Urban Mobility Services: Opportunities for Car Manufacturers

Von der Hochschule für Bildende Künste Braunschweig
zur Erlangung des Grades einer Doktorin der Philosophie
– Dr. phil. –
genehmigte Dissertation von

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Dezember 2013

Dedicated to the cities that made me who I am.

Executive Summary

The car system with all its advantages and disadvantages is ripe for a change. While vehicle manufacturers and infrastructure constructors still try to “build their way out of congestion” and achieve improvements by mere “technology fixes” there is increasingly more room for social innovations[1] like mobility services. Mobility services assist individuals in changing locations and include conventional “driver services”, such as public transport or taxis, “vehicle provision services” such as car rental or car sharing, and “information and assistance services” which comprise all services assisting users in organising their travel more conveniently. Their potential contribution to solving the pervasive burdens of urban mobility – e. g. congestion, pollution, land use – and their response to changing user needs has recently increased their popularity in research, planning and practice. In the past, car manufacturers were largely excluded from this growing market. However, in 2009 two car manufacturers entered the mobility services market with innovative offers: Daimler with the public vehicle fleet "Car2Go" in Ulm/Germany and Peugeot with its prepaid rental service "Mu" in many European cities. These moves sparked the interest in mobility services among competitors – Daimler and Peugeot were followed by BMW with “DriveNow”, Volkswagen with “Quicar” and Citroen with “MultiCity” – and, along with many other factors, motivated this thesis.

This thesis explores the factors influencing the future demand of mobility services, before identifying criteria for customer acceptance and analysing the opportunities car manufacturers have in this new business area. The EU-15 countries were chosen as the geographical region for this thesis as they represent homogenous mobility behaviour and transport infrastructure patterns. The timeframe for the analysis are developments from now until 2020 because mobility services are considered as already marketable services and do not require substantial research and development activities anymore.

The current trends fostering the acceptance and feasibility of and demand for mobility services are determined in a key factor analysis process including an uncertainty-impact and a cross-impact analysis. The final set of key factors covers all the STEEP sectors and indicates that the demand for mobility services in the EU-15 is likely to grow until 2020. The main reasons are policies infringing car ownership or use and encouraging the use of alternative modes of travel; rising fuel prices which make private car ownership and use less attractive; increasing burdens of urban mobility which make alternative modes of travel imperative; a rise of post-modern utilitarian ethics which promote use (service) over ownership (product) and functionality/rationality over emotionality/status; and a rising environmental awareness and consumer education programs. The feasibility of mobility services will be enhanced by the progress of several smart car technologies which integrate vehicles into the mobility internet[2] and BEV technologies which are best implemented in shared approaches; likewise the increasing attractiveness of extending the service value chain will likely pave the way for mobility services.

Additionally to the external key factors a close look at the potential users of mobility services results in clear recommendations for the design of mobility services. The main finding is the need for a tailored design for specific user groups. This includes aspects like demographic change, mobility lifestyles, and groups experiencing barriers in their daily mobility. Therefore, pricing structures for mobility services need to compete with low-cost vehicle ownership. As continuing urbanisation will increase the demand for intermodal mobility, a priority should be set on mobility services that foster intermodality, i. e. integrated information and assistance services. Finally, mobility services should respond to the challenges which actually cause the increasing demand for mobility services, e. g. rising fuel prices and regulatory policies.

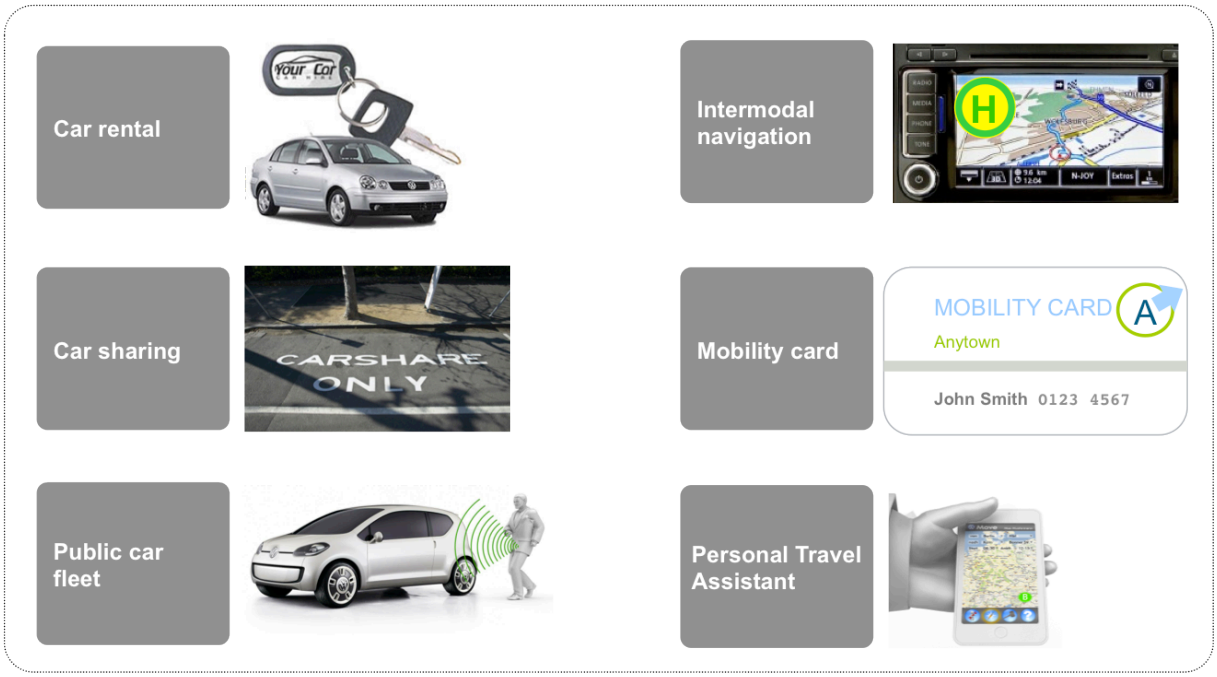
[1] Cox 2010; Dennis/Urry 2009
[2] Mitchell 2010

Combined, these insights result in a catalogue of requirements for urban mobility services which can be used for assessing the customer acceptance of a chosen service type. It consists of the following criteria:

Simplicity: The level to which a service can be used without further instruction or preparation.
Reliability: The level to which a user can rely on the proposed service characteristics, e. g. punctuality.
Flexibility: Indicates how much usage patterns can be adapted to individual needs (spontaneously).
Access: Indicates the accessibility (e. g. physical proximity) of a service.
Availability: The level to which a service is available at a given point of time.
Transparent fare and payment system: The level to which a fare and payment system can be understood and tracked and the level of instruction needed for this.
Attractive image: The degree to which a service reveals an attractive, popular image that raises the status of the user.
Added value for users: The level to which using a given service provides a value to a user which cannot be achieved otherwise or by using conventional services.
Usefulness: The number of use cases the service applies to.
Intermodality: The degree to which the service facilitates intermodal mobility.

After the frame for mobility services is set, the next obvious question relates to the opportunities car manufacturers have in this new market. The key factor results indicating a growing demand for mobility services taken together imply a much stronger growth of mobility services than generally anticipated. However, OEM still will ask at which costs these new market shares and a better image might be gained. An agenda for selecting the proper mobility services to enter the market with and a reasonable set of strategic options for entering the market will lead the way.

As a first step, it needs to be determined which service type will most likely meet customer demands. This is achieved by applying the criteria from the catalogue of requirements to a set of mobility services which car manufacturers could possibly offer.



The results show that those mobility services which are more innovative and challenging to the provider also receive higher customer acceptance ratings. Combined with an analysis of their fit to the main mobility types identified for 2020, it is obvious that car manufacturers should focus on a public vehicle fleet when it comes to vehicle provision services. However, as a start car sharing or even car rental could be installed but preferably only if the objective is to transform these into a public car fleet. For the information and assistance services, the personal travel assistant clearly stands out in acceptance and innovation level but also in the range of challenges it implies. Initially, the mobility card could be combined with a stationary intermodal navigation system, thus offering a set of services similar to the personal travel assistant.

When choosing an appropriate strategy, it needs to be kept mind that car manufacturers are entering this market under two constraints: There are only comparatively small market shares to be expected, and they are not well prepared internally for the challenges awaiting a service provider. Since mobility services offered by car manufacturers classify as radical, systemic, social, and open innovations initiated upon market pull and therefore qualify as sustainable innovations, they generate quite a few challenges for car manufacturers. Even though the external opportunities are high and risks are low, the internal weaknesses far outweigh the strengths manufacturers can bring into this new business area. There are basically six strategic options, some of which can be combined:

1) Outsourcing mobility service sub-units: Independent, but internally tightly coupled sub-units can best achieve a high innovation level within a productivity- and profit-oriented organisation.
2) “White label” services: Buying turnkey solutions from existing service providers on the market who offer their systems or software as a “white label” service, including development and operation relieves OEM from the burden of developing and operating a service where they still lack experience and know-how.
3) Packaging products with services of other providers: Car manufacturers can package their own product with the offers of other service providers, especially when they are already providing vehicles for another mobility service provider (see option above).
4) Providing vehicles for mobility service providers: Partnerships with mobility service providers already exist but not to the extent desired by most providers. Service providers could benefit from lower vehicle prices while car manufacturers could benefit from the positive image created by the cooperation and from the additional distribution channel for their vehicles.
5) Incorporating enabling technologies into vehicles: Incorporating smart technology which supports intermodal travel into their vehicles, especially those used for vehicle provision services, is a first step to preparing the product portfolio for mobility services.
6) Expansion of vehicle related services: By providing insurance and taxing services and mobility guarantees (in case of failure, repair or maintenance) along with access to extra vehicles via a car pool subscription and re-marketing services car manufacturers can enhance their existing service packages.

Outsourcing subunits (1) will be the most challenging path when embarking on the mobility services boat because it challenges conventional approaches to innovation in the automotive industry. However, coupled with a smart business idea and a consistent strategy, it will hold the largest benefits because it allows the OEM to get established as a (at least partial) mobility service provider. Purchasing white label services (2) is certainly less challenging and almost as beneficial because it relieves OEM from the efforts required for establishing a service in a subunit but it still allows a manufacturer to position itself as a mobility service provider. The option with the lowest challenges compared to its benefits is clearly packaging products with existing services (3). The customer can access existing services but is intro-

duced to them by a car manufacturer – an easy option for image building and upgrading the value of vehicles. The other options are default options in case none of the options 1 to 3 seems feasible or attractive to a manufacturer.

Once engaged in mobility services car manufacturers need to restructure their innovation processes but also to intensify resp. introduce new research areas. These include research on intermodal mobility behaviour, service science, organisational impacts of introducing a sustainable innovation, and research on the impacts of mobility services on transport and environment.

To sum up, car manufacturers are not likely to transform their product- and production-based business model completely into a mobility service provider business because the volumes to be expected on the mobility services market are too low and the associated risks are higher than the opportunities. The shifts from the product orientation to service orientation and from the economic/financial performance perspective to non-tangible performance indicators will be the biggest obstacles for car manufacturers when becoming a sustainable organisation. Their competitive advantages regarding short innovation cycles, strong customer orientation and high capacities to imitate existing mobility routines are likely to be outweighed by the competitive disadvantages of low levels of experience of and disposition to cooperate with other transport providers and the lacking capacity of OEM to provide an added value to users. Even though *internal* weaknesses are easier to conquer than *external* threats, the path dependency of OEM and the related productivity dilemma – once a company has shifted its focus on the efficiency of production (exploitation), its resources for innovation (exploration) are diminishing[3] – will make it difficult (but not impossible) to overcome them. But with a consistent strategy, a focus on flexible innovation and a sincere desire to collaborate with other providers the gains will be worth the efforts as an increasing number of customers will demand mobility services from car manufacturers.

[3] Abernathy 1978

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Abbreviations

ASEAN	Association of Southeast Asian Nations
BEV	Battery electric vehicle
BRIC	Brazil, Russia, India, China
BRT	Bus rapid transit
CAGR	Compound annual growth rate
CDM	Clean Development Mechanism (mechanism of the Kyoto protocol)
CKD	Completely knocked-down
CNG	Compressed natural gas
CO_2e	CO_2 equivalent
CSO	Car sharing organisation
EIA	Energy Information Agency (U.S.)
EOR	Enhanced oil recovery
ERoI	Energy return of investment
GHG	Greenhouse gases
HEV	Hybrid electric vehicle
ICE	Internal combustion engine
ICT	Information and communication technologies
IEA	International Energy Agency
IPCC	International Panel on Climate Change
LDV	Light duty vehicle
LPG	Liquefied petroleum gas
mb/d	million barrels per day
mtoe	million tons oil equivalent
NEFZ	Neuer Europäischer Fahrzyklus (New European Driving Cycle)
NGO	Non-governmental organisation
NMT	Non-motorised transport
OEM	Original elements manufacturer (car manufacturer)
PHEV	Plug-in hybrid vehicle
pkm	passenger kilometres
R&D	Research and development
RoW	Rest of the world
SKD	Semi knocked-down
STEEP	Society, Technology, Economy, Ecology and Politics
SUTP	Sustainable urban transportation planning
TCO	Total cost of ownership
vkm	vehicle kilometres
ZEV	Zero emission vehicle

1. Introduction

Modern mobility is dominated by the privately owned car because it embodies the main values of modernity which are individuality, flexibility and diversification. However, car-centred mobility and transport policies come at a cost. Not only do they coerce some individuals into driving and exclude others from the amenities of modern life but they also generate a host of burdens of mobility, ranging from pollution, accidents or energy dependency to congestion, anxiety and loss of urbanity. The car system with all its advantages and disadvantages is ripe for a change. While vehicle manufacturers and infrastructure constructors still try to build their way out of congestion and achieve improvements by mere "technology fixes" there is increasingly more room for social innovations.[4] These include mobility services which 1) allow customers to use vehicles instead of owning them and 2) offer services that connect transport modes, especially private with public ones. As the necessity and demand for these services rises manufacturers are increasingly including them in their portfolios.[5] When the idea for this thesis was developed in 2008, car manufacturers played only a minor role on the mobility services market. This changed while the first chapters for this thesis were written when Daimler and Peugeot ventured into mobility services in 2009, their success and customer acceptance dispelling the scepticism of the public, of researchers and of others car manufacturers. The latter followed suit with again more services during the last years. Their entrance in the mobility services market with highly flexible and professional mobility services changed the market place significantly. Yet, as the market is still very young – actually still too young for any kind of retrospective or a more than tentative outlook – the basic layout of the thesis remained the same, answering the questions of future mobility services demand growth and identifying and assessing barriers and opportunities for car manufacturers in the market.

The motivation for investigating mobility services is founded on several external trends which are likely to increase the demand for mobility services in the near future:

Unsustainable Transport: "Unsustainable Transport"[6] is the term that best describes the current condition of many urban transport systems. It is presently impacted most by external developments like rising resource prices due to increasing demand and resource scarcity, and increasing burdens of mobility, including congestion, pollution, financial burdens on the individual as well as on the public, and mobility inequalities. In order to achieve sustainable development of urban transport it is necessary to diminish the burdens of mobility and the resource demands while at the same time enabling a seamless, flexible and affordable mobility for all.[7]

Urban planning: Transport planning has developed a three-fold approach for achieving higher sustainability: Reduce, Shift, Improve. While *reducing* mobility needs is mainly a task of urban planners and *shifting* transport modes the task of local transportation providers, vehicle manufacturers traditionally have focused on *improving* technology by increasing the efficiency or lowering the tail-pipe emissions of their vehicles. This thesis assumes that car manufacturers can also engage in the *shift* approach by offering integrated and non-integrated mobility services and thus make a further contribution to the sustainable development of urban transport development.

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4 Cox 2010; Dennis/Urry 2009
5 Canzler/Knie 2009; Grünig/Marcellino 2009; Shaheen/Cohen 2013
6 Banister 2005
7 EU Commission/Joint Expert Group on Transport & Environment 2006

Transport sector regulation: Increasing regulation aiming at reducing, shifting and improving transport urges providers and manufacturers to change their products and portfolios. In order to comply with higher environmental standards manufacturers are lowering the emissions and fuel use of their vehicles. But transport measures aiming at reducing or shifting transport volumes (e. g. congestion charging) may discourage car use and increase the demand for other transport modes and services.

Innovative target groups: Future mobility types will demand a much more diversified set of mobility services that facilitate seamless mobility.[8] To date, these demands are not served appropriately even though first estimates indicate that there are considerable market shares to be gained.[9] Future urban structures and reurbanisation efforts will draw mainly high-income and service oriented inhabitants into the congested city centres, thus increasing the demand for innovative mobility solutions.[10]

Market and competition: One option for car manufacturers to achieve full potential in an increasingly regulated and competitive market is to integrate mobility services in their portfolios. In the past couple years, the role of car manufacturers in developing and implementing mobility services noticeably increased. There are signs that car manufacturers are beginning to understand that their business might not be in automobiles, but in mobility[11] and that they need to enlarge their portfolios.[12] As many companies are reaching the limit of segment and bodystyle diversification, they have enlarged their service ranges, especially in saturated markets in the OECD. For the more part, these services are car oriented, i. e. they support the purchasing and maintenance process of a privately owned car (e. g. full-service leasing or financing). Already today, vehicle-related services make up a significant part of the turnover and profit of OEM:

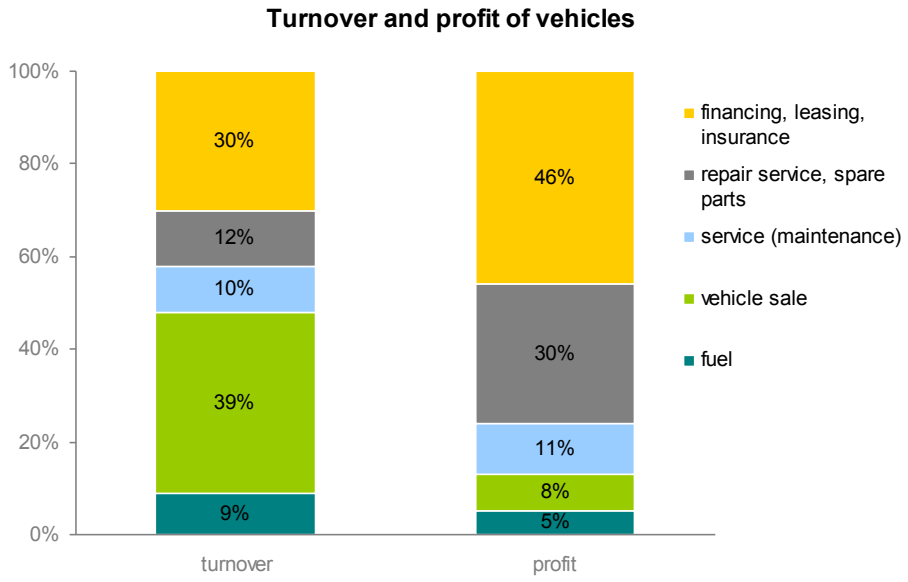

Figure 1: Turnover and profit shares of vehicles[13]

Technology progress: While concepts of “use, don’t own” have relied in the past on idealistic consumers willing to cut back on their mobility by accepting complicated procedures to access vehicles or transport services, innovative ICT systems make access to vehicles and

[8] Canzler/Hunsicker 2007: 7ff.; Winterhoff 2009
[9] Winterhoff 2009; see also chapter 2.3.4
[10] Zegras 2006:5
[11] Levitt 1975 [1960]:2; Canzler/Knie 2009:29
[12] Nagel/Wimmer 2009:175; Inkinen 2009:4
[13] Koch 2006:55

transport comfortable and enable seamless travel, thus attracting users from a larger social group or market.

This array of current developments in the mobility sector is the key motivator for writing this thesis and for highlighting the perspective of car manufacturers. Investigating such a dynamic field implies that even during the completion of the last phrases of this thesis new developments on the mobility services market had to be included and updated. Consequently, upon publishing some information might already be outdated while other new bits of information will be missing.

1.1. Car manufacturers in urban markets

This thesis will look at mobility services from the perspective of car manufacturers and focus on urban markets. A brief overview of the current trends and challenges of the automobile industry in urban markets will be presented in this introductory chapter in order to provide a framework for the analyses to follow.

The years 2008 and 2009 were marked by an exceptional economic crisis[14] which had severe impacts on car manufacturers world wide. The automobile industry's situation had already been difficult before the crisis, especially due to saturated markets and excess capacities,[15] but it worsened significantly in 2008/2009. Existing excess capacities grew and made companies increasingly inflexible in their investment decisions. In 2009, excess capacities amounted to 25 %: While only 50 million cars were sold annually, there were production capacities for 65 million cars.[16] Regional car sales figures were affected differently by the economic crisis:

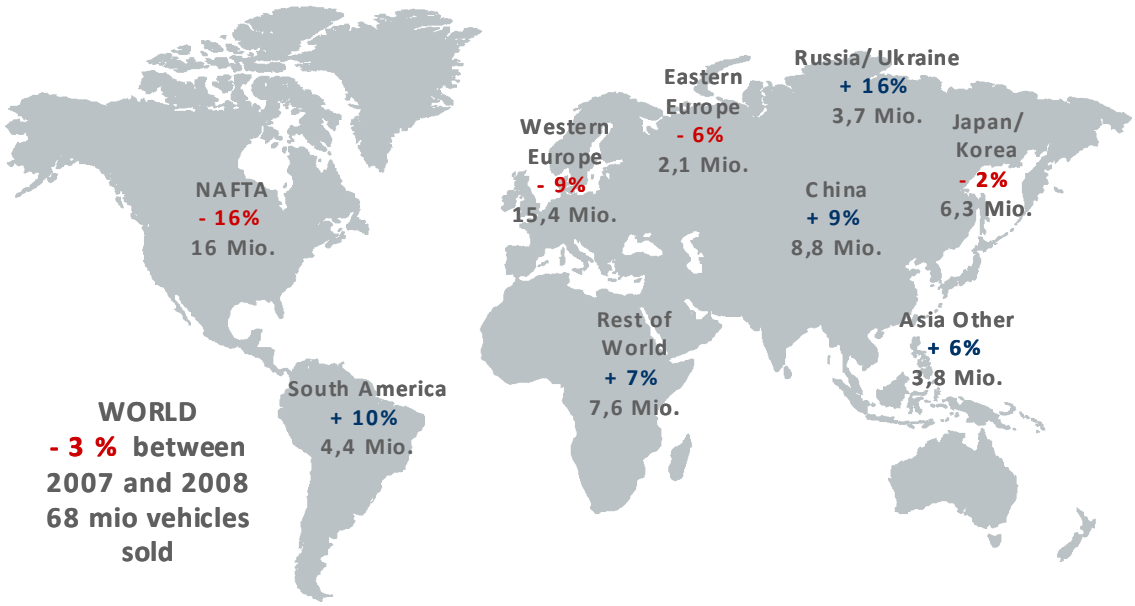

Figure 2: Regional LDV sales 2009[17]

The plus in the emerging markets was not able to make up the downturn in the larger markets, with the result of a 3 % car sales decline worldwide. There is also a variance of up to

[14] For more details on the economic crisis see chapter 3.3.6
[15] VDA 2009
[16] VDA 2009
[17] Roland Berger 2009

45 % in the effect on the different car manufacturers. While the “big three” Ford, Chrysler and GM and most Japanese manufacturers experienced big losses during the economic crisis, manufacturers like Volkswagen, Hyundai and Fiat were hardly affected.

As economy stabilized from 2010 on, so did vehicle sales and production. Most brands were able to finish the FY 2011 with a clear plus in their volumes with the exception of Mazda and Honda – which in part is due to the lagging Japanese economy:

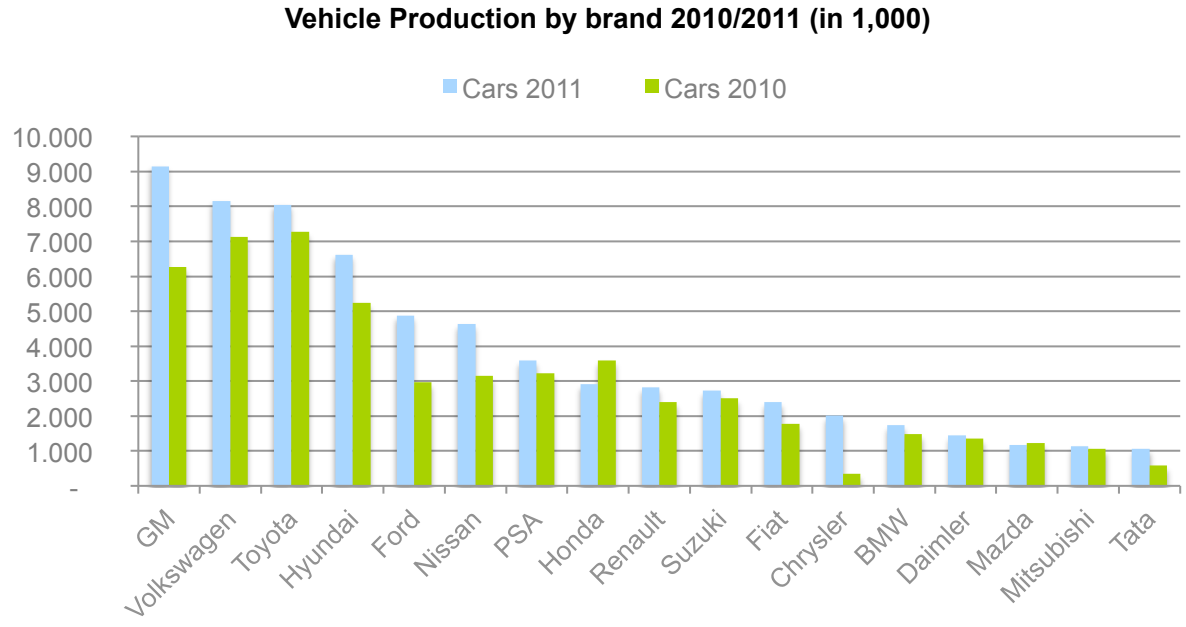

Figure 3: Change in vehicle sales by brand (2010 vs. 2011)[18]

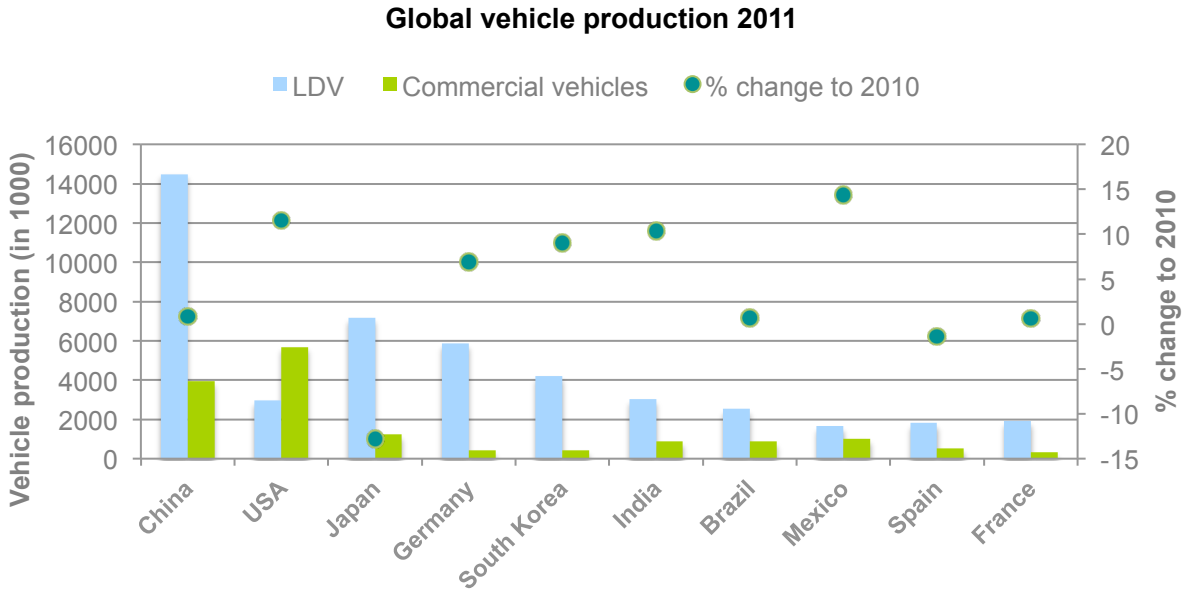

Figure 4: Global vehicle production (2011)[19]

[18] OICA Production Statistics 2011, 2010
[19] OICA Production Statistics 2011

Altogether, after the 9 % decline in 2009 due to the 2008 global financial crisis, global car production returned to 22 % growth in 2010, and then consolidated at the current 3 % yearly growth rate.[20] The outlook for the automotive industry remains mixed until today, with headlines warning of a meltdown occurring here and there, but most experts accrediting healthy stability to the industry.

As the automotive industry is a core industry in many industrialised countries, a common measure of economic stimulus packages during the economic crisis of 2008/2009 was a scrapping premium which provided a financial bonus for scrapping an old car and replacing it with a new one. Besides stimulating the automotive market governments intended to renew national car fleets and make them more environmentally friendly. The stimulus packages averted the worst consequences of the economic downturn for many car manufacturers even though many critics argued that they distorted market processes. The features of the premiums varied among countries:

Scrapping Premiums in Europe (2009)

Germany Umweltprämie
Duration: Jan–Dec 2009
Total Budget: 5 billion €
Bonus per capita: 2,500 €
Number of recipients: 1.7 mil.
Conditions: Age of scrapped car: >9 years; new vehicles need to fulfill Euro 4 emission standard

France Superbonus/Prime à la caisse
Duration: Dec 2008–Dec 2011
Total Budget: 390 mil. €
Bonus per capita: 1,000–2,000 €
Number of recipients: n.a.
Conditions: Age of scrapped car: >10 years; max. emissions of new vehicle: 160 g CO2/100km; premium rises with lower emission levels

Italy Incentivi alla rotamazione
Duration: 2009
Total Budget: n.a.
Bonus per capita: 1,500–5,000 €
Number of recipients: n.a.
Conditions: Age of scrapped car: >10 years; new vehicle needs to fulfil Euro 4 emission standard; max. emissions of new vehicle: 140 g CO2/100km (gasoline)/ 130 g (diesel); highest bonus for alternative fuel/engines; bonus also applicable for two-wheelers

UK Scrapping premium
Duration: May 2009–Feb 2010
Total Budget: 330 mil. £
Bonus per capita: 2,200 €
Number of recipients: 150,000
Conditions: Age of scrapped car: >10 years; no environmental requirements for new car

[20] OICA Production Statistics 2011

Even though economic impacts dominated, the environmental effects were largely positive:[21]

- Emissions of the new vehicles tend to be lower, even in countries which have not tied the scrapping premium to environmental standards. In Germany, these vehicles emit 74 to 99 % less emissions, depending on the pollutant, than the substituted vehicle.
- Fuel consumption and CO_2 emissions of the new vehicles tend to be lower, e. g. in Germany fuel consumption was 1 l/100 km lower.
- Noise emissions of new vehicles are lower than old vehicles.

