life of consumers. Innovative products and services might also generate new forms of behaviour and use, which again might have strong implications for the actual environmental impact. Behavioural rebound-effects or 'revenge effects' (Tenner, 1996; van Dieren, 1996) are likely to occur with any technological innovation. It means that innovations might result in behavioural effects that are contradictory to the initial aims of an innovation. Examples of this rebound effect are the so-called "paperless office", which resulted in an enormous increase in paper consumption, and the fax, which resulted in an increase of the volume of mailings. Rebound-effects are therefore important, because behavioural changes contribute directly to the environmental effects.
- Finally, in most literature, the main concern is with mobilising industry and policy makers instead of validating the approach. Emphasis is put on presenting the general approach, the underlying ideas and a selection of successful examples. As a result, little solid empirical data on the actual environmental effects is presented. It can be questioned to what extent the approach produces the expected environmental benefits in the empirical reality.

In reaction to our critical observations, we have formulated two preliminary research questions:

1. *What are the determinants of adoption of innovative and more environmentally efficient products and services?*
2. *What are the changes in environmental effects of the introduction of such innovative products and services?*

These two questions have been visualised in a conceptual model, which is shown in figure 1.1. The two question marks in the model refer to the two preliminary research questions. Both questions relate to the transition from the current consumption practice to a new consumption practice and the resulting environmental effects: to a great extent, the current consumption practice is conditioned by a set of existing products and services that facilitate individual consumers or households to satisfy their needs. As a result of particular consumer

behaviour, a set of environmental impacts is generated that leads to large scale environmental problems on an aggregated level.

Figure 1.1 Conceptual model

The new consumption practice should be created through the development and market introduction of innovative products and services that are much more environmentally efficient. Consumers are tempted to adopt the new options, which intervene in the existing consumption practice. Once consumers have adopted the new options, a new consumption practice is born. In the end, the new consumption practice leads to changes in environmental effects.

Below, the two core concepts will be discussed in more detail. Section 1.4. focuses on the concept of consumption practice, which is the object of change through the introduction of alternative products and services. In section 1.5. we elaborate on the concept of innovative products and services, which is a container concept for various approaches to improving the environmental efficiency. The relationship between a consumption practice and its environmental effects can be described by the equation discussed in section 1.2.

1.4 Consumption practice

For a better understanding of the nature of consumption practice, it is useful to look at the role products play in consumer behaviour. Products can be seen as indispensable instru-

ments in consumption; they facilitate the fulfilment of consumer needs. Products are closely related to consumer behaviour and, inherently, condition consumption behaviour to a large extent.

We define "consumption practice" as the way in which a desired utility or functionality is produced for the individual consumer. A consumption practice can be understood as a transformation process. It is a description of how such a desired functionality is produced. It not only describes the kind of products involved in the transformation process, but also the organisation of the process, the kind of consumption activities involved, and the kind of resources needed.

For instance, in the case of cleaning clothes, the desired utility is cleaned clothes. This is realised through an extensive process in which a washing machine has to be loaded by the user, filled with detergent, programmed, started, and after a while emptied again. Then the user has to dry the clothes on the line and iron them. Various products are needed like a washing machine and an iron. Besides, resources like water, electricity and detergent are needed. An alternative consumption practice for the same utility is bringing the laundry to the launderette. Obviously, the consumer behaviour related to this consumption practice varies substantially.

The entire consumption practice is the object of design and development. It is assumed that, when developing innovative products and services, not only the hardware – artefacts or products – is designed, but also the organisation of the production process of a certain utility, as well as the kind of input consumers have in the production process. Here, the term production process must be taken in a very broad sense. It refers to the conceptualisation of a production process, in which various input factors or production factors are used for the production of certain results. Figure 1.2 shows the conceptualisation of the production process through which utility is produced.

Fundamental for a proper understanding of the concept of consumption practice is the distinction between the three input or production factors: (1) Hardware, which includes products as well; (2) resources, which include energy and material resources and (3) consumption activities. Consumption activity refers to the time input of people, which may be provided either by service suppliers or by the individual consumers themselves. In other words, it is the behaviour of people in the production process of a certain utility.

Figure 1.2 Consumption practice

The concept of consumption practice emerged from a discussion among economists, economic psychologists and market researchers on a theoretical framework explaining why consumers choose certain products over others. In reaction to former theories on consumption, in particular the micro economic price theory, various researchers have developed alternative theoretical concepts (Lancaster, 1966, 1991; Baudet, 1974; Becker, 1976; Gutman, 1982; Reynolds and Gutman, 1984). The central assumption in these alternative theories is that consumers buy and use products because of their characteristics in use. All theories start from the assumption that only in the use of products, product characteristics are turned into useful end results or utilities for consumers. However, every author uses its own concepts:

For example, Becker (1965, 1976) argues that consumers choose products because of their so-called "commodities". These commodities are a function of specific products, combined with the personal effort in terms of time investment. Commodities are the result of the household production function, in which the time investment plays an important role. Products are just one of the input factors in the production of commodities; invested time is another. Consumers are thought to be maximising utility for the household, in which the product, the time expenditure, the abilities of the customer and the context are the input factors for the production of "commodities" (the – desired – output).

Lancaster's framework (1966, 1991) has the closest links to our conceptualisation of "consumption practice". In his theoretical perspective he explains consumption as a transformation process of product characteristics into utility. In the transformation process, the utilities for the consumer are produced by means of "consumption activities". This involves the use of (a) product(s). Lancaster argues that the consumer derives utility from a product only indirectly, by turning product characteristics into utilities through consumption activities.

Consumption activity is actually a behavioural practice of a complex interaction between consumer and product. The interaction with the product is aimed at the production of characteristics, which directly results in a set of utilities. So, in Lancaster's view the consumer is an active actor, who produces characteristics for him/herself, that fulfil his/her needs. As in Becker's theory, time expenditure is seen as an integral part of the consumption activity. The practice in which the demanded characteristics are produced is dominated by both products and activities. This complex interaction is defined by Lancaster as "consumption technology". Consumption technology is the process, determined by various factors like products, time, and context, in which characteristics are produced by consumers. Consumption technology describes how consumers get the utilities that satisfy them; the concept contains a process as well as a set of applied means. Our concept of consumption practice is very similar to the Lancaster's concept of consumption technology.

The concept of consumption practice is useful here for a couple of reasons:

- It helps in the description of a certain practice or solution to get a specific end-result.
- It provides a reference point for the comparison of various solutions that generate a specific utility or unit of service.
- The concept helps in defining the object of design and development in an innovation process.
- It underlines the relationship and interaction between a certain product and consumer behaviour in generating a specific utility or unit of service.

- It stresses the instrumental role of products in consumption because products are seen as pieces of technology that enable consumers to realise certain desired utilities.

1.5 Innovation strategies for reducing environmental impact

Above, it is assumed that through the development and market introduction of innovative products and services consumer behaviour can be changed and environmental effects reduced. The development of innovative products and services should aim at increasing the environmental efficiency of these products and services. However, the literature doesn't mention a single kind of innovation strategy but a large diversity, varying from small improvements to radical innovations (see e.g. Cramer, 1997). So, to reduce environmental effects, various kinds of innovation strategies could be chosen. These innovation strategies can be differentiated for their effectiveness in increasing environmental efficiency, as well as for their time scope and complexity in implementation.

In this study we have chosen to investigate one particular innovation strategy, called the "Eco-efficient Services"-strategy, in greater detail. In order to specify this strategy and to compare this particular innovation strategy with others, this section provides a classification of strategies for environmental innovation.

A classification of strategies for environmental innovation

Various authors (Brezet, 1997; Jansen & Vergragt, 1993; Vermeulen & Weterings, 1996) suggest various classifications of innovation strategies to improve the environmental efficiency of products and services. For instance, Vermeulen and Weterings even connect the various classes of innovation strategies to potential or expected environmental improvement levels or "factors". In the application of strategies for environmental innovations they distinguish four phases: Phase one focuses on product improvements (factor 2 improvements); phase two on improvements on existing product concepts (factor 5 improvements); phase three focuses on innovations in function fulfilment (factor 10 improvements) and phase four on system innovations (factor 20 improvements). The classification of Vermeulen en Weterings is based upon an analysis of the strategies for environmental optimisation of products and product systems followed in past programs (see e.g. de Hoo, 1991; Zweers and te Riele, 1995; Brezet and van Hemel, 1997; Jansen and Vergragt, 1993). Among the various innovation strategies in particular the system borders for change vary considerably. An important underlying assumption in this classification is that by stretching the boundaries of the system, opportunities to diminish the environmental effects are enhanced.

Inspired by the classification of Vermeulen en Weterings, we propose a slightly adapted classification. We suggest a distinction between the various innovation strategies based on the differences in "objects of design", or "objects of change". This classification helps to position the "Eco-efficient Services"-strategy more precisely within the context of all other innovation strategies aimed at a reduction of environmental effects. In defining the object of change, it is essential to specify which elements are to be included in this system of change. All elements that do not belong to the system of change can, in accordance to systems theory, be called the context. This context is assumed to be external to the system of

change. The context can be interpreted as a given set of boundary conditions, within which changes have to be realised.

We suggest five different objects of change for which different kind of innovation strategies have been developed and applied. For each of the objects of change different criteria for environmental optimisation can be formulated:

- Production processes of products

The most restricted context in which measures to improve the environmental impact of products can be taken, is in the area of production. In the past, many studies have been performed on the environmental improvement of production processes. These approaches leave the product concept unchanged and try to reduce the environmental impact of production by means of add-on clean-up technology, or by integral production optimisations (see e.g. Dieleman *et al.*, 1993). Within this set of strategies, the aim is to accomplish environmental production optimisation based on the existing production process.

- The specific product design over its life-cycle

The second level of improvement activities, concerns the optimisation of a specific product design over its entire life-cycle. The way in which the product itself is treated over the life cycle, and the product concept are given boundary conditions. The improvement activities are basically of a technical nature, which means that the concept of product use remains unchanged, and that only the materialisation of the product itself is adapted to environmental requirements. Different types of adaptations can be made to the existing product concept, varying from e.g. the use of less toxic materials, to lowering the weight of a product, or preventing the wasteful use of a product. Most activities related to eco-design belong to this category. Their main aim is to optimise the existing product design from a life-cycle perspective by using selected (non- renewable) materials, reducing energy consumption, closing material cycles, extending product-life and reducing emissions and waste streams. Based on insight in the relationship between specific design solutions and the changes in environmental effects, a whole range of possible improvement options have been defined. The LiDS-wheel (Brezet and van Hemel, 1997; van Hemel, 1998) shows the range of options to reduce the environmental impact. The LiDS-wheel itself however also addresses other innovation strategies, like the functional optimisation of products. The essence of improving a specific product design over its life-cycle is in fact the application of these more or less general "green design rules", or rules of thumb, in a sensible way, balancing between the environmental impact, the economic reality of a specific company and the opportunities within a specific product system (Böttcher and Hartmann, 1997). The choice for the most appropriate set of improvement options, basically depends on the characteristics of the product itself, the nature of its users, the various (production) processes involved in the products life- cycle and – most importantly – on the opportunities in a specific market.

- The product chain

A more complex and ambitious approach to environmental optimisation is the optimisation of the product chain over its complete life-cycle. The complexity results from the fact that different actors in the product chain are involved. In this class of strategies the aim is to adapt the product chain in such a way that the environmental impact of the product is

reduced. Co-operation between various actors in the product chain is essential for realising this type of strategy (Den Hond, 1996). Organising such a co-operation is often very difficult, since many different companies have to work closely together to form an environmentally optimised chain. This type of strategy is often referred to as "integral chain management" (Cramer *et al.*, 1993). Basically, the optimisation of the product chain over its life-cycle is aimed at closing material cycles through product recovery and recycling options. An important aspect of this type of strategy is that the way in which products are used, i.e. the way in which consumption functions are fulfilled, remains unchanged.

- The product's function fulfilment

An even more complex strategy towards environmental optimisation of consumption practices, is through innovative solutions based on new product or service concepts for fulfilling consumption functions. This strategy has also been called "alternative function fulfilment" (Brezet *et al.*, 1994). This strategy is based on an analysis of the way in which specific functions are being fulfilled. An economically and ecologically inefficient way of function fulfilment can have a number of causes: the rather infrequent use of a product; the temporary use of a product; the existence of separate products for different functions that can be integrated into one product; the fact that a product can be substituted by dematerialised services, etc. By focusing at function fulfilment it might be possible to come up with alternative solutions that have (far) less environmental impact. Providing services as an alternative to products is often mentioned in this context (see e.g. Stahel, 1991, 1993, 1994; Manzini, 1993, 1994, 1997; Giarini and Stahel, 1993; Hinterberger *et al.*, 1994; Schmidt-Bleek, 1994). The aim of this strategy is to optimise the function fulfilment or the production of end results as required by consumers.

In the scientific debate over the past five years one commonly used and broadly accepted concept for the optimisation of function fulfilment has emerged (see for a review of the literature on this topic: Bierter, Stahel and Schmidt Bleek, 1996 or OECD, 1997). This is the concept of the so-called "Eco-efficient Services" (Stahel, 1994; Bierter, Stahel and Schmidt Bleek, 1996; Ö-team, 1998; Schrader, 1999). The concept of "Eco-efficient Services" is based on ideas about the "Service Economy" (Giarini and Stahel, 1993) or 'utilisation-focused economy' (OECD, 1997). The Service Economy aims to optimise the function fulfilment or the production of end-results, instead of optimising the production and distribution of goods. The core of this concept is the fact that the utilisation value of goods is sold instead of the goods themselves. As a result, businesses are providing services rather than selling products.

- The social/ cultural/ legal/ economic/ physical context

The last strategy we mention here, focuses on changing the context of production by influencing the existing cultural, social, legal, economical, and physical boundary conditions in such a way that environmentally friendlier alternatives and technologies become more attractive. This type of strategy seems to move beyond the confinements of product development and into the realm of national politics, since the object of change lies well beyond the realm of influence and interest of the individual company.

Autonomous changes in social and cultural preferences with respect to the nature of and the quantity of demand may also contribute to environmental improvements. In recent pub-

lications the term "sufficiency" (see e.g. SustainAbility, 1995) has been introduced as a reference to the decreased consumption demands of individuals. Such a trend can certainly have a great influence on the overall environmental impact of consumption.

The above-mentioned classes of strategies towards environmental improvements in technical systems were based on a distinction between the system of change/design and its context. In all cases, the context provides a set of boundary conditions, and the system itself is to be optimised by system internal criteria of well-performance. These need to be specified for each level of analysis and optimisation, but can not be inconsistent with lower-level criteria of well-performance.

Research focus

In this thesis the focus will be on one specific strategy in the functional optimisation of existing product systems. As the object of change and design we chose the way in which functions are currently fulfilled. We will adopt the concept of "Eco-efficient Services" as a potential innovation strategy to optimise the function fulfilment of customers or the production of useful end-results. The choice for our specific research focus is based upon a number of considerations:

- First of all, in the mid-nineties various authors characterised the "Eco-efficient Services"-strategy as a very important strategy towards sustainable consumption (see e.g. Stahel, 1991, 1993, 1994; Manzini, 1993, 1994, 1995; Ryan, 1993; Hinterberger et al., 1994). Their arguments were mainly of a theoretical nature. We found it valuable to empirically test the implicit and explicit expectations with regard to the potential of so-called "Eco-efficient Services" to reduce environmental effects. The implicit expectations are best illustrated by the premature name of this concept!
- A second argument for studying the strategy of "Eco-efficient Services" was that in the existing literature we found many blank spots with respect to our two research questions concerning the environmental effects of "Eco-efficient Services" in the empirical reality and the determinants of the acceptance of "Eco-efficient Services". Given the social relevance of this discussion – which is amply demonstrated by a number of policy documents on this issue (see e.g. Ministry of VROM and EZ, 1997) – and the urgent necessity to reduce the environmental impact of the economy, further research is definitely needed.
- A third argument is that the "Eco-efficient Services"-strategy is often illustrated with a new development in the Netherlands, the Car Sharing services (see e.g. Manzini, 1993, 1994, 1995). This new social development provides challenging new research opportunities. It provides the opportunity to empirically test the theoretical ideas with regard to "Eco-efficient Services".
- And finally, with our choice to study "Eco-efficient Services" as an innovation strategy for reducing environmental effects, we respond to the vivid discussion about the experiences and results of past programs on Eco-Design and the optimisation of product design over its life-cycle. The results of the Eco-design programs have been called successful (te Riele and Zweers, 1994; Crul, 1994; Brezet et al., 1994; Böttcher and Hartmann, 1997; Gertsakis et al., 1997). However, what most of these programs and specific interventions have in common, is their basic short term perspective and their mod-

est reduction in environmental effects (see e.g. Bakker 1995; Vermeulen *et al.*, 1996; RMB, 1996; OECD, 1997). The strategy of "Eco-efficient Services" has frequently been suggested as a strategy that could help address these limitations. Moreover, it is thought that such a fundamental innovation strategy would bring about an improvement of the environmental efficiency with a factor 10 (see e.g. Vermeulen *et al.* 1996; RMB, 1996).

1.6 Area of investigation: Car Sharing services in the Netherlands

In essence, both research questions (see 1.3) call for an empirical reflection on the theoretical concept of the "Eco-efficient Services"-strategy. To answer our research questions, neither scientific experiments nor any other kind of simulation could be used as a research method. To evaluate the actual environmental impact in the empirical reality and to distinguish the determinants of adoption, the study of appropriate cases in a field study proved indispensable, as sufficient understanding could not be gained on the basis of theory alone.

Choice of specific area of investigation

As soon as the concept of "Eco-efficient services" was chosen as the innovation strategy we wished to study, we had to decide in which field the theoretical ideas could best be tested. Various fields were considered, like washing and ironing services, energy services, leasing services of large consumer goods, and telecommunication services. Since little specific scientific knowledge was available on the concept of "Eco-efficient Services", particularly on the consumer perspective and the changes in environmental effects, our choice for the case to study could only be made quite pragmatically, based on a couple of rather general criteria. These criteria included:

- obviously, the case should apply to the definition of the concept of "Eco-efficient Services";
- the possibility to collect empirical data among users of these services on both acceptance issues and consumer behaviour;
- the availability of a set of users of who recently switched over to the use of "Eco-efficient Services";
- the potential for enhancing the environmental efficiency of the consumption practice through the development of these new services;
- the potential for reducing the environmental effects with the new service through changes in consumer behaviour;
- the existence of an autonomous development in the market aiming at the introduction or further expansion of an "Eco-efficient Service";

On the basis of these criteria, we chose to study the concept of "Eco-efficient Services" in the field of Car Sharing services in the Netherlands.

Car Sharing is an innovative and emerging commercial concept that arouses great interest among many sectors of society, especially among individual consumers. Car Sharing is basically a service that offers rental cars as an alternative to the privately owned car. The service is aimed at providing access to a car and the use of a car whenever necessary. The Car Sharing concept relies on a new organisation structure for the car system. The car is no

longer the user's property, but is owned by an organisation, the "fleet manager". This fleet manager provides all clients with a car, whenever they need one. The economic transaction between the customer and the service supplier is based on the utilisation value of the car: consumers pay per unit of enjoyed service, which is measured in time and in mileage. We may therefore conclude that Car Sharing is an example of the concept of "Eco-efficient Service". Whether Car Sharing actually is more environmentally efficient, must be proven by research.

In the beginning of 1994, we selected Car Sharing services as the field of research for a number of reasons:

- Car Sharing services are an example of the concept of "Eco-efficient Services": They are often mentioned as such by various experts on this topic, because these kind of services provide mobility by car as an alternative to the privately owned car. The utilisation value of a car is sold instead of the car itself. Chapter 2 will expand on the nature of the concept of "Eco-efficient Services" in more detail.
- For our research among clients of various Car Sharing corporations, we secured the support of the Dutch ministry of Transport. Their support was a convincing argument in getting the various companies to co-operate and allowing us access to their database of clients.
- Most organisations involved in the field of Car Sharing shared the assumption that by developing and introducing Car Sharing services, an interesting alternative to the current inefficient ways of car use could be created. It was often mentioned that in Western societies the consumption practice of private car ownership was very inefficient because according to the statistics (CBS, 1997), on average, cars are used for only 73 minutes a day. Shared car use with a couple of households would enhance the efficiency substantially. Knowledge on the potential to enhance the environmental efficiency is however lacking.
- Another commonly mentioned assumption was that Car Sharing services would stimulate consumers to make less use of the car and to use the train and public transport instead. The argument was that due to the absence of fixed costs of car use for households and the (almost) complete variabilisation, alternative travel modes would become more attractive. As a result, consumption behaviour was likely to change substantially, as were the related environmental effects. Insight in the changes in behaviour was not available.
- Finally, right from the start of the development in the early nineties, consumer acceptance of Car Sharing services seemed to be feasible (see also AGV, 1993). The autonomous development in the market showed that the great public interest could be turned into actual membership of such service organisations without financial support from the government.

We decided to address the two major research questions in this thesis, mentioned in section 1.3., by conducting an empirical study on Car Sharing in the Netherlands. The empirical study consists of a large scale survey among consumers who (out of positive or negative motives) have decided to adopt Car Sharing.

The field of research: Car Sharing

Car Sharing is interpreted as a practical example of an Eco-efficient Service and must be understood as an umbrella concept for a large variety of formal and informal service offers to individual consumers or households. For this study we have defined Car Sharing as follows:

Car Sharing is the sequential use of one single automobile by various users independent from each other. The sequential use of the car is made possible by a more or less formal service organisation within which the costs for car use are paid in proportion to the actual use. This formal organisation might be formed by third parties or companies.

In addition to this definition some clarifying remarks can be made:

- Car Sharing services are originally meant as an alternative to the privately owned and individually used car. However, the service is open for all consumers, carless people as well as current car owners. So, in practice, Car Sharing services might function as an alternative to buying a car (or even buying a second car) or as a substitute for the privately owned car (or even the second or third car).
- In the current practice the car is already one of the consumer goods subject to shared use. In most cases the car is bought by the family or the household and intended to be used by all individual members of the household who have a drivers licence. Often informal arrangements are made for shared use and the costs are seldom charged to the individuals within the household. In our study we do not consider the shared use of the car within a household as a formal organisation for Car Sharing.
- The definition also includes non-commercial Car Sharing organisations. Frequently, various households already use a car together. Based on an agreement between the various households, all the participants of this rather informal organisation have access to a common car. Here, all costs are charged to the individuals to the extent of their use of the car. In this study, however, we aim to search for strategies for industry, and we therefore propose to exclude non-commercial Car Sharing organisations from the scope of our empirical study.
- Within Car Sharing schemes, generally the car is either subject to shared ownership or to the ownership of a third -commercial- organisation. This means that in Car Sharing services the connection between the availability of a car or access to car use and the (individual) car ownership is broken.
- In comparison to conventional rental services, Car Sharing services can be seen as an innovation for various reasons. First Car Sharing service position themselves as an alternative to the privately owned car. Secondly Car Sharing services are far more flexible than conventional rental services: Cars can be rented for short periods of time (one hour) and cars are not distributed from centralised outlets, but from special parking places in the urban area. Above all Car Sharing services apply the newest information and communication technology to identify users, to register the use of the car and to facilitate the payment of the service.
- We make a clear distinction between Car Sharing services and taxi services, since Car Sharing involves self-driving.

In short, we will interpret Car Sharing as an innovative and emerging commercial service concept that offers a new kind of rental car as an alternative to the privately owned car. The service is aimed at providing access to a car and the use of a car whenever necessary.

Shared car use

Most cars are designed for the transport of at least two passengers; the majority even for four to five. Often cars are also used for the transport of two or more passengers. It must be stressed that these types of shared car use are not considered in this study, although their relevance for reducing the environmental impact of mobility is very high! It is important for a clear understanding of the concept of Car Sharing to distinguish various kinds of shared car use. According to Baum and Pesch (1994) four different forms of shared car use can be distinguished, either based on whether the arrangements between the various users are formal or informal, or based on whether the shared use is sequential or simultaneous. The table below illustrates the differences between hitch-hiking, commuters in van-pools, shared car use within households and Car Sharing service schemes.

	Informal	Formal
Car-Pooling	hitch-hiking	commuters in van-pools
Car-Sharing	common usage within the household	Car Sharing service schemes

Table 1.1 A characterisation of Car Sharing (Baum and Pesch, 1994)

1.7 Specification of empirical research questions and method

In section 1.3. two preliminary research question were formulated, questioning the general idea that by developing innovative products and services – which are much more environmentally efficient in their production of certain functions – a new consumption practice could be created that results in less environmental impact. As we have shown in 1.5., various innovation strategies to improve the eco- efficiency can be distinguished. Based on our choice of the concept of “Eco-efficient Services” as an innovation strategy to improve the environmental efficiency of a certain consumption practice, the preliminary research questions could be reformulated: The first one, concerning the determinants of consumer acceptance can be reformulated as: (What are the determinants of consumer acceptance of Eco-efficient Services?) and the second one, concerning the changes in the environmental effects as: (What changes occur in the environmental effects as a result of the introduction of so-called “Eco-efficient Services?”).

Given our choice to study Car Sharing services as an example of the concept of “Eco-efficient Services”, these two research questions can be specified into more detailed empirical research questions:

Consumer acceptance

The concept of "Eco-efficient Services" is an approach that, in theory, leads to more environmentally efficient consumption practices and to less environmentally damaging consumer behaviour, which also applies to the particular case of Car Sharing. However, (large scale and) positive consumer acceptance is a necessary condition for realising the desirable environmental effects. In case of little consumer acceptance, the implementation in the market would definitely fail and, in that case, the practical value of the concept would be negligible. It can reasonably be argued that the practical value of Car Sharing depends on its long-term acceptance as an alternative option. It is important to recognise that for long-term consumer acceptance two different conditions must be fulfilled:

First of all Car Sharing must be adopted by consumers in a market in which different competing consumption practices exist, with the private car as a dominant option. In the consumers' choice, Car Sharing must prevail over the other options, on the basis of one or more competitive advantages. Consumer acceptance in the long run requires first of all a positive purchase decision in favour of Car Sharing.

Secondly, the adopted innovation must not only be the preferred option in the adoption process, but also a satisfying option in the long run. This means that Car Sharing must maintain a high perceived service quality during all the service transactions over a longer period of time. A high perceived service quality can be considered a precondition for the permanent incorporation of the innovation in consumer behaviour. The reason for this lies in the nature of services: Whereas cars are generally bought and therefore "force" the consumer to adhere to his own car, Car Sharing services usually provide the consumer with flexibility in consumption and leave the consumer the option of buying a car (again). For long-term consumer acceptance and for a long-term value of the concept of "Eco-efficient Services" in general and for Car Sharing services in particular, the service provider must maintain a high service quality for its customers.

Based on the first general research question, we have specified two empirical research questions with respect to the case of Car Sharing:

1a. What are the determinants of the adoption of Car Sharing by the individual consumer?

The term adoption refers to a theoretical perspective ("The diffusion of innovations" by Rogers, 1983, 1995) on the acceptance and the social diffusion of an innovation in society. In chapter 5 this theoretical concept will be discussed further in relation to the current study. Car Sharing can be seen as an innovation that needs to be accepted by individuals before they will actually adopt the innovation. Adoption can be seen as the result of a more or less extensive decision-making process with regard to an innovation. It finally leads to use of the innovation.

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

Once people, convinced of the potential benefits of this service for their daily practice,

decide to try Car Sharing, it is essential to keep these people as long-term customers. This is not only essential from a business point of view, but if Car Sharing organisations succeed in doing so, it will prove that, in the long term, Car Sharing is also a feasible concept. If customers are not satisfied with Car Sharing and leave the service organisation, this would mean that, in the long run, buying automobility instead of buying a car is not a viable solution for fulfilling customer needs. A high service quality perception can be considered a key concept in retaining customers. It represents the general attitude towards the performance of a specific service over time and is based on the satisfaction with numerous separate services rendered over time.

Changes in environmental impact

Our second general research question concerns the changes in environmental effects in the empirical reality, when so-called "Eco-efficient Services" are introduced as an alternative means for producing a certain functionality. From the equation of Ehrlich and Holdren (1971) (see section 1.2.) can be concluded that for an assessment of the changes in the environmental effects, two essential elements must be distinguished. 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. Changes in both elements contribute to changes in the overall environmental effects.

The first element is a technical or functional assessment based on a comparison of the environmental effects of the production of one unit of service. In this kind of assessment changes in consumer behaviour are not taken into account. In chapter 2, the mechanisms by which so-called "Eco-efficient Services" influence the environmental efficiency of a certain consumption practice will be formulated. These mechanisms are based on the expected changes in the technological and organisational systems in the context of the Service Economy and the resulting changes in the environmental efficiency of the production of units of service. From the description of the new service system, an assessment can be made of the environmental efficiency of the production of a specific unit of service, in comparison with the former solution.

The second element is a new element in the overall environmental assessment, especially with regard to innovative products and services. Changes in consumption behaviour contribute to a large extent to the overall environmental impact. What these changes entail is generally unknown. Changes in consumer behaviour can only be evaluated through empirical study. As we intend to do an empirical study on consumer behaviour in Car Sharing services, we are able to specify our empirical research question in more detail:

2. What are the changes in mobility behaviour after the adoption of Car Sharing and how can these changes be explained?

For the environmental assessment, a comparison of past mobility behaviour with the new mobility behaviour is needed. Mobility behaviour basically refers to the use of the various means of transport, including the use of the car. Reducing the environmental impact of mobility requires a reduction in the use of the car and the shift to other – less polluting – travel modes.

1.8 The structure of this study

To conclude the first chapter a schematic overview of this thesis can be provided (figure 1.3). As shown by this scheme, in this thesis a clear distinction is made between theory and the empirical study. The empirical part of this study is basically a consumer behaviour study.

Figure 1.3 The structure of this thesis

In Chapter 2 the innovation strategy of “Eco-efficient Services” will be discussed in more detail. Based on theoretical considerations, the “Eco-efficient Services” approach is expected to lead to consumption practices that are more environmentally efficient than existing solutions. Theoretical modelling of the environment-economy relationship and the role of artefacts in the economic process of creating wealth has lead to the theoretical concept of “Eco-efficient Services”.

The empirical research questions that follow from the theoretical concept of Eco-efficient Services, are tested in the field of Car Sharing service schemes. In chapter 3 a description of the field of Car Sharing services in the Netherlands is given.

In chapter 4 the empirical research questions are specified for our field of research. Based on exploratory research, the empirical research questions are discussed in more detail.

Chapter 5 aims to specify the conceptual model that describes the major research concepts and relationships relevant to the empirical research questions. A general theory on innovation decision making and consumer behaviour, together with findings from our exploratory research, supports the construction of our conceptual model and the formulation of hypotheses in this chapter.

Chapter 6 elaborates on the research *method* and the data collection. Chapters 7, 8, and 9 report on the testing of the hypotheses. Chapter 7 deals with the adoption decision of Car Sharing services; chapter 8 with the service quality perception of Car Sharing services and chapter 9 with the changes in mobility behaviour.

In chapter 10 the second research question, regarding the changes in environmental effects is answered, based on the empirical data.

The final two chapters contains the conclusions of our empirical study on Car Sharing and reflects on these results from the perspective of the theoretical concept of Eco-efficient Services. The epilogue projects the development into the future, into the year 2010.

2 The concept of “Eco-efficient Services” as a potential innovation strategy for sustainable consumption

2.1 Introduction

In chapter 1, the concept of “Eco-efficient Services” was introduced as one of the possible innovation strategies to reduce the environmental effects of consumption. Then we presented the Eco-efficient services approach as the type of innovation strategy we choose to study. This approach is based on a different or new kind of transaction between supply and demand: the concept of “Eco-efficient Services” encompasses all market approach strategies that offer the utilisation value of products instead of their transactional value. Although the outlines of the concept of “Eco-efficient Services” have roughly been sketched, a closer look is definitely needed. Questions like ‘what exactly does this approach entail’, ‘what is the origin of this concept’, or ‘why should this approach lead to lower environmental impact’, must be discussed further. That is the subject of this chapter.

The concept of “Eco-efficient Services” entails a specific analysis of the interaction between the economy and the ecology, especially with respect to flows of material. This is particularly important since, through technological development, companies design (parts of) the transformation process of resources – or what has been defined as “consumption practices” – into socially useful and desired results.

Over the past two decades, environmental economists have been working on new kinds of models for the interaction between the economy and the ecology, especially with respect to the material flows (see e.g. Huetting, 1980; Opschoor, 1989; Pearce and Turner, 1990; Dietz et al., 1991; Turner et al., 1994; van Dieren, 1996, 1997; Daly, 1977, 1992, 1996). They developed a new macro economic model, specifying the relationship between the ecology and the economy, that is rather different from conventional macro economic models. The basic assumption of environmental economists is the lesson that can be drawn from the laws of thermodynamics: all resource extraction will eventually result in waste products and all systems will develop towards high entropy (see e.g. Georgescu-Roegen, 1971). They assume that in the long run the economy is entirely dependent on the capacity of the eco-system to regenerate the high entropy material flow from the economy and to produce low entropy resources for the economic system. It is this capacity for regeneration that limits the size of the economy. The economy should therefore aim at using the maximised flow of resources in the most productive way for human society. This implies that, for economic development, it is not the mere growth of the economy that is most important, but the extent to which a certain flow of materials and energy is turned into useful results for society. The environmental economists’ plea for a qualitative economic development can therefore be seen as a search for guidelines to enhance (ecological) efficiency. Turner (1994) concludes: *“Once the materials balance perspective is adopted, it is easy to see that the way humans manage*

their economies impacts on the environment and, in reverse direction, environmental quality impacts on the efficient working of the economy”.

2.2 The “Steady-State Economy”

Building upon the fundamental analysis of the environmental economists regarding the relationship between the economy and the ecology and the conclusion that the limits of the eco-system also impose limits on economic activities, especially regarding the extraction of resources and the output of wastes into the natural environment, the former World Bank economist Daly has developed a conceptual model of a “sustainable” economy. His model presents a description of efficiency, which relates the efficiency of economic activities to the impact on the natural environment. Daly’s conceptual model contains an analytical framework for the economy and some basic criteria for economic development and is called the “Steady State Economy” (SSE). Understanding this model helps to grasp the concept of “Eco-efficient Services” (section 2.4).

In his books “Steady State Economics” (1977, 1992) and “Beyond Growth” (1996), Daly has defined the concept of “Steady State Economics” from the notion that the earth, in a material sense, is a closed system and that (economic) development, progress, and welfare should be defined within the boundaries of this system earth. His underlying assumption is that the economy can be seen as a physical, open system, a fund of services, that yields assets, maintained by a throughput beginning with the depletion of nature’s resources of useful low entropy and ending with the pollution of nature’s sink with high entropy waste. In the interaction between the natural environment and the economy, two physical entities are important: the stock of capital (consisting of people and artefacts) and the flow of throughput. The stock is created for human purposes: the stock satisfies wants and needs and can be seen as a fund that provides services for society.

The assumption that the stock is “only” a means to an end, and not an end in itself, is fundamental in the SSE concept, as it is in the context of this study. From this assumption follows that wealth does not depend on the mere availability of a certain stock, but on the amount of services derived from that stock, at low maintenance costs.

In his vision on environmental economics, Daly attributes a large role to the laws of thermodynamics. Here he draws heavily on the pioneering work of Georgescu-Roegen (1971) and Boulding (1966). The second law is especially valuable as it helps to understand the interaction between the natural environment and economic activities: all useful things are of a low-entropy nature and low entropy is scarce in the universe. Low entropy matter/energy is the ultimate means for all economic activities and exists in two forms: a terrestrial stock and a solar flow. Daly argues that, society depends on the earth’s capacity to regenerate for all its fundamental needs and should therefore keep its throughput within the carrying capacity of the earth. This means that the level of throughput should keep in pace with the earth’s capacity to produce low entropy energy and material.

Daly defines the Steady State Economy (SSE) as "an economy with constant stocks of people and artefacts, maintained at some desired, sufficient levels by low rates of maintenance *"throughput"* (...) The concept of "constant stock" plays a key role in the Steady State Economy. With the "stock" Daly means both all available artefacts and people: "Stock (...) may be thought of as the set of all physical things capable of satisfying human wants and subject to ownership." In Daly's view, the stock has been created because it offers advantages to society. These advantages are called "services" or "the satisfaction experienced when wants are satisfied". The advantages of a stock are essentially a flow over time. This means that they must be treated as a dynamic quantity over time.

The third main concept Daly introduces in his Steady State Economy is *"throughput"*. Throughput stands for the stream of materials and energy flowing from natural sources into the economy and out again into the natural environment. Throughput is needed for the maintenance and renewal of the stock. The figure below shows the Steady State Economy and the interrelations of the various entities, the eco-system and the economy.

Figure 2.1 The concept of the Steady State Economy (Daly, 1977)

Despite the fact that Daly characterises the economy as a "constant stock", he does not argue against technological changes. On the contrary, the composition of the stock is subject to technological development, structural changes in institutions, economic boundary conditions, cultural changes, as well as the specific know-how and experiences of people. It is called a constant stock because the capital stock in the broadest physical sense of the term, (including capital goods, the total inventory of consumer goods, and the population of human bodies) should remain at a constant level. From the fundamental notion of the limitations of the eco-system earth, also characterised as "Spaceship Earth" (Boulding, 1966), follows the existence of a certain – but difficult to establish – level of throughput, at which the quantity of stock that can be maintained and renewed over time has reached its limit.

Within the Steady State Economy, a clear distinction is made between economic development and economic growth. Economic growth suggests that the stock increases in a quantitative sense, and therefore the needed throughput grows as well. In contrast, economic

development aims at a further improvement of the productivity of the stock in terms of the services delivered, while maintaining a constant level of throughput. This leads to a qualitative development rather than a quantitative one, resulting in a larger stock. Thus, from a Steady State perspective, all economic and technological development should be aimed at the qualitative improvement of product systems. In this perspective, the definition of efficiency is essential, because it specifies what kind of optimisation is needed.

In the concept of the SSE, the notion of efficiency takes on a completely different meaning from the one it has in conventional economics, where efficiency is associated with the extent to which materials can be transformed into products and the extent to which products can be marketed at low cost. In conventional economic theory efficiency is used as a measure for production costs in a larger sense, including distribution.

The SSE concept, however, takes the position that all costs, in a monetary and in an environmental sense (throughput), necessary to produce an amount of services over a certain period of time must be taken into account. These costs have to be measured against the quantity of services delivered over time. It is the "nature, extent, quality and complexity of the capital stock that determines how much service, how much want satisfaction, is yielded by the stock". This determines the service/ throughput ratio, which Daly also called the "service efficiency of the stock", or simply "efficiency".

By minimising the throughput and enhancing the service delivered by the stock, society benefits in terms of prosperity and a reduction of the environmental impacts of economic acts. In Daly's view, it is the amount of services delivered which is important and not the mere availability of a certain stock. Wealth depends on the quality of the stock and its capacity to provide the necessary services over time. The following identity shows the concept of efficiency in Steady State Economics:

$$\begin{aligned} \text{Efficiency} &= \frac{\text{benefits}}{\text{cost}} = \frac{\text{service}}{\text{throughput}} & \text{I} \\ \\ \text{Efficiency} &= \frac{\text{services}}{\text{stock (1)}} \times \frac{\text{stock (2)}}{\text{throughput (2)}} & \text{II} \end{aligned}$$

Figure 2.2 Efficiency in the Steady State Economy as defined by Daly (1977)

Service is the final benefit of economic activity and is by nature a function of the stock and not the mere availability of products or stock. Throughput is the total of costs needed to maintain and replace the stock. Efficiency (defined as benefits divided by costs) equals services delivered by the stock over time divided by the throughput needed by the stock.

The efficiency of the stock is expressed by Daly, in a simplified form, in two ratios. Each of the two ratios in the second equation expresses a dimension of efficiency. The stock appears in both ratios, as it can be seen as the intermediate entity between the throughput (which has to be minimised) and the services resulting from the stock:

1. The (artefact) service efficiency (services / stock)

The service efficiency of a given amount of stock depends on the allocation of various artefacts to various people to satisfy their individual needs for service. It is the extent to which, with a minimum of stock, the highest possible amount of -services can be produced for a group of people. Stahel e.g. (1994) defines this as "utilisation optimisation" or "utilisation efficiency". In practice, service efficiency could be raised by e.g. increasing the frequency of use of individual products by means of shared use between various people. The existing Car Sharing schemes in Western Europe are a good example of attempts to optimise the service efficiency related to artefacts like cars.

2. The (artefact) maintenance efficiency (stock / throughput)

Maintenance efficiency is essentially the turnover or the renewal period of the artefact stock. The more durable, repairable, upgradable and high-level recyclable the stock, the longer it will last. The less maintenance and replacement a stock requires, the greater its maintenance efficiency is.

Conclusions

From Daly's analysis, an important conclusion can be drawn regarding technological innovation and the definition of products (as a substantial part of the stock in the economy): improving the service efficiency and improving the maintenance efficiency are two complementary strategies. Both types of efficiency reflect the same underlying assumption: the main economic value of a product does not originate in the mere existence of the product, but relates to its capacity for providing functionality or services to consumers over a certain period of time with the least possible throughput.

Although this assumption might be correct from a theoretical point of view, at present it is certainly not common practice in industry. It is also questionable whether this assumption is compatible with the current practices of consumers and their perception of the value of products for individuals. These are issues we aim to address in our empirical study.

2.3 The "Service Economy" versus the "Industrial Economy"

Daly's description of the relation between the economic system and the ecological system and his modelling of these two systems with respect to long-term existence, was formulated on a very high level of abstraction; the macro-economic level. His conceptualisation shows (1) that the economic system is fundamentally subordinate to the ecological system, and (2) that for a useful and relevant assessment of the efficiency of present solutions to fulfil needs, the functionality of artefacts is an appropriate analytical basis, and (3) that wealth does not depend on the mere availability of artefacts or products, but on their performance in use. Artefacts or products should be treated as instrumental to fulfilling consumer needs.

Despite these valuable, general conclusions, few concrete (prescriptive) guidelines can be derived from this set of theoretical ideas for innovative processes within industry. Since it is our aim to investigate the opportunities for changing consumer behaviour based on innovative solutions for fulfilling consumer needs, the implications of the Steady-State Economics for product policy and innovation processes need to be investigated in more detail.

In his concept of Steady-State-Economics, Daly only implicitly suggests some strategies towards a qualitative improvement of the "stock". The stock represents the state of the art of technological knowledge and the existing organisational structure. Any qualitative improvement should therefore focus on technological and organisational change, so that the required functionality, or services, can be produced with less throughput.

One of the pioneers to bridge the gap between this kind of macro-economic ideas and real-life strategies regarding product policy and product innovation was Stahel, of "the Productlife Institute" in Geneva. His work is closely connected with the concepts of Steady State Economics. The strategies he suggests are based on what he calls 'a new economic paradigm': the "Service Economy" (see e.g. Giarini and Stahel 1993).

The Industrial Economy

Stahel's ideas about the Service Economy were formulated in reaction to a widely used model of economic development, called the "Industrial Economy". According to Giarini and Stahel (1993), the key characteristic of the "Industrial Economy" was an increase in productivity: by making better use of scarce resources, more goods could be produced with less resources. A more specialised production technology and new and increasingly efficient tools – in terms of speed, labour intensity and capital requirements – were the key features of this process. New methods of production were developed in order to maximise the production of goods at the lowest costs. The complete production process was thus optimised, up to the point of sale. As a result, profits depended on the reduction of production costs and on providing as many goods to the market as possible, at the lowest possible cost. Giarini and Stahel stated that the "Industrial Economy" is basically a quantitative development.

A second essential characteristic of the "Industrial Economy" is the monetarisation of the economy and its separation from the non-monetarised world. This meant, for example, that goods which were freely and abundantly available, like fresh water and other natural resources, had no price. The "Industrial Economy" excluded the non-monetarised world from the economy, and focused exclusively on an (economic) optimisation of production. As a result, the "Industrial Economy" didn't include any external factors (the non-monetarised world) in its optimisation of production systems. Thus, non-monetarised costs could be passed on to the non-monetarised world without influencing economic decision making. This approach seems to suggest that these costs do not have any effect on the economic system, ignoring a reality which actually shows the opposite.

Giarini and Stahel argue that the dominant model of economic development, associated with the economic optimisation of the production of goods by specialised technologies and the economy of scale, has reached its limits. There are several reasons why the Industrial Economy does not seem to work anymore as a way of bringing more prosperity to society:

Today's industrial systems are designed in such a way that the production costs of goods have dropped to very low levels; nowadays, production costs only make up a very small part of the total costs involved in making a product available to a consumer. Optimisation of the production system therefore does not contribute as much to the competitiveness of a company as it has done in the past. Moreover, the optimisation of existing production systems has meanwhile become a less important tool for cost reduction than, for example, improvements to the distribution system.

Optimisation of production systems often involves an increasing specialisation and centralisation, or even globalisation, of production. As a result of the economy of scale strategy, distribution and organisational costs have increased, since most products are now produced far away from where the (potential) clients live. Centralisation inherently causes more trade and more and larger freight volumes. These costs must be balanced against the decreasing marginal costs in production. In many areas of production, the advantages of the economy of scale no longer outweigh the increase in distribution cost and effort.

Another fundamental limitation of the "Industrial Economy" is that, despite the fact that the production system and the economy are not isolated from the non-monetarised world, the monetarised economy does not recognise the contribution of the non-monetarised world in the production of wealth. Common sense suggests – and even economists have always admitted this – that a substantial part of all productive activities in society are performed within a non-monetarised context. Moreover, the externalisation of the non-monetarised costs to the non-monetarised world has slowly become a substantial force that is already affecting the monetarised economy. The productivity of the natural capital (e.g. de stock of fish, soil, trees) has already declined to such an extent that it has started to influence the creation of wealth.

The Service Economy

In response to the analysis of the "Industrial Economy" above, Giarini and Stahel argue that our current society is progressively moving out of one cycle, the "Industrial Economy", and into another: the "Service Economy". They defend the idea that this is an obvious progression, not only in theory, but – more importantly – that it is an inevitable shift in real-life economic development: *"The process of diminishing returns of technology is not only one of the keys to a proper assessment of the situation, but also a crucial way of bringing economic analysis closer to scientific and empirical requirements. It does not mean that technology has ceased to develop or produce useful results. Quite the contrary. It merely means that the main results of modern developments in science and technology do not have to do primarily or exclusively with manufacturing systems. (...) In future, any fundamental innovation, even at the manufacturing level, will take place within the context of the Service Economy, where the main target will be that of making products available throughout their period of utilisation (or in other words, the selling of utilisation, that is a service, rather than goods".* (Giarini and Stahel, 1993)

Above all, Giarini and Stahel show that this shift in the economic paradigm has already started: it is already partially reflected in changes in the manufacturing industry and in changes in business. According to them, the main force behind this change is the fact that for almost all products the pure manufacturing costs account for only a minor part of the

retail price of products. The relative importance of production costs becomes even less significant if a cost assessment for the full life cycle of the product is made. The costs of using, maintaining and servicing the product are often substantial, which makes the relative importance of the production costs even smaller. They conclude that, in general, the production as the focus for economic optimisation has lost a great deal of its importance, especially when all functions in the product chain from "cradle to grave" are included.

According to Giarini and Stahel, the decreasing relative importance of the production function, in comparison with various other functions in the product chain, is basically the result of the economic developments over the last century: since the first decades of the industrialisation, production systems have become much more complex and require much more specialised functions and services in order to develop, produce, and deliver products to the customers. Nowadays, the modern complex product chain is indispensable to make products available to consumers. It consists of many specialised tasks related to the complexity of the entire production system, like planning, marketing, product development, engineering, production planning, assembly, distribution, servicing, repair, waste treatment and many more.

To summarise Giarini and Stahel's argumentation, the complex mature production chains can be characterised by two, partly related, elements.

First, products have become so complex that they can only function – and become valuable for customers – with the support of the complete product system. Many functions, like servicing, maintenance, spare parts, information, updating of software, specific additional products, and many more, contribute to the way a product functions within a product system, a system which, as has been argued before, extends well beyond the mere production function. So, for any improvement in the efficiency of the product itself, the entire product system should be taken into account. To increase product efficiency, not only all separate functions in the product system should be economically optimised but, preferably, the integral product chain be redesigned for a more efficient performance of the product's functionality.

Secondly, with the increasing importance of the product system for the performance of a product, and a diminishing role for the product itself, the cost structure also changes. In the Industrial Economy the costs of the product (the hardware) played a major role in the total life cycle costs of the product's use, whereas nowadays the product itself is one of the less important cost factors. As a result, the costs of product use, which incorporate all life cycle costs over the utilisation period, including those for the product itself, become the optimisation focus.

A comparison of two economic paradigms

By means of a comparison between two models of economic development, Giarini and Stahel have specified two different economic "paradigms": the Industrial Economy and the Service Economy, of which, according to them, the latter evolves quite naturally out of the former. *"The real difference between the two is the concept of economic value. In the Industrial Economy, economic value was linked to a product's existence, to its transactional value and to improvements in productivity, derived essentially from improvements in the manufacturing process. Economic value in the Service Economy, on the other hand, is derived from the functioning of a system, the productivity of which can only be measured*

in terms of improved and increased performance, as related to the final result. The reference is not to the product, but to its utilisation, which is the proper and useful functioning process." It is the utilisation value during the utilisation period – as defined by Giarini and Stahel – which is the key issue in economic and technological/organisational development. So, in the Service Economy the focus of analysis and the focus of improvement is on the functionality of a product system, which includes a product, or the results of the utilisation of the product system.

Connected to these two economic paradigms, two different business economic principles for generating turnover and profit exist. In the Industrial Economy profitability is linked to the point-of-sales volume of goods and the capacity to reduce the production and distribution costs of goods by economy of scale advantages, whereas in the Service Economy profitability is based upon the efficiency in providing results, or the sale of utilisation of goods. Thus, in the Service Economy profitability is based upon the quality of a system aimed at providing services to the customers.

To summarise, we will mention some important characteristics of the (new and emerging) Service Economy. Based on these characteristics, a distinction can be made between an economy (the Industrial Economy) in which a linear production-consumption system dominates, generating high levels of throughput, and an economy (the Service Economy) that seeks technological and organisational solutions for a more efficient use of resources to produce the services society demands. It can be argued that in the long run the Service Economy puts strong economic incentives on ecologically efficient solutions for customer demands, i.e. solutions that require the least possible throughput. This argument will be developed further in section 2.5.

An important characteristic of the Service Economy is that it seeks to optimise product systems, instead of the production of products. Within the Service Economy, current solutions for providing a demanded functionality to customers are analysed in the context of the entire product system, from cradle to grave, or from the input of basic resources to the output and treatment of used materials. Over this entire life cycle, an optimised solution for producing the desired functions is sought, even if this requires completely new technological solutions or organisational restructuring. This integral approach is the result of the strong interconnectedness of product and product system.

A second important characteristic for businesses in the Service Economy is the fact that, despite the various practical strategies and variations in strategies, a common basis for generating cash-flow and profits is used. Instead of generating turnover by selling as much products as possible, businesses now generate turnover by selling the functionality of products or, in other words, the utilisation value of products. As a result of this new commercial orientation, profit can only be made when, over the full life cycle, higher levels of efficiency are reached, either by increasing the functionality of a product or by using less resources.

A third characteristic of the Service Economy is the instrumental role of products. In the Service Economy the role of products in the consumption process has changed. In the Industrial Economy, the product is seen as the ultimate aim to be owned by the customer in

order to get the desired functionality. In the Service Economy however, the product, or the hardware, is only instrumental in the production of utility. The way in which products are made available to customers is established on the basis of an assessment of how a certain utility could be produced most efficiently. This view on products as only instrumental in the production-consumption system, allows the producer, who develops innovations, to focus on optimising the functionality of the product by making adaptations on the system level (e.g. fleet management, recovery systems, shared use of goods).

As we stated before, the ideas of Giarini and Stahel (1993) regarding the Service Economy can be associated with the ideas of Daly (1992) regarding the Steady State Economy. Both views aim to optimise the generation of a certain end result. This means that the end result is generated with the least possible input of resources. Both theories have a highly instrumental view of products and advocate substantial changes in the way end results are produced. The efficiency of the production of end result can be improved by technological and organisational innovations. The main difference between the two theories lies in the fact that Daly's Steady State Economy is a macroeconomic view whereas the ideas of Giarini and Stahel regarding the Service Economy are meant to be applied in the context of individual companies. Since both views are consistent in their underlying assumptions, we treat the ideas of the Service Economy as a framework, in which the rather abstract ideas of Daly can be translated into more practical guidelines for individual companies.

2.4 The concept of "Eco-efficient Services"

Within the context of the Service Economy, the basis for commercial activities is the utilisation value of products, or the value of products in their use. Businesses seek profit by enhancing the efficiency of producing this value for their customers and the customers themselves seek to optimise their use of products. Consistent with the market approach of producers, customers seek the most efficient option for getting the products functionality at the lowest possible cost. In this section we will discuss in more detail what kind of strategies for product policy can be followed to turn the conceptual ideas of the service economy into practice in the consumer market.

Eco-efficient Services

Central in all innovation strategies in the Service Economy, is the concept of "Eco-efficient Services". Despite the fact that various authors have discussed this concept, few explicit definitions have yet been provided (see for an overview e.g. Bierter, Stahel and Schmidt-Bleek, 1996). Most authors stress the utilisation value of products as the dominant economic value underlying the transaction between supply and demand. Some of them also refer to the changing property rights held by customers and producers, in comparison with traditional supply-demand transactions (Schrader, 1998). In these traditional transactions, property rights are almost always held by the customer or the user. In this study the following definition of the concept of "Eco-efficient Services" will be used:

Eco-efficient Services are all kinds of commercial market offers aiming at fulfilling customer needs by selling the utilisation of a product(system) instead of providing just the product. Eco-efficient Services are services, relating to any kind of product, in which the some of the property's rights are kept by the producer.

Various aspects of this definition need to be discussed here:

1. Eco-efficient Services is a business concept of the Service Economy

Eco-efficient Services are commercial offers that comply with the ideas of the Service Economy, as discussed in paragraph 2.3. They can be seen as an extension, and a practical example of the ideas of Steady State Economics. Commercial offers in the service economy basically supply functions or end-results instead of hardware or arte-facts, and turnover is based on the sales of these end-results. This conclusion is essential because, as we stated before, these models present a number of important boundary conditions for a more sustainable economy and a more sustainable society, at least from a material flow perspective. New or innovative economic activities should therefore be formulated within these conceptual models.

As a result of the commercial orientation on the utilisation value of products and product systems, in Eco-Efficient Services, the profit basis of industry is in the functional optimisation of a certain consumption practice. In other words, a company makes more money if it can provide the same (amount of) product-related services with the input of less resources.

2. The environmental effects of Eco-efficient Services

The underlying assumption of the concept of Eco-efficient Services is that with the introduction of such commercial offers, the environmental efficiency of a certain consumption practice could be enhanced. It is expected that through functional optimisation of a certain consumption practice, less resources will be needed to produce a unit of service, which will lead to a reduction in the environmental effects. This idea must of course be treated as an assumption until extensive empirical testing has proven it to be true.

3. Eco-efficient Services are services

Eco-efficient Services are (intangible) services. This statement might be rather confusing for two reasons. First, the concept of Eco-efficient Services must be distinguished from another kind of commercial transactions, called services. Eco-efficient Services can be seen as a special category of services. Secondly, confusion can arise because services themselves are a complicated notion:

Service has a lot of connotations, varying from 'something done to help or benefit others' to 'benefits or advantages', 'a system or arrangement that supplies public needs' 'a form of worship' and many more. Reflecting on the large amount of recent literature on services and service marketing, Grönroos (1990) has formulated a general definition: "A service is an activity or series of activities of more or less intangible nature that normally, but not necessarily, take place in interactions between the customer and the service provider, which are provided as solutions to customer problems."

In our study, we will understand a service as a commercial transaction in which customers pay for specific benefits, provided by the acts or performances of a service organisation. These benefits are essentially of an intangible nature. In contrast to the purchase of a product, a service does not lead to the ownership of a product.

In service marketing literature, a whole range of specific characteristics of services is discussed (see e.g. Zeithaml, 1984; Zeithaml *et al.*, 1985; Grönroos, 1990). Kotler (1997) mentions four general characteristics of services: (1) services often relate to products, (2) services are basically intangible, which means that they cannot be stored, traded, or easily shown and communicated, (3) services do not result in a transaction of ownership, which is the tangible proof of a transaction and (4) services require that consumers participate to a certain extent in the production. Given the fact that Eco-efficient Services are nothing but a specific category of services, these characteristics also hold true for our concept.

Eco-efficient Services in particular are those services which relate to products, or which are meant as substitutes for tangible products. The connection with products is essential in understanding the concept, since Eco-efficient Services are directly related to the concept of the Service Economy, which aims to sell the utility of products *in stead of* the products themselves.

In addition to the definition of a service as a commercial transaction and the content of that transaction (which is the utilisation value of products), the concept of service can also be related to the product and its functionality. Products must be treated, in the context of the Service Economy, as units that produce utility when they are used. As argued before, the utility is what makes a product useful. The production of utilities by means of the use of a specific product needs to be optimised from an environmental perspective. Now, products can be understood as units that produce services as well (Schmidt-Bleek *et al.*, 1994). Services can therefore also be seen as a function of the product in the context of use. It is exactly this (unit of) service, as a function of a product, that is sold in the specific commercial transaction called "service".

4. Eco-efficient Services: needs defined in terms of utilisation value

Eco-efficient Services are units that fulfil customer needs. Needs, however, are a complicated concept which is difficult to operationalise. Despite the vagueness of the concept, it is essential for successful innovations. In innovation studies, failure of innovation processes is often attributed to a lack of understanding of customer needs. Innovation practice thus faces a dilemma:

On the one hand, needs can be interpreted as a social construct, related to current, well-known consumption practices, preferences, and values in consumption. In these consumption practices needs are fulfilled by means of product use. It can be questioned, however, to what extent these needs are defined in terms of the products themselves, or in terms of the end results people get when they use these products. It is very likely that consumers project their needs upon the means to the ends!

On the other hand, in order to arrive at innovations, or completely new solutions for customer needs, one has to distinguish between means and ends. An entrepreneur who wants to develop innovations, has to form his own interpretation of what customers (may) want to buy, because market research cannot establish consumer needs – and in particular future needs – in an unambiguous manner.

To conclude, within the concept of Eco-efficient Services customer needs are defined in terms of the utilisation value of products. This assumption must be tested in empirical research or proven by success in the market.

5. Eco-efficient Services rearrange the property rights of goods

An important characteristic of Eco-efficient Services is that the concept rearranges the property rights of goods (see e.g. Petersen, 1994; Bierter, Stahel and Schmidt-Bleek, 1996; Schrader, 1998). In the conventional transactions between supply and demand, a transaction of ownership of goods in exchanges for money was common. With the acquisition of ownership of the product, the owner receives all property rights connected to the product. Silver (1983) describes five property rights: (1) the right to use a product, (2) the right to retain profits from this product, (3) the right to change properties of this product, (4) the right to sell or dispose of the product and (5) the right to exclude others the use of this product. In Eco-efficient Services, conventional transactions of ownership of products are substituted by the performance of product related services. The customer now only buys the utility of a product or its units of service. A rearrangement of property rights is therefore inevitable. As the description of practical strategies related to the concept of Eco-efficient Services will show, only specific elements of the property rights will be handed over to the customer for a certain period of time. In most cases the producer retains ownership of the products and, for a limited time only, passes some of the property rights, like the right to use a product and the right to retain profits from this product on to its customers in exchange for money:¹

A typology of strategies related to the concept of Eco-efficient Services

The concept of Eco-efficient Services encompasses various strategies for product policy. All these strategies have in common that the utilisation value of the artefacts is sold by the producer and bought by the customer. They can however be distinguished according to the extent to which property rights are handed over to the user of the products, and to the extent to which the customer participates in the production of units of service. After all, one of basic characteristics of Eco-efficient Services is that certain tasks and responsibilities related to the well-performance and the operation of the products are out-sourced to external service suppliers. The following three categories of strategies related to the concept of Eco-efficient Services can be distinguished (see also Manzini, 1993, 1994; Bierter, Stahel and Schmidt-Bleek, 1996; Schrader, 1998):

1. Product-life extension services

The first category of strategies for Eco-efficient Services are the product-life extension services. Here the customer acquires the right to use a specific product for a certain period of time. He is given the guarantee of a proper functioning of the product over the contract time. In case of damage or malfunction, the customer is provided with (free) repair and maintenance services, so that the useful life-span of the product is extended.