When looking at these positive effects it needs to be considered that the share of the new vehicles' total vehicle kilometres tends to be very low. E. g. in Germany they constituted only 4 % of all vehicle kilometres in 2009.[22] Their impact on the reduction of GHG emissions and total pollution is therefore minimal. A drawback on the positive effects is the energy intensity of the production process which, depending on the substituted vehicle's age, may be higher than the achieved reductions in the vehicle use phase.

The economic impacts of the scrapping premiums in Europe were very different in each country as shown by the following figure:

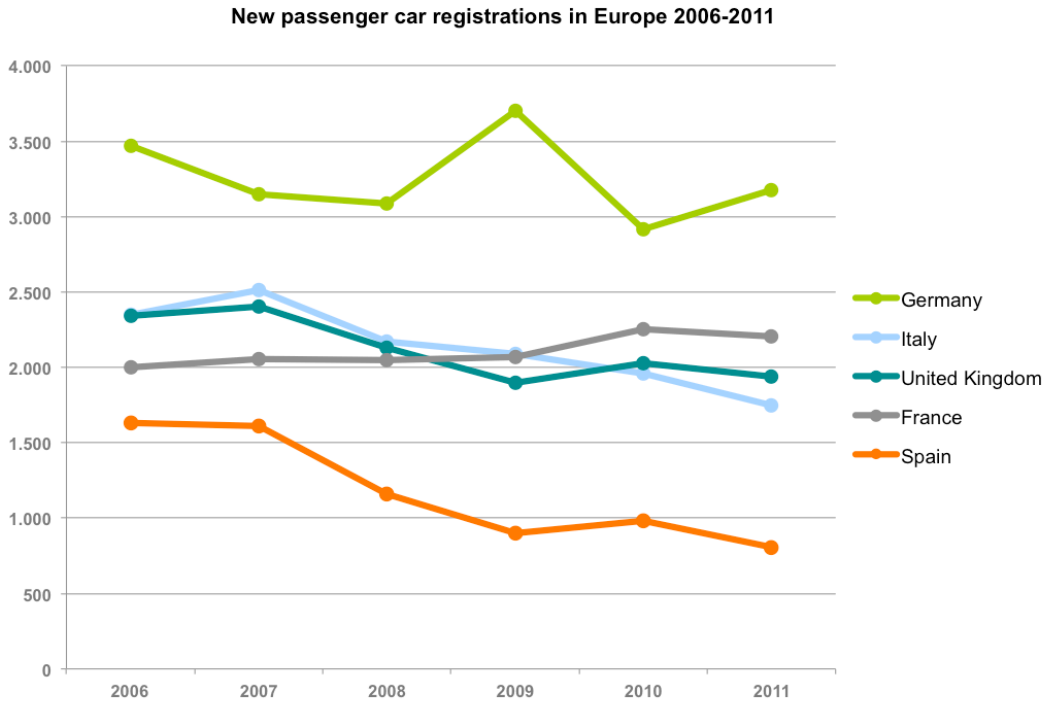

Figure 5: Development of car registrations in Europe[23]

It is obvious that some scrapping premiums could not avert a downturn of car sales in general while others – as the German premium – increased car sales above previous levels. As a part of the purchases were advanced purchases it was expected that the car industry would experience severe hardships after the phase-out of the scrapping premiums.[24] This turned out to be especially true in Germany, the largest passenger car market in Europe and the country with the strongest scrapping premium incentive. Registrations in 2010 fell below 2008 levels and only returned back to pre-crisis levels in 2011. The largest downturn was experienced by Spain which is still trying to cope with the aftermath of the big 2008 crisis.

[21] Höpfner 2009:6-7
[22] Höpfner 2009:9
[23] ACEA 2012
[24] BCG 2009

The countries already vulnerable economy was hit severely by the crisis and has not been able to recover since 2008, of which drastically decreased car sales are only one consequence.

Whether and when the car industry will recover is contested among experts. Despite major dips in sales development most manufacturers expect to catch up with their goals within the next 5 to 10 years. The market forecast for 2013 and 2018 therefore looks as follows:

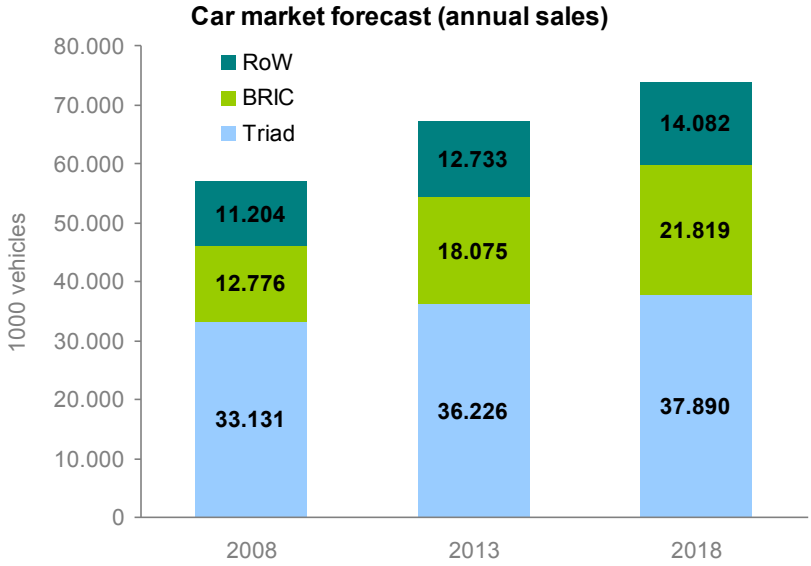

Figure 6: Global car market forecast[25]

The forecast demonstrates clearly that the largest growth is to be expected in the emerging markets. OEM will face ever higher customer demands and severe competition and consolidation.

Beyond the economic crisis, car manufacturers currently face the following challenges specific to urban markets, e. g.:

Urban transport crisis: Even if "the" urban transport crisis does not exist, many cities experience different levels of traffic problems ranging from congestion, parking shortage, pollution to accidents and inequality.[26] Many of these problems are caused by cars and/or affect cars.[27] The challenge therefore is twofold: mitigating problems caused by cars and adapting to problems affecting cars. OEM have worked mainly on mitigating the effects of pollution, accidents and noise, while their opportunities to mitigate congestion and parking shortage are minimal to non-existent. On the adaptation site, OEM have invested e. g. in reducing stress caused by parking and congestion and in passive security systems.

Urban transport regulation: Non-fiscal measures (speed limit zones, bans on vehicles) and fiscal measures (toll roads, congestion charging zones) increasingly pressurise vehicle manufacturers and make car use and ownership in urban areas less attractive even though they affect only small numbers of users so far.[28]

New mobility behaviour and customer preferences: Due to the massive problems affecting urban car travel and, in some places, viable alternatives to car use and ownership (high quality public transport and NMT infrastructure, high densities for short trips) car ownership and use is declining slightly in certain cities around the world. Especially for the younger genera-

[25] AID 2012
[26] see chapter 3.3.9
[27] Hotzan 1994:134; see also chapter 2.2.2
[28] see chapters 2.2.2 and 3.3.10; IEA 2009:252

tion of developed megacities, car ownership and use is seen as increasingly less attractive and necessary.[29] This trend is fuelled by rising oil prices; the prospect of alternative fuels and drive-trains will only slightly ameliorate the situation because they are not expected to gain significant market shares before 2020.

At the same time, urban markets also offer new opportunities for car manufacturers, part of them directly related to coping with the described challenges:

Growth markets in emerging countries: Car ownership in emerging and developing countries is growing dramatically. Demand will grow most in emerging markets while the triad markets are already saturated:

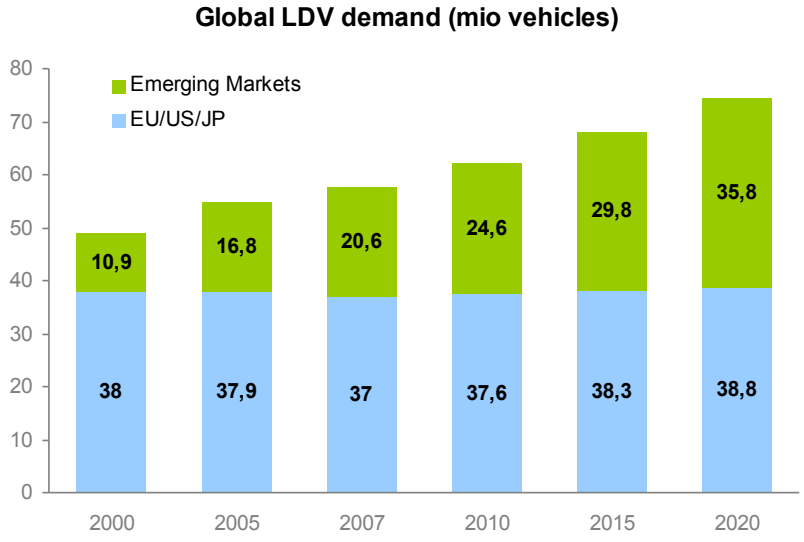

Figure 7: Global annual LDV demand forecast[30]

This continues a trend that could be observed in the last decades in Europe where several Eastern European countries tried to catch up with Western European standards and more than doubled their vehicle stock between 1990 and 2005:

[29] Hucko 2010
[30] OECD 2006

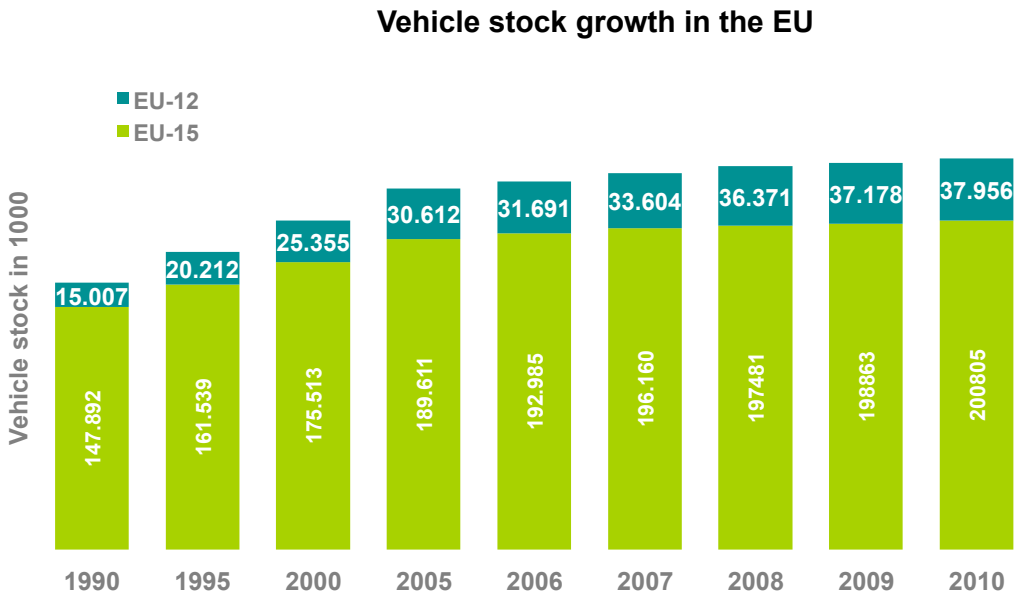

Figure 8: Development of vehicle stock in EU-12 and EU-15 (1990–2010)[31]

A look at car ownership forecasts though reveals that markets in emerging countries will not be saturated before 2020. At given levels of income, the propensity for individuals to purchase cars in non-OECD cities is greater than in OECD cities.[32] Car ownership rates will increase but not even reach half of world average until then:

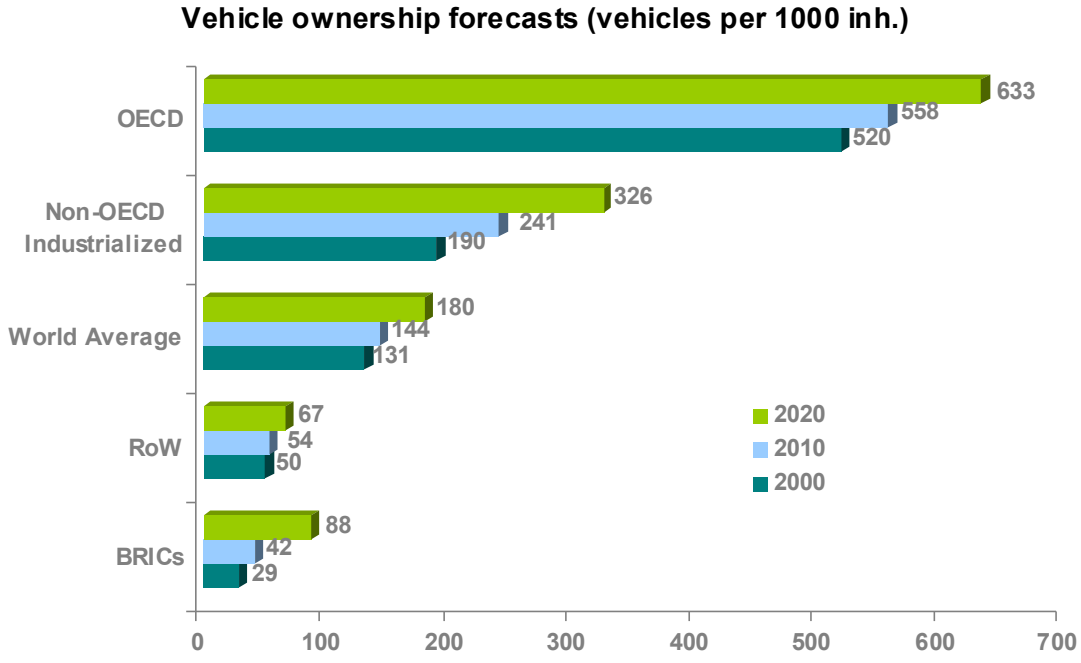

Figure 9: Vehicle ownership forecasts[33]

[31] European Commission Directorate for Energy and Transport 2012:84
[32] Banister 2005:227
[33] OECD 2006

Both figures clearly show that while emerging countries are growth markets for OEM, developed markets will call for new concepts and services in order to maintain or increase market shares. It is disputed whether emerging markets might be even more open to new services and concepts because mobility behaviour is not that habitualised yet and because there are still basic mobility needs to be filled which could be met with services even better than with products ("leapfrogging").[34]

Urban traffic as a test area for product and service innovations: Small and compact vehicles and new technologies for reducing burdens of mobility, especially battery electric vehicles (BEV) are most needed and useful in urban areas; therefore, their performance and viability can be tested there best.[35] This is the case e. g. for BEV fleets which are tested by Volkswagen Group in Berlin (VW Golf "TwinDrive"), by Daimler in Berlin, Stuttgart, Paris, London and selected cities in Italy, Smart in Zurich, Renault-Nissan in Paris, Ford in Cologne and by BMW/Mini in Berlin and Munich (Mini), all of which benefit from state-sponsored BEV programs.[36] Another case is the Toyota iQ, the first vehicle developed especially for urban traffic, even though similar cars of the A00 segment fulfil the same criteria (e. g. Smart ForTwo, Renault Twizzy). Having recognised this opportunity, many car manufacturers are now exploring vehicles designed specifically for urban traffic (see overview in annex 6.3), some of them with specific research projects, others with designated departments (see overview in chapter 4.3.1).

Bridging access gaps: Even the largest efforts to increase urban densities and access and to improve public transport infrastructure will leave gaps in the urban transport system which only motor vehicles can bridge effectively. Even if users are willing to balance their modal split, at least for standard trips, there will always be a) certain times of the day when public transport is not available, b) certain weather conditions when NMT or even public transport modes are not attractive, and c) certain areas which still are or cannot be served by public transport. Additionally, there are trips even in urban transport when the car is not only the most convenient, but also the most resource and cost efficient mode. This applies especially to hours or areas where public transport operates at capacities below the environmental and economic break-even.

1.2. Changing paradigms

With the main trends impacting on mobility services demand and the challenges and opportunities of car manufacturers in urban markets in general as a background this thesis will analyse the potential of incorporating mobility services in the portfolio of the automotive industry. However, mobility services need to be considered as one element within a larger paradigm change in society and mobility. A paradigm (or leitbild[37]) structures and channels the development of an organisation or society.[38] Depending on the item in question different paradigms do apply. When talking about mobility services the following paradigms need to be considered:

1. Paradigms governing society in general
2. The paradigm governing mobility

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[34] Winterhoff 2009:33; Rammler 2007

[35] Lahl (2009); Grünig/Marcellino 2009:16; Fraunhofer IAO 2010; see also chapter 3.3.4

[36] The German government provides € 500 million until 2020 (Die Bundesregierung: Nationaler Entwicklungsplan Elektromobilität, 2009).

[37] There is no concise English translation for the German "leitbild". For purpose of linguistic usability and simplicity the author will substitute "leitbild" with "paradigm" because its meaning is closest to the definition of "leitbild". Another reasonable option would be "shared mental model" (see Denzau/North 1994) but since it has a very specific connotation in economic research it will not be applied here.

[38] Dierkes 1992

3. The paradigm governing innovation

Sustainable development as the leading paradigm of the post-modern society

Around 1990, our post-modern society started to be governed by the paradigm of sustainable development[39] which requires a balance of social, economic and ecologic aspects in order to achieve a thriving future for all parts of society and across generations (intra- and intergenerational justice).[40] Sustainable development replaces old paradigms of resource depletion and technological progress by all means and has affected many parts of society, including mobility, economy and innovation. While sustainable development is a commonly agreed upon meta-paradigm which more often than not constitutes the preambles of federal laws, constitutions and programmes, its implementation in everyday life and in the institutions of our society has not come very far. The main reason for this implementation gap is the inertia of existing institutions, systems, and paradigms[41] and the obstacles of balancing the three dimensions of sustainability (so-called "triple bottom line").[42] Sustainable development usually requires the Schumpeterian "creative destruction" of routine behaviour, production processes and traditional power division, spearheaded by a change pioneer.[43] Thus it turns some parties into opponents even though in the sustainable development game there are no opposing parties; rather its success is conditional upon the unity of all players involved.

The post-modern mobility paradigm: Seamless and zero-impact transport

With rising burdens of mobility the conventional mobility paradigm of "faster, bigger, further" and the predominance of the automobile is increasingly being questioned. The primary objective of many transport stakeholders has become to reduce the burdens of mobility and even to initiate a shift away from car-centred mobility. This is in line with the sustainability paradigm. Since the seminal OECD *International Conference towards Sustainable Transportation* in Vancouver in 1996 "sustainable mobility" or "sustainable transport" has become the widely accepted paradigm for decision makers and stakeholders in the transport sector. Primarily it has raised awareness that current transport patterns are mostly *unsustainable;* the shift towards truly sustainable mobility has not been achieved yet as transport sector indicators demonstrate. This concerns especially the unachieved decoupling of economic and transport volume growth which is at the forefront of sustainable transport objectives.[44] As the old paradigm, the new causes conflicts among and within stakeholders. Some features of the new, more "sustainable" paradigm contradict principles of the old paradigm, as exemplified by the conflict between end-of-pipe emission catalysts and low-cost transport. The challenge and opportunity for the profiteers of the conventional paradigm – esp. vehicle manufacturing industry – is to create innovative solutions for balancing these conflicting objectives. This thesis will investigate mobility services as one option to create a solution that provides profits for vehicle manufacturers but also contributes to the mitigation of the burdens of mobility.

The post-modern innovation paradigm: Systemic, disruptive, social

In the past, innovations used to equal technical innovation. They became the foundation for societal progress and economic success. Yet, it is undisputed that in order to achieve progress towards a sustainable society social and systemic innovations are indispensable.[45] The success of car manufacturers depends mainly on their capability to innovate their products and processes, the latter being important in a market based on price competition. While

[39] Blättel-Mink 2006
[40] For the foundation of the sustainable development paradigm see WCED 1987; for a further discussion see e. g. Homer-Dixon 2006; Kopfmüller 2001; Tremmel 2001; Jänicke 2008
[41] Leggewie/Welzer 2009; Held 2007:370
[42] Hermann 2005:69
[43] Kristof 2010:44
[44] Held 2007:252; 258
[45] Homer-Dixon 2001; Kopfmüller 2001; Tremmel 2003; Jänicke 2008; Worldwatch Institute 2008; Held 2007

those innovations recognisable to the customer are mostly of a technical nature,[46] social innovations – e. g. mobility services –, which require or generate changes in behaviour and attitudes, are rare in the automotive industry. This thesis investigates to which extent mobility services are sustainable innovations[47] and how this innovation category helps car manufacturers to thrive and defend their position in a competitive market while at the same time contributing to progress towards sustainability.

This thesis will investigate mobility services based on the assumption that including them in a portfolio is a promising way for car manufacturers to adjust to and to succeed in an environment marked by these new paradigms. Mobility services are an opportunity for car manufacturers to live up to their social responsibility and to demonstrate their long-term orientation by addressing current and future needs of the society.[48] So far, many of the value propositions of car manufacturers have complied with conventional paradigms of innovation and mobility. They have focused on product and process innovations, and catered to the needs of an automobile lifestyle. As the analysis of the car manufacturers' environment (see chapter 3) will show, several trends will reduce the need for product/process innovations and will – at least partly – phase out the automobile dominated lifestyle of our society, the increasing demand for integrated mobility services being one of the most prominent consequences.

1.3. Key research questions

The thesis will operationalise the questions arising from the challenges of urban vehicle markets and the paradigm changes by addressing three main topics:

1. Mobility services demand:
   a) How do current trends foster the acceptance of, the feasibility of and demand for (integrated) mobility services? (chapter 3)
   b) Who are the potential users of mobility services? (chapter 2.3.3) How big is the potential market volume to be tapped? (chapter 2.3.4)
2. Customer acceptance of mobility services: What are the requirements for successful mobility services? (chapters 2.3.5, 3.4, 4.1)
3. Car manufacturers and mobility services:
   a) Which mobility services could be offered by car manufacturers? (chapter 5)
   b) How can car manufacturers participate best in the growing market for mobility services? (chapters 5.3, 5.4)

1.4. Scope of the thesis

The thesis will focus on services for personal urban mobility in EU-15 that could be (potentially) offered by car manufacturers until 2020.

1.4.1. Thematic scope

Urban transport:

[46] There are also process and organisational innovations which are common in the automotive industry but usually not visible to the customer. (Inkinen 2009:9)
[47] see chapter 5.1
[48] Lyons/Urry 2007:3

The thesis touches only on aspects of personal transportation in urban areas. A city is "a location where the processes of economic, social and cultural activities are concentrated in space: a node of production, exchange and interaction within and between these functions. […] The basic characteristics of the city are size, density and diversity."[49] Per definition, urban transport as compared to rural transport and long-distance travel comprises all mobility activities effectuated in an urban area. These activities can be restricted to urban areas but can also have their point of origin or destiny in non-urban areas.[50]

The reason for focusing on urban transport and excluding long-range and rural transport is the high urbanisation rate of the EU-15 and the high pressure of urban transport problems (see chapter 3.3.9), but also the fact that mobility services have the highest relevance for compact urban areas.[51]

Another reason for choosing urban areas as a focus is the high concentration of existing mobility services in urban areas. Even though e. g. car sharing schemes can also be found in smaller cities as long as they have a compact urban structure[52] and car sharing is being discussed as a solution for suburban commuting[53] the major share of mobility services will is offered in compact urbanised areas.

Mobility Services:

The thesis will look at services providing or assisting with personal urban mobility. This excludes the following topics:

- Vehicle sales/leasing and ownership
- Mobility services addressing professional/company needs[54]
- Mobility services addressing goods logistics
- Mobility services addressing the special needs of rural communities

A definition of mobility services will be developed in chapter 2.3.

Car manufacturers:

This thesis will look at mobility services from the perspective of car manufacturers. While they did not play an important role in this business area in the past, they have started to enter it during the last couple years – against many odds and most forecasts – triggered by market challenges and external trends (see chapter 3). Therefore, the urban mobility services that this thesis will look at will need to address vehicle use or ownership in order to be offered by car manufacturers.

Limits of this thesis:

The thesis will *not* focus on the potential impact of mobility services on urban transport and the environment even though mobility services are only a means to an end and not an end in itself. Therefore their impact on transport development needs to be thoroughly assessed. It is strongly recommended to decision makers to develop and apply assessment systems for estimating resp. evaluating the impacts of any measure including mobility services on the performance of urban transport systems and on environmental health.[55] This is necessary in order to prevent the implementation of seemingly innovative services that actually contradict

[49] Docherty 2008:83
[50] Nuhn 2006:183
[51] Grünig/Marcellino 2009:17
[52] momo Car-Sharing 2010
[53] Grünig/Marcellino 2009:11
[54] For examples of companies' experiences with car sharing see Bundesverband CarSharing 2010
[55] For examples of mobility services assessment see Wilke 2007; Bundesverband CarSharing 2008; Haefeli 2006; Hoffmann 2002; Loose 2007; Maertins 2006; Böhler/Hunecke 2008

established goals of sustainable urban transport planning (SUTP).[56] However, this aspect would open up a completely new research arena – an arena that belongs to environmental analysts.

1.4.2. Regional scope

As foresight is similar to weather forecasts – local weather may deviate significantly from regional or national weather forecasts – it is indispensable to narrow trends down to an applicable local level. Whether this be continents, countries, regions, cities or even city quarters depends on the issue discussed. Transport systems are highly local but are shaped by a) local, b) regional and c) national politics and by d) global megatrends. The analysis esp. of key factors influencing mobility services until 2020 (chapter 3) will address several regional levels but the focus of analysing impacts on mobility services will be the EU-15 area.[57] It is a rather homogeneous market compared to the EU-25, which includes markets in transition (Eastern and Central Europe), or the OECD, which would include some non-European countries with significant differences in mobility behaviour and transport infrastructure compared to Europe.

1.5. Current status of research and literature

There are currently no analyses of this scope concerning mobility services offered by car manufacturers. However, there is plenty of literature on (1) urban transport and sustainable urban transport planning, (2) mobility services in general, (3) the selected key factors, (4) mobility behaviour and markets, and (5) car manufacturers and innovation.

The literature on **(1) urban transport and sustainable urban transport planning** is very comprehensive. Theoretical approaches like Adey (2010) or Urry (2007) frame the field which originates from the practice of planning. Student introductory works like Low/Gleeson (2003), Gather/Kagermeier/Lanzendorf 2008, Knowles/Shaw/Docherty (2008) or Nuhn/Hesse (2006) and professional handbooks like Schöller-Schwedes et al. (2007) provide a comprehensive overview on the whole subject while deep-diving into selected current topics. Sustainable urban transport planning is specifically addressed by Deakin (2001), Held (2007), Bruun/Kenworthy/Schiller (2010), Banister (2005), Gudmundsson/Höjer (1996), including the origin of the term and its definition, as well as by Gudmundsson (2003) which introduces potential indicators for measuring sustainable urban transport. The status quo of urban transport and its prospects are presented by European Environment Agency (2009), World Business Council (2004) and Schöller-Schwedes/Rammler (2008), most of the results presenting an unsustainable, dynamic state of urban transport following historically proven patterns of hypermobility, a term coined by Adams (2000), and de-urbanisation. A seminal text on automobility was published by Kingsley/Urry (2009) which maps out new routes for urban individual mobility beyond the privately owned car and presents a new “car system”. This figure will be used in the framing chapter on urban mobility of this thesis (chapter 2.2.1). Similarly controversial are Bertolini/Le Clerq/Straatemeier (2008) and Conley/McLaren (2009) which present new paradigms for sustainable urban transport planning and open up controversial debates about the modern car society.

The topic of **(2) mobility services** is framed by Beutler (2004), who introduces the concepts of intermodality and multimodality, and conceptual works by Canzler/Hunsicker/Karl (2007), Herdegen/Rammler (2006), Maertins (2006) and Maertins/Schmöe (2008), some of which like Grünig/Marcellino (2009) address specific topics. However, most literature on mobility services and their implementation, impacts and user groups has its origin in accompanying

[56] Rammler 2005:15

[57] EU-15 consists of Austria, Belgium, Denmark, Finland, France, Germany, Great Britain, Greece, Italy, Ireland, Luxembourg, Netherlands, Portugal, Sweden, Spain.

research of mobility service projects, including Böhler (2010), Böhler/Hunecke/Grischkat (2008), Haefeli (2006), Harms (2003), Hoffmann (2002), Loose (2007), Schwieger (2004), and Wilke (2007). Their results show clearly that mobility services are still a niche market; despite their respectable growth and customer relationship management efforts they were not able to gain significant market shares. Outlooks on the market opportunities of mobility services are provided by Diez/Kohler/Mayer (2010), Haefeli (2006), Wilke (2002), Shaheen/Cohen 2013 and Winterhoff (2009).

For the analysis of the **(3) key factors** (chapter 3.3), plenty of literature and online information exist. The most important works used for this thesis are (by category):

- Climate change and environmental aspects: Droege (2008), EEA (2008), Gilbert/Parl (2007), IPCC (2007), leggett (2006), Leggewie/Welzer (2009), Rahmstorf/Schellnhuber (2007), Stern (2006), UBA (2006), World Bank (2008)
- Urbanisation and demography: BMVBW (2004), Carsten (2005), Newman/Beatley/Boyer (2009), Siemens AG (2008), Worldwatch Institute (2007)
- Transport Systems, infrastructures and mobility behaviour: BMVBW (2002), Canzler/Hunsicker/Knie (2009), DIW/infas (2009), Doshi (2007), European Commission Directorate for Energy and Transport (2009), Gilbert/Perl (2007), Hunsicker/Karl/Lange (2009), Hunsicker/Sommer (2009), Kenworthy/Laube (2001), Kenworthy (2003), Knie/Peters (2009), Knoll et al. (2003), Metz (2008), Mietsch (2007), OECD (2006), Roth (2006), Schade (2009), Siemens AG (2008), WBCSD (2004).
- Automobile industry and technology: Aigle/Marz (2007), ACEA (2010), Aral (2009), BCG (2010), Dings (2009), European Federation for Transport and Environment (2009), Leifheit (2009), Stan (2008), Winterhoff (2009), WBCSD (2004)

For the **(4) user and market analyses** (chapters 2.3.3 and 2.3.4) of mobility in general and mobility services specifically, BMU (2008), dena (2009), Eckhardt (2006), Grünig/Marcellino (2009), Herdegen/Rammler (2006), infas 2009, ipsos (2008), Karl/Maertins (2009), Maertins (2006), Ulrich/Duranton/Köhler (2009), Winterhoff (2009) and BMVBW (2004) describe the general preconditions for customer acceptance of mobility services. Empirical user studies like Böhler (2010), Böhler/Hunecke/Grischkat (2008), DIW/infas (2008) and Zumkeller (2008) complement this introduction into the field by being more specific on user groups and long-term behavior changes. As the most common kind of mobility services are still car sharing services, some studies and market analyses focus exclusively on this service, e.g. Fliegner (2002), Haefeli (2006), Hoffmann (2002), Maertins (2003), Schwieger (2004), Wilke/Böhler/Bongardt (2007) and Shaheen/Cohen (2013).