1 For a thorough and more fundamental discussion on the property rights related to e.g. Car Sharing we want to refer to the dissertation of M. Petersen: *Ökonomische analyse des Car Sharing* (1994).

In practice, (operational) leasing is the commercial concept by which product-life extension services are realised. The customer pays per period of time for the right to use the product, the right to derive profits from using the product and the right to exclude others from using this product. In addition, the producer keeps the right to change the properties of the product; it is in fact his responsibility to maintain the properties of the product. Finally, the producer also decides about the sale or disposal of the product when the contract period with the customer has ended.

Well-known and successful examples of product-life extension services are the leasing of copiers, trucks, construction equipment, medical equipment, computers, apartments, etc.. Especially the leasing practice of copiers has become a model for a society that combines technological progress with closed loop product-systems and material cycles.

2. Product-use services

Product-use services are commercial offers that give customers the opportunity to use a product for a limited period of time, and only when they need it. Many products are only required on a limited number of occasions and for a limited amount of time. Purchasing such products can be rather economically inefficient. Short-term rental can therefore be an interesting alternative to product purchase. In the literature, product rental, as an alternative to product purchase, is often discussed in terms of pooling or sharing systems (see e.g. Stahel, 1994). In these systems, a large number of people share the use of (a pool of) products. As a result, these products, are used more intensively.

There are several well-known examples of these rental systems: laundromats, hotels, tool rental, camping-gear rental, taxis and Car-Sharing schemes. By means of these more or less sophisticated rental services consumers can use products for some time without the need to purchase and to own them. They only have to pay when they use the products. With regard to the property rights, these services offer the right to use the product and to gain profits from it. The main difference with the product-life-extension services is that product-use services are based upon the right to exclude others from use of the product for a limited period of time.

Car Sharing schemes, which is a new development in a couple of West-European countries, in particular in the Netherlands, is a remarkable example of these product-use services. It is remarkable because this market is so dominated by private ownership and the individual use of products. As these rental service schemes are (still) a rather niche-market phenomenon – despite their obvious and substantial economic advantages – we decided to test the idea of Eco-efficient Services on its viability for the consumer market in the field of Car Sharing. Moreover, Car Sharing can be seen as a logical consequence of the implementation of the ideas of the Service Economy in the consumer market with strong implications for consumption patterns, consumer value systems, technological development and operational management of service systems.

3. Result services

Result services refer to those services in which the producer offers the results of product use. All property rights related to the products needed to produce these results, remain entirely at the supply side. The customer pays only for the proper results, and is rather indifferent of the applied technology and products. Above all, the customer has hardly any involvement

in the production process of utility, but outsources this completely, since he is only interested in the end-results and not in the process by which these end-results are achieved. In fact, the products and technology used are hidden away behind the service system and are completely instrumental in the production/consumption process. Just as the previous service categories, result services are meant to substitute privately owned product solutions in fulfilling market needs. These service systems find their legitimacy in the inefficiencies of the current ways of producing the utilities for customers.

Examples that illustrate this strategy, are the energy services, in which illuminated and heated spaces are offered instead of kilowatt-hours or cubic meters gas, and washing services for cleaning clothes or diapers. Least-Cost Planning is often used as a tool to invest in new energy saving technology by energy producers, which allows them to earn (more) money with less energy carriers sold. Stahel (1993) also refers to integrated pest management with crop insurance. Another often quoted example is the document facility management within companies, run by officers of copier manufacturers.

2.5 Environmental consequences of the concept of "Eco-efficient Services"

In the previous section a variety of strategies for product policies was presented, all of them complying with the theoretical concept of Eco-efficient Services. These strategies are primarily based on theoretical considerations on how environmental effects could be reduced. The key to this is that the producer does not sell the products themselves, but instead the utilisation value of the products. The various strategies suggest different ways to sell the utilisation value of products.

The concept of Eco-efficient Services is developed on theoretical considerations on why these strategies would potentially lead to more environmentally efficient production and consumption systems. These theoretical considerations can basically be summarised in one central assumption: by providing end-results instead of providing the means to these ends, companies get an economic interest in the functional optimisation of a consumption practice. Providing the same end-results with less input of resources and materials would have a positive impact on economic profits. The literature (see e.g. Stahel, 1991, 1993, 1994, 1998; Manzini, 1995; Meijkamp, Hendrickx and Moll, 1998) provides a set of mechanisms that would lead to an improvement in the environmental efficiency of a consumption practice and thus to a reduction in environmental effects.

In this section we intend to discuss in more detail why the concept of Eco-efficient Services would lead to more environmentally efficient production and consumption systems and which kind of mechanisms are responsible for these effects. The concept of Eco-efficient Services is frequently presented in a rather normative manner, as a plea for change. One of the major arguments is that by doing business within the context of the Service Economy, the economy could be changed into a more economically efficient and ecologically sound society: a range of socially desired functions could be produced in a much more economically and ecologically efficient way, if all supply-demand transactions would be based upon the utilisation value of products and product systems. From a scientific point of view,

however, one should be very careful in accepting these ideas. It is still unclear what these ideas actually mean in practice and whether specific commercial practices do not differ from general theoretical conceptions. It may even be questioned whether it is justified to call these strategies Eco-efficient Services!

How would the Eco-efficient Services approach affect the environmental impact?

The general assumption regarding the (beneficial) environmental effects of the Eco-efficient Services approach is based on the expectation that because producers are paid for the units of service provided to customers, they will get an economic interest in reducing the amount of resources (materials and energy) necessary for producing these units of service (Stahel, 1994). This economic interest would stimulate technological, organisational and marketing innovations directed towards integrated solutions that are optimised over the entire life cycle, since all costs over the complete life cycle will be amortised over all the units of service over the entire life cycle. In other words, in the long run the concept of Eco-efficient services would stimulate the development and implementation of solutions that are optimised with respect to their functioning. This functional optimisation of product systems does not respect conventional consumption practices, but seeks the best available technological and organisational solutions, since utility is being sold instead of products. It can therefore be assumed that:

- The Eco-efficient services approach will stimulate a continuous improvement of a consumption practice towards a higher environmental efficiency.

How would product-life extension services affect the environmental impact?

With respect to the product-life-extension services in particular it can be assumed that the following mechanisms can reduce environmental effects:

- Product-life extension services will lead to products that can be used for a longer period of time, through maintenance and repair of that product. Because the producer is being paid for a specific period of use, he will seek to minimise his costs for a functioning product over the longest possible period of time. To a certain extent, life-extension of products by proper maintenance, repair and upgrading is in the economic interest of producers.
- In order to comply with the requirements of product-life extension, the product's design will have to be adapted to the requirements of repair, upgrading and maintenance.
- In the development of new products the end-of-life consequences will already be taken into account, because the ease of disassembly and the capacity to reuse parts or materials is in the economic interest of the producer. For the producer will finally be confronted with the disposal efforts/costs of his products.

How would product-use services affect the environmental impact?

The most fundamental difference between product-life extension services and product-use services is that the latter provide more opportunities for an optimisation of the utilisation of each product. Actually, here market needs are fulfilled by means of the smallest possible fleet or pool of products. Because of the shared economic interest in product life extension, product-use services are expected to be ruled by the same mechanisms concerning envi-

ronmental impact as product-life extension services.

It can be assumed that there are also some mechanisms which are specific to product-use services:

- Because of the enhanced service efficiency of these products, the amount of products needed to fulfil market needs will be substantially reduced.
- Because of the intensified use of the product, the lifetime of the product, in terms of years, will be substantially reduced. Paradoxically, this will have beneficial effects on the environmental impact. products in a pool are used intensively, since the extent to which these products are used directly relates to the profitability of the investment in the product and of the company itself. Intensified use of a product severely shortens its lifetime (in years) because the product wears out much faster. This means that the product needs to be replaced more frequently. There are several reasons to assume that this frequent replacement of a product has environmental benefits, especially on a longer term and on a larger scale:
- In a pooling system a faster replacement of products is possible, which means that always the newest, most environmentally efficient models can be implemented. Old and inferior models will rapidly disappear because of the relatively short product lifetime.
- The shorter economic payback period presents a smaller economic risk, which facilitates relatively more expensive investments in superior technology.
- Since products are returned from their service life to waste much faster, the time span between assembly and disassembly becomes smaller. This increases the opportunities for – and profitability of – high level reuse, i.e. the reuse of parts and subassemblies and thus facilitates the recycling of materials.
- With product-use services, individuals are not bound by an economic investment. In the case of individual product use and ownership, the investment in a product stimulates, for reasons of decreasing marginal costs, the use of only that specific product. For this reason, the economic investment prevents flexibility in the choice of options to fulfil a specific consumer need. Product-use services however, do offer flexibility in the choice for a specific consumption technology, which will lead to more frequent use of more environmentally efficient options.

How would result services affect the environmental impact?

In the two strategies mentioned above, the utilisation value of a product is sold by handing the product itself over to the customer, whereas result services offer the consumer only the end results. With result services, all products are owned, operated and maintained by the producer. In fact, the producer manages an integrated service delivery system. We could however not formulate any additional mechanisms affecting the environmental impact, which are specific to result services.

2.6 Position on the concept of "Eco-efficient Services"

The concept of Eco-efficient Services was introduced as a theoretical concept which might lead to more environmentally efficient consumption practices and thus to less environmental effects in consumption. If industry starts to develop and implement such environmentally efficient consumption practices as an alternative for existing ones, one might expect that

(1) businesses will find new market opportunities, since they will develop new ways to produce desired functionalities in a much more economically efficient way and that (2) these functionalities will be produced in a less ecologically damaging way.

However, the concept of Eco-efficient Services primarily originates from macro economic ideas and theories concerning the environmental effects of production, and not from empirical observations or practices. Based on an analysis of the current economy, the concept of Eco-efficient Services was formulated by various authors like Stahel (1993, 1994, 1998) and Manzini (1993, 1994, 1997).

In a scientific research process, defining concepts is highly valuable to start with, but these theoretical ideas need critical evaluation and extensive empirical testing before their value is proven and they can be accepted. We therefore want to put some crucial question marks behind some aspects of the concept of Eco-efficient Services. They all relate to the theoretical nature of the concept and its relevance for everyday life:

- First of all, the concept of Eco-efficient Services has its origin in a macro economic analysis, with strong implications for the individual consumer. In the literature on Eco-efficient Services, however, the perspective of the individual consumer receives little attention. Few questions are asked about the acceptance of these new kind of consumption technologies. Eco-efficient Services definitely require large changes in how people fulfil their needs, how they behave, and how they relate to products. It is plausible to expect problems in the market acceptance of these kind of market offers.
- Secondly, the concept of Eco-efficient Services implicitly assumes that services, as products of the Service Economy, will function as a full substitute for products of the Industrial Economy. This assumption implies that, from the consumer's perspective, both options to produce a certain functionality / unit of service, are interchangeable: that it makes no real difference for consumers. Or, in other words, both options fulfil the same customer need. It can be questioned whether innovations in the economic practice will function as a full substitute for the former consumption practices or whether they will create their own new markets. The history of innovations has shown that innovations usually have their own dynamics and create their own, new markets, which may result in adverse environmental effects.
- As we have seen in chapter 1, the behaviour of consumers is highly important for the total environmental impact of consumption. So, when making an environmental assessment, changes in consumer behaviour due to the use of new consumption practices for producing the desired utilities must be taken into account. The concept of Eco-efficient Services implicitly assumes that consumer behaviour does not change after the adoption of an innovative product or service. It can be questioned to what extent the amount of units of service demanded remains unchanged in daily practice when an Eco-efficient Service is substituted for a privately owned product.

Our position with regard to the concept of Eco-efficient Services has resulted in our empirical research question as formulated in chapter 1. By answering this research question we aim to reflect on the concept of Eco-efficient Services as a potential innovation strategy for "sustainable consumption". In this study we have chosen the field of Car Sharing schemes in the Netherlands as the area of investigation.

3 Car Sharing, a mobility service innovation in the Netherlands

3.1 Introduction

In chapter 1 we explained why the Car Sharing service schemes in the Netherlands were chosen as the area of research. The two empirical research questions addressed here specifically refer to this category of mobility service innovations. Car Sharing can be interpreted as a practical example of the concept of “Eco-efficient Services” and can therefore be used for the exploration of this theoretical concept. Car Sharing forms an example of a so-called product-use-service.

Although we have already described the nature of this kind of mobility services, in this chapter we aim to provide a more detailed description of the area of investigation to provide a context for our consumer research. The concept of Car Sharing can be described from three different perspectives: from the consumer's perspective, from the service supplier's perspective and from the perspective of the government. The scheme below (figure 3.1) illustrates how these three perspectives interact.

Figure 3.1 The market of Car Sharing and the role of the government

First of all, Car Sharing services can be described from the perspective of the individual consumer and his potential costs and benefits from Car Sharing. This perspective is essential since new services must provide relative benefits to the individual consumer, otherwise there will be no market for these services.

Secondly, from the supply-side perspective, various kinds of service schemes could be set up to provide Car Sharing services to individuals. Today a variety of operational forms of Car Sharing schemes are already in practice. They have different characteristics and can be categorised.

Finally, in the context of Car Sharing schemes in the Netherlands, the government's perspective is important as well, because of its involvement in the development of Car Sharing schemes.

Below, all three perspectives will be discussed in more detail. We must stress, however, that this study is primarily interested in the market.

3.2 Cost and benefits for consumers

In this study we understand Car Sharing as an innovative and emerging commercial service concept that offers a new kind of rental cars as an alternative to privately owned cars. It can be called innovative because rental cars compete with private car ownership and because these kinds of rental services are far more flexible than conventional rental services. Individuals who contract these services always have a car at their disposal near their home, without having to worry about the technical and financial problems attached to car ownership.

In the Netherlands, as well as in other European countries, various service arrangements exist. In the market various kinds of Car Sharing services compete with the private car. It can be questioned on what basis – which kind of attributes of Car Sharing services and which kind of (perceived) benefits – service suppliers enter into competition with private car ownership. What kind of (supposed) relative advantages do they offer to the market? What might be the reason for the individual consumer to switch to Car Sharing services in order to get the desired functionality, which is to have the opportunity to use a car whenever they need it.

Advantages and disadvantages of Car Sharing

Based on an analysis of marketing communication material of the various service suppliers and on the literature about the consumer perspective on Car Sharing (Meijkamp and Douma, 1996; Censydiam, 1996; Stichting voor Gedeeld Autogebruik, 1996; AGV, 1997) we can list the possible (dis)advantages of Car Sharing services over the private car. Most of the relative advantages are turned into selling points to convince potential clients to adopt these services.

The following advantages of Car Sharing services are frequently mentioned in the brochures of service companies like "GreenWheels", "AutoDelen Amsterdam", "Call-a-Car", "Auto-op-Afroep", "Budget SnelwegPlan", and "AutoAbonnee":

- Cost savings

The first and most important advantage of Car Sharing suggested, is that by using this service instead of buying and using your own car, individuals would save money. Since fixed costs constitute a large proportion of the costs of car use, substantial financial savings can be achieved by sharing these costs.

- **Flexibility in use**
Many cars are not frequently used. Car Sharing services offer use of the car only when needed. Since the mere ownership of a car (without actually using the car) is expensive, the flexibility in use could be considered an advantage for people who use a car rather infrequently.
- **Flexibility in model use**
Car Sharing schemes are basically a managed fleet of cars that can be used by a large number of people. Thus, each consumer has a variety of cars at his disposal. Consumers can freely choose from various types of cars with different functional properties or emotional values, according to their specific needs.
- **No investments**
Car Sharing does not require a substantial investment for which consumers often have to take out a loan and pay interest to a bank.
- **Convenience**
Since Car Sharing services offer access to car use and a guaranteed performance of the car, people buy convenience: the service supplier is responsible for all the paper work involved in insurance, tax payments, technical inspections, etcetera.
- **Parking place**
Car Sharing provides cars in special, pre-paid parking spaces. This means that on their return, clients always find a free parking space for their car.
- **No maintenance**
The service arrangements imply that the supplier is fully responsible for the proper maintenance of the car and all costs and risks involved. In case of any malfunction, the service supplier even offers alternative transportation.
- **No risks**
Car Sharing services generally offer insurance for damage, accidents, theft, injury or death. This means that consumers do not run any financial risks.
- **Environmentally friendly image**
Car Sharing services are marketed by the service companies as an environmentally friendly mobility solution. Their environmentally friendly image appeals to a specific group of consumers.

On the basis of a positioning study for the marketing communication of Car Sharing services in general (Censydiam, 1996) some positive, emotional values could be added to this more tangible list of customer benefits: reliability, enjoyment of mobility, modern mobility solution, smart choice, new kind of freedom, enjoying just the advantages of car use, variation in car use, responsibility in choice making, conscious choice, etc.

The literature (Meijkamp and Douma, 1996; Sweers, 1996; AGV, 1997) also mentions some inherent disadvantages of Car Sharing services:

- **Car Sharing needs reservation and planning**
Most Car Sharing schemes can only offer a guaranteed car when a reservation is made beforehand.
- **Car Sharing leaves no opportunities for individualisation of the car**
Obviously, Car Sharing schemes use rather standardised car models that fit the wishes

of a broad range of consumers. Because of the shared use of the cars, there is no room for personal modifications.

- Car Sharing is more expensive in case of frequent car use
Depending on the frequency of use, the period of use, the kind of car, and the distances covered, a break-even point is reached above which Car Sharing services are more expensive than using a privately owned car.
- Car Sharing requires covering a certain distance to get to the car
In a Car Sharing scheme the cars are not available close to the home, but at an outlet of the service organisation. So, consumers have to pick up the car at some distance from their home.
- Car Sharing requires identification to the organisation and the car
A car can never be used anonymously. The user has to be identified first, either by showing his papers or through information technology,
- Car Sharing might be associated with a loss of social prestige
Car ownership is frequently associated with social prestige. For most people, the use of a Car Sharing service does not carry a similar social prestige.
- Car Sharing leads to a reduced ability for self expression by the choice of car
By choosing a particular car people feel they express themselves; the car says something about who they are. To a certain extent, this potential for self expression is lacking in Car Sharing services.
- Car Sharing makes individuals dependent of an organisation
In contrast to private car ownership, consumers are dependent on external organisations for mobility. So feelings of loss of control could be associated with Car Sharing services.

Empirical research is needed to see to what extent these advantages and disadvantages play a role in the acceptance of Car Sharing services as an alternative to the privately owned car.

Cost structure of private cars and Car Sharing

One of the fundamental differences between Car Sharing services and private car ownership, as two solutions to provide mobility by car, is their different cost structure. To understand the costs and benefits of Car Sharing services on a conceptual level, it is important to discuss the differences in cost structure in more detail.

The costs of car use are generally determined by six major cost factors: depreciation, interest costs, taxes, insurance, fuel costs and repair and maintenance costs. Only the last two cost factors (fuel costs and maintenance and repair costs) are directly related to the extent to which the car is used and are therefore variable costs. The other cost factors are fixed costs.

The economic benefits of Car Sharing for the individual can basically be explained by the cost structure of car use: A large proportion of the costs of car use is related to the fixed costs, which are almost independent from whether or not the car is actually being used. By sharing these costs with a group of individuals, a substantial financial benefit can be created for each individual.

The Dutch automobile association (the ANWB) has calculated the costs for a large variety of privately owned cars, based on extensive empirical research (Onrust *et al.*, 1996, 1998). Table 3.1 below shows that the proportion of the fixed costs (which can be shared in a Car Sharing service scheme) varies from 62% to 81%, depending on the size and age of the car. For diesel, the fixed costs are generally even much larger (Onrust *et al.*, 1996, 1998).

Table 3.1 The relative contribution of various costs factors in car use (Onrust *et al.*, 1998)

Costs (in average %)	Compact new	Compact used	Medium new	Medium used	Large new new	Large used
Depreciation	41%	37%	45%	37%	48%	39%
Interest costs	11%	8%	10%	11%	11%	10%
Taxes	5%	7%	6%	9%	6%	9%
Insurance	16%	10%	17%	12%	16%	12%
Total fixed costs	73%	62%	79%	68%	81%	70%
Fuel costs	23%	28%	18%	25%	17%	25%
Repair/ maintenance	4%	10%	3%	7%	2%	5%
Total variable costs	27%	38%	21%	32%	19%	30%

The Dutch consumer association (Consumentengids, 1996) has calculated that an average household, driving 60 days a year, 150 km per day (which is about 9000 km per year) in a standard Opel Corsa, can save about Dfl. 320,= per month by switching to Car Sharing. Table 3.2 below, shows the differences in costs and cost structure between the privately owned car and Car Sharing services. Clearly, the amount of money saved depends on the yearly mileage, the type of the car, the price structure of the Car Sharing service, and the pattern of use. These savings can therefore only be treated as indicative.

Table 3.2 Price structures (in Dfl./ month) of Car Sharing and private cars (Consumentengids, 1996)

Private car			Car Sharing	
<i>Fixed costs:</i>				
depreciation	230	(30%)	–	
interest costs	90	(12%)	–	
insurance	145	(19%)	–	
taxes	45	(6%)	–	
rest	25	(3%)	–	
participation fee			10	(2%)
<i>Variable costs:</i>				
fuel	140	(18%)	125	(28%)
maintenance and repair	95	(12%)		
additional kilometres	–		55	(12%)
rental costs	–		260	(58%)
Total costs:	770	(100%)	450	(100%)

3.3 Market developments

Development and growth in the past

It is hard to trace back when Car Sharing first emerged as a service concept for mobility (see also Petersen, 1994). It might be plausible to believe that this concept is as old as the existence of the car itself: Interviews with elderly people (B&A Group, 1998) revealed that as early as the nineteen thirties several car dealers in many cities were already providing access to regular car use through contracts for a certain amount of mileage per year by car. In the sixties, shared car use on an informal basis existed in communes and similar arrangements have been known to exist among several households.

Probably one of the best known formal systems of Car Sharing, was the "Wit-kar" in Amsterdam. These special, white, electrically powered vehicles, distributed through public pooling stations in the city of Amsterdam, ran for a couple of years in the seventies. The organisation, however, failed to maintain and extend the system of stations from which these city vehicles could be taken. The "Wit-kar" finally disappeared, also because the support from the local government was withdrawn.

The start of the modern development of commercial Car Sharing services in the Netherlands can be found in the beginning of the nineties. Several local initiatives emerged, inspired by ideas and developments abroad, especially in Switzerland (Muheim et al., 1991) and Berlin, Germany (Petersen, 1994). In the Netherlands, *Huur-op-Maat* (Meijkamp, 1995) was one of the first fully operational systems run on a commercial basis.

Since then, the involvement of many social actors and entrepreneurial initiatives have fed the market development and adoption of Car Sharing systems by consumers. Although exact numbers about the amount of Car Sharing participants, the number of Car Sharing systems and the number of outlets are not available, some well founded estimations were made by the "Stichting voor Gedeeld Autogebruik" (1998): Meanwhile (1999), the number of participating consumers in commercial systems has risen to about 25.000. In more than 100 communities about 20 different Car Sharing systems are offered, with more than 500 outlets. Especially the development and growth of the schemes of *AutoDelen* and *GreenWheels* has been remarkable. Within a period of three years they have been able to build a network of about 60 new outlets.

Characteristics of current Car Sharing schemes

The market nowadays shows a variety of operational service schemes under the umbrella concept of Car Sharing. An analysis of Car Sharing practice shows that these mobility services can be provided in various ways, in various organisational forms, under various kinds of service conditions and facilitated by various forms of technology. They all basically offer the individual consumer the (frequent) utilisation of a car, but can differ on more or less important details with respect to the so-called "consumption practice".

When comparing the current Car Sharing schemes, a wide range of characteristics can be distinguished by which a specific service scheme can be described:

1. Organisation

- The nature of the organisation
Car Sharing organisations can be either commercial or non-commercial. An organisation of a couple of families aimed at sharing a car, does seldom aim to make a profit, whereas commercial rental organisations do.
- The core business
Car Sharing organisations can be distinguished according to their core business. Some companies see their Car Sharing services only as an addition to their conventional rental activities.
- Extension of the distribution network
Car Sharing services might either be offered at one single distribution point or at various distribution points within one city or even throughout the country.
- Government involvement
In some cases the local government was involved in the initiation of the business, and sometimes the government supports specific systems in their market communication.

2. Location

- Distribution of cars
The distribution of the cars can have a centralised or decentralised organisation. When the cars are delivered to the customers' homes, the distribution is decentralised. When companies just provide cars from their offices, the distribution is centralised.
- Parking space
Every Car Sharing organisation needs parking space for its fleet. These parking spaces might either be privately owned or in a public space.
- Urban / rural
Most Car Sharing organisations offer their services in large and crowded urban areas. Some of them, however, open up outlets in smaller towns and even rural areas.

3. Service conditions

- Minimum rental period
Among the various systems, the minimum rental period varies from one hour to 24 hours. Some systems have a minimum rental period of 4 hours.
- Need for reservation
In a couple of systems there is no need for reservation in advance. However, in such cases service suppliers cannot guarantee a car.
- Reservation period
In order to have a guaranteed car people need to make a reservation in advance. The reservation period can vary between one hour and 24 hours.
- Availability of cars
Since cars are sometimes handed over by personnel, the opening hours of the office limit the availability of cars, especially during weekday evenings and weekends.

4. Payment

- Cost structure

Various kinds of cost structures exist for Car Sharing, which are often closely related to service conditions like the minimum rental period. A subscription system in which people buy a certain amount of days in advance, requires longer rental periods with a minimum of four hours. For more flexible systems with shorter minimum rental periods, both a flat tariff structure in which people pay per hour and per km and a digressive tariff structure in which the prices per hour and km decrease with the length of the rental period are used.

- Moment of payment

Car Sharing systems might either charge in advance – for a certain volume of rental days over a year – or afterwards, after the rental period. There are two forms of payment afterwards: immediate payment after use and monthly payments.

- Computerised payment

Depending on whether information technology enables a Car Sharing company to automate management of their fleet, payment (each month) might be computerised.

- Fuel costs

Some systems provide cars without any fuel costs included. When fuel costs are included in the service arrangements, sometimes a petrol station pass is provided for payment.

5. Identification

- Identification

The use of the car must be charged to a specific customer. The costs for use, penalties or damage must be charged to an individual consumer. The identification of a customer might either be realised by use of information technology (chip keys or magnetic cards) or by personnel.

- Deposit

In some cases customers have to leave a deposit or a credit card number behind in case the car is damaged.

6. Additional services

- Home delivery service

In some cases service providers deliver / pick up cars at costumers homes, at extra cost.

- Public transport facilities

As part of their service package, some Car Sharing organisations provide specific (discount) facilities for the use of public transport or local taxi services.

- Network service

In the case of an extensive network of distribution points over a large geographical area, some systems provide the opportunity to pick up a car in other cities than the customer's residence.

Categorisation of Car Sharing services

Based on the various characteristics of Car Sharing systems, a categorisation of such service schemes can be made (see also Ruiz van Hattem, 1997). We distinguished six different kinds of Car Sharing service schemes. Table 3.3. shows the characteristics of the various categories of Car Sharing systems. Because informal arrangements exist in a great variety, few explicit characteristics could be given:

1. informal arrangements
2. neighbourhood systems
3. short-term rental systems
4. subscription systems
5. voucher systems
6. closed systems

Table 3.3 The categorisation of Car Sharing services

	Informal arrangements	Neighbourhood systems	Short-term systems	Subscription systems	Voucher systems	Closed systems
Commercial basis	no	yes	yes	yes	yes	yes
Core business	–	yes	no	no	no	yes
Extension distribution network	–	large	small	large	large	small
Car distribution	–	decentral	central	central	central	decentral
Parking space	public	public	private	private	private	private
Geographic area	–	urban	urban	urban	urban	urban
Minimum reservation period	–	no	no	4 – 24 h	4 – 24 h	no
Need for reservation	–	no	no	yes	yes	no
Reservation period	–	no	no	24 h	24 h	no
Availability of the car	always	always	office	office	office	always
Cost structure	–	variable	variable	fixed	fixed	variable
Moment of payment	–	monthly	directly	monthly	before	monthly
Computerised payment	–	yes	no	yes	no	yes
Identification	–	electronic	personnel	personnel	personnel	electronic

1. Informal arrangements

The first type of Car Sharing system – one that clearly stands out from the rest – is an informal system, based on self-organised groups of two or more households. Here, no commercial third party is involved. Sometimes a contract is made up, in which an agreement of shared use is formulated. Frequently the mileage of every single user for every single trip is written down in a special note-book. Usually, the contribution to fixed car costs is related to the extent of car use. There is a great variety of arrangements within this category. The participants in this kind of pool are often relatives, friends or neighbours.

2. Neighbourhood systems

This is the most flexible and innovative rental system, compared to the conventional rental practice: a small pool of cars (about five) is parked in the direct vicinity of the customers. Members of the Car Sharing organisation pay a substantial monthly or annual fee for their participation and sometimes a deposit or a share which they get back when they cancel their membership. With the help of information technology and electronic identification (chip keys) the fleet is managed, reservations are made, customers are identified and costs are charged to each individual. A computerised system follows the use of (one or more of) the cars, and the participant is billed monthly. The minimum reservation time is one hour and the minimum utilisation period is also one hour. Consistent with the flexible service design, the costs vary over the day, decrease with the length of use and vary for different types of cars.

The two major examples of these systems are the Rotterdam-based company "Green-Wheels" with outlets in various big cities in the Netherlands (www.GreenWheels.com) and the Amsterdam-based AutoDelen® (www.AutoDelen.com), which has most of its outlets in Amsterdam.

3. Short-term rental systems

Short-term rental systems have their roots in the conventional car rental businesses. At the moment, these operational systems are run as a new kind of rental, in addition to the conventional rental services. These rental systems were facilitated by a new kind of software that enables companies to rent out cars for only one hour. When conventional rental turns out cheaper, the customer can easily switch back to the traditional service offer. The fact that the customer hardly pays any membership fee, underlines the fact that these systems are just conventional rental systems made more flexible. The cars are distributed right from the office by personnel and the customer has to pay after each trip. A short reservation period is possible because no separate car fleet is created for the short-term rental service. One of the best-known examples is "BAS" (Buurt Auto Service) in Amsterdam. This service has benefited from the involvement of the local government, since this service is expected to help reduce the immense parking pressure in the area. The government supported the introduction of this new service by subsidising the market communication.

4. Subscription systems

The subscription systems form quite a different category of Car Sharing services: the customer subscribes to a predetermined number of rental days per year (with a minimum of 10 days a year) and pays a fixed price each month, depending on the amount of rental days and the size of the car. The subscription includes 100 km free mileage per rental day; extra kilometres must be paid. At the end of the year the actual use is balanced with the prepaid monthly fees. In most cases, the consumer has to become a member and pay a low membership fee. Subscription schemes normally require a rather long reservation period of 24 hours in advance. Since this kind of Car Sharing services is an extension of conventional car rental services, the distribution of the cars takes place through an existing network of rental outlets or offices. The identification of the customer and the delivery of the car is carried out by company personnel. Often these outlets are not located at the most convenient locations for the consumer.

Today, various subscription systems exist: the oldest examples are the ANWB "Auto-op-Afroep" service (recently in co-operation with Budget Rent a Car), "Call-a-Car" in Haarlem and various nearby cities, and "Huur-op-Maat" in Leiden. Since spring 1998, a national franchise formula for BOVAG associates (car dealers and car rental companies) is operational, called "AutoAbonnee". Through this franchise formula a similar service is offered in various cities.

5. Voucher systems

Some large (international) car rental companies want to associate themselves with Car Sharing as well, despite their strong roots in the incidental rental market and their interests in business rental services, which is illustrated by their distribution network. To retain customers, various companies like AVIS, Hertz, Budget, and Europcar Interrent have introduced voucher systems for their regular customers. Basically, these companies sell voucher packages for a about 10 rental days. These vouchers are valid only during a limited period of 12 to 18 months. Such voucher packages offer financial benefits for the regular use of rental cars. In most cases, the shortest rental period is half a day (4 hours) and during the week-ends two days rentals are required. The distribution of cars is realised through the existing network of rental offices, manned by service personnel.

6. Closed systems

In contrast to the Car Sharing services presented above, this last category concerns services that are not open to the general public. Car Sharing services have also been developed and introduced for specific groups of people with specific mobility needs and at specific locations. Here, quite a variety of service arrangements can be distinguished, each of them for a specific user group.

Examples of closed systems are: GreenWheels, which offers specific services for employees of Nedlloyd in Rotterdam and Budget Rent-a-Car, which offers a special service package for the employees of KLM. In contrast to all other Car Sharing systems, these closed systems do not offer their services at the residence of individuals, but at locations where specific mobility needs exist, like working offices or transfer places like stations and airports. Meanwhile, numerous Car Sharing services are operational in the Netherlands, with varying service arrangements. Specific information about each specific service offer can be found in the monthly magazine (*Consumentengids*, 1996) of the Dutch consumer organisation (*De Consumentenbond*) or at the Website of the "Stichting voor Gedeeld Autogebruik".

Developments abroad

In various European countries similar systems have been developed for Car Sharing services. The background, the actors involved and the primary aims of these systems and experiments are, however, quite diverse. In Germany, more than 60 Car Sharing organisations with about 20.000 participating households were operational in 1997 (Britton *et al.*, 1999). A number of Car Sharing organisations only operate in one specific city, others are branches of a greater umbrella organisation, the "Car Sharing co-operative" (Car Sharing Deutschland Genossenschaft e.G.). Many of these Car Sharing organisations are not aimed at making a profit: more than half the organisations opted for the form of a registered society (Harms *et al.*, 1998). The biggest German Car Sharing organisation is StattAuto, a Berlin based company.

Within about 10 years, StattAuto set up a system with 150 cars in 46 locations, and with more than 3500 participants. Today, they employ 10 full-time and 35 part-time workers. Recently, various Car Sharing organisations in Switzerland (ATG, ShareCom and CSC) have merged into one national organisation, called "Mobility" (Harms *et al.*, 1998). This rapidly growing organisation, with growth rates of 54% for the amount of members and 32% for the amount of cars) is flourishing and investing in new information technology and a better, more efficient organisation. By the end of 1997, Mobility counted 17.400 participants, 740 cars and 200 car locations in Zürich alone.

In France (Paris) and Italy (Torino), various industry led experiments have started to produce electrical vehicles for public use (Massot, 1997). These experiments were mainly set up to gain experience with electrical vehicles for city trips and various other new technologies that need extensive infrastructural facilities. Battery charging is realised by induction, access is controlled through ICT, and GPS systems are used for locating the vehicles. Both experiments are rather small scale (about 20 cars) and get a lot of financial support from industry and government.

3.4 Car Sharing and governmental policies

At first glance, Car Sharing services might seem to be just a commercial development, initiated and operated by existing companies and new entrepreneurs. However, it cannot be denied that the government has had a substantial role in the development of this concept over the last couple of years. The government approaches Car Sharing schemes from a social point of view and supports this development because it expects society will benefit from it.

Increasing mobility

Over the last 50 years mobility has increased tremendously in almost every country in the world, but most dramatically in the industrialised countries, like the USA, Great Britain, France, Germany, and the Netherlands. In the Netherlands the number of cars has increased from about 139.000 in 1950 to 5,6 million in 1995 (CBS, 1996) and the fleet is expected to grow to 8 million in 2010 (Min V&W, 1988). Since 1950 the total mileage by car has increased with a factor 30 (!) to about 140 billion kilometres per year (CBS, 1996) and the total mileage by public transport has doubled to about 27 billion kilometres. These figures indicate the increasing impact of mobility on our current society, and especially the increasing pressure on the ecological system and the direct environment in which people live: congestion on the roads, parking problems in the cities, air pollution (in cities), traffic accidents, the impact on natural areas and wildlife, noise pollution, are but a few of the problems the increasing mobility presents.

With increasing scientific evidence that the growing mobility by car seriously affects the quality of the natural environment and the fact that the problems related to the growing mobility are a great burden on the national economy, (the growth of) mobility became a recognised political problem since the beginning of the eighties. The government basically defined the problems as twofold (Min V&W, 1988): the accessibility of the economic centres and the protection of the natural environment against the external effects of transport. Accessibility of the economic centres is considered an essential condition for economic

development and growth, especially in the Netherlands, where the economy is heavily reliant on its transportation and distribution role for the greater part of western Europe. Protection of the natural environment is needed because transport affects the natural environment in three ways: (1) by air pollution and emissions, (2) by noise pollution and (3) by fragmentation of the countryside.

Policy measures

The analysis developed ten years ago in the policy program SVV II still (in 1999) represents the underlying framework for Dutch transportation policy. A range of complementary strategies and measures have been effectuated over the past ten years: (1) by tackling problems at their source, (2) by managing and restraining car mobility, (3) by improving alternatives to the private car, (4) by developing a selective accessibility policy in road systems and (5) by strengthening the structural foundations of the transport policy.

The policy measures taken have had a positive impact on a couple of emissions, like NO_x , lead and VOS (RIVM, 1997), but with respect to a large amount of other policy targets, these measures have had no sufficient effect till now. The increase of car use, the growing consumption of (non-renewable) energy, the increasing CO_2 -emissions, the marginal reduction of the noise nuisance, the fragmentation of natural areas, the pressure on land use and many more aspects (RIVM, 1997 and Min. VROM, EZ, LNV & V&W, 1997) all indicate that these measures are not sufficient to reduce the overall environmental impact of transport and to fulfil the targets as defined in the policy programs NMP II and SVV II, especially in times of economic growth.

Reducing car use as a specific policy aim

One of the central policy aims in SVV II (1988) is that car use, which without any policy interference is expected to increase with about 70% in 2010, should be halved: this means that car use should not exceed the 1986 level with 35%. The following index table shows the most recent transport policy aim (Min. V&W, 1988) for the regulation of car use:

Table 3.4 Policy aims with respect to car use in the Netherlands in relation to the expected and realised growth (CBS, 1996; Min. V&W, 1990)

Year	1986	1989	1994	2000	2010
Policy target (index)	100	117	125	130	135
Expected growth (index)	100	–	–	–	170
Realised growth (index)	100	112	126	?	?

Apart from substantial efforts to stimulate car-pooling (aimed at an increase of the occupation rate of cars used for commuting from 1.2 to 1.6) in SVV II, no attention is given to shared car use as an instrument to influence overall car use. Above all, no measures aimed at influencing the growth of car ownership and the total amount of cars have been formulated in SVV II, despite the fact that in the same policy plan the total fleet is expected to grow from 5.6 million cars in 1994 to 8.0 million cars in 2010. The absence of policy measures to halt the growth of car ownership might be questionable, because statistics show that over the past thirty years the average annual distance of each car remained very stable. The

average annual distance fluctuated between 15.000 km and 17.000 km/ year (CBS, 1995). So with a growing number of cars an almost equally increasing mileage will be realised. The policy document SVV II already stated that concerning "the basic package of measures in the areas of public transport, parking, cycling, the employer-focused approach, behavioural changes and pricing (petrol-duty increases, the peak-hour surcharge on car tax and tolls) cannot keep the increase in car use below 50%. The remaining reduction, to a rise of only 35% by 2010, can be achieved only if these various measures prove more successful than we can currently assume or if pricing policy is applied more vigorously." So the need for new policy initiatives could already have been predicted ten years ago.

Car Sharing as an official policy strategy

The presentation of the Nota Milieu en Economie (Policy Plan on the Environment and the Economy) in 1997 can be seen as an attempt to introduce some new, additional policy initiatives to realise the policy aims as defined in SVV II. The Policy Plan on the Environment and the Economy aims to stimulate specific entrepreneurial activities in order to realise policy aims. The fundamental idea in this policy plan is that enhancing the efficiency of transport systems does not only create economic advantages, but also leads to an ecological improvement of the economy. One of the new concepts presented in this recent policy program, is Car Sharing. The Policy Plan on Environment and Economy states that because of Car Sharing services "car ownership is no longer a necessary condition to be able to use a car".

According to the Policy Plan on Environment and Economy, Car Sharing can be considered relevant for Dutch (transport) policy for several reasons. This policy plan concludes that Car Sharing contributes both to the improvement of the natural environment and to the accessibility of crowded inner cities:

- Car Sharing stimulates conscious car use.
- Car Sharing stimulates use of public transport.
- Car Sharing creates employment in the provision of services and car maintenance sectors.
- Car Sharing leads to a reduction of the amount of cars parked in the streets, which results in a more efficient and more economic use of scarce space.
- Car Sharing services offer only new cars, so only less polluting cars are used.

Current Dutch policy with regard to Car Sharing

Over the past couple of years the government has been involved in initiating Car Sharing services by creating a stimulating environment for entrepreneurs to develop and implement new Car Sharing services, without subsidising the operation of these services (Bakker, 1998). In the beginning of the nineties, the government's interest in Car Sharing was heightened by at least three factors: at the time, various kinds of private and commercial Car Sharing initiatives were taken to solve parking problems; A Swiss study (Muheim, 1991) suggested that Car Sharing would lead to a reduction in car use and to an increase in public transport use; and thirdly, a feasibility study commissioned by the Dutch government (AGV, 1993) suggested that especially in cities with good public transport facilities and scarce parking facilities a substantial number of households would be interested in the concept. In the beginning, rather unconventional policy initiatives were taken: meetings and workshops with var-

ious entrepreneurs were organised to allow an exchange of ideas and experiences. Above all, these workshops revealed what kind of problems had to be overcome before Car Sharing services could be implemented in practice.

Later on, the government passed on its co-ordinating role to a new foundation for the stimulation of Car Sharing in the Netherlands ("Stichting voor Gedeeld Autogebruik", founded in 1995). This foundation, financed by the ministry of Transport, has been given the task to communicate Car Sharing to the public and the press, to give advice to (starting) entrepreneurs and to support the authorities in their policy making with regard to Car Sharing (Bakker, 1998). This foundation, with its threefold objective, has turned out to be an effective and useful instrument to support the development of Car Sharing systems on a very practical level by stimulating the co-operation between market parties and by providing information to (potential) participants.

In addition, the Ministry of Transport has developed a set of policy measures. The policy activities and policy measures that have been, or will be taken with regard to Car Sharing (Bakker, 1998; Min. VROM, EZ, LNV & V&W, 1997; Sweers, 1997; Min. VROM, 1997) are summarised below:

1. Research and knowledge development

Market research on the acceptance of Car Sharing as an alternative for the privately owned car and gaining insight into the changes in mobility behaviour are two basic interests that require extensive, quantitative research. These issues are essential for effective policy making.

2. Monitoring

Because of the dynamic growth of the market, monitoring is needed with respect to its size, the services offered, and related developments.

3. Market communication

Communication of the Car Sharing concept is an important condition for large scale market acceptance. By developing an umbrella name, "Autodate", and careful market positioning by means of a nation-wide campaign (Influence Communications, 1996) the government has communicated the concept – and its variety of operational forms – to the public

4. Knowledge transfer to local and regional authorities

Car Sharing services are offered in a very decentralised manner. This implies that support for consumers and service suppliers needs to be provided in every individual place. Transfer of knowledge to local and regional authorities is therefore essential. To achieve this, a special brochure for local and regional authorities will be developed.

5. Facilitating an appropriate parking policy

Parking facilities are essential for Car Sharing services. Parking space for the cars is provided by individual local governments, which all have their own parking policy. At the moment, uniform national guidelines are being developed for local governments, which will enable them to assign parking space to service suppliers on uniform criteria.

6. Promoting further development of Car Sharing services

For specific groups of users, like business people or frequent users of public transport, new and more appropriate service offers need to be developed and tested in demon-

stration or pilot projects. Specific projects are supported by various stimulation programs.

7. Facilitating the co-operation between service suppliers

By co-operating, service suppliers are better capable to further the development of Car Sharing, the implementation of the concept and the communication to the public. The "Stichting voor Gedeeld Autogebruik", a national Car Sharing foundation working with full support of the Dutch government, has a key role here.

8. Facilitating the implementation of ICT in Car Sharing operations

Information and communication technology can help reduce operation costs and improve the service quality offered to customers. Currently, experience with these technologies in the area of Car Sharing is still rather limited. The Ministry of Transport is developing various activities to stimulate the integration of new information technology in Car Sharing schemes.

3.5 Concluding remarks

Car Sharing service schemes were chosen as the area of investigation for our research. This chapter provides a context for the results of our empirical study. The results of our consumer behaviour study should be interpreted in the light of current governmental policy making, as well as in the light of the current marketing strategy of Car Sharing service companies.

From our description of the field can be concluded that Car Sharing is basically a market driven development, in which the government has an active role. This role is primarily one of supporting the initiation and market introduction of new services. The government does not subsidise the operations of such services in any way. In the Policy Plan on Environment and Economy, a budget of 15 million guilders over six years (1998 – 2003) has been allocated to the stimulation of innovations in mobility services, including Car Sharing services.

So, the development is mainly driven by entrepreneurial activities of a variety of actors, who see market opportunities for this kind of services. At the moment, the development of Car Sharing services is still in its first stages. This implies that the market changes rapidly. At this moment there are numerous developments that have an impact on the market: the number of services available is increasing; the nature of the service arrangements changes; there is further integration of new information technologies; and various entrepreneurs are seeking integration in public transport services.

Car Sharing organisations currently discuss their position in the entire transport system. These service organisations can either position themselves as "mobility" centres or as alternatives to the privately owned car. In the case of the strategic choice of becoming a provider of mobility services – in which car use through Car Sharing is only one of the options in the total service package for mobility – the organisation will need to integrate in conventional public transport services. Since many service organisations acknowledge the inherent limitations of Car Sharing and see that Car Sharing services might function best when offered complementary to public transport, they seek further integration. The way in which this inte-

gration could best be realised is still under investigation. Recently, a Car Sharing company and the Dutch Railways have started an experiment in which a special service offer was made to "frequent users" of the railways. The implementation of new information technology is probably most important. Especially when cars are distributed in a decentralised manner from unmanned stations, information technology is indispensable for a well-functioning and safe system. When supplying a car to an individual, it is essential to identify the user, to register the car that is used and the use itself in terms of mileage, the time the car is used and sometimes the period of the day. Electronic identification of clients by way of chip keys or magnetic cards is becoming common practice. For the registration of the use, a board computer is installed in the car. The user has to identify himself to the computer before the car can be started. For security reasons and fleet management purposes, a GPS system (Global Positioning System) is sometimes installed.

To conclude, we want to underline that in future, operational service schemes will definitely very different from the existing ones. The current schemes are in a process of continuous improvement and change. Companies are learning from their experiences in the empirical reality of today, developing and improving their services to better satisfy customer needs and make their service scheme more successful in the market.

4 Exploratory research on Car Sharing

4.1 Introduction

The three empirical research questions with regard to Car Sharing as specified in chapter 1. refer to three dependent variables. The dependent variables are (1) the adoption decision with respect to Car Sharing; (2) the service quality perception after usage; and (3) the changes in mobility behaviour. These dependent variables represent three separate results from three separate choice making processes: the innovation adoption decision process, the innovation evaluation process and the travel mode decision process. In all three processes choices have to be made that presumably can be predicted by various sets of variables. Each choice results in a decision, which either can be measured in terms of behaviour – the outcome of the decision – or in terms of attitude (the intention to extend the contract).

In relating the three dependent variables, a decision process model can be defined that describes the relationships between these variables (see figure 4.1) The figure shows the innovation adoption decision process, the innovation evaluation process and the travel mode decision process and provides the basis for relating the dependent variables to each other. In the process model a distinction is made between the input (the service offer of Car Sharing), the various decision processes and their outcomes. The innovation adoption process and the innovation evaluation process can be seen as complementary in the extended innovation decision process.

Figure 4.1 Consumer decision processes with regard to Car Sharing Services

For each of the decision processes, a specific conceptual model needs to be specified that describes how the outcome of the decision can be explained. For exploratory reasons we have therefore performed three different kinds of research activities to generate more insight

into the nature of the three different decision processes and their relevant variables.

First, a literature review with regard to the modelling of each of these three decision making processes will be presented in section 4.3 Secondly, a focus group study with experienced users of Car Sharing system will be presented in section 4.4 to generate a qualitative insight into the decision making process. Finally, we conducted a survey among users of Car Sharing system in Leiden ("Huur-op-Maat"). This study was meant to obtain quantitative insight in the changes in mobility behaviour among users of this particular scheme.

4.2 Review of literature

Below, the findings and major conclusions of the literature review will be presented. For exploratory reasons, we found it useful to review the existing literature on the knowledge about the explanation of the three central dependent variables.

1. The adoption decision with respect to Car Sharing

Only a few empirical studies have focused on the adoption decision of Car Sharing. Two studies (Baum and Pesch, 1994; Muheim *et al.*, 1992) analysed some determinants of the market acceptance of Car Sharing services by empirical analysis. Some other studies tentatively suggested possible determinants of the adoption decision (e.g. AGV, 1993 and Petersen, 1994) but didn't test them through empirical research. The general opinion is that Car Sharing will receive wider market acceptance if the convenience of car use is similar to owning a car and the costs for car use do not exceed those of a private car (Baum and Pesch, 1994). Based on the existing literature, a number of possible determinants can be listed (table 4.1).

A distinction can be made between person oriented, service oriented and context oriented determinants. It does not become clear to what extent these determinants play a role in the adoption process and what their relative contribution is to the adoption process. Most of these possible determinants speak for themselves. Some deserve further explanation: For instance, the value of the car as a prestigious good refers to the emotional value of car ownership. People often find car ownership of high value to show others who they are and to distinguish themselves from others.

Convenience in the transaction process refers to the number of activities consumers have to go through before get access to a car. Filling out forms, waiting to be helped, and covering long distances do not contribute to a convenient transaction process.

Convenience with regard to additional activities refers to a number of activities or responsibilities that are needed to drive a car. For instance, getting an insurance, paying taxes, taking care of maintenance and repair, and cleaning the car are all different kinds of additional activities, which – for some people – do not contribute to convenient car use.

Table 4.1 Possible determinants of the adoption of Car Sharing services

Possible determinants of adoption of Car Sharing services	Effect	Source ¹
Person oriented:		
financial advantage	positive	1,2,3
car ownership	negative	1,2,3
frequency of car use	negative	1,2,3
car use for commuting	negative	1,2
conscious car use	positive	2
environmental consciousness	positive	2,3
value of car as a prestigious good	positive	2
Service oriented:		
availability nearby home	positive	1,2,3
guaranteed availability	positive	1,3
low fixed costs	positive	1
low costs	positive	1
reliable cars	positive	1
safe cars	positive	1,3
new cars	positive	1,3
flexibility in reservation	positive	1
possibility to use different types of cars	positive	1,3
convenience in the transaction process	positive	1,3
convenience with regard to additional activities	positive	3
direct availability of the car	positive	3
Context oriented determinants:		
rising costs of car use	positive	1
availability of public transport facilities	positive	1
• service frequency of public transport services	positive	1
• provision of facilities for safe cycle traffic	positive	1
price of petrol	positive	1
reduction of parking facilities in urban space	positive	1
a subsidy for selling the private car	positive	1
parking facilities for Car Sharing systems	positive	1

1 Sources: 1 Baum and Pesch, 1994; 2 Muheim, 1992; 3 Petersen, 1994

2. The service quality perception of Car Sharing services

None of the available studies on Car Sharing reported on service quality issues and the perception of service quality. This might be explained by the fact that in the early days of the development most service suppliers first paid most attention to convincing potential clients to join their Car Sharing schemes. The problem of retaining clients by providing a high quality service on a continuous basis was probably considered of secondary importance. It would require an optimisation of the organisation in order to be able to deliver a constant quality over time.

3. The changes in mobility behaviour

This third dependent variable has received most research attention up to now. The reason for this specific interest is perhaps that Car Sharing services receive (a great deal of) their social and political legitimacy particularly because of these changes in mobility behaviour. Three (large scale) descriptive studies have been published on the changes in mobility behaviour. Overall, these studies report rather similar tendencies in the changes in mobility behaviour:

The study of Muheim and Inderbitzin (1992) is the first study which addresses this issue. The participants of the Swiss scheme ATG (Auto Teilet Genossenschaft) were asked to report on their mobility behaviour and to estimate their use of various transportation modes before and after adoption (146 respondents). Mobility behaviour was operationalised by car mileage (privately owned, rental and borrowed) per year, spending on public transport per year and the average amount of trips by bicycle. The research results show substantial differences in mobility behaviour before and after adoption, if a distinction is made between formerly carless people and former car owners.

- The total mileage of all participants (by car and by public transport) decreased with 3%, but former car owners reduced their mileage with 17% and the formerly carless people increased their mileage with 3 %.
- The total car mileage per year decreased with 52% among the former car owners and increased with 4% among the formerly carless people.
- A large proportion of the mobility by car is substituted by use of public transport: the former car owners increased their mileage by public transport with 49%.

It must be mentioned that the average ATG member has a lower yearly mileage than the average Swiss (only 71%) and uses public transport far more frequently (260%).

A German study (Petersen, 1994) provides some insights in the Berlin Stattauto system ($n=254$). The changes in mobility behaviour, however, are measured on an interval level. Petersen concludes that after adoption of Stattauto the overall car mileage is reduced from 8.680 to 4.090 kilometres a year, which is about minus 53%. In his results, no distinction is made between former car owners and formerly carless people. Above all, he reveals in a far more qualitative manner that there might be some effects on travel mode choices, which are consistent with the tendencies of the Swiss study.

By far the most extensive ($n= 602$) study on the changes in mobility behaviour until now is the study of Baum and Pesch (1994). Their data refer to several Stattauto systems in various German cities. The results of this survey study provide a more detailed insight into the changes in mobility behaviour of new members of Car Sharing systems.

- The overall mileage by car is reduced by 42% and the overall use of public transport increases by 39%. This suggests that substitution takes place between the car and public transport.
- The difference in changes in mobility behaviour between car owners and carless people is again substantial: former car owners reduce their car mileage by 60%, whereas the carless people increase theirs with 42%.

Table 4.2 Changes in mobility behaviour among Stattauro users
(Baum and Pesch, 1994)

	Before adoption	After adoption	Changes in behaviour
Mileage by car (km/ year)	7.000	4.050	-42%
• carless people	2.740	3.900	+42%
• car owners	10.450	4.175	-60%
Mileage by public transport (km/ year)	3.900	5.441	+39%
Frequency of car use (per month)	10,8	3,2	-71%
• carless people	1,6	2,5	+56%
• car owners	24,6	3,7	-85%
Frequency of cycling (per month)	18	20	+11%
Average trip distance (km)	53,4	77,7	+46%

- Regarding the frequency of car use, a remarkable difference exists between car owners (24,6 trips a month) and the carless people (1,6 trips a month).
- Despite huge differences in frequency of car use before adoption, Car Sharing supports a rather low frequency of use among both groups after adoption (2,5 and 3,7 times a month). It seems Car Sharing is a good option for those who need a car about once a week.
- Adoption of Car Sharing not only seems to affect motorised mobility, but also influences the use of the bicycle. An increase with 11% is reported within the Stattauro system.
- Baum and Pesch also measured the average trip distance by car. They conclude that Car Sharing discourages use of the car for shorter distances. The results also suggest that trips are combined more often.

All studies on the behavioural changes through Car Sharing are basically of descriptive nature. None of these studies prove there is a causal relationship between changes in mobility behaviour and the adoption of Car Sharing. There is still no insight in what kind of intermediate mechanisms connect the adoption of Car Sharing and the resulting changes in mobility behaviour. Only the study of Baum and Pesch gives two explicit suggestions for the explanation:

1. The reduced availability of the car

Car Sharing services usually prevent direct access to a car in front of the home. In order to get a car, one has to cover a certain distance, either walking or cycling. This spatial separation between the home and the parking place of the car causes a certain resistance, which results in a lower frequency of car use.

2. The improved cost transparency

Car Sharing leads to an improved cost transparency because the costs are entirely dependent of the car use. In contrast to Car Sharing, the private car has, due to high fixed costs, a degressive cost structure, which leads to decreasing marginal costs when driving more. An

objective cost-benefit analysis between car use and the use of public transport is therefore easier.

Conclusion

The existing literature provides some descriptive knowledge about Car Sharing. However, insight into the relative contribution of the various potentially explaining variables suggested is missing. No attempts have been made to model the adoption, the changes in behaviour or the service quality perception. In the light of the research questions addressed here, it is indispensable to develop a conceptual model which can be tested empirically. Many variables might be relevant for answering our research questions. The question remains, however, to what extent these variables are actually relevant and how they relate to each other.

To be able to specify the relations between dependent and (groups of) explaining variables, we intend to develop a conceptual model for each of the three dependent variables individually. Our empirical study will be set up to investigate or test these relationships.

4.3 Exploration by focus group studies

To develop our conceptual model, the basis for the empirical study, we conducted two focus group sessions with participants of one of the first operational Car Sharing scheme in the Netherlands, called "Huur-op-Maat" in Leiden.

Huur-op-Maat, a Car Sharing service for the citizens of Leiden, was initiated in 1993 by the town council of Leiden, but is run by four different rental companies on a fully commercial basis. Huur-op-Maat was initiated by the town council as an experiment within the framework of a larger project aimed at improving the quality of the old centre of Leiden.

In October 1994, all 125 members of the Huur-op-Maat scheme were mailed with the request to participate in a focus group discussion about their experiences with this scheme. They were promised a 25 guilder compensation. Of the large response (34%) only twenty people were selected for two discussion groups, one with former car owners and the other with formerly carless people. Both discussions were taped on video and written down in a full protocol. These protocols were summarised into a set of conclusions, which will be discussed here.

The focus group studies (Meijkamp and Douma, 1995) were conducted in order to find out empirically which aspects were important for the explanation of (1) the adoption of Car Sharing and (2) the aspects related to the changes in mobility behaviour. In addition to the insight gained from the literature on Car Sharing schemes, we expected that these focus groups might reveal new aspects which we could integrate in our conceptual model. Through discussions with consumers, a better and in-depth insight could be gained in the real-life decision making process and the experiences of the consumers themselves (see e.g. Churchill, 1991). These focus group discussions were also used as an aid in designing a better survey instrument, one which appeals to the language and the understanding of the participants of the Car Sharing scheme (Churchill, 1991).

Main conclusions of the focus group discussions

For an in-depth understanding of the motivation for participation in a Car Sharing scheme, it seems important to differentiate between various market segments. The distinction between former car owners and formerly carless people is one of the most obvious segmentation principles. Despite the many similarities between these two consumer groups, substantial differences in the explanation of the adoption and the changes in mobility behaviour might be expected.

1. Determinants for adoption

For all participants, the financial benefits of using *Huur-op-Maat* as an alternative to the private car seem to be one of the major determinants of adoption. The relative economic advantage can be attributed to a large variety of variables or characteristics. For example, the former frequency of car use and use of the car for commuting are important indicators for economic advantages: Car Sharing becomes less attractive with increasing car mileage. For a positive adoption decision the difference between the costs of the private car and the Car Sharing services must be substantial, otherwise non-economic factors like "convenience" will influence the decision negatively.

The extent to which people perceive an economic benefit from the use of Car Sharing also depends on their reference. In order to make a fair comparison, the costs of Car Sharing should be compared with those of a new car. Because many people compare the costs of Car Sharing with public transport or a second hand car, adoption for economic reasons is not very likely to happen. Especially the formerly carless people are likely to compare Car Sharing with the costs of public transport or with the costs of buying a second hand car of more than about three years old.