The role of **(5) car manufacturers and innovation** (chapter 5) is analysed in several texts from industrial sociology, but also by market research institutes. The seminal work of Abernathy (1978) is based on an empirical study of innovation at the Ford Motor Company and concludes that volume manufacturers have much more difficulties with radical, systemic innovations than small production units. Adler/Benner/Brunner (2009) and Benner/Tushman (2003) have commented extensively on and expanded Abernathy's theories. Approaches to innovation in general can be found in Blättel-Mink (2006), Blättel-Mink/Renn (1997), Dierkes/Hoffmann/Marz (1992), Christensen (2002) and Rogers (2003), with Aigle/Marz deriving innovation type categories from innovations in the automotive industry. Stamm (2003) and Vahs/Murmester (2002) have edited comprehensive works on more practical aspects of innovation management, while Inkinen (2009) investigates the close relation between innovation and foresight, and INFU (2010) presents a compilation of current innovation trends. Vargo/Lusch (2004) expand the innovation focus from products to services and develop a "new dominant logic for marketing" which deviates from the conventional product-based logic. Current innovation trends in the mobility sector are described in Bratzel (2008) and Winterhoff

(2009). The opportunities for car manufacturers in the mobility services market are highlighted by Diez/Kohler/Mayer 2010 and Winterhoff (2009).

While there is plenty on sources on the topics that frame this thesis – mobility and transport planning, car manufacturers and innovation – there is a clear lack of literature that analyses the link between mobility services and car manufacturers, especially regarding opportunities for engaging in this thriving, but small field of business. This thesis aims at contributing to this void by presenting a selection of potential mobility services which could be offered by car manufacturers and their strategic options.

1.6. Empirical research plan

This thesis uses an interdisciplinary approach by touching on aspects like human behaviour, business planning, environment scanning, and sustainable urban transport planning. It draws on methods from different scientific disciplines, mainly transport research and future research. The methods to be used will be described in the following subchapters.

The thesis will start with framing the research area of (sustainable) urban transport (chapter 2.2.1) and zooming in on the contested role of the car in urban travel (chapter 2.2.2). It will then develop a working definition of mobility services (chapter 2.3) and put them in context with the general sustainable urban transport planning debate (chapter 2.3.1). After looking back at the young history of mobility services (chapter 2.3.2), a thorough analysis of the (potential) users of mobility services follows (chapter 2.3.3). The latter constitutes part of the answers to the key questions developed in chapter 1.3 by addressing the mobility services demand issue. It is further enlightened by a market assessment (chapter 2.3.4). The external factors impacting mobility services demand are selected and analysed in chapter 3. This chapter constitutes the core of empirical analysis of this thesis. With the user-related and external impacting factors as a foundation, the catalogue of requirements is developed in chapter 4.1. This is followed by a first look at existing activities of the automotive industry in the mobility services market, before presenting six mobility service concepts that could be implemented by car manufacturers. Both existing and potential services are assessed according to the catalogue of requirements.

Chapter 5 is the core chapter of this thesis as it presents opportunities for car manufacturers to become involved in the mobility services market. After positioning mobility services within car manufacturers' innovation context, strategic options for involvement in the mobility services market are developed. The chapter closes with a research and action agenda for car manufacturers, including recommendations for selecting appropriate mobility services, suggestions for market entry strategies, and research arenas that need to be initiated resp. intensified. The conclusion (chapter 5.4) sums up the author's insights on the likely development of car manufacturers and the mobility services market and finally presents a vision (chapter 5.5) for future mobility service features which foster customer satisfaction and success for the provider alike.

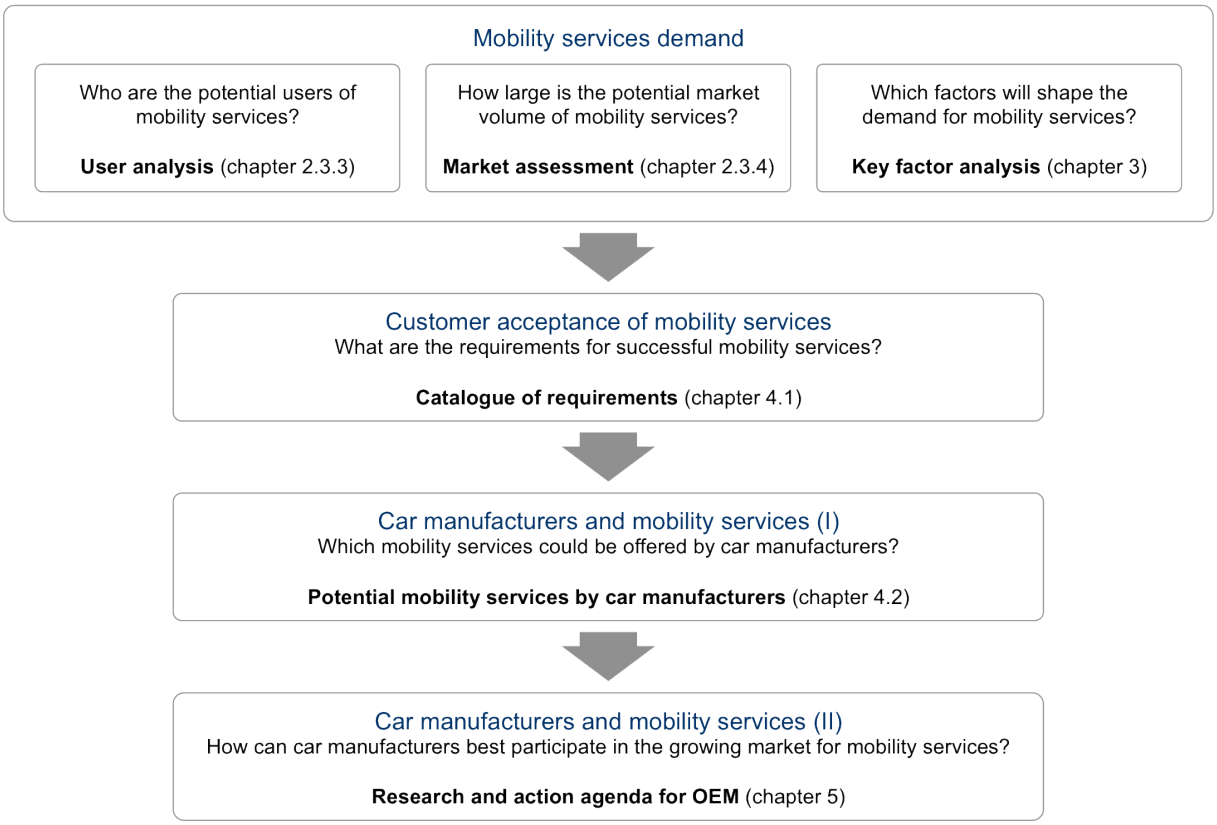

Figure 10: Thesis project overview

As a few of the steps mentioned require further explanation, their methodology will be presented in more detail in the following paragraphs.

Mobility services user analysis

Customer acceptance is a key prerequisite to success of a product or service. Chapter 2.3.3 will first look at the factors influencing users' mobility behaviour and relate them to mobility services. In a next step, results from studies on the changes in mobility behaviour mobility services could evoke are presented in order to frame the potential impacts of mobility services. Most importantly, a working set of mobility types of the future will be identified by drawing on existing segmentations, including a forecast on the size and needs of each type. This set will be used for determining the customer fit of different (existing and potential) mobility services by car manufacturers. As a conclusion, criteria for user acceptance of mobility services will be derived in order to be incorporated into the catalogue of requirements (chapter 4).

Market assessment

Which are the potential market shares of mobility services, esp. of mobility services by OEM? Venturing into a new business field such as mobility services requires analysing thoroughly their market potential. This question needs to be answered in a qualitative manner – this is achieved by the catalogue of requirements in chapter 4.1 – and also a quantitative way. In the context of this thesis the latter will be achieved by gathering insights from existing market studies and assessing their validity in chapter 2.3.4. The objective is to create a research and action agenda along the potential mobility services presented in chapter 4.2 by highlighting the specific user and provider benefits of each type.

Key factor analysis

When looking into the future of a product or business, it is important to look into the future of the customers: What are their needs and desires in the future, which challenges will they have to cope with?[58]

To answer these questions key factors influencing the future demand for mobility services will be identified, described and analysed regarding their concrete impact on mobility services. The procedure looks as follows:

1. Preselection of potential key factors
2. Uncertainty-impact analysis
3. Cross-Impact analysis
4. Definition of final key factor set
5. Description and analysis of key factors (time horizon 2020) with a focus on their impact on mobility services

These steps are the preliminary steps of a scenario process[59] and help to select the factors most relevant for the analysis of the environment of a given topic or sector. As only the *impact* of the factors on mobility services demand is of interest for this thesis, a complete scenario process including alternative projections and quantitative or qualitative scenarios will not be performed.

1. Preselection of potential key factors

In a brainstorming process and with the help of available literature or existing scenarios, a list of potential key factors is generated. Some of the literature used is listed in chapter 1.5. This thesis will also draw on existing scenarios developed by the Volkswagen Group Foresight department, all of them related to the future of mobility and the automotive market.

2. Uncertainty-impact analysis

An uncertainty-impact analysis evaluates two aspects:

- How certain or uncertain is the development of a factor?
- How important is the factor for the field to be investigated?

For a scenario process or key factor analysis, factors with high impact and high uncertainty are the most relevant. Factors with high impact but low uncertainty are so-called givens, while factors with low impact and high uncertainty are the surprise candidates. The main objective of an uncertainty-impact-analysis though is to single out those factors that are neither important nor uncertain. The two questions above are answered by a quantitative judgement on a scale from 0 (low uncertainty resp. low impact) to 8 (high uncertainty resp. high impact). Consequently, factors with low values for both criteria end up in the lower left corner of a matrix along the axes uncertainty and impact and can be singled out.

[58] Nagel/Wimmer 2009:174f.
[59] Kosow/Gaßner 2008

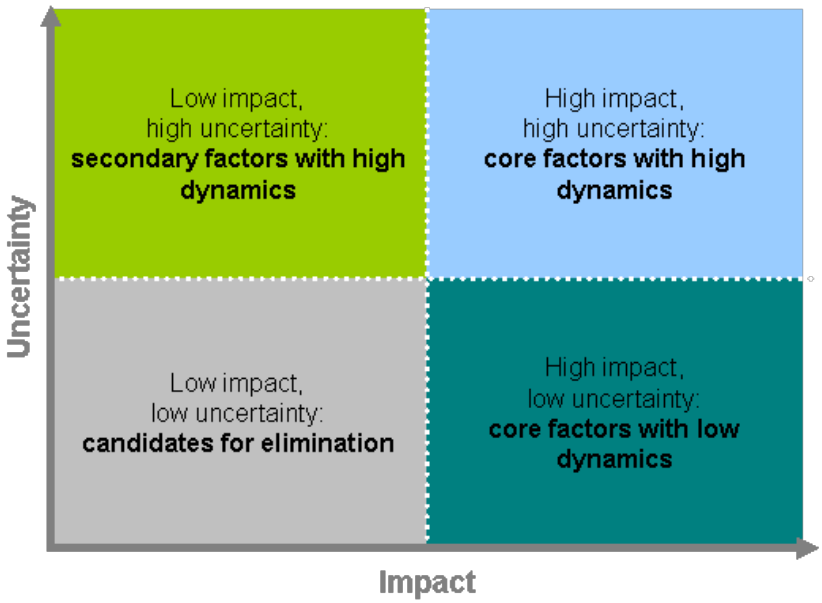

Figure 11: Generalised uncertainty-impact analysis matrix

As these evaluations can not or only hardly be based on objective criteria, an intuition-based evaluation is performed by a group of experts. Group intelligence raises the objectivity of a subjective process.[60]

3. Cross-impact analysis

This reduced set of key factors will now be further reduced by evaluating their mutual impacts on each other. This is done by either determining the level of cross-impact in a matrix or by using graphical tools like those included in scenario software. Such an analysis allows identifying the level of activity and passivity of each factors (active-passive matrix). The objective of this analysis is to single out those factors that are neither very active themselves nor very passively influenced by other factors. As in an uncertainty-impact analysis, group intelligence needs to be applied, too. But as determining the cross-impact of a certain number of factors can be a monotonous and laborious, usually a smaller team will perform it.

4. Definition of final key factor set

After narrowing down the large set of key factors, the remaining factors are clustered along the STEEP sectors (society, technology, economy, ecology, politics)[61] and, if necessary and appropriate, additional sectors according to the field of study in question. The clustering along STEEP sectors does not follow fixed definitions, but is done according to the needs of the analysis in question.

5. Description and analysis of key factors

This is the main workload of the key factor analysis. Each factor needs to be described according to a pre-defined structure. The status quo is described as well as possible future developments. Then their impact on the field in question is analysed in order to generate an integral picture of its future development.

Catalogue of requirements

Operationalising the results of the key factor analysis (chapter 3) and the user analysis (chapter 2.3.3), a catalogue of requirements will be developed in chapter 4.1 for checking the user-friendliness of potential (chapter 4.3.2) and existing (chapter 5) mobility services by car

[60] Kosow/Gaßner 2008:29; Steinke 2007:324
[61] Bishop/Hines 2006:56f.

manufacturers. The requirements are not weighed as all are deemed equally important. Similar requirements are clustered. Each requirement will be described briefly along with rating levels “low”, “middle”, and “high”.

Car manufacturers and mobility services

Chapter 4.3 identifies and describes potential mobility services that could be offered by car manufacturers. They are selected according to technological feasibility and assumed customer acceptance. The evaluation of their customer acceptance is performed via the criteria in the catalogue of requirements. As the proposed services are only potential services and no real implemented ones, the assessment is hypothetically. In case a car manufacturer or any other provider were to actually implement such a service, the assessment would have to be repeated on realistic terms.

The rationale for engaging in mobility services is developed along different business models which each represent a different depth of transformation towards a service oriented company. It is accompanied by an analysis of the strengths, weaknesses, opportunities and threats (SWOT) companies entering into the mobility services business field will face. The chapter closes with a synthesis on the selection of mobility services according to customer acceptance (usefulness for mobility types and catalogue of criteria assessment) and to the results of the SWOT analysis before developing a research and action agenda for car manufacturers that want to enter the new business field.

2. Urban mobility services

Transport systems are large, complex systems like most systems of modern society. The larger the system, the more patterned and regulated it is and the higher the risk for system lock-in. This increases predictability but reduces flexibility to respond to altered environments. Urban transport systems currently face multiple dynamic challenges, ranging from resource scarcity to climate change and traffic overload. They need to respond to these challenges and often do so in a piecemeal fashion. In order to achieve system innovation though, more than one element of a system needs to be changed.[62] Elements need to be integrated and opt for coexistence rather than for competition. Mobility services aiming at deprivatising vehicles and integrating different transport modes are one tool to alter some of the elements of urban transport systems towards sustainable development, but their success will ultimately depend on the adaptation of other system elements as well. The following subchapters will explain the status quo of urban transportation, the role cars play in it and how mobility services can be an instrument for system innovation. As the success of mobility services hinges on its users, a whole subchapter will be dedicated to them as well. After a brief look at the estimated market potentials of mobility services, the chapter will close with a synthesis of the customer acceptance factors.

2.1. The role of social sciences in transport research

As this thesis is anchored in the disciplinary field "sociology of mobility", the following paragraphs will explore the nexus between mobility/transport research and social sciences.

The connection between society and mobility is illustrated by the quote "Mobility shapes society, and society shapes mobility."[63] The strongly intertwined systems of transport and society – translated into a system of vehicles and individuals in modern times – have directed the paths of history. The paradigms governing society have strongly affected the predominant mobility paradigm. As already touched upon in chapter 1.2, the current societal paradigm of sustainable development has started to affect the prevailing paradigm of the automobile society (see also chapter 2.2.2). This interdependence alone justifies a strong integration of both sciences.

Yet, for the most part, social sciences resp. sociology and transportation research have never been much integrated, neither in basic nor applied research. Only with the advent of the integrated paradigm of sustainable development, which has the objective to address social, economical, and ecological needs alike, the two disciplines have begun to merge. A pure sociology of mobility or transport could evolve only recently,[64] and many experts still demand its further expansion. Many of such efforts have their origin in the social science disciplines while the commitment from the transport planning side is still low. The latter is more reluctant to include other disciplines, as it is preoccupied with operational issues which follow fixed paths and paradigms and leave less room for a societal perspective. It has to be acknowledged though that major efforts have been made in order to include the customer perspective in transport planning. As transport systems serve the movement of people and goods,

[62] Homer-Dixon 2007; Dennis/Urry 2009
[63] Lyons/Urry 2007:3
[64] Canzler 2006:14; Wilke 2007:53

society's needs, preferences and habits have to be respected when implementing them.[65] It is crucial to assure the acceptance of potential users of a vehicle or transport service. This imperative of participation makes social science indispensable in transportation planning.[66]

Above and beyond the sustainability paradigm it is modernity itself that calls for the integration of social sciences and transport planning. The so-called "wahlverwandtschaft"[67] of mobility and modernity is due to the fact that modern societies with their main features individualisation, differentiation, and flexibility rely on high mobility levels in order to enable individual lifestyles, re-integrate differentiated work patterns and transport industrial goods. The transport mode that best complies with the principles of modernity is the car: it is individually owned and used, and it allows for flexible mobility.[68] Hence, the post-modern criticism of the dominance of the car in Western and, increasingly, emerging countries[69] and of hypermobility in general.[70]

The fact that modern society is more than ever a "society on the move" calls for a new social research paradigm. Currently, the "mobilities" paradigm, a term coined by British sociology scholar John Urry, mirrors this development and is adopted by several representatives of the merging disciplines of transport and social research.[71] The paradigm assumes that our social life is constituted by five different "mobilities":

1. "corporeal travel of people […] (from daily commuting to once-in-a-lifetime exile)
2. physical movement of objects to producers, consumers and retailers […]
3. imaginative travel effected through the images of places and peoples […] in various media
4. virtual travel […]
5. communicative travel […] via communication technologies"[72]

While social research traditionally looks at these "mobilities" separately, the new mobilities paradigm "emphasises the complex assemblage between these different mobilities",[73] thus following the rising need for a multi-disciplinary approach to social transport research.[74] Accordingly, the mobilities paradigm knowingly challenges the traditional identity of social sciences which regards „social life as a purified social realm independent of the worlds of nature and objects".[75] Besides nature and objects, it is also necessary to include the systems which distribute and move people and goods around the globe in the analysis of mobilities.

The peculiar perspective of the mobilities paradigm unveils a number of paradoxes governing our mobile society, e. g.:

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65 Tully 2006:234

66 Korff 2007:6

67 Rammler 2001; Rammler 2008; Tully 2006:230; Aigle/Marz 2008:16

68 Henderson 2009:148; Canzler 2006:15; Canzler 2007:12

69 e.g. Conley/McLaren 2009

70 Adams 2001

71 Some representatives of the merging disciplines of transport/mobility and social research are: The project team "Mobilität" (Mobility) at the Wissenschaftszentrum Berlin (Social Science Research Centre Berlin) which includes namely Weert Canzler, Andreas Knie and Stefan Rammler. (see Canzler 2006) The role of social sciences in transportation research is also illustrated by academic institutions dealing with transport. Increasingly, such institutes include social sciences in their research projects, as exemplified by the Institute of Transportation Design at the School for Applied Arts in Braunschweig/Germany. (Herdegen 2006:11)

72 Urry 2008:14

73 Urry 2008:14

74 Canzler/Kaufmann/Kesselring 2008:181

75 Urry 2008:15

- The “mobilities” lens does not intend to minimise or replace the significance of places, systems or immobilities in social analysis. As the systems perspective reminds us, mobility depends not only on flows, but also on fixities, i. e. on a vast system of immobile material worlds, including paths, roads, ports, airports, parking areas, stations, bridges etc. While the world is becoming more mobile, it is also experiencing an increase of immobile structures. Ironically, the most “mobile“ modes require the largest physical structures, as illustrated by the aeroplanes which need extensive areas for airports and massive volumes of concrete and other materials for the fixed infrastructure on the ground.
- Despite the fact that modern social connections are to a lesser degree based on propinquity than traditional ones, the significance of face-to-faceness for maintaining social connections that are otherwise conducted at a distance should not be underestimated. The mobilities paradigm treats distance as a problem and therefore as a relevant issue for analysis.

These and other paradoxes that exist in the modern mobile world are addressed rather than dismissed by the new mobilities paradigm. It leaves room for exploring conflicting issues and finding solutions to reconcile seemingly insurmountable differences. This wide, almost contingent range of aspects provides new perspectives for understanding social phenomena. Given the significance of “mobilities” in our society, neglecting this perspective would lead to highly unbalanced research results. Recent discourses on globalisation, transnationalisation and cosmopolitanism[76] illustrate the awareness of this circumstance.[77]

Adopting a “mobilities” perspective in social research challenges the methodological agenda of sociology. Conventional methods are conceived for a sedentary approach and “increasingly difficult to implement with the goal of identifying mobility phenomena”.[78] Representatives of the paradigm therefore suggest that a new range of methodologies for studying mobilities be developed. As different disciplines will be involved, interdisciplinary research methods will fit best. Of course, as the paradigm is fairly new, there hasn’t been much opportunity for empirical trial yet. First advances are presented in the volumes “Tracing Mobilities” by Canzler/Kaufmann/Kesselring [2008], “Aeromobilities” by Cwerner/Kesselring/Urry [2009], and more generally in “Mobilities: New Perspectives on Transport and Society” by Grieco/Urry [2012]. By bringing together the leading authors working at the intersection of social and transport science, the last title reinforces the need to include the social aspect in mobility research by pointing out the negative policy consequences that result from its neglect. It raises warning signs resulting from a declining availability of fossil fuels and the lack of an alternative to oil for transport sector. To mark the point, the volume develops metaphors like Urry’s “autogeddon”, symbolised by the construction and deconstruction of high-carbon lifestyle cities which “ceaselessly strive for visual and environmental excess”.[79] Also, with regard to achieving integrated societies, it identifies the risks related to an increasing number of highly commercialised and simulated environments. Another achievement of the volume surely is the exploration of the many paradoxes modern mobilities consist of, even those on the policy side (e. g. Glenn Lyons’ analysis of “Technology Fix Versus Behaviour Change” which points out the advantages and disadvantages of both paradigms and favoring a combination of both paradigms in order to build a robust strategy for the future). On a methodological side, it showcases the application of new methods introduced in the discipline, some of them using and profiting from new information technologies which permit more detailed monitoring at every level of mobility (e. g. the analysis of “What We Do Whilst Driving” by Laurier and Dant in the volume using video data collected directly in the users’ vehicles).

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[76] Compare the research platform Cosmobilities at http://www.cosmobilities.net

[77] Canzler/Kaufmann/Kesselring 2008:181

[78] Canzler/Kaufmann/Kesselring 2008:186

[79] Urry 2012:8

An even more far-reaching interdisciplinary perspective on mobility, even though not within the strict sense of "mobilities" research, is offered by the volume "The Ethics of Mobilities – Rethinking Place, Exclusion, Freedom and Environment" by Bergmann/Sager [2008], entering a dialogue with the fields of ethics, philosophy, and religious studies. It opens up the arena for an even wider field of daily and intellectual life that is affected by modern mobility.

Another field which integrates transport and social research is the transdisciplinary field of socio-ecological research, well established in the German scientific community. It explores dilemmas and solutions for a transition to a sustainable society, among those the transition to sustainable mobility. As mobility is determined mainly by routines, which are perceived as a barrier to change, socio-ecological research analyses options for changing these routines. Sustainable development usually requires the Schumpeterian "creative destruction" of routine behaviour, production processes and traditional power division, spearheaded by a change pioneer.[80]

Conventional sociological research on routine behaviour is very likely to address mobility behaviour because daily travel is highly routinized[81] and individuals are not completely rational in their mobility behaviour. New routines are only acquired when a trigger event (change of residence, change of family status) prompts individuals to consider alternatives.[82] Inertia and mental effort can inhibit individuals to review the relative merits of alternative travel choices[83] and outplay rational decision making.[84] As "modern mobility happens to be individual mobility"[85] the coercive character of a privately owned car exacerbates the habitualisation of mobility behaviour: Once purchased, a vehicle constantly compels the owner to use it. Its permanent availability and high fixed costs make other alternatives less valuable.[86] (More on mobility routines see chapter 2.3.3) As we will see, mobility services that imitate existing mobility routines – most of them based on individual motorised mobility – by reducing transaction costs are likely to have the highest market acceptance.[87] It pays tribute to the fact that social transformations are only possible if not they do not place exaggerated demands on individuals.

While in the past, progress was equivalent to further specialisation of individuals and institutions, post-modern development benefits from integration. Post-modern mobility clearly requires the re-integration of transport modes, scientific disciplines and business activities in order to develop an integrated perspective in theory and, in the end, integrated services in practice. While the former is being achieved by the mobilities paradigm, the latter still awaits full realisation.

2.2. Urban Transport

Urbanity and mobility are interdependent and, along with individualisation, differentiation, secularism, rationalism and others, core aspects of modern societies.[88] Mobility and cities enable the reintegration of disintegrated and differentiated societies and by that reproduce the differentiation of modern societies.[89] This "wahlverwandtschaft"[90] makes urban mobility a

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80 Kristof 2010:44

81 Götz 2007:764; DIW/infas 2002:103; Petersen 2006:69, 75; Maertins 2006:118; Tully 2006:234; Wilke 2007:56; Wilke 2002b:13; Bamberg 2004:251; Harms 2003:160f.

82 Canzler 2006:16; Brook 2004:6; Wilke 2009:112; Harms 2003:296; Brook 2004:6

83 Lyons 2006:1; Soron 2009:187; see also Kristof 2010:55

84 Tully 2006:231; Wilke 2002b:14

85 Maertins 2008:87

86 Grünig/Marcellino 2009: 9; Canzler 2006:22; Gegner 2004:13; Eckhardt 2006:95

87 Wilke 2002b:14, 26; Canzler/Hunsicker 2007:5

88 Borken/Fleischer 2006:4; Nuhn 2006:329

89 Canzler 2006:15

symbol per se for modern, industrialised societies.[91] At any time in history, the transport technology available determined the shape and structure of cities. “Transport shapes societies and is shaped by them.”[92] Likewise, transport also shapes *cities* and is shaped by them: “Mobility is not just movement but also an extension of ideologies and normative values about how the city should be configured and by whom.”[93]

Every period faced its individual challenges which were caused by internal and external factors.[94] Medieval cities were built for walking and minor carriage traffic, 19th century cities first for trams and later for trains, and the 20th century was the century of the car.[95] Therefore, from the 19th century on, urban transport planning focused more on infrastructures and technologies and less on non-motorised, “natural” modes of transportation.[96] Today, urban transport systems in developed countries are fairly mature but require a lot of maintenance and renewal. Decision makers here are recognising the value of walkable, liveable spaces for urbanity. On the other hand, transport systems in emerging cities can hardly keep up with the dynamics of urban growth. Here, many cities tend to repeat the mistakes of the Western world, even to the point of eliminating conventional transport modes from certain urban areas while a few other cities are renowned for their progressive sustainable transport systems (e. g. Bogotà/Columbia, Curitiba/Brazil).[97]

Per definition, urban transport as compared to rural transport and long-distance travel comprises all mobility activities effectuated in an urban area. These activities can be restricted to urban areas but can also have their point of origin or destiny in non-urban areas.[98] Due to higher densities in urban than other areas urban transport systems are usually more diversified and have higher capacities. The latter may reach their limit when there are more mobility activities at a certain 1) time or 2) place than infrastructure available or 3) when mobility activities are not evenly distributed among different modes of transport. Depending on spatial patterns, a wide range of road- and rail-based transport modes serves urban mobility needs, and a smooth traffic flow depends on a balanced distribution of mobility activities along these modes in space and in time. Due to the current car-orientation of many societies, many communities are putting a disproportionate part of their efforts into road infrastructure and road traffic and are neglecting the slow modes (non-motorised transport/NMT) and public transport. The challenge of balancing urban transport includes not only motivating politics to pursue a more balanced approach, but also motivating individuals to balance their mobility behaviour. The obstacles to switch mobility behaviour are very high because it is highly habitualised.[99] Mobility services can play a role in enabling individuals to use a wider and more ideal range of transport modes and are therefore a key instrument in achieving sustainable urban transport.

In the following, approaches to achieve a more sustainable transport development and the central role of the car in urban transport are analysed more closely, including an outlook on its potential future role.

2.2.1. Sustainable urban transport planning (SUTP)

Pollution, congestion, accidents are the most prominent problems associated with urban travel, more specifically with road traffic and motorised vehicles. These problems accrue in

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90 Rammler 2008
91 Götz 2007:768; Rammler 2005:7; Wilke 2007:63
92 Lyons/Urry 2007:1; see also Nuhn 2006:183; Kirchner/Ruhrort 2007:575
93 Henderson 2009:149
94 Schöller-Schwedes 2007:3; Nuhn 2006:193; Kirchner/Ruhrort 2007:576f.
95 Schäfers/Kunz 2006:56; Rammler 2005:9
96 Cox 2010:64; Newman/Kenworthy 2007:81; Mettler-Meibom 1993:7
97 Banister 2005:227
98 Nuhn 2006:183
99 Götz 2007:764, 767; infas/DIW 2002:103; Maertins 2006:118; Petersen 2006:69, 75; Schade/Schlag 2007; Feldhaus 1998:219; Bamberg 2004:251

cities where transportation systems do not match urban form, e. g. high density areas not fit for non-motorised transport or suburban areas not served by high-speed, high-volume transit. With the advent of the automobile, Western cities and most recently emerging countries cities are serving mainly the needs of car travel and prioritise road infrastructure financing. In the current literature regarding sustainable transportation planning this biased priority is regarded as the main cause of the "urban mobility crisis" prevalent in most of the larger cities.[100] The few successful cities, e. g. Singapore, Tokyo or Copenhagen, have eased the burdens of mobility by integrating urban and transportation planning which guarantees a match between urban form and development on the one side and transport systems on the other side.[101] An efficient and flexible transport system is one of the key attributes of "major world cities […] which can compete globally".[102] With a sound design, transport systems can enhance cities' characteristic features – *dimension* (i. e. size), *density, and diversity*[103] – and help them to thrive.[104] Likewise, these cities have expanded public and non-motorised transport (walking and cycling) infrastructure. This has not only relieved the traffic situation as it shifts some trips from motorised to more sustainable transport modes; it also improves the general quality of life, social equality and attractiveness of a city[105] because it "show[s] that a city is for its people and not for the motor vehicles of its upper classes."[106]

Sustainable transport is "a somewhat nebulous concept" since it emerged with the Brundtland report in 1987 but today there are several definitions which successfully conceptualise it.[107] According to the definition adopted by the Ministers of Transport of the EU-15, sustainable urban transportation

- "allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations.
- "is affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development.
- "limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimising the impact on the use of land and the generation of noise."[108]

Transportation is a means to an end, not an end in itself. The end of transport systems is not to generate more traffic and increase mobility and travel volumes. Rather, "transport planning […] implies developing urban regions that offer people and firms the means to reach *more* opportunities (such as jobs, services, social contacts) with *less* mobility"[109] while at the same time achieving a balance of social, economic and ecological development. Based on these and many other paradigms and definitions[110] the following principles of sustainable urban transportation planning have emerged:

Urban structure that minimises travel distances: This requires prioritising internal development over external development, i. e. centralisation over decentralisation. In cases where internal development is no longer feasible, external development should be located along central transport axes/spines, creating new subcentres which provide a high variety of facili-

[100] Vasconcellos 2005; Banister 2005
[101] Banister 2005:210
[102] World Bank 2007:2
[103] Docherty 2008:83
[104] Kennedy 2005
[105] Kenworthy 2002:14
[106] Peñalosa 2003:xxix; compare also Holz-Rau 2007:22
[107] Gudmundsson 2004:38
[108] EEA 2007:293
[109] Bertolini 2008:71
[110] e. g. Deakin 2001:6; Schellhase 2000:51; Banister 2005:233; Gather 2008:63; Bruun 2010:2

ties. Besides reducing traffic distances, this approach also reduces land consumption, another critical issue in sustainable urban development.[111]

Elimination of traffic inducing incentives and introducing rewards for low-impact mobility: On the one hand, laws and regulations that reward high mobility levels should be eliminated; on the other hand low-impact travel or avoiding travel should be rewarded. This can include tax incentives for individual expenses that improve the modal split or prioritising funding for new developments in central or well-connected areas over those on the urban fringe.[112]

Equitable and fair transport systems: Ensuring access, safety and security for all means adapting transport systems to the needs of the most vulnerable participants. It includes increasing the safety and security of all transport modes, a general deceleration throughout the city and barrier-free access for those with limited mobility capacities (elderly, children, and disabled persons).[113]

Multimodality and intermodality: Increasing the use of multiple transport modes in one journey (intermodality) or in one person's mobility patterns (multimodality) requires seamless transfers between modes and integrated mobility services, backed up by intelligent transport systems. Multimodal mobility increases the individual quality of life. There is not the one ideal transport mode but depending on the purpose of the trip and individual needs there are different ideal transport means. Walking, driving a car, cycling, taking the bus or the train are not competing modes but rather complementing or coexisting ones.[114]

Demand management instead of expanding infrastructure: Since traffic flows do not behave like liquids but rather like gases expanding into every space available it is not possible to eliminate congestion and overcrowding by increasing road capacity. Rather, travel demand needs to be minimised by push measures (financial disincentives for road and car use) or pull measures (high-quality alternatives to the car, like public or non-motorised transport).[115]

The measure of increasing the density of urban areas (compact cities) has received special attention in sustainable urban transport planning. High urban densities are supposed to reduce transport energy use even though thorough empiric evidence of this correlation is still not available.[116] Up to now, increasing transport speeds and ranges, esp. individual motorisation, have fuelled spatial decentralisation which again further drove motorisation.[117] High densities do not only make it easier to achieve sustainable transport because they "shorten the length of trips by all modes, make walking and cycling possible for more trips and create sufficient concentrations of activities for an effective, frequent public transport service";[118] rather, minimising automobile dependence becomes essential if dense cities do not want to explode into decentralisation[119] even though it is rather difficult to reverse the process of decentralisation.[120] Due to demographic and economic factors,[121] some cities already today show a slight increase in their urban densities, in contrast to the global trend of decentralisation and suburbanisation. This countertrend, also called reurbanisation, might well continue into the future.[122] It has to be noted though that land use patterns that favour public transport

[111] Newman/Kenworthy 2007:71-72; Holz-Rau 2007:21; Kenworthy 2003:62
[112] Deakin 2001:6; OECD 2000:341; Böhler 2007:19; Banister 2005:76; EEA 2007:308
[113] Hine 2008:49; Zegras 2006:4; Holz-Rau 2007:22; Tully 2007:38; Gather 2008:79f.
[114] Tully 2007:38; Dennis/Urry 2009:94f.
[115] EEA 2008:11; Newman/Kenworthy 2007:74-75; Lyons/Urry 2006:3; Litman 2001; Victoria Transport Policy Institute TDM Database; Mitchell 2010:133f.
[116] Banister 2005:97f.; Schellhase 2000:55
[117] Zegras 2006:9
[118] Kenworthy 2003:62
[119] Zegras 2006:5; Nuhn 2006:190
[120] Banister 2008:73
[121] Newman 2003:33
[122] Kenworthy 2002:13

and non-motorised transport (NMT) do not automatically change mobility behaviour but they are an essential prerequisite for doing so.[123]

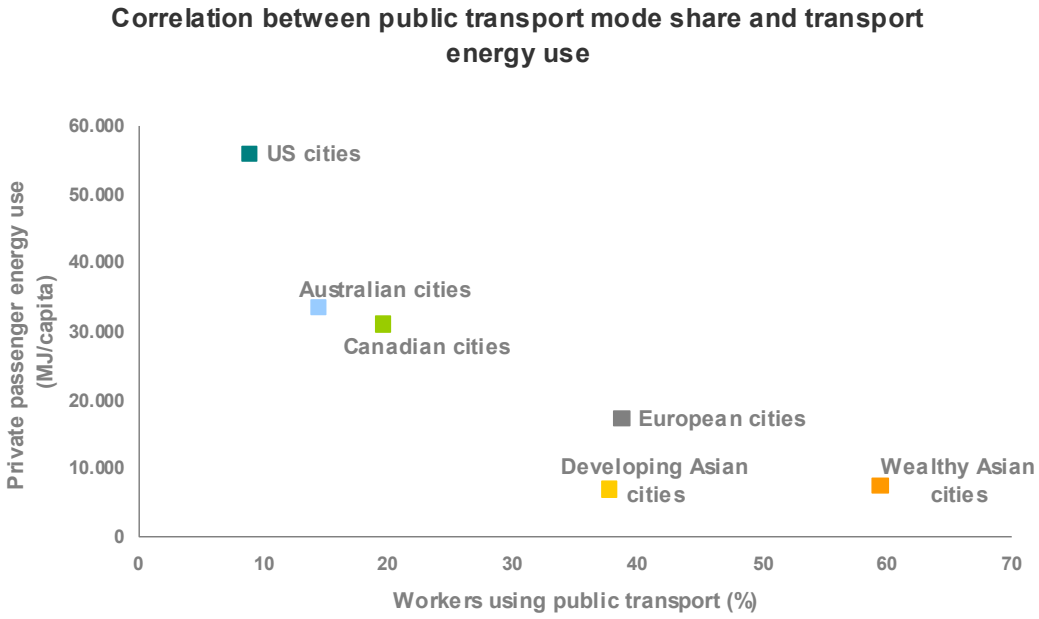

Figure 12: Public transport mode share and transport energy use[124]

A main cause for "unsustainable transport"[125] though is a lack of local governance, finances and executive power.[126] The complexity of transport planning tasks calls for the integration of transport policies, land-use planning measures[127] and technical improvements at the vehicle. An integrative strategy allows a non-biased, non-dogmatic planning approach which is mode and technology neutral and therefore goal-oriented. It makes possible to fulfil the claim "not to prohibit the use of the car [but] to design cities of such quality and at a suitable scale that people would not need to have a car."[128]

2.2.2. The contested role of the car for urban transport

Modern societies with their main features individualisation, differentiation, and flexibility rely on high mobility levels in order to enable individual lifestyles, re-integrate differentiated work patterns and transport industrial goods. The transport mode that best complies with the principles of modernity is the car: it is individually owned and used, and it allows for flexible mobility.[129] The scope of action it offers is larger than that of any other transport mode.[130] The car-based society enjoys many luxuries but is also burdened by collective and individual problems[131] as is illustrated by the following figure:

[123] Nuhn 2006:333
[124] Kenworthy/Laube 2001
[125] Banister 2005:6; see also Bruun 2010:3
[126] Globescan 2006:28; Nuhn 2006:200; Doshi 2007:4; EEA 2007:311; Held 2007:860
[127] Kennedy 2005:395
[128] Banister 2008:74-75
[129] Henderson 2009:148; Canzler 2006:15; Canzler 2007:12
[130] Grünig/Marcellino 2009:9; Winterhoff 2009; Adler 2011
[131] Flade 2007:490f.; Wolf 2007:347

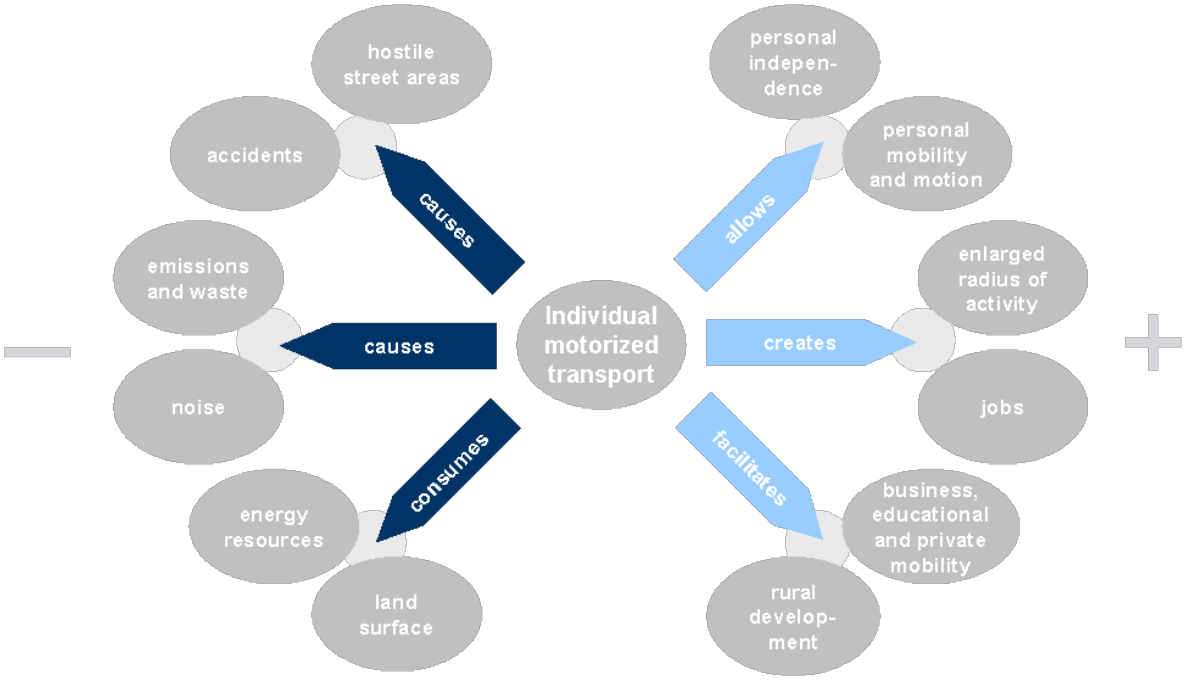

Figure 13: Positive and negative impacts of vehicle traffic[132]

In many urban areas, the negative impacts outweigh the positive. Planners and researchers have pinned the car as the main cause of the current transport crisis.[133] The following table gives a more detailed overview of problems caused by cars:

Environmental	Economic	Social
• Toxic air emissions • Photochemical smog • High greenhouse gas contributions • Loss of forest and rural land • Greater storm water problems from extra hard surface • Noise pollution	• Oil vulnerability • Depletion of resources • Costs from accidents and pollution • Congestions costs • High infrastructure costs in new sprawling suburbs • Loss of productive agricultural land • Loss of urban land to asphalt • Obesity and other health impacts	• Loss of street life and community • Loss of public safety • Access problems for those without cars and those with disabilities (social mobility divide) • Road rage • Neighbourhoods cut up by roads

Table 1: Problems in cities related to cars[134]

Many of the sustainable urban transport planning principles mentioned in the chapter before tackle problems caused by planning approaches that have prioritised individual motorised modes and roads.[135] Some of the problems have been successfully addressed by improved vehicle technologies.[136] Yet, even zero-emission vehicles will ease only a few of the above mentioned burdens of the automobile society. The most recent decline in oil resources accompanied by different price hikes has fuelled the debate about alternative fuels and drivetrains for motorised transport. Currently, car companies are competing for the pole position in battery electric vehicle product launch to be the first on the road to post-fossil mobility. Despite these efforts, their main attention is on the development of conventional combustion

[132] Hotzan 1994:134
[133] e. g. Banister 2005:7; Martin 2009:219f.
[134] Newman/Kenworthy 2007; Gudmundsson 1996; Wolf 2007; Grischkat 2008:63f.
[135] Vasconcellos 1997:6; Turton 2006: 619
[136] OECD 2010, OECD 2012

engines because they will make up the more part of the drivetrains for the decade to come, regardless of further price increases or expected production cut backs on oil resources. Manufacturers are also continually expanding their "eco" labels quantitatively (applying to a wider range of models) and qualitatively (regarding more aspects of the product cycle), accompanied by long-term, sophisticated communication strategies. Unfortunately, in the past, gains in vehicle efficiency have been overcompensated by the growth in absolute vehicle kilometres travelled and by higher demands for comfort, speed, and vehicle sizes.[137]

However, "too many cars in a city will continue to be a problem no matter what fuel is used."[138] Technology fixes will hardly reduce congestion levels, land use, accident rates, infrastructure costs, or the loss of "urbanity".[139] Historically, "growth in wealth and car use was simultaneous in cities when car ownership was at a relatively low level, but growth in car use peaked at a certain optimum, and after that point further growth in car use was detrimental to a city's economic development."[140] Even though the lack of road capacity is often perceived as the main cause of traffic problems, and road capacity expansion as a cure-all for traffic problems, road expansion usually induces traffic.[141] Cities cannot just "build their way out of congestion"[142] because "traffic is […] not a liquid that flows where it is directed, but a gas which expands to fill all available space."[143] Therefore, the effectiveness of expanding road capacity is questionable, especially in already densely built up areas which form a legacy fabric and make road building extremely expensive and both socially and environmentally disturbing.[144] Adversely, the congestion focus further supports automobile oriented policies because citizens, planners and lobbyists are inclined to focus on the most prominent problems only.[145] A congestion focus in policy and planning may further the motorisation level of a city as decision makers usually try to build their way out of congestion.[146]

Today, "there is an increasing willingness to deal with the adverse impacts of mobility while acknowledging its benefits"[147] which means, among others, to control the unrestrained growth of car ownership and land consumption by roads. Regardless of planners' and researchers' vows not to damn or eliminate the car completely from the urban landscape cars still have to assume a scapegoat role in various arenas of discourse. Along with the Corporate Social Responsibility (CSR) debate, which puts businesses' ethical, social, and environmental performance into focus, the public increasingly directs its attention on the untapped potentials of car manufacturers' responsibilities to advance the sustainable mobility paradigm – beyond mere product innovation measures.[148] The sustainable transportation debate requires car manufacturers to become true mobility service providers and to include aspects like seamless mobility, accessibility, and public and non-motorised transport modes in their portfolios. Undisputedly, individual mobility will always stay a desired element of modern life and motorised individual mobility a necessity in certain situations and geographical contexts; therefore, the car will not and cannot be eliminated from the urban (and even less the rural) sphere.[149] But it will play a decisively different role than today. Changing social practices and policies, economic conditions and technology leaps, especially the advent of

[137] EEA 2008:4; Borken/Fleischer 2006:35; Gorham 2002:6; Eck/Stark 2009:503
[138] Lee 2007:72; compare Banister 2005:67; Cox 2010:55f.
[139] Kenworthy 2002:13; Dennis/Urry 2009:63; Canzler/Knie 2007:29-30; Nuhn 2006:193; Held 2007:863; Dierkes 1998:32; EEA 2008:11; Held 2007:859
[140] Townsend 2003:45
[141] Banister 2005:7; Dietrich/Pfleiderer 2003:147-150; Gather/Kagermeier 2008:155f.; Vester 1990:410; Becker/Gerike 2009:141
[142] Kenworthy 2002:15
[143] Kenworthy/Newman 2000:23; Litman 2001:40
[144] Gwilliam 2003:202
[145] Vasconcellos 1997:5
[146] Kenworthy 2002:15
[147] Bertolini 2008:71
[148] WBCSD 2008
[149] Canzler/Knie 2009:11, 25

the electric car, will alter mobility systems and the role each mode occupies within them. Car systems[150] will not only be affected by new technologies and materials but also by a different way of owning and using cars as well as communication among cars (Car2Car) and between cars and transport infrastructure (Car2X).[151] In order to achieve systemic innovation, more than one element of a system needs to be changed.[152] According to Dennis and Urry (2009), a new car system (see Figure 16) requires technological *and* social innovations, even though it is contested whether technological innovations need to precede social innovations in order to guarantee a wide acceptance of new practices.[153]

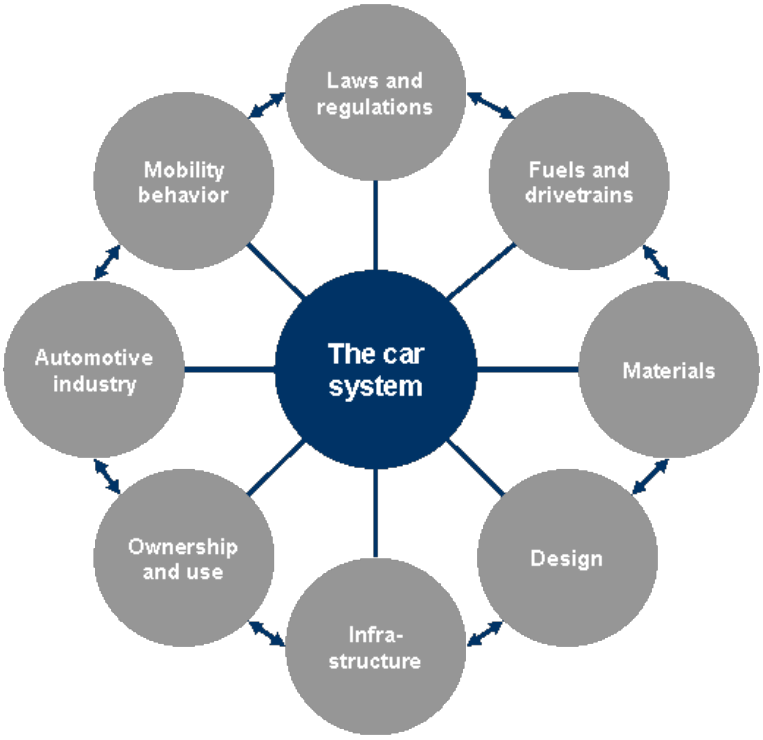

Figure 14: The new car system[154]

The future car system will have to comply with the paradigms governing society, mobility and innovation (as laid out in chapter 1.2). Mobility services will play a more prominent role than today, not only because they will become technologically feasible but also because transport policies and social practices will increase the demand for them. Smart, efficient vehicles and different options for using and owning them will bring new players onto the transport arena, all of them offering services for vehicle provision or seamless mobility. The specific role of these services in the future mobility paradigm will be analysed in the following chapters.

2.3. Mobility services

Mobility services[155] are defined differently depending on literature source and practical application. While car manufacturers refer to car-oriented services merely as leasing, financing, and repair services, science and planning have adopted a broader understanding of mobility services and include all services that are based on material transportation or immaterial in-

[150] Wilke 2002b:14
[151] Dennis/Urry 2009:62; Martin 2009:228
[152] Dennis/Urry 2009:33; see also Mitchell 2010
[153] Canzler 2008:317, 321
[154] Dennis/Urry 2009:65
[155] For a discussion on the services paradigm and the service-product dichotomy see Vargo/Lusch 2004

formation services.[156] Thus, mobility services are understood as independent marketable services that assist individuals in changing locations.[157] Such mobility services have two main functions:

- to facilitate (seamless) mobility and
- to deprivatise vehicles.[158]

They help individuals to incorporate flexibly a wider range of transport modes in their daily mobility choices. For their success it is crucial that they simulate the daily mobility habits of potential users because mobility behaviour is highly habitualised.

For this analysis, the following mobility service types are considered appropriate:[159]

Mobility service type	Examples
Information and assistance:[160] Such services have the objective to make travel more convenient and even seamless. They provide data on schedules, locations etc., support the organisation of trips and make purchase of tickets and access licenses easier. They can include several public and private transport modes and services and are most useful in urban areas with high proportions of mixed travel.[161]	• Community mobility information centres of public transport providers • IT-based real time traffic information (RTTI) • "Concierge" services (personal or IT-based mobility assistants) • Mobility card
Vehicle provision services: These services enable individuals to use a vehicle such as a bike or car without the need of owning it.	• Car rental • car sharing • Public vehicle fleet • Public bike fleet
Driver services: They release individuals from steering and owning a vehicle.	• Public transport • Taxi • Chauffeur services

Further criteria for categorising mobility services are:

- Appropriation (private vs. public ownership)
- Usage modus (individual vs. collective)
- Integration of different modes (monomodal vs. multimodal)

The following table shows how a sample of services currently on the market could be categorised:

	Type	Appropriation of vehicle	Usage modus	Integration of different modes
Car rental, Car sharing, Public car fleet	Provision of the means to be mobile	Public ownership	Individual	Monomodal
Public transport	Driver service	Public ownership	Collective	Multimodal
Taxi	Driver service	Public ownership	Individual	Multimodal

156 Schwieger 2004:25
157 Böhler 2010:26; Böhler/Hunecke et al. 2008:27, 35; Note: A clear and internationally accepted definition of mobility services does not exist. (Schreiner 2005:11)
158 Schöller-Schwedes 2008:247; Tully 2007:38
159 For a comprehensive overview of mobility service definitions and types see Schwieger 2004:22f.
160 Information and assistance services are usually supplementary services to the other two categories of mobility services (see Böhler 2010:24).0
161 Beutler 2004:15

Mobility card	Information and assistance	n. a.	n. a.	Multimodal
***Reference:* Private car**	n.a.	Private ownership	Individual	Monomodal

Table 2: Mobility services typology

As this thesis deals with mobility services that could be offered by car manufacturers and include cars the "driver service" category will not be analysed more closely. Institutional and structural factors prevent car manufacturers from becoming public transport providers or taxi companies. Their only stake in this business area is the provision of a vehicle fleet for a public transport or taxi company. Having recognised this opportunity, some automotive groups operate bus manufacturers (e. g. Scania and MAN in the Volkswagen Group; Mercedes Benz, Setra and Orion in the Daimler Group); some manufacturers offer special taxi vehicles (e. g. the Milano Taxi concept by Volkswagen).

2.3.1. Mobility services in sustainable urban transport planning

Mobility services are one element of sustainable urban transport planning which comprises short-term and long-term collective and individual measures (see Figure 15).[162] Their positive contribution to sustainable urban transport is not a given,[163] and they are definitely not a cure-all for today's transport problems.

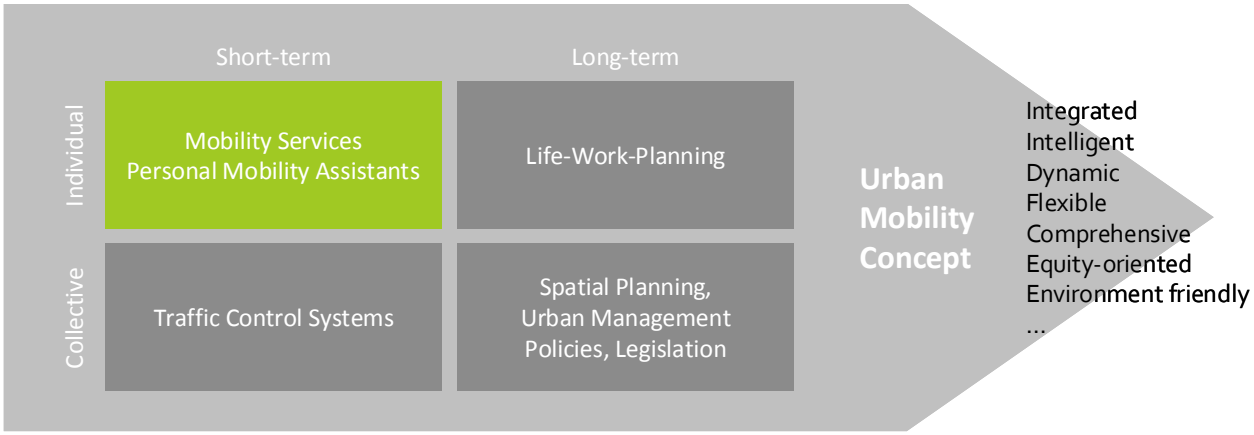

Figure 15: Mobility services in urban transport planning context

The two objectives of mobility services, to facilitate seamless travel and to deprivatise the means of mobility, are both core elements of sustainable urban transport planning:[164]

Intermodality and multimodality: Balancing transport modes

A balanced use of transport modes is necessary to distribute transport flows evenly among modes. Depending on trip length, origin and destiny, time, and trip purpose, different modes are appropriate. The right mix of modes saves resources, time, and costs for individuals and society alike. The terms for this kind of flexible mobility behaviour are intermodality and multimodality:[165]

[162] For a comprehensive overview of transport policies and measures in current use compare Banister 2005:85
[163] Rammler 2005:15; Maertins 2006:3, 5; Kenworthy 2002:14
[164] Banister 2005:70; Böhler 2010:42
[165] Beutler 2004:9

Intermodality: Utilisation of different transport modes during a journey (i. e. including a transfer)

Multimodality: Utilisation of different transport modes on different journeys

Urban intermodality refers to trip chaining of urban transport modes, such as car, taxi, public transport, bike, and walking. Seamless urban travel does not only require a virtual connection of transport modes as could be offered by mobility services (information and assistance) but also a physical connection. This includes e. g. physical proximity (esp. walkability[166]), parking facilities for cars and bikes, and interchange stations. Being a core field of urban transport research and policy[167] it can hardly be influenced by OEM. Therefore, the physical preconditions of intermodality will figure in this thesis only as a prerequisite for the access to vehicle provision service stations.

Multi- and intermodality play a prominent role in transport policy. The term intermodality does not only refer to individual route planning, but is also "a concept and principle of cooperation and organisation of several modes of transport."[168] Recognising that monomodal traffic burdens society disproportionately, the European Union has included intermodality as a key principle in its long-term transport strategy[169] so that efforts to balance transport modes have been included in many national transport policies. Mobility services can support inter- and multimodal mobility behaviour. Intermodality benefits primarily from informational assistance which can achieve seamless travel, while multimodality benefits most from vehicle provision or transportation services.

The best solution though is a cooperative approach between different mobility service types. For example, half of the larger European car sharing providers is already cooperating with local or regional public transport associations by offering reduced rates and special sign-up conditions for regular public transport customers, free parking for car sharing vehicles at public transport stations, shared marketing and advertising or even shared electronic access cards, and others.[170] As many providers deem the state of the collaborative activities as merely satisfactory, there seems to be room for qualitative improvement. Quantitative improvement is obviously needed for the collaboration with bicycle providers/bicycle rental companies and taxi operators as only 25 % resp. 17 % of the large car sharing providers are cooperating with them (e. g. via discounts for car sharing customers, cashless payment or joined advertising).[171]

Up to the 70ies, only individual motorised and public transport were included in empirical studies on modal split and intermodal/multimodal mobility behaviour. NMT was included only later, namely by the German research institute *Socialdata* under the leadership of W. Broeg.[172] This study layout still serves as a basis for the large empiric studies on mobility, called "Mobilität in Deutschland" (Mobility in Germany).[173] Today the importance of NMT trips is widely accepted and is included in most of the large mobility studies especially since it is so crucial for achieving a more balanced modal split.