Another important condition for recognising that (at lower frequencies of car use) Car Sharing provides an economically beneficial alternative, is the cost involvement. In the discussions many people stressed their extensive calculations with respect to the costs of the car, their knowledge about all cost factors and their willingness to take these financial costs into account when deciding on the adoption of *Huur-op-Maat*.

Some people also mentioned that environmental problems have had a decisive influence in their positive adoption decision. So, environmental consciousness and knowledge about environmental problems in relation to car use seem to be explaining determinants as well. The trouble in finding a parking place nearby home has been suggested as another argument why people decided to adopt *Huur-op-Maat*. The provision of parking facilities in cities is valued as a great advantage. Here, a perceived disadvantage of the private car is likely to function as a determinant of adoption.

Some people put forward that the convenience associated with Car Sharing was another stimulating factor in adoption. According to the perception of the people, the absence of paperwork, maintenance tasks and financial risks can be positive arguments for adoption. Finally, the perceived inconvenience of the use of public transport is suggested by the carless as a determinant of adoption. This might be extended to a general factor: the dissatisfaction with all travel modes that form an alternative to the car.

2. The decision making process

According to the participants of the focus group, the decision whether to buy a car or not and whether to participate in a Car Sharing scheme is preceded by an extensive decision making process, which sometimes takes years. On the basis of the focus group discussions, we expect that for former car owners and for carless people, the nature of the decision making process is different: the carless are not used to the frequent use and the direct availability of a car. They can therefore increase their mobility without large initial investments. For them, the use of Car Sharing services is more or less an extension of their normal mobility behaviour. So no fundamental changes in mobility are required. As a result, they might take the decision much more spontaneously. Former car owners, on the other hand, must change their mobility behaviour substantially. They have to break through certain patterns of habitual behaviour, which makes it more difficult to adopt Car Sharing. Above all, they still have a car, which must be sold. Many former car owners argued that a strong incentive must exist for change. Severe problems with the car or changes in someone's personal situation have been put forward in as strong incentives to adopt Car Sharing.

3. Individual differences: the value orientation

An important issue in the discussion was whether or not the participants would become "a different kind of people". Many of the participants felt that they differed from other people in their attitudes and values. Especially the meaning of the car for the individual seems to be rather distinct. The great majority of people attributes high social status to the ownership of a car, whereas the adopters are more likely to see the car just as an instrument for transport.

4. The service quality perception

In 1995, the Huur-op-Maat service was offered by four different suppliers. Therefore, in the discussion comparisons were made of the operational performance of each of them. The service quality perception clearly relates to the extent to which a company fulfils its promises. For instance, when people make a reservation, the company must provide a guaranteed car. The reliability of the customer service and the availability of the cars, especially in the weekends and evenings were said to be important for the satisfaction with the service. Apart from the service people get, the way in which people are treated also contributes to their satisfaction. Obviously, the personal attention and the politeness of the service personnel is an important additional quality factor.

5. The influence on car use

According to the participants, Car Sharing definitely would have effects on the mobility behaviour. However, these effects strongly depend on former car ownership. For carless people, Huur-op-Maat usually means an increase in car use. Many of them didn't consider buying a car at all. Huur-op-Maat provides them with the opportunity to use a car more often without any investments. On the other hand, Huur-op-Maat helps them to cope with the spatial restrictions of the service provision of public transport. Huur-op-Maat would prevent them from purchasing a car in the future.

For the former car owner, Huur-op-Maat represents a systems that leads to a selective car use. Due to the inherent barriers to get access to a car, other and possibly more appropri-

ate travel modes are considered for a specific trip. This deliberate choice making regarding the travel mode used is further supported by the variable cost structure and the direct feedback of the costs of car use.

6. The interaction between various transport modes

Besides the influence of Car Sharing on car use, changes in the use of alternative travel modes can also be expected. For the participants of *Huur-op-Maat*, the car is just one of the travel mode options in a broader package, including public transport, the train, the bicycle and walking. The participants have suggested that, to a certain extent, these travel modes are exchangeable. Because of the reduced availability of the car, former car owners will more frequently use alternative travel modes. It has been suggested that public transport is used more often.

For the formerly carless people quite an opposite effect can be expected. Here, according to the participants, public transport use is substituted by car use.

Concluding remarks

For answering our research questions the focus group discussions were of limited value: they did not clearly lead to distinctions between more or less important determinants, nor did they provide a quantitative answer to our questions. However, for the construction of a conceptual model and the design of the questionnaire, the focus group discussions were very helpful. In addition to the determinants mentioned in the literature various important determinants were identified, as well as some interesting relationships among various variables.

4.4 An exploratory survey in Leiden

In addition to the focus group discussions, a survey study was set up for exploratory reasons. The aim of this study is to explore quantitatively the changes in behaviour before and after participation in the *Huur-op-Maat* scheme in Leiden (Meijkamp and Douma, 1995). A questionnaire was used to collect data about the (estimated) mileage and the frequency of use of various travel modes before and after participation. The questionnaire also included a list of items on a 5-point scale to allow an inventory of the changes in travel behaviour with respect to specific trips and the use of specific travel modes for specific kinds of trips. The questionnaire was sent to all 124 participants of *Huur-op-Maat* in 1994 (Meijkamp and Douma, 1995). The mailing received a response of 52%.

The results on the changes in car use, as shown in the figure 4.2, reflect to a large extent the impressions we got from the focus group discussions and other survey studies (see e.g. Baum and Pesch, 1994). The average use of the car decreased from 13.260 km a year to only 4051 for the former car owners. In contrast, the carless people increased their mobility by car from 1440 kilometres a year (by conventional rental and borrowed cars) to 5010 kilometres. Although these results might be interpreted as indicative for the changes in car use, some remarks can be made:

Figure 4.2 Changes in car use before and after participation in Huur-op-Maat in Leiden

All participants use the car far less than the average Dutch household. The average car owning household drives up to 24.163 kilometres a year, whereas the average carless household drives 1.716 kilometres (CBS, 1995). Car Sharing seems to be an alternative for households with a particular demand for car use of about 4.000 to 5.000 kilometres a year. Few differences in volume of car use exists between the car owning households and carless households.

The survey revealed that the majority of the participants of Huur-op-Maat didn't own a car before participation: 64% of the respondents, of which 38% never had a car before. 36% of all respondents owned a car just before participation and almost all of them (95%) substituted their car for Huur-op-Maat services. For many carless people, Huur-op-Maat is an alternative for buying their own car: 46% seriously considered buying a car, either a new or a second hand one. This is supported by the fact that 16% of all carless people was very sure, and 22% stated that they probably would have bought their own car if no Huur-op-Maat service had existed.

By means of a list of items on a 5-point scale with statements on the changes in mobility behaviour through participation in Huur-op-Maat, an inventory of more specific changes in travel behaviour could be made. Basically, this is a measurement of the respondents' perceptions of how Huur-op-Maat affects their mobility behaviour. In the analysis a distinction was made between former car owners and the carless people.

The results among the carless people show a somewhat confusing picture of how Car Sharing might affect mobility behaviour: almost all items show a large variance in scores, despite the fact that some tendencies of change suggested in the focus group discussions are visible. Even with respect to the frequency of car use the results do not provide an unequivocal answer.

With respect to the way in which Huur-op-Maat might affect mobility behaviour of car owners, the picture is much clearer: people drive less (short) trips by car, do not commute by car anymore, and use the car almost exclusively for leisure time and holidays. However, the effects on public transport use, travelling by train and by bicycle are less unequivocal.

Table 4.3 Changes in mobility behaviour among the former car owners of Huur-op-Maat

Items:	Agree				Disagree
Since I am a member of Huur-op-Maat,	1	2	3	4	5
we make less trips by car	67	10	0	10	14
we make less short trips by car	76	10	0	0	14
we do not commute by car anymore	67	0	5	0	29
we do not use the car anymore for shopping	48	19	10	0	24
we just take the car for holidays and leisure	71	10	5	0	14
we take the bicycle or go walking more often	43	14	10	0	29
we take the taxi more often	0	14	5	14	62
we travel more often by train	29	5	14	5	48
we travel more often by public transport	29	5	5	19	43
we use more frequent home delivery service	19	5	10	10	52
we combine more often our trips	29	19	24	5	24

Table 4.4 Changes in mobility behaviour among the carless people of Huur-op-Maat

Items:	Agree				Disagree
Since I am a member of Huur-op-Maat,	1	2	3	4	5
we make more trips by car	35	14	5	30	3
we take the car for holidays more frequent	30	8	16	3	38
we take the car especially in the evenings	5	5	3	16	65
we take the car especially in the weekends	27	14	8	16	30
it is more convenient to visit people far away	38	27	8	5	14
we travel less often by public transport	14	11	11	19	41
we combine more often our trips	27	24	22	14	11

For exploratory reasons, this quantitative study was very helpful: It allowed us to formulate certain expectations with regard to changes in behaviour. Above all, it revealed a substantial variation in possible effects on mobility behaviour. We may therefore conclude that participation in Car Sharing schemes alone might not suffice as an explanation for the changes in mobility behaviour.

4.5 Conclusions

In this chapter we distinguished three separate dependent variables following the three central empirical research questions. These dependent variables are (1) the adoption decision with respect to Car Sharing; (2) the service quality perception after use of the service and (3) the changes in mobility behaviour. We have seen that these three dependent variables represent three separate results from three separate choice making processes: the innovation adoption decision process, the innovation evaluation process and the travel mode decision process. The relationship between the dependent variables can be described by a decision making process model. *Despite the fact that the three dependent variables might be inter-related, we decided to first study the explanation of each of these dependent variables individually. Therefore three separate conceptual models are required.*

To be able to specify such conceptual models we performed some exploratory studies. We intended to gain some preliminary insight into the explanation of the three dependent variables. For exploratory reasons, we performed a literature study on Car Sharing, focus group discussions with participants in such schemes, and a small scale quantitative study. Based on the results of this exploratory research, we indeed gained more insight in possibly relevant determinants and the nature of some of the relationships between variables.

However, these studies are not sufficient to specify a proper conceptual model, due to a lack of appropriate theoretical frameworks. We therefore conclude that a more general theoretical approach is needed, to construct a conceptual model for each of the three dependent variables, which explains the adoption, the satisfaction and the changes in behaviour in a more detailed way. In the following chapter we will search for a theoretical basis for our conceptual models, in which the (empirical) findings of the exploratory studies can be integrated. Hopefully, these conceptual models will ultimately allow large scale empirical testing.

5 Conceptual model

5.1 Towards a conceptual model

In the previous chapter we specified a consumer decision process model in which the relationship between the three dependent variables is modelled. The three dependent variables are (1) the adoption decision on Car Sharing, (2) the service quality perception of Car Sharing services and (3) the changes in mobility behaviour. These dependent variables represent three separate results from three separate choice making processes: the innovation adoption decision process, the innovation evaluation process and the travel mode decision process. As illustrated in the consumer decision making process model, the innovation adoption process and the innovation evaluation process can be seen as complementary in the (extended) innovation decision process.

Innovative decision processes have been the subject of study within a number of domains where there is a concern with the processes of adoption and diffusion of innovations, whether they be new ideas, practices, technologies, or new products. Much of the theory, modelling, methodology, and empirical findings on diffusion of innovations is multidisciplinary. The description of Car Sharing in chapter 3 and the exploratory research in chapter 4 point to the multidisciplinary nature of our research problem.

The innovative decision process regarding Car Sharing, as conceptualised in chapter 4, shows great similarity with one of the basic theoretical frameworks in innovation literature, which is the "Diffusion of Innovations"-model of Rogers (1983, 1995). This meta study on innovation diffusion studies can be seen as a reflection on more than 3.000 publications on diffusion of innovations. Rogers suggests a communication model which explains the adoption and social diffusion of an innovation.

Our conceptual model for both the innovation adoption process and the innovation evaluation process heavily depends on the extended innovation-decision process as conceptualised by Rogers. We have, however, made several adaptations on specific aspects. In response to the limitations of Rogers' model of the innovation decision processes for our purposes, we specified our own conceptual model for the innovation adoption process and the innovation evaluation process. The insights gained in the exploratory research helped us to adapt Rogers' innovation decision making model and include new/ additional predictors.

To explain the way in which existing theory is used, we will first discuss innovative decision processes in general, with special attention to Rogers' conceptual model of the adoption and diffusion of innovations. After this, we comment on the appropriateness of these innovation decision models for our research purposes. The three separate conceptual models for our study will be presented consecutively in sections 9.2, 9.3 and 9.4.

5.1.1 The "Diffusion of Innovations"-model by Rogers

For our study we have chosen to treat Car Sharing (as offered in a variety of forms) as a normal innovation, exactly in the way Rogers describes them in "Diffusion of Innovations" (1995): "an idea, practice, or object that is perceived as new by an individual or other unit of adoption". As far as human behaviour is concerned, it matters little whether or not an idea is "objectively" – measured by the lapse of time since its first use or discovery – new. It is the perceived newness of the idea for the individual which determines his or her reaction to it. If an idea is new to the individual, it is an innovation.

Rogers' concept is relevant for a wide area of applications and provides an useful basis for analysis of the acceptance problem of Car Sharing: "One reason why there is so much interest in the diffusion of innovations is because getting a new idea adopted, even when it has obvious advantages, is often very difficult.... Many innovations require a lengthy period, often some years, from the time when they become available to the time when they are widely adopted. Therefore a common problem for many individuals and organisations is how to speed up the rate of diffusion of an innovation." (Rogers, 1992)

The diffusion of innovations is defined by Rogers as the process by which (1) an *innovation* (2) is *communicated* through certain *channels* (3) over *time* (4) among the *members of a social system*. These four main elements are identifiable in every diffusion research study and in every diffusion campaign, like the diffusion of Car Sharing in the Netherlands.

The innovation-decision process is the process by which an individual passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and finally to confirmation of this decision. This process consists of a series of actions and choices over time in which an individual evaluates a new idea and decides whether or not to incorporate the innovation into his daily practice, as shown in figure 5.1.

Figure 5.1 Stages in the innovation-decision process (Rogers, 1995)

5.1.2 The various aspects of innovation diffusion research

Rogers' framework does not clearly distinguish between the sociological perspective of the diffusion of innovation within a society and the adoption of an innovation on the individual level. In our study we are basically interested in the adoption and evaluation of the innovation from the perspective of the individual, and less in the pattern of diffusion through society. Gatignon and Robertson (1991) propose a framework similar to that of Rogers, but make a clear distinction between the adoption process and the social diffusion process. Figure 5.2 below shows the main (assumed) relationships between the core concepts in this model.

Figure 5.2 Relationships of the consumer diffusion paradigm (Gatignon & Roberts, 1991)

The main elements of the diffusion research paradigm, according to Gatignon & Roberts (1991) are the following:

- 1 the innovation and its characteristics
- 2 the social system in which the innovation diffuses
- 3 the diffusion process
- 4 the adoption process by the individual consumer
- 5 the personal influence
- 6 the personal characteristics of the adopters
- 7 the marketing strategy for the innovation
- 8 the competitive activities within the product category.

Elements 7 and 8 are not included in Rogers' model. Each element will be briefly discussed here. Not all elements are equally important for our research, but they indicate the variety of relevant aspects in the adoption and diffusion of innovations.

1. The innovation and its characteristics

Clearly one of the key elements of the diffusion of innovations is the innovation itself, as it is perceived by the consumer. It is obvious that the characteristics of the innovation itself will have a strong bearing on the innovation adoption decision process and the speed and the nature of diffusion. Rogers (1983, 1995) proposes five major characteristics on the basis of which innovations can be evaluated: (a) relative advantage, (b) compatibility, (c) complexity, (d) trialability and (e) observability.

- a. *Relative advantage* is the degree to which an innovation is perceived as better than the idea it supersedes. The degree of relative advantage may be measured in economic terms, social prestige factors, convenience and satisfaction. According to Rogers it does not matter whether an innovation has a great deal of objective advantage. What does matter is whether the individual perceives the innovation as advantageous. The greater the perceived advantage of an innovation, the more rapid its rate of adoption is going to be.
- b. *Compatibility* is the degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of potential adopters. An idea that is incompatible will not be adopted as rapidly as an innovation that is compatible. The adoption of an incompatible innovation often requires the prior adoption of a new value system, which is a slow process.
- c. *Complexity* is the degree to which an innovation is difficult to understand and use. Innovations that are simpler to understand are adopted more rapidly than innovations that require the adopter to develop new skills and understanding.
- d. *Trialability* is the degree to which an innovation can be experimented with on a limited basis. An innovation that is trialable represents less uncertainty and risk to the individual who is considering it for adoption, as it is possible to learn by doing.
- e. *Observability* is the degree to which the results of an innovation are visible to others. The easier it is for individuals to see the results of an innovation, the more likely they are to adopt it. Such visibility stimulates peer discussion of a new idea.

In our study we are not so much interested in the characteristics that make Car Sharing service more or less successful in comparison with other kind of innovations. We are primarily interested in characteristics that determine the successful adoption of Car Sharing as such. Therefore, we will operationalise the potential relative advantages of the innovation, as well as search for values, past experiences and needs that indicate to what extent Car Sharing is compatible with the ideas of the potential adopter.

2. The social system in which the innovation diffuses

Many innovation diffusion studies are rooted in classical sociological research. The existence of the context of a social system is considered important for the decision of the individual in that context. Three major social characteristics are thought to affect the diffusion process (Gatignon and Robertson, 1991): first, there are the norms and values of the social system, or social subsystem. Because social norms and values are not static, a second factor is the system's normative evolution, for example towards a greater acceptance of technology. Third, homogeneity of the social system encourages faster diffusion by maximising interpersonal content.

In order to reduce the complexity of our study, the influence of the social system on the individual decision maker is not taken into account. Establishing the influence of the social

environment on the decision making process of the individual would require a separate study. In this study we therefore assume that the individual decision maker is not influenced by his/ her social environment.

3. The diffusion process

The diffusion process is reflected in the innovation's aggregate adoption curve over time, i.e. the rate of penetration of the innovation in society or in a specific market segment. In studies on the diffusion of innovations three major characteristics were used as dependent variables (Gatignon and Roberston, 1985): (1) the shape or pattern of the aggregate adoption curve over time, (2) the rate of adoption at specific periods, and (3) the size of the potential market over time.

Like our study, most innovation diffusion studies focused on the first users of the innovation. Rogers distinguishes various market segments in the adoption process, based on the innovativeness of an individual. The innovativeness of an individual is defined as the degree to which an individual is earlier in the adoption of an innovation than the other members of a system. In a comparison between the innovativeness of individuals in a social system, various adopter categories can be distinguished. Each of them is characterised by a similar speed of adoption of the innovation after the market introduction. Rogers defines five adopter categories: (1) the innovators, (2) the early adopters, (3) the early majority, (4) the late majority and (5) the laggards.

Our research is aimed at the innovators since we focus on the first group of participants of Car Sharing schemes. The consumers that participate in Car Sharing systems at this moment can be seen as the innovators. They can be distinguished from those who have rejected Car Sharing for whatever reason. At the time of research no dynamic analysis could be made, because Car Sharing is such a young innovation that it has not (yet) spread over society. The diffusion process can only be studied *ex post*, after the fact, and is therefore excluded from our study.

4. The adoption process by the individual consumer

The adoption process concerns the decision sequence that consumers use to determine whether or not to adopt the innovation. These innovation decision processes are at the core of diffusion theory. Many authors have conceptualised the adoption process as a process in which awareness precedes interest, evaluation, trial and adoption. In his literature study, Brezet (1995) extensively discusses the various theoretical ideas on the nature of the decision process.

Gatignon and Robertson (1985) state that many authors fully ignore information-processing theory and behavioural decision processes and that such a model "exhibits a learning bias", as is the case in Rogers' model. This 'learning bias' refers to the idea that consumers must progress through a deliberate purchase hierarchy. Despite its usefulness for structuring, many adoption decisions may not resemble this learning sequence. In section 5.2., where we specify and discuss the conceptual model for the adoption decision, we will come back to this issue, because various cognitive concepts like "habitual behaviour" seem to be important in the context of Car Sharing.

Rogers' basic assumption on the diffusion of innovations is his conviction that an individual's decision about an innovation is not an instantaneous act, but rather a process that occurs over time and consists of a series of actions and choices. The innovation is extensively evaluated before it is put into practice. Rogers conceptualises the innovation-decision process in five stages: (1) knowledge, (2) persuasion, (3) decision, (4) implementation and (5) confirmation. An individual gets 'knowledge' of an innovation, when he or she learns of the innovation's existence and gains some understanding of how it functions. The 'persuasion' takes place when an individual forms a (un)favourable attitude toward the innovation. The 'decision' is made when an individual engages in activities that lead to the choice to adopt or to reject the innovation and 'implementation' is reached when an individual puts an innovation to use. Finally, 'confirmation' takes place when an individual seeks reinforcement on an innovation decision that has already been made.

The innovation-decision process involves time, in the sense that the five steps usually occur in an ordered sequence in time. Rogers defines the innovation-decision period as the length of time required to pass through the stages of the innovation-decision process.

For our study we choose the innovation-decision process as a basis to start from. It helps formulate our conceptual model and supports the analysis in a sensible way. However, we also expect there are some limitations to this model of deliberate decision making. Our exploratory research gives rise to the expectation that habitual behaviour is likely to influence the nature of the innovation decision making process in some aspects, since it influences the nature of the cognitive process of decision making. In section 5.1.3 we propose some modifications to this effect, based on considerations of a theoretical nature. These modifications will be empirically tested.

5. The personal influence

The diffusion of innovation is a social process in which information about a new idea, a new product or service is communicated by individuals. The effects of the transmission of information depend on the nature of the communication process and the relationship between the sender and the receiver.

According to Gatignon and Robertson (1985), the extent and impact of personal influence is conditioned by a number of factors: (1) the relevance of the information for the decision-making process of the potential adopter; (2) the role of information from members of the social system in relation to the information from other sources; (3) the direction of the information (information-seeking versus information-giving); (4) the motivation or intent of the information exchange; (5) the form (visual or verbal) of the information; (6) the sign (positive or negative) of the information; (7) the characteristics of the information provider and (8) the origin of the information.

In the context of our study, the nature of the communication of the innovation is considered of minor importance. Neither the exploratory empirical research, nor the literature have provided signals of the importance of personal influence in the adoption of Car Sharing.

6. Personal characteristics of innovators and other adopters

From a pragmatic point of view, knowledge about the personal characteristics of innovators is highly valuable, since marketers like to position their products in specific markets. The

personal characteristics of innovators can be used to divide the market into more specified segments. Companies can reach their customers more effectively by tailoring their services to the specific needs in certain market segments. Unfortunately, marketing research on the personal characteristics of innovators has not produced consistent conclusions. Nevertheless, there are a few variables which do seem to discriminate innovators from later-adopters or non-adopters: a higher income, a higher education, a younger age, a greater social mobility, a positive attitude towards risk, a greater social participation, a higher degree of opinion leadership, etc. (Robertson, Zielinski and Ward 1984).

In our research we will explore the personal characteristics relevant in the adoption of Car Sharing, as suggested by the research findings in the literature on transportation behaviour, the exploratory empirical research on Car Sharing, and relevant literature.

7. The marketing strategy for the innovation

Although it seems to be rather obvious that the speed, shape and extent of the diffusion of an innovation largely depends on marketing strategy, not much research could be found on this subject. In the past, marketing strategy "has usually been ignored in the literature on innovation decision processes" (Gatignon and Robertson, 1989). Hultink (1997) however, showed that, with respect to product launch strategies, both on a strategic as on a tactical level, successful products were distinct from unsuccessful products.

A marketing strategy includes a large number of marketing mix variables, such as price strategy, advertisement strategy, sales strategy and distribution strategy. For several reasons this aspect seems to be very difficult to include in our study on Car Sharing. First of all, little variation can be created, since only a few different Car Sharing companies exist. Moreover, the variation in marketing strategy can be characterised by a large number of variables (see e.g. Hultink, 1997). Studying the influence of all these variables would take a separate study. And, above all, it is very hard to establish the influence of a specific marketing strategy only a short time after the introduction of a new service.

8. Competitive activities within the product category

The marketing of an innovation does not take place in a complete monopolistic situation. Various competitors market similar products and services. The extent to which competing alternatives exist for a specific innovation influences consumer decision-making and the attention the innovation receives.

These aspects are not included in our research, largely because in many cities and areas within cities no competition exists between suppliers of Car Sharing services.

5.1.3 Limitations of the innovation diffusion paradigm for our study

Given the research questions, it seems rather obvious to choose the innovation diffusion paradigm as the main theoretical framework for our study and as the basis for our conceptual model. After all, we consider Car Sharing a "normal" innovation, as defined by Rogers. Above all, our two central dependent concepts (the adoption or implementation of the innovation and long term membership, in terms of confirmation) are explained by the diffusion paradigm. In the assessment of the appropriateness of the innovation diffusion paradigm, however, we came across four important limitations for our research purposes:

1. It offers no explanation for changes in behaviour after adoption of an innovation

The diffusion of innovation paradigm does not offer any conceptual framework explaining the behaviour with respect to the innovation or the changes in behaviour caused by the adoption of an innovation. Because changes in behaviour are one of the essential aspects in an environmental assessment, we need to refine our own conceptual model to explain the changes in (mobility) behaviour. The exploratory research showed that changes in mobility behaviour are likely to occur.

2. It ignores the role of habits in adoption decisions

The innovation diffusion paradigm explains the adoption of the innovation on the basis of a model of rational decision making. This model assumes that people make deliberate choices based on expectancy-values of innovative options. Gatignon and Robertson state that under conditions of high cognitive processing this model seems to be a reasonable representation of the adoption process (1985). The variables that determine the amount of cognitive processing involved in the adoption of an innovation are (Gatignon and Robertson, 1985): (1) the extent to which products require high consumer education, (2) the innovation adoption or switching costs, (3) the social relevance and (4) the extent to which more people are involved in the decision. When these variables are applied to the case of Car Sharing, it seems plausible to assume that a process of extensive cognitive processing is likely to take place. This kind of cognitive processing includes the stages knowledge, persuasion, decision, implementation and confirmation. At first glance, a model of rational decision making seems to be a good representation of how adoption decisions take place in Car Sharing.

On the other hand, in the case of Car Sharing it can seriously be questioned to what extent deliberate choices precede the adoption or non-adoption decision. We assume that habitual behaviour plays an important role in the explanation of non-adoption in particular: non-adopters are more guided by habits than by deliberate, but negative choices concerning Car Sharing. Several recent publications on travel mode choices (see e.g. Aarts, 1996) argue that models of reasoned action (Fishbein and Ajzen, 1975) do not entirely explain travel mode choices because they ignore an important aspect, which is that these choices are made on a repetitive basis. As a result, future travel mode choices are likely to be more dominated by habitual behaviour than by deliberate decision making.

On average, a consumer has to make a choice about a travel mode over a 1000 times a year (CBS, 1997). If every trip would be a completely different one, a rational choice would be likely. However, in general, transportation behaviour consists of similar trips in similar conditions, like daily commuting, weekly shopping, etcetera. In various studies on repeated behaviour and especially transport behaviour – which to a large extent is repeated behaviour – researchers concluded that what once was a rational choice has become repeated behaviour from the past (see e.g. Banister, 1978; Verplanken *e.a.* 1994; Aarts, 1996). Behaviour that has been successfully performed many times tends to become habitual. This means a deliberate choice is no longer made and people rely on behavioural scripts instead.

Habitual behaviour can be best understood as the immediate relationship between stimulus and response, in this case the need to travel to a specific destination and the travel mode choice. This relationship is described as an associative or automatic response to a specific

situation. Habitual behaviour is also explained as relying on a script: "the more often we have engaged in the activity, the more likely it is that we will rely on scripts for the completion of the activity and the less likely it is that there will be any correspondence between our actions and the thoughts that occur simultaneously" (Aarts, 1996). The fact that, in the case of repetitive behaviour (like mobility behaviour), habits are formed over time implies that in the case of a transport mode innovation, habits may play an important role in the explanation of non-adoption.

3. It does not take into account individual differences on subjective variables

Most innovation diffusion literature pays little attention to individual differences on subjective variables. Apart from variables indicating the differences in communication behaviour and the ability to deal with uncertainty and change, like how people deal with new information, new technologies or changes in practices and their perception of the risks of innovations, few individual differences on subjective variables are taken into consideration. Motivational variables, like attitudes and values are not taken into account either, although various publications (see e.g. Vinson, Scott and Lamont, 1977 and Rokeach, 1979) suggest that, to a great extent, consumer choice behaviour can be explained by people's value-orientation. In most innovation diffusion literature the adoption of innovations is thus only explained on the basis of objective variables like socio-demographic characteristics and the subjective concepts mentioned above.

Especially with regard to Car Sharing, we can expect that individual motivational differences, which are exemplified in the differences in value-orientation of consumers, strongly contribute to the explanation of the adoption. The qualitative research supports this assumption. According to the participants, adopters differ from non-adopters in their value orientation, especially regarding their perception of the car and the meaning they attach to it.

4. Car Sharing is a service and not a product

Car Sharing is a service, which is a performance by people, and not a tangible entity. Because of its intangible nature, it is very difficult for consumers to evaluate the service innovation before purchase. This has implications for modelling the decision making process. First of all, because the evaluation of a service before purchase is very difficult and, most importantly, because discontinuation of the adoption is far less problematic than is the case with the adoption of products.

Although innovations have been defined rather broadly by Rogers as "an idea, practice or object that is perceived as new by an individual", the innovation diffusion paradigm mainly relies on the idea of acquiring ownership of the innovation. By acquiring ownership, the (potential) benefits of the innovation become accessible to the individual. The economic and legal nature of the transaction however, generally results in a fairly poor trialability, since the consumer has to invest in a product before he can try it out. The financial costs for correcting a non-satisfying purchase are substantial. Rogers discusses the decision to reject the innovation as the *disenchantment discontinuance*. It is the result of dissatisfaction with its performance. The innovation decision model mainly focuses on the initial adoption of an innovation and is less concerned with explaining the discontinuance of the process.

In the case of Car Sharing, and of services in general, an economic transaction in which a tangible product changes hands is absent. Consumers buy incidental performances instead

of investment goods. This means that the perceived risk is lower and the trialability is much higher. The consequence for the innovation decision model is that the confirmation phase needs review. It can be expected that the extensive possibilities for reflection on the adoption strongly influence the innovation-decision process, especially in the confirmation phase.

Similar considerations have resulted in propositions about an important difference in the decision making processes for products and services (Zeithaml, 1984): *"Consumers engage in greater post-purchase evaluation and information seeking with services than with products"* and *"Consumers may find post-purchase evaluation more essential with services than with goods, because services possess experience qualities which cannot be adequately assessed prior to purchase"*.

We conclude that in Rogers' model, the evaluation process of the adoption is undervalued and that, in the case of Car Sharing, it needs to be elaborated. In the area of service marketing research, we want to look for an extension to Rogers' model, which explains the specific characteristics of services with regard to consumer decision-making. Especially the evaluation of services and the perception of service quality seem to be essential in the long-term customer satisfaction with Car Sharing.

5.1.4 Concluding remarks

Given our research questions, we conclude that Rogers' theoretical perspective on the adoption and diffusion of innovations provides an interesting theoretical framework. Despite some inherent limitations, it provides a useful and appropriate structure for the greater part of our empirical research.

Rogers' model suggests some useful variables that might help explain the adoption of Car Sharing – our first empirical research question. A selection of the most relevant variables from the list of Gatignon and Robertson (1985), allows us to specify the core concepts which have to be operationalised for the case of Car Sharing (see table 5.1). To include the characteristics of the individual decision maker, we will add a set of variables that indicate the value orientation of the individual. On the whole, we will follow Rogers' interpretation of these concepts. Although we have argued that it would be almost impossible to determine the influence of marketing strategy on adoption, we will test whether the characteristics of service system itself have a similar influence.

With respect to the possible influences of habitual behaviour on the cognitive process of decision making, we decided to study the existence of this mechanism empirically. Whether the deliberate decision making process is a valid assumption must be proven by our research. In the following section, the conceptual model explaining the adoption of Car Sharing will be discussed in detail and all concepts and variables will be operationalised.

Regarding the second research question (concerning the service quality perception of Car Sharing), Rogers' model offers few theoretical holds. This results from the fact that Car Sharing is a service. Rogers model mainly focuses on the initial adoption of products and less on the evaluation of services. It is the evaluation of services that is important for continued use of the service, and thus for the long-term adoption. The service-quality perception can be seen as the core concept in the evaluation of the adoption of a service. In section 5.3 we will introduce a conceptual model explaining the service quality perception, which is based on theoretical ideas derived from the field of service marketing research.

Table 5.1 Selection of concepts for the empirical research

Elements of the innovation diffusion paradigm (Gatignon & Roberts, 1989)	Elements selected for our empirical research on the adoption of Car Sharing
the innovation and its characteristics	perceived characteristics of the service
the social system	X
the diffusion process	X
the individual's adoption process	innovation decision process: adoption
the personal influence	X
the personal characteristics	characteristics individual decision maker
the marketing strategy	the service system
the competitive activities	X

Rogers' framework does not provide a lot of theoretical background on changes in mobility behaviour. It does not explain how individuals use innovations after they have adopted them and has no use for explaining changes in behaviour. So, for our third research question we have to develop a specific conceptual model too, founded on different theories. In section 5.4, we will describe our conceptual model for the analysis of the changes in mobility behaviour.

5.2 Conceptual model for the adoption of Car Sharing

On the basis of our exploratory research, reported in chapter 4, and reflection on various theoretical perspectives, we have defined our conceptual model explaining why people decide (not) to adopt Car Sharing. Various sets of variables are thought to be related to the adoption decision. The figure shows the conceptual model for the adoption decision. In the remainder of this section we will discuss this conceptual model in more detail, giving special attention to important theoretical ideas and the operationalisation of abstract concepts.

Figure 5.3 Conceptual model for adoption

In our study we assume that, the adoption process is affected by three major sets of variables. First, we assume that the characteristics of the decision maker contribute to the explanation of the adoption. Apart from these variables, we also expect the individual decision maker's perceived characteristics of the service and the objective characteristics of the service scheme to be predicting variables for adoption. This means that the design of the service and the various characteristics of the service that can be perceived in advance relate to this decision. In the conceptual model we have specified these various relationships in terms of hypotheses, which will be tested in the empirical study:

Hypothesis 1 The groups of adopters, as well as the groups of non-adopters, do not differ among the various service schemes.

Hypothesis 2 Adopters differ from non-adopters in their individual characteristics, which include:

- a their social demographic characteristics
- b their personal characteristics and attitudes
- c their previous practice
- d their physical environment

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

Hypothesis 4 Differences in the service system contribute to the adoption of Car Sharing services.

The set of variables represented by the "characteristics of the decision maker" has gone through some important changes, in comparison with Rogers' model. Because Rogers' characterisation of individuals did not suit entirely our purposes, we added the value-orientation of individuals to the model, in particular the domain-specific values. To allow further specification the value-orientation of individuals, we also added general environmental attitudes to our conceptual model. These environmental attitudes have frequently been used in earlier empirical studies on changes in behaviour aimed at reducing the environmental impact. However, up to now they have not proved very successful in explaining people's behaviour. Still, our exploratory research results seems to indicate – as do previous social and psychological studies on environmental issues – that these concepts are relevant for the adoption of Car Sharing.

And finally, we have extended the model with some cognitive concepts related to habitual behaviour. As argued before, habits seem to play an important role in travel mode decision making, since mobility behaviour is highly repetitive and therefore likely to be rather habitual. All additions to the conceptual model will be discussed below.

With regard to the perceived characteristics, no fundamental adaptations to Rogers' theoretical constructs were made, apart from the operationalisation of the perceived characteristics for the case of Car Sharing. Below, we will discuss the operationalisation of the conceptual model.

Testing the influence on the adoption of the variation in specific objective service characteristics would be impossible, since a great variation in service designs (or different companies) in the research population could not be generated. Based on the variation in our dataset, testing whether the overall service design contributes to the adoption is more appropriate (hypothesis 4).

To clarify our modifications to Rogers' model we will discuss the various additions from their respective theoretical perspectives. We will successively discuss how (5.2.1) personal values, (5.2.2) environmental attitudes and (5.2.3) habits can be integrated in our study:

5.2.1 Theoretical perspectives on adoption: personal values and decision making

As we have argued in 5.1, in his model Rogers does not include any variables explaining motivational differences among individuals. However, given the results of the focus group studies, our study might gain in clarity and significance if we integrate motivational characteristics in our model. Based on insights derived from the means-end theory (Gutman, 1982) we propose to add some personal characteristics to our research model, representing the value-orientation of decision makers.

The means-end theory (see also e.g. Reynolds and Gutman, 1984) explains the choice between various product alternatives with different attributes by means of the value orientation of individuals. Although Car Sharing and the private car have similarities in functionality, a preference for Car Sharing can presumably at least partially be explained by means of differences in the value orientation of consumers. Means-end chains can be seen as mental maps that illustrate which images, meanings and reasons underlie specific choices and behaviour. Behaviour is usually prompted by the need to achieve something, by the desire to reach an end-state. In other words: behaviour is a means to an end. Reynolds and Gutman define the means-end chain as the connection between product attributes, consumer consequences and personal values. This representation of the relationship between product, product use and product values seems to be very suitable for this study. Attributes are features or aspects of products or services. Consequences accrue to people from consuming or using products or services. They may be desirable or not. Values or end-states are important beliefs people have about themselves and about feelings concerning others' beliefs about them. Values determine the relative desirability of consequences.

Embodied in the means-end chain model are the variation of abstraction levels. These levels are a way of categorising the contents of associations about a product class and extend from the physical aspects of products to personal values. These can be operationalised in terms of subcategories of attributes, consequences and values, as shown in table 5.2.a.

Physical characteristics are defined as being measurable in physical units; abstract characteristics represent more abstract attributes of subjective nature, like "smells nice" or "tastes good"; functional consequences are exemplified by concrete outcomes of product use, like "saves money"; psychological consequences are related to the individuals consequences in the social context, like "having more friends"; the instrumental-value level reflects an external orientation relating to how we are perceived by others, like "makes me feel accepted", and finally, the terminal or internal-values level relates to how one views oneself and what one wants to realise for him/herself.

Table 5.2.a Abstraction levels in a means-end chain (Reynolds & Gutman,1984)

Abstract	Values	Terminal (internal)
		Instrumental (external)
	Consequences	Psycho-social
		Functional
Concrete	Attributes	Abstract characteristics
		Physical characteristics

Van Raaij en Verhallen (1990) made the following interpretation of the means-end chain, as depicted in the figure 5.4. On the one hand we have products or services that have specific attributes. As a result of use, these attributes turn into consequences of both a functional and a socio-psychological nature. These consequences are important in the light of customers values. What we can learn from this structure is that the set of specific attributes is clearly related to a set of consequences and, even more important for the problem in hand, to a set of values. Values are thus considered responsible for the selection and maintenance of choices and behaviour.

Figure 5.4 The means-end chain (Van Raaij en Verhallen, 1990)

The adoption of Car Sharing, which is basically an alternative to the privately owned car, can supposedly be partly explained by differences in the value orientation of people. As an option to fulfil an individual’s mobility needs, Car Sharing and the private car are very similar. Many attributes and consequences in use are similar, but also some substantial differences exist. It is not at all clear on what aspects these two options differ with respect to the mental map of the customers. To investigate if the values of individuals are in deed an important factor in the prediction of adoption, we will assess to what extent the value orientation discriminates between adopters and non-adopters. Thus, relevant differences in (perceived) consequences of use should become clear. We add this as another hypothesis:

Hypothesis 2b-I Adopters differ from non-adopters in their individual characteristics, particularly in their (domain-specific) value orientation.

As already suggested by hypothesis 2b, we do not want to select just any values to explain the (non)adoption of Car Sharing, but particularly the domain-specific value-orientation. A domain can be described as an area of behaviour that is aimed at the same goal (Verhallen e.a. 1989). Our domain can be described as the domain of mobility behaviour. There is a good reason for focusing on the domain-specific value-orientation:

In various studies on market segmentation, based on the value orientation of individuals, several authors concluded that only on a domain specific level, significant correlations between predictors and the dependent variable can be produced (see e.g. Oppedijk van Veen 1986, Leeftang and Beukenkamp, 1987, Verhallen e.a., 1989 and van Raaij e.a. 1990). In order to segment the market, or to define existing relationships between product supply and product related behaviour, a classification of segmentation variables was suggested (Van Raaij en Verhallen, 1990). A relevant choice of segmentation variables is essential for finding existing relationships and predicting behaviour variables.

Segmentation variables can be either brand-specific, domain-specific or general, see figure 5.5. General variables can be used independently from specific products or product classes. Domain-specific variables are related to a specific domain of products or services, like food or transportation. Brand-specific variables relate to the purchase and use of a specific product or brand.

A commonly used division of segmentation variables, is that of objective versus subjective variables. About the scales of measurement, e.g. income or frequency of use, used for objective variables, there is hardly any discussion. For subjective variables, various measurement procedures can be used to measure the more evaluative variables (Frank, Massy and Wind, 1972).

	Objective (behaviour)	Subjective (evaluation)
	brandloyalty	brandloyalty (attitude)
A. Brand-specific	frequency of use acts	preferences evaluations purchase intentions
B. Domain-specific	frequency of use substitution complementarity behaviour	interests perceptions attitudes domain-specific values
C. General	income education residence patterns of behaviour	lifestyle personality general values

Figure 5.5 Classification of segmentation variables (van Raaij en Verhallen, 1990)

The reason we have chosen to use domain-specific values instead of general values of products or brand-specific values and attitudes, is threefold:

- First, past research results have frequently stressed that general personal characteristics are not very predictive for more specific behaviour and hence not a good basis for segmentation purposes (see e.g. Verhallen et al. 1989).
- Secondly, incorporating brand and product-specific attitudes, preferences, and evaluations in the prediction of a specific behaviour (in our case the adoption of Car Sharing), would require insight in the complete set of all relevant values involved in the decision process on a very specific level, including the specific contexts, times and targets. In terms of research effort this would be less efficient.
- Finally, and most importantly, we are dealing with the problem of a substitution of options within a specific domain, in which Car Sharing is seen as the new alternative for car ownership (or public transport use). To avoid the pitfalls of mixing up various measurement levels, the use of domain-specific values would be most appropriate to explain the adoption of Car Sharing.

5.2.2 Theoretical perspectives on adoption: environmental attitudes

Another kind of personal characteristics which we consider important for our explanation of the adoption of Car Sharing, is the consumer's value orientation towards environmental problems. Hypothesis 2b states that adopters differ from non-adopters in their personal characteristics. The value orientation towards environmental problems, as a separate dimension of the personal characteristics, deserves special attention:

This class of potential explaining variables has a long tradition in social-psychological research on the regulation of consumer behaviour with respect to environmental impact, also referred to as "environmental behaviour" (Ester, 1979; van der Meer, 1981; Nelissen et al., 1987; Midden, 1993; Spaargaren, 1995). This kind of scientific studies is closely connected to the attitude-behaviour model of Fishbein and Ajzen (1980), which is based on the idea that behaviour is the result of deliberate decision making and rational choice. The core concept of the model is the consistent relationship between attitudes and behaviour. On the basis of people's attitudes, consisting of a motivational component and a normative component, their choices and their resulting behavioural responses could be predicted.

Studies on environmental behaviour or on choices for more environmentally friendly alternatives often point to the strong relationship between 'environmentally preferable behaviour' on the one hand, and values and attitudes towards the environment and environmental problems on the other. A concept like "environmental consciousness" has frequently been used as a cognitive-motivational concept which connects the environmental consequences of consumer behaviour with the individual benefits of this behaviour for the consumer. Environmental consciousness can be understood as an attitude towards the (natural) environment, environmental problems, and the protection of the environment against human influences (Nelissen et al., 1987). Environmental consciousness is in fact a general attitude and does not relate to any specific behaviour or decisions.

Tertoolen (1994) distinguishes two components of "environmental consciousness" in the context of mobility behaviour: (1) the attitude towards the damage to the environment human behaviour causes, and (2) the willingness to make a personal contribution to a cleaner environment. These two dimensions will be referred to as "environmental con-

sciousness" and "willingness to act". Tertoolen pleads for a more specific operationalisation of both concepts for the consumption domain under study, in our case mobility. By a more domain specific operationalisation of "environmental consciousness" and "willingness to act", problems arising from differences in levels of measurement could be prevented and the relationship could be studied in a more meaningful way.

For our purposes, we don't feel the need to develop a new scale to measure the "environmental consciousness" and the "willingness to act" as specific personal characteristics. We will use the operationalisations of Tertoolen (1994) and test whether, like in other studies on the adoption of alternative environmentally friendly behaviour, these two environmental attitudes will play a significant role in the adoption of such innovations. We therefore hypothesise:

Hypothesis 2b-II Adopters differ from non-adopters in their individual characteristics, with in particular in their "environmental consciousness" and their "willingness to act".

5.2.3 *Theoretical perspectives on adoption: habitual behaviour versus deliberate choices*

Like in innovation diffusion research, research on the prediction and the regulation of individual transport behaviour generally relies on expectancy value models, which are strongly rooted in theories of rational choice (see, for example Ben-Akiva, 1992). The "subjective expected utility" (SEU) model is probably one of the best known in this field (Edwards, 1954). According to the SEU model, the estimation of the utility of alternatives can be calculated by adding the products of the subjectively perceived likelihood and values of the various consequences associated with each alternative. The SEU model is essentially concerned with assessment of the utility of options, i.e. forming deliberate attitudes towards options. The model assumes that individuals try to maximise economic utility and use a value function to evaluate the alternatives among which they have to choose. With regard to behaviour, the model assumes that the alternative with the highest value is chosen.

One of the most influential and well documented expectancy-value models, one which explicitly relates utilities (or attitudes) to actual behaviour, is Fishbein and Ajzen's attitude-behaviour model, also known as the theory of reasoned action (1975, Ajzen & Fishbein, 1980). The theory of reasoned action postulates that, prior to the execution of an act, individuals trade off the perceived positive and negative consequences of that act, and then decide to perform or not to perform the behaviour. The model is widely used in studies on human behaviour in general, and car choice behaviour in particular (e.g. Shepard, Hartwick & Warshaw, 1988; Aarts, 1996). What is important here, is that the model of reasoned action emphasises the deliberate character of individual choice. It is exactly this deliberate manner of choice making – which is reflected in a strong behaviour prediction value of attitudes and intentions – that is questioned in the context of the adoption of Car Sharing, especially regarding the explanation of non-adoption.

Over the last two decades, more and more researchers on travel mode choice behaviour have started to argue that the model of reasoned action (and other models based on the assumption of rational choice) ignores an important aspect of travel mode choice: the fact

that travel mode choices are made on a repetitive basis (Goodwin, 1977; Banister, 1978; Verplanken et al., 1994; Aarts, Verplanken & Van Knippenberg, 1994). In many studies on transport behaviour, which to a great extent is repeated behaviour, researchers concluded that what once was a rational choice has become repeated behaviour from the past (see for a review Ouellette & Wood 1996). Behaviour that has successfully been performed many times tends to become habitual.

Habitual behaviour can be best understood by the immediate relationship between stimulus and response, or by the direct association between specific trip goals and the travel mode choice, without the need to trade-off travel mode options. So we may say that habitual behaviour reflects the automatic or heuristic nature of behaviour, while non habitual behaviour is guided by a process of reasoning.

The research so far (see e.g. Triandis, 1977; 1980; Ronis et al., 1989; Eagly and Chaiken, 1993; Aarts, 1996) suggests that in the case of repeated actions, subsequent behaviour is not only determined by attitudes and intentions but also by habit strength. The research suggests that the relationship between choices of options relies on deliberate decisional processes, in which attitudes towards options and behavioural intentions precede choices and behaviour, but that future behaviour and choice making is also guided by a heuristic or less elaborate decision making process in which the impact of past behaviour and habits is strong. Triandis (1977) proposed a model which describes the relationship between habit and decision making in terms of an interaction between intention and habit in the prediction of behaviour. In his model the probability of an act (P_a) is a weighted function of habit (H) and behavioural intention (I), multiplied by "facilitated conditions" (F):

$$P_a = F \cdot (w_h \cdot H + w_i \cdot I) \quad (\text{Triandis, 1977})$$

In fact, Triandis hypothesised that as the same behaviour is executed more frequently in the past and thus increases in habit strength, the performance of that behaviour is less guided by attitudes and intentions. Habit strength may thus moderate the relationship between reasoning-based concepts (attitudes and intention) and subsequent goal-directed behaviour (see also Ronis et al., 1989). Empirical tests of Triandis model have indeed shown that habit and attitudinal concepts interact in the prediction of repeated behaviour (e.g. Aarts et al., 1994; Mittal, 1988; Montano & Taplin, 1991).

The idea that travel mode choices are not only guided by attitudes and intentions, which is fundamental for the model of reasoned action, but are also driven by habits, could have at least three implications for understanding the adoption of Car Sharing and the mobility behaviour after adoption:

- First, we can expect that habitual behaviour will form an explanation for non-adoption, possibly even a stronger explanation than (negative) attitudes and intentions. The mere fact that many individuals do not make deliberate choices on travel modes, implies that these people also do not seriously consider changing over to a Car Sharing system as an alternative to the private car. Hence, the attitude towards Car Sharing will not be very predictive for (non-)adoption.
- Secondly, Car Sharing implicitly demands from its users that they differentiate more between various transport means, whereas the privately owned car doesn't. It is likely

that if a car is not immediately available, alternative travel mode options will be considered and chosen more frequently, because to a certain extent the barrier to use a car has increased. In other words, the decision making process for travel mode choices is likely to become more deliberate.

- And thirdly, since Car Sharing forces the individual towards more deliberate travel mode choices over time, we can expect the adoption of Car Sharing to have an effect on mobility behaviour, and, more specifically, to result in reduced car use.

The last two consequences of habits refer to the travel mode decision making process, which will be discussed further in 9.3., which deals with the travel mode decision making process and the resulting (changes in) mobility behaviour.

With regard to the innovation adoption decision, we may conclude with the assumption that the adoption itself is likely to be affected by habits as well as by attitudes and behavioural intentions. From the theoretical framework above we can therefore hypothesise that:

Hypothesis 2b.III Habits in travel mode choices will have a negative influence on the adoption of Car Sharing.

Hypothesis 2b.IV The attitudes and intentions towards Car Sharing will have a positive influence on the adoption of Car Sharing.

Hypothesis 2b.V Habits will have a moderating effect on the predictive value of the intentions towards adoption.

5.2.4 Operationalisation of concepts

Based on the theoretical perspectives discussed above, we have operationalised the three sets of independent variables (the characteristics of the individual decision maker, the perceived characteristics of the service and the service system). As will be explained in chapter 6, when we discuss the research method, only four different service systems will be selected for our empirical study.

With respect to the two other clusters of variables, tables 5.2 and 5.3 list the variables belonging to the individual characteristics of the decision maker and the perceived characteristics of the Car Sharing service. Some of these measures need further clarification:

Characteristics of the individual decision maker

For the operationalisation of the individual decision maker we distinguish between the social-demographic and personal characteristics (which are the subjective characteristics), the physical environment of the individual, and his or her previous practice. The *social demographic* variables, like age, sex, household size, amount of children, net income per household per month, and the work situation were measured by standard operationalisations (CBS, 1997).

The *physical environment* is operationalised by asking the respondents for the estimated distance between their home and several destinations like the nearest shopping centre, the city centre, the train station, their work, and the nearest outlet of the Car Sharing service.

The set of *personal characteristics*, considered relevant for our study, was operationalised as follows:

The perception of car costs: The perception of car costs indicates which costs are associated with the car, when people make a cost assessment. Basically, a distinction can be made between the variable costs (for petrol only) and the overall costs, which also include the fixed costs that need to be amortised over time. The perception of car costs is thus a nominal variable with two classes.

Involvement with the costs of a car: The involvement with the costs of a car refers to the extent to which people take the costs into account when deciding to use the car. It was measured on a 5-point scale, ranging from never to always.

Decision involvement: Decision involvement in travel mode choices can be measured by an 8-item scale, as developed by Aarts (1996). This tested multiple item scale reflects the deliberate nature of travel mode choices.

Environmental attitudes: The environmental attitudes and their operationalisations were extensively discussed in the previous section. They were made in accordance with Tertoolen (1994).

Table 5.2.b Individual characteristics of the decision maker, used for explaining the Adoption of Car Sharing

Social-demographic characteristics	Previous practice
age	former car ownership
sex	age former car
household size	total car mileage
children	mileage by rental car
education	mileage by borrowed car
net income	frequency of car use
work situation	frequency of train use
	frequency of bicycle use
Personal characteristics	frequency of public transport use
perception of car costs	frequency of car rental
cost involvement	commuting by car
decision involvement	season tickets for public transport
value: environmental consciousness	habit: never considering train use
value: willingness to act	habit: using car rental
domain specific values	habit: considering car versus public transport
	habit: considering car use versus bicycle use
Physical environment	habit: used to combining trips
distance to work	habit: car used mostly by more people
distance to shopping centre	habit: need for a car known long before
distance to city centre	habit: travel mode decision instantaneously
distance to train station	
distance to car outlet	

Domain specific values: A list of 51 items was selected with various domain specific values, including trip specific requirements, attitudes relating to specific travel modes, values relating to car ownership, values relating to the use of specific travel modes and values relating

to mobility in general. All domain specific values are listed in chapter 6. The selection of these items was based on the qualitative exploratory research, as well as on literature on market segmentation of car purchase and car use. (Oppedijk van Veen and Verhallen, 1986)

The *previous practice* is operationalised in various ways:

Former car ownership: the question on whether people owned a car before adoption refers to the period directly before adoption.

Age former car: if people owned a car before adoption, the year of construction was asked.

car mileage: car mileage was measured by asking for the estimated mileage by private car, rental car, and borrowed car in the year before the adoption of Car Sharing. The total mileage by car is the sum of these three values.

Frequency of use of various travel modes: for the use of the car, the train, the bicycle and public transport, we asked to estimate the average frequency of use per week in the period directly before adoption of Car Sharing. The questionnaire explicitly mentioned that a return trip counted as two trips.

Commuting by car: we asked what mode of transport had been used for commuting in the period directly before adoption of Car Sharing

Season tickets for public transport: as the operationalisation for season tickets for public transport, ownership of one of the available reduced price season tickets for rail transport or public transport was used.

Perceived characteristics of the service scheme

The *perceived characteristics of the service*, finally, were operationalised as follows:

cost perception: The cost perception refers to the extent to which people find Car Sharing expensive or cheap. A five-point Likert scale was used here.

valuation distance to the outlet: The evaluation of the distance to the outlet depends on the individual and the way how this distance is covered. This attitude towards Car Sharing was measured with a five-point Likert scale, ranging from acceptable to not acceptable.

quality perception: The overall quality perception was measured by asking the question: "What is your overall impression of the service quality of (name of Car Sharing scheme)?", using a five-point scale ranging from good to bad for the answers.

cost comparison with rental: An indication for the extent to which Car Sharing is seen as a specific kind of car rental service is the cost comparison with car rental. A nominal scale, including yes and no was used here.

attitude towards Car Sharing: The attitude towards Car Sharing was measured from the reaction to the statement: "For me personally, Car Sharing is a good alternative to the privately owned car", using a five-point scale ranging from agree to disagree.

Table 5.3 Perceived characteristics used for explaining the adoption of Car Sharing

Perceived characteristics of the service scheme

Cost perception (of the service)
 Valuation distance to the outlet
 Quality perception (of the service)
 Cost comparison with rental car
 Attitude towards Car Sharing
 Estimation of savings

5.3 Conceptual model for the service quality perception of Car Sharing services

Rogers describes the innovation evaluation phase in the extended innovation decision making process as the confirmation phase. At this stage, the individual seeks reinforcement of the innovation decision he already made or reverses his previous decision to adopt the innovation. The perceived service quality can be considered the central concept in the innovation evaluation phase of services and helps to explain whether or not people stick to their innovation decision. In this section a conceptual model for the service quality perception of Car Sharing services will be presented.

Our aim in studying the “post-purchase” evaluation process – which starts after signing a contract with a Car Sharing organisation and paying the membership fee – is coming to understand which variables contribute to customer retention. As we have argued before, long-term participation is crucial for market success, as well as for achieving the desired effects on mobility.

The intention to remain a member of the Car Sharing organisation is seen as an important indicator of customer retention. Discussions on the predictive value of the intention on the long-term membership – a stated preference variable – are excluded. As in comparable studies on the intention-behaviour relationship, many relevant issues could be included and many variables are likely to influence the translation of the intention into behaviour.

On conceptual grounds, consistent with the reasoned action theory of Fishbein and Azjen (1975), we may interpret the service quality as an overall attitude towards Car Sharing (see also e.g. Olshavsky, 1985, who sees quality as a form of overall evaluation of a product, similar in many ways to attitude). Thus, predicting the intention by measuring the service quality perception seems sensible.

As we will discuss below, several possible predictors for the perceived service quality are suggested. To measure service quality, as revealed by the performance of the service organisation, we have defined two dimensions, consistent with Grönroos (1990): the technical or outcome dimension and the functional or interactional dimension. For exploratory reasons, some extra (sets of) variables are investigated in their predictive value for service quality. No explicit theoretical concepts underlie the relationships between the perceived service quality and the perceived characteristics of the service, the characteristics of the individual decision maker, his mobility behaviour and the constitution of the services on a strategic level.

Based on the conceptual model and the specified relationships, we have formulated a couple of hypotheses, that will be tested empirically:

- 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 for 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 for 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 for 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

Figure 5.6 The conceptual model of perceived service quality in Car Sharing systems

5.3.1 Theoretical perspectives

Despite the broad definition of “innovations” by Rogers (“an idea, practice, or object perceived as new by an individual or other unit of adoption”), which could fit (Car Sharing) services very well, the innovations his study are mainly technological: “Almost all of the new ideas discussed in his book are technological innovations” (Rogers, 1995, p. 35). As already touched upon in section 5.1, it is questionable whether his model of diffusion of innovations is applicable to the adoption and diffusion of services in general, and in particular the adoption of Car Sharing services. Various service marketers (see e.g. Grönroos, 1990 and Lovelock, 1994) argue that the nature of services is very different from that of products and that the marketing of services is quite distinct from the marketing of products. From a theoretical point of view, one of the major objections against the use of the “Diffusion of Innovations” framework in the case of Car Sharing is the fact that the innovation itself is basically not a technological innovation. Car Sharing can be seen as an innovative service organisation aimed at a more efficient use of the automobile. Consumers do not buy a product, in other words, they do not acquire the ownership of a tangible product, they buy services. The fact that people buy services instead of products has far-reaching implications for the nature of the innovation decision making process:

The innovation decision making process for services

Zeithaml (1981) proposes a theoretical framework for isolating the differences between consumer evaluation processes for goods and services, referring to two studies by Nelson (1970) and Darby and Karni (1973). Nelson first distinguished two categories of qualities of consumer goods: search qualities and experience qualities. Search qualities are attributes which can be determined prior to purchasing a product, like colour, price, fit, feel, hardness and smell. Experience qualities are attributes which can only be discerned after purchase or during consumption. Examples of these characteristics are taste and wearability.

Figure 5.7 A continuum of evaluation for different types of products (Zeithaml, 1981)

Darby and Karni (1973) add a third category of qualities of goods: the credence qualities. These credence qualities are characteristics which the consumer may find impossible to evaluate even after purchase and consumption, because one needs to have highly professional skills to do so, as in the case of evaluating car repair or medical services.