[166] Definition walkability: Walkability or walking accessibility is based on how much walking effort is needed to access a point of interest, e. g. a public transit station, by walking. (Burckhart 2009:65)
[167] Banister 2005:177
[168] Burckhart 2009:71; see also BMVBW 2002; Beutler 2004:8f.
[169] European Commission 2004
[170] momo Car-Sharing 2010:26
[171] momo Car-Sharing 2010:31
[172] Götz 2007:760
[173] DIW/infas 2002; infas/DLR 2008

Data on mobility including data on multi-/intermodal behaviour (i. e. modal split) are available from the following sources:

Germany:
- German Statistical Office (Statistisches Bundesamt Deutschland)[174]
- Mobilität in Deutschland (MiD)[175]
- System of representative traffic surveys (System repräsentativer Verkehrsbefragungen/SRV), Technical University of Dresden[176]
- German Mobility Panel (Deutsches Mobilitätspanel), University of Karlsruhe[177]

Europe:
- EuroStat (statistical office of the European Union)[178]
- European Environment Agency: Europe's Environment (2007)
- EU energy and transport in figures[179]

Global:
- Millennium Cities Database (International Union of Public Transport)[180]

Inter-/multimodality enhances the quality of urban life for individuals and for urban society as a whole. It allows individuals to optimise time resources (seamless travel) and financial resources, and it benefits society as it allows reducing resource use and distributing traffic flows more evenly among different modes.[181] Research shows that cities with high public transport and NMT shares have lower resource and land use, emissions, noise levels, and traffic accidents.[182] Additionally, public health is affected by the positive effects of walking and cycling. The following graph demonstrates the impact a balanced modal split has on resource use:

[174] http://www.destatis.de/
[175] DIW/infas 2002; infas/DLR 2008
[176] http://www.tu-dresden.de/srv/
[177] http://mobilitaetspanel.ifv.uni-karlsruhe.de/
[178] http://epp.eurostat.ec.europa.eu/
[179] European Commission Directorate for Energy and Transport 2009
[180] Kenworthy/Laube 2001
[181] Götz 2007:764
[182] GTZ 2002; Gwilliam 2002:5f.; Burckhart 2009:63

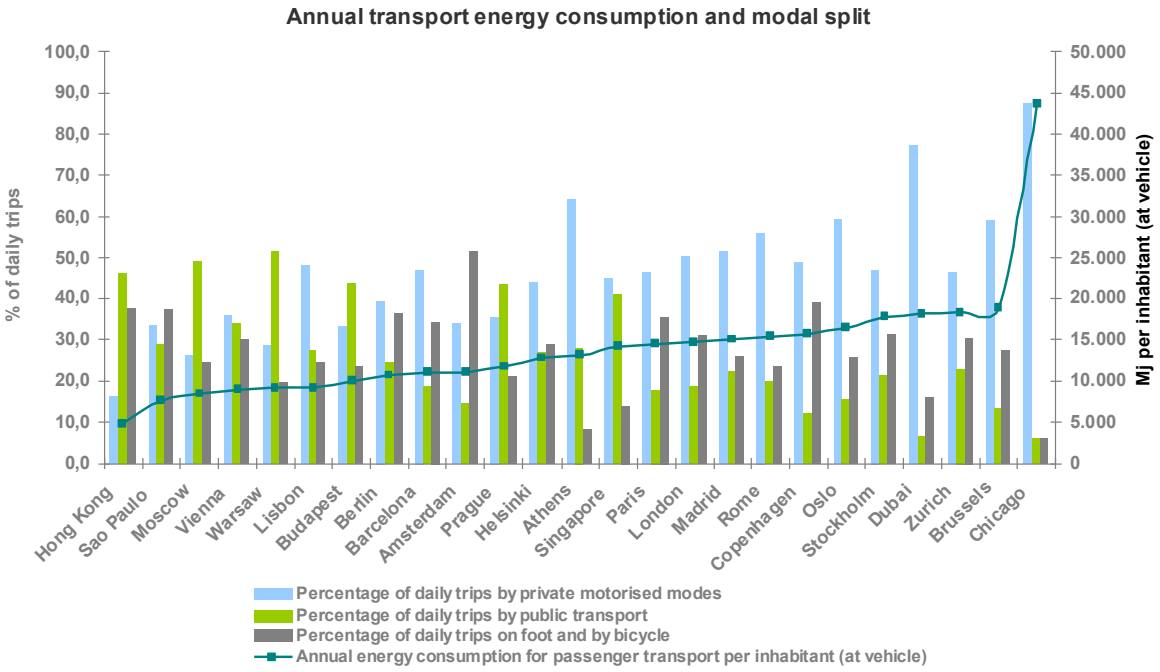

Figure 16: Annual transport energy consumption and modal split[183]

Cities with a balanced modal split have lower energy consumption levels per inhabitant than car-dominated cities. The figure clearly shows the high impact of NMT shares on energy use: Cities with low public transport and high private motorised shares still have comparably lower energy consumption if their NMT share is high (e. g. Amsterdam, Copenhagen); but cities with high public transport shares and low NMT shares have higher energy use than their counterparts with high NMT share.

A brief look at the development of mobility figures in Germany will illustrate the case of rising inter- and multimodality. In the last two decades, the modal split for Germany has evolved as follows:

[183] Kenworthy/Laube 2002

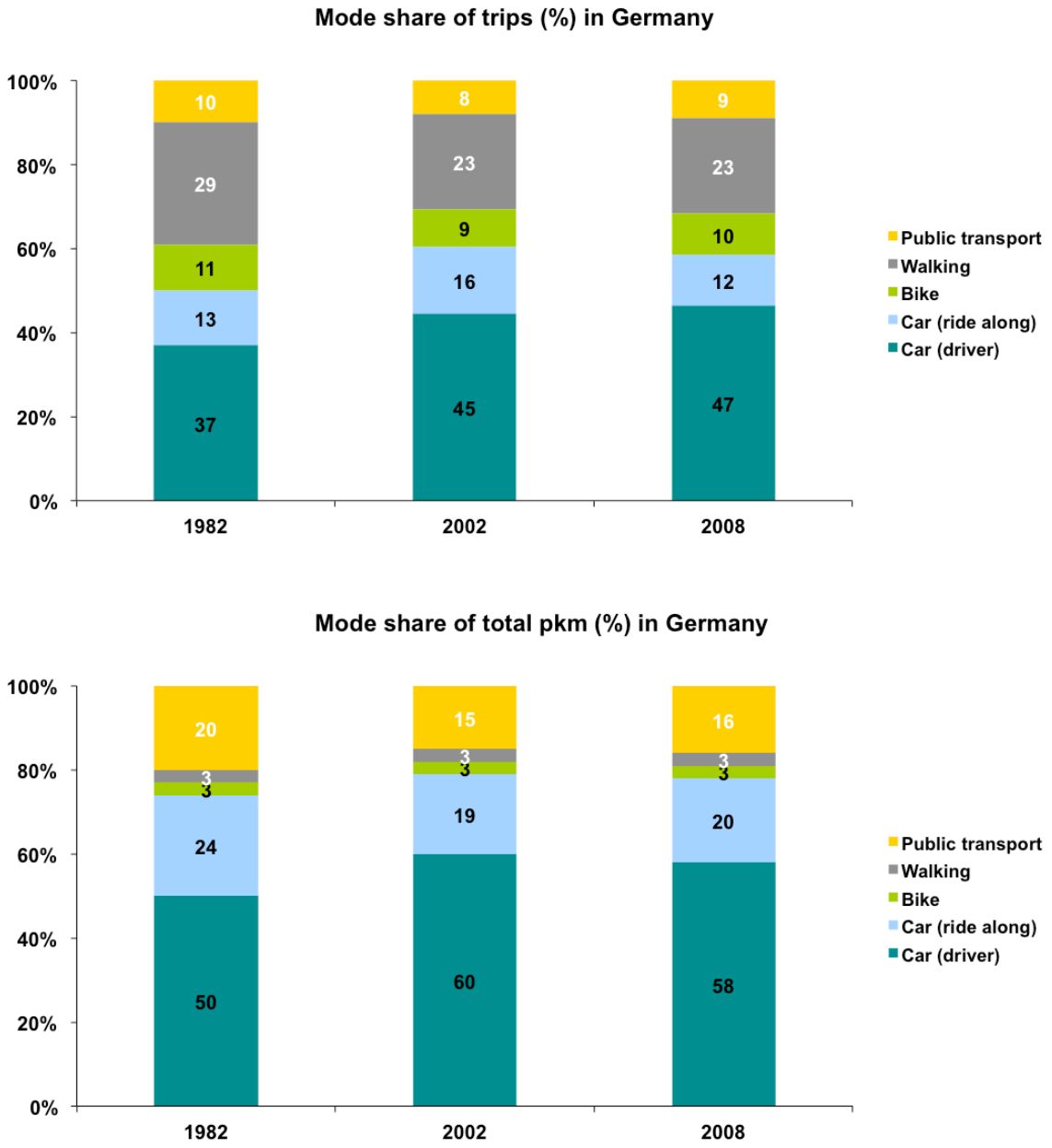

Figure 17: Evolution of modal split in Germany[184]

After NMT and public transport shares shrunk significantly in the 1990ies, they increased slightly from 2002 to 2008 even though they have not yet arrived at 1989 levels. Under present conditions the shares of car travel will probably continue to decrease. Since the German government promotes NMT travel by improving pedestrian and bike infrastructure and there is a general trend towards more "physical" transport modes this decrease is less likely to be attributed to rising public transport shares.

While Figure 19 shows the evolution of the distribution of trips among transport modes, the next figure illustrates the actual share of inter-/multimodal users. In Germany, 12 % of the population are inter-/multimodal users in their daily mobility:

[184] infas/DLR 2008

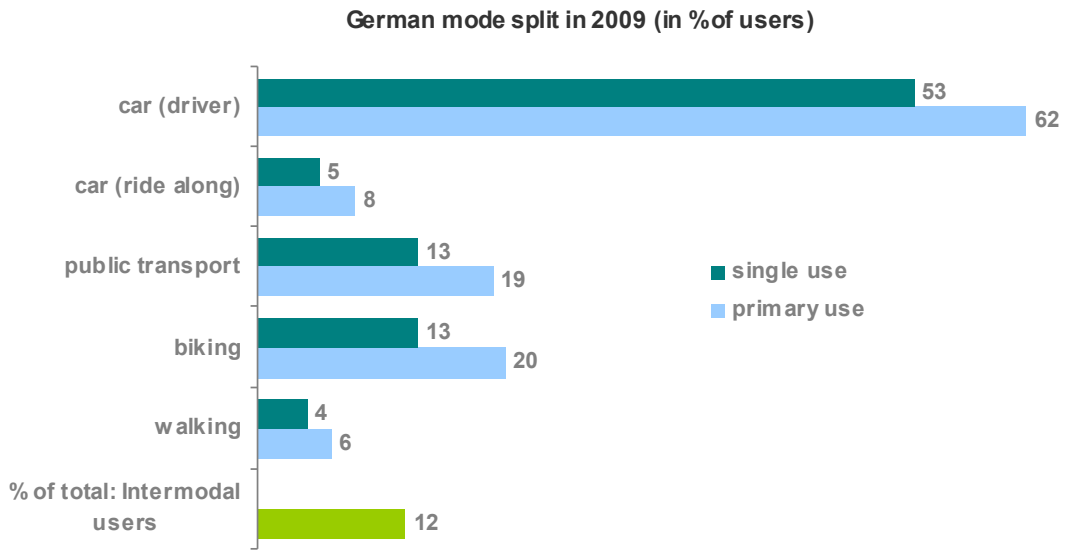

Figure 18: German mode split (daily mobility)[185]

While Figure 18 shows that 12 % of users have intermodal mobility behaviour, the following figure illustrates the development of this fact over the last decade (in share of trips):

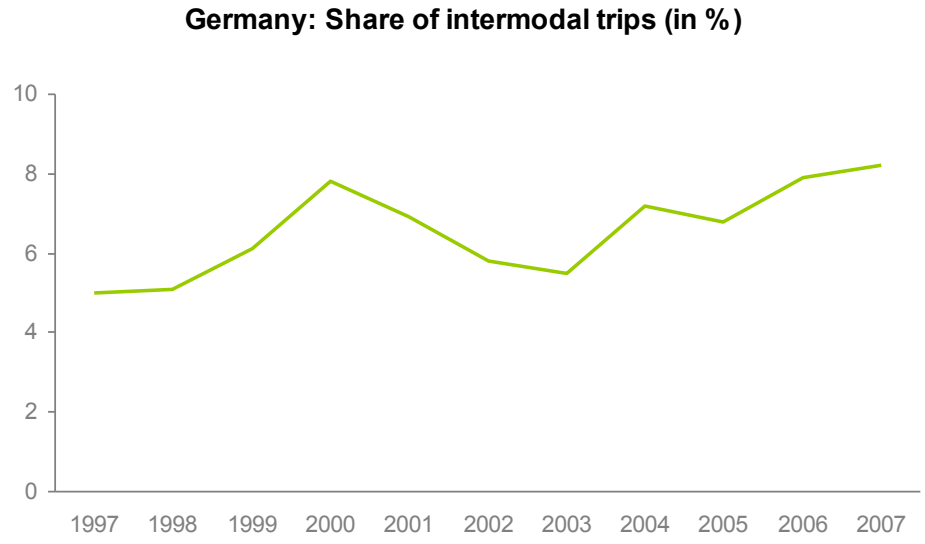

Figure 19: Share of trips with more than one mode of transport[186]

According to the study of Zumkeller and Chlond (2008), the share of trips with more than one mode of transport is highest on trips to work where it has grown from 8 % in 1997 to 13 % in 2007. Obviously, individuals are more willing to combine transport modes on routine trips than for other travel purposes.

Deprivatising vehicles

Mobility services, especially the “vehicle provision“ type, reflect the “general shift in contemporary societies from economies of ownership to economies of access [which] will challenge the nature of contemporary consumer societies”[187] because they allow using mobility prod-

[185] infas 2009:5
[186] Zumkeller/Chlond 2008:79
[187] Dennis/Urry 2009:97

ucts without the need to own them. The benefits of collaborative consumption range from reduced personal burden and cost to lower environmental impacts. At the same time, they enable people to save money, time, and space; build closer relationships; and move from passive consumers to active collaborators.[188]

Deprivatising vehicles affects sustainable urban transport mainly in the following ways:

- Space (parking): Non-privately owned vehicles in shared use can replace several private vehicles, depending on the mobility service in question. E. g. for car sharing in Germany it is assumed that one car sharing vehicle replaces 4 to 8 private vehicles.[189] Thus, parking space is saved, mainly at the place of origin. On average, privately owned vehicles are used only 1 h per day while shared vehicles are used longer and thus occupy parking spaces for shorter times.[190]
- Access: Vehicle provision services make vehicles accessible for those who cannot afford to own vehicles.[191]

As vehicle provision services make vehicles accessible not only for those who cannot afford vehicles but also for those who deliberately do not own any or do not have any at their hand, negative effects can also be observed. Vehicle use can increase and trips by other modes can be replaced by trips with a motorised vehicle.[192] This aspect needs to be considered in future empirical studies about vehicle provision service effects.

The following developments fostering the deprivatisation of vehicles can be observed currently:

Functions instead of products: Consumer research shows that individuals primarily demand functions resp. a certain use/effect rather than products. This demand can be satisfied more efficiently by services.[193] While other industries have already implemented this principle, most prominently in the communication sector, the mobility sector still comes short of offering functions instead of products.

(Total) Costs of ownership (TCO): With increasing fuel prices and lower income available for mobility due to economic stagnation and the erosion of the middle class total cost of ownership for cars is becoming a main criterion for choosing a vehicle. For some use cases, switching to a shared vehicle may become an attractive option.[194]

Car-free households: As it concerns developed countries, car ownership in cities is typically lower than in rural areas. The following graph illustrates this fact for Germany where car ownership rates in the three small city states are much lower than in the states with larger territories and higher shares of rural areas:

[188] Botsman/Rogers 2010
[189] Glotz-Richter/Loose/Nobis 2007:333; Beutler 2004:15-16
[190] Herdegen 2006:36
[191] Beutler 2004:15-16; Winterhoff 2009:45f.
[192] Maertins 2006:3, 5; Rammler 2005:15
[193] Levitt 1975; Böhler/Hunecke 2008:31; Vargo/Lusch 2004; Vargo/Lusch 2008
[194] Botsman/Rogers 2010

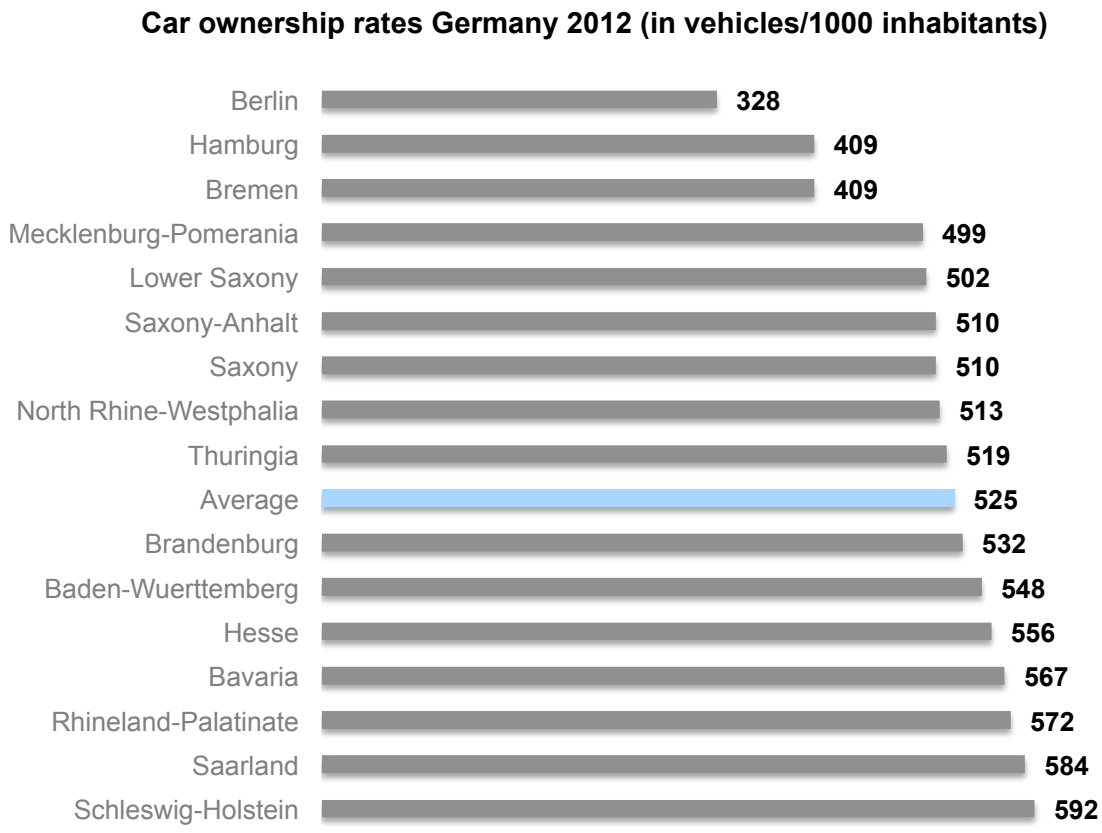

Figure 20: Car ownership in Germany[195]

This corresponds to similar disparities in public transport patronage, as illustrated by the percentage of people never using public transport:

[195] Data retrieved from online databases of Kraftfahrzeugbundesamt www.KBA.de

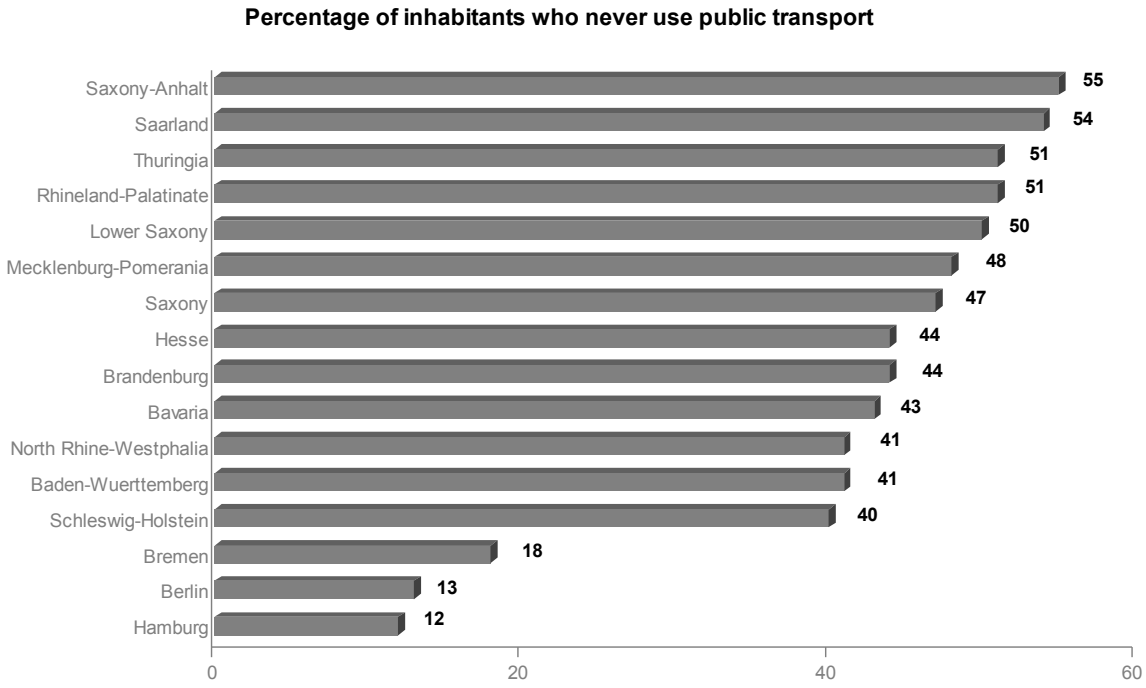

Figure 21: Public transport occupancy disparities in German Bundeslaender[196]

While car ownership is rising or stagnating in most regions of the world cities with high densities, rigid traffic regulation and/or high public transport access and service levels cause a downward trend. The same is true for driving licenses which are obtained at much lower rates by young people in certain agglomerations around the world.[197]

Car-free developments:[198] Another trend that contributes to the decrease of car ownership in some cities are car-free[199] developments (quarters, districts, blocks). Right now, there are 340 "ecovillage" cities or quarters in Europe[200], most of them incorporating sustainable concepts of mobility. Car-free developments do not only limit the use of a car within their borders, but they are designed in a way that it is not necessary to own or use a car. Proximity to facilities and mobility services (esp. public transport) reduce or eliminate the need to use a private car.

Social leapfrogging in developing markets: Even though the emerging countries' ability to leapfrog is contested[201] structural conditions – e. g. low car-ownership rates, low parking provision – might give them a head start in innovative mobility services. Currently there are only weak signs that this is happening but companies seeking to raise their market shares might accept the challenge and profit from the opportunity of offering vehicle provision services in non-saturated markets.[202]

Challenges of mobility services

Both objectives of mobility services, balancing the modal split and deprivatising vehicles, face challenges related to mobility behaviour, and only some of them can be overcome by

196 DIW/infas 2008:101
197 Grieb 2009; Winterhoff 2009:19
198 Crawford 2000; Schwieger 2004:148; an up-to-date list of noteworthy car-free developments around the world can be found at http://www.carfree.com
199 Converting a single street to car-free use is referred to as pedestrianisation.
200 www.ecovillage.org, www.gen-europe.org
201 e. g. Kenworthy 2002:14
202 Schöller-Schwedes 2008:247; Winterhoff 2009:23

innovative mobility services. The following table provides an overview of the barriers users of mobility services face:[203]

Challenge	**Features of mobility services necessary for addressing the challenge**
Challenges of shifting modal split	
Inconvenient interfaces, complicated fare systems • Switching from one mode to another is complicated, inconvenient and time-consuming • Tariff systems are difficult for newcomers; purchasing tickets is complicated	Electronic ticketing, pay-as-you-go, integrated mobility cards, personal mobility assistants
Unattractiveness of public transport[204] • Public transport is perceived to be slower than riding a car • Unattractive vehicles and transit stations: Crowding, cleanliness, comfort, noise • Insufficient infrastructure for parking private vehicles/bikes at stations • Low accessibility, insufficient reach of public transport networks	High quality public transport: reliable, safe, clean, covering large areas, high frequency, adequate access, cost-efficient Examples: Curitiba, Singapore
Habitualised mobility behaviour[205] • Individuals are not rational in their mobility behaviour: they do not always chose the shortest/cheapest/ fastest route or mode but rather hold on to acquired routines • Flexibility to change routines only arises when circumstances change dramatically (so-called trigger events, e. g. upon change of residence).[206]	Services that imitate routine behaviour, following “instant access, open end, one way” principles[207]
Coercive character of a privately owned car • Once purchased, a vehicle constantly compels the owner to use it. Its permanent availability and high fixed costs makes other alternatives less valuable.[208]	Services that imitate routine behaviour and cost structures of private vehicles[209]
Challenges of deprivatising vehicles	
Perceived inconvenience • Not having a vehicle permanently at your hand is perceived as inconvenient. • This can be aggravated if mobility services have complicated booking procedures and are not flexible.	Instant access and comprehensive, up-to-date information on mobility alternatives
Need for privacy, individualism • Deprivatised vehicles are shared vehicles – some users may not want to share a product with others because they perceive it as jeopardy to their privacy and individualism.[210]	Applications for individualising shared cars, e. g. adjusting settings via a smart card

[203] For an empirical study on barriers to mobility services use see e. g. Böhler 2010
[204] Brög 2003:12; Grischkat 2008:51, 226
[205] Götz 2007:764; DIW/infas 2002:103; Petersen 2006:69, 75; Maertins 2006:118; Tully 2006:234; Wilke 2007:56; Wilke 2002b:13; Bamberg 2004:251; Harms 2003:160f.
[206] Harms 2003:296; Canzler 2006:16; Brook 2004:6; Wilke 2009:112
[207] Maertins 2008:76; Wilke 2002b:14, 26
[208] Grünig/Marcellino 2009: 9; Canzler 2006:22; Gegner 2004:13; Eckhardt 2006:95
[209] Maertins 2006:119; Canzler/Hunsicker 2007:17
[210] Feldhaus 1998:202; Baum/Hüttenrauch 2008:64; Böhler 2010:132

Besides these mobility behaviour aspects there are institutional, political and economic impediments to achieving the objectives of mobility services:

Non-integrated transport systems: Not in all cities transport systems are structurally and physically integrated. For intermodal journeys this means that users need to buy different tickets for each interchange, (real-time) information about other modes is not available, they can not park a vehicle (bike, car) at a public transport station, or interchange time is inconvenient e. g. while walking from a bus station to a train station. Integrating transport systems is especially a problem when the share of private providers is high, like in many developing countries cities. Before motivating non-users to use public modes the public transport system itself will need to undergo substantial improvements.

Car- and road-oriented transport policies: Infrastructures have the tendency to increase a system's persistence and reduce their flexibility (system lock-in).[211] Once built they last for decades while retrofitting is costly and time-consuming. In most developed countries, mobility behaviour is adapted to existing car-oriented infrastructure, and therefore citizens' demands for improving alternatives to the car are low. These habits and needs of the citizens are mirrored by most urban transport policies. This is copied by cities in developing countries and causes even more problems there.[212] Unless transport policy will improve the framework conditions for mobility services they will not develop their full potential.[213]

Questionable benefit of mobility services: Whether facilitating modal shift really promotes sustainable urban development is argued in literature and planning. Depending on the users` lifestyle, mobility needs, and disposable incomes, more mobility services can generate more mobility or substitute unsustainable transport patterns.[214] After all, mobility services are no end in itself: “Even the paradigm of intermodality continues the technological and organisational integration of structural differentiation and thus causes a growth in transport volumes.“[215] So far, only a few very specific empirical studies on mobility services have investigated these side effects[216] but not in a consistent manner. A framework for a non-biased analysis of mobility services which allows assessing their contribution to sustainable mobility, be it positive, neutral, or negative, would be the next step in research on mobility services.

Questionable profitability of mobility services: Not much is known about the profitability of existing mobility services due to nondisclosure policies of the providers. In the past, mobility services were either attractive for customers but not profitable for the provider or vice versa.[217] E. g. car sharing users needed to pay higher fees than they would pay for a privately owned car, that way making it attractive only for those who ideologically supported the idea of car sharing and already had a multi-/intermodal mobility behaviour[218] or those who did not need a car very often.[219] Recently though more and more mobility services have become attractive for customers *and* profitable, mainly due to more flexible functionalities and more advanced business models.[220]

The described challenges show clearly that mobility services are no panacea for urban transport problems but only one element in an integrative sustainable urban planning agenda. Only certain uses will be appropriate, and depending on the city or urban area in question, the benefits for environment and society will vary significantly.

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[211] Dennis/Urry 2009:43
[212] GlobeScan 2006:28; Vasconcellos 1997:5; Banister 2005:193
[213] Böhler 2010:145
[214] Böhler/Hunecke 2008; Maertins 2006:3, 5
[215] Rammler 2005:15
[216] Schwieger 2004:31
[217] Wilke 2009:115
[218] Maertins 2006:129
[219] Generally, car sharing is not cost-efficient for individuals who drive more than 10,000 km/year.
[220] Klimm 2010

2.3.2. Development path of mobility services

This development was and is driven by (future) changes in mobility behaviour and urban mobility conditions (see chapter 3) and by technological progress, but more so by the desire of all players in the mobility sector – OEM, utilities, IT developers, rental companies and municipal governments – to participate in this small, but thriving new market. These dynamics are the motor for the transition towards higher professionalisation, integration, user-friendliness, and technological complexity. The individual stages of the process are overlapping, i. e. there is a coexistence of the three stages of mobility services:

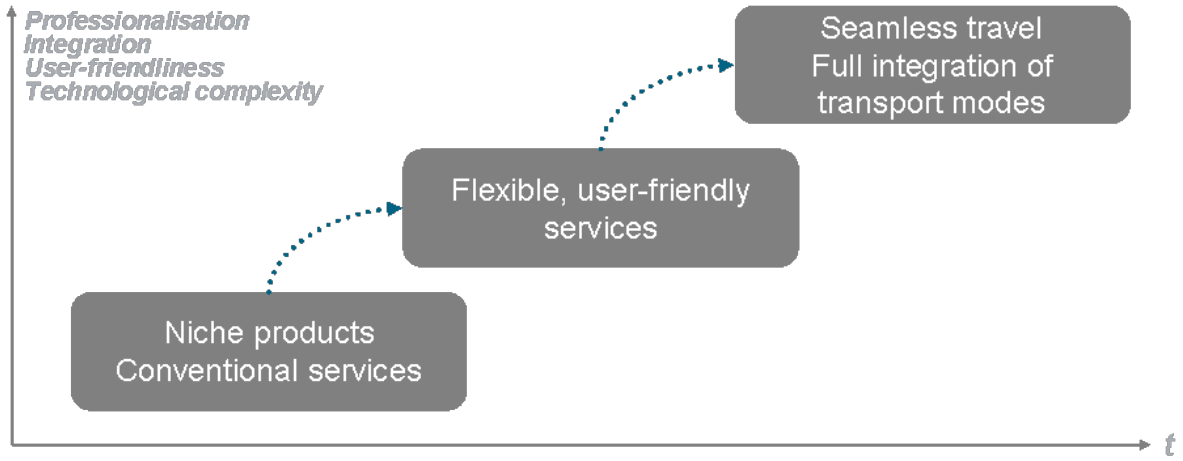

Figure 22: Development path of mobility services

Providers increasingly design services in a way that makes them more similar to routine private car use[221] because "modern mobility happens to be individual mobility."[222] Regarding the intermodality of such services, some authors complain that "combining public means of transport with individual or private means of transport remains […] an exception"[223] while others focus on the existing examples of successful cooperation and their potential for increasing customer acceptance.[224] Vehicle provision services dominate the present, but the future will belong to sophisticated information and assistance services using advanced technologies for achieving simple usability. Integrating all means of transport – private and public ones – will constitute the main challenge of the next generation of mobility services, requiring technological and social innovations alike. This is typical for all developments involving paradigm changes.