Zeithaml (1981) arrays goods and services on a continuum of evaluation, ranging from easy to evaluate to difficult to evaluate. At the left end of the continuum are goods that are high in search qualities, and therefore very easy to evaluate even before purchase. In the centre are goods and services that are high in experience qualities, and therefore more difficult to evaluate because they must be purchased and consumed before assessment is possible. At the right hand side of the continuum are goods and services that are high in credence qualities, and therefore the most difficult to evaluate because the consumer may lack sufficient knowledge to ascertain whether these goods satisfy their needs even after consumption. Zeithaml's most important point is that by applying the continuum of evaluation, ranging from easy to evaluate to difficult to evaluate, the distinction between products and services as well as the differences in the underlying extended innovation decision making processes can be better understood. Products, at the left side of the continuum, can much more easily be evaluated before purchase than services. As discussed in chapter 2, services are intrinsically more difficult to evaluate in advance than goods since with services production and consumption are inseparable, they are intangible, and their performance is heterogeneous. Various arguments can illustrate the differences between the innovation decision making process for products and services:

First, services are basically *intangible* and are more like an experience than something that can be felt and tested before purchasing. Therefore, services must be experienced before a clear evaluation of their quality can be made.

Secondly, services – and especially Car Sharing services – distinguish themselves from products by their high *trialability*. Car Sharing services can be tried many times in advance without a lot of risk, uncertainty about benefits or performance of the innovation and without a substantial financial investment. A consumer can experience and try out these services even when he owns a private car (which Car Sharing services are meant to substitute). So, compared to the adoption of technological innovations by the direct purchase of goods, the adoption of services is of a less decisive nature. By their nature, services stimulate evaluation through experimentation.

Thirdly, because of the *inseparability* of production and consumption, the consumer participates in producing the service. In many services the interaction between service supplier and customer is very intensive. The client influences the performance and quality of the service by his own participation in the service production process. The quality of most services not only depends on how the provider performs, but also on how the consumer co-operates. The experience qualities of services are therefore rather high.

The *heterogeneity* refers to the inability of service providers to offer a service of constant quality. Customers experience these variations in satisfaction, which are sometimes even below their level of minimum satisfaction. This implies that for evaluation, the variation in customers' experiences with a provided service is important.

Zeithaml argues that, because in services experience and credence qualities dominate, consumers may employ different evaluation processes than they use with goods, where search qualities dominate. The areas in which the characteristics of services may lead to divergent evaluation processes, are: the information search; the evaluative criteria; the size and the composition of the evoked set of alternatives; the perceived risk; the adoption of innovations; the brand loyalty; and the attribution of dissatisfaction.

Based on these considerations, some conclusions can be drawn on how the evaluation processes on goods and services differ:

- Because of the very high trialability of services, it can reasonably be expected that the innovation decision making process – before purchase – is less extensive because (1) the value of the service is difficult to evaluate in advance and (2) the risks and costs are rather low compared to the adoption of a technological innovation. In the case of services, it seems to be much easier to try them without having fully evaluated them in every detail beforehand.
- Furthermore, because the retention costs are low, the post purchase evaluation process, which is based on the first experiences with the service, will be more extensive in comparison with a situation in which a product is bought.
- Because the consumption of services is very often a rather repetitive process in which the same service is bought on a regular basis, the evaluation of the service is spread over time. This is a decisive factor in the continuous process of service consumption or loyalty to the service provider. Therefore, the evaluation of services is likely to be rather dynamic over time.
- The last relevant issue in this review of differences between services and products is the performance of the service organisation. As we have seen in the description of the Car Sharing services in the Netherlands (see chapter 3), the organisation of the delivery of cars to the customers is rather critical and represents the basic innovative character of Car Sharing services, when compared to the regular car rental business. Not only the service design is important: the performance of the electronic information system and the performance of personnel in the daily service provision process, also make a large contribution to the evaluation of the service.

Summarising the fundamental difference between the innovation decision making processes for the privately owned car and the Car Sharing service, we would suggest that it is the evaluation process after first purchase that makes all the difference. It is likely to be far more extensive and dynamic over time and not only involve product oriented aspects, but also the performance of the service organisation.

Service quality and customer retention

If the aim of a Car Sharing service is, as stated before, to be attractive for customers in the long run, high service quality is indispensable. Providing a high quality service is an essential strategy for success and survival in today's competitive environment. It is not only a precondition for customer retention, but also for profit and other financial outcomes of the organisation. (Zeithaml *et al.*, 1996, Greising 1994, Rust *et al.* 1995) The relationship between service quality and market success or profits is however "neither straightforward nor simple" (Greising 1994, Zahorik and Rust, 1992).

Although many studies have shown that, on a highly aggregate level (see for a discussion e.g. Zeithaml et al., 1996) a high service quality leads to e.g. higher profits, returns on investments and a bigger market share, the influence the many specific strategic measures to improve service quality have on market success and profit is far from clear. Even the mediating mechanisms between service quality and market success are still virtually unknown. Generally, there is a distinction made between offensive effects (capturing new customers) and defensive effects (retaining customers). In our discussion we will focus on customer retention. In our terminology, we will incorporate 'capturing new customers' in our study of the pre-purchase decision making process, referred to as the adoption of Car Sharing.

Enhancing service quality and lowering customer defection rates can be profitable to companies. Various researchers even conclude that "marketing resources are better spent keeping existing customers than attracting new ones" (Fornell and Wernerfelt, 1987). This is however only valid in specific markets and for specific products. For small and new entrants in emerging markets, it would be silly not to give high priority to share-building strategies as well. Retaining customers does not only mean that the investments made to capture new customers become profitable, but these clients also become more profitable because they can be served more efficiently, since they are more familiar customers.

Figure 5.8 A model of the behavioural consequences of service quality (Zeithaml, Berry and Parasuraman, 1996)

Zeithaml, Berry and Parasuraman (1996) have suggested a conceptual model that describes the relationship between the service quality and its financial consequences for businesses. Behavioural intentions (favourable versus unfavourable) and behaviour (remaining versus defecting) are the determining variables in the relationship between the service quality and (financial) success in the market. The left portion of the model is at the level of the individual and proposes that service quality and behavioural intentions are related. The authors suggest that the service quality determines whether a customer ultimately remains with or defects from a service organisation. The model begins with a customer's assessment of the service quality and posits that when service quality assessment is high, the customer's behavioural intention is favourable, which strengthens the bond with the company.

Behavioural intentions can be viewed as indicators that signal whether customers will remain with or defect from the company.

Besides addressing questions of operationalisation of behavioural intentions and service quality, this conceptual model calls for a wider perspective on service quality, as to its content and as to ways of explaining this construct variable. If service quality is indeed such an important determinant of a long-term customer relationship, it is essential to know how it could be optimised. In order to specify and operationalise service quality we will review the literature on this construct variable.

Service quality

In the eighties, the concept of quality was one of the extensively researched subjects in the marketing arena, but the focus was most dominantly on goods. The Japanese approach towards quality prevailed: "Zero defects; doing it right the first time" (Parasuraman *et al.* 1985) or, as Crosby (1979) defined it rather similarly: "conformance to requirements". All these quality approaches relied on the idea that quality was an objective criterion, that could be defined in advance.

Knowledge about goods quality, however, is insufficient to understand service quality. When conceptualising service quality, three important characteristics of services, their intangibility, heterogeneity and inseparability, must be taken into account.

Because of their **intangibility**, with services precise manufacturing specifications concerning uniform quality can rarely be set. Most services can not be counted, measured, inventoried, tested or verified in advance of sale to assure quality. Because of their intangibility, a service organisation may find it difficult to understand how consumers perceive their services and evaluate service quality (Zeithaml, 1981).

Because of their **heterogeneity**, the performance of services varies from provider to provider, from customer to customer and from day to day. The inconsistency of behaviour and the interaction between provider and customer causes difficulties in defining a quality standard. Thirdly, the **involvement of the customer** in the service production process, introduces another disturbing factor in the quality of the service performance. For example, if in a Car Sharing system a car is not brought back in time, this may have serious consequences for the capacity to provide other clients with the services agreed upon and for the perceived service quality of other clients.

Grönroos (1990) summarises this discussion with the conclusion that service quality is not a static and objective concept, but that "what counts is quality as it is perceived by customers". Buyer-seller interactions (or service encounters) will therefore have a critical impact on the perceived service quality:

Grönroos suggests that the service quality as it is perceived by customers has two dimensions: the technical or outcome dimension and the functional or process related dimension (Grönroos, 1990, 1984, Parasuraman *et al.*, 1985, and Lehtinen, 1982). These dimensions can be characterised as WHAT is provided and HOW services are provided, respectively. What customers receive in their interactions with the firm is clearly important to them and to their quality evaluations. However, this is not **the** quality of the service delivered; it is only one dimension. The other dimension, the interactional or functional dimension, refers to how the service is being delivered. This dimension contains all elements that play a role in the co-operation between customer and service supplier in the production of the required service.

Since the beginning of the eighties, when a couple of researcher created the new marketing research area of service marketing, one paradigm has rapidly become dominant in the study of services and service quality. Many discussion were based on the principles of the so-called GAP-model. This model starts from the conviction that service quality perception involves a comparison of the expectations (the norm) with the performance (or the actual experience with the service organisation). Service quality perception is not just the experience with the service, stretched out over the various service dimensions, but also the extent to which service performance meets the expectations of customers. Service quality is defined as a difference score. Good perceived quality is obtained when the experienced quality meets, or preferably exceeds the expected quality level (Grönroos, 1984).

This gap-paradigm (the gap between expected and experienced quality) was integrated with the notion that service quality is based on a technical and a functional quality dimension. To establish the actual service quality perception level, the expected and experienced quality level should be measured for both dimensions. Although this total perceived service quality model has been extended into a general model in which both the perception of the customer and the perception of the service manager with respect to the total service quality are integrated (see e.g. Zeithaml, 1988), this study will be restricted to the consumer perspective and the consumer evaluation process.

5.3.2 Measuring service quality

Marketing research on service quality does not only need a robust conceptualisation of service quality, but also efficient measuring instruments, in particular multiple items scales that reliably measure all relevant aspects involved in the service evaluation of overall quality. Parasuraman, Zeithaml and Berry also developed a widely used multiple-item scale for measuring consumer perceptions of service quality, called SERVQUAL (1988). This scale is subject to intensive discussion about its reliability and efficiency in measuring perceived service quality.

Based on exploratory research, Parasuraman and his colleagues have deduced a set of 10 potentially overlapping dimensions of service quality. These dimensions are tangibles, reliability, responsiveness, communication, credibility, security, competence, courtesy, understanding the customer, and access (see also Parasuraman et al., 1985). These 10 dimensions serve as the basic structure for service quality. Each dimension was operationalised in a couple of items and each item was recast into two statements; one to measure expectations about firms in general within the specific service industry and the other to measure perceptions about the particular firm whose service quality was being assessed. By means of scale purification they finally suggested five independent dimensions:

- *Tangibles* The quality of physical facilities, equipment and appearance of the personnel.
- *Reliability* The ability to perform the promised service dependably and accurately.
- *Responsiveness* The willingness to help customers and provide prompt service.
- *Assurance* The knowledge and courtesy of employees and their ability to inspire trust and confidence.
- *Empathy* Caring, the individualised attention the firm provides its customers.

In response to this multiple item scale to measure the service quality as perceived by the individual, some considerations were made with respect to the appropriateness of SERVQUAL for our research purposes:

1. Generalisation of SERVQUAL dimensions

It can be questioned whether these five independent dimensions are valid in the context of the measurement of service quality in Car Sharing, since they were found within the context of very specific service industries, rather remote from Car Sharing or car rental, which are high capital goods. In a confirmatory factor analysis, Cronin and Taylor (1992) didn't find support for the five-dimensional solution in any of the four types of service industry. We decided to use the 10 dimensions as suggested, since they proved to be a comprehensive set for describing the many aspects involved in the interaction between the customer and the Car Sharing service system.

2. No technical or outcome quality measure

The SERVQUAL scale only measures the interactional quality dimension and does not integrate the technical outcome of the service. Especially in the context of Car Sharing this dimension seems to be important. Having the opportunity to use a car, is clearly the core of a Car Sharing service. For customers, as the focus groups revealed, the technical quality of the car seems to be an essential element in the service quality perception. If cars are dirty or damaged, this will influence the quality perception of the customers.

3. The efficiency of the measuring instrument SERVQUAL

SERVQUAL is a measuring instrument that consists of a total of 44 items, partly because service quality includes 22 items, but more importantly, because difference scores have to be measured. From a practical point of view this is not very efficient (Cronin and Taylor, 1992). Moreover, little if any empirical evidence supports the relevance of the expectations-performance gap as the basis for measuring service quality (Carman, 1990). In fact, the marketing literature seems to prefer simple performance-based measures of service quality (see e.g. Churchill, 1991).

Cronin and Taylor (1992) have tested an alternative measurement method, called SERVPERF, solely relying on the (perceived) performance of the service, based on the 22 performance items of the SERVQUAL scale. In all of the four investigated service industries (banking, pest control, dry cleaning and fast food) the SERVPERF scale explained more of the variation in service quality than the SERVQUAL scale. For reasons of efficiency, we have chosen to use the SERVPERF scale instead of the SERVQUAL scale in our study.

4. Service quality, customer satisfaction and purchase intention

In service marketing literature, there has been a lot of discussion on the prediction of purchase intention (see e.g. Cronin and Taylor, 1992). On theoretical grounds, Cronin and Taylor (1992) suggested a structural model, shown in the figure below. In a LISREL procedure, they found in a significant relationship on all points, apart from the impact of perceived service quality on the purchase intention.

In this model, perceived service quality is a global judgement, or attitude, relating to the superiority of the service, whereas satisfaction is related to a specific transaction. An attitude is the consumer's relatively enduring affective orientation towards a product or service, while satisfaction is the emotional reaction following a disconfirmatory experience which is consumption specific and is therefore situational dependent (Oliver, 1981).

Customers might be satisfied in specific service performances but this does not imply a high overall service quality perception. The two concepts are related in such a way that incidents of satisfaction over time result in perceptions of service quality. Oliver summarises this as follows: "satisfaction soon decays into one's overall attitude toward purchasing". Service quality perception is thus a dynamic process over time, based on many experiences.

Figure 5.9 A structural model on service quality and satisfaction (Cronin and Taylor, 1992)

In our study we will exclude the dynamics of service quality, but try to explain the perceived overall service quality and the intention to extend the contract in the next year.

5. Other predictors of service quality perceptions

The GAP-model includes some additional determinants for the explanation of the service quality perception, like the company's image, marketing communications, customer needs and word-of-mouth. In this study we want to restrict ourselves to the customer related variables. Especially the concept of needs, or mobility needs, seems to be relevant here. If we assume that these needs reveal themselves in existing mobility behaviour, for exploratory reasons, it seems sensible to include many determinants of mobility behaviour and to study their impact on service quality perception. In our study we therefore extended the conceptual model concerning service quality with several determinants concerning the individual's mobility behaviour.

6. Perceived characteristics service system and service quality

Service quality is a container concept in which many aspects are integrated. Which other perceived characteristics of the service system contribute to service quality is rather under-researched, even the impact of price on service quality perception has hardly been investigated. We conclude that for exploratory reasons, other perceived characteristics of the service system, like the perception of its price, and the evaluation of the distance-to-outlet, should also be investigated as to their impact on service quality perception.

7. The influence of the service design on the quality perception

The original GAP model does also not include differences in service designs. Car Sharing services are provided through various kinds of service systems with different objective characteristics. We expect that, apart from the service performance, also the service design contributes to the perceived service quality. For exploratory reasons we will integrate the variation among service designs in our conceptual model.

5.3.3 Operationalisations

Given the considerations discussed above, we selected a set of variables for the explanation of the service quality perception. Based on the various concepts included in the conceptual model (see figure 5.6) we are able to list all the measure used in the questionnaire and to present the operationalisations of the various construct variables.

Purchase intention

Purchase intention was measured with a question whether they were intended to extent the contract next year. It was answered on a 5 point scale, ranging from "surely not" to "certainly yes".

Overall service quality perception

The overall service quality perception was measured with the question: "What is the overall impression of the quality of (the specific Car Sharing scheme)?" It was answered on a 5 point scale ranging from good to bad.

Technical service quality perception

- The possibility to use different cars, is a big advantage
- The car is always cleaned very well
- In the car you don't have great nuisance of cigarette smoke
- The cars are insured properly
- The cars are being maintained very well

Functional service quality perception

- If I make a reservation, than I can count on X to have a car
- I am sure that if I have a special requests, X handles my request properly
- X is very precise in charging their customers
- X does what it promises
- When I call, the people of X know to tell if a car is directly available
- When I arrive at the outlet to catch the car, the people of X expect me already
- The employees of X are always willing to answer your questions
- The employees of X are always able to answer my questions
- The employees of X are always able to inform me about the rental costs
- The employees always stay calm in difficult or stress situations
- Making a reservation by telephone is convenient
- When I make a phone call to make a reservation, X responds quickly
- When I arrive at the outlet, I do not need to wait long, before I can drive away
- The outlet of the car is at a convenient place
- The opening hours of X are convenient to me
- There is sufficient opportunity to rent a car during the weekend
- There is sufficient opportunity to rent a car for the evening
- There is sufficient opportunity to rent a car for only a part of the day

- It is well possible to park the bicycle near the outlet
- The employees are always very polite to their customers
- The contract with X is formulated clear and understandable
- The conditions for using a car from X are very clear
- The behaviour of employees of X instils confidence in customers
- X will never charge their customers too much on purpose
- When you sign a contract with X, you need not be afraid of financial risks
- It is clear enough in advance how much you will have to pay
- If I call shortly before I want to rent a car, they will do everything to help me
- has employees who give you personal attention
- Employees of X understand your specific needs
- The office of X is visually appealing
- The employees of X have a neat appearance
- The brochures of X look nice
- The membership card is important to show you participate in Car Sharing
- X uses a modern reservation system

Perceived characteristics of the service

- Cost perception service
- Valuation distance to the outlet
- Quality perception service
- Attitude towards Car Sharing
- Estimation of savings

Characteristic of the individual decision maker

All characteristics of the individual decision maker are similar to the ones used in the conceptual model for adoption (see § 5.2)

Individuals mobility behaviour

- Total car mileage
- Mileage by rentals
- Mileage by borrowed car
- Frequency of car use
- Frequency of train use
- Frequency of cycle use
- Frequency of public transport use
- Frequency of car rental

Car sharing system

The variation in Car Sharing schemes is restricted to four schemes. So these will be characterised only by dummy variables in the analysis.

5.4 Conceptual model for changes in mobility behaviour

On the basis of our observations from the exploratory research, the available literature and some theoretical considerations, we constructed a conceptual model on the changes in mobility behaviour. The dependent variable in this conceptual model, represented by the

construct "mobility behaviour" covers a whole range of relevant variables concerning the use of the various means of transport on a aggregate level, i.e. the use of travel modes in times per week, or mileage per year. This behaviour is the result of many travel mode choices over time.

The specification of the conceptual model rests on the idea that changes in mobility behaviour are caused by influences on the travel mode decision making process. For exploratory reasons, various variables are integrated in the conceptual model. In the literature no formal theoretical ideas or models were suggested to explain the changes in mobility behaviour reported in various tentative studies (see e.g. Baum and Pesch, 1994 or Muheim *et al.*, 1992). We must therefore treat the construction of this conceptual model as an attempt to develop some ideas about possible explanations for these changes in mobility behaviour. One of the underlying theoretical ideas in our conceptual model is the assumption that Car Sharing influences the travel mode decision making process, turning it from a more habitual into a more deliberate one. Our model should be interpreted as an analytical model, aimed at an exploration on the variation in changes on mobility behaviour, instead of a rather formal model conceptualising travel mode decision making.

Figure 5.10 Conceptual model on travel mode decision making process

5.4.1 Hypotheses

In our conceptual model on the travel mode decision making process, which results in changes in mobility behaviour, a couple of hypotheses have been specified. All relationships examined are thought to be relevant in explaining the changes in mobility behaviour:

- Hypothesis 10** The characteristics of the individual decision maker correlate with the changes in mobility behaviour, which include:
- decisional involvement in travel mode choices (positive)
 - habit strength in travel mode choices (positive)
 - cost involvement (positive)
 - environmental attitudes (positive)
 - domain-specific values

- Hypothesis 11** The perception of a Car Sharing service correlates with the changes in mobility behaviour, which include:
- a. cost perception (positive)
 - b. valuation distance to the outlet (positive)
 - c. distance to the outlet (positive)
 - d. quality perception
- Hypothesis 12** The changes in mobility behaviour differ among the various service system.

5.4.2 Theoretical perspectives

Transportation research has quite extensively dealt with the way in which people make travel mode choices. Two different research approaches are commonly distinguished: the revealed preference and the stated preference or attitudinal approach (Knippenberg et al., 1989). In this study we will use the *stated preference or attitudinal approach*. This approach incorporates the subjective variables in the models of travel mode choices and travel mode decision making. These subjective expected utility methods are essentially concerned with an assessment of the utility of various travel mode options. It is assumed that the option with the highest (expected) utility will be chosen by the consumer. Fishbein and Ajzen's model, known as "the theory of reasoned action" (1975), has been an influential expectancy-value model for more than twenty years. It has been used in a large variety of scientific domains, as well as within transportation research. Fishbein and Ajzen explain the underlying psychological processes of human behaviour with a model in which attitudes toward performing a behaviour, together with subjective norms (representing the experienced social pressure) are considered the antecedents of behavioural intentions, which in turn precede behaviour. The main assumption in most studies regarding travel mode choice is that individuals make deliberate choices.

As we have already touched upon in 5.2, travel mode choices are not only guided by attitudes and intentions, represented in the model of rational choice, but also by habits: If the model of reasoned action is applied to travel mode choices, we must assume that for every trip a destination is chosen. The subsequent decision-making process is concerned with the choice of a specific travel mode. The model of reasoned action suggests that the individual makes a deliberate choice in which the advantages and disadvantages of the various travel modes are evaluated. The attributes of each travel mode are valued and involved in the multi-attribute choice. To go through such a deliberate choice making process before every trip is fairly difficult and intellectually demanding, especially if the context of the decision remains the same. It can therefore be questioned if this model is appropriate for repetitive choices and behaviour. Instead, we can assume that highly repetitive (travel mode) choices tend to become habitually based, instead of remaining fully deliberate choices. Again, habits can be understood as simple heuristic "choices", in which behaviour is more like an automatic response to a specific situation, where travel mode "choices" are directly associated with a specific need to travel needs.

Aarts (1996) concludes at the end of a similar discussion: "*The research so far suggests that in the case of repeated actions, subsequent behaviour is determined by intentions on the*

one hand and by habit strength on the other hand. Furthermore, there is also ample evidence indicating that habit predicts intentions over and above attitudes and subjective norms." In his study "Habits and decision making" he argues that habit plays an important role in travel mode decision making in several ways: first, habit guides intentions and subsequent behaviour directly. Secondly, when habits are strong, behaviour is less guided by attitudes and intentions. Third, habit reduces the elaborateness of the decision making process. This means that strong habits are accompanied by less information acquisition and utilisation, and less complex or more heuristic decision rules.

Habits, travel mode decision making and Car Sharing

Especially the last conclusion about the influence of habits on travel mode decision making processes seems to be relevant for explaining the changes in mobility behaviour in relation to the adoption of Car Sharing. It supports the overall assumption for the explanation of the changes in mobility behaviour, which is that, for various reasons, Car Sharing changes the cognitive process of travel mode choice making. Because Car Sharing requires planned car use, and prevents spontaneous car use, travel mode decisions are forced to be taken more deliberately. As a consequence, habitual behaviour and habitual car use are less likely. Instead, a deliberate choice between the various travel modes is stimulated. This is important because a lot of car trips can be substituted with other transport means, if no habitual choice is made. It may also imply that people reconsider their needs for transport and give up their intentions for a specific trip.

In our view, this expected influence on the travel mode decision making process is the result of two behavioural consequences of Car Sharing:

1. Car Sharing has got inherent properties which prevent unplanned and unconscious car usage, as the car is no longer unconditionally available in front of the home. One needs to make a reservation in advance to be sure a car is available and one needs to go to the outlet to pick the car up. This is supposed to have consequences for the cognitive processes in the decision making. It is expected that the changes in behaviour can be explained by the shift from a basically habitual travel mode choice to a more deliberate and rational decision. So, users of Car Sharing are forced to a higher involvement in transport mode choice and are stimulated to make a rational choice for every trip they want to make, instead of habitually choosing for the one and only transport mode they always use, the car.
2. An important result of Car Sharing is the fact that the price structure has become almost completely variable. This has several consequences:
 - a. Consumers get more direct feed-back on the costs of car use. This makes them more aware of all costs for driving a car and prevents them from neglecting the cost factor.
 - b. Comparison of the costs of a car with those of public transport on a full economic basis is far easier and thus stimulates a travel mode shift, because for many trips the costs of driving a car exceeds the costs of public transport.
 - c. Car Sharing prevents a situation in which people become economically locked-in: once people have made the investment in a car, they tend to drive more because in this way the fixed costs can be amortised over more kilometres and car use becomes cheaper.

These two behavioural consequences of Car Sharing clearly refer to an increase in the deliberate character of travel mode choices; the first one by forcing to make explicit decisions, the second by emphasising the costs involved. The central assumption in the analysis is that Car Sharing influences the way in which the various travel modes are being used and that the allocation of the various travel modes will shift as a result of the reduced availability of the car and a greater awareness about the costs of car use.

Operationalisations

In the conceptual model on the travel mode decision making process no new variables were introduced. All operationalisations used are consistent with those described before.

6 Research method

6.1 Research method

There were only a few research methods that suited our specific research questions. Some of the more experimental designs had to be excluded, because of the empirical nature of the research interest and the large amount of variables involved. Given the quantitative nature of our research questions, a survey research seemed the obvious choice. However, the choice between different survey methods like personal interviews, telephone interviews and mailed questionnaires, and between a longitudinal or a cross sectional survey was less obvious, since there are lot of conflicting opinions about the merits of all these methods. Thus, the choice which research method to apply was primarily made on practical considerations, like time budget, financial budget and the practical possibilities in the research field. The choice for the mailed survey method, and especially for a cross sectional survey was made for the following reasons:

Since this research is to a large extent of an exploratory nature, a substantial amount of variables have to be included. This means that neither telephone interviews nor personal interviews are appropriate. Telephone interviews are less appropriate because of the inherent limitations of the length of the questionnaire and personal interviews primarily because of their costs. We preferred the cross sectional survey over the longitudinal survey because of the strict time limits to our research, the research costs, and because of the complexity of the longitudinal survey.

In defining our research design, we also had to deal with a number of practical restrictions: Access to people that have had experiences with Car Sharing systems over a longer period is essential for consumer research on Car Sharing. Especially in the beginning of the research trajectory, there were few fully operational large scale systems in the Netherlands that had sufficient clients.

Furthermore, the selection of respondents was restricted by the willingness of the various suppliers in the market to participate in the research and to facilitate the research with up-to-date mailing lists.

Time and budget also laid restrictions on the selection and approach of respondents and on the research design as a whole. Since our research was aimed at determining the effects of Car Sharing on mobility behaviour, a longitudinal study would have been most appropriate. This was however not feasible because of our restricted time and financial means. Given these considerations we therefore decided to rely on self-reporting behaviour and on estimations of past mobility behaviour.

Taking into account these restrictions and considerations, we arrived at the following research design: The data set analysed in this study is generated by a mailed survey among almost 3.300 households in three different Dutch cities, Amsterdam, Rotterdam and Haarlem. For this study, four Car Sharing service schemes were approached (two in

Amsterdam, one in Rotterdam and one in Haarlem). In all four schemes, the research model was tested in a similar procedure: by selecting addresses of households that had been involved in decision making regarding Car Sharing. Some of them became adopters, the others became non-adopters. The analysis of the data on the research questions can be made both on the scheme-specific level and on the so-called conceptual level, as shown by the figure below.

Figure 6.1 Conceptual and scheme-specific level

National Evaluation Program on Car Sharing

The research was facilitated by the Dutch ministry of Transport, in particular the "Adviesdienst Verkeer en Vervoer" (the Transportation Research Centre of the ministry). The data collection took place in the context of the NEP, the "National Evaluation Program on Car Sharing" (Meijkamp and Theunissen, 1995; 1996). The NEP was conducted in 1996 after an exploratory studies (Meijkamp and Douma, 1995) and relied on three basic elements:

1. Based on the results of the exploratory studies, a conceptual model was developed. This conceptual model, as described in chapter 5, formed the basis for the questionnaires.
2. Two different subpopulations were distinguished, for which two questionnaires were developed. The first subpopulation was selected on the basis of their participation in a specific Car Sharing scheme. The second group was selected on the basis of their knowledge about, and to a certain extent also interest in, a specific Car Sharing scheme. This group (the non-adopters) had approached one of the Car Sharing schemes to get more information. It can therefore reasonably expected that they had been considering participation.

3. The third basic element in the NEP was the inclusion of four Car Sharing schemes. All four schemes were conceptually similar, since they sold the utilisation of cars on the consumer market, but on a operational level there were differences. There were operational differences in the organisation of the distribution and delivery of cars, the role information technology played in the service performance, the rental conditions, the minimum rental time, the payment procedure, etcetera.

Selection of the four service schemes

In the selection of the four different service schemes, a number criteria were used:

- The selected service schemes had to be representative for the available Car Sharing services in the Netherlands at the time of research (1996).
- A Car Sharing service had to have a large group of clients with substantial experience with the scheme.
- Each service scheme had to have a reliable and updated database, containing not only the addresses of their clients, but also of a group of people that had been in contact with the company but hadn't signed a contract (yet).
- A company had to agree with active participation in the research trajectory. The contribution of the company consisted of recommending the research survey to their clients and providing an up to date mailing list.

Table 6.1 The major attributes of the investigated Car Sharing services

	Service A	Service B	Service C	Service D
Subscription costs	yes, Fl. 350,-	yes, Fl. 100,-once	yes, Fl. 60,- /year	yes, Fl. 365,- / year
Guarantee	Fl. 350,-	no	no	Fl. 500,-
Location car outlet	local living area	central, rental firm	central, rental firm	local, living area
Minimum rental period	1 hour	1 hour	1 day	1 hour
Combination with long term rental	no	yes	yes	yes
Identification	electronic key	personnel	personnel	electronic key
Payment	monthly, all utilization costs	direct after use	monthly subscription fee	monthly, all utilization costs
Price structure	± Fl. 5,-/ hour and ± Fl. 0,60/ km	Fl. 5,-/ hour and Fl. 0,50/ km	Fl. 38,- to Fl.77,- / day	Fl. 4,50/ hour and Fl. 0,45/ km
Reservation needed	no	no	yes	no
Reservation period	1 hour	1 hour	24 hours	1 hour

After discussions with many Car Sharing companies, a selection was made. For reasons of confidentiality, which for some companies was a precondition for participating in the research, the four companies will be identified as A, B, C and D.

All four schemes are running in large urban areas in the western part of the Netherlands. Their direct urban environment is not completely the same. The environment differs slightly with respect to parking problems, the level of congestion, the access to public transport services and the social, cultural and demographic composition of the area of operation. Table 6.1 lists the operational characteristics of the four service schemes:

Description of the four service schemes

On a conceptual level, all four selected schemes seem very similar. All of them offer rental cars as an alternative to the private car and all aim at a long term relationship with clients as a provider of car access. The four service schemes differ only on minor operational attributes:

Service A is offered by a company that can be best described as a new and young business that has its core business in Car Sharing services. It offers these services in the area their clients' live. Clients find cars at their disposal near their home, in unmanned stations or outlets with about five different types of cars. The application of information technology reduces the transaction costs: a board computer car registers the utilisation of the car, a chip key identifies the persons at the outlet and an on-line connection with the centre facilitates fleet management and booking. Company A explicitly wants to help diminish environmental problems and contribute to the quality of the city. It distinguishes itself with a green image. The entrance costs of this service are relatively high and the rental service is relatively flexible as well.

Service B has its roots in the traditional rental sector. Apart from their traditional services, they developed a Car Sharing service that works complementary. The main advantage of the Car Sharing service is the possibility to rent a car per hour. For longer periods normal rental arrangements are suggested. The most important incentive for this arrangement is the extreme pressure on parking space. The local governments facilitate this service with promotion and parking permits. The offer of company B is very open: membership is not associated with any obligations, the reservation period is only one hour and the entrance fee is low.

Service C is a so-called subscription system, in which people are expected to buy a certain amount of rental days per year. Before they enter the scheme, clients have to sign a contract specifying the type or class of car and the number of rental days per year. Payment is collected monthly and automatically. This system offers no opportunities for short term rental and customers need to make a reservation 24 hours in advance. The threshold to become a member is rather low, because of the fairly low entrance fee, but on the other hand there is a minimum subscription of 10 days per year. The distribution of the cars is organised from normal rental companies, which are usually not located in residential areas. Company C is in fact the result of co-operation between several rental companies.

Service D is a Car Sharing system that is quite similar to service A, but operates in different cities. Company D says it sells car access over the year, 24 hours a day, close to their customers' homes. For this service, members of this organisation have to pay quite substantially. There is, however, no obligation to use the car. There is no need to make a reservation in advance, but to be guaranteed of a car one has to make a phone call at least one hour in advance. Chip keys and information technology enable a flexible, reliable and accurate service performance.

Selecting the respondents

From each of the four service schemes we selected a sample group with adopters and a sample with non-adopters. This resulted in eight independent samples of respondents: four adopter samples and four non-adopter samples. To recruit the adopters, the obvious choice was to mail all participants in the four service schemes. The recruitment of the non-adopters however, needs further explanation:

Company A, C and D all had a database with addresses of people that over the last couple of years had shown any form of interest in the Car Sharing scheme. These people had asked for more information on a special offer or on prices and conditions. All addresses not older than one year, were mailed.

Company B, however, did not keep a list of addresses of potential clients that had shown interest in the scheme. Therefore, it was decided to follow a special recruiting and selection trajectory to generate a comparable and relevant database of potential respondents. The fact that a promotion campaign had been run only one year before our research activities, made it possible to recruit people who knew about scheme B and were interested in it. This promotion campaign was financed by the local government. The aim was to inform and convince households about the advantages of the Car Sharing service. Car Sharing was promoted as a measure to reduce the parking problems in that part of the city. Every household received a brochure in the mail. Since all households in the vicinity of the rental outlet had been mailed recently, it could reasonably be expected that there was a group of people who had read the brochure, knew about the content of the service offer and were interested in it.

It was decided to approach a large amount of households in the area of the town that was mailed in a non-select manner. People were selected for the database by means of a telephone interview: 4419 telephone trials have been made, of which 1425 lead to contact. Of all the people contacted 29% (415) were familiar with the Car Sharing offer of company B, and 19% (269) were familiar with company B and willing to give their names and addresses and participate in the research.

These 269 addresses were mailed the questionnaire. This group wanted to participate in the research despite their low interest in Car Sharing: 61% did not find it interesting for themselves. The response to the mailing was 48% (129 respondents).

6.2 Questionnaire development

In chapter 5, we presented our conceptual research model, based on our exploratory empirical research, a review of the literature, and various theoretical reflections. In presenting this model, we explained the operationalisation of the various concepts in a general sense. Based on these operationalisations, a mail questionnaire was developed, as a preliminary project for the evaluation program commissioned by the ministry of Transport (Meijkamp and Theunissen, 1995). This questionnaire consisted of the complete battery of variables, worded in general terms. For two reasons, this questionnaire could not be directly applied to the research and had to be slightly adapted. First, the conceptual model with its operationalisations is a model that refers to the concept of Car Sharing. As we have illustrated, operational differences exist in the practices of the four different service schemes. The general questionnaire was therefore adapted to the local situation and the specific service offer. In adopting the expressions and wordings used within each service, accounting for the availability of specific facilities, and adding new items and variables of interest to the specific entrepreneurs, all four questionnaires turned out slightly different. However, special care was taken not to disturb the consistency of the questionnaires, so a proper comparison could still be made on the conceptual level. Secondly, the operationalisation of the con-

ceptual model had to be changed to the requirements of the two subpopulations, the adopters and the non-adopters. Especially the explaining variables of the perceived service quality and all variables regarding experiences with the schemes were not relevant for the interested. Moreover, a differentiation between the two questionnaires was made with regard to the motives to participate and the motives not to participate, or the conditions under which non-adopters would adopt Car Sharing. The questionnaires were tested for clarity in various ways. First, the questionnaires were subjected to the scrutiny of various professional market researchers. Secondly, the questionnaires were discussed with all four schemes, in preparatory meetings for the research trajectory. The project management of the Ministry of Transport, as well as the management of the service organisations reviewed the questionnaires on comprehensibility and readability. Finally, the questionnaires were tested by several non-professional people. All comments were integrated and all difficulties discovered were overcome in the final versions of the research instrument.

6.3 Data collection and response

In 1996, the data were collected independently among the four companies. In keeping with the collaboration with the ministry of Transport, the descriptive results of each of the four service systems were reported separately. (Meijkamp and Theunissen, 1996 a, b, c, d). These separate studies followed a similar trajectory. After introductory talks (1), specific questionnaires for the local situation were proposed (2). These questionnaires were discussed, adapted and finalised for mailing (3). The mailing was conducted by the companies themselves (4). The mailing contained a questionnaire, a response envelope of the Technical University of Delft (free of charge), a letter signed by the managing director of the specific scheme asking for participation in this research, and a letter from the Ministry of Transport stating the relevance of the research and urging the respondent to participate in the evaluation program. The response was processed (5) and then reported back to the local companies and the Ministry of Transport individually (6).

Table 6.2 Overview response rates

		Sent (month '96)	Mailed (quantity)	Response (n)	Response (%)
Service A	adopters	September	300	108	36%
	non-adopters	September	1200	390	33%
Service B	adopters	March	245	67	27%
	non-adopters	June	269	129	48%
Service C	adopters	March	142	75	53%
	non-adopters	March	176	59	34%
Service D	adopters	May	160	87	54%
	non-adopters	May	800	231	29%

Response

Table 6.2 shows an overview of the various response rates among the eight subsamples. The response rates vary between 27% and 54%. Some plausible arguments for the variation

in response can be formulated. First, a great deal of difference in the response among the adopters and the non-adopters can be explained by a greater involvement with the subject among adopters.

In the case of service B, two exceptions can be distinguished. At the one hand, the response among the adopters is rather low, only 27%. The reason for this might be the fact that only one year before, another survey had been conducted among the participants. This reduced the respondents' willingness to participate in a similar survey. The high response rate among the non-adopters could have been caused by the specific nature of the sampling procedure: this subpopulation was the only one that was recruited by telephone. They committed themselves to the research. Not a lot can be said about the non-response, since the service suppliers had hardly any information available on the participants, let alone the non-adopters.

In the analysis of the data, the four data sets of the adopters will frequently be combined, as well as the four sets of non-adopters. The relative contributions of each of the two subpopulations differ, just as their proportions within the four subpopulations of the four service schemes:

Table 6.3 Proportion between adopters and non-adopters

	Overall	Service A	Service B	Service C	Service D
Adopters	30%	22%	28%	56%	27%
Non-adopters	70%	78%	72%	44%	73%

6.4 Preliminary data processing

Some of the concepts in our conceptual model were measured with multiple item scales. Before analysing the data and testing the hypotheses, it can be very useful to reduce the complexity of the analysis by applying methods of data reduction. The concepts that were measured by multiple item scales are variables like "environmental consciousness", "the willingness to act" (to solve environmental problems) and "decisional involvement". These variables can be reduced to one single construct variable. Apart from these multiple-item scales, the (domain-specific) value-orientation, as measured by 51 separate items, can also be reduced to fewer construct variables or factors. Here, a factor analysis is most appropriate because this method enables a structural analysis of a large number of variables by defining a set of common underlying dimensions, or factors. For these factors, scores based on several original variables can be calculated and then used as a substitute for these original variables.

Decisional involvement

Decisional involvement was measured on an 8-item scale (Aarts, 1996). As a measure for the consistency within a multiple-item scale, Cronbach's alpha can be calculated. High values of Cronbach's alpha suggest the unidimensionality of the items. For our data set, a Cronbach's alpha of .80 has been calculated. Combining the 8-item scale into one single construct, "decisional involvement", is therefore allowed.

Environmental consciousness and willingness to act

Despite three decades of research on environmentally sound behaviour and extensive use of concepts like "environmental consciousness" and "willingness to act", these concepts have never become clearly defined concepts. Various authors use different scales to measure these concepts, many of which have not been fully tested, neither empirically nor conceptually. In our study, we didn't want to develop new constructs, but instead decided to use one which has frequently been used in the Netherlands. Our scale was derived from a specific study on changing mobility behaviour (Tertoolen, 1994 and Nelissen, 1987; see also chapter 5). This scale was investigated on its dimensionality with a factor analysis.

In our analysis we first found a clear three factor solution, in which the item "I am not a member of an organisation for the protection of nature, and will never become one" formed a factor on its own. We therefore decided to exclude this item from the analysis, for conceptual reasons. A two factor solution, with both factors having an eigenvalue higher than 1, remained. The two constructs that were meant to be measured, were reflected in the solution. For both factors, Cronbach's alpha was calculated, in order to test their reliability. For factor 1, environmental consciousness, Cronbach's alpha was .86 and for factor 2, the willingness to act, Cronbach's alpha was .65. We may therefore conclude that both constructs are internally consistent enough to be applied. In the table below, the factor loadings, after rotation, of the various items on the two factors are shown. For our investigation on the influence of "environmental consciousness" and "willingness to act" on the adoption of Car Sharing we will use the factors resulting from the factor analysis.

Table 6.4 Results of factor analysis on attitudes towards environmental problems

Factor 1 (eigenvalue 4,4) environmental consciousness	Factor loadings
• It won't get that bad with the environmental pollution.	.73
• Only if the reasons for the deterioration of the forest are clear, preventive measures must be taken.	.68
• Many statements regarding the environmental problem are far from proven.	.70
• For me, trees dying because of environmental pollution is an issue not worth mentioning.	.68
• Although traffic contributes to air pollution, I do not see the necessity to take measures against it.	.73
• If we want to earn money in the Netherlands, we have to accept a certain environmental pollution.	.61
• The problem of environmental pollution is merely a hobbyhorse of a specific group of people.	.73
• In my opinion, too much attention is paid to the environmental pollution caused by cars.	.56
• It is quite normal that nature has to give way to the construction of roads.	.58
Factor 2 (eigenvalue 1,3) willingness to act	
• I would be prepared to drive less by car for a better environment.	.58
• For a cleaner environment it would be good to make petrol more expensive.	.77
• In my opinion there are too many cars in the Netherlands.	.62
• If I drive a car and pollute the air by doing so, I am prepared to pay more tax for this.	.71

Table 6.5 Results on the factor analysis on the domain specific values

Factor 1. (eigenvalue 6,8) A car establishes identity	
For me the car is to show my personality	.81
For me the car is a manner to tell who you are	.79
The car is just a means of transport	-.72
The car shows that you are successful	.56
To me the car is almost like my own living room	.52
A car must fit to a person	.49
Driving a car is a sport activity	.38
The train is for people who can not afford a car	.37
Factor 2. (eigenvalue 3,0) The car provides freedom and welfare	
The car gives people freedom	.69
The car gives me a feeling of independence	.69
Driving a car gives me a feeling of freedom	.68
A car in front of my house makes me feel free	.64
The car contributes to an increase in welfare	.50
The car is indispensable for modern man	.49
The car is a magnificent piece of technology	.43
Factor 3. (eigenvalue 2,9) The importance of flexibility in travelling	
I want to be able to decide to go out spontaneously	.70
I do not want to be dependent, when I travel	.69
If I have to go somewhere, I want to travel as fast as possible	.64
I do not like to plan my trips in advance	.61
In my life I want to be as much as flexible as possible	.38
In the train you do not have privacy	.34
It is important to be somewhere exactly on time	.34
Factor 4. (eigenvalue 2,2) The importance of technological perfection and reliability	
A car must not have any damages	.76
A car must always be clean	.75
A car must be finished in every detail	.71
When buying a car technical properties are important	.43
A car trip must first of all be comfortable	.41
It is more important that a car performs well then that it is cheap	.36
I want a life in which I know what I can expect in advance	.31
Factor 5. (eigenvalue 2,0) Car Sharing consistent profile	
Car maintenance is an unpleasant task	.64
Taking care of a car is time consuming and annoying	.61
Cars lead to non-conscious mobility behaviour	.61
Cars make people lazy	.52
I want to live environmentally friendly	.48
The car is an important polluter of the environment	.43
Cars driving is expensive	.42
It is important to make conscious choices in life	.36
Factor 6. (eigenvalue 1,6) The attitude towards cycling	
Cycling is tiresome	.59
Cycling is wonderful for relaxation	-.57
Within cities the bicycle is the best means for transport	-.57
Within cities, you can get everywhere on a bicycle	-.47
Cycling is dangerous	.47

Factor 7. (eigenvalue 1,4) The attitude towards driving a car yourself

It is great when you don't have to drive yourself	.68
Driving car is tiresome	.65
Driving the car is fun	-.63
In the train you have time to your self	.36

Note: Only factor loadings (after rotation) > .30 are shown

Domain-specific value orientation

The value-orientation of the respondents was measured by 51 items. For reasons of efficiency, the dimensionality of these values has been analysed using factor analysis.

The first analysis showed that from the 51 items, 15 factors could be derived with an eigenvalue higher than one. However, many of them (6 factors) did not contribute more than 2,5% to the percentage of the explained variance. On conceptual grounds we have selected the first 7 factors, which seem to provide a reasonable and consistent basis for analysis (table 6.4).

The first factor (eigenvalue 6,8) expresses the meaning of the car for the individual and especially the extent to which this product is associated with providing identity in a social context. High values express that the car is far more than just a means of transport.

The second factor (eigenvalue 3,0) expresses the meaning of the car to the individual itself. It relates to the meaning of the car in terms of feelings of freedom and independence.

Factor three (eigenvalue 2,9) reflects the importance of being flexible in travelling. Low values indicate that people do not mind planning and deciding on their trips in advance.

Factor four (eigenvalue 2,2) is related to the expectations and requirements of a car. It expresses the importance of technological perfection, neatness and reliability of a car.

At first glance, factor five does not seem to be a one-dimensional construct. On closer observation however, we can reduce this factor to a dimension that is very specific to Car Sharing. All expectations and conventional beliefs about Car Sharing contribute to this factor, e.g. dislike of maintenance and taking care of your own car, the willingness to use a car consciously and the negative environmental effects of car driving.

High values on factor 6 (eigenvalue 1,6) reflect negative attitudes towards the bicycle.

Factor 7 (eigenvalue 1,4) expresses enjoyment in self-driving. High values suggest that one likes to be driven or finds driving tiresome or annoying; low values indicate that car driving is considered fun.

6.5 The combination of eight subsamples

This study is primarily interested in exploring the dependent variables on the conceptual level of Car Sharing as a generic commercial principle, instead of investigating the relationship between the specific systems of service design and the dependent variables. The variation in the four different services studied clearly complicates such an analysis. To investigate the differences in population of the four service schemes, we will test hypothesis 1. first:

Hypothesis 1: The groups of adopters, as well as the groups of non-adopters do not differ among the four service systems.

By testing this hypothesis we investigate the additional variation that is introduced by combining the subsamples. The question is, to what extent the combination of the subsamples of adopters and non-adopters creates more variation in the data set and to what extent it might be a disturbing factor in the analysis, caused by the fact that the specific attributes of each service scheme contribute to the explanation of the dependent variables. As a precaution, we must take into account that – despite our conclusions on a comparison of the four service schemes in 6.1.4, the specific attributes of the service scheme might also contribute to the explanation of the adoption, the satisfaction and the effects on mobility behaviour.

The hypothesis 1 is a rather exploratory one. About the differences between the four different samples, few explicit assumptions can be made in advance. The possible differences among the four service schemes will be tested for the following characteristics of the individual decision-maker: (1) social-demographic (objective) characteristics, (2) personal (subjective) characteristics, (3) previous practice or behaviour, (4) the physical environment of the individual and (5) the individual's perception of strategic service characteristics. The possible differences among the four different samples will be tested for both the adopters as well as for the non-adopters.

Table 6.6.a The social-demographic characteristics of the **adopters**

	Total N=337	Service A N=108	Service B N=67	Service C N=75	Service D N=87	Test statistic	
Age (years)	39,0	41,5	37,6	41,9	35,3	F=10,0	p=.000
Sex (% male)	59	59	55	64	60	$\chi^2=1,2$	p=.760
Household size (persons)	2,3	2,3	1,9	3,1	1,9	F=17,9	p=.000
Children (persons)	0,9	0,9	0,6	1,3	1,1	F=5,3	p=.002
Education (%)						$\chi^2=9,3$	p=.025
lower educated	17%	15%	27%	18%	11%		
middle educated	11%	8%	6%	15%	13%		
higher educated	72%	77%	67%	67%	76%		
Net income (Dfl./ month)						$\chi^2=38,1$	p=.000
< 30.000 (%)	16%	10%	39%	3%	19%		
30.000 - 38.000 (%)	13%	12%	17%	11%	12%		
38.000 - 52.000 (%)	30%	29%	27%	35%	28%		
> 52.000	41%	49%	17%	51%	42%		
Work (%)						$\chi^2=46,5$	p=.003
> 25 hours/ week	68%	65%	54%	77%	75%		
< 25 hours/ week	9%	4%	15%	11%	10%		
free-lance	15%	20%	25%	6%	10%		
pensioner	3%	4%	0%	4%	1%		
else	5%	7%	6%	2%	4%		

Social-demographic characteristics

With regard to the social-demographic characteristics, for both adopters and non-adopters it was tested whether the four subsamples differ. For the adopters, most variables differ among the four service systems, see table 6.6.a. Only on the composition on sex, the groups of users of the Car Sharing schemes do not differ. On age, income, level of education and work the samples differ significantly.

Also for the *non-adopters* the composition of the subsamples do differ significantly. Here only the sex of the respondents shows no difference (see table 6.6.b).

Table 6.6.b The social-demographic characteristics of the **non-adopters**

	Total N=809	Service A N=390	Service B N=129	Service C N=59	Service D N=231	Test statistic
Age (years)	38,4	40,5	36,8	39,5	35,5	F=11,9 p=.000
Sex (% male)	55	55	54	43	56	$\chi^2=3,3$ p=.340
Household size (persons)	2,2	2,1	2,0	2,9	2,2	F=4,0 p=.008
Children (persons)	0,8	0,6	1,5	1,3	1,5	F=30,2 p=.000
Education (%)						$\chi^2=19,4$ p=.000
lower educated	17%	12%	23%	21%	18%	
middle educated	6%	5%	3%	10%	9%	
higher educated	77%	83%	74%	69%	73%	
Net income (Dfl./ month)						$\chi^2=27,3$ p=.000
< 30.000 (%)	19%	13%	34%	1%	24%	
30.000 - 38.000 (%)	14%	15%	8%	13%	17%	
38.000 - 52.000 (%)	26%	26%	27%	38%	23%	
> 52.000	41%	46%	31%	48%	36%	
Work (%)						$\chi^2=43,0$ p=.009
> 25 hours/ week	64%	59%	71%	69%	68%	
< 25 hours/ week	8%	9%	7%	16%	6%	
free-lance	13%	17%	9%	7%	9%	
pensioner	4%	5%	2%	5%	3%	
else	11%	10%	11%	3%	15%	

The personal characteristics

The personal characteristics we considered the most relevant were: the perception of car costs, the cost involvement, the 7 factors resulting from the factor analysis on the domain specific values and the constructs "environmental consciousness" and "willingness to act". Hypothesis 1. is tested for the four adopter and the four non-adopter samples:

Table 6.7.a The personal characteristics of the **adopters**

	Total A N=337	Service B N=108	Service C N=67	Service D N=57	Service E N=87	Test statistic
Perception car costs						
only fuel costs	32%	49%	26%	40%	18%	$\chi^2=19,5$ p=.000
all car costs	68%	51%	74%	60%	82%	
Cost involvement						
yes	79%	61%	86%	81%	88%	$\chi^2=20,7$ p=.000
no	21%	39%	14%	19%	12%	
Environmental						
consciousness	—	—	—	—	—	F =1,0 p=.384
Willingness to act	—	—	—	—	—	F =0,9 p=.470
Value: cars are means						
for identity	—	—	—	—	—	F =0,2 p=.920
Value: cars are symbols						
for freedom	—	—	—	—	—	F =0,8 p=.519
Value: importance of						
flexibility in travelling	—	—	—	—	—	F =8,0 p=.000
Value: importance of						
technological perfection	—	—	—	—	—	F =4,8 p=.003
Value: Car Sharing						
consistency	—	—	—	—	—	F =2,3 p=.074
Value: anti cycle attitude	—	—	—	—	—	F =1,9 p=.116
Value: car driving dislike	—	—	—	—	—	F =0,6 p=.580

We can see that for the *adopters*, “environmental consciousness”, “willingness to act”, and all value factors, except for the dimensions “importance of flexibility in travelling” and “importance of technological perfection” do not differ significantly. In contrast, the perception of car costs, the cost involvement and the value dimension “importance of flexibility in travelling” differ significantly.

In the tested comparison between the four *non-adopters* samples, we found significant differences on the perception of car costs, the cost involvement, the willingness to act and on two value dimensions, the “anti cycling attitude” and “the dislike of car driving”.

Table 6.7.b The personal characteristics of the **non-adopters**

	Total N=809	Service A N=390	Service B N=129	Service C N=59	Service D N=231	Test statistic
Perception car costs						
only fuel costs	80%	84%	83%	77%	70%	$\chi^2=7,8$ p=.050
all car costs	20%	16%	17%	23%	30%	
Cost involvement						
yes	52%	48%	43%	53%	68%	$\chi^2=11,6$ p=.009
no	48%	52%	57%	47%	32%	
Environmental						
consciousness	–	–	–	–	–	$F=2,2$ p=.085
Willingness to act	–	–	–	–	–	$F=2,8$ p=.040
Value: cars are means						
for identity	–	–	–	–	–	$F=2,2$ p=.084
Value: cars are symbols						
for freedom	–	–	–	–	–	$F=1,0$ p=.397
Value: importance of						
flexibility in travelling	–	–	–	–	–	$F=0,8$ p=.490
Value: importance of						
technological perfection–	–	–	–	–	–	$F=1,6$ p=.187
Value: Car Sharing						
consistency	–	–	–	–	–	$F=0,2$ p=.887
Value: anti cycle attitude–	–	–	–	–	–	$F=4,1$ p=.007
Value: car driving dislike–	–	–	–	–	–	$F=4,6$ p=.004

Mobility behaviour

Testing hypothesis 1 with respect to the individual's mobility behaviour, again results in a partial confirmation (table 6.8.a). On several variables, the four *adopter* samples can not be treated as similar. They differ on former car ownership, total car mileage, frequency of train, bicycle and city transport use, season tickets for public transport and on some car use practices.

Comparing the four non-adopters samples, we can also see that for a number of variables the samples are not similar. These variables are: car ownership, frequency of car, train, bicycle and public transport use, and the percentages of people who commute by car, who have a season ticket for public transport and who are familiar with car rental. Therefore, hypothesis 1 cannot be accepted.

Table 6.8.a The mobility behaviour of the **adopters**

	Total	Service A	Service B	Service C	Service D	Test statistic	
	N=336	N=108	N=66	N=65	N=86		
Former car ownership (%)	29%	40%	22%	25%	25%	$\chi^2=8,5$	$p=.036$
Total car mileage (km/ year)	8450	9990	5100	11480	6510	$F=4,9$	$p=.002$
Mileage by rentals (km/ year)	1420	1280	1930	1530	1120	$F=0,6$	$p=.648$
Mileage by borrowed car (km/year)	660	1060	680	450	690	$F=2,3$	$p=.080$
Frequency of car use (x/week)	2,5	3,1	1,9	3,0	1,6	$F=2,3$	$p=.062$
Frequency of train use (x/ week)	2,2	1,4	1,6	2,3	3,5	$F=3,6$	$p=.014$
Frequency of cycle use (x/ week)	14,3	16,4	13,9	13,1	11,6	$F=8,3$	$p=.000$
Frequency of public transport use							
city transport (x/week)	2,9	3,2	3,9	1,6	2,6	$F=3,8$	$p=0.10$
regional transport (x/week)	0,6	0,3	0,6	0,9	0,6	$F=2,0$	$p=.106$
Frequency of car rental (x/ year)	4,6	3,6	4,6	6,9	3,8	$F=2,2$	$p=.086$
Commuting by car (%)	16%	21%	12%	20%	9%	$\chi^2=6,0$	$p=.063$
Season ticket public transport (%)	60%	59%	60%	62%	82%	$\chi^2=11,6$	$p=.009$
Habit: regular use car rental	2,5	2,6	2,3	2,3	2,5	$\chi^2=4,8$	$p=.188$
Habit: never considering car vs. public transport	4,2	4,3	4,2	4,2	4,2	$\chi^2=0,3$	$p=.950$
Habit: never considering car vs. bicycle use	3,6	3,9	3,6	3,8	3,5	$\chi^2=4,0$	$p=.260$
Habit: used to combining trips	2,2	2,4	2,3	2,0	2,0	$\chi^2=6,4$	$p=.093$
Habit: car used mostly by more people	2,8	3,0	3,1	2,1	2,9	$\chi^2=21,6$	$p=.000$
Habit: car needed, known long before	3,0	3,4	3,0	2,0	3,4	$\chi^2=48,4$	$p=.000$
Habit: travel mode decision only shortly before	3,2	3,1	3,3	3,6	2,8	$\chi^2=18,4$	$p=.000$

Table 6.8.b The mobility behaviour of the **non-adopters**

	Total	Service A	Service B	Service C	Service D	Test statistic	
	N=809	N=390	N=129	N=59	N=231		
Car ownership before (%)	56%	55%	47%	44%	64%	$\chi^2=13,6$	$p=.004$
Total car mileage (km/ year)	8980	8750	10290	8680	8840	$F=0,6$	$p=.586$
Mileage by rentals (km/ year)	870	1100	490	300	830	$F=2,3$	$p=.079$
Mileage by borrowed car (km/ year)	1010	820	1110	1880	1180	$F=2,4$	$p=.066$
Frequency of car use (x/ week)	3,6	3,1	4,9	6,5	2,9	$F=6,7$	$p=.000$
Frequency of train use (x/ week)	2,1	1,9	1,6	1,7	2,9	$F=6,0$	$p=.000$
Frequency of cycle use (x/ week)	12,4	13,8	11,2	11,4	11,0	$F=4,1$	$p=.007$
Frequency of public transport							
use city transport (x/ week)	2,8	3,1	3,2	0,6	3,1	$F=5,6$	$p=.000$
regional transport (x/ week)	0,5	0,4	0,5	0,8	0,8	$F=3,8$	$p=.018$
Frequency of car rental (x/ year)	2,9	2,8	3,1	2,5	3,2	$F=0,3$	$p=.826$
Commuting by car (%)	15%	14%	28%	9%	22%	$\chi^2=26,7$	$p=.000$
Season ticket public transport (%)	66%	65%	58%	56%	74%	$\chi^2=13,0$	$p=.005$
Habit: regular use car rental	3,8	3,6	4,2	3,9	3,9	$\chi^2=15,9$	$p=.001$
Habit: never considering car vs.							
public transport	3,2	3,2	3,1	3,2	3,3	$\chi^2=2,0$	$p=.576$
Habit: never considering car vs.							
bicycle use	3,3	3,4	3,1	3,5	3,2	$\chi^2=4,8$	$p=.186$
Habit: used to combining trips	2,6	2,6	2,6	2,5	2,5	$\chi^2=0,6$	$p=.886$
Habit: car used mostly by more							
people	3,0	3,1	2,9	2,8	2,9	$\chi^2=3,1$	$p=.375$
Habit: car needed, known long							
before	3,2	3,2	3,2	3,1	3,3	$\chi^2=0,5$	$p=.926$
Habit: travel mode decision only							
shortly before	3,2	3,0	3,4	3,3	3,2	$\chi^2=7,0$	$p=.072$

The physical environment

With respect to almost any variable indicating the physical environment of the respondents hypothesis 1 cannot be accepted, neither for the adopters nor for the non-adopters. Among the adopters, only on the distance to work the samples do not differ; among the non-adopters the distance to work and the distance to the train station are the only variables on which the subsamples do not differ.