Vehicle provision services

There are basically three different kinds of vehicle (i. e. car) provision types: car rental, carsharing, and public vehicle fleet. They differ in many aspects but there is a continuum between them. This leads to a lack of clarity in the terminology, e. g. some literature sources use the term car sharing also for public car fleets, specifying it by the term "*flexible* car sharing".[225] For this thesis, the following distinction between the three main types of vehicle provision services is made, allowing a clear differentiation of the services:

	Car rental	Car sharing	Public vehicle fleet
Booking			
Instant	No	No	Yes

[221] Büttner/Knie 2006:70; Wilke 2002b:14, 26
[222] Maertins 2008:87
[223] Maertins 2008:88
[224] momo Car-Sharing 2010:86
[225] e. g. Grünig/Marcellino 2009

access			
One way	Yes/No	No	Yes
Open end	Limited	No	Yes
Registration/ identification	Registration necessary every time a car is rented	Membership; identification per driver licence	Membership; easy access (e. g. RFID chip card)
Payment	Rental fees depend on vehicle segment; payment on a daily or weekly basis; fees include fuel but have a limited kilometre range	Membership fees; usage fees depend on vehicle segment; kilometre, fuel and time charges	No membership fees; fees on a minute or hour basis; discounts for day trips
Stations	At main transport hubs (train station, airport)	In neighbourhoods	Downtown in walking distance or without fixed stations
Fleet	Mixed (wide range)	Mixed (small range)	Usually only a single kind of vehicle/ segment
Pre-booking	Required	Required	Possible, but not necessary

Table 3: Comparison of car rental, car sharing and public vehicle fleet

Depending on the use case and mobility type, each vehicle provision service will appeal to different user groups and providers because each feature has advantages and disadvantages. Exemplarily, this is explained for the case of services with fixed stations vs. services without stations:

	Service with fixed stations	**Service without fixed stations**
Advantages	• Vehicles easy to locate (for users and providers) • Users do not need to search for a parking place	• High flexibility • No expenses for stations
Disadvantages	• Low flexibility • Expenses for stations	• Vehicles more difficult to locate • Users need to search for a parking place

Table 4: Advantages and disadvantages of public vehicle fleets with and without fixed stations

Depending on urban structure, profitability objectives and main user groups, each provider will chose an individual set of properties, thus sometimes creating new types of mobility services which do not clearly fit into any of the three categories in Table 3. The development of the features of vehicle provision services will likely reflect the general development path of mobility services (see **Figure** 25 above).

During the last decades, car sharing schemes have been the most popular vehicle provision types in Europe, especially in Switzerland and Germany.[226] In general, car sharing has a great, but mostly unexploited, potential in Europe. The more flexible the service the more appealing it will be to large customer groups in the future.[227] Currently, there are 150 car sharing organisations in Europe. In 2009, there were 478,500 car sharing club members, 75 % of which located in Germany, Great Britain and Switzerland. The number of car sharing club members and vehicles in selected European countries are as follows:

[226] Haefeli 2006:3
[227] Wilke 2009:118

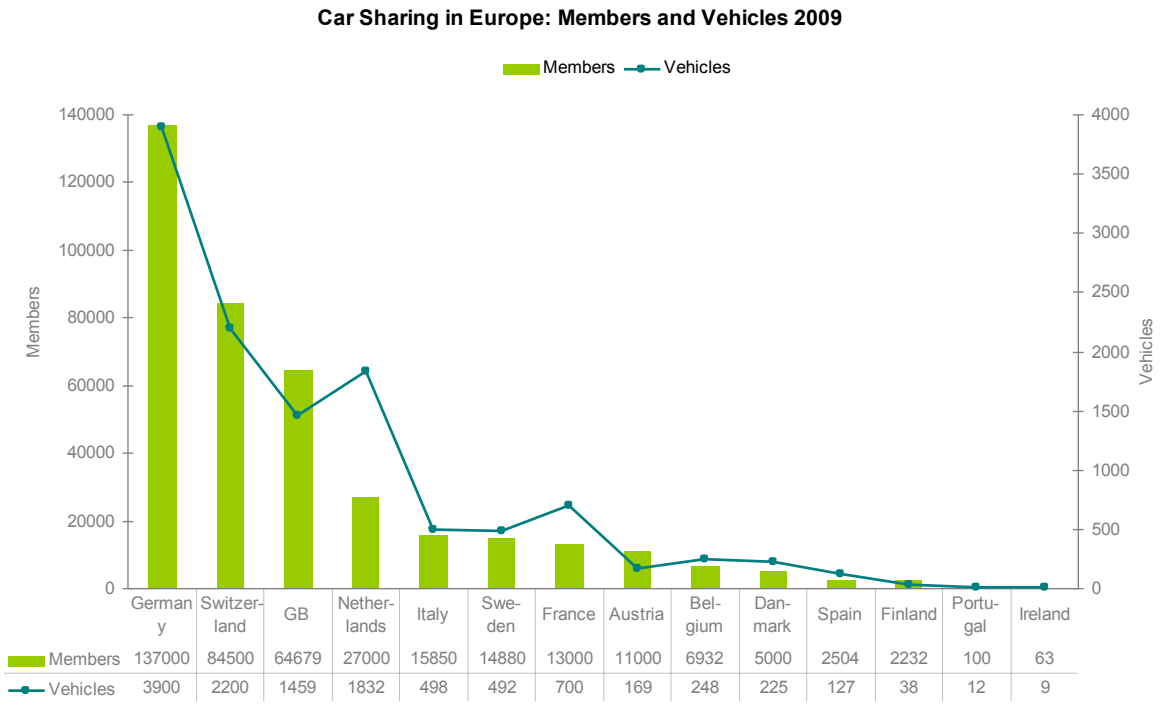

Figure 23: Car sharing in Europe: Members and vehicles 2009[228]

The figure demonstrates clearly that there are still large differences in market penetration in European countries. The member/vehicle ratio is also very different, ranging from 7 members per vehicle in Ireland to 65 in Austria, as well as the car sharing participation (member/population ration) and provider structures, the latter ranging from centralised (e. g. one provider in Switzerland) to heterogeneous (e. g. 115 providers in Germany).

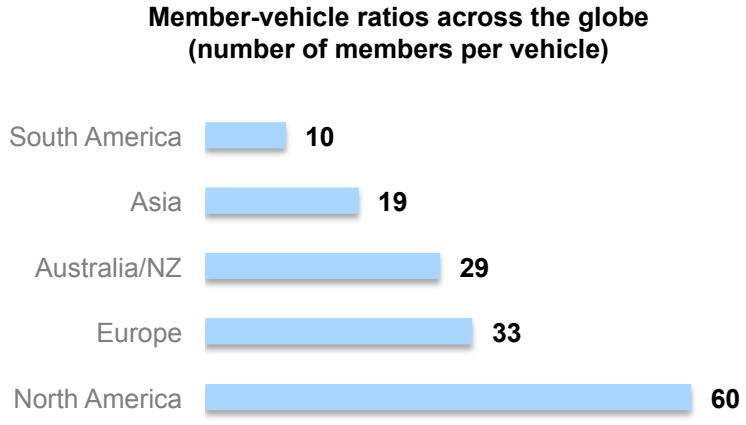

Figure 24: Member-vehicle ratios across the globe[229]

One important reason (one-way) car sharing schemes are have received higher attention lately is the introduction of BEV technology:[230] “Electric car sharing offers an opportunity to introduce a new technology to widespread use that would otherwise continue to reside in a

[228] momo Car-Sharing 2010:6; For a detailed report on the state of car sharing including growth perspectives in the countries of the figure above see ibd. pp. 7ff.

[229] Shaheen/Cohen 2013:21f.

[230] Note that some earlier car sharing schemes consisted of BEV and PHEV but the programs were phased out because the acceptance was too low. [Shaheen/Cohen 2013:21]

niche market, due to the high costs of the cars. Electric vehicles could fit nicely in a station-based system – as they will require dedicated and predictable access to electricity. […] it may very well be that car sharing offers the best prospect of all options to achieve a widespread introduction of electric vehicles in urban areas."[231] It is estimated that 20 % of vehicles in vehicle provision services (excluding car rental) can be electric.[232] This development will be accelerated by the speedy installation of charging infrastructure.

However, there are three reasons that make it less likely for conventional car sharing providers to incorporate BEV technology at large: First, the expensive battery technology will have to be reflected by the car sharing tariffs, making it less attractive for users; second, long recharging cycles prevent the flexible and frequent usage of vehicles during the day; and third, car sharing users are less-frequent car drivers for whom a new drive train technology will present an additional barrier to vehicle use.[233] Existing car sharing providers will substitute only small shares of their fleets by BEV vehicles in order to retain their existing target groups. Therefore, most public BEV fleets will probably be deployed independently of car sharing organisations and run by new players on the market (municipalities, utilities, OEM).

Similar reasons have prevented the expansion of vehicles with other alternative drivetrain technologies in most vehicle provision services. E. g. vehicles with CNG or LPG technology depend on fuelling stations offering CNG or LPG which are not deployed evenly across cities (depending on the country). Hybrid technology is only applied in upper class vehicles so far, a segment not very common in vehicle provision services (except car rental). Until now alternative drive train technologies are not established well enough on the market to allow their widespread usage in the niche market of vehicle provision services. However, the small share of alternative drivetrain technologies is compensated by the comparatively high vehicle fleet fuel efficiency because car sharing providers offer smaller and newer cars than the average fleet on the market.

While the sector started out with low-tech, private cooperatives and ideologically driven services it has now arrived at a stage where it attracts larger groups of customers[234] and achieves profitability, thus setting the stage for additional players and providers – e. g. car manufacturers – to enter the arena.[235] The years 2008/2009 marked an important turn regarding vehicle provision services on the market as two car manufacturers entered the mobility services market: Daimler/Smart with the flexible public car fleet "Car2Go" in Ulm, and Peugeot with the car and accessory rental service "Peugeot Mu" (for details see chapter 4.3.2). Later, several others followed, e. g. BMW with its "BMW on demand" service, Volkswagen with "Quicar" and Citroen with "Multicity". These market entries by OEM – which were accompanied by several car sharing ventures of conventional car rental companies (Sixt, Hertz, Avis), some of them teaming up with OEM – present just one episode in a long-term development that can be observed in the mobility services sector which before had been dominated by non-automotive providers.[236]

Operator	Brand name	Countries served	Start
Avis[237]	CARvenience	UK	2001
Avis	Okigo	France	2011
Citroen	Multicity	Germany, France	2012

[231] Grünig/Marcellino 2009:20
[232] Kellenberger 2009:11. Note that the German Railway DB CarSharing fleet plans to have a 10 % BEV share by 2011 [Klimm 2010].
[233] bcs 2008:5
[234] Winterhoff 2009:67; Shaheen/Cohen 2013
[235] Wilke 2005:109; Wilke 2007:55, 155
[236] Shaheen/Cohen 2013
[237] In January 2013, Avis acquired the US CSO Zipcar for 550 US$, demonstrating the high value oft he car sharing company. (Piper 2013)

Hertz	Hertz On Demand	France, Germany, Spain, UK	2009
Sixt	Sixti Car Club	Germany	2008
BMW/Sixt	DriveNow	Germany	2011
Daimler	Car2go	Germany	2008
Ford	GoCar	Ireland	2008
Peugeot	Mu	France, Netherlands, Germany	2009
Peugeot	Greenwheels (partnership)	France, Netherlands	2009
Volkswagen	Quicar	Germany	2011
Volkswagen	Streetcar partnership	UK	2007

Table 5: OEM and traditional car rental companies with shared-use vehicle programmes in Europe[238]

Besides the mobility sector players mentioned above, a new kind has barely entered the market, but to date has not enough members to make a significant difference: Peer-to-peer car sharing services. Platforms like Tamyca, RelayRide or CarZapp allow private vehicle owners to rent out their cars hourly and offer an insurance cover for both sides. Car owners profit by earning an extra income which can be used to cover some of the fixed costs, while users have the advantage of renting out vehicles in their neighbourhoods. As of mid-2012, there were 33 personal vehicle sharing organisations worldwide, 10 of the in the US. Technological advances supporting unattended acess and real-time information about vehicle availability are just one factor fostering P2P car sharing. Another factor is the increasing acceptance of owners to rent out privately-owned cars, a side effect of the "use, don't own" trend.[239]

Another popular and exemplary – even though for car manufacturers not relevant option – are bike sharing programs which are evolving rapidly all over the world. The largest and most renown scheme is Vélib' in Paris which offers 20,000 bikes at over 1.450 stations (average distance between stations: 300 m) since 2007, with the first hour of rental free of charge. Bike sharing schemes usually feature fixed stations within a given perimeter, but more advanced systems work without stations (e. g. DB Call A Bike/Germany). Some bike sharing schemes are even free, especially in developing countries, or offer the first half to whole hour for free. Increasingly, they feature complex tracking technologies which allow for high flexibility, instant access and easy billing procedures. E. g. incorporating satellite geo-positioning technology could have two benefits: users can locate the next bicycle very easily using their mobile phone or from a desktop computer, and the service operator can easily retrieve lost or stolen bikes. It could also relieve providers from investments in rental stations and increase the flexibility and attractiveness of a scheme as station-based schemes offer only as much convenience and flexibility as there are rental stations. The success of programs around the world – some of them even including E-Bikes – demonstrates that bike sharing systems have clear appeal to municipalities and users.[240]

Information and assistance services

Seamless travel, i. e. a disruption-free change between transport modes, is the most important challenge of future information and assistance services and makes up the last stage of the mobility services development path. Information and assistance services on the market so far include only selected transport modes or are available only in limited areas.[241] They apply a broad range of technologies and are evolving rapidly due to technological progress of intelligent transport systems (ITS) and traffic management systems (TMS).[242] This allows

[238] Shaheen/Cohen 2013:24 and own research
[239] Shaheen/Cohen 2013:26f.
[240] Grünig/Marcellino 2009:16
[241] Canzler/Hunsicker 2007:11
[242] Mitchell 2010:130f.

offering services like real-time traffic information or automatic Check-In/Check-Out (CICO) applications, thus incorporating vehicles and users into the mobility internet. So far, most information and assistance services on the market are a service that combines ticketing of different transport modes which allow users to shift with more ease between the modes of transport. New technologies allow to further integrate systems and applications, resulting in services like *yélo* in La Rochelle/France or Cisco's *Personal Travel Assistant* which incorporates booking, routing and information services for all modes of transport (within a given city) in a smartphone application.

The market for information and assistance services is rather complex as it is challenging to initiate and manage the cooperation necessary for intermodal services. So far, the cooperation between different modes and providers has not achieved the level necessary for seamless, integrated mobility services. Generally, transport mode providers perceive each other as competitors because each party is afraid to lose customers or users to other modes. But sustainable transport depends on the coexistence of transport modes because they complement each other.[243] Coexistence is the state of two or more entities existing peacefully together, usually in a temporal or spatial sense, in order to achieve equilibrium and increase efficiency. This is precisely what can be achieved by offering a wide range of transport choices to users and by fostering the structural equality of the choices. Transport providers are slowly changing their attitudes towards mode integration: Public transport is becoming more open to include individual modes into their portfolios (e. g. car sharing or rental for public transport users, providing car/bike parking at public transport stations), and providers or manufacturers of individual vehicles are more open to include public transport or shared vehicles into their portfolios (e. g. car manufacturers offering vehicle provision services). This trend cannot be quantified yet but is clearly noticeable among decision makers in the transport sector.[244]

2.3.3. Users of mobility services

This chapter will answer the following questions concerning the potential users of mobility services: What drives users' short- and long-term mobility behaviour? (see section 2.3.3.1) How will mobility behaviour be changed by mobility services? (see section 2.3.3.2) How can future users be categorised? Which user groups will demand which types of services? (see section 2.3.3.3) Along with the results of the impact analysis (chapter 3), the results of this chapter will create the basis for the catalogue of requirements (chapter 4.1).

2.3.3.1. Factors shaping mobility behaviour

In short, three characteristics of human mobility behaviour stand out:[245]

1. Mobility behaviour tends to be habitualised.
2. Costs, time and comfort are the most important criteria for choosing a certain transport mode.
3. There is no average customer/user or mobility behaviour.

It is contested whether mobility *desires* or mobility *needs* dominate decision processes in everyday mobility of individuals; there is a tendency to absolve individuals from the responsibility of their transport choices and make external constraints responsible for people's mobility behaviour.[246] Generally, when determining travel mode, distance and destiny, and travel

[243] Banister 2005:8; Tully 2007:38
[244] Canzler/Knie 2009:25; Schwieger 2004:31f.
[245] Götz/Konrad 2007; Lyons 2006; Maertins 2006; Schade/Schlag 2007; Tully 2006; Petersen 2006:69, 75
[246] Soron 2009

time – all three contributing to mobility behaviour – both objective and subjective aspects play a role for individuals:[247]

Objective factors	Subjective factors
General Transport infrastructure supply Transport technology Urban form and structure Safety Security Weather and topography Transport regulations/policy *Individual* Vehicle ownership Disposable income Age Professional activity Health Gender Place of residence Driver licence	Cultural paradigms Lifestyles Individual preferences Attitudes Routines

While the central factor "lifestyles" will be analysed in chapter 2.3.3.3, in the following a selection of the most important factors shaping mobility behaviour are described in short:

Objective/hard factors

Transport infrastructure supply:[248] Individuals who are not captive but can choose a mode of travel will choose those who are most reliable, cheap, comfortable, and quick. Reliability, speed and comfort depend to a great extent on the infrastructure and service levels of each mode. Even though bicycle lanes and public transport which fulfil these criteria are no guarantee that people switch to these modes, their well-functioning is a prerequisite to it.[249]

Transport technology:[250] Technologies shape society and are shaped by it. Because technologies open up the field for new social practices rather than substituting old ones[251] the range of mobility practices and behaviour increases along with the growth in technology options. Real-time information allows for more flexible mobility behaviour and tends to increase trips and trip lengths. The hopes for intelligent transport systems to influence mobility behaviour have not been fulfilled though.[252]

Urban densities and planning:[253] The shape and density of cities is a prerequisite but not a guarantee for a change in mobility behaviour.[254] High urban densities make dense public transport networks not only cost-productive,[255] but also attractive for users, and make many destinations accessible via foot or bicycle. Their influence on modal split is as follows:

[247] Böhler 2010:40; Tully 2006:231; Götz 2007:764; Grischkat 2008:51; Feldhaus 1998:173f.
[248] see also chapter 3.3.5
[249] Nuhn 2006:333
[250] see also chapter 3.3.4
[251] Banister 2005:33
[252] Axhausen 2006:4; Lyons/Urry 2007:1
[253] see also chapters 2.2.1 and 3.3.1
[254] Nuhn 2006:333; Grischkat 2008:49
[255] IEA 2009:240

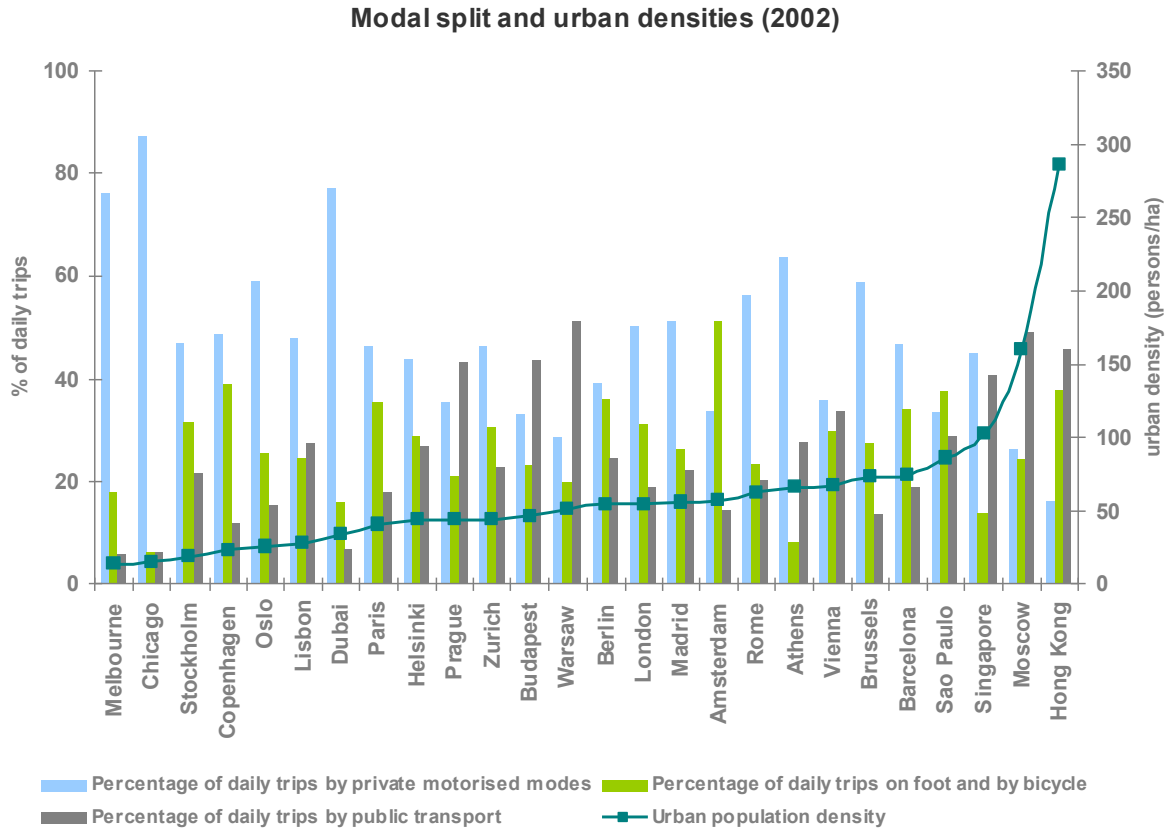

Figure 25: Modal split and urban densities[256]

In general, cities with low densities have a higher share of private motorised trips while in high-density cities public and non-motorised modes are predominant. The trend shown in the graph is ambiguous though which makes it clear that densities are not the only factor influencing mode choice.

Safety: Safety influences mainly the choice of travel modes, less the choice of destiny/route or time. As non-motorised modes expose individuals more to safety hazards than most motorised vehicles transport planning has the objective of rendering its use as safe as possible. The use of bikes is largely dependent on the provision of extensive and safe bike lane networks.

Security: Especially women, children/youth and elderly make their mobility behaviour dependent on security aspects. Trips at times, in areas or with modes that expose them to (perceived) threats will not be taken or shifted to other times, destinations, or modes.

Topography and weather: Many empirical studies have demonstrated the impact of topography and weather conditions on modal choice. The more burdensome the topography of an area/city, the more transportation needs are fulfilled by modes that substitute or support human power. The more unpleasant the weather, the less people are willing to chose a mode that exposes them to the outdoors. Therefore, both topography and weather have a significant impact on the non-motorised modes which not only require human power but also expose users to weather conditions. However, as weather and topography are only two among many factors influencing mode choice it is not automatically the sunny or flat cities that have a higher NMT share than rainy or hilly cities (as many Dutch and Scandinavian cities are proof of).

[256] Kenworthy/Laube 2002

Transport regulations/policy:[257] Even though political measures alone will not change today's mobility culture they can support a paradigm shift.[258] Eliminating traffic inducing incentives and introducing rewards for low-impact mobility can include tax incentives for individual expenses that improve the modal split, prioritising funding for new developments in central or well-connected areas over those on the urban fringe, measures for demand management or designing a market framework that favors new sustainable businesses.[259] Generally, measures which limit or regulate mobility are not welcomed by those who are affected by them.[260]

Disposable incomes: Disposable incomes influence the choice of modes, number of trips and trip lengths. In the EU-15, the middle class is shrinking while the fringes are growing.[261] With other expenses rising, disposable incomes for mobility which range between 14 and 20 % of household budgets (EU-15) are likely to shrink.[262] With rising fuels prices expenses for vehicle purchase need to be limited, illustrated by the rising share of low-cost vehicles.

Subjective/soft factors

Cultural: Modern society is characterised by a high level of individualism, enforced flexibility, complexity, rationalism, and multioptionality.[263] The impacts of these aspects on mobility behaviour are as follows:

Individualism: A need for independence, dispersed activity patterns and smaller household sizes lead to more individual trips, lower car occupancy rates and higher car ownerships rates.

Flexibility: The need to be mobile anywhere and anytime and to change individual plans quickly and instantaneously makes collective modes of transport less attractive.[264]

Multioptionality: The desire to be able to chose any of the many given options at will calls for independent flexible mobility solutions.

Rationalism: The demand for the most cost, time, and resource efficient means of transport make transport and mobility a utility in everyday life.

Complexity: The diverse demands of everyday life call for multi-purpose vehicles/modes.

It can be concluded that in modern society, many people expect or wish to go anywhere from anywhere, instantly. This “utopian frictionlessness“[265] motivates people to choose faster over slower modes and to make more or farther trips than necessary.

Individual preferences: Individuals have different criteria for choosing transport modes. In general, reliability comes first while speed and comfort seem to come last. This finding confirms the notion that mobility is, above all, primarily a functional activity:

[257] see also chapter 3.3.10
[258] Nuhn 2006:333; Dennis/Urry 2009
[259] Deakin 2001:6; OECD 2000:341; Böhler 2007:19; Banister 2005:76; for a list of transport policy measures see chapter 3.3.10
[260] Axhausen 2006:16
[261] Canzler 2009:14
[262] Gather 2008
[263] van der Loo/van Reijen 1999; Dick 2009:11; Wilke 2002a:18; Winterhoff 2009:14f.; Henderson 2009:147
[264] Canzler 2007:12
[265] Doshi 2007:7

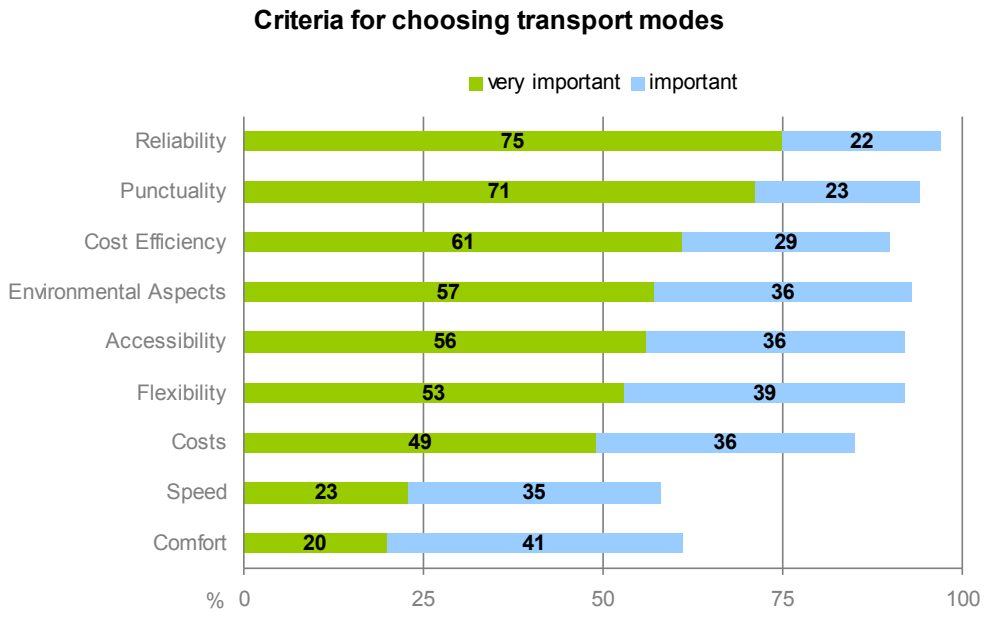

Figure 26: Criteria for choosing transport modes[266]

Attitudes: Attitudes do not equal behaviour, but they frame it. Therefore, e. g. a generally positive attitude towards low-impact mobility does not automatically result in low-impact behaviour.[267] This is called cognitive or post-purchase dissonance and troubles planners and manufacturers alike. When it comes to actually changing mobility behaviour or spending more money on "better" choices many customers who allegedly profess a positive attitude towards a given product or service will not chose it.[268]

Routines: Mobility behaviour is highly routinised. New routines are only acquired when a trigger event (change of residence, change of family status) prompts individuals to consider alternatives.[269] Inertia and mental effort can inhibit actions to review the relative merits of alternative travel choices[270] and outplay rational decision making.[271]

2.3.3.2. Impacts of mobility services on mobility behaviour

Mobility behaviour finds its expression mainly in mode choice, but also in distances travelled and in the number of trips taken. How will mobility services influence individual mobility behaviour? While some behavioural changes have been empirically analysed by assessment studies (see literature list in chapter 1.5) others need to be deduced from changes based on similar provisions. This section will provide a brief overview of the most important and most likely changes in mobility behaviour evoked by the two mobility service types relevant for car manufacturers. The most comprehensive analyses of the impact of mobility services on mobility behaviour are provided by bcs [2008], Böhler/Hunecke [2008], Haefeli [2005], Harms [2003] and Maertins [2006]. However they relate only to geographically limited services and address vehicle provision services only.

Vehicle provision services

In general, the cause-effect relation of access to resp. usage of (existing) vehicle provision services, esp. car sharing, and differences in mobility behaviour is contested: It is unclear

[266] infas 2009
[267] Grischkat 2008:59; Soron 2009:188
[268] Eck/Stark 2009:505; Becker/Gerike 2009:228
[269] Canzler 2006:16; Brook 2004:6; Wilke 2009:112
[270] Lyons 2006:1; Soron 2009:187; see also Kristof 2010:55
[271] Tully 2006:231; Wilke 2002b:14

whether a trigger event (change of residence, change of family status) prompts individuals to change mobility behaviour and consider alternatives to car ownership/use or whether the access and usage of vehicle provision services prompts them to change their mobility behaviour.[272] The majority of car sharing users enter the club membership with a mobility behaviour which is already adapted to lower car usage, [273] thus using car sharing as a mobility security, i. e. "a stabilising factor that makes life in the future possible without a personal car."[274] With more flexible and innovative provision services this kind of behavioural preconditioning might become less necessary.[275]

The extent to which vehicle provision services will affect modal shift, esp. vehicle miles, depends largely on the effect on car ownership of the users.[276] It is estimated that one vehicle from e. g. car sharing can substitute up to 7 privately owned cars, compared to 2.3 vehicles for flexible car sharing services (public car fleet).[277] Other sources estimate even up to 14 vehicles substituted by one car sharing vehicle.[278] The share of car sharing members who removed their car upon entering a car sharing club varies[279] but can be as high as 50 % (see Table 6). Vehicles from vehicle provision services also tend to be used as a substitute for the second or third car in a household, thus decreasing the number of cars in households but not the number of households with cars.[280]

Country/City	Car-free households before joining in %	Car-free households after joining in %
London	49	74
Great Britain (without London)	44	75
Switzerland	60	76

Table 6: Car-free car-sharing households before and after joining[281]

Pay-as-you-go schemes will positively disrupt mobility routines. Combined with intelligent information services, users will make more informed decisions about time and cost aspects of transport modes and destinations, reducing trips and trip lengths significantly[282] and shifting to more viable roads and modes.

However, vehicle provision services can also increase vehicle usage. More mobility services can generate more mobility or substitute unsustainable transport patterns.[283] This is especially true for flexible car sharing/public fleets which are easily accessible and imitate individual motorised mobility patterns.[284] They may encourage users of public transport or NMT to use a car for certain trips or substitute public transport trips by vehicle trips. The latter phenomenon can be observed e. g. in Paris where the public bike fleet *Vélib'* has decreased public transport patronage but not car use.

Information and assistance services

[272] Wilke 2007:64
[273] Harms 2003:296; Böhler/Hunecke 2008:39
[274] momo Car-Sharing 2010:81
[275] Wilke 2007:70
[276] Grünig/Marcellino 2009:10
[277] Wilke 2007:XXIV
[278] Kellenberger 2009:7; momo Car-Sharing 2010:28
[279] Maertins 2006:40
[280] Haefeli 2006:34
[281] momo Car-Sharing 2010:70
[282] Maertins 2006:32
[283] Böhler/Hunecke 2008; Maertins 2006:3, 5
[284] Wilke 2002b:14, 26; Wilke 2007:93; Canzler/Hunsicker 2007:5

Depending on the objective of information and assistance services mobility behaviour can change in different ways. Basically, they allow users to choose the fastest, cheapest and most convenient route and transport mode, thus also improving overall urban transport balance. Many such services aim at increasing public transport and NMT usage by facilitating the booking and planning of combined trips. Services which include route planning and adaptation to traffic conditions, automatic ticketing and real-time traffic information (seamless mobility) can generate a user experience which is similar to trips by private car. However, it is crucial that they address the barriers caused by routine behaviour prevalent in individual mobility. Again, with information and assistance services, esp. combined tickets the cause-effect relation between change in mobility behaviour and access to the service is unclear. While users of combined tickets tend to have a multi- or intermodal mobility behaviour beforehand, other services have the potential to transform mobility behaviour in the long run.

2.3.3.3. Mobility types of the future

As the average mobility/transport user does not exist many studies have developed mobility types or mobility life styles.[285] Lifestyles determine more the long-term aspects of mobility behaviour while mid- and short-term aspects such as location/place of residence, scope of activity, cost preferences and the use of information about travel influence the short- to mid-term aspects of mobility behaviour. While mobility types in the past were based on static features like income, education and other socio-demographic factors, the current dynamics require a more flexible typology based on current trends (see chapter 3) and on the factors that determine mobility behaviour (see chapter 2.3.3).[286] Even though not based on a thorough empirical research basis, this task is best achieved[287] by a segmentation by Winterhoff [2009] which suggests the following mobility types for 2020:

Mobility type	Short description	Mobility services requirements
Greenovator	• Takes into account the socio-ecological consequences of mobility • Demands innovative and sustainable solutions • Part of the LOHAS segment	• Greenovators tend to use public transit, NMT and car sharing products more often • Mobility services need to offer an added value for environment and society
Family Cruiser	• Heavily depends on mobility in an increasingly fragmented network of family and friends	• Simple mobility solutions that support complex family needs, e. g modular mobility packages • Only little demand for car substitutes
Silver driver	• Actively engages in the third phase of life • Has ample product experience and a high quality awareness	• Services that help to manage complexity • Professional hire and share systems, combined with public transport for long trips
High-frequency Commuter	• Has an everyday life characterised by high mobility frequency • Needs mobility predominantly in tomorrow's mega-cities	• Services that help to manage complexity and reduce stress • High demand for attractive transit (reliability, comfort, pricing) • Intelligent car pooling tools • The car is the preferred vehicle for the last mile
Global Jet Setter	• Needs global mobility as a prerequisite for fulfilling the job • Demands exclusive premium support	• Premium all-round services (personal mobility assistance) • Focus on convenience and comfort

[285] DIW/infas 2002; Böhler 2006; Hunsicker/Karl 2008:22; Götz 2007:762; Hunecke 2009; Winterhoff 2009; for an overview of lifestyle-based mobility research models see Grischkat 2008:46.
[286] Hunsicker/Karl 2008:21
[287] Another useful segmentation is proposed by Diez 2010.

Sensation Seeker	• Looks at mobility as a symbol of liberty, a fun lifestyle, status and prestige	• Mobility services are not attractive for this type as the (privately owned) car is their dominant mode of transport
Low-End Mobility	• Most affected by rising prices, has a limited mobility budget • Is ready to downgrade travel volumes	• Low-end mobility users are willing to cut back on individual desires • Affordable mobility concepts • Car sharing, car pooling, NMT and public transport as attractive options

Table 7: Mobility types based on long-term trends for 2020[288]

While some mobility types are characterised mainly by their actual mobility *needs* and specific use cases (e. g. family cruiser, high-frequency commuter, global jet setter), others are determined more by their mobility *desires* and attitudes (e. g. greenovater, sensation seeker). This implies that individuals can belong to several mobility types at once.

According to tentative projections, the largest segments will be the greenovators, silver drivers and high-frequency commuters, making up about three quarters of the market in 2020. Greenovators and high-frequency commuters, but also global jet setters correspond to the "metromobiles" identified by Canzler/Hunsicker et al. [2007] for the German market. Metromobiles are characterised by age (25–65 years), residence (cities of > 50,000 inhabitants), income (above average) and marital status (single or married, no kids). They have a flexible, multioptional mobility behaviour and are therefore considered as a potential pilot market for innovative mobility applications in Germany.

On the other hand, family cruisers and low-end users belong to a group with lower incomes and/or less flexible mobility needs. However, together with the three largest segments they will comprise over 90 % of the market in 2020, leaving niches to the sensation seekers and global jet setters.[289] The third column of Table 7 demonstrates that the largest segments will create a significant demand for a variety of mobility services. In order to succeed on the market and respond to consumer demands, product-focused companies (like car manufacturers) will need to incorporate services that cater to the needs of these mobility types.

2.3.4. Market potential of mobility services

This thesis will and can not generate a genuine analysis of future mobility service market potentials but in order to provide a first impression on the user volumes to be expected selected analyses from literature will be presented.

The market potential of mobility services can be assessed from different viewpoints: 1) market shares of mobility services related to the total mobility market; 2) shares of specific mobility types which are potential mobility service users; and 3) potential market volumes of specific services (e. g. car rental).

1) Market shares of mobility services

According to a study by Winterhoff [2009] which investigates opportunities for car manufacturers in saturated markets the market for mobility services in general will make up 21 % of the total mobility market by 2020, thus leaving the lion share to traditional vehicle ownership models. Yet, the seemingly small share of 21 % represents a very dynamic market involving innovative providers and customers.

2) Market shares of mobility service user groups

The same study by Winterhoff [2009] presents a mobility type segmentation for saturated markets (for additional information see chapter 2.3.3.3) according to which the largest segments – *greenovators, silver drivers, low-end users* and *high-frequency commuters* – (mak-

[288] Winterhoff 2009:31ff.
[289] Winterhoff 2009:57f.

ing up about three quarters of the market in 2020) will demand a large array of mobility services.[290] The individual requirements of each group will differ, ranging from affordable mobility packages to exclusive travel management, from car substitutes to additional vehicle lease options, from mere informational assistance to complete "driver" services (i. e. public transport).

Canzler/Hunsicker et al. [2007] have identified the *metromobiles* as a user group which demands integrated mobility services in Germany (see chapter 2.3.3.3). They currently make up 3.2 million potential users and are divided into three different mobility types which can be located along an axis describing the attitude towards the car. 1) "Car adherents" manage the major part of their daily mobility with a car; 2) "public transport pragmatics" use public transport where possible but like to have fall back options which include cars in case public transport can not offer the service needed; and 3) "public transport ecologists" have a negative attitude towards the car and organise their daily mobility almost exclusively with public transport and NMT. Due to their characteristics – age (25–65 years), residence (cities of > 50,000 inhabitants), income (above average) and marital status (single or married, no kids) – and their flexible mobility behaviour this group will create a demand for innovative, integrated mobility services, both vehicle provision and information and assistance services. The share of "car adherents" will increase compared to the share of "public transport ecologists" which currently are the largest mobility service user group will decrease.

3) Market volumes of specific mobility services

Customer potentials of *car sharing* vary significantly, depending on the method used and on spatial limits. The following table provides an overview of more recent car sharing customer potential studies for Europe and the two largest European carsharing markets Germany and Switzerland, of which some of them will be explained in more detail further down:

Country/Region	Current customers	Potential customers until 2016	Source
Europe	480,000	4–7 mio	Kellenberger/Kumar 2009
		560,000	Shaheen/Cohen 2013
Germany	160,000	1.1 mio	Loose 2007; Canzler/Hunsicker 2007
		900,000	momo Car-Sharing 2010
		1.5–2.0 mio	Loose et al. 2004
		1.44 mio	Canzler/Knie 2005; Maertins 2006
		0.87–6.4 mio	Wilke/Böhler 2007
Switzerland	84,500	500,000	Haefeli 2006

Table 8: Comparison of estimates of future potential for the development of Car-Sharing

According to Kellenberger/Kumar et al. [2009] the number of users of car sharing services (including public vehicle fleets) in Europe will grow from 480,000 users in 2009 to 4–7 mio. users in 2016. This suggests a growth of the shared vehicle fleet to 80,000-100,000 cars in 2016 which implies a user/car ratio of 35 compared to 17 users/car in 2009. A similar, more recent study by Shankar [2012] expects car sharing users to grow from a current 700,000 to 15 mio in 2020, as well as a rise in car sharing vehicles from 21,000 to 240,000. Another 310,000 vehicles might be available via peer-to-peer services where private car owners rent out their vehicles via mutual platforms.

[290] Winterhoff 2009:57f.

Germany is the largest car sharing market in absolute customer numbers. In 2009, the number of car sharers in Germany grew by 15 %, while the number of car sharing vehicles grew by 19 % and the number of car sharing stations by 16 % (see **Figure** 30). However, due to the success of the scrapping premium, the growth of car sharing participants remained below expectations in 2009.[291]

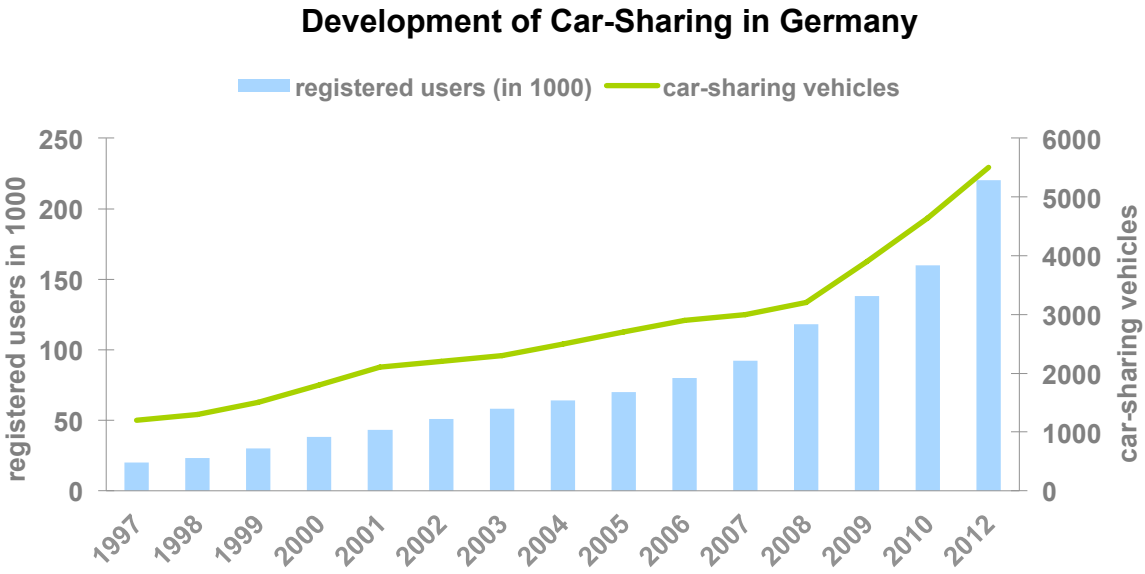

Figure 27: Car-sharing in Germany – registered users and vehicles[292]

In 2012, there are 220,000 car sharing subscribers in Germany and 5500 car sharing vehicles in 270 cities, many featuring more than one provider. There is a clear concentration of car sharing organisations in Southern Germany (see Figure 31).

[291] bcs 2008
[292] bcs 2009:2

Figure 28: Car sharing systems in Germany[293]

Based on the metromobiles presented by Canzler/Hunsicker [2007], Loose [2007] identifies a potential of 1.1 mio car sharing users for German cities with > 50,000 inhabitants. Compared to the current number of car sharing club members (160,000 in 2010)[294] there is a large untapped potential which waits for innovative, customised services to enter the market.

A study by the EU project momo Car-Sharing ("More options for energy efficient mobility through Car-Sharing") synthesizes the number of car sharing members relative to the population and the number of years the service has been in the market in the respective country. Figure 32 makes clear "that Switzerland has, by a large margin, the highest growth in Car-Sharing participation in relation to population numbers. [In] 2009, almost 1.1 % of the population were registered as customers of the Car-Sharing provider Mobility. Germany, the Netherlands and Sweden come a distant second with 0.16 and 0.17 % respectively. Thus, based on the proportion of the population that participates in Car-Sharing, Switzerland is approximately seven times better than the next countries. […] if Germany had comparable participation numbers to Switzerland, it would have 900,000 Car-Sharing customers."[295] The added

[293] BCS 2010

[294] Half of the German car sharing members are inactive users, i.e. they have used the car sharing service only once in the last two years.

[295] momo Car-Sharing 2010:15-16

trendline (light blue, excluding the variables for Switzerland) in the same figure demonstrates which European countries have achieved above-average development since the establishment of the first Car-Sharing services and where growth is comparatively slower. It has to be noted though that for the above-average car sharing countries Great Britain and Sweden, Netherlands and Austria, car sharing services are most in demand in the respective capital regions, while in the rest of the country a good deal of development potential has yet to be realised.

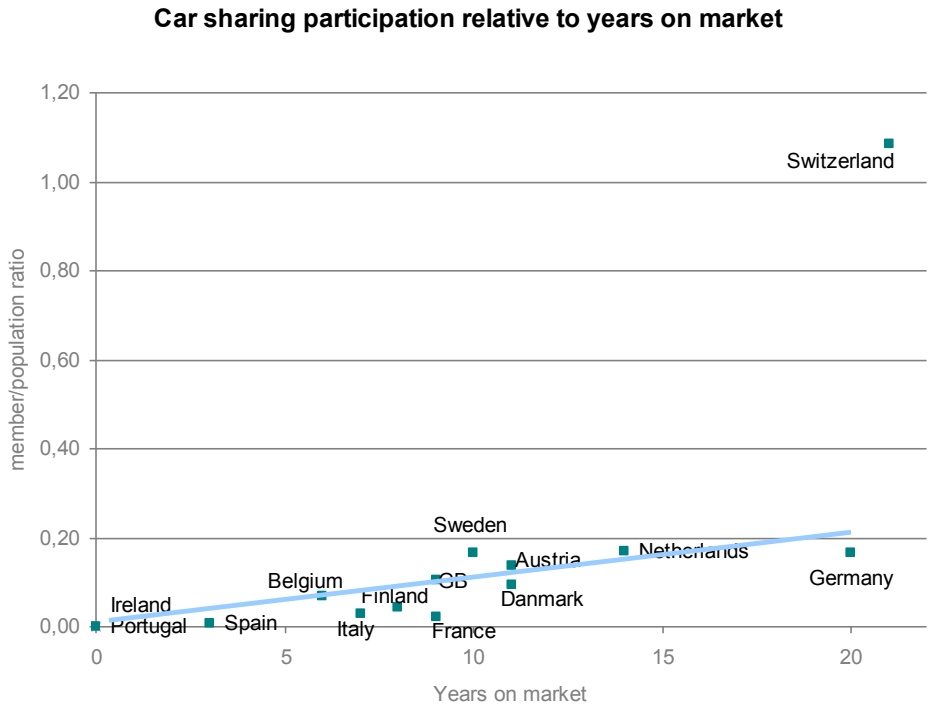

Figure 29: Growth potentials: Car sharing participation relative to years on market[296]

The different market potential assessments demonstrate that the market potential for mobility services is regarded as positive but that success will depend 1) on customer acceptance and 2) differentiated services for each user profile as well as 3) on the improvement of certain framework conditions. Condition 3) will need to include:

- improving the quality of supplementary transport modes (especially public transport) and infrastructure,
- intensifying the interconnectivity of different mobility services on national and international levels,
- increasing the flexibility of car sharing (towards flexible car sharing resp. public vehicle fleets),
- adapting marketing activities to target groups,
- higher professionalisation levels, and
- the development of new forms of car sharing (e.g. peer-to-peer car sharing).[297]

Most important, the role of municipalities and transport policy in fostering mobility service friendly external conditions should not be underestimated. A lack of market stimulation and

[296] momo Car-Sharing 2010:15
[297] Harms 2003:77; Shaheen/Cohen 2013

favourable legislation (e.g. transport policies that discourage the use and ownership of private vehicles can cause mobility service markets to stagnate and reduce user acceptance.[298]

2.3.5. Design of mobility services: Factors for customer acceptance

Mobility behaviour is shaped by a diverse set of factors: objective and subjective factors, needs and desires, enabling and constraining factors. The mobility types are one way to cluster these diverse aspects and help mobility providers and manufacturers to align their portfolios. Yet, they are only a tool to manage complexity; they will not be able to reduce it. Manufacturers will be forced to diversify their portfolios to an extent that reaches beyond conventional product diversification and include mobility services. When doing this it will be paramount to foster customer acceptance by respecting individual needs and desires. To sum up the analyses of chapter 2, the factors for customer acceptance of mobility services are:

- Mobility services should address the **needs of the mobility types** that have the highest demand for them (greenovators, silver drivers, high-frequency commuters, low-end mobility users). They need to be **professionally** managed and offer individual options for each user group.
- Mobility services need to blend with **mobility routines** and should support multioptional behaviour, i. e. be flexible and convenient. Simplicity, reliability and flexibility are the key requirements for mobility services. They can be achieved by a service design that follows the principles of “instant access, one way, open end” and incorporates real-time traffic information.[299]
- Mobility services need to support **intermodality**. Organisational **integration** with other modes of transport therefore is a key to customer acceptance.[300] It is also the most challenging aspect of developing mobility services.
- Mobility services need to be **convenient** to use. Mobility services therefore need to incorporate **smart technologies** and applications. Real-time information on vehicle provision systems, public transport and traffic conditions is the most important factor for fostering inter- and multimodality.
- Mobility services need to offer an **added value** for the users which they can not obtain by using conventional or competing services. A seamless integration of public transport modes will not be enough value added for users who have established car-based mobility routines; therefore, integrated mobility services ideally need to include car-based mobility services like car fleets or car sharing.
- The **benefit** of mobility services needs to be assessed and communicated openly. Even though mobility services can contribute to the sustainable development of urban transportation they do not always do so to the extent proclaimed by providers. Modest benefits need to be declared honestly in order to avoid the impression that mobility services are a panacea for all burdens of urban mobility.

[298] Kellenberger 2009
[299] compare also Maertins 2006:118, 147; Rogers 2003:15f.; Canzler/Hunsicker 2007:17
[300] compare also momo Car-Sharing 2010:86

3. Key factor analysis: The future of mobility services in urban transportation

Current trends like rising resource prices, increasing traffic problems and complexity of everyday life will likely increase the demand for mobility services in industrialised countries until 2020. This chapter will explore the validity of this assumption and analyse these and other factors contributing to this growth in more detail by using elements of foresight methods. It will answer the following questions:

- Which external trends determine the future demand and feasibility of mobility services?
- How do these trends interact with each other (cross-impact analysis)?

3.1. Corporate foresight and future research methods

"The objective of foresight is to identify opportunities for science and technology to address challenges facing society."[301] This general description of the function of foresight can be turned into: "The objective of *corporate* foresight is to identify opportunities for corporate research, development and innovation to address challenges facing society." Therefore, any research and development by companies should not only serve their own economic interests and satisfy customers but try to benefit a wider range of society and its problems. The challenge is to address those problems which traditionally do not lie within the range of corporate objectives. Since the overall objective of sustainable development is achieving and retaining a high quality of life, in this case of urban life, more aspects than just environmental soundness of vehicles need to be addressed by car manufacturers.

Even though the future cannot be predicted – only possible and probable future scenarios can be drawn – and even though it is not clear "to what extent […] further development is shaped by self propelling mega-trends on the one hand and by planned interferences on the other" many future researchers and strategic planners are convinced that the future "can significantly be influenced" and "consciously be directed".[302] It has to be consented though that due to the fast dynamics of change it becomes increasingly difficult to assess even the near future. This challenge makes it even more important for dynamic business sectors like the automotive industry to analyse outside developments thoroughly and continually as well as to set own trends.

In order to shape the future and set trends, the future or "possible futures" must be known first. Future(s) studies or research have evolved as a proper, though not yet widely acknowledged scientific discipline with a standard set of methods. One central input or method to futures research and strategic planning is *environmental scanning,* i. e. a continual scanning of the changes and trends in the above mentioned STEEP sectors (society, technology, economy, ecology, and politics).[303] Key elements of environmental scanning are database and literature reviews, commissioned expert essays, key person tracking and conference monitoring. As organisations tend to view the world outside only as it relates directly to their business concerns it is the job of future analysts to engage their organisations in adopting a more holistic view. Experience has shown that "automotive companies, for example, may fall into monitoring only vehicle and transportation trends, ignoring or downplaying developments

[301] Lyons/Urry 2003:3
[302] Topp 2002:1
[303] Glenn/Gordon 2006:3; Bishop/Hines 2006

outside these two areas."[304] Investigations among corporate foresight departments in various businesses have shown that there is a clear ranking among the STEEP sectors: Technology and economy rank on top, politics rank lowest.[305] The ranking in the automotive sector likely follows this pattern. Therefore, holistic environmental scanning becomes essential as trends outside the direct business concerns might influence corporate strategies. E. g., the current global water crisis (water shortages and a lack of water and sanitation services) lies outside the typical automotive sector market research area but in the future might have implications for vehicle production sites and human resources.

Another core method of corporate foresight are *scenarios*, the most common method of futures research. From a wide range of influencing factors they develop one or more consistent pictures of the future. They are more suitable for defined problems and draw on insights generated by environmental scanning exercises. There are two directions of scenarios: More common are forward scenarios, which extrapolate the present into several possible futures. They are of a descriptive and often quantitative nature. Less often used are backcasting scenarios, which assume a desirable future and then trace back the path to arrive at this point in the future. It is of a normative and qualitative nature and serves as a strategy tool per se.

Additionally to environmental scanning and scenarios, the core of future research methods[306] used in corporate foresight consists of:

- Creativity methods for small and large groups (e. g. future labs)
- Expert interviews (e. g. Delphi)
- Systems thinking (e. g. System Dynamics, Cross-Impact)

In corporate foresight, these methods are then integrated into a framework comprised of the following activities: Framing, Scanning, Forecasting, Visioning, Planning, and Acting.[307] This thesis is concerned mainly with *framing* and *scanning*, but has *visioning* as a starting point; it will touch on *forecasting* by drawing on existing market assessments; and it will finish with a first glimpse on *planning* options for car manufacturers, hoping to provide some valuable impulses for *acting*.

Futures research can clearly be distinguished from market research. Market research uses quantitative, linear forecasts, attends to shorter time horizons (five to ten years) and looks only at trends directly relevant to the automotive market. Future research works with a broader range of possible future developments (derived from the methods named above, like scenarios or the Delphi method), looks farther into the future – the normal horizon for future studies in 2008 today are the years 2030 to 2050 – and scans developments in all sectors and scientific disciplines. It is thus able to anticipate future developments that cannot be detected by a mere extrapolation of present trends. The actual asset of future research is that it enables organisations to initiate necessary change processes early.

On different levels, both market and future research are able to provide appropriate input for mid-term innovations that enable the corporation to thrive (and sometimes survive) in future dynamic environments. Innovations based on such inputs can range from mere gradual technology improvements to technological evolutions or strategic revolutions. Ideally, the communication of the desirable innovations is followed by initiating the implementation pro-

[304] Bishop/Hines 2006:56
[305] Burmeister/Neef 2002:56
[306] For a more extensive overview on future research methods readers may refer to the Futures Research Methodology of the Glenn/Gordon [2006]; for the application in corporate foresight please refer to the empirical study of Burmeister/Neef [2002], the strategic sourcebook of Bishop/Hines [2006] and the foresight studies and strategy development guide of Loveridge [2009]. A detailed history of foresight studies and futures research is provided by Uerz [2006].
[307] Bishop/Hines 2006

cess (transfer) which then usually is handed over to the R & D and/or innovation management departments.

Most of the larger car manufacturers today have implemented foresight programmes, be it internally through own foresight or future research departments or externally through permanent consultants. Ideally, they are allowed to play the "court jester" of a corporation and can hint at trend reversals, wild cards[308] and "inconvenient truths" early and repeatedly. Depending on their integration and standing in the corporate organisational structure future research departments can affect R & D programmes and business strategies in a way that aligns them with expected and, even more important, desired future developments.

As it is common for all integrative processes future research and planning activities are highly communicative.[309] This is not only due to the need to pass on insights about future developments and strategic recommendations to the target audiences named above. The more important and more labour- and people-intensive part of corporate foresight is its cross-sectoral function (see figure 2) which results from its objective to bring together stakeholders and experts from in- and outside the corporation. Collecting their expertise and helping them to engage in discourses enables corporations to combine existing knowledge with the sometimes vague and often complex knowledge about the future and to initiate innovation-oriented processes needed for economic success. Corporate foresight therefore is not only interdisciplinary and trans-disciplinary, but additionally has a cross-sectoral function in corporations. These are also core characteristics of sustainable development and, more recently, of sustainable transport planning.[310]

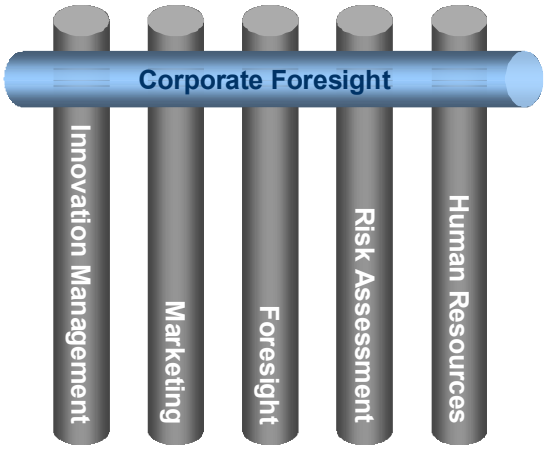

Figure 30: Future research as a cross-sectoral function in corporations[311]

Corporate foresight activities differ in scope and purpose, methodology and topics and always reach beyond the traditional scope of automotive market research. Thus, they ensure that the major strands of the global sustainability debate are not lost to the car manufacturer's view. Foresight activities allow companies to detect areas where new or adapted products, services and strategies will be needed and to set and shape trends according to their corporate strategy instead of merely aligning strategies with trends. In order to promote corporate foresight on a broader base, detailed evaluation and follow-up of foresight activities are still needed. Evaluation reports could serve as a proof for the effectiveness of corporate foresight activities.

[308] Steinmüller/Steinmüller 2004
[309] Bertolini 2008:72
[310] Banister 2008:79
[311] Burmeister/Neef 2002:43

Corporate foresight in the automotive industry has been practiced for some decades, and research esp. on urban mobility is very common at many large car manufacturers (see chapter 4.3.1). However, some experts criticise its low effectiveness and call for a higher transparency and more open discourses. For this reason, this thesis aims at analysing thoroughly a new trend or business area which is believed to relieve cities from most of their urban transport problems and which car manufacturers are therefore frequently asked to engage in. A close look at future trends will reveal the actual acceptance and feasibility of mobility services, while the market analysis will reveal their market potential. This will help to temper exaggerated hopes and clearly communicate the likely benefits and opportunities which mobility services provide for car manufacturers to comply with new paradigms of mobility and innovation. The results will enable businesses to make smarter decisions regarding future portfolios and fitting services to the actual needs of customers.

3.2. Selection of key factors

The long list of potential key factors is narrowed down in two steps, first by eliminating those factors that are neither relevant nor uncertain, and then by eliminating those with a low passivity or activity index. The final set of factors will be described in detail (chapter 3.3) in order to identify some impacts on the future demand for mobility services.

3.2.1. Preselection of potential key factors

Based on key factors used for several mobility-related scenarios studies[312], the following list of potential key factors has been identified (in arbitrary order):

Potential key factor	Definition
Drive train technology	Development of drive trains and fuels (internal combustion engine, hybrid technologies, battery electric vehicles; biofuel, gas, electricity, fuel cells)
Demographic change	Changes in size and composition of the population; aspects like growth and shrinking, migration, ageing
Energy portfolio	Mix of resources to generate energy
Energy resources – price and availability	Price and availability of energy resources, esp. aspects of resource scarcity and growing demands
Information technology (IT)	Development of information technology, esp. those relevant for transport
Public transport infrastructure	Extension and maintenance level of public transport; service levels
Individual motorised transport infrastructure	Construction and maintenance level of roads and parking spaces
Non-motorised transport infrastructure	Construction and maintenance level of pedestrian roads and cycle lanes and relevant infrastructure
Climate change	Short and long term impacts of climate change, especially on cities and urban infrastructures
Cultural significance of the car	Significance of the motor vehicle as a symbol for wealth, progress, status, freedom etc.