Table 6.9.a The physical environment of the **adopters**

	Total	Service A	Service B	Service C	Service D	Test statistic	
	N=337	N=108	N=67	N=75	N=87		
Distance to work	14,9	14,1	15,2	13,5	17,0	$F=0,3$	$p=.832$
Distance to shopping centre (km)	0,8	0,7	0,6	0,9	0,9	$F=4,5$	$p=.003$
Distance to city centre (km)	1,8	1,2	1,9	2,3	2,1	$F=6,4$	$p=.000$
Distance to train station (km)	2,1	1,9	2,4	2,5	1,6	$F=5,0$	$p=.002$
Distance to car outlet (km)	1,7	1,0	1,2	3,0	1,6	$F=70,4$	$p=.000$

Table 6.9.b The physical environment of the **non-adopters**

	Total	Service A	Service B	Service C	Service D	Test statistic	
	N=809	N=390	N=129	N=59	N=231		
Distance to work (km)	16,9	15,7	17,7	11,2	19,9	F=1,4	p=.230
Distance to shopping centre (km)	0,8	0,7	0,7	1,4	0,9	F=12,7	p=.000
Distance to city centre (km)	2,2	1,8	2,2	2,9	2,6	F=8,7	p=.000
Distance to train station (km)	2,1	2,3	2,5	2,9	2,4	F=1,2	p=.322
Distance to car outlet (km)	2,5	2,2	2,3	3,8	1,6	F=58,0	p=.000

The perception of the service offer

Probably the clearest basis for rejection of hypothesis 1 is the perception of the service offer. Among the adopters, hypothesis 1 holds for only one variable, the valuation of the distance. Among the non-adopters, hypothesis 1 must be fully rejected. The tables below show the results of the statistical tests.

Table 6.10.a The perception of the service offer by the **adopters**

	Total	Service A	Service B	Service C	Service D	Test statistic	
	N=337	N=108	N=67	N=75	N=87		
Cost perception service (5P, 1 = cheap)	3,0	3,3	2,6	2,9	2,9	$\chi^2=20,2$	p=.000
Valuation distance to the outlet (5P, 1 = acceptable)	1,7	1,6	1,7	1,8	1,7	$\chi^2=2,4$	p=.488
Quality perception service (5P, 1 = bad)	4,3	4,2	4,1	4,6	4,3	$\chi^2=15,2$	p=.002
Attitude towards Car Sharing (5P, 1 = positive)	1,6	1,4	1,8	1,4	1,8	$\chi^2=9,9$	p=.019

Table 6.10.b The perception of the service offer by the **non-adopters**

	Total	Service A	Service B	Service C	Service D	Test statistic	
	N=809	N=390	N=129	N=59	N=231		
Cost perception service (5P, 1 = cheap)	3,5	3,6	3,0	3,5	3,5	$\chi^2=20,9$	p=.000
Valuation distance to the outlet (5P, 1 = acceptable)	2,3	2,1	2,4	3,0	2,4	$\chi^2=19,8$	p=.000
Quality perception service (5P, 1 = bad)	3,5	3,5	3,3	3,3	3,6	$\chi^2=17,8$	p=.000
Attitude towards Car Sharing (5P, 1 = positive)	2,3	2,1	2,6	2,7	2,3	$\chi^2=16,1$	p=.001

6.6 Discussion and implications

Analysing the relationship between the individual decision maker and the service scheme is not the basic interest in this study. Still, we decided to conduct the analysis for two reasons: first, for all respondents the descriptive statistics of all relevant variables had been established, and the variations among the four independent service schemes were known. Secondly, the analysis was made to test whether the four subpopulations would differ.

From the results of testing hypothesis I. (the groups of adopters and the groups of non-adopters do not differ among the four service systems) can be concluded that for a substantial number of the relevant variables the hypothesis cannot be accepted. The question here is in which way the partial rejection of hypothesis I. might influence the testing of the other hypotheses. We stated before that our research interests are basically on the conceptual level, that we focus on Car Sharing as a generic concept and are less interested in the relationship between the specific service schemes and the dependent variables. If the four subpopulations do not contain homogeneous groups of respondents, is it then still allowed to combine these four partially different populations and to analyse them in combination? In our view, combining the four subpopulations does not produce many analytical problems:

First, if the differences in descriptive values in absolute terms are analysed in relation to the standard deviations, very few variables differ substantially. Statistically the variables differ, but the differences are so small that they are not likely to influence the independent variables.

Secondly, we can consider what factors determine the differences between the four systems. One obvious, but important explaining factor is the fact that the four service schemes are offered in four different urban areas. Because of the different social, economic and cultural situations, differences exist between the direct environments of the service schemes. The adopters and non-adopters are recruited from dissimilar populations. As a result, differences in research populations can – to a certain extent – be attributed to social-geographical differentiation. Because of the different areas of operation, differences will also exist in e.g. access to public transport, the availability of public facilities, shops, recreational facilities, and the level of parking problems and congestion. It therefore seems fair to conclude that most relevant variables are not related to the service design as such or, in other words, to the strategic characteristics of the service itself, except for 'perception of the service offer'. In spite of these arguments, it cannot be denied that a small part of the variation in the subpopulations is likely to be caused by differences in the service itself and its selective attractiveness for specific user groups. Thus, in the analysis of the dependent variables, we must take into account that the outcome could be slightly influenced by variations in the service design, and – related to this – by differences in the composition of the subsamples.

7 The adoption of Car Sharing services

7.1 Motives for (non-)adoption

In the questionnaire for the adopters, an additional set of statements was included that dealt with the motives for participation. These motives provide a first insight in the adoption of Car Sharing. This list of motives for adoption was formulated on the basis of the qualitative research. The respondents were asked to reveal their motives for adoption, using a 5 point Likert scale (1 = agree, 5 = disagree). Table 7.1 shows the results of the descriptive statistics.

Table 7.1 Motives for adopters to participate in a Car Sharing organisation

	% Agree	Average	Carless	Car owner
The increasing costs of car driving	55%	2,7	2,8	2,3
Travelling by public transport takes too much time	42%	3,0	3,0	3,3
The parking problems nearby home	37%	3,3	3,4	3,1
A worn out old car	21%	4,1	4,5	3,1
Travelling by public transport becomes expensive	20%	4,0	3,9	4,0
Less money to spend	19%	4,0	4,0	4,1
Needs to travel with little children	17%	4,2	4,1	4,4
High repair costs of the present car	15%	4,3	4,5	3,8
A new appointment	6%	4,7	4,7	4,6
Travelling by public transport is impossible	5%	4,7	4,7	4,6
Family extension	4%	4,8	4,8	4,8
Retirement	3%	4,9	4,9	4,8
Moving to another residence	2%	4,9	4,9	4,8
Deteriorated physical condition	2%	4,9	4,9	4,9

In the analysis, a distinction was made between (former) car owners and (former) carless. Consistent with the findings in the exploratory research, we found some rather obvious differences between these two groups. The former private car, whether it was worn out or needed considerable repairs, played a substantial role in motivating former car owners to participate in a Car Sharing scheme. In contrast, for formerly carless people public transport was no longer a satisfactorily solution for their mobility needs. Apart from these – subtle – differences in motivation among the two groups, the analysis suggested one dominant motivating factor for both: the role of costs. Both groups stated that because of the increasing costs of car driving they had become a participant of a Car Sharing scheme.

So we can conclude that costs – in terms of time and money – seem to play a major role in the adoption of Car Sharing. But, as economic reasons turn out to be the most important motivation for both the carless, and the car owners, this raises questions about the perception of costs. It can be reasonably expected that both populations have different reference points for their perception of costs.

Reasons for non-adoption

Among the non-adopters we investigated which reasons were given for not adopting Car Sharing. Many possible reasons were suggested and the respondents were asked for what reason they didn't want to become a member of a Car Sharing organisation. A maximum of three options could be chosen. Table 7.2 below lists the descriptive results. A distinction between (former) car owners and (former) carless people was made here as well.

Table 7.2 Motives for non-adoption of Car Sharing

	Carless	Car owner
Car Sharing is too expensive	67 %	44 %
Subscription costs are too high	67 %	33 %
The outlet is too far away	27 %	37 %
The reservation time is too long	14 %	26 %
The ownership of a well functioning car	5 %	56 %
The possibility to frequently borrow a car	33 %	13 %
The frequency of use is too high	5 %	41 %
The wish to have the car in front of the house	10 %	24 %
The mileage per year is too high	8 %	31 %
The lack of confidence in the organisation	7 %	8 %
The attachment to the car	3 %	16 %
The car is a hobby	0 %	5 %
The environmental image of Car Sharing	1 %	4 %

Reasons for non-adoption: car owners

The most important motivation for non-adoption is the mere fact that people still own a car. This is quite a remarkable result. It suggests that either the benefits of the privately owned car outweigh Car Sharing, or that just the transition from the old situation to Car Sharing is a barrier in itself. It could mean that the transaction costs, in terms of both time and money, for selling the private car are too high or that a continuation of the existing behaviour and the existing way of fulfilling needs is preferred, which might indicate that habitual behaviour plays an important role in explaining (non-)adoption.

Other important reasons for non-adoption are financial and practical reasons, like the frequency of use and the distance to the outlet. 37% of the respondents report that the distance to the outlet is just too far away. So in the cost/benefit analysis of consumers not only monetary costs, but also costs in terms of time investment seem to play a part.

Reasons for non-adoption: carless people

The reasons for non-adoption among carless people differ from those of car owners. Financial reasons are the dominant factor: first, the overall price perception of the service, and secondly, the price to subscribe to the service scheme. In many cases, people still have access to a far cheaper option, which is borrowing a car. Of course, this involves costs as well, but very often only in social terms. The fact that the price of the service is perceived a high might also be related to the reference to which costs are compared to.

Conclusions and implications:

Based on an analysis of the descriptive statistics on the motives for adoption and non-adoption, some conclusions can be drawn:

- First, it has become clear that remarkable and relevant differences exist among respondents, with respect to their motives to adopt or not adopt Car Sharing, in particular between the two main (potential) customer groups, the (former) car owners and the (formerly) carless people. For marketing purposes, it is important to integrate these differences into marketing strategies.
- Car owners are likely to continue their present practices, which on itself might be an important reason for non-adoption. The fact that in the case of car ownership, also the ownership itself stands in the way of adoption, could have important implications for marketing strategy: only when people are in serious trouble with regard to the availability of their personal car, a strategic reconsideration of their present consumption and mobility practices is probable.
- From the present research results, few signals for non-adoption due to lack of confidence in the service system or a negative image can be reported. This might however be slightly biased by the higher motivation of the respondents.
- Economic optimisation and the convenience of car mobility seem to be the most important reasons for the motivation to adopt Car Sharing. Here, convenience includes aspects like flexibility, responsibility and easy access to a car.

7.2 Exploration on determinants of (non-)adoption

In this section, which investigates the determinants of adoption, we will test hypothesis 2 and hypothesis 3, which have been formulated as follows:

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

To explore the adoption decision, a comparison between the two major subsamples, the adopters and the non-adopters, is most obvious. Both groups can be expected to differ on the relevant variables in the decision making process regarding the participation of Car Sharing. Instead of only testing whether adopters and non-adopters differ, which would satisfy for testing the hypothesis, we also investigated the association between the various independent variables and the adoption decision. For marketing purposes, also the strength of the correlation between each specific variable and the adoption decision is of particular interest. It not only reveals the distinction between two variables, but to a certain extent also the importance of their contribution to the explanation of the adoption.

Table 7.3 Bivariate correlations between characteristics of the decision maker with the adoption decision

	All respondents N=1143	Carless N=685	Car owners N=458
Social-demographic characteristics			
Age			
Sex			
Household size			
Children		.15**	
Education	-.12*	-.16*	
Net income			
Work	.11		
Personal characteristics			
Perception car costs	.43**	.15	.29**
Cost involvement	.39**		.22**
Decisional involvement			
Value: environmental awareness			
Value: personal responsibility in environmental issues			.13**
Value: cars are self expression			
Value: cars are symbols of freedom			-.19**
Value: just-in-time is important			
Value: conscious car use important			.12**
Value: anti cycle attitude			
Value: non self-driving appreciation			
Value: technological perfection important	-.13**	-.15**	
Previous practice			
Car ownership before	-.14**		
Age former car			.19**
Total car mileage		.20**	
Mileage by rentals			.16**
Mileage by borrowed car			
Frequency of car use	-.12**	.11*	-.13**
Frequency of train use			
Frequency of cycle use			-.10*
Frequency of public transport use			
Frequency of car rental	.12**	.11	.10*
Commuting by car	-.12**		-.18**
Season ticket for public transport			
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**	
Habit: car used mostly by more people			
Habit: car needed, known long before			
Habit: travel mode decision only instantly			

Significance: **<.01, *<.05, non significant correlations not listed, correlations $|r| < 0.1$ not listed

	All respondents N=1143	Carless N=685	Car owners N=458
Physical environment			
Distance to work			
Distance to shopping centre			
Distance to city centre			-.17**
Distance to train station			-.11**
Distance to car outlet	-.10**	-.10**	
Significance: **<.01, *<.05, non significant correlations not listed, correlations r <0,1 not listed			

To calculate the coherence between the two variables, various measures were calculated, depending on the level of measurement: for the metric independent variables Pearson's r was calculated; for the ordinal and the nominal independent variables the contingency coefficient was calculated (Arisz, 1996).

Explaining the adoption from the characteristics of the decision maker (Hypothesis 2)

Hypothesis 2 was tested by means of bivariate correlations between characteristics of the decision maker and the adoption decision. Three separate analyses were made: among all respondents, and among the (former) car owners and carless people respectively. The results are presented in table 7.3.

With respect to the *social-demographic characteristics*, we may conclude that these variables hardly have any bearing on the adoption decision. Low and often not very significant correlation coefficients were found on the level of education, participation in the workforce and the amount of children in the household.

Regarding the *personal characteristics*, some remarkable correlations with the adoption decision were found: the perception of car costs correlates relatively strong ($r=.43$), as well as the cost involvement ($r=.39$). However, among the two separate subpopulations, car owners and carless people, the results are more confusing. Only among the car owners the contribution of both concepts was confirmed. Regarding the value orientation and the environmental attitudes, only among the car owners some explaining difference could be found, but the correlation coefficients are not very high.

Testing hypothesis 2 on the *previous practice* revealed some interesting aspects, that could be relevant in explaining the adoption. First, from the analysis it is clear that previous experience with car rental can explain the adoption to a certain extent. The frequency of car rental and the familiarity with car rental correlate with the adoption decision. This suggests that at least part of the adopters have been recruited from the traditional rental market, in which case Car Sharing cannibalises on the turnover of that market.

Secondly, the more people commute by car, the less the acceptance exists for a Car Sharing alternative. An obvious explanation for this is that for daily, or very frequent use, Car Sharing doesn't have financial advantages nor practical advantages.

Another impression we got from the bivariate analysis, is that habits might play an important role in the explanation, since non-adopters make far less a deliberate choice among various travel modes. They far more often agree with statements that they never consider train use, that they never consider using public transport or the bicycle instead of the car. This suggests that non-adopters make far less deliberate choices for alternative travel modes.

Their habitual behaviour is also suggested by their frequency of car use.

With respect to the *physical environment* few significant correlations with the adoption decision were found. This data set did not show a substantial correlation ($r=.10$) between the distance to the car outlet and the adoption, despite its importance in the motivation for (non-)adoption. Car owners who have better access to alternative travel modes, seem to adopt Car Sharing more easily. The data reveals a weak correlation with the distance to the train station and to the city centre, but this might be caused by the fact that only in those areas Car Sharing services are offered.

Explaining the adoption from perceived characteristics of the service (Hypothesis 3)

In table 7.4 below, the results of testing hypothesis 3. are listed. On each of the variables, the hypothesis is accepted. On the costs perception of the service, the valuation of the distance to the outlet, the overall quality perception, the general attitude towards Car Sharing and on the cost comparison with traditional rental, modest and significant correlations were found.

Table 7.4 Bivariate correlations between perceived characteristics of the service scheme with the adoption decision

	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, non significant correlations not listed, correlations $|r| < 0.1$ not listed

Conclusions

Hypothesis 2, which states that adopters differ from non-adopters on their individual characteristics, can only be partially accepted. Only on a number of these characteristics, a significant difference between adopters and non-adopters was confirmed by our data.

In contrast to Rogers' characterisation of innovators, we did not find a highly significant distinction between adopters and non-adopters of an innovation with respect to the social demographic characteristics. Rogers suggests that innovators have more money to spend and are higher educated. Probably because of the research design, too little variation with regard to (latent) interest was created. The group of non-adopters was chosen because they had already shown interest in the Car Sharing system by asking for more information. The group of non-adopters is therefore far from representative of the whole population of non-adopters, but actually tends to be more in favour of a Car Sharing system. For the carless, two discriminating characteristics were found: the amount of children ($r=-.15$) and the level of education ($r=.16$).

The perception of car costs and the cost involvement in the travel decision seem to play an important role in the decision making process, especially for car owners. From other studies we know that the way in which fixed and variable costs are treated in decision making processes is far from economic. A full economic cost-benefit analysis is hampered by ignorance or underestimation of fixed costs, the complexity of the calculation, and attributing the costs to other factors. The concept of Car Sharing basically requires and facilitates full-cost accounting, but it is exactly this property that prevents people from forming a positive attitude towards Car Sharing. Little is known about the psychological mechanisms that influence the cost-benefit analysis that is made by the individual, but it is essential in persuading consumers.

With respect to value orientation, adopters differ from non-adopters only on some domain specific values. Among the car owners, in particular the value orientation discriminates adopters from non-adopters. Car Owners who see a car as a symbol of freedom are less likely to adopt Car Sharing ($r=-.19$), in contrast to those who find conscious car use important ($r=.12$). Given the environmental responsibility and the willingness to act consistently as (general) value dimensions, it can be concluded that among car owners only the personal responsibility in environmental issues has some discriminating value ($r=.13$).

With regard to the perception of the service offer can be concluded that all measured variables explain the adoption. On the basis of the research results, little differentiation between car owners and carless people could be made. All respondents showed modest association values between 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 compared. It can be question however, how these perceptions come about and which factors contribute to the variation in the perceived characteristics.

The role of previous practice seems to be important in the explanation of adoption: especially among (former) car owners, the previous practice discriminates between adoption and non-adoption. It can however be questioned what the explaining mechanism behind the previous practice is. On the one hand, it might be an important indicator explaining the individual's benefit of Car Sharing. In this line of thought, a high frequency of car use relates to disadvantages of Car Sharing because of growing inconvenience and less financial benefits. Here, characteristics of previous practice represent important considerations in a deliberate decision making process, in which people aim at the maximisation of personal utility.

On the other hand, previous behaviour might also represent a mechanism that is frequently called habitual behaviour, in which no elaborate and conscious choices are made. The mechanism of habitual behaviour can be best characterised by the direct association between previous behaviour and current choices, in which a decision making process in which the pros and cons of different behavioural options are evaluated is absent. In fact, the nature of the decision making process can be questioned. In the next paragraph we will therefore first open the black box of the decision making process and investigate the role of previous practice and habits. Only after this analysis we will investigate the adoption in a multivariate analysis.

Hypothesis 3, which states that adopters differ from non-adopters on their perception of the perceived characteristics of the service, can be fully accepted. Moderate correlation coefficients were computed for all perceived characteristics.

7.3 Habits, attitudes, intention and adoption

As we concluded from the exploratory analysis on the adoption of Car Sharing, the role of habits needs further analysis. In chapter 5, we argued that habits might be an important concept in the context of Car Sharing for two reasons. First, habit might play a role in the explanation of (non-) adoption of Car Sharing, and, secondly, habits might provide an explanation for changes in mobility behaviour. Here, we will investigate the role of habits in the adoption process of Car Sharing.

After our exploratory analysis on the adoption, the "black box" of the decision making process will now be opened, as habits influence the nature of the decision making process. Before, we assumed that the innovation decision making process was merely based on rational decision making and deliberate choices. As was argued in chapter 6, habits – by definition – change the cognitive process of "decision" making.

The main reason to assume that habits play an important role in the decision making process on the adoption of Car Sharing, is the highly repetitive nature of travel mode choices. We argued that in the case of repetitive behaviour, choices are likely to become habitual. This means that choices are the result of past behaviour, and not of a deliberate decision making process. Travel mode choices seem to be made on simple heuristic principles or behavioural scripts.

In chapter 5, we hypothesised that habitual behaviour will form an explanation of non-adoption, and possibly a stronger explanation than (negative) attitudes and intentions. The mere fact that many individuals do not make deliberate choices on travel modes, implies that these people also do not seriously consider changing over to a Car Sharing system as an alternative to the private car. Hence, the attitude towards Car Sharing will not be very predictive for the (non-)adoption.

Operationalisation of habit

In transportation research and other types of psychological research, habit has been operationalised in different ways (Aarts, 1996; Eagly & Chaiken, 1993). Many researchers measured habit simply by asking respondents to report on the frequency of past behaviour. It can be questioned whether this is an appropriate measure: repeated occurrence is necessary for the formation of habit, but it is not the same. There has been much discussion whether travel mode choices are based on deliberate choices or whether these decisions are made rather automatically. In his discussion of the operationalisation of habits, Mittal (1988) concludes that "awareness is the discriminating factor". If recurring behaviour – even very frequently recurring behaviour – is accompanied by awareness and much deliberation, it must be considered as driven by attitudes and intentions, and not by habit. Here, the extent to which people form an opinion about behavioural options and arrive at subsequent choices is most relevant.

The way in which habits were operationalised in this study on the adoption of Car Sharing must be seen in the light of what this system wants to achieve with its participants: it wants them to make more differentiated travel mode choices, and to be less dependent of the car. The extent to which individuals are used to trading off alternative travel modes for the car is therefore of particular interest here. The bicycle, for short trips, and public transport (if available), for other trips, can be an appropriate alternatives for the car. Therefore, key in our measurement of habit is the extent to which people deliberately choose between the car and other travel modes, like public transport or the bicycle.

Analytical model

From the preceding discussions one central assumption regarding the explanation of the adoption of Car Sharing may hold: the adoption itself is likely to be affected by habits. In the adoption of Car Sharing, habitual decision making has a filter function: people who have formed a strong habit, won't adopt Car Sharing at all, because they don't make deliberate travel mode choices. Hence, it can reasonably be expected that effects on mobility behaviour can only be seen among people who do not have formed a strong car habit.

Figure 7.1 The interaction between attitude/ intention and habit strength

Based on the theoretical framework above, we hypothesised that habit strength in travel mode choices will negatively and significantly relate to the adoption (Hypothesis 2b.III); that the attitude and intention towards Car Sharing will be positively and significantly related to the adoption (Hypothesis 2b.IV); and that a significant moderating effect of habit on the predictive value of the intention on the adoption can be expected (Hypothesis 2b.V).

These hypotheses will be tested for the (former) car owners only, for several reasons:

- We particularly aim to investigate the possibilities for substitution of the private car with Car Sharing.
- From a transport policy perspective, (former) car owners are the most difficult to influence in their car use, and therefore the most interesting for research purposes.
- Tentative foreign research suggests that for this group the changes in mobility behaviour after adoption of Car Sharing are likely to be highest.

- For this group the change in direct car access is greatest, since this group suddenly lacks private car access. The expected effects on travel mode choices will therefore be greater.

Intercorrelations

The descriptive statistics presented in table 7.5 show that, for our data (1) non-adoption was overrepresented, (2) the intentions were moderate ($M=2,7$ on 1-5 scale), (3) the attitudes towards Car Sharing were moderate as well and varied widely ($M=2,4$ with $SD=1,3$ on a 5-point scale), (4) the habit was relatively weak, and (5) that, in comparison with the Dutch population, the respondents showed a moderate car use, but the variance among the sample was considerable.

With respect to almost all correlations, we must conclude that the values are rather low. Obviously, as one would expect, the highest correlations exist between adoption and intention ($r=.44$), between adoption and attitude ($r=.33$) and between attitude and intention ($r=.54$). These three central concepts in reasoned action theory suggest that deliberate decision making is important in the explanation of the adoption of Car Sharing.

Table 7.5 Descriptive statistics of measured variables among (former) car owners

Descriptives & Intercorrelations ^a							
	n	M	SD	1	2	3	4
1 Adoption (1 = adoption, 2 = non-adoption)	458	1,7	0,4				
2 Intention (1 = positive, 5 = negative)	452	2,7	1,3	.44**			
3 Attitude (1 = positive, 5 = negative)	447	2,4	1,3	.33**	.54**		
4 Habit (2 = strong, 10 = weak)	440	7,3	2,4	-.24**	-.13**	-.17**	
5 Past behaviour (frequency of car use/ week)	458	6,6	7,8	.13**	.22**	.28**	-.15**

^aDecimal points are omitted; * $p<.05$. ** $p<.01$

The operationalisation of habit is a very difficult issue in the explanation of the adoption of Car Sharing. Habit, as operationalised by some researchers in terms of past behaviour, correlates only very weakly with the adoption. It is however quite confusing how this should be interpreted. Low levels of car use contribute to positive attitudes ($r=.28$), intentions ($r=.22$) and finally adoption ($r=.13$). In a cost/benefit analysis, the frequency of use is an important indicator, for practical reasons as well as for the economic evaluation and thus for deliberate decision making. On the other hand, it could also be seen as a measure for habitual behaviour. If the intercorrelations between past behaviour and habit ($r=-.15$) are analysed, we may conclude that past behaviour, at least to some extent, expresses some relevant aspects of habits.

We also calculated the correlation between our habit measure (in terms of the two item scale on making a trade-off between various travel modes) and a generally accepted measure for habit in transport research. This last measure – the 8 –item scale on decisional involvement (Aarts, 1996), which has a high internal consistency (Crombachs' $\alpha=.83$) and expresses the extent to which people make a deliberate travel mode choice for every single trip – correlates substantially ($r=-.42$; $p<.01$) with our habit measure. This means that both measure similar concepts, although decisional involvement seems to be less relevant for our study on the adoption of Car Sharing ($r=.02$, n.s.).

Mediating effect of habit on intention-adoption relation

Table 7.5 shows the correlations between adoption and attitude, intention and habit respectively. Based on these findings, hypothesis H 2b.III can be accepted, since the correlation between adoption and habits – although rather low – is negative ($r=-.24$) and significant ($p=.000$). In practice, this means that the more habitual individuals behave – without considering alternatives for the car in their travel mode decision making – the less likely they will be to adopt Car Sharing as an alternative to the private car.

Hypothesis H 2b.IV is accepted as well, because positive attitudes towards Car Sharing (with an r of .33 and $p=.000$) and the behavioural intentions (with an r of .43 and $p=.000$) both correlate significantly with the adoption. This means that, despite the rather low values, rational decision making regarding the adoption of Car Sharing is likely.

To test the interaction effect (Hypothesis 2b.V), a discriminant analysis was conducted with the adoption as grouping or the dependent variable (table 7.6). The discriminant analysis was chosen because of the dichotomous nature of the dependent variable. Three independent variables were entered stepwise (F to enter=3,84; F to remove=2,71), maximising the minimum Mahalanobis distance (D squared) between the two groups: the intention (I), the habit measure (H), and the interaction variable (I x H). The table below shows the results of the analysis.

Table 7.6 Results of discriminant analysis on the adoption of Car Sharing

Summary table:

	Predictor	Wilks' Lambda	Sign	Minimum D squared	Sign.
Step 1	Intention (I)	.8098	.0000	1,38	.0000
Step 2	Habit (H)	.7797	.0000	1,66	.0000
Step 3	Interaction (I x H)	.7668	.0000	1,79	.0000

Canonical discriminant functions:

Fcn	Eigen-value	% of Var.	Cum.%	Canonical Corr.	After Fcn	Wilks' Lambda	Chi-square	df	Sign.
					0	.766	114,8	3	.0000
1	.3041	100	100	.4829					

Standardised canonical discriminant function coefficients:

Independent variables	Discriminant Function coefficients: Function 1
Intention (I)	.8793
Habit (H)	.3971
Interaction (I x H)	.2666

The discriminant function 1 is highly significant and consists of 3 independent variables. All three significantly contribute to discriminating the adopters from the non-adopters. Not only the behavioural intention and the habit, as could be expected, but also the interaction term (HxI) are entered into the function. The standardised canonical loadings are listed below. The reasonable loading of the interaction term is of particular interest here. The conclusion from the discriminant analysis is that hypothesis H 2b.V can also be accepted. The discriminant function 1. explains $(.4829)^2 = 23\%$ of the variance.

The nature of the interaction is revealed when a sample split is made as close as possible at the median of the distribution of the habit measure. Based on a split between the values 7 and 8 a split was made and then the correlations between intention and adoption, and attitude and adoption respectively were calculated for the two subgroups (see table 7.3).

Table 7.7 Correlations of attitude/ intention with the adoption

	Attitude	Intention	N
Non split	.33**	.44**	440
Weak habit	.32**	.46**	234
Strong habit	.28**	.38**	206

As can be seen in table 7.7, for both habit groups the correlations are still highly significant ($p < .01$). However, the difference is not very significant in a Fishers z-test, $z = .85$. As expected, the intention-behaviour correlation is stronger among the weak habit group. In the weak habit group, the deliberate choice is (a little) stronger than among those who have a stronger habit. The last group is less guided by deliberate choices, but by more by habits. Thus, when habits are strong, 14% of the variance is explained by the intention, and when habits are weak, only 21%.

Conclusions

In the analysis in 7.3, we investigated the role of habit in the adoption of Car Sharing. We showed that habit influences the adoption negatively. With increasing habit strength in travel mode choices, operationalised in this study as the extent to which people trade-off between the car and alternative travel modes, adoption becomes less likely. As a consequence, we may expect that the adoption decision selects the people that will finally use Car Sharing as an alternative to the private car. As a result, the participants will be less habitual in their travel mode choices. Furthermore, it can be expected that this pre-selection of the participating population also affects the influences on behavioural changes.

In the adoption of Car Sharing, the attitude and the intention clearly play a dominant role. The importance of these two central concepts of "reasoned action" proves that a deliberate choice, based on the pros and cons of Car Sharing as an alternative to the private car, underlies the adoption decision. In this analysis it is not investigated how these attitudes and intentions regarding Car Sharing are formed. This analysis will be made in section 7.4.

For a better understanding of the adoption of Car Sharing, the mediating effect of habit on the attitude-intention-adoption process (the reasoned action), is also important. In this study we showed a rather modest interaction effect of habit on the (reasoned) decision making process in the prediction of the adoption, i. e. the relation between attitudes/intentions and the adoption: in the case of a strong habit, the relationship between people's opinions and their intentions regarding Car Sharing plays a less important role in the explanation of adoption, than in the case of a weak habit. This means that non-adoption could be explained differently than the adoption of Car Sharing. In the case of adoption, it is very likely that people become a participant of such a scheme, because they acknowledge the benefits of the system for their situation. In the case of non-adoption, instead of a negative opinion towards

Car Sharing, habitual behaviour seems to play an important role. The mere fact that people do not trade-off between Car Sharing and the private car, or between the private car and other travel modes, keeps them from forming an opinion about Car Sharing and thus from making a deliberate – negative or positive – decision. To convince these people, it is important to break through their habits and stimulate them to make a deliberate decision on whether or not to adopt. Further research is needed on how to break through the habitual behaviour of the non-adopters.

7.4 Explaining attitude and intention towards Car Sharing

Reasoned action in the adoption process

Despite the role of habits in the decision making process (which to a certain extent prevent reasoned action and a cost-benefit analysis regarding Car Sharing) the dominant role of reasoned action in the adoption process cannot be denied. On the contrary, from both the exploratory analysis of the data in 7.2 and the descriptive analysis (Meijkamp & Theunissen, 1997) can be concluded that people only participate in Car Sharing because they see relative advantages in the innovation.

According to the theory of reasoned action, the formation of a positive attitude and intention towards Car Sharing is essential for understanding the adoption. It is therefore important to investigate which factors contribute to the formation of an (positive or negative) attitude towards Car Sharing. For marketing purposes, as well as for transportation policy purposes, it would be indispensable to study the evaluation process of consumers regarding the pros and cons of Car Sharing. As Car Sharing seems to have a high potential for reducing the amount of cars (in crowded cities) further stimulation of the concept would be beneficial from the perspective of society as a whole.

Explaining the attitude towards Car Sharing

For exploratory reasons, we first made a bivariate analysis between various possible determinants of the attitude towards Car Sharing and the attitude measure itself. On theoretical grounds, we assumed that the attitude towards Car Sharing would depend on either the personal characteristics or the perceived characteristics of the innovation.

Table 7.8.a Correlation coefficients with the attitude among non-adopters

		All respondents N=788	Carless N=435	Car owners N=353
Social-demographic characteristics				
Age		-13**	-16**	-26**
Sex:	Male	-	-	-
	Female	-	-	-
Household size		-	-	-
Children		-	-	-
Education:	Lower education	-	-	-
	Higher education	-	-	-
Income	Lower net income	-	-	-
	Higher net income	-	-	-
Working:	Part-time/ no work	-	-	-
	Full-time work	-	-	-
Personal characteristics				
Perception car costs		-	-	-
Cost involvement		-	-	-
Decisional involvement		14**	-	14*
Value: environmental consciousness		-15**	-	-16**
Value: willingness to act		23**	20**	18**
Value: cars are selfexpression		-08**	-	-14*
Value: cars are symbols of freedom		-14**	-	-10*
Value: just-in-time is important		-18**	-13**	-15**
Value: conscious car use important		25**	-27**	14*
Value: anti cycle attitude		-	-	-
Value: non self-driving appreciation		-	-	10*
Value: technological perfection important		-	-	-
Previous practice				
Age former car		12**	-	12**
Total car mileage		22**	16**	-
Mileage by rentals		-	-	-
Mileage by borrowed car		-	13**	-
Frequency of car use		27**	-	24**
Frequency of train use		-17**	11*	-15**
Frequency of cycle use		-11**	-	-
Frequency of public transport use		-	-	-
Commuting by car		24**	-	19**
Subscription to public transport		12**	-	17*
Physical environment				
Distance to work		-	-	13**
Distance to shopping centre		-	-	-
Distance to city centre		-	-	-
Distance to train station		-	-	-
Distance to car outlet		-	-	-

Significance: **<.01, *<.05, non significant correlations not listed, correlations $|r| < 0,1$ not listed

Table 7.8.b

	All respondents N=788	Carless N=435	Car owners N=353
Perception service scheme			
Cost perception service	21**	35**	10*
Valuation distance to the outlet	14**	—	18**
Quality perception service	-22**	-23**	-20**
Cost comparison			
• with car, less than 3 years old	—	—	—
• with car, more than 3 years old	15**	15**	—
• with a new car	—	—	—
• with the train and public transport	14**	—	—
• with normal rental	—	—	—
Savings estimation	25**	23**	20**

Significance: **<.01, *<.05, non significant correlations not listed, correlations $|r| < 0.1$ not listed

The analysis of the determinants of the attitude was limited to the non-adopters. Although the Car Sharing attitude was measured among adopters as well, we decided to exclude the adopters in the analysis. Basically, we are interested in how a positive or negative opinion towards Car Sharing is formed. This is essential for the development of an appropriate marketing strategy meant to persuade potential clients to become a member of a Car Sharing organisation. Including the adopters would muddle the analysis, because among the adopters the attitude towards Car Sharing may to a large extent be founded on experiences, instead of on perceptions and expectations alone. Adopters, by definition, have had the opportunity to evaluate the usefulness of the service, on the basis of their own real-life experiences. In our analysis, we want to make an explicit distinction between the pre-adoption decision making and the post adoption evaluation process, which will be discussed in chapter 9.

The bivariate correlations between the attitude and the various possible determinants of the attitude were calculated for three populations: for all respondents, for the car owners, and for the carless people. In the exploratory research we concluded that there would be substantial differences between the two groups of potential clients with respect to their motivation. The frame of reference in the decision making, as well as the need for mobility can be assumed to differ substantially between the two groups. Table 7.4 lists the results of the bivariate, exploratory analysis. Positive correlation coefficients point to a negative influence on the attitude towards Car Sharing.

Apart from the age of the respondents, none of the *social-demographic characteristics* correlate with the attitude, but especially among the car owners the age variable shows a relatively strong correlation. Surprisingly, older car owners tend to have a more positive attitude towards Car Sharing.

With regard to the *personal characteristics*, particularly the value orientation seems to influence the attitude, which is not surprising in the light of the means end theory. This stresses the fact that people evaluate market offers on their value orientation. Both the environmen-

tal consciousness and the willingness to act seem to have an influence on how people evaluate Car Sharing, particularly among the car owners.

Of all specified and characterised *previous practices*, many correlate significantly with the attitude measure. Especially among the car owners, the current practices with regard to mobility, like the frequency of car use and the frequency of train use, explain the attitude: the more people travel by train the more positive their attitude towards Car Sharing is. Commuting by car negatively influences the attitude. Apart from these variables, also the age of the car correlates with the attitude: the older the car the more positive the attitude people have towards Car Sharing.

Few variables that characterise the *physical environment* seem to influence the opinion on Car Sharing, except for the distance to work among the car owners: the further away they live from their work, the more negative their attitude is.

With regard to the *perception service offer*, many of the concepts seem to contribute to a positive attitude: the cost perception, the valuation of the distance to the outlet, the perceived quality and the estimations on the savings in mobility costs.

All variables mentioned here, explain to a certain extent how the attitude is formed. However, the question remains to what extent all these separate variables do also constitute independent dimensions for the explanation of the attitude. Below, we will therefore analyse the data in a multivariate manner and address the multi-colinearity problems.

Regressing relevant variables on attitude

To explain the attitude from a set of variables, a mere bivariate analysis is not sufficient. Although the various correlation coefficients express the relevance of the specific variables for the explanation of the dependent variable, it provides little insight in the intercorrelations among the various independent variables and thus in the multi-colinearity among the predictor variables. Generally, a simple model with a few highly relevant variables is preferred over a model with many less important variables, which are not independent from each other.

A multiple regression analysis is often applied to analytical problems in which a concept (here the attitude) is explained by different variables. The method helps to select the variables that explain most of the variation of the dependent variables. The approach we used in choosing the variables for inclusion in the regression equation, is the stepwise estimation. This approach allowed us to examine the contribution of each predictor variable to the regression model, by adding an additional predictor that explains both a significant portion and the largest portion of the error remaining from the first regression equation, or by eliminating predictor variables with partial F tests that indicate that they do not make a statistically significant contribution. Probability values of F ($F_{in}=.20$ and $F_{out}=.25$) were used in the selection of variables. Finally, a test on the significance of the overall regression model was conducted, to find a regression model that explained as much as possible of the variation in the attitude (R square) with the least possible variables, indicated by the adjusted R square.

We will report on three regression equations for all three populations, (1) all the respondents, (2) the car owners, and (3) the carless people. Only the variables with statistically significant bivariate correlations were tested for inclusion in the regression equation. Furthermore, we have pairwise excluded cases with missing data.

All respondents	Multiple R	.51017		
	R Square (adj. R square)	.26027	(.23287)	
	Standard Error	1.08769		
	<u>Analysis of Variance</u>	DF	Sum of Squares	Mean Square
	Regression	10	112.38977	11.23898
	Residual	270	319.42913	1.18307
	F=9.500	Significance F=	.0000	

All respondents	Step in	B	Beta	Standard error	T-value	Sign. T
Frequency of car use	1	.031	.168	.010	3.034	.003
Estimations on savings	2	.155	.179	.048	3.224	.001
Quality perception	3	-.228	-.136	.091	-2.513	.013
Value: Car Sharing consistent	4	.230	.186	.067	3.449	.000
Price perception	5	.186	.149	.067	2.765	.006
Value: flexibility in travelling	6	-.134	-.105	.068	-1.970	.049
Evaluation distance to outlet	7	.093	.106	.047	1.954	.052
Age	8	-.011	-.096	.006	-1.798	.073
Building year of the car	9	.024	.091	.014	1.672	.096
Value: car is means for identity	10	-.096	-.078	.066	-1.461	.145
(constant)		.030		1.368	.002	.982

With 10 predictor variables 26% of the total variance can be explained among all respondents. Most of the variables make a highly significant contribution in the total explaining value. The most important factors are the frequency of car use, the estimations of the savings on mobility costs with Car Sharing, the quality perception of the service scheme, the value dimension "Car Sharing consistency" and the price perception of the scheme. The last factor is a highly subjective factor, based on many different perceptions with respect to cost price. Of minor importance are the two value factors "cars are means for social identity" and "the importance of flexibility in travelling", the age of the private car and the age of the individual as well as the evaluation of the distance to the outlet.

Carless people	Multiple R	.54043		
	R Square (adj. R square)	.29207	(.25667)	
	Standard Error	.93988		
	<u>Analysis of Variance</u>	DF	Sum of Squares	Mean Square
	Regression	6	43.73438	7.28906
	Residual	120	106.00534	.88338
	F=8.25135	Significance F=	.0000	

Carless people	step in	B	Beta	Standard error	T-value	Sign. T
Priceperception	1	.342	.315	.084	4.061	.000
Value: Car Sharing consistent	2	.268	.224	.093	2.864	.005
Quality perception	3	-.298	-.205	.113	-2.644	.009
Estimations on savings	4	.151	.191	.062	2.459	.015
Age	5	-.016	-.136	.009	-1.742	.084
Amount of trips per week	6	-.009	-.117	.006	-1.495	.138
(Constant)		2.364		.663	3.570	.000

A higher percentage of explaining power was achieved in the analysis of the carless people, more than 29%. At the moment, the carless are by far the largest group of adopters. Persuading carless people seems less difficult than convincing car owners. Six key variables were found, that explain the attitude among the carless people. The price perception of the service offer (which is the extent to which the service is evaluated as expensive or not) is the most important predictor in the regression equation. Besides, also the value dimension "Car Sharing consistency", the quality perception, the estimations on the potential savings with the scheme and the age of the respondents are important predictors. The total amount of trips also contributes, though less significantly, to the total explanation of the variance.

Car owners	Multiple R	.49128		
	R Square (adj. R square)	.24135	(.17466)	
	Standard Error	1.20865		
<hr/>				
	<u>Analysis of Variance</u>	DF	Sum of Squares	Mean Square
	Regression	8	42.29103	5.28638
	Residual	91	132.93489	1.46082
	<hr/>			
	F=3.61877	Significance F=.0011		

Car owners	step in	B	Beta	Standard	T-value	Sign. T error
Age	1	-.026	-.223	.011	-2.343	.021
Frequency of car use	2	.037	.228	.017	2.141	.035
Total amount of trips per week	3	-.017	-.183	.010	-1.740	.085
Quality perception	4	-.226	-.125	.169	-1.335	.185
Willingness to act	5	.182	.138	.122	1.487	.141
Estimations on savings	6	.117	.122	.091	1.297	.198
Evaluation distance to outlet	7	.124	.137	.086	1.450	.151
Environmental consciousness	8	-.156	-.125	.117	-1.341	.183
(Constant)		3.932		.899	4.375	.000

Finally, the attitude towards Car Sharing of the non-adopters, which is conceptually the most interesting group, can be explained for 24%. This group will potentially substitute their private car for a shared car. This group represents the larger group among all driving license

holders, but is also the most difficult to persuade. Eight factors could be distinguished that explain the attitude among the car owners, which are the age of the respondents, the frequency of car use, the total amount of trips per week, the quality perception, the value dimension "willingness to act", the estimated savings with the service, the evaluation of the distance to the outlet of the car and – considered less significant- the environmental consciousness.

The contribution of the service system to the adoption of Car Sharing (H 4)

Hypothesis 4. states that differences in the service system contribute to the adoption of Car Sharing. In the context of our research design this is difficult to test, since most respondents only know one single Car Sharing system. At the time of research, there was not much competition between the various service systems, because each of these services were provided in a rather small areas, which did not overlap so individual consumers couldn't make a comparison between different Car Sharing service systems. Therefore, the relative preference for a specific kind of service could not be established.

As a preliminary way of testing hypothesis 4 we investigated to what extent the Car Sharing attitude was influenced by the service system involved. In the multiple regression analysis we entered four dummy variables, each representing a service system. However, based on this analysis we did not find any significant contribution of a specific service system, so we must reject hypothesis 4. However, this rejection must be seen in the light of our method of testing.

7.5 Discussion on the adoption of Car Sharing

To achieve environmental improvements in consumption behaviour, not only the conceptualisation and development of eco-efficient services is needed, but also a successful market introduction of these services. If such innovative services with good qualities in fulfilling consumer needs at a higher level of eco-efficiency are not adopted by society, no environmental improvement in consumption is realised. The obvious conclusion is that creating large scale adoption of eco-efficient services is an essential element in improving the environmental performance of the consumption system. For this reason, the adoption of Car Sharing received focal attention in this study. Our starting point in this study is therefore that ecological success is not only determined by a positive comparison between the private car and Car Sharing services with regard to environmental efficiency, but also by the final market penetration. This large scale market penetration is preceded by the individual adoption of Car Sharing services.

In search of relevant determinants of the adoption we have tested hypotheses 2 and 3, that state that adopters differ from non-adopters on individual characteristics and on their perception of the characteristics of the Car Sharing service. Hypothesis 3 was fully accepted: non-adopters perceive Car Sharing services as more expensive, think that the car outlet is too far away, perceive the overall service quality lower and generally have a more negative attitude towards Car Sharing.

Hypothesis 2 was not fully accepted, because only on specific variables significant differ-

ences were found. Apart from the importance of the perception of car costs, whether in terms of only fuel costs or in terms of full costs and the cost involvement in travel mode decision making, few other remarkable and discriminating variables were found.

A possible explanation for the limited number of discriminating variables could be the research design. The non-adopters were recruited from databases containing people that, on their own initiative, had shown interest in a Car Sharing scheme. The main argument for selecting the non-adopters this way was that these people at least were informed about Car Sharing and had been more or less involved in a decision making process. A disadvantage of this research design is that it is highly probable that the non-adopters tend to be in favour of Car Sharing, and therefore not representative for the complete non-adopters population.

The behaviouristic approach used in the analysis of the data, treated the decision making process as a black box. As a result, in the first analysis no cognitive aspects of the decision making process were taken into account. Consistent with most innovation theories, it was assumed that consumers evaluate the attributes of Car Sharing on rational grounds and in a deliberate and conscious process, forming attitudes and intentions which precede behaviour. Rogers expresses this decision making process in terms of knowledge, persuasion, decision, implementation and evaluation.

However, the assumption of a rational and deliberate decision making process was questioned in a later stage: testing hypothesis 2 raised questions of how to interpret the role of previous practices in the explanation of the adoption. We assumed that habitual behaviour could also be involved in the decision making process. The main reason for assuming that habits play an important role in the decision making process on the adoption of Car Sharing, is the highly repetitive nature of travel mode choices. It was argued that in case of repetitive behaviour, choices are likely to become habitual. This means that choices are predicted by past behaviour, and not by a deliberate decision making process. Travel mode choices seem to be made on heuristic principles. (Aarts, 1996)

In this chapter we investigated the role of habits in the adoption by means of a two item scale for habit strength. The key of our measure of habit strength is the extent to which people deliberately choose between the car and other travel modes, such as public transport and the bicycle. In our study, among car owners habit strength correlates negatively with the adoption. Moreover, habit strength mediates the intention-adoption relation, which indicates the deliberate nature of the decision making: in the case of stronger habits, the relationship between intention and adoption becomes weaker. This means that non-adoption has to be explained differently than the adoption of Car Sharing. To a large extent, non-adoption can be explained by the mere fact that people do not want to think about new behavioural options, but prefer to continue with their present behaviour. Hence, the attitude and intention towards Car Sharing will not be very predictive for the non-adoption. The motivation for non-adoption in 7.1, "the ownership of a well-functioning car", supports this view as well.

Despite the role of habits in the adoption, a larger role in the explanation of adoption can still be attributed to deliberate choice, based on attitudes and intentions. The contributing variables in the explanation of the Car Sharing attitude were distinguished in a regression

analysis. For two different groups of non-adopters separate regression models were made. For the *carless people* the following variables, in order of decreasing importance, explain the Car Sharing attitude:

- the price perception
- the value dimension "Car Sharing consistency"
- the quality perception of the service
- the estimations on savings
- the age of the respondents
- the total amount of trips per week

For the *car owners* the following variables, in order of decreasing importance, explain the Car Sharing attitude:

- the age of the respondents
- the frequency of car use
- the total amount of trips per week
- the quality perception of the service
- the willingness to act
- the estimations on savings
- the evaluation of the distance to the outlet
- the environmental consciousness

For a further understanding, and probably also for more explaining power, one has to diversify in market segments, apart from the distinction on car ownership.

8 Service quality perception of Car Sharing services

8.1 Service quality and the intention of contract extension

For long term acceptance of Car Sharing, not only adoption of the service innovation is needed, but also long term customer retention. In chapter 5 we argued that a high perceived service quality is one of the (most) important preconditions for continued participation in the Car Sharing scheme and essential for long term use of that service. An important predictor of continued participation is the (behavioural) intention towards extension of the contract with the Car Sharing organisation. Therefore, we decided to analyse the data set on the relationship between the intention to extend the contract and the service quality perception among the four separate schemes, as well as in a "pooled" analysis. The hypothesis we tested was:

Hypothesis 5 The overall service quality has a positive impact on the intention of contract extension

Descriptives and correlations among the four schemes

Table 8.1 below lists both the descriptive statistics on the service quality and the intention to extend the contract, split up over the four service schemes. We may conclude that a considerable variation in levels of perceived service quality was measured, which indicates different performances of the schemes in providing the required services to their customers. The implicit assumption here is that the perception of service quality is independent from the service scheme and its participants.

Also the values of intention show considerable variation among the four service schemes. Overall, 83% of the participants state that they are very sure, or sure to extend the contract next year. This implies that a share of the customers use the service as a temporary solution for their mobility needs. Further research is needed to find out what the reasons are behind their defection. One of the reasons might be a low perceived service quality.

Testing hypothesis 5, by correlating perceived service quality and the intention, lead to the conclusion that this hypothesis can be accepted. In the pooled analysis a correlation coefficient of .33 ($p = .000$) was computed. Among the four service schemes no uniform results were found. Varying correlation coefficients, from a very high .56 to a low and insignificant ($p .178$) .15 were found. A study by Cronin and Taylor (1992), did not find uniform and confirmative results for the service quality/intention relationship either. The relationship clearly seems to be more complex than is represented by a simple attitude-intention-behaviour model.

Table 8.1 Descriptive statistics and correlations, intention and service quality perception among the four service schemes

	Service A (n=79)	Service B (n=66)	Service C (n=73)	Service D (n=84)	Overall (n=302)
Service quality perception (5=high, 1=low)	4,2	4,1	4,6	4,3	4,3
% Positive (score ≥ 4)	86%	85%	97%	92%	90%
Intention for contract extension (5=very sure, 1=surely not)	4,3	4,4	4,5	4,3	4,4
% Positive (score ≥ 4)	78%	87%	86%	85%	83%
Spearman's correlation coefficient (R)	.56 (p=.000)	.39 (p=.001)	.22 (p=.034)	.15 (p=.178)	.33 (p=.000)

The service quality perception must be seen as an overall evaluative judgement of a service, which seems to be quite similar to an attitude. However, attitudes are formed *before* experimentation with a service. Attitudes are a priori expectations about the value of something (e.g. a service). The service quality perception, in contrast, is based on real-life experiences. The Car Sharing attitude might be treated as an opinion of these services in general, and the perceived service quality as an opinion about the performance of a specific service. Despite the conceptual differences, the Car Sharing attitude ("For me, Car Sharing is a good alternative to the private car.") correlates significantly ($r=.33$, $p=.000$) with the perceived service quality.

8.2 Measuring perceived performance of Car Sharing operations

In chapter 5 we suggested measuring the operational service performance, as perceived by the customers, on two basic aspects of service quality: the functional and the technical service quality. In the literature (e.g. Grönroos, 1990) these two aspects of service quality are discussed extensively, with particular attention to the interpretation of these constructs.

With respect to the technical service quality, hardly any general guidelines for measurement have been developed. Based on extensive exploratory research – literature research and focus group studies – we developed a multiple-item scale for measuring the technical service quality perception within Car Sharing schemes. In this section we will test the reliability of this scale and investigate the dimensionality of measuring the technical service quality perception.

With respect to the functional quality perception far more literature is available, suggesting how this construct should be operationalised. To start with, we adapted the 10-dimensional SERVPERF scale to the context of Car Sharing, again, on the basis of all information regarding the relevant aspects of the perception of customers we gathered in focus group discussions. Here, we tested the reliability of the multiple-item scales used to measure the 10 dimensions of the service quality perception. As was expected, and consistent with the conclusions in a number of other studies, first no clear pattern of dimensions emerged. A further investigation into the dimensionality of the functional service quality perception was conducted by means of a factor analysis, which will also be reported below.

The perception of the technical service quality

The technical quality perception was measured with a five-item scale. All these items stated different quality aspects of the car provided by the Car Sharing system. In a scale reliability analysis – calculating a rather low value of Cronbach's alpha (standardised item $\alpha = .55$) – no clear one-dimensionality was found in this scale, as was expected. The table 8.2 below shows the items involved, and the alpha values if the item would be deleted from the scale. The low value of Cronbach's alpha suggests that the items do not represent one single underlying dimension. We therefore decided to perform a factor analysis, to investigate the various aspects in the technical service quality perception.

Table 8.2 Technical quality perception scale, internal consistency

	Item	Alpha if item deleted
1	The possibility to use different cars, is a big advantage	.57
2	The car is always cleaned very well	.33
3	In the car you don't have great nuisance of cigarette smoke	.50
4	The cars are insured properly	.41
5	The cars are being maintained very well	.39

Quite clearly, item one turned out to be a separate dimension in the two, three and four factor solutions. In a three factor solution, a clear pattern was found that was easy to interpret. Table 8.3 shows the three-factor solution, after (VARIMAX) rotation, with the loadings of all the items on the three factors. These factors will be used in the explanation of the perceived service quality perception, since they explain 81% of the total variance.

Table 8.3 The three factor solution for the technical service quality perception

	Factor 1	Factor 2	Factor 3
Factor 1: reliability car			
The cars are insured properly	.88	–	–
The cars are being maintained very well	.84	–	–
Factor 2: neatness			
In the car you don't have great nuisance of cigarette smoke	–	.87	–
The car is always cleaned very well	–	.81	–
Factor 3: flexibility in car choice			
The possibility to use different cars, is a big advantage	–	–	.99

Note: only factor loadings (after rotation) > .30 are shown

The three-factor solution suggested that three independent dimensions are relevant in the technical service quality perception. Factor 1, 'reliability of the car', represents the performance of the car over time and the absence of risks. Factor 2, 'neatness', represents the cleanliness of the car, and contains the visual appearance as well as the smells of former car users, in particular cigarette smoke. Factor 3, 'flexibility of car choice', reflects the possibility to choose different cars for different trips.

Table 8.4 Cronbach's alpha values for 10 dimensions in the functional service quality

Alpha	Dimensions of the functional service quality perception	Alpha if item deleted
.79	Reliability	
	When I make a reservation, than I can count on X to have a car	.77
	I am sure that if I have a special requests, X handles my request properly	.73
	X is very precise in charging their customers	.76
	X does what it promises	.66
.69	Responsiveness	
	When I call, the people of X know to tell if a car is directly available	.51
	When I arrive at the outlet to catch the car, the people of X expect me ahead y.	.59
	The employees of X are always willing to answer your questions	.61
.75	Competence	
	The employees of X are always able to answer my questions	.75
	The employees of X are always able to inform me about the rental costs	.67
	The employees always stay calm in difficult or stress situations	.59
.70	Access	
	Making a reservation by telephone is convenient	.70
	If I make a phone call to make a reservation, X responds quickly	.68
	If I arrive at the outlet, I do not need to wait long, before I can drive away	.66
	The outlet of the car is at a convenient place	.70
	The opening hours of X are convenient to me	.64
	There is sufficient opportunity to rent a car during the weekend	.63
	There is sufficient opportunity to rent a car for the evening	.64
	There is sufficient opportunity to rent a car for only a part of the da	.66
	It is well possible to park the bicycle near the outlet	.72
	Courtesy	
	The employees are always very polite to their customers	
.89	Communications	
	The contract with X is formulated clear and understandable	
	The conditions for using a car from X are very clear	
.70	Credibility	
	The behaviour of employees of X instils confidence in customers	
	X will never on purpose charge their customers too much	
.61	Security	
	When you sign a contract with X, you need not be afraid of financial risks	
	It is clear enough in advance how much you will have to pay	
.78	Understanding the customer	
	If I call shortly before I want to rent a car, they will do everything to help me	.74
	X has employees who give you personal attention	.68
	Employees of X understand your specific needs	.69
.66	Tangibles	
	The office of X is visually appealing	.55
	The employees of X have a neat-appearance	.55
	The brochures of X look nice	.55
	The membership card is important to show you participate in Car Sharing	.68
	X uses a modern reservation system	.61

Functional quality perception

Based on suggestions from the literature (Parasuraman, Zeithaml and Berry, 1988; Grönroos, 1990; Cronin and Taylor, 1992) and on the results from our focus group discussions, we developed ten – presumably independent – dimensions, operationalised by multiple-item scales. These 10 dimensions represent the construct functional service quality perception. Our first interest was to investigate whether these multiple-item scales would be reliable measuring instruments; especially whether all the scales were of a unidimensional nature. For each dimension of the service quality construct, coefficient alpha was computed separately, to test whether the items that make up one dimension share a common core.

Table 8.4 lists for all dimensions the standardised item alpha and the 'alpha if items were deleted from the scale'. The values vary from a rather low .61 to a satisfactory .89. We conclude that, because the items and the constructed dimensions measured do not completely fit the context of Car Sharing, an investigation into the dimensionality of the functional service quality perception was needed.

Based on the 34 items concerning the functional service quality perception, we performed a factor analysis, and rotated (VARIMAX) the solution in order to arrive at independent factors. The analysis was a priori constrained to 10 factors. Applying the criterion for establishing the amount of factors (only those factors with an eigenvalue higher than one) would result in a nine factor solution, explaining 65% of the variance. However, no clear factor pattern emerged after rotation, due to the fact that many items had high loadings on several factors, which implies that the factors may not be independent from one another.

Finally, a six factor (rotated) solution seemed to offer the clearest factor pattern, which could be interpreted in a way that was highly relevant in the light of the empirical reality and the marketing practice. The total percentage of explained variance is 56%. Table 8.5 lists all factors with their item-loadings.

From the results of the factor analysis, in which the factor loadings of all items are listed, a rather easy to interpret factor structure emerged. In the solution, all items had a loading higher than .30 on one of the six factors, except the item "the outlet of the car is at a convenient place". Clearly, this is not an element of the service performance, but a characteristic of the service on a conceptual level, instead of on an operational level. In this factor solution some substantial differences with the original SERVPERF dimensions were found, resulting in a Car Sharing specific six-dimensional solution, instead of the five-dimensional solution of the SERVQUAL and the SERVPERF measurement scales.

The first factor (eigenvalue=10.8), explaining 32% of the variance, was called EMPATHY. It includes all items of three a priori dimensions (Parasuraman, Zeithaml and Berry, 1988) called "competence" (of the employees), "courtesy", and "understanding the customer". We summarised these items as the factor EMPATHY which can be understood as caring for, and giving individualised attention to, the customers. One of the perceived aspects added to this dimension is decent behaviour towards the client: the willingness to answer questions and keeping promises.

Table 8.5 Matrix with factor loading following a VARIMAX rotation on 34 items concerning the functional service quality perception

	F1	F2	F3	F4	F5	F6
Empathy						
The employees of X are always willing to answer your questions	73	-	-	-	-	-
The employees are always very polite to their customers	71	-	-	-	-	-
X has employees who give you personal attention	67	-	-	-	-	-
Employees of X understand your specific needs	66	-	-	-	-	-
The employees of X are always able to answer my questions	62	-	-	-	-	-
The employees always stay calm in difficult or stress situations	58	-	-	-	-	-
The employees of X are always able to inform about rental costs	57	-	-	-	-	-
If I call shortly before to rent a car, they will do everything to help me	55	-	45	-	-	-
X does what it promises	48	-	45	-	-	41
Assurance						
The conditions for using a car from X are very clear	-	78	-	-	-	-
The contract with X is formulated clear and understandable	-	75	-	-	-	-
When signing a contract of X, you need not be afraid of financial risks	-	65	-	-	-	-
On beforehand, it is clear enough how much you will have to pay	-	64	-	-	-	-
The behaviour of employees of X instills confidence in customers	49	57	-	-	-	-
X will never on purpose charge their customers too much	37	53	-	-	-	35
Responsiveness						
When calling, the people of X know to tell if a car is directly available	-	-	66	-	-	-
If I make a phone call to make a reservation, X responds quickly	-	-	57	-	-	-
Making a reservation by telephone is convenient	-	-	51	-	-	-
The opening hours of X are convenient to me	-	-	48	40	-	-
If I made a reservation, than I can count on X to have a car	-	-	45	-	-	40
If I make a phone call to make a reservation, X responds quickly	-	-	43	38	-	-
If I arrive at the outlet, I do not need to wait long, before I can drive away	-	-	43	-	-	-
A membership card is important to exhibit participation in Car Sharing	-	-	39	-	-	-
X uses a modern reservation system	-	-	35	-	-	-
Availability of cars						
The possibility to rent a car for the evening, is sufficient	-	-	-	90	-	-
The possibility to rent a car for only a part of the day is sufficient	-	-	-	82	-	-
The possibility to rent a car during the weekend, is sufficient	-	-	-	62	-	-
Tangibles						
The office of X is visually appealing	-	-	-	-	72	-
The brochures of X look nice	-	-	-	-	72	-
The employees of X are neat-appearing	35	-	-	-	69	-
Reliability						
X is very precise in charging their customers	-	41	-	-	-	52
I am sure that if I have a special requests, X handles it properly	47	-	-	-	-	51
Near the outlet, it is well possible to park the bicycle	-	-	-	-	-	47
The outlet of the car is at a convenient place	-	-	-	-	-	-

Note: **significant at $p < .01$; *significant at $p < .05$; decimal points are omitted

The second factor (eigenvalue=2,4), explaining another 7% of the variance, contains all items of the former dimensions "communication", "credibility" and "security", summarised into ASSURANCE. This refers to the capacity of the company and its employees to make people feel safe and confident in doing business with them.

Factor three, called RESPONSIVENESS, combines elements of the a priori-dimensions "responsiveness" and "access". It represents the nature and organisation of the interaction with the customer: the responsiveness of the reservation procedure by telephone, the extent to which the office responds to reservations at any time, and the extent to which information about rental possibilities is directly provided. A modern information system is perceived as an instrument that facilitates responsiveness.

Access (in a more objective sense: when cars are available and whether they are available for shorter periods) is seen as a separate dimension of the service quality perception. These items clearly refer to accessibility, but are far less representative of perceptions. The fourth factor is called AVAILABILITY OF CARS, but also indicates the flexibility of the organisation in providing cars at any time.

The fifth factor, TANGIBLES, remains largely unchanged. It concerns the appearance of all physical facilities: the equipment and the personnel.

The last dimension is RELIABILITY, which is the ability to perform the promised service dependably. Charging the customers the right amount of money and handling special requests properly are examples of reliability. Surprisingly, also the possibility to (safely) park your bicycle near the outlet belongs to this factor.

8.3 Explaining service quality perception by operational performance

Having established the measures for the technical and the functional quality perception, we now want to investigate their predictive value for the explanation of the overall service quality perception. First, we will test hypotheses 6a and 6b in a bivariate way, and calculate to what extent the three dimensions of the technical service quality perception correlate with the six dimensions of the functional service quality perception, before conducting a multivariate analysis on the explanation of the overall service quality perception.

Hypothesis 6a	The functional service quality correlates positively with the overall service quality perception
Hypothesis 6b	The technical service quality perception correlates positively with overall service quality perception

Table 8.6 lists all bivariate correlation coefficients between the overall service quality perception and the various dimensions of the technical service quality perception and the functional service quality perception respectively. The correlations between all the dimensions were computed as well. The correlations between the dimensions of the technical service quality perception and the functional service quality perception are not listed, since they are the result of the orthogonal rotation procedures.

As can be concluded from table 8.6, hypothesis 6a can be fully accepted. All dimensions of the functional service quality correlate positively with the overall service quality percep-

tion. As expected, the last dimensions of the factor solution show a less strong, but still significant correlation. So, all aspects in the interaction, as described by the factor scores, contribute to the explanation of the overall service quality perception.

Hypothesis 6b cannot be fully accepted, since the dimension "car in neat condition" is only very weakly correlated with the overall service quality perception. The other dimensions, "flexibility in car choice" and "car in reliable condition", show a far stronger correlation: .23 and .32, respectively. This result is quite surprising, because in the focus groups cigarette smoke seemed to form a substantial problem for many users.

Table 8.6 The explanation of service quality perception by operational performance

	1	2	3	4	5	6	7	8	9	10
1. Service Quality Perception	1									
2. Technical Quality Perception: <i>car in reliable condition</i>	.32**	1								
3. Technical Quality Perception: <i>car in neat condition</i>	.05	–	1							
4. Technical Quality Perception: <i>flexibility in car choice</i>	.23**	–	–	1						
5. Functional Quality Perception: <i>empathy</i>	.40**	.12*	–.10	.02	1					
6. Functional Quality Perception: <i>assurance</i>	.26**	.34**	.11*	.12*	–	1				
7. Functional Quality Perception: <i>responsiveness</i>	.32**	.30**	–.14*	.20*	–	–	1			
8. Functional Quality Perception: <i>availability of cars</i>	.21**	–.01	.24**	–.10	–	–	–	1		
9. Functional Quality Perception: <i>tangibles</i>	.21**	.28**	.03	.18**	–	–	–	–	1	
10. Functional Quality Perception: <i>reliability</i>	.15**	.21**	–.07	.12*	–	–	–	–	–	1

Note: **significant at $p < .01$; *significant at $p < .05$; decimal points are omitted

Especially with respect to the intercorrelations between the dimension of the technical service quality perception "car in reliable condition" and various dimensions of the functional service quality perception, relationships were found. This indicates that the two aspects of service quality perception are not independent factors, but that, from the perspective of consumers, they share a common core. It is therefore essential to perform a multiple regression analysis, based on a stepwise procedure, to investigate whether any additional explaining power can be found:

8.4 Multiple regression analysis on service quality

In this section we will conduct a multiple regression analysis in order to explain the perceived service quality not only with the service performance, but also with other sets of vari-

ables. The hypotheses below suggest that the perceive characteristics of the service, the characteristics of the individual, the mobility behaviour of the individual and the service design have additional explaining value in the overall service quality perception:

Hypothesis 7	The perceived characteristics of the service have a significant additional predictive value for the overall service quality perception, on top of the service performance
Hypothesis 8a	The characteristics of the individual decision maker have a significant additional predictive value for the overall service quality perception, on top of the service performance
Hypothesis 8b	The mobility behaviour of the individual decision maker has a significant additional predictive value for the overall service quality perception, on top of the service performance.
Hypothesis 9	The service design significantly contributes to the explanation of the overall service quality perception, on top of the service performance.

As indicated at the bivariate analysis in section 8.3, it is likely that some of the constructs are multi-collinear. So, to prevent including constructs in the regression equation that exhibit little additional explaining value, we need to use a sequential search approach in our selection of variables. For conceptual reasons, we want to distinguish between the service performance (hypotheses 6a and 6b) and the other potentially predicting constructs (hypotheses 7, 8a, 8b, and 9). We defined two blocks of variables, that were both entered into the regression equation in a stepwise procedure (P in .05 and P out .10). Hypotheses 7, 8a, 8b, and 9. are only tested for their additional explaining value. In table 8.7 the results of the multiple regression analysis are presented.

Although all dimensions of the technical service quality perception were included in block 1 (which contained both the technical and the functional service quality dimensions), none of them contributed to the explanation of the service quality perception in addition to the dimensions of the functional service quality perception. This is remarkable, because in all theories on service quality a clear distinction is made between WHAT is offered and HOW this is provided to people. Above all, the core of the Car Sharing service is the provision of a car. Despite the bivariate correlation with the technical service quality perception, little additional explanatory value can be ascribed to this construct, on top of the functional service quality perception. It seems that a large proportion of the technical service quality is already measured by the functional quality perception, resulting in multicollinearity between the two constructs.

Apart from the service performance, a couple of other variables were tested for their additional explaining value, as formulated in hypotheses 7, 8a, 8b, and 9. These hypotheses can be accepted for only two variables: the price perception of the service and the evaluation of the distance to the outlet. These two variables are both represented by hypothesis 7. The other hypotheses (8a, 8b and 9) must be rejected.

The price perception of the service, in terms of cheap or expensive, and the valuation of the distance to the outlet, contribute to the overall service quality perception. This means that

the more people perceive a Car Sharing scheme as cheap, the more they find it a high quality service. And the more people find the distance to the outlet unacceptable (which is different from the objective distance to the outlet), the lower the quality of the service is valued.

Table 8.7 Multiple regression analysis on the Service Quality Perception

(All adopters)	Multiple R	.620		
	R Square (adj. R square)	.384	(.369)	
	Standard Error	.524		
<u>Analysis of Variance</u>				
	DF	Sum of Squares	Mean Square	
Regression	8	56.2	7.02	
Residual	328	90.1	0.27	
F=25.5		Significance F=.0000		

All adopters	Step in	Multiple R	B	Standard error B	Beta	Sign. T
<i>Block 1 Service performance</i>						
Functional quality: empathy	1	.3618	-.2258	.0289	-.3421	.0000
Functional quality: assurance	2	.4593	-.1738	.0290	-.2633	.0000
Functional quality: responsivity	3	.5256	-.1581	.0288	-.2396	.0000
Functional quality: availability of cars	4	.5633	-.0956	.0288	-.1448	.0010
Functional quality: tangibles	5	.5851	-.1288	.0287	-.1951	.0000
Functional quality: reliability	6	.6027	-.1039	.0290	-.1574	.0004
<i>Block 2 Additional predictors</i>						
Price perception service	7	.6114	-.0756	.0327	-.1037	.0214
Evaluation distance-to-outlet	8	.6195	-.0737	.0291	-.1127	.0117
(constant)			4.6542	.1151		.0000

These results suggest that besides aspects of operational performance, also aspects of a more strategic nature relate to the service quality perception: the choice of the location for the outlet and the price structure of the service. However, it cannot be concluded that the different services create differences in service quality perception. It is in fact the perception of these characteristics, which is a subjective variable, which causes the variations. How these perceptions are formed and how they subsequently could be influenced needs further study.

Hypotheses 8a, 8b. and 9. must be rejected, since these variables do not provide any additional explaining value for the service quality perception. This means that none of the individual characteristics, not even the frequency of use of the various travel modes, contributes to the service quality perception. This confirms the idea that the perception of service quality is independent from the individual.

Not only is there an absence of explaining power in most individual differences (except for the price perception and the evaluation of the distance to the outlet), the service design does not offer any additional explanation for variations in the service quality perception either. Therefore it seems that, irrespective of the service scheme they participated in, customers' service quality assessments were made on the same criteria.

8.5 Conclusions

Starting-point for the analysis of the service quality perception of Car Sharing services in this chapter was the assumption that for long term acceptance of Eco-efficient Services, not only the adoption of the innovation is required, but also long term retention of the service. In our conceptual model we assumed that a high perceived service quality is essential for long term use of that service and that this high perceived service quality precedes the intention to extend the contract and the actual continued behaviour.

In our analysis of the data we tested hypothesis 5, which states that the overall service quality perception has a positive impact on the intention of contract extension. This hypothesis might be accepted, because a correlation coefficient of .33 was found between the two concepts. However, some variation in the strength of this relationship was found among the four different service schemes, exemplified by a variation in correlation coefficients from a .56 to a non-significant ($p=.178$) .15. No clear explanation is available for this variation. It might suggest that participants of the various schemes differ in the extent to which they treat Car Sharing as an experiment for themselves.

Based on two specific multiple items scales for Car Sharing, one for the construct of the functional service quality perception, and one for the technical service quality perception, we investigated the dimensionality of these two constructs. For the technical service quality perception we found a three factor solution explaining 81% of the total variance, including the factors "reliability of the car", the "neatness of the car" and the "flexibility in car choice". For the functional service quality perception we adapted the standard 10-dimensional scale SERVPERF to the context of Car Sharing, consisting of 34 items. However, for our purposes these 10 dimensions did not prove useful, since the internal consistency of the various dimensions was too low. A factor analysis provided a much more satisfactory six-factor solution, explaining 56% of the total variance. The factors "empathy", "assurance", "responsiveness", "availability of cars", "tangibles", and "reliability" seem to have a high practical relevance.

Testing these two sets of perceived service performance dimensions for their explaining power of the overall service quality perception (hypotheses 6a and 6b) almost all dimensions proved useful. Interestingly, the "neatness of the car" did not have any significant explaining power, despite the suggestions in this direction from the exploratory research. On the basis of the calculation of the intercorrelations between the dimensions of the two constructs, we must conclude that the functional and technical service quality perception are not independent constructs at all, despite the plausible general theoretical grounds for this independence and their conceptual differences.

In order to exclude problems of multicollinearity in the explanation of the overall service quality perception a multiple regression analysis with a stepwise entering procedure was performed. Two blocks of variables were entered stepwise in the regression equation, one with dimensions on perceived service performance, and the other with additional predictors, as specified in the hypotheses 7, 8a, 8b, and 9. The analysis confirmed the multicollinearity between the two service performance dimensions. None of the technical service quality perceptions were included in the regression equation, but all the dimensions of the functional service quality were.

As additional explaining variables only the price perception of the service and the evaluation of the distance to the outlet were found. So, except for these two variables, hypotheses 7, 8a, 8b, and 9 cannot be accepted. The rejection of hypothesis 9. also implies that no differences could be found in the way service quality is perceived among the four different service schemes.

9 Changes in mobility behaviour

9.1 Introduction

The second research question of this study, concerns the environmental effects of Car Sharing in practice. We argued that the actual changes in consumer behaviour are an essential element in answering this question. In this chapter the changes in consumer behaviour after the adoption of Car Sharing will be analysed. The relevant consumer behaviour for our purposes is the mobility behaviour.

The environmental effects of Car Sharing, due to behavioural changes, can be divided into the direct effects and the indirect effects. The direct effects are the result of the introduction and adoption of Car Sharing. In the case of direct effects, the causal relation between the stimulus and the response, or the effects, can hardly be questioned. The effect Car Sharing has on car ownership among participants is the most important direct behavioural effect. This will be discussed in paragraph 9.2.

The indirect behavioural effects are more complex. Although these effects might be related to the adoption of Car Sharing, it is difficult to interpret the effects as a direct causal relationship between the cause (the adoption) and the effects. These effects only become clear in the long run and, moreover, they are influenced by several intervening mechanisms. The assumed changes in mobility behaviour can be considered as the most important indirect effect of Car Sharing. In paragraph 9.3, the indirect effects, i.e. the reported changes on mobility behaviour of Car Sharing, will be discussed.

The overview of the reported changes in mobility behaviour, as presented in paragraph 3, is only valid on a highly aggregate level and does not provide an explanation for the reported changes, nor does it provide insight in the variations among the population. For exploratory purposes, in paragraph 4 some possible explanations are developed, based on the self-reported effects of Car Sharing on the participants' mobility behaviour. In the last section of this chapter the variations in the changes in mobility behaviour are explored, based on a number of variables that are considered relevant for the explanation.

9.2 Changes in car ownership

Car ownership before participation

For the assessment of the effects on car ownership, the distinction between former car owners and former carless people is essential. Car ownership just before participation in a Car Sharing scheme was measured. Table 9.1 below presents the percentages of carless people and car owners, without specifying the number of cars among the car owners. It can be concluded that the greater part (71%) of all adopters didn't own a car before and that the proportion of former car ownership varies among the four service schemes.

Table 9.1 Proportion of (former) car owners and carless people before adoption

	Average adopters	Service A	Service B	Service C	Service D
(former) Carless people	71%	60%	78%	75%	75%
(former) Carowners	29%	40%	22%	25%	25%

Changes in car ownership

The effect of Car Sharing that is most relevant in the context of this research, is the actual change in car ownership among the participants. The basic question is whether Car Sharing is a full substitution to the privately owned car, or whether it is an addition to the already available transport means and mobility services. Car Sharing can basically form an additional service to the formerly carless people, be a substitute for former car owners, or function as a second car for former car owners. We will refer to these three groups of adopters by the expression of respectively "new cardrivers", the "substituters" and the "second car drivers". Table 9.2 lists the proportions of each group and shows the variations among the four different service schemes. It can be concluded that, at the moment, Car Sharing primarily functions as an addition to available transport services for the formerly carless (71%) and that 9% uses it as a second car alternative.

Table 9.3 presents the data regarding the number of private cars that remain at the participants' disposal. It shows that relatively few people (2%) possess two or more cars alongside their membership of a Car Sharing scheme.

Table 9.2 Segmentation on changes in car ownership

	Car ownership before participation	Average Car ownership during participation	Service adopters (n=337)	Service A (n= 108)	Service B (n= 67)	Service C (n= 75)	Service D (n= 87)
New cardrivers	Carless	No private car	71%	60%	78%	75%	75%
Substituters	Car owner	No private car	21%	27%	16%	19%	17%
Second cardrivers		One or more private cars	9%	13%	6%	7%	8%

Table 9.3 Percentages of private cars during participation

	Average adopters	Service A	Service B	Service C	Service D
No cars	90%	87%	90%	92%	92%
One car	8%	10%	10%	8%	5%
Two or more cars	2%	3%	0%	0%	3%

Preventive effects on car purchase

Given the large proportion of formerly carless people, one might expect a preventive effect on (future) car purchase. Especially among formerly carless people it seems reasonable to expect that some people won't buy a private car, but adopt Car Sharing instead.

In our research we investigated the preventive effects of Car Sharing on car purchase by means of the statement "if no Car Sharing service would have been offered, I would have bought a car myself". If adopters would have bought a private car if no Car Sharing service had been offered, this constitutes an important (additional) effect on car ownership. The intention to buy a private car, if no Car Sharing service had been available at the time of the decision, could be combined with the real changes in car ownership. Thus, a better understanding can be reached of the possible preventive effects on future car purchase. From table 9.4, we can conclude that 5% of all adopters "certainly would have bought a car, if no Car Sharing service had been available", and that 17% "probably would have bought a car".

Table 9.4 The changes in car ownership combined with the preventive effects on future car purchasing among carless

		Average adopters	Service A	Service B	Service C	Service D
		(n=337)	(n=108)	(n=67)	(n=75)	(n=87)
Former Carless people	New cardrivers, no purchase intention	48	33	55	51	59
	New cardrivers, weak purchase intention	17	20	19	15	15
	New cardrivers, strong purchase intention	5	7	3	9	1
Former Car owners	Second car users	9	13	6	7	8
	Substituters	21	27	16	19	15

Changes in car fleet magnitude

One of the direct effects of Car Sharing, as we've shown before, is the substantial reduction in car ownership on the household level. This change in car ownership is an important indicator for the environmental effects, but it does not allow for the input of (new) cars within the Car Sharing schemes. For a clear policy evaluation and environmental assessment, the change in the magnitude of the overall fleet of cars is what really counts. Here, an assessment will be made on the overall reduction in the number of cars used for the supply of the demanded car mobility of all participants, including the still privately owned cars.

On the basis of our practical experiences within the car Sharing systems, the ratio of the number of contracts to the number of cars can be estimated at 1 car to 12 contracts. Given this factor, the effects on the total car fleet can be calculated with two methods:

1. Based on the actual number of cars in the situation before and after adoption, without taking into account the possible preventive effects on car purchase

With the research data presented above, the realised reduction in the number of cars can be calculated: 29% of the respondents owned a car before, 8% of all respondents kept their

private car and 2% of all respondents kept two private cars. We can therefore estimate that of all 847 households within the four investigated schemes, the number of car owning households decreased from 29% to 10 %, which is from 246 to 85 households. With 2% of the households owning two cars before participation, the reduction in cars can be estimated at 36%, despite the relatively large proportion of formerly carless people. We estimated that the total amount of cars among all adopters of the four service schemes was reduced from 269 cars to 173.

2. Based on the actual number of cars in the situation before and after adoption, *adjusted for the prevented autonomous growth of car ownership*

If we not only consider the actual reduction in the number of cars, but also the preventive effects of Car Sharing (as measured with self-reports), the reduction rate even increases. Our reference point here is the estimated autonomous growth, based on the 5% of the respondents that showed a very strong purchase intention ("I would certainly have bought a car, if the Car Sharing service had not been available").

This autonomous growth would have lead to an estimated 311 cars among all 847 households, which results in a reduction rate of 44%. That is a reduction in the number of cars from 311 cars to 173; of which an estimated 71 cars are owned by the Car Sharing systems. Figure 9.1. shows the calculated results of the changes in car ownership among the four service schemes in the evaluation program.

Per 1000 households it can be estimated that the number of cars will fall from 367 to 204, or from 37% to 20%.

Figure 9.1 The estimated reduction in the number of cars (n=847 households)

9.3 Changes in mobility behaviour

Apart from the direct effects of Car Sharing on car ownership, it may be expected that the adoption of Car Sharing also influences the mobility behaviour of the participants. In chapter 4., we presented a literature review on the effects measured abroad and in a small scale Dutch study. Here, we want to report the research results on changes in mobility behaviour of this study on four Car Sharing schemes in the Netherlands, since one of our main empirical research questions is: What are the changes in mobility behaviour after adoption of Car Sharing?

In this study, the term "mobility behaviour" is used as a container concept that includes a variety of categories of behaviour. Mobility behaviour describes how often people use cars, public transport and the train, as well as the bicycle for their transport needs. The changes in mobility behaviour are established by analysing the differences in behaviour between the year before adoption and the current behaviour, in terms of self-reported frequencies and mileages. In this study, mobility behaviour is operationalised in several ways:

- 1 *Total car mileage* includes mileage by private car, by rental car, by borrowed car and by Car Sharing on a yearly basis.
- 2 *The frequency of use of various transport modes*, which is the average number of trips by car, train, public transport and bicycle on a weekly basis.
- 3 *The relative importance of car use* is calculated from the frequency variables. It relates the frequency of car use to the total number of trips on a weekly basis.

The descriptive results of the changes in mobility behaviour will be presented in connection with these three operationalisations:

The effects on car mileage, overall results

The total car mileage can be calculated by adding the yearly estimated mileages by private car, by rental car, by borrowed car, and – in the 'after' situation – by "Car Sharing"-car (shared car). Table 9.5 lists the results of the respondents' reported car use, split up according to the differences in changes in car ownership, combined with the purchase intention among the formerly carless people.

Table 9.5 Changes in car mileage (km/ year)

	Average all adopters	Carless average carless	No intention	Weak intention	Strong intention	Car owner Substituter	Second driver
Car mileage before	8450	5360	5290	4430	9170	13.380	21.700
Car mileage after	5660 *	3820 *	3470 *	3990 *	6530 *	4.730 *	22.386
	(-33%)	(-29%)	(-34%)	(-10%)	(-29%)	(-65%)	(+3%)

* significance $p < .05$

Given the fact that the carless people did not own a car, it is quite surprising that the research results show that many of them drove a considerable mileage per year (5360 km/year). This mileage was realised by conventional rental cars and borrowed cars.

When the mileages before and after are compared, it can be concluded that a substantial average reduction of 33% was reported by all respondents, from 8450 down to 5660 kilometres per year. Split up according to changed car ownership, a clear difference between the three main user groups can be reported; a 29% reduction for the carless, a 65% reduction for the substituters, and a – non significant – increase (+3%) in mileage by the second car drivers. Besides the considerable differences in relative changes, also the absolute levels of mobility by car differ substantially. All these values suggest large variations *among* the participants and the interested, as well as *between* the participants and the interested. It can be questioned what variables, apart from former car ownership cause these variations in changed car use.

As explained in 9.1, with regard to the preventive effects on car ownership, three relevant groups could be distinguished among the formerly carless, based on the criterion whether or not they would have bought a private car, if no Car Sharing service had been available. Because of the large differences in their motivation to participate and in their situation, these five groups are expected to score differently on the reported changes in car mileage. Table 9.5 seems to support these ideas.

The effects on car mileage among the four companies

A variable that may influence the changes in mobility behaviour is the service scheme that is used. The data were analysed in a descriptive way with respect to differences in changes in mobility behaviour. Table 9.6 lists the variation among the four different service schemes with respect to the reported changes in car mileage.

Table 9.6 Changes in car mileage (km/ year), among the four companies

	Average adopters	Service A	Service B	Service C	Service D
Car mileage before	8450	9990	5100	11480	6520
Car mileage after	5660*	6540*	3160*	7100*	5240*
	-33%	-35%	-38%	-38%	-20%

* significance $p < .05$

Given the current transport policy aims, optimisation of the changes in car use after adoption of Car Sharing might be an interesting goal for policy makers. One of the possible instruments might be to regulate service offers in such a way that participants show an even greater reduction in car use after adoption. Certain elements in the design of the service might be related to changes in mobility behaviour. The reported changes in car mileage, as can be seen in the table 9.6 above, are quite similar, except for the results of company D. The absolute levels of mobility by car however differ substantially among the four schemes, like many other variables of the four subsamples. No conclusions can be drawn (yet) regard-

ing the optimal service scheme for reducing car use, since many different kind of variables might influence the change in mobility behaviour.

Changes in frequency of use

Besides changes in car mileage, the respondents also reported changes in the use of the various means of transport. Based on estimated frequencies of use (per week) of the car, the train, city transport, intercity busses, and the bicycle, some substantial changes in mobility behaviour could be determined, as shown in table 9.7.

We can see an overall reduction in the frequency of car use, as estimated by the respondents, from 3,5 down to 2,0 times a week. Only a small proportion of those 2,0 trips per week is realised with a privately owned car. In contrast to the overall reduction in frequency of car use, an increase was reported in the average use of the bicycle (+14%), the train (+36%), city transport (+30%), and intercity transport (+17%). Because of the strong variations in values, few reductions are statistically significant in a paired-samples T-test.

The results suggest that the reduction in car use and the increase in the use of alternative travel modes are connected. A travel mode shift seems to be one of the additional effects on the mobility behaviour of the participants of Car Sharing schemes. Furthermore, these results lead to the conclusion that not only the number of trips increased with 10%, but that the relative importance of the cars in providing mobility also declined from 15% to 8%.

Table 9.7 Changes in frequency of use of the various travel modes (per week)

	Average adopters	Carless	Substituter	Second car driver
Car use				
before	3,5	1,6	3,8	6,5
after, of which by	2,0 *	1,9	1,6 *	5,8
shared car	1,9 *	1,2	1,5 *	0,5
Cycle use				
before	14,3	15,1	11,6	14,5
after	16,3	16,5	14,8 *	17,3
Train use				
before	2,2	2,4	2,0	1,0
after	3,0	3,0	3,5 *	1,4
Intercity transport				
before	0,6	0,8	0,2	0,3
after	0,7	0,8	0,7 *	0,2
City transport				
before	3,0	3,2	2,0	2,9
after	3,9	4,0	3,5 *	3,8
Total amount of trips				
before	23,6	23,1	19,6	25,2
after	25,9	26,2	24,1	28,5

* significance $p < .05$

As to frequency of car use, there were also substantial differences in changes in mobility behaviour between the former car owners and the formerly carless and their subgroups. Apart from the different levels of mobility and the use of various travel modes, for each group different reduction rates were calculated.

With regard to car use, the highest reduction rates can be reported among those who substituted their car for Car Sharing. It can be assumed that, to some extent, the variation in reduction rates is related to differences in motivation. Substituters definitely have different motives for adoption than second car drivers. These motives are likely to influence the reduction rate. The current segmentation offers little insight in the motivation for adoption and the variation in reduction rates is therefore hard to explain.

Quite remarkable is the increase in car use: from 1,6 to 1,9 car trips a week among the carless people (which is 19%). This result contrasts with the reported decrease in car mileage: -29%. This might be explained by a significant reduction in the average trip length.

Significant differences in the use of intercity public transport, train use and city transport could be explained by changes in commuting practices, which account for a substantial part of the total amount of trips per week.

Among the adopters, the substitution of car use for use of public transport or the bicycle varies substantially. Again, the rate of reduction in car use and the rate of growth in the use of alternative travel modes is strongest among the substituters. To explain these results, we will perform some additional exploratory analyses.

Table 9.8 Changes in frequencies of use of travel modes (per week)

	Average adopters	Service A	Service B	Service C	Service D
Car use					
before	3.5	3.6	3.1	3.5	3.7
after, of which by shared car	2.0 *	2.9 *	3.7	1.2 *	3.0
	1.9 *	1.6 *	1.3 *	0.9 *	2.1
Cycle use					
before	14,3	18.3	14.8	14.3	13.6
after	16,3	19.1	15.3	15.3 *	14.4 *
Train use					
before	2,2	1.8	2.2	2.8	4.5
after	3,0	2.2	2.1	3.3	4.1
Use of intercity transport					
before	0,6	0.3	0.7	0.9	0.7
after	0,7	0.4	0.7	1.2	0.7
Use of city transport					
before	3,0	4.0	4.7	2.0	3.9
after	3.9	3.9	4.7	2.5	4.1
Total amount of trips					
before	23.6	28.0	25.5	23.5	26.4
after	25.9	27.7	26.5	23.5	26.3

* significance $p < .05$

Table 9.8 shows that the changes in mobility behaviour also differ considerably among the four service schemes. The question remains, however, to what extent these variations are caused by the lay-out of the service scheme, the operational performance of the service, the differences in urban context, the profile of the users, or other variables.

Change in the relative importance of car use

A measure of the substitution of car use with other travel modes is the relative importance of car use in the total number of trips per week, i.e. the frequency of car use, divided by the total number of trips. If the car becomes less important in providing mobility, the ratios for the bicycle and the train must also change. These ratios are corrected for changes in mobility in absolute terms by dividing them by the total number of trips before and after adoption, respectively. This analysis is made to investigate whether Car Sharing might induce less frequent car use, which is relevant from an environmental perspective, as well as for transport policy. Tables 9.9. and 9.10. show the changes in the relative importance of car use.

Quite clearly, the importance of the car in providing mobility reduces among most segments, but most strongly among the substituters. They choose the train and the bicycle for a larger proportion of their trips. Among the carless, the changes in the relative importance of the various travel modes seem to be far less significant. Their choice for the car even stabilises at 7% of their trips. To investigate the variation of these changes among the adopters and to distinguish the determinants of substitution of the car with alternative travel modes, further research is needed. It can be expected that to a certain extent the nature of the service itself will also contribute to the changes in mobility behaviour. It remains unclear how the results of this study (table 9.10) have to be interpreted, but in the next sections we will conduct some exploratory analyses.

Table 9.9 Changes in relative importance of travel modes (among the four schemes)

	Average adopters	Carless Average carless	Car owner Substituter	Second car driver
Relative importance of car use				
before (%)	15 %	7 %	19 %	26 %
after (%)	8 %	7 %	7 %	20 %
Relative importance of train use				
before (%)	9 %	10 %	10 %	4 %
after (%)	12 %	11 %	16 %	5 %
Relative importance of cycle use				
before (%)	61 %	65 %	59 %	58 %
after (%)	63 %	63 %	61 %	61 %

Table 9.10 Changes in relative importance of travel modes

	Average adopters	Service A	Service B	Service C	Service D
Relative importance of car use					
<i>before</i>	15 %	13 %	12 %	15 %	14 %
<i>after</i>	8 %	10 %	14 %	5 %	11 %
Relative importance of train use					
<i>before</i>	9 %	6 %	9 %	12 %	17 %
<i>after</i>	12 %	8 %	8 %	14 %	16 %
Relative importance of cycle use					
<i>before</i>	61 %	65 %	58 %	61 %	52 %
<i>after</i>	63 %	70 %	58 %	65 %	55 %

9.4 Searching for an explanation of changes in mobility behaviour

From an environmental or national transport policy perspective, the research results on changes in the mobility behaviour of users of Car Sharing systems presented above can be called encouraging. However, despite these encouraging research results, the assertion that the Car Sharing service itself causes these effects is far from proven (yet). First of all, because an appropriate and acceptable explanation for these effects, which is indispensable for the determination of a causal relationship, is still lacking. And secondly, because we haven't controlled for other determinants of mobility behaviour. Therefore, it is uncertain whether all other determinants of mobility behaviour have remained unchanged.

In this section we will, based on self-reported consequences of Car Sharing, discuss the changes in mobility practices in more detail and develop some possible explanations for the changes in mobility behaviour of the participants.

An inventory of the perceived effects of Car Sharing on mobility behaviour

The changes reported above provide insight in the effects of Car Sharing on the mobility behaviour of the respondents. However, these effects – over one year – are on a highly aggregate level, and do not tell us which kind of practices within a pattern of mobility behaviour are maintained and which aren't. For exploratory purposes, 19 items with a 5-point scale were formulated, which enable us to gain further insight in the possible changes related to the adoption of Car Sharing. The items question the possible effects of Car Sharing on mobility behaviour, as perceived by the participants. Table 9.11 shows the item-scores (1=agree, 5=disagree).

Table 9.11 Perceived qualitative changes in mobility behaviour

Since I participate in Car Sharing,	Adopters	Carless	Substituter	Second car driver
I choose more consciously how to travel	2,4	2,4	2,0	2,7
I use the car more consciously	2,6 *	2,8	1,8	2,8
I know better what car driving costs	2,7	2,7	2,5	2,8
it makes it easier to visit people far away	2,8 *	2,5	3,6	3,4
I combine more often my trips	3,0	3,0	3,3	2,8
I am likely to take the car in the weekends	3,1 *	3,0	3,1	4,1
We do not use the car for shopping anymore	3,1 *	3,2	2,8	3,7
We make, within the household, more car trips	3,2 *	2,8	4,3	4,2
The car has not been used (anymore) for commuting	3,3 *	3,5	2,4	4,0
I take the bicycle or go walking more often	3,3 *	3,6	2,4	3,5
We use the car only for holidays and leisure trips	3,3 *	3,3	3,1	4,4
We make, in the household, far less short trips by car	3,3 *	3,6	2,4	3,5
We make, within the household, less car trips	3,4 *	3,8	2,0	3,3
I travel far more by public transport	3,6 *	3,8	2,7	3,9
I travel far more by train	3,7 *	3,9	3,1	3,7
I am likely to take the car in the evenings	4,0	4,0	4,0	4,1
It is more likely to take the car for holidays	4,0 *	3,9	4,2	4,5
I stay more often at home	4,0 *	4,2	3,5	4,3
I take more often the taxi	4,3	4,3	4,5	4,2

* significant differences between three groups, one-way ANOVA, post-hoc Scheffé-test

The research, based on self reported changes, provides some remarkable results concerning qualitative changes in mobility behaviour. Overall, agreement seems to exist among respondents regarding the effects on the cognitive process preceding travel mode choices. This supports the basic assumptions we formulated on theoretical grounds. Relatively high percentages of participants agree with the statements that Car Sharing makes them choose travel modes more consciously and use the car more consciously as well. Moreover, many (51%) of the participants agree with the fact that Car Sharing increases their knowledge of car costs. It must be stressed that these effects are just perceptions and do not necessarily correspond exactly with what really changed. From table 9.11 it can be concluded that the effects vary among different user groups. A distinction was made regarding the changed situation in car ownership.

The formerly carless enjoy a greater car availability within the Car Sharing scheme. This seems to have consequences for their mobility behaviour: it increases their opportunities to visit more remote places, and it seems to stimulate car use. Consistent with the changes in the reported frequency of car use – which increased from 1,6 to 1,9 trips a week – the formerly carless agree *relatively stronger* with the statement that Car Sharing make them drive more frequently.

The former car owners were split up into those who have substituted and those who retained their car alongside their membership. The results show there is a difference between the two groups. The substituters state – stronger than the others – that they use the car more consciously. Compared to the others, they tend to be more influenced in their car use for shop-

ping, for commuting, in their use of the car for short trips and in their overall frequency of car use. This is supported by the reported changes in frequency of car use. They seem to substitute the car stronger for train use and even the bicycle.

The results suggest that the "second car drivers" are least influenced in their mobility behaviour. They still have a private car at their disposal. The shared car is thus an addition to their existing mobility options. The high values on the more conscious travel mode choices and the more conscious car use suggest that they probably answered in a very 'socially desirable' manner. It is hard to see how their availability of cars, which has increased, could have had any effect on travel mode decision making.

Variations in changes in mobility behaviour by the service design

One of the possible predictors for the variation in changes in mobility behaviour, is the nature of the Car Sharing scheme. The way in which the rental process is organised may for instance influence the convenience of access to the car and thus the choice for the car as travel mode. We may expect to get some indication of the effects of the structure of the service scheme on the changes on mobility behaviour, if we compare the four service schemes on the perceived changes in mobility behaviour. Table 9.12. shows the research results.

Table 9.12 Perceived qualitative changes in mobility behaviour, four services

Since I participate in Car Sharing,	Average score adopters	Service A	Service B	Service C	Service D
I choose more consciously how to travel	2,4 *	2.1	2.9	2.1	2.5
I use the car more consciously	2,6 *	2.3	3.1	2.3	2.9
I know better what car driving costs	2,7	2.4	2.7	2.9	2.8
It makes it easier to visit people far away	2,8	2.9	3.1	2.7	2.7
I combine more often my trips	3,0	3.0	3.2	2.9	2.9
I am likely to take the car in the weekends	3,1 *	2.8	3.4	3.7	2.8
We do not use the car for shopping anymore	3,1	2.9	3.4	2.9	3.5
We make, within the household, more car trips	3,2 *	3.5	3.1	3.4	2.8
Car has not been used (anymore) for commuting	3,3 *	2.8	3.7	3.0	4.0
I take the bicycle or go walking more often	3,3	3.1	3.6	3.0	3.6
We use the car only for holidays and leisure trips	3,3 *	3.5	3.8	2.6	3.4
We make, in household, far less short trips by car	3,3 *	3.0	3.8	3.1	3.6
We make, within the household, less car trips	3,4 *	2.9	3.7	3.4	3.8
I travel far more by public transport	3,6	3.4	3.8	3.4	3.9
I travel far more by train	3,7	3.5	4.0	3.4	4.0
I am likely to take the car in the evenings	4,0 *	3.6	4.1	4.8	3.8
It is more likely to take the car for holidays	4,0	4.1	4.2	3.7	4.1
I stay more often at home	4,0	4.0	4.0	4.0	4.2
I take more often the taxi	4,3	4.2	4.4	4.4	4.3

* significant differences between three groups, one-way ANOVA, post-hoc Scheffé-test

On several items there is a significant statistical difference between the answers of the respondents of the four service schemes ($p < .05$) in a one-way ANOVA and post-hoc Scheffé-test. This means that, at least in the perception of the respondents, these service systems have a different influence on people's mobility behaviour:

- First of all, between the four schemes an interesting difference exists in the extent to which Car Sharing influences the travel mode decision making. Especially services A and C stimulate their participants more to choose their travel modes more consciously. Service A explicitly presents itself as a system for conscious and moderate car use. Here, reasons of a more psychological nature may cause the difference in scores. With regard to service C, it can be expected that the length of the reservation period (24 hours) and the minimum rental period of one day are the causes of the more conscious car use and travel mode choices.
- Most participants more or less agree with the fact that Car Sharing has an impact on their cost awareness of car driving. Despite the various procedures for payment, the research results show no significant differences in cost awareness.
- Poor availability of cars in weekends and evenings (services B and C) influences the use of the car in these periods, which is not surprising. It might be expected that especially those people who want to use a car regularly in weekends and evenings, will decide not to adopt Car Sharing. This could be a serious drawback, since most social and recreational trips are made in these periods.
- Systems that offer 24 hours car access (services A and D) and provide the most flexible services (minimum rental periods of one hour) seem to have a slight disadvantage in influencing participants in their mobility behaviour. The participants of scheme D agree significantly stronger with the statement that they make more car trips and disagree significantly stronger with the statement that they make far less short car trips.
- Service C differs from the other systems, because of its subscription system. This system requires its participants to calculate their number of car rental days in advance. As a result, car drivers for whom their holiday is a critical reason for owning a car, are particularly attracted to service C.
- Among the four schemes, few differences can be found in the effect on the substitution of the car with alternative travel modes, like the taxi, the train, the bicycle and public transport in general. None of the four service schemes stands out because of its connection with public transport services, or its access to public transport services. In the case of explicit taxi arrangements, no distinction can be made regarding the use of taxi services. In general, few respondents associate Car Sharing with taxi services.
- Apart from the large disagreement with the statement that Car Sharing influences the overall trip-frequency, no distinction among the four services could be found.

Conclusions and implications

In section 9.3 we presented the research results on the reported changes in mobility behaviour after the adoption of Car Sharing. Apart from a substantial reduction in car mileage (minus 33%) and a reduction in reported frequencies of car use from 3,5 to 2,0 times a week, also a partial substitution of the car with alternative travel modes were found. At this point, the important question has arisen whether there is a causal relationship between these changes on mobility behaviour and the adoption of Car Sharing. We argued that as a condition for establishing such a causal relationship, a conceptual framework had to be developed from which the changes could be explained. An inventory on customer perceptions of these changes was made to find some probable holds for such a conceptual framework. On the basis of our theoretical considerations (see chapter 5) and the research find-

ings reported above, we can now formulate in more detail our ideas on the explanation for the changes on mobility behaviour.

The concept of Car Sharing has at least two important consequences for customers in their daily practice:

1. Car use with the scheme requires planning and often reservation in advance. Direct car access is denied because the car is not readily available in front of the house. This might facilitate the search for alternative travel modes, especially for short distances.
2. The costs of car use are based on utilisation only, without separate fixed costs. This results in a regular feedback on the costs for car use, not on a perception basis, but on real economic basis. The full-cost accounting and feed-back allows a more balanced cost/benefit analysis of public transport versus car use and therefore stimulates more frequent public transport use.

As a result of these effects on consumer behaviour, the cognitive nature of the travel mode decision making process would shift from a more habitual process into a more deliberate process. This means that when Car Sharing services are used, all travel options are evaluated for every specific trip. If the most appropriate travel mode is chosen for each specific trip, instead of always the car – irrespective of the kind of trip- it will become clear that the car is not always the most appropriate travel mode, considering criteria like time, costs, or convenience. As a result, for a number of trips the car will be substituted with other travel modes.

This explanation is supported by the analysis of the effects of Car Sharing on mobility behaviour, as perceived by the participants themselves. Most of them agree with statements that Car Sharing makes them use the car more consciously or, in a more general way, makes them more conscious in their choice of specific travel modes. Above all, their awareness of the costs of car driving was raised, according to the participants. The nature of the changes in mobility behaviour seems to be quite consistent with the explanation for the changes in mobility behaviour: people make less short trips by car.

Despite the fact that this explanation seems quite plausible for the substituters, the changes in the mobility behaviour of the formerly carless people are more difficult to understand. They seem to depend on whether their direct access to the use of the car is reduced or whether their cost awareness is raised. If, for instance, people could quite easily borrow a car from friends or relatives, they might be far less aware of all car costs and might already be acquainted with certain barriers to car use. Further analysis of the 'before' situation is needed to see if a similar explanation might apply to the formerly carless people.

We must also mention here that the research results regarding the changes in mobility behaviour among the carless do not entirely match with the results of other (foreign) studies. In some other studies, carless people generally show a considerable increase in their car mobility. Various researchers explained these changes with the assumption that Car Sharing services increased their access to car use.

If the organisation of the Car Sharing scheme is related to the explanation of the changes in mobility behaviour, no inconsistencies were found. If we compare the perceived effects among the four service schemes, we can conclude that the schemes that demand reserva-

tion (thus reducing direct car access) seem to have a stronger effect on travel mode choices, the number of short trips, and the total number of trips.

The analysis of the perceived effects on mobility behaviour reveals an important dilemma. On the one hand, we saw that the distance to the outlet is one of the important parameters in the adoption, and adoption is necessary to achieve any environmental effects. But, on the other hand, we also see that the further away the car outlet is, the stronger the effect on the changes in mobility behaviour is. The answer to this dilemma largely depends on one's primary aims with Car Sharing. In our view – bearing in mind the direct effects of Car Sharing (the reduction in the number of cars) – highly accessible services, organised in a very decentralised manner should be preferred over a more centralised organised service system, in which access is rather low. In which case the number of people who adopt Car Sharing, will be very low.

9.5 Investigating variations in changes in mobility behaviour

From our research results an important question arises: to what extent are these changes the result of the adoption of Car Sharing (as an alternative to the private car) and of the influence of this service innovation on travel mode decision making and consumer behaviour. It is this supposed causal relationship between adoption and changes in mobility behaviour that can be questioned. In the development of our explanation for the reported changes in mobility behaviour however, we are limited by our research design and our conceptual model. Unfortunately, we do not have a proper reference group and we haven't controlled for the determinants of mobility behaviour. In short, it can be questioned whether all variables remained unchanged before and after adoption of Car Sharing.

Although providing a tested explanation for changes in mobility behaviour is not the aim of this study, we are interested in exploring the variation in these behavioural changes. Based on an bivariate analysis, as specified by the hypotheses 10, 11, and 12, we can generate some indications of how the changes in behaviour might be explained and what kind of variables contribute to the variation in behaviour. In the conceptual model the following hypotheses have been specified:

Hypothesis 10 The personal characteristics of the individual decision maker correlate with the changes in mobility behaviour, which include:

- a decisional involvement in travel mode choices
- b habit strength in travel mode choices
- c cost involvement
- d environmental attitudes
- e domain-specific values

Hypothesis 11 The perception of the Car Sharing service correlates with the changes in mobility behaviour, which include:

- a cost perception
- b valuation distance to outlet
- c distance to outlet
- d quality perception

Hypothesis 12 The changes in mobility behaviour differ among the various service system

The operationalisation of changes in mobility behaviour

Operationalisation of the construct variable "changes in mobility behaviour" is complicated. First of all, it concerns a comparison of one variable at two moments in time: before and after adoption of Car Sharing. The question is how these two values should be compared, on an absolute basis or on a relative basis. As we have seen in the presentation of the descriptive results on the changes in behaviour, not only the absolute, but also the *relative* changes vary considerably among the participants. In advance, no explicit choice can be made on how the changes in mobility behaviour should be operationalised, and therefore both relative and absolute changes in behaviour will be computed and used as dependent variables.

For the unit of measurement, no explicit choice can be made either. We measured mobility behaviour both in terms of mileage per year and number of trips per week. The changes in behaviour will therefore be computed for both units.

To these four methods of operationalisation we added a fifth. Because modal shift is one of the major policy goals in (Dutch) transportation policy, we defined a measure that expresses the extent of the shift to alternative travel modes. The measure used is the difference in the number of car trips divided by the total number of trips by car, train, cycle and public transport before adoption.

Exploring possible explanations

Hypotheses 10, 11, and 12 were tested by computing the bivariate correlation coefficients (Pearson's) between the five indicators for the changes in mobility behaviour and the various explaining factors, as specified in these hypotheses. We chose to conduct the analysis for the substituters only, for several reasons: (1) The reported changes in behaviour are most significant among the substituters; (2) The change in car access is greatest among the substituters; (3) Because from our theoretical point of view on Car Sharing – as an example of an Eco-efficient Service – its role as a substitute for the private car is most interesting; and (4) The group of current car owners represents the largest and most interesting market segment for Car Sharing.

Table 9.13 Correlation coefficients between the changes in mobility behaviour and potential explaining variables (only substitutes, n=69)

	Relative change in car use (mileage/ year)	Relative change in car trips (trips/week)	Absolute change in car use (mileage/ year)	Absolute change in car trips (trips/week)	Modal split (trips/ week)
<i>Personal characteristics</i>					
Decisional involvement	–	31	–	–	–16
Habit strength	–	–20	–	–28 *	–
Cost involvement	–11	–10	18	–	–
Environmental consciousness	–	–12	–10	–12	–
Willingness to contribute	–	23	–	–	–11
Value: cars are self-expression	–	–	–	–	–
Value: cars are symbols of freedom	–	–	–	–24	–23
Value: just-in-time is important	–	–19	–	–14	–
Value: conscious car use is important	–	–	–	–	–
Value: anti cycle attitude	–	–	–	11	–
Value: non self-driving appreciation	–	–13	22	17	–
Value: technological perfection	–	14	–	–28 *	–27 *
<i>Perception service offer</i>					
Price perception	–	–29 *	14	–23 *	28 *
Quality perception	–	17	–	–	–
Evaluation distance	–	–15	–15	–21	16
Distance to outlet	–	–25	–10	–17	25 *
<i>Contribution service schemes</i>					
Scheme A	–13	–	18	16	10
Scheme B	–	–	–13	–	–10
Scheme C	26 *	–	–11	–	–12
Scheme D	–	–	–	–	–13

Note: Pearson's correlation coefficients; significance ** < .01, * < .05; correlations $|r| < 0.1$ not listed

Our dataset contains 69 respondents who substituted their private car for Car Sharing. Table 9.13 shows the results of the analysis. The main conclusions we draw from this analysis are:

- Our general impression from these results is that few relationships show a significant correlation coefficient with any of the indicators of changes in mobility behaviour. This might be caused by the fact that we have only 69 adopters who substituted their private car for membership of a Car Sharing scheme. Because of a rather small population and a lot of variation in changes in mobility behaviour, few relationships turned out to be strong and highly significant.
- The two indicators for the changes in mobility behaviour, based on the changes in car mileage per year, show considerably less and lower correlation coefficients than the indicators based on the changes in the number of trips by car per week. Clearly, the adoption of Car Sharing relates stronger to the changes in the estimated number of car trips per week. A possible explanation for this difference might be that Car Sharing does not affect the distance driven by car, but the travel mode decision making, which does

not relate to the trip length. This suggests that in the adoption of Car Sharing, a certain number of trips could be affected in travel mode choice. We use these two indicators as the main dependent variables.

- Hypothesis 10, concerning the influence of the personal characteristics on the changes in mobility behaviour, cannot be accepted entirely. Only on a few specific personal characteristics low significant correlation coefficients were computed: decisional involvement, habit strength, cost involvement, "environmental consciousness" and the "willingness to act", and some domain specific value dimensions. When people are highly involved in travel mode decision making and do not have a strong habit in travel mode decision making they are more likely to reduce their number of trips after adoption of Car Sharing. The same goes for environmentally conscious people and people who are willing to make a personal contribution to solving environmental problems. So, it is likely that the value orientation of the adopter can explain the changes in mobility behaviour. And not only the environmental values, but also the domain specific values form an explanation for the changes in mobility behaviour.
- Hypothesis 11, dealing with the relationship between the changes in mobility behaviour and the perception of the service, cannot be accepted to its full extent either. Although for most tested variables a correlation coefficient of more than .10 could be computed, few of them have a significance higher than .05. The price perception of the service – the extent to which people find the Car Sharing service expensive – correlates significantly ($p < .05$) with the changes in the number of car trips per week: the more people find Car Sharing expensive, the smaller the reduction in car use. Another interesting result is the influence of the distance to the car outlet: the more people find the outlet of the car too far away, the lower the reduction in car use is.
- Hypothesis 12 questions the influence of the service design on the changes in behaviour. In our analysis, we found no evidence for a contribution to the changes in mobility behaviour. As this influence was tested in a very generic way, further research is needed to study the influence of specific attributes of the service on the changes in mobility behaviour.
- From the bivariate analysis of the various explaining variables with the modal split indicator no clear conclusions can be drawn. The correlation coefficients that were computed did not show great consistency with the other results. Obviously, we introduce new research problems by relating the changes in car use to the overall number of trips per week by all travel modes.
- We conclude that our analysis could not provide substantial data to explain the changes in mobility behaviour. We were however limited by our research design and our data set. This study does not aim to establish cause and effect, but to establish the changes in environmental effects. The changes in mobility behaviour are an important element in this assessment.
- We recommend that further and more specific research is done on the explanation of the reported changes in mobility behaviour. In particular the role of the Car Sharing in breaking through habitual behaviour seems interesting.

10 Changes in environmental effects

10.1 Introduction

In the introduction of this thesis we put forward the assumption that innovative products and services would lead to a reduction of harmful environmental effects. We particularly expected the so-called Eco-efficient Services to have great potential for reducing the environmental impact of production and consumption. This assumption was tested for the case of Car Sharing services. We expected Car Sharing services to have great potential for reducing the environmental impact of mobility.

In this chapter we aim to quantify the environmental effects of the adoption of Car Sharing services. To make this assessment, we not only have to examine how the consumption practice of Car Sharing improves the eco-efficiency but also how the changes in mobility behaviour contribute to a reduction of environmental effects.

In chapter 1 we discussed a model (Ehrlich and Holdren, 1971) for describing the environmental impact or effects. In this model the total environmental impact of production and consumption (EI) is expressed in the product of the world population (P), the amount of units of service (US), and the environmental metabolism (EM) of those systems that produce units of service. The size of the world population was excluded from this study. We argued that this model could be helpful in analysing the changes in environmental impact resulting from changes in consumption practices. For the environmental assessment, the two entities (the changes in consumer behaviour and the improvement of the environmental metabolism of the new consumption practice) need to be analysed, as well as their interaction.

Changes in the amount of units of service (a characterisation of the volume and the nature of consumption) have to be established on the basis of empirical data on changes in consumer behaviour. Our empirical study provided data on changes in mobility behaviour after the adoption of Car Sharing services as an alternative to the privately owned car.

Changes in the environmental metabolism have to be established by comparing the way in which two consumption practices generate a certain unit of service. In other words, a comparison has to be made between two different systems with respect to the environmental effects they generate in the production of a unit of service.

The interaction between the acceptance of an innovative consumption practice by consumers and their subsequent use of that innovation could also have strong implications for the environmental evaluation of an innovation: An innovation that was intended as an eco-efficient substitution for existing consumption practices could become, at least to a certain extent, an addition to the existing consumption package. Innovations that were intended as substitutions for existing consumption practices could overshoot their mark and create completely new markets with new innovative consumptive practices. Moreover, an innovation intended to be an alternative solution for producing units of service is also likely to influence the level of consumption (or the total amount of units of service consumed). Therefore, if an alternative consumption practice is offered to fulfil an existing need, this does not necessarily mean that the level of consumption will remain unchanged.

On the basis of this analysis we distinguish two different kinds of environmental assessment: an assessment of the environmental metabolism of Car Sharing services and an integral assessment of the changes in environmental effects after the adoption of Car Sharing services. Through these assessments the changes in environmental impact can be better understood.

1. The assessment of the environmental metabolism of Car Sharing services

Car Sharing services can be seen as an alternative to the privately owned car. Although people still use cars for their mobility needs, the way in which a Car Sharing service provides cars for transport is completely different. Basically, it disconnects private car ownership from car use. Car Sharing services facilitate a different consumption practice. The first assessment focuses on a comparison between Car Sharing and private car ownership. Each consumption practice has its own environmental metabolism, which differs on various aspects. The effects of changes in mobility behaviour are not included in this analysis.

2. The integral assessment of the changes in environmental effects after the adoption of Car Sharing services

As we have seen in the presentation of our research results, the adoption of Car Sharing services involves substantial changes in mobility behaviour. People completely change the way in which they travel (see chapter 9). Overall, car use is reduced and public transport use is increased. Given the differences in environmental metabolism between the various travel modes, the environmental effects will certainly change in nature and quantity. In the second assessment an integral environmental assessment will be made of the mobility behaviour of all adopters of Car Sharing services, before and after adoption. Thus, the changes in environmental effects can be calculated.

10.2 The method for the environmental assessments

The environmental assessments were based on a well-known and broadly accepted method to quantify environmental impacts. This method is generally referred to as Life Cycle Assessment (LCA). LCA has emerged as a useful analytical tool for evaluating the environmental profile of products or services. LCA is frequently used as a tool for decision support in e.g. product development or policy making. It does not prescribe specific choices, but provides guidelines to evaluate production processes, products, services and product systems. It is also used for identifying improvement options in existing product and service systems.

For our environmental assessments we follow the widely accepted series of guidelines from the code of practice of SETAC (1991, 1993). SETAC (the Society of Environmental Toxicology And Chemistry, 1991) has defined LCA as follows: *"LCA is a process to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and materials used and wastes released into the environment; and to identify and evaluate opportunities to affect environmental improvements. The assessment includes the entire life cycle of a product, process or activity, encompassing extracting and processing raw materials; manufacturing, transportation and distribution, re-use, maintenance, recycling and final disposal."*

In the code of practice of SETAC, a description of the methodology for LCAs, an LCA is defined in terms of various phases: (1) goal definition and scoping; (2) inventory analysis; (3) impact assessment; (4) improvement assessment.

Goal definition and scope

An LCA is an approximation of a vast and complex reality. It is therefore necessary to specify in advance exactly what is to be analysed, which goals must be fulfilled and what the system boundaries are. To perform an LCA, it is important to specify the functional unit, which is the basis for comparison.

Inventory analysis

The second part of an LCA is making an inventory of all relevant processes. It starts with a definition of the system under analysis and its system boundaries. This inventory generally involves three steps: the definition of all relevant processes of the product system; the specification of all processes and their input data and output data; and the compilation of the data into inventory tables. Inventory tables list all relevant impact substances related to the functional unit.

For the inventory we used the widely used software package "SimaPro 3.0" of Pré Consultants in the Netherlands (Goedkoop, 1999). This software package helps listing all impacts and compiling an inventory table. IDEMAT (Remmerswaal, 1999), which is a large database with recent data on the environmental impact of a large variety of materials, processes and products was an important source for environmental data on a variety of relevant processes.

Impact assessment

In the impact assessment procedure, all the data from the inventory analysis are grouped together into a number of generally recognised environmental impact categories, like "greenhouse effect" or "acidification". This procedure is called the classification of environmental impacts and consists of four steps (Guinee, 1995): (1) the definition of generally recognised environmental problem types which should be considered in an LCA; (2) the definition of classification factors indicating how much one unit of environmental input or output contributes to a particular environmental problem; (3) the multiplication of environmental inputs and outputs with their classification factors and the subsequent aggregation of the results per problem type into a number of effect scores; and (4) the normalisation of the effect scores. In our environmental assessment we used the CML method (Heijungs et al., 1992), which is at present the most commonly used classification method (Brezet and Van Hemel, 1997).

Although the classification results in a condensed list of environmental impacts, its interpretation is still problematic. The impact scores all have different dimensions and significance. To assess the various environmental impact scores in relation to each other, specific valuation methods are needed. In our study we have applied various valuation methods:

1. The Eco-Indicator (Goedkoop, 1995) is a emission-oriented one-point indicator that expresses the seriousness of the environmental effects.
2. The EPS-Indicator (Steen and Ryding, 1992) is based on the estimated financial consequences of environmental problems and attempts to translate environmental impact into

a form of social expense. This indicator not only includes emissions, but also the negative consequences of all inputs in terms of resources and energy.

3. In addition to these more formal valuation methods, it is also possible to calculate the reduction in parking space needed. This effect of Car Sharing is highly valued from a policy perspective but absent in commonly used environmental assessment methods.

Improvement assessment

The improvement assessment is aimed at the identification, evaluation and selection of options for environmental improvements in products or processes. On the basis of the (extended) LCA methodology, Heijungs *et al.* (1992) distinguishes two basic strategies for improving existing products: the dominance analysis and the marginal analysis. In the dominance analysis, the main origins of the environmental problems are traced. These origins are then analysed for their functionality in the product life-cycle. Very often the main contributors to specific environmental problems can be eliminated by choosing new solutions. The marginal analysis is based on the sensitivity of the total environmental impact to changes in specific processes, design solutions and materials used. Improvement processes can be selected using knowledge of the sensitivity of the result to small changes in the data. In the conclusions of this thesis on the changes in environmental effects (§ 11.3) we will extensively discuss all possibilities for improvement of Car Sharing services from an environmental point of view.

Conclusions

In the previous section we stated our intention to carry out an assessment of the environmental metabolism of Car Sharing services. However, the question arises to what extent the method described above is appropriate for analysing the environmental metabolism of Car Sharing services in comparison with that of the privately owned car. We have to admit that the concept of environmental metabolism, as introduced by Ayers (1989), not only deals with the output, but also with the input of a system. Both the input and the output of a system could induce environmentally harmful effects. Our main valuation method (the Eco-Indicator method) however, is basically emission-oriented (Goedkoop, 1995). As we already stated in chapter one, the question of how input-related effects and output-related effects could be incorporated into one valuation method is still the topic of scientific debate (see e.g. Reijnders, 1998; Cramer, 1999; Potting, 1999).

Despite the extensive scientific discussions and the uncertainties surrounding LCA, we have chosen to use an internationally accepted and applied method: the Eco-Indicator. We are aware of the many scientific restrictions of our choice, but in the context of this thesis we cannot solve these scientific problems. This thesis merely aims to provide an indication of the relative environmental impact of Car Sharing services in comparison with the privately owned car.

10.3 Results of the environmental assessment

10.3.1 Goal definition and scope

As argued in the introduction, two different environmental assessments have to be made. Each of these assessments has its own goal:

1. The assessment of the environmental metabolism of Car Sharing services

The goal of this assessment is to compare Car Sharing services with the privately owned car. Both are options for using a car. The functional unit for this assessment is defined as the use of a car in a household over one year for a 5660 km. This mileage is the average mileage of a household that adopted Car Sharing services.

2. The integral assessment of the changes in environmental effects after the adoption of Car Sharing services

The goal of the second assessment is to quantify the changes in environmental effects after the adoption of Car Sharing. The adopters' entire mobility behaviour is taken into account, including the use of cars, trains, public transport and the bicycle. The functional unit can thus be defined as the entire mobility behaviour of a household that adopted Car Sharing over one year.

10.3.2 The inventory

Car Sharing schemes

In taking inventory, we first listed all the processes that had to be included in the environmental assessment of Car Sharing services. The inventory was based on an analysis of current Car Sharing schemes and of the configuration and organisation of schemes like GreenWheels and AutoDelen (see also chapter 3.). Figure 10.1. shows the most important processes and products or artefacts within our system boundary. The processes are described from the consumer perspective.

1. Subscription

Consumers have to subscribe to a Car Sharing scheme. In order to subscribe, consumers have to visit the office of the service organisation only once. The office itself is small and according to IFIAS (1974) the office represents a third order environmental effect, which can be neglected in an environmental assessment. If one compares e.g. the energy use of such offices with the energy use of the entire fleet of cars and with the changes in energy use due to changes in mobility behaviour, the environmental effects of the office are neglectable.

2. Reservation

All members have the right to use a car whenever they want. To be guaranteed the use of a car, it is necessary to make a reservation in advance. Reservations are made by telephone. They have a minimal environmental impact. The call centre is relatively small and, again, constitutes a neglectable third order effect (IFIAS, 1974).

Figure 10.1 The inventory on Car Sharing services

3. Car access

The cars are available at specific parking places in cities. In most cases the outlet consists of about 5 cars and a communication unit, which provides access to the cars to members of the service organisation. They have to identify themselves at the communication unit, as well as at the car, by means of an electronic key.¹ The outlet is at an average distance of about 1.700 meters from a member's home, a distance which is covered by cycling or by walking (Meijkamp *et al.*, 1997). The cars are supervised, cleaned and maintained by the service organisation. All cars are entirely cleaned and washed once every month.²

- 1 The identification unit, which includes a small computer and different interaction devices, has a power to a maximum of 100 Watt. This process can be neglected because the unit is only active incidentally. The stand-by power of the unit is an estimated 20 W, which equals over one year the energy consumption of about 20 KM by passenger car. Above all this unit serves on the average five different cars.
- 2 The cleaning of the car can be neglected, because twelve washing cycles consume less than 0,7% of the total energy (one cleaning requires 30 MJ energy and 60 litres of water).

The following processes are taken into account:

- The cars are provided at specific parking places of the Car Sharing organisation, that cover an average area of 12,5 m² (CROW, 1998).
- Every trip is an estimated 2 km longer because people have to pick up luggage at home.
- Every trip is an estimated 1 km shorter because people do not need to search for a parking place.
- Based on practical experience only one car is provided for every 12 contracts.
- For maintenance and supervision purposes an additional 40 km per year per car are made.

4. Car use

The fleet of cars is rather diverse and consists of different sizes and types. Customers can choose any car they want, but the prices vary among the different cars. Customers pay per kilometre and per hour, petrol included. In the environmental assessment the following processes are taken into account:

- The composition of the car fleet can be characterised by a division in four classes: 70% (class A); 15% (class B); 10% (class C); 5% (class D). In each of these classes, the entrepreneurs choose the most fuel efficient cars.³
- All cars in the Car Sharing scheme have a maximum age of one year. Moreover, these cars are always the newest models and of the latest technology.
- The cars are generally replaced after about 8 months and find their way to the private market.
- All cars take unleaded petrol.
- With respect to maintenance and repair, Car Sharing organisations follow the conventional procedures for all new cars.

5. Payment

All bills are collected automatically. Based on the electronic data on car use, the computer calculates the charges for each household. Every month the invoice is paid automatically.

The average private car

The average private car forms the frame of reference for Car Sharing services. Data with respect to the different environmental impacts of an average private car (CE, 1997) can be found in SimaPro 3.0 (Goedkoop, 1999) and in IDEMAT (Remmerswaal, 1999). We used these standard data for our analysis. The values in these databases are mainly derived from standard statistics of CBS and refer to cars in private ownership. On average, the privately owned car uses 68% petrol, 20% diesel and 12 % LPG. Standard repair, maintenance and end-of-life treatment are also taken into account.

Environmental data on the various travel modes

For the second environmental assessment, we also need to have environmental data on the various travel modes. For the alternative travel modes, all environmental effects are attributed to emission values per mileage (Oude Elberink *et al.*, 1999). The data on the various travel modes used for the environmental analysis are shown in table 10.1.

3 The data on the composition of the car fleet is based on an interview with the director of AutoDelen (Bosboom, 1999). The data on fuel usage is based on the technical data of the car manufacturers.

With regard to the bicycle, it is assumed that the environmental impact can be neglected in relation to that of motorised transport. For the bus reliable data were available from CE (1997).

With regard to the environmental impact of the train, recent data became available at the third International Conference on Eco-Balance in Japan. These data were verified in contacts with the Dutch Railways (NS Materieel, 1999). The environmental data on cars from Car Sharing schemes were calculated on the basis of the inventory described above and recent data on fuel consumption of those cars used in the current Car Sharing schemes (Oude Elberink *et al.*, 1999).

Table 10.1 Overview of the data used, regarding the various travel modes

	Bus	Train	Car sharing vehicle	Average private car
Fuel consumption	0,33 (l/ KM)	71,9 MJ/ KM	0,064 (l/ KM)	0,084 (l/ KM)
Occupation rate	37%	37%	household	household
Source	CE, 1997	EcoBalance, 1998	Oude Elberink <i>et al.</i> , 1999	SimaPro 3.0; CE, 1997
Product-life (KM)	800.000	14.400.000	200.000	200.000
Total weight	10.300	192.000	827	1065
Steel	7.210	150.000	578	745
Plastics	515	4.000	81	105
Aluminium	721	10.500	65	84
Glass	412	4.000	31	40
Rubber	515	4.000	58	75
Copper	206	14.000	8	10
Lead	41	765	5	6
Oil	-	1120	-	-
Rest	721	4.000	-	-
Source	CE, 1997	NS, 1999; CE, 1997	Oude Elberink <i>et al.</i> , 1999	SimaPro 3.0; CE 1997

Mobility behaviour

All data with respect to the use of the various travel modes are taken from our empirical dataset, as presented in chapter 9. For the use of cars, both private cars and cars from Car Sharing schemes, we can use the data expressed in mileage per year. With respect to the data for the train and the bus, the frequencies of use per week had to be multiplied by the average trip length for each travel mode, 46,0 KM and 8,9 KM respectively (CBS, 1997)

10.3.3 The impact tables

The environmental metabolism of Car Sharing services

After defining the relevant processes and gathering the environmental data for all processes, all impact scores were compiled and divided into various classes or impact categories. This resulted in an impact table, expressing the emission equivalents of all impacts for each of the impact categories. The first impact table (table 10.2) shows a comparison between the impact of the average privately owned car and the impact of Car Sharing.

Table 10.2 The impact table of the comparison between the average Dutch car and Car Sharing

Impact category	Unit (in KG- equivalents)	The average Dutch car/ km	Car Sharing/ km
Greenhouse	kg CO ₂	.227	.176
Ozone	kg CFC 11	5.25 E-10	4.07 E-10
Acidification	kg SO ₂	.0019	.00167
Eutrophication	kg PO ₄	.000297	.000273
(Airborne) heavy metals	kg Pb	8.55 E-8	6.48 E-8
Carcinogenic substances	kg B(a)P	2.75 E-9	2.11 E-9
Winter smog	kg SPM	.000448	.000247
Summer smog	kg C ₂ H ₄	.000678	.000638
Pesticides	kg active substances	0	0
Energy	MJ	3.35	2.63
Exergy	MJ	3.35	2.62
Solid	Kg	.00828	.00638

The changes in environmental impact after the adoption of Car Sharing services

For the second assessment, which involves comparison of the adopters' mobility behaviour before and after the adoption of Car Sharing services, a calculation on the total environmental effects was made as well. Table 10.3 shows the results of the environmental effects, expressed in the units of each of the impact categories.

Table 10.3 The impact table of the comparison of the mobility behaviour of adopters, before and after adoption

Impact category	Unit (in KG equivalents)	The entire mobility behaviour of an average adopter, before adoption	The entire mobility behaviour of an average adopter, after adoption
Greenhouse	kg CO ₂	2650	2090
Ozone	kg CFC 11	4.7 E-6	2.95 E-6
Acidification	kg SO ₂	23	19.1
Eutrophication	kg PO ₄	3.23	2.52
(Airborne) heavy metals	kg Pb	.00107	.000875
Carcinogenic substances	kg B(a)P	2.68 E-5	1.82 E-5
Winter smog	kg SPM	6.78	5.95
Summer smog	kg C ₂ H ₄	6.06	4.09
Pesticides	kg active substances	0	0
Energy	MJ	43700	37100
Exergy	MJ	43900	37500
Solid	Kg	98	78.2

10.3.4 The environmental metabolism of Car Sharing services

The first environmental assessment aims to compare Car Sharing with the privately owned car. Both can be seen as solutions that offer access to and regular use of a car. In this assessment we make a comparison between the two options. The functional unit is defined as the use of a car in a household over one year over a distance of 5660 km, which is the average carmileage in a Car Sharing scheme.

Figure 10.2 shows the results of the comparison between the environmental impact of Car Sharing and that of the private car. The results are expressed in the Eco-Points of the Eco-Indicator (Goedkoop, 1995) and in Eco-points for the various impact categories. The figure shows a comparison between the environmental effects of the use of an average Dutch car and the effects of the use of Car Sharing services for a similar yearly mileage. For both options also the shares of environmental impact of the car itself (construction, maintenance, repair and waste treatment) and the environmental impact of the car use are shown.

The main conclusion from this analysis is that the environmental impact of one kilometre of transport by Car Sharing is an estimated 14% lower than that of the average Dutch car in private ownership. This reduction is the result of several factors. The main factor is the relatively light weight of the cars used in the service scheme in comparison with the average Dutch car, which results in an estimated 13% reduction in fuel consumption. Due to the smaller weight of the cars used in the service scheme, also the environmental impact of the production of the car is less (minus 23%).

Figure 10.2 The comparison between the environmental impact of Car Sharing and the private car

Furthermore, from figure 10.2 can be concluded that there are no substantial changes in the nature of the environmental impact. The most important environmental impact is acidification, followed by summer smog and the greenhouse effect.

Theoretically, Car Sharing services have the potential to reduce the amount of (parking) space with a factor 12 (- 88%) because one car is shared by twelve households. This factor is, however, only of theoretical value because in practice not all adopters will substitute their private car for Car Sharing.

10.3.5 The integral environmental assessment of the adoption of Car Sharing services

In this second analysis we aim to make an integral assessment of the changes in environmental effects after the adoption of Car Sharing services. The environmental effects of the changes in mobility behaviour are an integral part of this analysis. Therefore, the functional unit was defined as the entire mobility behaviour of a household that adopted Car Sharing over one year. The comparison consists of an assessment of the environmental effects of the entire mobility behaviour before and after adoption, among all adopters. This means that not only the use of the car, but also the use of the bicycle, bus, and train have to be taken into account.

Compare boxes; Method: SimaPro 3.0 Fco-indicator 95/Europe g/indicator

Figure 10.3 The environmental impact of adopters of Car Sharing, before and after adoption

Figure 10.3 illustrates the reduction in environmental impact as a result of the adoption of Car Sharing services. The first column shows the average Dutch household (CBS,1998), as a point of reference. The second column shows the environmental impact of the entire mobility behaviour of the adopters before adoption and the third column the environmental impact after adoption of Car Sharing services.

From these figures can be concluded that the group of adopters has a relatively environmentally friendly mobility behaviour in comparison with the Dutch average. Before adoption, the environmental effects of their mobility behaviour were already an estimated 23% below the Dutch average. The main reason for this is their rather low car mileage before adoption.

The adopters reduce their environmental impact, expressed in terms of Eco-Indicator points, with an estimated 21%. Their total environmental impact after adoption, is even an estimated 40% lower than that of the average Dutch household. All three major environmental effects, "acidification", "summer smog" and the "greenhouse effect" have almost proportionally been reduced.

Figure 10.4 The changes in environmental impact over the various impact categories

In figure 10.4 above, the environmental effects are shown for the various impact categories. From a transportation and environmental policy point of view, it is important to notice how the adoption of Car Sharing reduces (- 21%) the greenhouse effects because of mobility. In comparison with the average Dutch household, the contribution to the greenhouse effect of Car Sharing adopters is an estimated 38% lower. This lower contribution can be traced back

almost completely to the reduction in CO₂ emissions. With respect to the effects on acidification, we calculated a reduction of 17%, and with respect to summer smog even a reduction of 32%. However, the figure clearly shows that the acidification is the most important environmental effect of all impact categories.

To explain the reduction in environmental impact, it is useful to make a distinction between the environmental impact of the use of public transport and the impact of the use of cars (figure 10.5). In the first two columns, the environmental effects of the car use and public transport use of the average Dutch household are shown as reference points. The same division is shown for the adopters, before and after adoption respectively.

It is clear from this analysis (figure 10.5) that for the average Dutch household the contribution of the use of public transport to the total environmental impact is marginal (3%). Among adopters, the environmental impact of public transport use before adoption is relatively much higher (32%). After the adoption of Car Sharing, the environmental impact of public transport use increases by 32%, whereas the impact of car use falls with 38%. It can be concluded that both in the situation before and after adoption, the importance of car use in the environmental assessment exceeds that of public transport use. Furthermore, it can be concluded that the reduction in environmental impact is largely the result of a substantial reduction in car use, despite a relatively small increase in the use of public transport.

Compare boxes; Method: SimaPro 3.0 Eco-indicator 95/Europe g/Indicator

Figure 10.5 The changes in environmental impact due to car use and public transport use

As we saw in chapter 9, there is substantial variation in changes in mobility behaviour among the adopters. We distinguished three major adopter groups: the (formerly) carless, who didn't own a car before adoption; the substituters, who substituted their car for Car Sharing and the second car drivers, who still own a car and are using Car Sharing as a second car. The results of the environmental assessment can be presented for these three groups as well (figure 10.6). For each of the market segments the environmental impact of mobility behaviour before and after adoption is shown. We can conclude that although the environmental impact is reduced in only two market segments, they are the two largest segments. The carless reduce their environmental impact after adoption with an estimated 14% and the substituters with 48%. The second car drivers, which currently form only 9% of the overall population, increase their environmental impact with an estimated 4%. Obviously, the substituters are the most interesting target group from an environmental policy point of view.

The variation in changes in environmental effects is largely explained by the variation in changes in mobility behaviour among the three adopter groups (see also chapter 9). The substituters show the largest reduction in car use, whereas the second car drivers increase their mileage with 3%.

Compare boxes; Method: SimaPro 3.0 Eco-indicator 95/Europe g/indicator

Figure 10.6 The changes in environmental impact over the three major adopter groups

If the analysis is made with respect to car use only (figure 10.7) conclusions are similar. The two major market segments reduce their environmental impact of car use. The carless with an estimated 35%, the substituters even with 69%. In contrast, the second car drivers increase their environmental impact of car use merely with an estimated 2%. Based on these analyses it can be concluded that there is little reason to believe that any substantial counterproductive environmental effects of Car Sharing schemes exist.

Compare boxes; Method: SimaPro 3.0 Eco-indicator 95/Europe g/indicator

Figure 10.7 The changes in environmental impact of car use for the three adopter groups

Environmental impact in terms of EPS-Indicator scores

The results above were verified by applying another valuation method, the EPS indicator (Steen and Ryding, 1990). All analyses lead to similar conclusions. Figure 10.8 shows the results of the analysis of all environmental effects for all adopters, before and after adoption.

Compare boxes; Method: EPS96/EPS/indicator

Figure 10.8 The changes in environmental impact expressed in EPS-Indicator points

The reduction in environmental impact, as a result of adoption of Car Sharing is an estimated 27%, expressed in EPS points (in Eco-Indicator points this value is 21%). The environmental impact of adopters is an estimated 47% lower than that of the average Dutch household (in Eco-Indicator points this value is 40%). Although the percentages show small differences, the tendencies and conclusions are similar to the analysis made with the Eco-Indicator method. We therefore conclude that the analysis with the EPS indicator confirms our conclusions.

Changes in parking space needed

One of the most obvious effects of Car Sharing schemes is that it saves scarce space. Although conventional environmental assessment methods hardly pay any attention to effects on space requirement, this is slowly moving into the heart of the environmental debate (see e.g. de Boer, 1995 or Wackernagel and Rees, 1995). The great pressure on free space in the economy and the importance of space for a properly functioning ecology make this effect worth investigating.

On the basis of the empirical research data on changes in car ownership and the data on the organisation of Car Sharing schemes, it is possible to estimate the number of parking places saved. Based on the average area of about 12,5 square meters for a parking place (CROW, 1996), the total amount of space saved can be calculated.

Figure 10.9 Changes in the amount of cars (per 1000 households)

Figure 10.9 shows the changes in the number of cars per 1000 households. These numbers can be considered representative for current Car Sharing schemes. On average, every 1000 Dutch households own 887 cars (CBS, 1997). The number of cars among the adopters can be estimated at 367 cars per 1000 households. After the adoption of Car Sharing this number is reduced with 44%, to 204 cars. This means a reduction of 163 parking places per 1000 households, which equals 2038 m².

In comparison with the average Dutch household, 683 fewer cars are used for the provision of mobility by car, which equals 8538 m². It is, however, important to note that each group travels a different yearly mileage by car.

10.4 Conclusions

In this chapter we made an attempt to answer our research question regarding the actual environmental effects of the adoption of Car Sharing services. In a variety of ways we made a quantified assessment of the changes in environmental effects among the adopters of Car Sharing services. It must be stressed here that the conclusions from our assessment are based on the assumptions we formulated and our choice of the method of assessment.

We emphasised from the start that we would not only be interested in the assessment of the service system as such, but also in the environmental effects resulting from the changes in mobility behaviour. In order to explain the total environmental effects, in the introduction of this thesis we made the distinction between the environmental metabolism of a system to produce certain units of service and the extent to which units of service are consumed, which directly relates to the use of these systems. In response to the assessments made in this chapter, we are now able to specify the factors that contribute to the changes in environmental effects. These factors can be divided into factors related to the environmental metabolism and factors related to the consumption of units of service. All these factors contribute to the overall reduction of environmental effects with an estimated 21%.

Environmental effects are influenced by changes in the *environmental metabolism* of the system that generates mobility. The following factors are responsible for a more environmentally efficient fulfilment of functions:

- The fleet of cars in a Car Sharing scheme consists of relatively small cars, in comparison with the Dutch privately owned cars. This means that less material is used and less waste is produced.
- The small car size also has a strong relationship with fuel efficiency. Therefore, in Car Sharing schemes consumption of fossil energy is reduced, which has a great impact on the enhancement of the environmental metabolism.
- For part of their trips, adopters use alternative travel modes. All alternative travel modes have a better performance with respect to their environmental efficiency in generating mobility. Especially the substitution of car use by bicycle use generates a substantial overall improvement of the environmental metabolism.

Another set of factors that contribute to a change in environmental effects are the changes in the *consumption of units of service*, represented by the mobility behaviour and the relative use of all travel modes:

- The factor that contributes most to the reduction in environmental effects is the change in car use. Although a small minority of the adopters (9%, the second car drivers) increase their car mileage by 3%, overall there is a substantial decrease in car use (minus 33%).

- The increase in the use of alternative travel modes does not cancel out the reduction in car use. Especially because a larger part of the mobility need is fulfilled by use of the bicycle. The results for the environmental effects are positive.

This analysis shows that, when making an environmental assessment, it is important to include the changes in consumer behaviour, in this case mobility behaviour. Furthermore, the analysis shows there is great differentiation in (the changes in) mobility behaviour and subsequent environmental impact. Among the three market segments, there is substantial variation in the changes in behaviour. From an environmental perspective, the group of substitutes is by far the most interesting. They reduce their total environmental impact with an estimated 48%, whereas the second car drivers only show a 6% reduction and the formerly carless only reach 14%.

Our assessment of the space saved as a result of the reduction in cars and necessary parking space, has led to the conclusion that the number of cars is reduced by 44%. Per 1000 households this equals an estimated 2038 m² reduction in parking space. When the reduction figures of the various impact categories are compared, the effects on land use seem the strongest.

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 ultimately results in an the aggregated environmental impact on the macro level. As shown in section 1.1, many studies argue that current consumption practices and consumer behaviour cannot be called "sustainable", as defined by United Nations World Commission on Environment and Development. Without any substantial changes these consumption practices present a serious threat to the environment and to human society as a whole. In reaction to this general social problem, we posed the question how consumer behaviour could be changed in order to reduce its environmental impact.

Here, this general question is narrowed down 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 by developing innovative products and services and introducing them to the market. In this approach industry has a key role to play. By offering 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 focussed 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 is sold, instead of the product itself. This strategy is based on a different view on the (economic) value of products, also called "the economic paradigm of the Service Economy" (Giarini and Stahel, 1993). For example, the concept of the Eco-efficient Services strategy suggests that not the mere ownership of cars is of value to people, but the ability to use a car for a certain period of time, to cover a certain distance. Consistent with this assumption, it is the use of a car, and not the car itself, that should be sold.

Based on theoretical considerations, various authors assume that the application of the Eco-efficient Services strategy will lead to the optimisation of the production of the desired units of service (Giarini and Stahel, 1993; Manzini, 1993; Stahel, 1994; 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.

However, as a starting point for this thesis we take the view that the concept of Eco-efficient Services is a theoretical idea that has not been sufficiently tested. There are only a few practical examples that suggest the concept of Eco-efficient Services is more than just a theoretical idea. Our approach towards the concept of Eco-efficient Services is therefore that this strategy needs to be tested in the empirical reality.

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

1. The first research question refers to the **consumer acceptance** of Eco-efficient Services and examines the determinants of the adoption.
2. *The second research question refers to the **environmental impact** of Eco-efficient Services and examines the changes in the environmental impact as a result of the market introduction of Eco-efficient Services.*

To answer these two questions we conducted an empirical study in the field of Car Sharing services in the Netherlands. In the mid nineties, various 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 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. Our empirical study included four of the most innovative service schemes.

This chapter rounds off this thesis with discussions and conclusions on three levels of abstraction. First, we will discuss the results of our empirical study on Car Sharing in the Netherlands and draw some 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. Also, we will outline the environmental potential of Car Sharing services in 2010.

Secondly, we will reflect upon the value of the concept of Eco-efficient Services. On the basis of the results of the empirical study on Car Sharing in the Netherlands, we will discuss the practical relevance of the theoretical concept of Eco-efficient Services and the implications for the wider theoretical framework of Eco-efficient Services.

Thirdly, 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, was subdivided 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 of the scheme as an alternative for the privately owned car. For a long-term social acceptance the innovation must not only be adopted by consumers, but Car Sharing services also must have a high perceived service quality, covering all the service transactions over a longer period of time. A high perceived service quality can be seen as a precondition for the incorporation of the innovation in consumer behaviour in the long run. Both central elements of consumer acceptance (the adoption decision and the service quality perception) were studied in our empirical research:

11.2.1 Research results: the adoption decision on Car Sharing services

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

- Hypothesis 2** Adopters differ from non-adopters in 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 in their perception of the characteristics of the service scheme

Results of testing hypothesis 2

Instead of only testing whether adopters and non-adopters differ, which would satisfy for testing the hypotheses, we investigated the association between the various independent variables and the adoption decision. For marketing purposes, the strength of the correlation between each specific variable and the adoption decision is of particular interest. It not only

reveals the difference between two variables, but to a certain extent also their contribution to the explanation of the adoption.

Hypothesis 2 was only partially accepted. Depending on the group of adopters analysed (the entire population, the former car owners or the formerly carless), a set of explaining variables was found that correlate significantly with the adoption decision. Table 11.1. shows the variables that help distinguish adopters from non-adopters. A positive correlation coefficient indicates that when the value of the explaining variable increases, the adoption of Car Sharing services is more likely.

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

	All respondents N=1143	Carless N=685	Car owners N=458
<i>Social-demographic characteristics</i>			
Children		.15**	
Education	-.12*	-.16*	
<i>Personal characteristics</i>			
Perception of 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**	
<i>Previous practice</i>			
Former car ownership	-.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**	
<i>Physical environment</i>			
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.

Results of testing hypothesis 3

With regard to the role of the perception of the service offer in the decision making process on adoption (hypothesis 3), we concluded that all variables measured 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.

The research results show little differentiation between car owners and carless people. All respondents show 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.

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

	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

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 car owners and carless people.

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

Testing 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 the basis of their past (mobility) behaviour. However, these results raised new questions with regard to their implications. Past behaviour might either be an indication of deliberate reasons to adopt Car Sharing, or refer to the existence of habitual behaviour. In this thesis, we had reason to assume that habits might play a role in the decision making process on the adoption of Car Sharing, because of the highly repetitive nature of travel mode choices. We argued that in the case of habitual behaviour, (non-)adoption can better be explained by past behaviour than by deliberate choices.

To test the assumption that habits play an important role in the decision making process on 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 weighed or by habitual behaviour. The innovation adoption and diffusion theory is entirely based upon the assumption that people make deliberate choices when they decide on 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 11.1 Improved conceptual model on adoption for all respondents

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

By testing hypotheses 2b.III/IV/V, we 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 was operationalised (Meijkamp and Aarts, 1997) as habit strength, which is the extent to which people make a deliberate choice between the car and other travel modes, like public transport and the bicycle.

In our analysis (figure 11.2) we showed that habit strength negatively influences the adoption. When habit strength in travel mode choices increases, adoption of Car Sharing becomes less likely. As a consequence we may expect that the adopters are a highly select group of consumers. They will be less habitual in their travel mode choices.

For a better understanding of the adoption of Car Sharing, the (modest) mediating effect of habit on the attitude-intention-adoption process (the reasoned action), is also important. In the case of a strong habit, the relationship 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. This means that non-adoption could be explained differently than adoption of Car Sharing. In the 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 a negative opinion towards Car Sharing, habitual behaviour seems to play an important role. The mere fact that people do not trade-off between Car Sharing and the private car, or between the private car and other travel modes, keeps them from forming an opinion about Car Sharing and thus from making a deliberate – negative or positive – decision. To convince these people, it is not only important to convince them with arguments, but first and 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 cannot 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), we consider the adoption of Car Sharing to be primarily based on a positive attitude towards this service. To understand the final adoption of Car Sharing, it is therefore essential to determine which factors contribute to the formation of this attitude towards Car Sharing.

The variables that explain most of the variation in the Car Sharing attitude were entered into a multiple regression analysis. We analysed three populations: the entire sample of non-adopters, the carless non-adopters and the car owning non-adopters. In order to exclude the possibility that the attitude is based on direct experience, instead of on an attitude formed without any experience, we excluded the adopters from our research sample and only analysed the non-adopters. Table 11.3 shows the Beta-coefficients of the regression analyses on the Car Sharing attitude and the R-square of the regression equation.

The regression analyses for the three samples did not result 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 the entire sample, the carless people and the car owners respectively.

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

	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 number 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

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 for customer retention, a number of hypotheses were formulated. In our empirical study, we tested the hypothesised relations 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 for 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 for 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 for 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 shows the results of testing the conceptual model for service quality perception. Testing lead 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 on 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 formulated as: “empathy”, “assurance”, “responsiveness”, “availability of cars”, “tangibles” and “reliability”. All these dimensions have explaining power for the overall service quality perception (hypothesis 6a).
- For the technical service quality perception, a three factor solution was found, explaining 81% of the total variance. The technical service quality perception includes three different dimensions: the “reliability of the car”, the “neatness of the car”, and the “flexibility in car choice”. All these dimensions show significant correlation with the overall service quality perception, except for “neatness of the car” (hypothesis 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 that the dimensions of the functional service quality were all included. 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 were found: the price perception of the service (.10) and the evaluation of the distance to the outlet (.11). This means that both a clear price structure of the service, one that stresses the low costs, and an extensive distribution network with excellent locations could contribute to a higher service quality perception. These results suggest that hypotheses 8a, 8b, and 9 must be rejected. Neither the characteristics of the individual

and his mobility behaviour nor the service system 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: consumer research on Car Sharing services

In the previous section we summarised the results of our empirical study on Car Sharing services in the Netherlands and presented 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 from these analyses in a more general sense, and what conclusions we can draw from this empirical study. In this section we will present our main conclusions regarding the adoption decision and the service quality perception.

11.3.1 *The adoption decision on Car Sharing services*

Before drawing general conclusions on the adoption of Car Sharing services, it is important to look at some basic characteristics of our study:

First, it is important to note that the analyses create a rather static picture of the adoption decision process. The analyses make it seem as if all determinants are equally important in every stage of the adoption decision making process. This impression is illusory and is caused by our behaviourist approach. This approach treats the adoption decision process as a black box and just aims 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 caused by the selection of respondents. Only people that had shown interest in Car Sharing services, and that had entered into a certain decision making process with regard to the adoption of Car Sharing services, were selected for our research. The sample is therefore very likely to have a pro-adoption bias.

Thirdly, our empirical research model is mainly of an exploratory nature. This study just aimed to identify the relevant explaining variables for the adoption decision.

Now what can be concluded from the analyses?

- The explanation of the adoption of Car Sharing services varies considerably among the different 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 formerly carless and former car owning households, for example, results in two sets of explaining variables, that overlap only partially. The differences in the explanations are probably caused by differences in the reference situations. Car owning households that are considering to trade in their privately owned car for a Car Sharing service rely on their experiences with car ownership and all its consequences. Carless households seek opportunities to increase their access to car use and increase their mobility. 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 tend to be very cost conscious and are motivated to adopt Car Sharing services because of various negative experiences with private car ownership.

- Habitual behaviour prevents rational decision making

From 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 for different variables) in the explanation of adoption might indicate Car Sharing services have a number of relative advantages over the privately owned car. The fact that Car Sharing services provide substantial financial benefits at a low frequency of car use cannot be denied. However, the fact that past behaviour correlates with adoption also points to the existence of habitual behaviour.

Based on the empirical evidence, we conclude that habitual behaviour plays an important role in the explanation of the adoption decision. 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. So, in convincing those who have a habitual mobility behaviour, the first question is how these habits can be broken and how people can be stimulated to consider Car Sharing as an alternative to the privately owned car.

- Economic savings are the main motivation for adoption of Car Sharing services

If a deliberate decision is made on the adoption of Car Sharing services one major motivation can be distinguished, which 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 of the service. Our study also suggests that economic savings are not the only motivating factor. Parking problems with a privately owned car and extensive care and maintenance tasks are two other – albeit less important – motivations.

- Insight in the real costs of car use is an important boundary condition for 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. To a large extent, the costs for car use consist (62 to 81%, Consumentenbond, 1998) of fixed costs. Despite their large share in the total costs for car use, consumers often neglect the fixed in their travel mode decision making process. 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.

- For a broader consumer acceptance, Car Sharing services should have good accessibility

We also conclude from our analysis that good accessibility of Car Sharing services is an important boundary condition for the adoption of Car Sharing services. 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. 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 in accordance with consumers' wishes. Good accessibility is an important supply-side condition for market success.

- For broader consumer acceptance, Car Sharing services must have a high service quality image

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. 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 the service organisation.

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

We expected the value orientation of consumers to be very important in explaining the adoption of Car Sharing services. However, from our empirical findings we have to conclude that this expectation is not entirely confirmed. Only among former car owners some explaining value of the value orientation could be found. Adopters tend to associate cars more with their negative consequences, and less with values like freedom and welfare. For the so-called substituters, these "anti-car values" clearly provide a strong motivation to change their behaviour. For the formerly carless, however, the value orientation can hardly be distinguished.

- The environmental attitudes have some explaining value For adoption of Car Sharing services among former car owners

Environmental attitudes only have explaining value in the adoption of Car Sharing services among former car owners. People who feel a strong personal responsibility to contribute to a cleaner environment are more likely to adopt. In the overall explanation however, this explaining 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 hardly any impact on the adoption decision.

The adoption decision making process on Car Sharing services

On the basis of our study of the determinants of adoption of Car Sharing services, some conclusions on the adoption decision making process can be formulated:

The nature of the adoption decision making process is strongly influenced by the existence of habitual behaviour. If consumers have weak habits in mobility behaviour, which means they are likely to consider various travel modes for each trip, they follow a process of rational decision making. This process was modelled by Rogers (1995), who distinguishes the stages knowledge, persuasion, decision, implementation and confirmation. Our study followed this line of thought and found that, among those who made a deliberate decision on the adoption of Car Sharing services, his ideas were confirmed.

However, in cases where there is strong habitual mobility behaviour and little consideration of which travel mode to choose, the adoption process must be modelled differently. Here, there is no decision as a result of a deliberate cognitive process. 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 offhand, without any serious and deliberate consideration.

This raises the question whether this habitual behaviour is sustainable over time or whether it can be changed. Various authors (Franke, 1998; Harms and Truffer, 1998) have suggested that it is possible to 'break through' habitual mobility behaviour. Our study also reveals some empirical evidence for the idea that – at certain specific moments in life – people are willing to reconsider their situation with respect to mobility. When, for example, people have an old car that has to be replaced or the costs for repair of their current car are very high, or when people get a new job, change their residence or have children, they 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 individuals could consider. To become a serious option, these services must be available nearby and must provide high quality professional services at reasonable prices. As soon as people are willing to fundamentally reconsider the organisation of their mobility behaviour, they enter into the normal rational decision making process as was 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 average, 90% of the adopters evaluate these service with high or very high service quality. These results can be interpreted as an indication that, at least in some cases, Car Sharing can be 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

As a result 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. 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 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. These results have far-reaching practical implications: In order to retain customers, a service organisation has to focus all efforts on maintaining a constant high level of service quality. Consumers are relatively indifferent about the quality of the car. Instead, they want a smooth service. The way in which the distribution of cars is organised and operated is crucial. Trying to compete on the basis of 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 convenience for the consumer and a smoothly operating service organisation.

- For optimisation of the service, six aspects of the performance of Car Sharing services are important

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 of 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. Clients should always feel that the 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.
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 tangible elements should express the high quality character of the service organisation.
5. All transactions must be correct. This means that payment and all other agreements are handled reliably.
6. Cars must be available at any time. This means 24 hours a day, even in weekends.

- 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, other variables have an impact on the service quality perception as well. 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 see the service as expensive or not, as well as the extent to which cars are provided at a location that is convenient to them, influence people in their evaluation of the service quality. This implies that through an appropriate/ price structure of the service as well as through an appropriate/extensive distribution network with excellent locations, a high service quality is generated. In return, customers will remain loyal to 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 outcome of a study. Especially in a field study – carried out in close collaboration with various entrepreneurs, their clients, and the Dutch Ministry of Transport – the research method must be designed to take into account the boundary conditions and the practical restrictions of all parties involved. Therefore, it is valuable to reflect upon the research methods and procedures and to relate them to the outcome of the study.

One single questionnaire

All empirical data had to be collected in one single cross sectional study. The group of appropriate households that could be approached with a questionnaire was rather limited in size and could be contacted only once. So, given the different research questions and the enormous variety of variables of interest, a rather long questionnaire was inevitable. However, such a long questionnaire does not attract a great response and also does not stimulate a careful response. Despite the extensive questionnaire our response was acceptably large and of good quality, with few missing data. Still, we would have preferred several different questionnaires addressing different kinds of research interests, because then each subject could have been dealt with more extensively. With respect to the perception of transport costs, the perception of the service, the measurement of habitual behaviour, and various background variables, we were somewhat limited in the data available. If there had been an opportunity to investigate specific aspects in more detail, like e.g. the perception of costs, we would 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 one comes across new and highly relevant aspects and variables, such as the importance of habitual behaviour in explaining the adoption of Car Sharing.

Operationalisation of major concepts on theoretical grounds

Because only one single measurement could be taken among the group of households, we had to specify our core concepts on theoretical grounds. There were no possibilities for an operationalisation based on empirical validation. For the operationalisation of service quality perception 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 had been possible, this core concept could have been measured much more efficiently.

Above all, our results show that theoretical concepts not always match empirical reality. The distinction between technical and functional service quality perception might be plausible from a theoretical point of view, but our results show that these concepts are highly interdependent. Given the results of the focus group studies, it is 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 the empirical results from the exploratory research confirm our intuitive assumption that the quality of the car is important for the overall quality perception. If people were offered an old and dirty car for the same price, it is reasonable to expect their service quality perception to be lower.

Pro-innovation bias

In our study we have chosen to include only those households that had either adopted Car Sharing or had rejected the innovation after some consideration. All non-adopters were recruited from a database of people that had once shown interest in Car Sharing by requesting further information. Although this way of selecting non-adopters has avoided problems caused by lack of knowledge about the innovation, it also made the research sample rather in favour of adoption. It is very likely that if the group of non-adopters had been randomly selected from the general public, the differences in the determinants of adoption between adopters and non-adopters would have been more meaningful. There is however no reason

to believe that there would have been great differences in the explanation of the adoption of Car Sharing.

Little variation between 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. There is reason to question whether the four different schemes, that only have subtle differences in service concepts, provide sufficient variation to test this hypothesis properly. Further research is therefore recommended, especially among people that are able to choose from different service offers. We must also take into account that at the moment of research virtually no competition existed among the four service schemes, because they were offered in quite different urban areas. So, the adopters did not have any choice between various service offers. It is reasonable to believe that in case of a choice between various service offers, some will be more convincing than others in getting consumers to substitute their car for Car Sharing. Specific research aimed at investigating which service system is preferred over others, could shed 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 can aid marketing managers in the development of a marketing strategy that attracts more customers. However, the incentives for changing the way in which people fulfil their mobility needs have not become clear. Because habitual behaviour plays an important role in (non-)adoption, specific events or occasions could be expected to be important. Which changes in these background variables lead to adoption could not be established. Qualitative empirical research could have revealed this kind of variables.

Static over time

The data were collected in mid 1996. At that moment, the four different service schemes had been operational for no longer than two years. At the time, these new services were (and still are) in a process of constant change and development. With respect to e.g. the implementation of information technology, the extent of the distribution system, the price structure and the reservation system, all service schemes have since developed further. Our research, however, is tied to the service systems as they were in 1996. Still, we have reason to believe that the results of our study are still valid. In the first place, our study is based on the analysis of the data of four different service schemes. So, the results refer to the concept of Car Sharing rather than to one specific Car Sharing scheme in particular. In the second place, the development in Car sharing services is directed at lifting barriers and enhancing the relative advantages for consumers. Therefore, it can reasonably be expected that this development will not introduce essentially new problems for the adoption of Car Sharing, but will only facilitate the adoption of the innovation.

11.4.2 Reflections on the applied theoretical framework

To study the case of Car Sharing, for the two empirical research questions, regarding the adoption decision and the service quality perception, two completely different theoretical

perspectives were used. Below, we will discuss the value of each theoretical framework separately.

The adoption of Car Sharing services

Given our first research question and 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 on "Diffusion of Innovations" (1995) was an obvious one. His framework explains in general terms how innovations find their way in society, or fail to do so. A similar interest underlies our choice to study Car Sharing services: we expected that this kind of innovative services could contribute to a reduction in environmental impact. The choice for this theoretical framework was also quite obvious because it helps to define measures to improve the adoption of innovation by either marketing-oriented actions or 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 in the analysis of Car Sharing services, this framework helps to understand the problems of adoption and diffusion. It not only provides a structure for the analysis, but it also specifies a broad variety of factors that might affect the adoption and diffusion of specific innovations like Car Sharing services. Our empirical results show that we found confirmation for a variety of variables.

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 can identify the following limitations:

- Although Rogers specifies a decision making process involving 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 is valuable for conducting a behaviourist analysis of the decision making process. It does provide some help in opening the black box of the decision making process. Our analysis shows that by combining a behaviourist analysis of the empirical data with an analysis of the cognitive aspects of the decision making process, insight in the adoption of innovations can be extended.
- The innovation decision model starts from the assumption that innovation adoption decisions are made deliberately. The decision making process involves getting to know about the innovation, followed by forming an attitude towards the innovation, 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 innovation, we find that, to a certain extent, it also limits our understanding of non-adoption. Our research shows that non-adoption is 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 decision. From a practical point of view, understanding non-adoption is even more important than knowing why people adopt. In our opinion, the innovation adoption theory should be modified in such a way that habitual behaviour becomes an integral part of the theory.
- From the outset, we saw the fact that motivational variables like existing values and attitudes are not integrated in Rogers framework as a limitation for our study. Our research

shows that (domain-specific) values indeed have an additional explaining value in both the adoption decision and the formation of the attitude towards Car Sharing. 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 already shown interest in the new service on their own initiative. We expect the explaining effect of motivational variables to increase when the group of non-adopters is randomly selected.

- In his conceptualisation of the innovation decision process, Rogers mentions 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. Rogers' publication (1995) does not make clear how these prior conditions can be fulfilled in order to facilitate adoption of innovations, or by 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 a lot to gain from the introduction of theoretical concepts from the area of service marketing. Especially regarding the explanation of the implementation and confirmation stages of the innovation decision process, a lot of additional clarification is needed. Concepts like e.g. service quality perception, which are central in the evaluation process of services, shed 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 extended 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 (the result of the operational performance of service organisations), the behavioural intentions to remain with or leave certain service provider, and the actual behaviour. In Rogers conceptualisation this would be called continued adoption or confirmation.

The general model for the behavioural consequences of service quality was operationalised for Car Sharing services. For exploratory reasons we extended the model with additional variables like the perceived characteristics, the characteristics of the individual decision maker, the individual's mobility behaviour and the variation in Car Sharing schemes.

On the basis of our practical experience with this conceptual model, we can conclude that this model was more than appropriate for a first empirical study. With a multiple regression analysis, a selection of most important variables could be made to explain the service quality perception. When, in future, the service quality perception is modelled in more detail, a large number of variables can be excluded. It is important to know that service quality perception is independent from the characteristics of the individual and his mobility behaviour. We also found that service quality perception does not vary among different service schemes. We must, however, admit that a more detailed study on how to model service quality perception is required. The following limitations can be used as a guideline for such a remodelling of service quality perception:

- In the research results, the technical and the functional service quality perception, as operationalised according to Parasuraman, Zeithaml and Berry (1988), turn out not to be independent concepts. On theoretical grounds (Grönroos, 1990), 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 seem promising at first glance, their 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) requires an extensive questionnaire with 34 items. Such an extensive instrument is not very efficient in the collection of data. A more condensed measuring instrument should be developed on the basis of further empirical research. Especially for monitoring the operational performance of a Car Sharing service organisations this is an absolute necessity.
- In the theoretical perspective of Grönroos (1990), the perceived characteristics of the service are not mentioned as determinants of service quality. Our exploratory studies show, however, that the 'price perception of the service' and the 'evaluation of the distance to the outlet' have additional explaining power. Both variables refer to characteristics that do not have anything to do with the operational service performance, but are part of the general service offer. Clearly, the theory needs modification here.
- The theoretical framework of Grönroos (1990) does not explain 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 is expected that the perceived price of the service also plays an important role in the service quality perception. We have to conclude that Grönroos' framework has its limitations: too much attention is paid to the 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 of the empirical research: the changes in environmental impact

Our second research question concerns the changes in environmental impact as a result of the adoption of Car Sharing services. In the introduction of this thesis we 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) consumer behaviour in relation to these systems. Both are factors in the total environmental impact.

Two kinds of data were needed to answer this research question: data on the changes in mobility behaviour as a result of adoption of Car Sharing services and an assessment of the environmental efficiency of the Car Sharing system. 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 on the changes in mobility behaviour, we performed a large survey study among the adopters of four different Car Sharing schemes. Based on self-reported behaviour, we gathered data on 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 was supported by widely used software packages like SimaPro 3.0 (Goedkoop, 1999) and IDEMAT (Remmerswaal, 1999). This analysis is presented in chapter 10.

11.5.1 Results of the environmental assessment of Car Sharing services

For analytical purposes, the environmental assessment was divided into two different assessments (see chapter 10). In both cases the changes in environmental impact were calculated. These are the results:

The assessment of the environmental metabolism of Car Sharing services

In the first assessment, the privately owned car was 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% lower than that of the average Dutch car.
- the advantage of Car Sharing schemes is mainly the result of the use of relatively light-weight 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

The integral assessment of the changes in environmental effects of Car Sharing services provides the answer to the second research question. Based on an assessment of the environmental efficiency of Car Sharing services and our empirical data on the changes in mobility behaviour, the overall changes in environmental impact were calculated. These are the most important research results:

- 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 reduction in environmental impact was 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, as a result of their entire mobility behaviour, is an estimated 40% lower than that of the average Dutch household.
- For every environmental impact category, a reduction was calculated. With respect to the changes in impact on the greenhouse effect, an average reduction of 21% was computed.
- 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 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 the

use of public transport and the bicycle, (3) the reduction of the environmental impact of car use through Car Sharing and (4) the fact that all alternative travel modes are more fuel efficient than the car.

11.5.2 Conclusions on the changes in environmental effects

On the basis of the research results discussed above, some more general conclusions can be drawn regarding the changes in environmental effects after the adoption of Car Sharing services. It must be stressed that these conclusions must be seen in the context of the assumptions made for the analysis and our choice for the method of environmental assessment.:

- 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 points, the reduction of environmental effects was calculated at 22%. These calculations were based on empirical data of current Car Sharing schemes and on the changes in the mobility behaviour of adopters of these schemes. The calculations were 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 and 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 and changes in behaviour. The analysis of the research results shows 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 consumption processes. Transport demands a large input of energy resources; it requires fuel. In the total environmental effects, all other processes are of minor importance. Production, maintenance and disposal of vehicles does not account for more than 15% of the impact per unit of service. Increasing the fuel efficiency of all transport means is therefore the best way to reduce the environmental impact.

- Car Sharing services do not show the expected improvement of environmental efficiency.

Various authors (Jansen and Vergragt, 1993; Vermeulen en Weterings, 1996; von Weizsäcker et al., 1997; Fussler, 1996 and Brezet, 1997) expected great potential from innovative products and services in reducing the environmental effects. Car Sharing services were frequently mentioned as a concept with high potential. As an innovation that further optimises the way in which a function is fulfilled, the concept of Car Sharing has often been associated with environmental improvement factors of 4 or even 10, since it is. However, our study shows that these expectations of possible improvement rates might be too optimistic,

at least in 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, is mainly the result of the use of relatively small cars.

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

- Of all the environmental impact categories, the largest reduction in environmental effects is achieved by the reduction in parking 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 the impact categories are compared with respect to their 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 parking space in urban areas.

- Car Sharing schemes are an effective instrument for reducing 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 effective instrument for reducing CO₂ emissions, which are the main cause for the greenhouse effect.

- There is substantial variation in the changes in environmental impact among market segments.

A more detailed analysis of the changes in the environmental impact shows that there is great variation among the various market segments. The group of adopters that substitute their car for Car Sharing service reduce their environmental impact the most, by 48%. This variation provides a useful basis for a more selective policy on the adoption of Car Sharing services, from both an environmental and transport policy perspective.

- The factors that contribute to a reduction of environmental effects can be divided 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. The following *behaviour-oriented 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 smallest and most fuel-efficient car possible for a certain trip helps save energy.

The following *system-oriented factors* can be distinguished:

1. Use of the newest and most fuel efficient vehicles creates a relative advantage over the average car.
2. Selection of the most energy-efficient and lightweight vehicles within a certain car class makes 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 were formulated (see chapter 2). In response to the question "How would the Eco-efficient Services approach affect the environmental effects?" we distinguished a variety of mechanisms that would affect the environmental effects of so-called Eco-efficient Services. As Car Sharing can be seen as a specific example of the concept of Eco-efficient Services, it is valuable to reflect upon these assumptions in the light of our empirical results.

- The Eco-efficient Services approach will stimulate a continuous improvement of a consumption practice towards higher environmental efficiency.

This rather abstract assumption is based on theoretical ideas concerning the so-called "Service Economy" (Stahel, 1993). In the context of the Service Economy it is expected that if producers get paid for the utilisation value of artefacts, they 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 provision of units of service. In practice, this means an improvement of the entire service organisation, resulting in a reduction in the use of resources (hardware, time and money).

In the practice of Car Sharing only weak empirical evidence for the existence of this mechanism could be found. The main reason for this might be the fact that Car Sharing schemes are still in an early phase of development, and their size is still small. Their first goal is to up-scale the service organisation and attract more clients. For the further optimisation of the existing schemes, great effort is put into the implementation of new information technologies that allow electronic identification of clients and exact registration of car use, and offer possibilities for car fleet management. These measures are necessary for a profitable service operation, but from an environmental point of view they hardly make any contribution to the functional efficiency. They make it possible to operate the service using less cars and service personnel, but they do not reduce the overall environmental impact substantially.

Another reason for the conclusion that there is only weak empirical evidence, is that in the current service schemes cars are used for a maximum of 2 years. After a certain period of time the vehicles are sold. This means that the life-extension of cars (as a result of special repair and maintenance treatment) cannot be measured, since repair and maintenance issues only become important after a number of years.

The only observation that confirms the continuous improvement towards higher environmental efficiency, is the fact that various entrepreneurs always choose the most fuel-efficient cars. Fuel efficiency directly affects their profit margin because they charge a price per kilometre in which petrol is included.

- As a result of the enhanced service efficiency of these products, the number of products needed at a specific moment to fulfil market needs will substantially be reduced.

True to the nature of the service, Car Sharing indeed reduces the number of vehicles needed to provide a group of consumers with mobility by car. However, our study shows that the number of vehicles depends on the composition of the group of adopters and on 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 parking space needed.

Because the total car mileage is reduced by 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 depend on the actual use of the car and not on its availability. The main reason for this is that the factor time does not play a role in 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. Clearly, 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 one year. With the constant improvements in fuel efficiency, Car Sharing schemes are always more than six years ahead with the application of new technology. It must be admitted that most cars are sold after one or two years of use in a Car Sharing scheme and that these cars still have a – limited – second life.

- *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 its effect on the reduction of the environmental impact can not be measured 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 opportunities for – and profitability of – high level reuse, i.e. the reuse of parts and subassemblies and thus facilitates the recycling of materials.

For this mechanism no empirical evidence is found either. As Car Sharing schemes are still rather small, in comparison with 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 use. So, no collective end-of-life treatment is possible.

- With product-use services, individuals are not bound by an economic investment. 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 the case of individual product use and ownership, the investment a product stimulates, for reasons of decreasing marginal costs, the use of only that specific product. For this reason, the economic investment prevents flexibility in the choice between options that fulfil a specific consumer need.

Although our empirical study does not provide the data to confirm the existence of this mechanism, in the case of Car Sharing services it is very likely that 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 will more often choose alternative travel modes. It is however doubtful whether they do this for reasons of environmental efficiency. We assume that the choice for alternative travel modes is primarily motivated by economic and practical reasons.

11.5.4 Reflection on research method

In performing the environmental assessment, our experiences with the application of the LCA method and the guidelines of SETAC have been very helpful. Through its life-cycle approach and its integrated product-systems approach, the method offers insight in the factors that determine the total environmental impact and the major impact categories. The results of the LCA clearly show the multidimensionality of environmental effects.

However, the results of the LCA study can only be evaluated within 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 used. In other words, LCA studies are in essence an approximation of the empirical reality with regard to the environmental performance of products and processes. Therefore, the results of an LCA cannot be interpreted as an absolute environmental profile. They are however valuable for the comparison between Car Sharing and other alternatives and for the quantification of the changes in environmental effects after the adoption of Car Sharing.

Of course the quality of the results of a simulation depends on the quality of the data used as input for the analysis. For the analysis, both data on changes in mobility behaviour and data on the environmental effects of various processes were used. It is important to note that the data on mobility behaviour are from our own empirical research. The other data were gathered 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 on the changes in behaviour were collected through self-reported behaviour. The respondents were asked to estimate their car mileage 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. If there had been no financial or time restriction for our study, we would have preferred to carry out a longitudinal study based on frequent reports. However, in the area of transportation research our method is frequently used. Especially because we are mainly interested in changes in mobility behaviour, we see this method as appropriate.

Data collection: the Car Sharing schemes

Our environmental assessment was strictly limited to current Car Sharing schemes. With a further development of these service systems and a further professionalisation of the service organisations, the environmental consequences will certainly change. In the future, different groups of users might be reached and convinced, which might result in quite different behavioural effects of Car Sharing schemes. Also the environmental metabolism of Car Sharing schemes might change as a result of adaptations in the service system. Based on the assumptions regarding these changes, some predictions can be made with respect to the environmental impact of future Car Sharing systems.

The environmental assessment was based on assumptions about the current Dutch Car Sharing schemes. As shown in chapter 3, a variety of Car Sharing schemes can be distinguished. When we compared the operational differences of these services to our assumptions, we concluded that these differences will have hardly any influence on the environmental effects. The main 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, fuel consumption has a strong impact on the environmental effects.

Environmental assessment

The environmental assessment aimed at comparing the environmental metabolism of the average private car with that of Car Sharing. Both are solutions to get mobility by car. Our comparison was 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 concluded that the one dimensional character of the environmental assessment (based on a functional unit) did not entirely represent the multidimensional reality of 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 was also 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 subsequent changes in environmental effects, can be attributed to the adoption of Car Sharing. In other words: to what extent does a causal relationship exist between these changes in behaviour and the nature of a Car Sharing scheme?

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

11.6 The environmental potential of Car Sharing services in 2010

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

The question then arises to what extent Car Sharing service could contribute to the environmental policy aims. The results of 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. To assess the merits of a large scale implementation of Car Sharing, we calculated the environmental potential of Car Sharing services in the future. On the basis of the results of our empirical study we made a number of assumptions for 2010, which are presented below. Our assessment of the potential is of a rather speculative nature. It is important to note that the conclusions on the environmental potential of Car Sharing services are based on these assumptions.

11.6.1 Car Sharing services in 2010: the assumptions

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

1. the market penetration of Car Sharing schemes in 2010
2. the use of the various 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 households participating in Car Sharing schemes. The division over the various user groups has changed to 30%, 50%, and 20% for the "carless", the "substituters" and the "second car drivers" respectively.

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

Table 11.4 Market penetration of Car Sharing services in 2010

	Composition population in 1999	Composition population in 2010	Number of Dutch house- holds in 1999 (in millions)	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 car drivers	9 %	20 %	1,0	8 %	80.000
Total	100 %	100 %	6,5	6,2 %	400.000

The assumptions regarding 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 convinced in the short term, but the number of carless households from which new customers can be attracted is relatively small, only some 1.5 million households. About 25% of these households have a net income of more than about 31.000 guilders a month. We assume that 8% of the entire population of carless households is interested in the ability to use frequently a car through a Car Sharing scheme. The group of households with one car, from which potential substituters can be attracted, is relatively large. In the long term, this group represents the largest sub-population although they are currently most difficult to attract. For the substituters, Car Sharing services offer 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 estimated number of households in 2010 is a conservative estimate based on current values (CBS, 1998). Foreign studies have arrived at similar estimations. Baum and Pesch (1994) estimated the market potential of Car Sharing in Germany at 3% of the population and, based on a recent study of Muheim (1998), the Federal Swiss Governments estimated the market potential even at 9%. Our estimate fits in well with these values.

Assumptions on the use of the various travel modes in 2010

The use of the various travel modes is essential for the total environmental effects. Our calculations are based on the following assumptions:

In the assessment only the use of motorised travel modes will be taken into account.

The level of reference is calculated on the assumption that the adopters in 2010 have a similar mobility behaviour as the current adopters in our study. Obviously, the changed composition of the group of users, which has large implications for mobility behaviour, is 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.

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 were taken from our empirical study.

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

In the environmental assessment the use of all motorised travel modes is taken into account. These are our 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.
- On the basis of estimations of the car industry (Automotive Engineering International, 1998), the average fuel consumption in 2010 can be estimated at 4 litres per 100 km, which means an average reduction in fuel consumption of 33%. We assume that by 2010 various improvements and innovative technologies will have been implemented.

- The average age of a car increases from 7,82 years to an estimated 9,65 years. This estimate is based on the extrapolation of the improvements over the last 15 years (CBS, 1998). We therefore assume that the improvement in the fuel efficiency of the average Dutch car is not more than 28%.

As a result of the assumptions above, the calculations on the future environmental effects of Car Sharing schemes will only have relative value. This causes no problems, however, because our main interest lies in the **change** in environmental effects.

Assumptions on the environmental metabolism of Car Sharing services in 2010

At the moment, Car Sharing systems are still in development. Therefore, we do not expect that in 2010 the Car Sharing schemes will have remained 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 a further fine-tuning 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. On the basis of these assumptions, we are able to estimate the potential for improvements in the environmental effects of Car Sharing services per unit of service. We assume that in 2010 the following changes and improvements will have been realised:

- Given our current experiences with Car Sharing services, it seems possible to enhance the utilisation efficiency even further, to 1 car for 20 contracts. This can be realised through changes in mobility behaviour of the adopters over a number of years and through measures aimed at the reduction of non-productive time.
- Given the economic interests of the entrepreneurs to reduce fuel consumption, they will choose the most fuel efficient car available in the market.
- Fuel consumption is expected to be further reduced, with an estimated 5%, because of 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 on the monthly bill and rewards for fuel efficient driving, participants can be stimulated to use the car more efficiently. This effect can be even stronger when so-called 'econometers' are installed in cars. On the basis of empirical research, Bongard (1990) concludes that by changing people's driving behaviour a reduction in fuel use of more than 10% can be realised. We hold on to our conservative estimate of 5%.
- In 2010, the life span of the car, expressed in mileage, will have increased by an estimated 20%. Through an increase in the economy of scale, it will become more profitable to keep cars longer in the service system. Maintenance and repair will not be outsourced anymore. Because extending the lifetime of the car directly affects the economic results, more effort will be put into maintenance and repair, which will lead to an extended product-life.

11.6.2 The environmental metabolism of Car Sharing services in 2010

In 2010, Car Sharing schemes will be quite different from the current ones and their environmental metabolisms will have changed too. First, we assess the potential for environmental improvement of Car Sharing service, based on the functional unit, which is defined as the provision of mobility by car for one household over one year. The analysis was made for the average car mileage 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 car use in a current Car Sharing scheme. For each of these three options, also the impact resulting from the average use and the production of the vehicle is shown.

The comparison shows that Car Sharing schemes have an estimated potential for improvement of 35%. A large part of this potential for improvement can be explained by the assumed 33% increase in fuel efficiency as a result of more fuel-efficient vehicles and a more efficient driving style. The increase in the life span of the car reduces the impact for the production of the car from 43 to 33,3 μPt (-33%).

In comparison with the average current Dutch car, the environmental impact of a future Car Sharing scheme is an estimated 44% lower, at a constant mileage. In 2010, however, the average Dutch car will also have become more fuel-efficient. On the other hand, Car Sharing schemes will have the advantage of always using the latest – and therefore most fuel-efficient – technology. Privately owned cars disappear from the market only after 10 to 15 years.

Based on the assumption that the composition of the group of adopters changes substantially, we can estimate the changes in the number of cars needed for the provision of mobility and thus the changes in the amount of (parking) space required. For this estimate, we assume that the group of adopters will consist of 30% “formerly carless people”, 50% “substituters”, and 20% “second car drivers”. Figure 11.5. below shows the results of the calculations.

In 2010, an estimated number of 300 parking places are required for every 1000 households, which adds up to about 3750 m². Compared to the situation before adoption (in 2010), this means an estimated reduction of 65%. Expressed in square meters, the reduction is estimated at 7000 m² per 1000 households. In comparison to the situation after adoption in 1999, however, the amount of parking space needed per 1000 households has increases by 47%. This is an effect of the relatively strong increase in the number of “second car drivers”. They all still own (at least) one car and in addition subscribe to a Car Sharing organisation.

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

11.6.3 The environmental potential of Car Sharing services in 2010

On the basis of the environmental metabolism of Car Sharing services in 2010, as calculated above, and the other assumptions formulated, the environmental potential of Car Sharing services can be calculated. The calculation was performed for the entire user group of 400.000 households. Figure 11.6 below shows the results of our calculations. The environmental impact is expressed in Eco-Indicator points. For all three user groups the potential changes in environmental impact were calculated. The figure shows the number of Eco-Indicator points 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:

- The 400.000 households could reduce their environmental impact as a result of mobility by an estimated 30%. For the “carless” this percentage is only 13%, and for the “substituters” 46%. However, the environmental impact of the second car drivers increases with an estimated 5%.
- From an environmental point of view, the substituters are the most interesting group, both in an absolute and in a relative sense.
- These households could save an estimated 0,34 Megaton of CO₂ emissions (31%) and reduce emissions that cause acidification by 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 Car Sharing systems, we concluded that per 1000 households an estimated number of 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. In parking space, this means a reduction 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 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 a number of assumptions, we defined a scenario for 2010 in which Car Sharing services are widely implemented. We formulated assumptions on the market penetration in 2010, the use of the different travel modes, and the environmental impact of all travel modes. These assumptions were formulated based on our best knowledge of the current situation and used to calculate the potential for reductions in environmental effects. Our research data on the current situation were used as reference. Our calculations on the potential for a reduction in environmental effects have led to the following conclusions:

- Current Car Sharing schemes have potential for improvement of their environmental metabolism. The environmental impact of the average use of Car Sharing services can be further reduced with 35%. The measures that need to be taken to achieve this improvement of the environmental metabolism are not challenging.
- Based on the assumptions for 2010, a reduction in environmental impact of 30% for a group of 400.00 households was calculated, supposing these households will change over to Car Sharing services. 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, the conclusion from our calculations 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. In future, Car Sharing service could have such positive effects, particularly in reducing CO₂ emissions and necessary parking space, that it can be recommended to the government to pay special attention to stimulating this development.
- If the Car Sharing services develop according to our assumptions, these mobility services could become an effective instrument for reducing CO₂ emissions. From the recent Dutch policy framework for the reduction of greenhouse gasses, called the "Uitvoeringsnota Klimaatbeleid" (VROM, 1999), we can conclude that Car Sharing services could contribute an estimated 0,34 Mton to the reduction in CO₂ emissions. Also with regard to the policy target for the field of transport (2,9 Mton in 2010), this potential reduction seems to be an interesting contribution. Compared to all other policy measures, this would be a very important 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 were chosen as the subject of our empirical study. Car Sharing was seen as a good example of the theoretical concept of Eco-efficient Services. This case study provided an interesting field for our empirical investigations

into this concept. On a higher level of abstraction, 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 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 for 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. Because there are too many differences among the services of the three categories of Eco-efficient Services, it is very hard to generalise from only one study on one particular case. Generalisation is equally difficult for the adoption of services, the service quality perception, and the changes in consumption behaviour after the adoption of the new service. The following differences among the Eco-efficient Services make generalisation difficult:

- the extent to which property rights are handed over to customers
- the mechanisms that lead to improvements in environmental efficiency
- the organisation of the service provision 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 related to the ownership of goods
- the cost structure of product use
- the extent to which a certain product requires maintenance and repair
- the extent to which financial risks are involved over the life cycle of the product
- the transaction costs for transferring the goods to customers
- the extent to which alternative consumption practices are available

All these differences make the diversity among the Eco-efficient Services too great to generalise the empirical findings on 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 an isolated case, this study has 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 number 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 solutions to optimise the functional efficiency. In innovation processes, it is very productive to identify problems in consumption in order to focus the activities on development.

Moreover, this approach is very much designer-like and reflects their design activities (Dorst, 1997).

- The concept certainly helps to transform "life-cycle-thinking" into new business opportunities. Not only from an environmental point of view, but also from a 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 incorporate all costs over the entire life cycle in the development of innovative solutions. It creates new boundary conditions for business interest in more economically and environmentally efficient solutions.
- In addition, the concept of Eco-efficient Services provides a set of ideas of how this extended producer responsibility (Lindhqvist, 1992) 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 could 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 product system is improved and 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 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 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.

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 some more specific lessons can be learned. Because the empirical results on Car Sharing services cannot 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 treated as normal innovations as to 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 that of other kind of innovations.

- The relative advantages of Eco-efficient Services, as perceived by the consumer, are essential in adoption.
- The perception of fixed and variable costs has an important impact on the adoption of Eco-efficient Services. If there is no insight among consumers in the entire life-cycle

costs, especially in all variable costs over the service life of the product, Eco-efficient Services will meet with little acceptance in the consumer market.

- The environmental attitude only plays a subordinate role in the adoption decision of Eco-efficient Services.
- Consumers only give up ownership of goods and buy services instead, when the transaction costs, both in terms of time and money, are relatively low. This also implies that these services must be easily available wherever and whenever needed.
- For 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 consumer behaviour after the adoption of Eco-efficient Services are difficult to explain and vary substantially over different market segments.
- Strong habitual behaviour prevents 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 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, consumer behaviour could be changed, which would lead to a reduction in 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.

From our study on Car Sharing services in the Netherlands we conclude that the concept of Eco-efficient Services certainly is valuable for the process of change towards Sustainable Development and Sustainable Consumption. For several reasons however, the value of this concept in the process of change is only complementary and limited:

- The concept of Eco-efficient Services is basically an innovation strategy by which the environmental efficiency of specific consumption practices can be enhanced. It merges the economic interests of companies with the societal interest to reduce the environmental impact of production and consumption. This results in a further optimisation of certain consumption practices with respect to their environmental efficiency. 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 consumer 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 only contributes 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 likely to vary tremendously among the various markets 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 about 14% less environmental effects, it can reasonably be expected that in other cases the increase in environmental efficiency will be much higher (see e.g. Goedkoop et al., 1999).

- It is questionable whether the Eco-efficient Services strategy could contribute to a "sustainable" society. This innovation strategy 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. However, 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 questionable whether Eco-efficient Services, as a specific kind of innovation in function fulfilment, will ever result in such improvement factors. 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 also 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 the development of new markets and therefore new sources of pollution.
- The context in 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 not account for the possibility of changes 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 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 just aims to provide a more environmentally efficient alternative for this demand. It does not raise any questions regarding the justification of the demand for a certain functionality from an environmental point of view (see SustainAbility, 1996). The absence of criticism towards certain consumption practices can be seen as a limitation towards a more "sustainable" society.

12 Epilogue

The end of a long study like this is always somewhat arbitrary. In the process of research, many questions are raised, and not all of them can be answered. But to finish such a study, it is absolutely necessary to narrow down and keep focused. However, in the last section one inevitably arrives at the conclusion that one's research efforts were only first attempts at achieving a better understanding of the concept of Eco-efficient Services and that, fortunately, in the outside world the development of Car Sharing services has only just begun. To give others the opportunity to start where this thesis ends and to help practitioners with the insights generated through this study, below I will formulate a number of recommendations. I hope this study will be an inspiring source for new projects, research 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 number of recommendations can be derived that may be useful for Car Sharing entrepreneurs who want to increase the competitiveness of their service and its success in the market:

- To convince the public to adopt Car Sharing as an alternative to private car ownership, accessibility of Car Sharing services must be excellent. This implies that a high density distribution network is indispensable and cars must be available 24 hours a day.
- For their mobility, Car Sharing users also make quite intensive use of alternative travel modes. Therefore, integration of Car Sharing services in public transport services to form an integral package of mobility services would cater to the demands of Car Sharing users.
- Car Sharing schemes are mainly attractive for short individual trips and not for longer periods of use, like long weekends and holidays. Therefore, further integration of short-term rental and long-term rental into one service packages is 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 both improves the reliability of the service and facilitates the efficient allocation of cars.
- To retain customers over a longer period, a smoothly organised service provision with clear service standard, is essential. In the organisation of the service provision process, the aspects "empathy", "assurance", "responsivity", "image of tangibles", "reliability" and "availability of cars" are the core aspects that determine the service quality perception.
- In order to break through habitual behaviour, it is recommended to increase the trialability of the service. Giving potential clients the opportunity to try out the service scheme at low cost, will certainly have a convincing effect on consumers to adopt Car Sharing.

- Marketing communication should be focused on the moments in life when people make strategic decisions about their mobility behaviour and reconsider their options. At these occasions, Car Sharing must become one of the options in the decision making process.
- To convince people to adopt Car Sharing services, a transparent cost structure of Car Sharing services is needed. However, to prove the relative advantages of these services for the individual, not only a transparent cost structure is needed, but also a realistic comparison with the entire costs – flexible *and* fixed – of the privately owned car. In marketing communication, the real costs of a privately owned car must be stressed over and over again.

Recommendations for (transport) policy makers

This study has shown that Car Sharing services can make a contribution to transport policy and environmental policy aims. We concluded that this development deserves further governmental involvement. These are the recommendations to (Dutch) policy makers for stimulating the further development of Car Sharing services:

- A very restrictive parking policy in urban areas is an important incentive for success. High parking prices and great pressure on scarce parking space are important factors that encourage consumers to adopt Car Sharing services. Local governments have many policy instruments at their disposal that can create the right boundary conditions in this respect.
- The large fixed costs of car ownership provide an economic incentive for Car Sharing services, because sharing these costs with others creates economic advantages for consumers. By continuing to tax car ownership, the central government could maintain this economic incentive.
- An important boundary condition for the entrepreneurs that run Car Sharing services is the availability of special parking facilities in the urban area. Local governments should provide excellent parking facilities in the urban areas.
- City planners should consider the demand for special parking spaces at railways stations, park and ride stations and other strategic locations in cities. It is recommended specific guidelines are developed 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 in which alternative travel modes are easily available. So, a further development of public transport services by local governments will help to provide a favourable context for Car Sharing services. It is recommended that the integration of both types of mobility services is stimulated.
- To improve the quality of Car Sharing services, it is recommended that specific projects of Car Sharing organisations, like the implementation of new solutions with respect to information technology, are stimulated and facilitated.
- To stimulate the environmental potential of Car Sharing services, it is important to develop a selective stimulation policy. Only those companies that provide a serious and high quality market offer and highly flexible services should benefit from governmental support.
- It is further recommended that the use of highly fuel efficient vehicles in Car Sharing schemes is stimulated. This would further increase their environmental potential.
- The environmental analysis of Car Sharing services shows that stimulating the use of bicycles 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 more insight into the consumer behaviour and the environmental effects related to the use of this kind of services. Still, a large number of questions still remain unanswered. However, after conducting this study we are now better able 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 incentives can break through old habits and lead to adoption of Car Sharing services?
- What is the role of the background variables in the decision making process?
- How can the perception of car costs (both fixed and variable costs) be explained?
- How can 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 in 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 most successful in convincing consumers to adopt Car Sharing as an alternative to the privately owned car?
- What are the preferences of the various market segments with regard to the service concept?

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 customer retention?
- What role do the perceived characteristics play in the explanation of the 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 can the changes in mobility behaviour be optimised from an environmental perspective?
- What are the dynamics of mobility behaviour over time?
- How can the 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 yet sufficiently tested, this approach can be recommended as an interesting source of inspiration for new innovation opportunities for industry. Based on the literature and our experiences with Car Sharing services, it seems to be an approach that not only leads to environmentally efficient alternatives, but also to strategic advantages in terms of stronger customer relationships and more added value. Moreover, it offers an alternative to competition based on price setting or product quality. This approach is particularly challenging for industry because it focuses on the development of an infrastructure for the provision of services. The concept of Eco-efficient Services is recommended because it offers businesses the opportunity to develop a competitive advantage over others with respect to service quality, instead of relying on technological superiority or lower product price alone.

Recently, Electrolux started an experiment with 7000 households in the context of the "Smart Home project". Electrolux offers these households free washing machines and only charges for the use 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. At the launch of the Smart Home project, Michael Treschow, President and CEO of Electrolux announced that "Pay per wash" would only be the first of a whole line of products and services for the Smart Home Electrolux will introduce in the coming years.

It looks promising that several research institutes in Europe, such as Delft University of Technology, Lund University, and the Politecnico Milano, have developed initiatives to further explore the concept of Eco-efficient Services in their programs. In these programs, joint ventures with industry are established in order to create new businesses. Kathalys, the centre for Sustainable Product Innovation of TNO in the Netherlands and the Delft University of Technology are now working with companies such as XEROX, KPN, and Ahrend to create a more sustainable workplace service (Van der Horst e.a., 1999) and with NIKE to create more environmentally efficient mobility services. In addition, Delft University, together with a number of other research institutes all over Europe, is also involved in the so-called SUSHOUSE project. This project aims to study the possibilities for more sustainable alternatives for three household functions: nutrition (shopping, cooking, eating), shelter? housing and textile care?. Research on the development of innovative services is an integral part of this project (Vergragt, 1998).

Recommendations for policy decisions 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.

This case shows that such new consumption practices, supported by new product and service systems, can only be realised by extensive experimentation in a real-life setting. Many practical problems can not be foreseen before the start of the experiment. 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, we recommended to public authorities that, in order to bring about the necessary changes in society towards sustainable development, experiments with new consumption practices should receive much more support.

A second recommendation for policy decisions on environmental management is to introduce a policy on extended producer responsibility that stimulates the environmental optimisation of product systems. By introducing 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. Extended producer responsibility is a strong incentive for incorporating 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, develop a service infrastructure to recover used products and optimise the utilisation of products, probably by using elements from the concept of Eco-efficient Services.

Recommendations for further study of the concept of Eco-efficient Services

We recommend further study of the concept of Eco-efficient Services on a number of issues:

- 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 worth, industry certainly has a need for specific methods to develop this kind of services. Our case study made clear that the development of new service organisations and especially the integration of information technology in those service organisations are important aspects of the development of Eco-efficient Services.
- This study has nourished the idea that the application of the concept of Eco-efficient Services will certainly not be successful in all product categories. If success is defined in three dimensions (market success, commercial success and environmental benefit) it can be questioned which product-related or product use-related factors determine the potential for complete success in all three dimensions.
- It is plausible to assume that the context in which Eco-efficient Services exist is very important for their success. Further research is needed to identify the factors that facilitate the development of these kind of innovations and that make them successful in the market.
- In this study, a first attempt was made to unfold the relationship between Eco-efficient Services and their environmental effects. At the moment, there is little understanding of the more general environmental potential of Eco-efficient Services and the kind of factors responsible for the contribution to improvements in environmental effects.

- In relation 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. We can question 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 was set up in a design context, a context in which designers try to integrate environment requirements in product development. For those involved the area of environmental product development we have a number of recommendations:

- Designers need to have a clear image of what the problems are they have to respond to. Often these problems are defined in quite conventional terms, on the basis of problematic aspects of existing solutions. Based on our study, it also seems useful to redefine problems entirely and to question existing solutions on a conceptual level. As designers have the ability to create images of entirely new solutions in advance, they are able to redefine what customers need. In general it is recommended to designers to critically question any given design task, and to do research on the nature of the solutions that have to be developed. Especially with respect to sustainable solutions there is a need for unconventional solutions.
- When analysing the design task, an in depth analysis of the efficiency of product use can be a source of inspiration for designers. In order to arrive at the conclusion that a certain product is very inefficient in use, one has to have images of how the product could be better organised or optimised. The analysis of current inefficiencies in consumption is closely related to the designer's ability to create new solutions. It is therefore recommended that current consumption practices are viewed 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 only to look at technological improvement of products. The case of Car Sharing services shows that by reorganising the entire product chain interesting new opportunities are created that are not primarily based on technological improvements. Designers are recommended to consider the opportunities for improvement that result from the development of product related services. From both a commercial and an environmental point of view, the integration of service aspects in product development is in most cases beneficial and in many cases even indispensable.
- In their efforts to reduce the environmental impact of consumption, designers should not overlook the possible rebound effects of new solutions. In the assessment of various design solutions it is important to first assess the possibilities for undesired effects in terms of consumer behaviour. In many cases these rebound effects also have negative environmental effects.
- We recommend 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 need further attention in design education. To provide their functionality to the user, products become increasingly dependent of service systems. New impulses are needed in design education to teach students new skills and knowledge; not only to make products fit the requirements of the

service systems, but also to be able to develop integrated product-service systems. It is recommended that a new course is developed which focuses 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 today and in the future

Scientific research on social issues is often rather conservative: it generally reflects upon present day reality or even upon the past. Design, on the other hand, aims to 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 achieved. Design is constructive and creative, which makes it a very attractive activity for designers.

Personally, I left my profession as a design engineer and developed my research skills, especially in the social sciences. However, as a social scientist, I can not forget about my own roots. It is impossible for me to do research without having ideas about how new knowledge could contribute to design processes or other processes of change. So, during the entire research process, I was constantly sharpening my vision of how Car Sharing services should be developed in the future, based on the insights generated by my research.

These activities finally led quite naturally to a presentation of a future vision for Car Sharing services. Together with Jelle Zijlstra, a professional designer in Rotterdam, I made a "grand design" of how Car Sharing services could be further developed into a large scale service network and how it could be integrated in the Dutch urban fabric. It was sent in 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 the first price of Dfl. 35.000,=. It seems to me that presenting our plan "Bewegingsruimte" (Meijkamp, Zijlstra and Zijlstra, 1999) is an appropriate way to finish this research project, because it translates the results of my 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 the service offer for the consumer is the most important factor for success of an innovative service system. The service offer must meet the needs of individual consumers and must provide relative advantages over existing solutions.

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

1. Cars must be available just around the corner, 24 hours a day. So a 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 use of the car and prepares the invoice.

3. The cars are distributed from special parking places in public areas.
4. Cars must be available with and without reservation, to allow room for flexibility and reliability.
5. At the distribution points, various kinds of cars must be available for different kinds of trips.
6. Apart from Car Sharing services for short trips of less than 24 hours, also long long-term arrangements must be easily available from the same umbrella organisation.
7. In addition to Car Sharing services, other mobility services, like train and local transport, must integrated in the service package.
8. Car Sharing services should operate in a national network of service suppliers so consumers can get these services in every city.

A 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 constitutes an interesting extra advantage over the situation in which these services are offered only locally.

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

1. A customer becomes a member of the entire mobility system, which includes the availability of a car near their home, the opportunity to get a car in any city where the network is represented and special conditions for the use of public transport.
2. The mobility system consists of different cells that individually sell one single brand. All individual cells have one common proposition for every customer in every city.
3. The network consists of several 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 residential 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 number of cars (about 5) are available. These cars are meant for rather short trips. At the SMALL scale, there is no choice in type of car.

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 all customers of that particular district with a wide range of different types of cars. From these distribution points, customers receive their cars for long-term use (more than two days). The MEDIUM scale outlet is located at the district 'gates', near local facilities like shopping centres or bus stations and has a reach of about 2 kilometres.

The LARGE scale is a high-tech distribution centre for cars near a large public transport centre or railway station. The cars from these distribution points are available to every customer of the Car Sharing organisation. The location of the LARGE distribution centre enables makes it possible to combine long-distance public transport use with short distance car use. Because parking space nearby railway stations is scarce, the idea is to install completely automated parking houses.

How to get there?

Our vision of the future mobility system is ambitious, but the ideas on its realisation we present below, 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 to a similar path of development:

From now on, a brand manager can invest in the further development of a Car Sharing brand, that can be implemented anywhere. The core of the service concept is an efficient and reliable software and hardware system that enables the automated and flexible distribution of cars at any location. A brand manager has to invest in advertising his service and stirring up a basic interest in Car Sharing services among the general public. At the same time, small scale Car Sharing trials have to start, to gain experience with the service in practice. By communicating the positive experiences with Car Sharing in practice, marketing can tap into the latent demand in the consumer market.

To upscale from local experiments and introduce Car Sharing at a larger scale, it is necessary to create a network of local service suppliers that operate the Car Sharing services and maintain the fleet and the contacts with customers. Local outlets are created using a franchise concept that enables local entrepreneurs to operate Car Sharing services and to benefit from a strong brand in the market. These outlets are not only an integral part of a large network of service suppliers, but they are also 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 public-private partnerships, both with local governments to create special parking spaces in public areas and local public transport corporations to create added value by integrating public transport services in the service offer.

To introduce the entire mobility system, a number of steps have to be taken:

2000	The SMALL scale must be further developed and introduced in the market. 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. The LARGE scale facilities give customers the opportunity to rent cars at different locations, just 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 long-term rental is organised. In any city district where demand is high, such a buffer stock might become necessary. These MEDIUM scale facilities might become focal points for local business activities and also 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 in urban areas. Integrated with the facilities for the Car Sharing corporation, these locations offer various kinds of facilities for businesses and employees, like teleworking centres, local distribution centres for E-commerce, 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

In most cases, grand designs like “Bewegingsruimte” are not a correct prediction of the future. Our grand design is not meant as a prediction for the future, but as a realistic source of inspiration for entrepreneurs. The primary function of this kind of designs is to encourage entrepreneurial activities and the co-operation between different actors. If this thesis – culminating in this design for a future mobility system – helps to generate the essential impulse in society to develop Car Sharing services into a widely available service system, I will be more than satisfied.

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 cer-

tain 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, instead 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.

Figure 1 Consumer decision processes with regard to Car Sharing

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 substitutes, 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%).

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.

Figure 2 Changes in car mileage per year, before and after the adoption of Car Sharing services

Figure 3 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:
 1. Implementation of the newest and most fuel efficient vehicles creates a relative advantage over the average privately owned car.
 2. 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 num-

ber 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.

Rens Meijkamp

Samenvatting

1. Introductie

Dit proefschrift gaat over consumentengedrag in relatie tot milieuproblemen. Het gaat uit van de veronderstelling dat de bestaande milieuproblemen veroorzaakt worden door de aard en de omvang van het consumptiegedrag van individuele consumenten. Verschillende studies wijzen erop dat het huidige consumptiegedrag en de bestaande wijzen van behoeftevervulling zeker niet "duurzaam" genoemd kunnen worden, zoals omschreven door de UN World Commission on Environment and Development (1987). Zonder substantiële veranderingen in consumptiepatronen zullen er op de lange termijn serieuze milieuproblemen ontstaan die van invloed zijn op de hele mensheid. In antwoord op deze analyse van dit maatschappelijke vraagstuk kan men zich afvragen hoe consumptiegedrag veranderd zou kunnen worden om daarmee de milieueffecten van consumptie te reduceren.

In deze studie hebben we deze algemene vraagstelling teruggebracht door ons te richten op één specifieke benadering om het consumentengedrag te beïnvloeden: Door de ontwikkeling van innovatieve produkten en diensten, gevolgd door de succesvolle marktintroductie ervan, zou aan consumenten een alternatief geboden kunnen worden. Consumenten zouden door middel van innovatieve produkten tot nieuw consumptiegedrag verleid kunnen worden dat minder milieubelastend is. In deze benadering voor het beïnvloeden van consumentengedrag vanuit milieudoelstellingen heeft de industrie een spilfunctie.

De ontwikkeling van innovatieve produkten en diensten, ook wel een "innovatieproces" genoemd, begint met de analyse van de bestaande wijze van behoeftevervulling. Behoeftevervulling kan geconceptualiseerd worden als een transformatieproces waarin verschillende input-factoren ingezet worden om een nuttig eindresultaat of een zekere functionaliteit te realiseren die uiteindelijk leidt tot behoeftevervulling. De drie verschillende input-factoren die hierbij onderscheiden worden, zijn: (1) de produkten, (2) de grondstoffen zoals energie en materialen, en (3) de menselijke inzet of arbeid. Op basis van deze conceptualisatie kan men innovatie verstaan als het heroverwegen of het optimaliseren van de wijze waarop een zekere behoefte wordt vervuld. Innovatie leidt tot een andere wijze van behoeftevervulling, waarbij op een nieuwe wijze produkten, grondstoffen, energie en menselijke arbeid worden ingezet. De optimalisatie van de behoeftevervulling kan leiden tot de verbetering van de milieu-efficiëntie, hetgeen betekent dat dezelfde functionaliteit wordt gerealiseerd tegen minder milieueffecten.

Voor de beoordeling van milieueffecten van consumptie wordt in deze studie gebruik gemaakt van de vergelijking van Ehrlich en Holdren (1971). Zij onderscheiden hiervoor twee determinanten: (1) het milieukundig metabolisme van een produkt(systeem) en (2) de (hoeveelheid) gebruikseenheden van produktgebruik. Het milieukundig metabolisme verwijst naar de milieu-efficiëntie van de behoeftevervulling en dus naar de milieu-efficiëntie van de "produktie" van een functionele eenheid/een gebruikseenheid. De hoeveelheid

gebruikseenheden hebben een directe relatie met het consumptievolume en dus met het consumentengedrag. De mate waarin een produkt wordt gebruikt om gebruikseenheden te genereren is de tweede determinant van de totale milieueffecten van consumptie. De milieueffecten van consumptie zijn volgens de vergelijking van Ehrlich en Holdren het produkt van de milieu-efficiëntie van de wijze van behoeftevervulling en de hoeveelheid gebruikseenheden die mensen consumeren.

2. Het concept "Eco-efficient Services"

In deze studie hebben we ervoor gekozen om één specifieke benadering ter milieukundige verbetering van de behoeftevervulling verder te bestuderen. Op basis van theoretische overwegingen kan verondersteld worden dat deze benadering leidt tot een vermindering van milieueffecten. Het is een innovatiestrategie die de "Eco-efficient Services"-strategie wordt genoemd en is gedefinieerd als:

Eco-efficient Services zijn alle commerciële aanbiedingen die de gebruikswaarde van een produkt(systeem) verkopen als een alternatief voor het verkopen van het produkt(systeem) zelf. Eco-efficient Services zijn vormen van dienstverlening die gerelateerd zijn aan produkten waarvan (een deel van) de eigendomsrechten bij de aanbieder blijven.

De "Eco-efficient Services"-strategie is gebaseerd op het principe dat de gebruikswaarde van produkten wordt verkocht, in plaats van de produkten zelf. Deze strategie gaat uit van een nieuwe visie op de (economische) waarde van produkten. Giarini en Stahel (1993) noemen dit het economisch paradigma van de "Service Economy". In de "Service Economy" worden produkten beschouwd als objecten die gebruikseenheden of functionele eenheden kunnen produceren. Omdat die gebruikseenheden gerealiseerd worden door het gebruik van de produkten, worden ze ook wel de gebruikswaarde van produkten genoemd. Dat betekent dat in de "Service Economy" produkten slechts als instrumenten worden beschouwd om datgene te produceren waaraan mensen behoefte hebben.

De "Eco-efficient Services"-strategie veronderstelt bijvoorbeeld dat niet zozeer het bezit van auto's waardevol is voor mensen, maar de mogelijkheid om er één frequent en flexibel te kunnen gebruiken. In lijn met deze veronderstelling zouden ondernemers dan ook niet meer auto's als zodanig moeten verkopen, maar automobilititeit en de mogelijkheid om een auto frequent en flexibel te gebruiken.

De "Eco-efficient Services"-strategie kent drie wezenlijk verschillende vormen waarin de gebruikswaarde van produkten verkocht kan worden. Zij worden onderscheiden op basis van de mate waarin de eigendomsrechten van produkten bij de transactie worden overgedragen naar de gebruiker van het produkt en de mate waarin de klant participeert in de produktie van gebruikseenheden. Een belangrijke eigenschap van "Eco-efficient Services" is dat een deel van de taken en verantwoordelijkheden die samenhangen met het goed functioneren van produkten, overgedragen wordt naar externe commerciële dienstverleners. De drie volgende categorieën van "Eco-efficient Services" kunnen worden onderscheiden:

1. Levensduur-verlengingsdiensten
2. Produktgebruiksdiensten
3. Resultaatsdiensten

Op basis van theoretische overwegingen stellen verschillende wetenschappers (Giarini en Stahel, 1993; Manzini, 1994; Stahel, 1996 en Bierter e.a., 1996) dat "Eco-efficient Services" leiden tot een optimalisatie van de behoeftevervulling. Dit zou het resultaat zijn van een verandering van de aard van de transactie tussen vraag en aanbod. In tegenstelling tot het verkopen van produkten, zouden ondernemers een bedrijfseconomische interesse krijgen in de economische en ecologische optimalisatie van de behoeftevervulling wanneer zij het gebruik van produkten zouden verkopen. Dit is het gevolg van het feit dat alle kosten van alle processen over de gehele levenscyclus moeten worden verdisconteerd over de gebruikseenheden die een produkt gedurende zijn gebruiksduur kan produceren. Alle kosten voor materialen en energie drukken daarmee op de winstmarge van de ondernemer die de gebruikseenheden verkoopt. Een van de potentiële voordelen van "Eco-efficient Services" is dat er een sterkere nadruk komt te liggen op systeemgerichte optimalisaties, in plaats van louter produkt- of procesgerichte maatregelen. Een beperking van het gebruik van materialen en energie om dezelfde hoeveelheid gebruikseenheden te produceren zou direct leiden tot een verhoging van de winstmarge van de ondernemer in de "Service Economy". Voor elk van de drie categorieën van "Eco-efficient Services" zijn (deels) verschillende mogelijke effecten op de milieueffecten te verwachten.

3. De onderzoeksvragen

Dit proefschrift beschouwt de ideeën over de "Eco-efficient Services"-strategie als een interessant theoretisch uitgangspunt. Echter, er bestaat nog maar weinig empirisch bewijsmateriaal over de effectiviteit van deze benadering. De mate waarin toepassing van deze benadering in de praktijk ook daadwerkelijk tot een vermindering van de milieueffecten leidt, is nog niet of nauwelijks grondig onderzocht. We gaan er daarom van uit dat deze benadering verder empirisch onderzoek verdient om tot waarde-oordelen over de effectiviteit te komen.

Daartoe zijn voor deze studie twee onderzoeksvragen geformuleerd: De eerste onderzoeksvraag richt zich op de determinanten van de consumentenacceptatie van "Eco-efficient Services". De tweede onderzoeksvraag richt zich op de verandering van de milieueffecten als gevolg van de adoptie van "Eco-efficient Services". De eerste onderzoeksvraag is te beschouwen als een belangrijke randvoorwaarden voor de mogelijke milieukundige effectiviteit van "Eco-efficient Services".

4. De dienstverlening van Car Sharing

Om deze twee onderzoeksvragen te kunnen beantwoorden hebben we een omvangrijke veldstudie opgezet. Dit empirisch onderzoek is opgezet in het veld van Car Sharing services in Nederland. Vanaf het midden van de jaren negentig zagen verschillende nieuwe vormen van commerciële dienstverlening het licht. Deze diensten bieden flexibele automobilititeit aan voor consumenten. Op basis van de definitie van "Eco-efficient Services" kunnen we concluderen dat dit een typisch voorbeeld is van dit theoretisch concept: Car Sharing

services worden in de markt gezet als een alternatief voor het eigen autobezit. Altijd wanneer de klant een auto nodig heeft kan hij bij een Car Sharing service organisatie over een auto beschikken, zelfs voor een korte gebruiksperiode van een uur. De economische transactie tussen de ondernemer en de klant is gebaseerd op de gebruikswaarde van de auto: De klant betaalt naar gelang hij met de auto heeft gereden en naar gelang de gebruiksduur. Sinds 1994 zagen verschillende nieuwe vormen van dienstverlening het licht, die zich in de loop der tijd vooral in stedelijke gebieden hebben ontwikkeld. Onze empirische studie is opgezet rondom vier grote en innovatieve Car Sharing services in Nederland.

Voor ons empirisch onderzoek op het terrein van Car Sharing services hebben we de twee onderzoeksvragen uitgewerkt tot drie empirische onderzoeksvragen:

1a. Wat zijn de determinanten van de adoptie van Car Sharing services?

1b. Wat zijn de determinanten van de service kwaliteitsperceptie van Car Sharing services?

2. Wat zijn de veranderingen in mobiliteitsgedrag na adoptie van Car Sharing services?

De adoptie van Car Sharing services kan als een essentiële randvoorwaarden worden beschouwd voor een eventuele effectiviteit van deze dienstverlening op de milieueffecten. De kwaliteitsperceptie van de dienstverlening is van groot belang voor een langdurige tevredenheid van de klant met het alternatief voor de eigen auto. De veranderingen in mobiliteitsgedrag kunnen, zoals de formule van Ehrlich en Holdren aangeeft, worden beschouwd als een belangrijke factor voor de veranderingen in milieueffecten. Wij beschouwen het mobiliteitsgedrag als een containerbegrip voor een variëteit aan gedragingen: het gebruik van de auto, de trein, het openbaar vervoer en de fiets. We veronderstellen dat deze gedragingen niet volledig onafhankelijk van elkaar zijn.

5. Het conceptueel model

De empirische onderzoeksvragen vormen de basis voor het consumentenonderzoek onder adopters en non-adopters van vier verschillende Car Sharing services in Nederland. De onderzoeksvragen refereren aan drie verschillende afhankelijke variabelen of drie verschillende besluitvormingsprocessen, zoals het schema met het conceptueel model hieronder illustreert. Voor elk van de drie afhankelijke variabelen hebben we een specifiek conceptueel model gespecificeerd, met daarin de hypothesen die aangegeven hoe de afhankelijke variabelen mogelijk verklaard kunnen worden. In het empirisch onderzoek hebben we data verzameld, waardoor de veronderstelde relaties getoetst konden worden.

Figuur 1 Consumentenbesluitvormingsproces met betrekking tot Car Sharing

6. Conclusies ten aanzien van de adoptie van Car Sharing

Dit onderzoek heeft geleid tot de volgende conclusies ten aanzien van de verklaring van de adoptie van Car Sharing services:

- De verklaring van de adoptie van Car Sharing services loopt sterk uiteen tussen de verschillende marktsegmenten. Vooral de verschillen tussen zij die niet en zij die wel over een auto beschikken voor adoptie (de zogenaamde nieuwe instappers en de substituters) waren groot. Het meest opmerkelijke verschil vormen het belang van de kostenperceptie van autokosten en de mate waarin men kosten expliciet betreft in de afweging tussen verschillende vervoersmodaliteiten. Autobezitters zijn sterker kostenbewust bij de adoptie en worden in sterke mate gedreven door negatieve ervaringen met het eigen auto-bezit.
- Gewoontegedrag vormt een belangrijke drempel voor de adoptie van Car Sharing services. Gewoontevorming in mobiliteitsgedrag voorkomt dat mensen weloverwogen nadenken over de vervoermiddelkeuze. Gedrag uit het verleden wordt in zulke gevallen zonder enige overweging herhaald zonder alternatieven te overwegen. Daardoor komen mensen er niet eens aan toe om na te denken over de mogelijke voor- en nadelen van Car Sharing services.
- Economische overwegingen (besparingen) vormen het belangrijkste motief voor adoptie van Car Sharing services. Als mensen geen financieel voordeel verkrijgen ten opzichte van een eigen auto, dan blijven er weinig andere argumenten over om lid te worden. Naast economische motieven spelen bestaande parkeerproblemen en alsmede de zorg om de onderhoud van de auto een rol om lid te worden.
- Inzicht in de werkelijke kosten van autogebruik is een belangrijke randvoorwaarde voor adoptie. Daarbij is de perceptie van de autokosten cruciaal. Het onderzoek toont dat die mensen die een goed inzicht in de kosten van automobilititeit hebben, en ook alle kosten, zowel de variabele als de vaste kosten in de afweging betrekken, veel sterker geneigd zijn tot adoptie van Car Sharing services.

- e. Car Sharing services moeten zeer goed toegankelijk en verkrijgbaar zijn wil men tot adoptie overgaan. Dat betekent dat de auto's op toegankelijke parkeerplaatsen direct in de woonomgeving beschikbaar moeten worden gesteld.
- f. Voor een brede consumentenacceptatie van Car Sharing services is een sterk kwaliteits-imago van groot belang. Hieruit kan worden afgeleid dat consumenten alleen tot adoptie geneigd zijn als men vertrouwen heeft in de organisatie en de kwaliteit van dienstverlening. Consumenten worden afhankelijk van een service organisatie en eisen daarom een grote professionele betrokkenheid.
- g. De waarde-oriëntatie van consumenten is alleen bij voormalig autobezitters enigszins van belang bij de adoptie. Met name de substituters onderscheiden zich van de non-adopters op basis van hun waarde-oriëntatie. Zij associëren auto's minder sterk met vrijheid en welzijn, en sterker met de negatieve consequenties van autogebruik.
- h. Milieuwaarden en milieuhoudingen hebben weinig verklarende kracht voor de adoptie van Car Sharing services. Alleen bij de autobezitters spelen verantwoordelijkheid voor milieuvraagstukken een (bescheiden) rol in de adoptiebeslissing.

7. Conclusies ten aanzien van de servicekwaliteitsperceptie van Car Sharing

Met betrekking tot de servicekwaliteitsperceptie van Car Sharing services kunnen uit deze studie de volgende conclusies getrokken worden:

- a. De kwaliteitsperceptie bij de bestaande Car Sharing services kan goed genoemd worden. Gemiddeld vindt 90% van de adopters dat de kwaliteit van de dienstverlening goed tot zeer goed genoemd kan worden.
- b. De perceptie van de servicekwaliteit kan beschouwd worden als een goede indicator voor de verlening van het contract met de service organisatie en dus voor een meer lange termijn klantenbinding. Het onderzoek laat een sterke correlatie zien tussen de perceptie van de servicekwaliteit en de intentie tot verlening van het contract met de Car Sharing organisatie.
- c. De perceptie van de servicekwaliteit is hoofdzakelijk afhankelijk van de wijze waarop de diensten geleverd worden (het HOE). De inhoud van de service (het WAT) oftewel de auto die geleverd wordt, heeft daarentegen slechts een ondergeschikte rol in de perceptie van de servicekwaliteit. Dat betekent dat het vormgeven van de service organisatie de crux is tot een positieve perceptie van de servicekwaliteit.
- d. Met het gegeven dat de wijze van dienstverlening essentieel is voor de perceptie van de dienstverlening wordt het van belang te identificeren welke factoren dan bij de dienstverlening met name van belang zijn. Deze studie wijst daarbij op zes onafhankelijke factoren die de prestatie van de service organisatie bepalen:
 - De mate waarin het personeel de klanten serieus neemt en ze helpt met hun vragen en problemen.
 - De mate waarin de klanten het gevoel hebben dat de voorwaarden duidelijk zijn en dat ze de organisatie kunnen vertrouwen.
 - De mate waarin de service organisatie ten alle tijde een direct en betrouwbaar antwoord geeft op vragen en wensen tot reserveringen.
 - De mate waarin de service organisatie een mooie en verzorgde uitstraling heeft.

- De mate waarin alle transacties en rekeningen correct zijn.
 - De mate waarin de auto's altijd, 24 uur per dag beschikbaar zijn en zelfs in het weekend.
- e. Naast de prestaties in de serviceverlening hebben ook de prijsperceptie van de service en de evaluatie van de afstand tot de parkeerplaats van de auto een invloed op de perceptie van de servicekwaliteit. Als mensen de dienstverlening duur vinden of als ze de afstand tot de parkeerplaats te groot vinden, dan heeft dat negatieve consequenties voor de perceptie van de servicekwaliteit.

8. Veranderingen in mobiliteitsgedrag na adoptie van Car Sharing

Om de tweede onderzoeksvraag te kunnen beantwoorden zijn de veranderingen in mobiliteitsgedrag, VOOR en NA adoptie van Car Sharing, vastgesteld. Deze gegevens vormen een belangrijke input voor de milieuanalyse van Car Sharing services. Vooraf kon worden verondersteld dat het mobiliteitsgedrag van de adopters zou veranderen na adoptie van Car Sharing services en dat deze veranderingen zich niet alleen tot veranderingen in het autogebruik zouden beperken.

Dit onderzoek laat zien dat het jaarkilometrage per auto van adopters met 33% afneemt. De verschillen tussen marktsegmenten zijn echter zeer groot. Zo is de verandering in jaarkilometrage per auto onder de substituters (zij verwisselen de auto voor Car Sharing services) het grootst (-65%). Onderstaand schema en figuur tonen de veranderingen in autogebruik, uitgedrukt in autokilometers per jaar.

De veranderingen in gebruiksfrequentie (per week) van de verschillende vervoersmiddelen laten eveneens grote veranderingen zien, die sterk per doelgroep verschillen. De tendens is dat autoritten gesubstitueerd worden door het gebruik van alternatieve vervoermiddelen. Terwijl de wekelijkse rittfrequentie van de auto met 43% afneemt, neemt het aantal ritten met de fiets met 14% toe, die met de trein met 36% en die met de bus met 28%. We concluderen ook dat het totaal aantal ritten met zo'n 10% toeneemt, na adoptie van Car Sharing services.

Figuur 2 Verandering in autogebruik (km/jaar), VOOR en NA adoptie van Car Sharing services

Figuur 3 Verandering in gebruiksfrequentie (keer/week), van diverse vervoermiddelen, VOOR en NA adoptie van Car Sharing services

9 Conclusies ten aanzien van de veranderingen in milieueffecten van Car Sharing

Om de tweede onderzoeksvraag te kunnen beantwoorden, is een uitgebreide integrale milieuanalyse gemaakt van de veranderingen in milieueffecten na de adoptie van Car Sharing services. In deze analyse zijn niet alleen de veranderingen in de milieuefficiëntie van de verschillende vervoermiddelen betrokken, waaronder die van Car Sharing services,

maar ook de veranderingen in het mobiliteitsgedrag van de adopters. De milieuanalyse heeft zich uitgestrekt tot alle adopters van vier verschillende Car Sharing services.

Car Sharing services worden in deze studie beschouwd als een speciale vervoersmodaliteit die zijn specifieke milieuefficiëntie kent. Om de milieuefficiëntie van Car Sharing services vast te kunnen stellen is een integrale levenscyclusanalyse gemaakt van alle processen die samenhangen met de productie van de functionele eenheid: de automobilititeit van een gemiddeld Nederlands gezin gedurende een jaar. In deze studie hebben we een vergelijking gemaakt van een gemiddelde Nederlandse personenauto en een gemiddelde auto uit een Car Sharing-systeem. Deze vergelijking leverde de volgende conclusies op:

- De milieueffecten van Car Sharing services zijn voor een gegeven kilometrage zo'n 14% geringer in vergelijking tot de gemiddelde personenauto.
- Het relatieve voordeel van Car Sharing services komt vooral voort uit de inzet van relatief lichte auto's. Het gewicht van deze auto's is zo'n 22% geringer, hetgeen tot een hogere brandstofefficiëntie leidt alsmede tot een geringere milieubelasting door de productie van de auto zelf.

Deze gegevens zijn gebruikt bij de integrale milieuanalyse van Car Sharing services, waarin ook de veranderingen in het mobiliteitsgedrag zijn betrokken. Deze milieuanalyse vormt het antwoord op de tweede onderzoeksvraag. We concluderen ten aanzien van de veranderingen in milieueffecten bij adoptie van Car Sharing services het volgende:

- Uit een vergelijking tussen de voorsituatie en de nasituatie bij alle adopters wordt duidelijk dat er sprake is van een reductie in milieueffecten van 21%, uitgedrukt met zogenaamde Eco-indicator punten.
- In vergelijking tot een gemiddeld huishouden zijn de milieueffecten van de adopters als gevolg van het mobiliteitsgedrag zo'n 40% lager
- De totale reductie in parkeerplaatsen, hetgeen direct gekoppeld is aan de reductie in aantallen auto's die worden ingezet om de adopters in hun mobiliteitsbehoefte te voorzien, kan op 44% worden geschat. Dit staat gelijk aan zo'n 2038 m² per 1000 deelnemende huishoudens.
- De reductie in milieueffecten loopt sterk uiteen tussen de verschillende marktsegmenten. De nieuwe instappers verlagen hun milieubelasting als gevolg van mobiliteit met zo'n 14% en de substituters met 48%. De tweede autogebruikers daarentegen zien hun milieubelasting toenemen met naar schatting 6%.

Op basis van deze onderzoeksresultaten is eveneens een aantal meer algemene conclusies te trekken ten aanzien van de veranderingen in milieueffecten bij adoptie van Car Sharing services:

- De introductie van Car Sharing services leidt tot een vermindering in milieueffecten, hetgeen het resultaat is van zowel verbeteringen in milieuefficiëntie, als ook van (positieve) veranderingen in mobiliteitsgedrag.
- De veranderingen in milieueffecten zijn voornamelijk het gevolg van een vermindering in gebruik van fossiele brandstoffen.
- Het relatieve voordeel van Car Sharing services ten opzichte van de gemiddelde Nederlandse auto is het gevolg van de inzet van relatief kleine auto's.
- Van alle milieu-impact categorieën, is het effect op de vermindering van het ruimtebeslag het allergrootst.

- De reductie van milieueffecten is zowel het gevolg van gedragsvariabelen, als ook van systeem georiënteerde variabelen.
- Ten aanzien van de gedragsvariabelen kunnen de volgende variabelen worden onderscheiden: (1) het autobezit, (2) de mate waarin autoritten zijn vervangen door het gebruik van alternatieve vervoermiddelen, (3) de substitutie van autoritten door fietsgebruik en (4) de keuze voor de meest zuinige auto voor een specifieke rit.
- Ten aanzien van de systeem georiënteerde variabelen zijn twee factoren onderscheiden: (1) de inzet van van de nieuwste en de meest zuinige auto's en (2) de selectie van de meest zuinige auto's binnen een zekere categorie.
- Car Sharing services voldoen op dit moment zeker nog niet aan alle verwachtingen zoals geformuleerd binnen het theoretisch kader van Eco-efficient Services. Dit concept veronderstelt dat ondernemers een sterke bedrijfseconomische interesse krijgen in de continue verbetering van de behoeftevervulling. De enige empirische observatie die deze verwachting bevestigt is het feit dat de meest ondernemers voor de meest zuinige auto's kiezen die beschikbaar zijn binnen een zekere klasse. Levensduurverlenging door reparatie en intensief onderhoud of zelfs de het opwaarderen van oudere auto's is zeker niet aan de orde. Daarvoor zijn beslist een aantal goede verklaringen aan te dragen. De belangrijkste zijn dat de ontwikkeling nog tamelijk premature is en dat de schaalgrootte van Car Sharing services nog tamelijk beperkt.

10. Het milieukundig potentieel van Car Sharing in 2010

In dit proefschrift is op basis van kennis van de huidige situatie een scenario voor 2010 doorgerekend. De vraag die daarbij aan de orde was is wat de milieuwinst in 2010 zou kunnen zijn als Car Sharing services tot volle wasdom zouden komen. Op basis van een aantal realistische veronderstellingen met betrekking tot de marktpenetratie, het gebruik van de verschillende vervoersmiddelen, de milieuefficiëntie van de verschillende vervoersmiddelen en de samenstelling van de populatie adopters, is een beeld van 2010 doorgerekend. De onderzoeksgegevens over de huidige situatie vormden daarbij een referentiepunt. De calculaties ten aanzien van de het milieupotentieel hebben de volgende conclusies opgeleverd:

- Het potentieel om bestaande Car Sharing services verder te verbeteren met betrekking tot hun milieuefficiëntie, is aanzienlijk: zo'n 25% verbetering is mogelijk zonder gecompliceerde maatregelen te hoeven treffen.
- Het milieukundig potentieel van Car Sharing services in 2010 is groot. Op basis van een aantal zeer realistische aannames, kan een vermindering van de milieueffecten van zo'n 30% gerealiseerd worden. Voor de verschillende milieu-impact categoriën zijn vergelijkbare percentages te berekenen. Voor CO₂-emissies in het bijzonder is een reductie percentage van 31% haalbaar.
- Met betrekking tot de verandering in het aantal auto's en daarmee in het aantal parkeerplaatsen, kan de conclusie getrokken worden dat het waarschijnlijk is dat in 2010 de reductie per 1000 huishoudens zo'n 65% bedraagt. Deze berekening is gebaseerd op de veronderstelling dat het aandeel substituters gestegen is van zo'n 21% nu tot zo'n 50% in 2010. Uitgedrukt in vierkante meters zijn dat zo'n 7000 vierkante meters per 1000 huishoudens.

- Als de ontwikkeling van Car Sharing services zich ontwikkelt tot het geschetste scenario, dan zal in 2010 een reductie van zo'n 0,34 Mton CO₂-emissies mogelijk zijn. Dat vormt ruim 12% van de taakstelling die in de Uitvoeringsnota Klimaatbeleid van het ministerie van VROM (1999) aan de sector verkeer en vervoer is opgelegd. Ook in vergelijking tot andere beleidsmaatregelen betekent dit dat Car Sharing services een potentieel zeer interessant instrument is.

11. De representativiteit van Car Sharing voor het concept "Eco-efficient Services"

Car Sharing services zijn gekozen als onderwerp van empirisch onderzoek vanwege het feit dat dit een krachtig voorbeeld is van het theoretisch concept Eco-efficient Services. Desalniettemin concluderen we dat het vrijwel onmogelijk is om de onderzoeksgegevens vanuit deze studie te generaliseren naar het bredere kader van Eco-efficient Services. Dit komt omdat er te veel relevante variabelen in het spel zijn.

Ondanks het feit dat deze studie naar Car Sharing services als een zelfstandige casus moet worden behandeld, kunnen er desalniettemin wel een paar meer algemene lessen getrokken worden ten aanzien van het concept Eco-efficient Services:

- Dit concept ondersteunt wel degelijk de analyse van de functionele efficiëntie van een bestaande wijze van behoeftevervulling. Door de identificatie van bestaande inefficiënties kunnen bestaande wijzen van behoeftevervulling geproblematiseerd worden, hetgeen aanleiding tot optimalisatie geeft.
- Het concept Eco-efficient Services ondersteunt de vorming van ideeën waarmee het "levenscyclus-denken" kan worden omgezet in nieuwe commerciële kansen. Het verkopen van de gebruikswaarde van produkten dwingt bedrijven tot een internalisatie van kosten over de gehele levenscyclus in de ontwikkeling van nieuwe produktconcepten. Zo kunnen bedrijven ondersteund worden om economische en ecologische motieven met elkaar te verbinden en tot nieuwe produkt-markt combinaties te komen.
- Het concept Eco-efficient Services biedt eveneens een raamwerk van waaruit het beleidsconcept "extended producer responsibility" een inhoud gegeven kan worden die aansluit bij de belangen van de industrie. Terwijl "extended producer responsibility" tot nog toe vaak werd gezien als een bedreiging voor de gangbare lineaire produktiewijze, maakt het concept Eco-efficient Services duidelijk dat met meer gesloten produktkringlopen, op een geheel andere wijze ook interessante marktkansen geschapen kunnen worden.
- Deze studie heeft de centrale veronderstelling van het concept Eco-efficient Services bevestigd: Door het gebruik van produkten te verkopen kan de milieuefficiëntie van de behoeftevervulling op produktsysteemniveau geoptimaliseerd worden. Er kan worden geconcludeerd dat de mate waarin verbeteropties worden doorgevoerd sterk afhankelijk is van de economische context. De prijsstructuur van arbeid, energie en grondstoffen bepaalt uiteindelijk in welke mate innovatieve technologische en organisatorische opties geïmplementeerd worden.
- Door de focus op de gebruikswaarde van produkten en de functionele efficiëntie van een wijze van behoeftevervulling, wordt als vanzelf een sterkere klantenfocus

gegenereerd. Om een een bestaande wijze van behoeftevervulling te optimaliseren zal men een helder beeld moeten hebben van wat consumenten eigenlijk voor functionaliteit wensen.

- Het concept Eco-efficient Services is gebaseerd op een zeer functionalistische conceptualisatie van produkten. Het veronderstelt dat produkten slechts gereedschappen zijn om bepaalde nuttige resultaten te produceren. Ofschoon deze nuttigheidswaarde og gebruikswaarde zeker essentieel is, kunnen de emotionele waarden die samenhangen met produkten en produktgebruik niet volledig genegeerd worden. Het negeren van de emotionele waarden kan als een zekere beperking van het concept Eco-efficient Services worden beschouwd.

12. De waarde van het concept "Eco-efficient Services" voor Duurzame Ontwikkeling

Het concept Eco-efficient Services is geïntroduceerd als een specifieke innovatiestrategie waardoor de industrie zou kunnen bijdragen aan "Duurzame Ontwikkeling" (WCED, 1987). Als resultaat van de ontwikkeling en introductie van innovatieve produkten en diensten, zo was de veronderstelling, zou het consumentengedrag beïnvloed kunnen worden en de milieueffecten gereduceerd. Vanuit de onderzoekservaringen met Car Sharing services kan nu de vraag gesteld worden wat de waarde van het concept Eco-efficient Services is voor "Duurzame Ontwikkeling". De centrale conclusie hierbij is dat de waarde van dit concept voor een ontwikkelingsproces richting "Duurzame Ontwikkeling" slechts aanvullend en beperkt is, om uiteenlopende redenen:

- Het concept Eco-efficient Services is feitelijk een innovatiestrategie waardoor de milieuefficiëntie van een bepaalde behoeftevervulling verbeterd kan worden. Toch is dit slechts een van de twee belangrijke factoren voor de verbeteringen van de milieueffecten. Het concept Eco-efficient Services is zeker niet gericht op het positief beïnvloeden van het consumentengedrag vanuit milieudoelstellingen. Wanneer de gedrags-effecten wel positief blijken uit te pakken is dat meer toeval.
- De mate waarin het concept Eco-efficient Services leidt tot een verbetering van de milieuefficiëntie van een behoeftevervulling zal sterk variëren tussen de verschillende markten. Terwijl Car Sharing services als een alternatief voor het eigen autobezit een relatief milieuvoordeel oplevert van ongeveer 14%, kan er verwacht worden dat op andere terreinen substantieel meer milieuwinst behaald kan worden. Bij Car Sharing services is slechts sprake van organisatorische aanpassingen, en niet van technologische aanpassingen van het produkt zelf.
- We concluderen op basis van onze inzichten uit deze studie dat het niet erg realistisch is te verwachten dat met de Eco-efficient Services- benadering een factor 10 milieuverbetering bereikt kan worden, zoals gesuggereerd door verschillende auteurs (Jansen en Vergragt, 1993; Vermeulen en Weterings, 1996 en Brezet, 1997). Als we aannemen van Weterings en Opschoor (1992) dat voor een duurzame samenleving de milieuefficiëntie van produkten en diensten met een factor 20 verbeterd zouden moeten worden, dan kunnen we concluderen dat het concept Eco-efficient Services slechts een beperkte rol kan te spelen in de veranderingen richting Duurzame Ontwikkeling.

- Het concept Eco-efficient Services leidt tot innovaties die hun eigen dynamiek in de markt kennen. Dat betekent dat deze alternatieven voor bestaande wijze van behoeftevervulling niet slechts een substitutierol zullen vervullen, maar ook voor nieuwe markten en nieuwe gebruikspatronen zullen zorgen en daarmee ook voor nieuwe vormen van milieuvervuiling.
- Het concept Eco-efficient Services neemt de bestaande omgeving (economisch, ruimtelijk, sociaal, cultureel, wettelijk, enzovoort) als een gegeven. Daarbinnen vormt zij een benadering die tot een optimalisatie leidt. Ondanks de waarde van het concept Eco-efficient Services voor de optimalisatie van behoeftevervulling mag niet vergeten worden dat het beïnvloeden van de omgeving evenzeer tot een dynamiek in de samenleving leidt die tot milieugerichte innovatie tot gevolg heeft.
- Het concept Eco-efficient Services neemt een zekere marktvraag als een gegeven. Daarvoor probeert zij een alternatief te ontwikkelen dat milieuefficiënter is. Zij vraagt zich niet af in welke mate de vraag naar producten en diensten vanuit maatschappelijke doelstellingen welk volledig gelegitimeerd is (SustainAbility, 1996). Het negeren van een zekere kritische reflectie op de vraag naar een bepaalde behoeftevervulling kan zeker als een beperking worden opgevat op weg naar Duurzame Ontwikkeling.

13. De epiloog

In de epiloog van dit proefschrift worden aanbevelingen geformuleerd voor het veld van Car Sharing services en voor het veld van milieugerichte innovatie.

Deze studie eindigt met een ontwerpersvisie op de toekomst. Met de kennis van de huidige situatie is een toekomst scenario ontwikkeld voor de ontwikkeling van Car Sharing services tot aan 2010. Deze visie is niet bedoeld als een voorspelling van de toekomst, maar als een "grand design" dat voeding geeft aan ondernemerschap en dat leidt tot samenwerking tussen verschillende maatschappelijke actoren die betrokken kunnen raken bij de uitbouw van Car Sharing services.

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Biographical note

Rens Meijkamp (Tilburg, 1967) was trained as an Industrial Design Engineer at the Delft University of Technology. During his study he worked on solar energy devices at the Murugappa Politechnic in Madras, India and as an office furniture designer for Jürgen Lange Design in Grafenau, Germany. His graduation project was a new cooking line for BK (Van Kempen & Begeer, Zoetermeer), which was exhibited in 1993 at the "Young Industrial Designers" exhibition in the Stedelijk Museum in Amsterdam.

After completing his study (1992) he received a research position at the Section for Environmental Product Development of the Delft University of Technology. Until 1997 he worked on various research projects for e.g. the Interdepartemental Program DTO, for the Dutch ministry of Transport and for a TU project group on "sustainable washing". Apart from this he was involved in tutoring Master's students and teaching courses in Environmental Product Development. During this period he also started his empirical research for this thesis. Some of the research results were presented before the Commission on Transport Issues of the Dutch parliament.

Since 1997, he works as a senior researcher and consultant at B&A Groep in The Hague. He is project manager of a large variety of research and consultancy projects in the area of innovations in mobility services and in the field of technology, innovation and environment for various ministries and semi-governmental organisations.

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