[312] e. g. Canzler/Hunsicker 2009; Carsten 2005; Hunsicker/Karl 2008; Winterhoff 2009

Mobility needs	Actual mobility activities of people and transport of goods (quantitative aspect)
Mobility behaviour	Factors influencing the choice of transport mode, trips, and trip lengths; attitudes shaping mobility (qualitative aspect)
Product portfolio of car manufacturers	Future range of products and services offered by car manufacturers (segments, bodystyles, service packages etc.)
Social disparities	Differences in income and opportunities within a population
Environment and transport policies	Political measures in the transport, energy and environment sector on local, national and supranational levels (e. g. road charging, emission levels, safety procedures, speed limits, climate change protocols)
Urbanisation	Development of cities and urban infrastructures
Burdens of mobility in cities	Problems in cities caused by transport activities, e. g. air pollution, congestion, accidents
Macroeconomic development	Macroeconomic development, esp. globalisation and financial markets

3.2.2. Uncertainty-impact analysis (UCI)

A group of experts from the Volkswagen research department was asked to participate in the cross-impact analysis. The median of their assessments resulted in the following matrix:

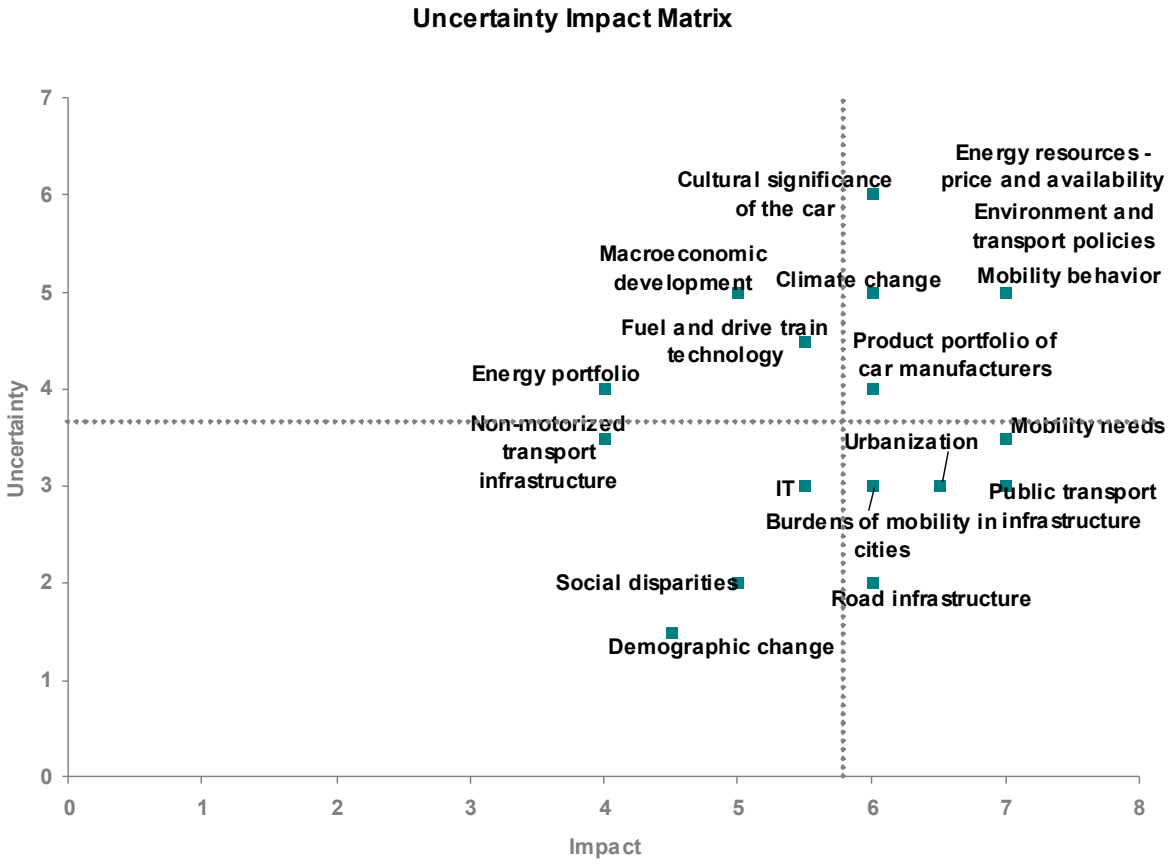

Figure 31: Result of the UCI analysis

The average of all uncertainty resp. impact values determined the position of the limiting intersection: at 5.8 for impact and at 3.7 for uncertainty. Factors below these values usually can be eliminated, which would affect the factors social disparities, IT development, non-motorised transport infrastructure and demographic change. The factor “demographic change” though was not singled out due to its strategic relevance for OEM, and the result for non-motorised transport infrastructure was too close to justify its elimination. Both were therefore retained in order to check their relevance in the following step. IT development will be included the infrastructure factors.

The remaining factors can be put into three categories:

a) High impact, high uncertainty (core factors with high dynamics)

- Energy resources – price and availability
- Environment and transport policies
- Mobility behaviour
- Product portfolio of car manufacturers
- Climate change
- Cultural significance of the car

b) High impact, low uncertainty (core factors with low dynamics)

- Urbanisation
- Burdens of mobility
- Mobility needs
- Road infrastructure
- Public transport infrastructure

c) Low impact, high uncertainty (secondary factors with high dynamics)

- Macroeconomic development
- Fuel and drive-train technology
- Energy portfolio

3.2.3. Cross-impact analysis

The cross-impact analysis was performed by the author together with experts from the Volkswagen group research department. The resulting active-passive matrix looks as follows:

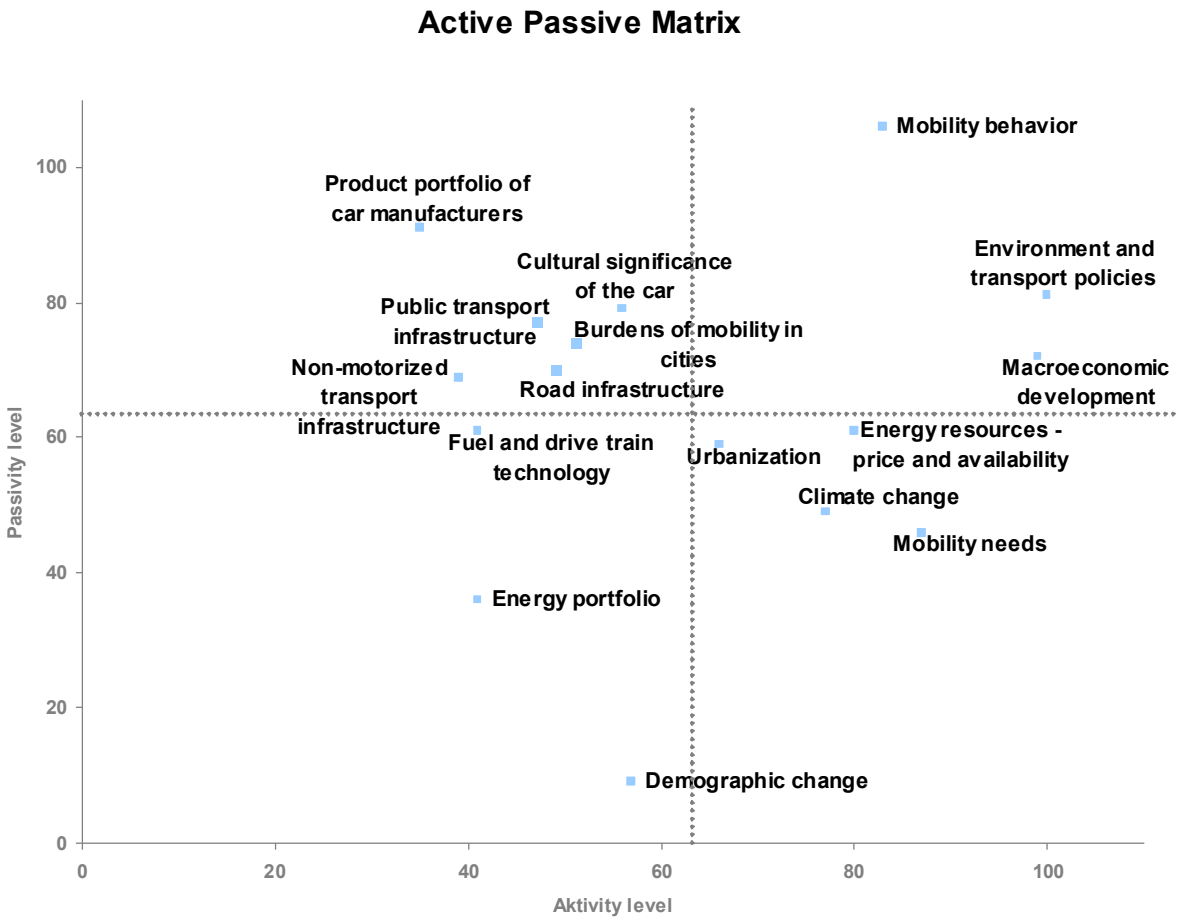

Figure 32: Active-passive matrix: Result of the Cross-impact analysis

The average of the activity resp. passivity level results determines the position of the matrix cross, i. e. 63 for the activity and 65 for the passivity level. Factors with lower values usually can be eliminated or integrated into other factors:

- The factor energy portfolio will be eliminated.
- “Fuel and drive train technology” will be combined with “product portfolio of car manufacturers”.
- “Cultural significance of the car” and “mobility needs” will be combined with “mobility behaviour”.
- The infrastructure factors (non-motorised, public, road) will be combined into one factor and will include IT aspects as well.
- Demographic change will again be retained as its strategic relevance is too high as to justify its elimination.

3.2.4. Definition of final key factor set

Grouped along the STEEP sectors, this is the final set of key factors:

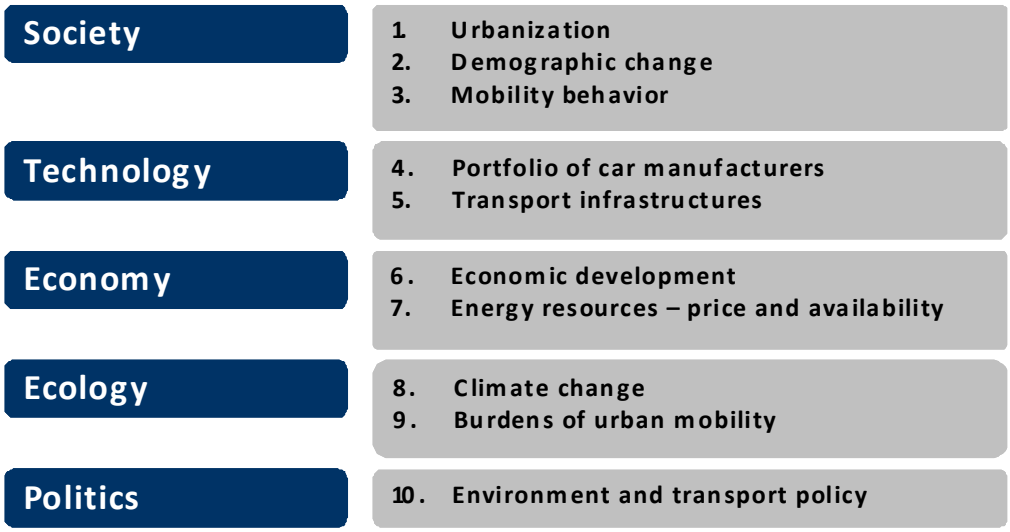

Figure 33: Final set of key factors grouped along STEEP sectors

The clustering of the final key factors reveals that social and economic factors have the highest share among all factors. This affirms the assumption that technology fixes alone cannot solve traffic problems.[313]

3.3. Analysis of key factors

In the following, the selected key factors will be described in detail in order to determine their impact on the future demand of mobility services.

3.3.1. Urbanisation

Definition:

Development of cities and urban structures.

Description:

Introduction

2007 was a historic landmark in human development: more than 50 % of the world population lived in cities. This share will rise to 60 % until 2030, comprising 4.9 billion people.[314] In the 21st century, the urbanisation process is most dynamic in emerging and developing countries while developed countries are already urbanised at 74 %. By 2030, the number of urban population in developing countries will be four times as high as in the Western world (3.9 versus 1.0 billion) because more than 95 % of the population growth in developing countries will occur in cities.[315] While the challenges of cities were highlighted in the past, more recent research and policy making balances this view by acknowledging the potential for sustainable development cities have due to their economies of scale.[316] They are regarded as innovative milieus: "The comprehension of the 'double-headed face' of mega-urbanisation demands that the general perception of megacities should shift from a predominantly negative view ('moloch', 'global sink') to a more positive perception of mega-urban areas as priority areas

[313] Lee 2007:72; compare Banister 2005:67
[314] UN 2007
[315] United Nations / Human Settlements Programme 2006:50
[316] Ehlers 2009:406; Kraas/Nitschke 2006:22

and drivers of change, with at least often undiscovered potential of improved sustainability and quality of life for many, at least more, if not all inhabitants."[317]

Figure 34: World urbanisation – development of urban and rural shares until 2050[318]

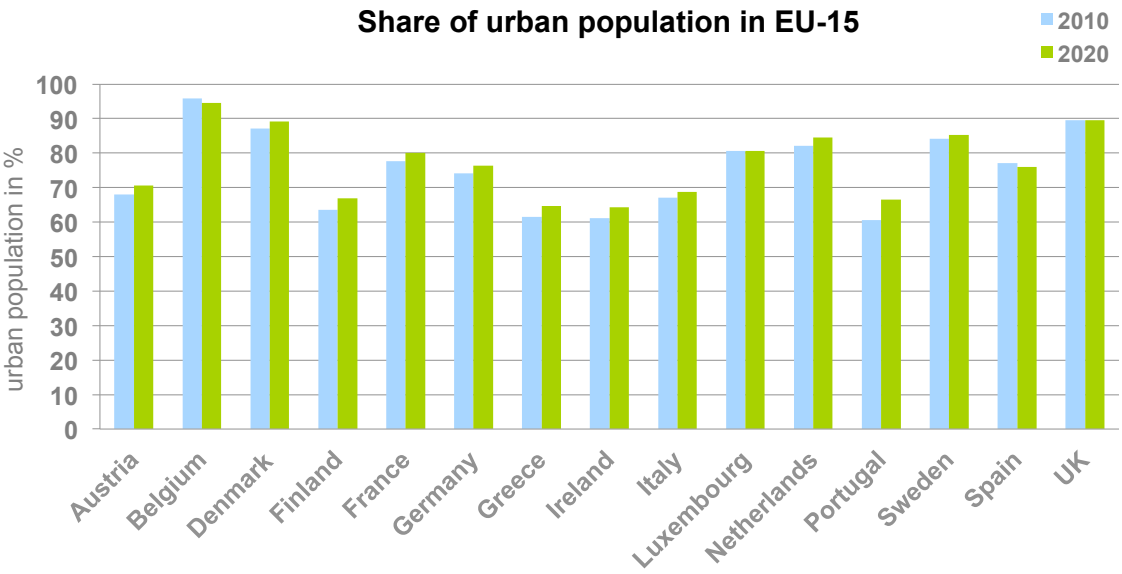

Figure 35: Share of urban population in EU-15[319]

[317] Kraas 2007:21
[318] UN World Population Prospects: The 2008 Revision, http://esa.un.org/unpp
[319] UN World Urbanization Prospects: The 2007 Revision, http://esa.un.org/unup/

Simultaneous growth and shrinking

While most of the urban population lives in medium-sized cities, there has been a sharp growth in megacities: In 1950, there were only two cities with more than 10 mio. inhabitants, but today there are 20 megacities. Their number and share of urban inhabitants will not continue to rise as steeply because the major part of urbanisation will take place in cities with <10 mio inhabitants. Worldwide, there are 400 cities with >1 and <10 million inhabitants of which 100 alone are located in China.[320] There is also a qualitative shift in mega-urbanisation: while in the past megacities were economic centres of growth, many of the newer megacities are sprawling cities that lack the traditional characteristics and benefits of cities.[321]

At the same time, there are 500 large cities (> 100.000 inhabitants) worldwide which have lost inhabitants in the last 10 years, and even more during the last 50-60 years.[322] Most of the shrinking cities are located in industrialised countries and post-Socialist countries. As there are also growth centres in the same countries, the current period is marked by simultaneity of growth and shrinking.[323]

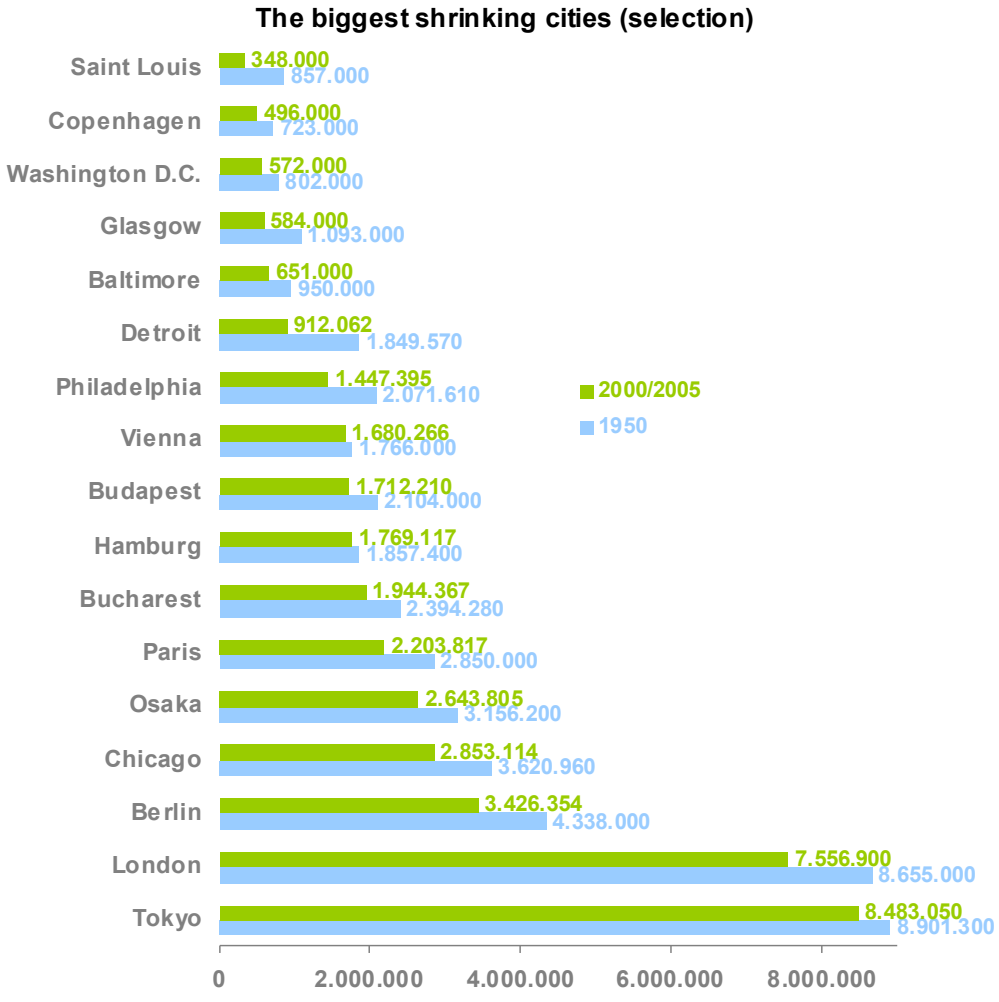

Figure 36: Population in shrinking cities in industrialised countries[324]

[320] Korff 2007:3
[321] Spreizhofer 2007:4; Docherty 2008:83; for a review on the sprawl debate see Hogan/Ojima 2008
[322] Oswalt/Rieniets 2006:15
[323] United Nations / Human Settlements Programme 2008:40; Oeltze/Bracher 2007:3
[324] Oswalt/Rieniets 2006:152f.

While the last figure shows cities that have been shrinking over the last five decades, the following figure includes those that experienced their main population losses during the last one or two decades, some of them due to the transition in the former socialist countries, others due to structural changes in industry and economy. Some of these cities have recovered their population size in the last decade after a loss in the 1990ies.

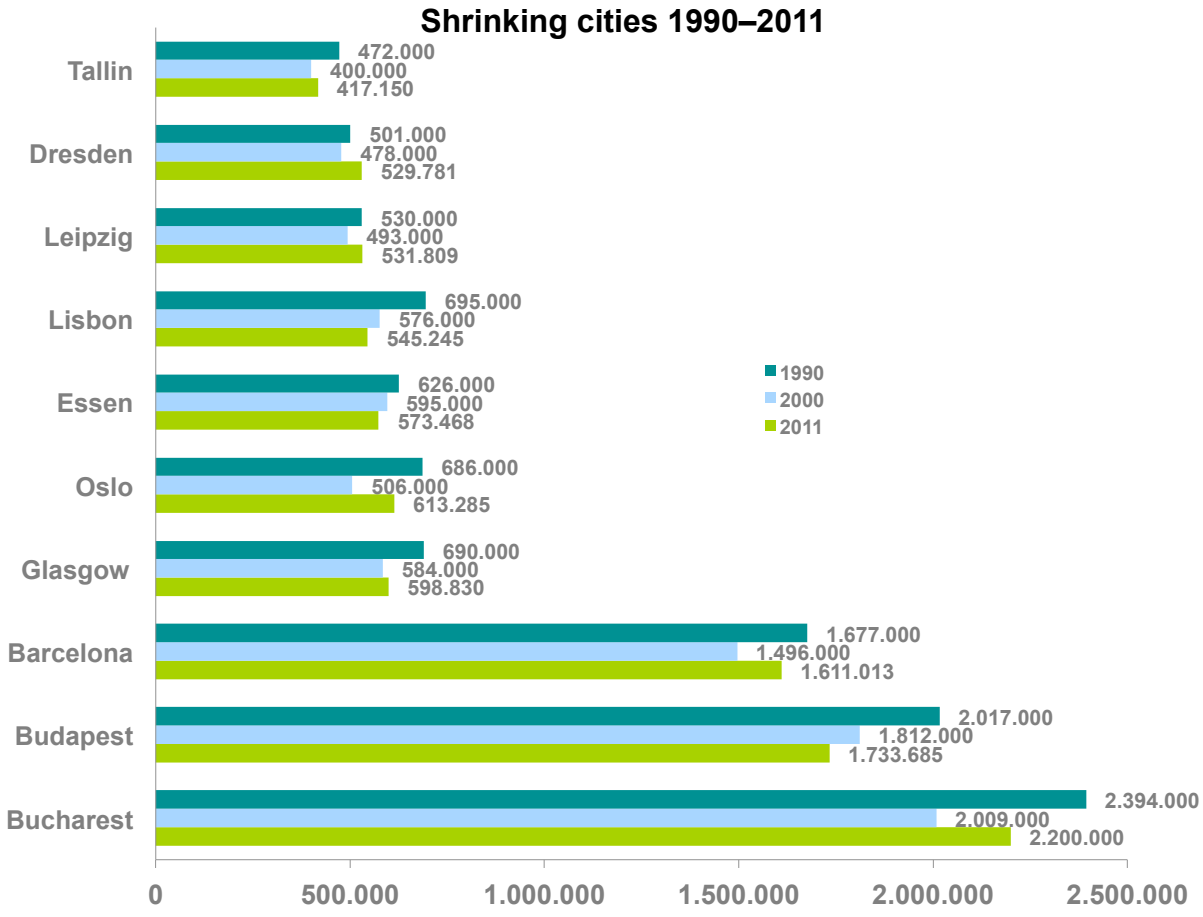

Figure 37: Shrinking cities since the 1990ies[325]

Shrinking processes vary from city to city and depend on social, economic and environmental conditions. The following figure illustrates the population development of the Eastern German city of Leipzig, which is marked by periods of conflict, regression, stabilisation as well as political change:

[325] Oswalt/Rieniets 2006:152f.

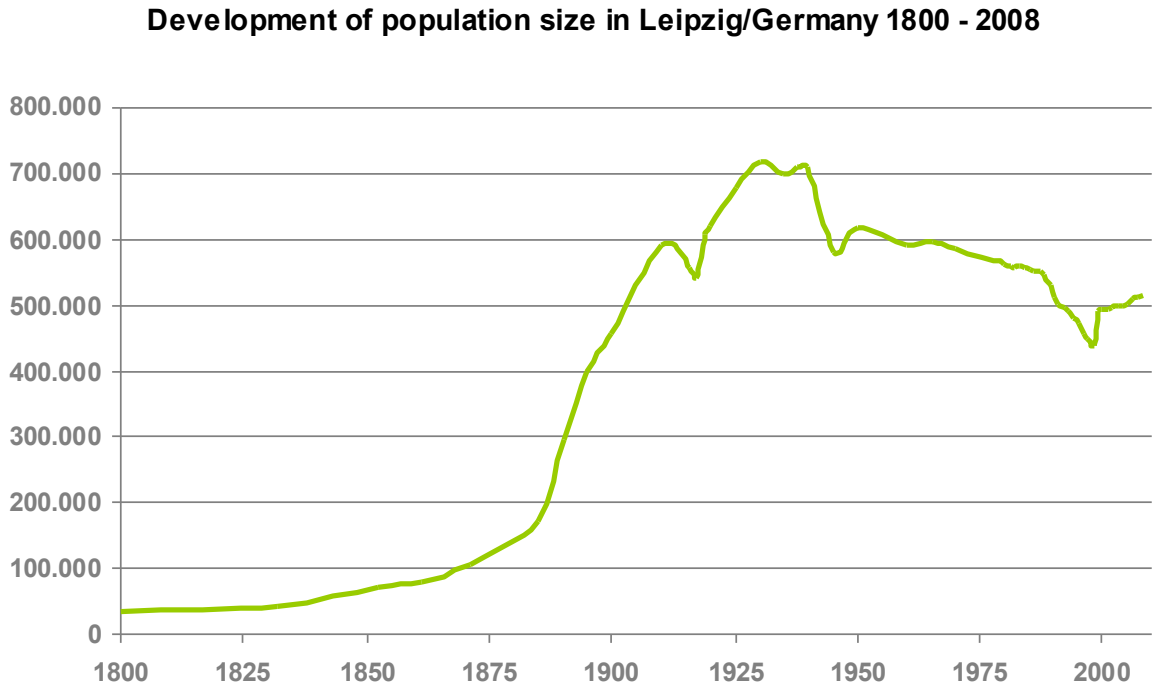

Figure 38: Growth and shrinking in Leipzig/Germany

Such non-linear processes need to be taken into account for any city. Even cities with a general growth trend may frequently experience short periods of population losses.

Suburbanisation and reurbanisation

The development of urban shapes has changed over the last decades and centuries, mainly influenced by transport infrastructure patterns (compare chapter 2.2). Since the 1950ies, motorisation has fuelled suburbanisation and spatial decentralisation (see Figure 41) causing fiscal, environmental, social and economic problems in cities.[326] Despite institutional barriers,[327] there are weak signs for a trend towards more compact cities: due to 4 demographic factors – increase of women in the workforce, decline in households with children, ageing of the population, increase in number of 1-2 person households – and the rise of the knowledge economy and creative class cities are likely to reurbanise, meaning that densities in inner-city areas will rise again.[328] Even though some urban problems are magnified in dense areas,[329] higher densities will make it possible to benefit from economies of scale and to provide low-carbon transport and energy solutions more efficiently.[330]

[326] Holz-Rau 2007:21; Rammler 2005:9; Zegras 2008:9; Oswalt/Rieniets 2006; Banister 2008:73; EEA 2006; Soron 2009:189
[327] EEA 2006:39
[328] Newman 2003:33
[329] Kenworthy 2002:13; EEA 2006:40
[330] Kraas 2007:9; Peñalosa 2003:17; Korff 2007:5-6

Figure 39: Urban expansion in Europe 1990–2020[331]

Governance: Partnerships for sustainability

Limited resources and poor planning – both areas of urban governance – are perceived as the main causes for urban development problems, especially regarding infrastructure.[332] An urgency and consciousness for sustainable development motivates local governments to set up challenging programs for achieving a sustainable future and, despite intense competition, to cooperate with each other. International city networks like United Cities and Local Governments (UCLG) or more general alliances like The Climate Group or the Clinton Global Initiative motivate cities to engage in climate change projects, urban renewal and other fields of sustainable development. Cities try to outperform each other in terms of quality of life, infrastructure development and innovation. While some municipalities in emerging countries even develop completely new towns which follow high standards of emissions, resource use and equality (e. g. Masdar/United Arab Emirates, Dongtan/China) communities in Europe will be limited to redeveloping individual quarters.

[331] EEA 2006:11
[332] GlobeScan 2006:28

City officials increasingly acknowledge that technology or infrastructure fixes alone will not solve their cities' problems and therefore focus on "soft factors" like urban creativity, social equality, or education.[333] This requires letting go of obsolete approaches to financing, governance, and management and is done so increasingly by new methods of urban governance which include citizen participation and the informal sector.[334]

Outlook to 2020

- Cities will continue to be the dominant settlement pattern in EU-15.
- Despite a general reurbanisation trend in the EU-15, suburbanisation will continue to prevail in cities of all sizes.
- Urban infrastructures will continue to consume large financial and natural resources.
- Urban governance is likely to move into the postmodern era.

Implications for mobility services

- An urban environment is conducive to multimodal behaviour.[335] As 80 % of OECD population lives in cities the market for multimodal and intermodal mobility services should be large.
- Urban densities make car ownership and use less necessary and less attractive. Individuals might therefore opt for alternatives for individual travel, e. g. public fleets or public transport.
- Shrinking cities: In areas where large public transport networks are no longer efficient, neither financially nor environmentally, individually tailored mobility services will be demanded by those who have no access to a car.

3.3.2. Demographic change

Definition:

Demographic change describes changes in the size (quantity) and composition (quality) of a population.

Description:

Demographic change in the EU-15 countries is characterised by three major trends until 2020: Declining population sizes, ageing population and an increase of the immigrant population.[336]

Declining population: Despite a growth in world population from 6.7 billion (2008) to 7.7 billion (2020) and even 9.1 billion in 2050 (UN medium estimate), the population in developed regions will grow at a much slower pace or even decline in some countries.

[333] Korff 2007:5; Landry 2008
[334] Doshi 2007:4
[335] Beckmann 2005; Grünig/Marcellino 2009
[336] If not indicated otherwise, all data on demographic change in this chapter are derived from Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2008 Revision*, http://esa.un.org/unpp

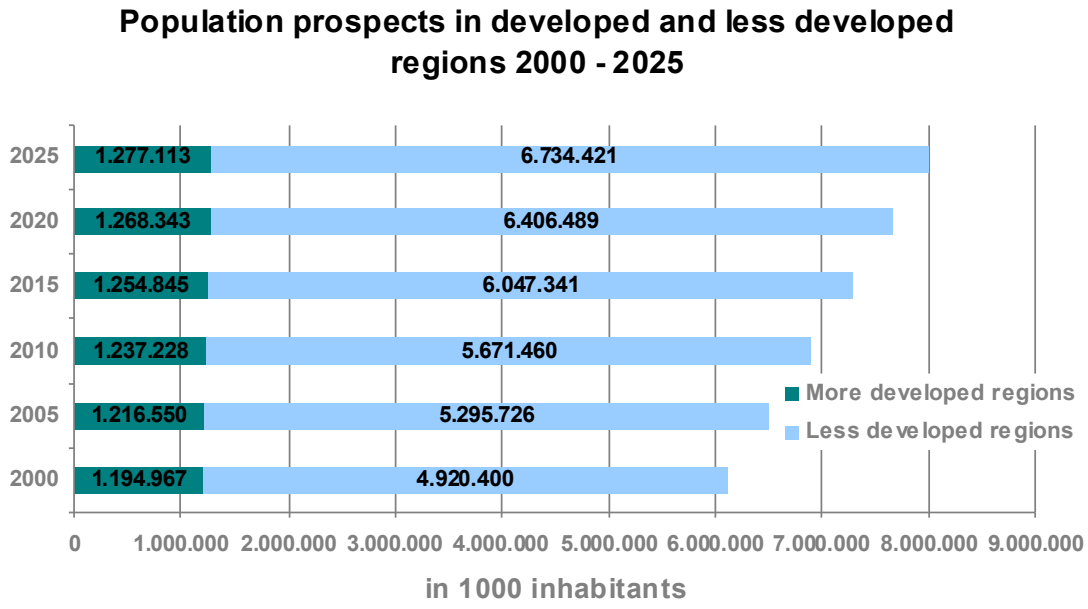

Figure 40: World population prospects

Despite a general stagnation in population growth in developed regions, there are large variations from country to country:

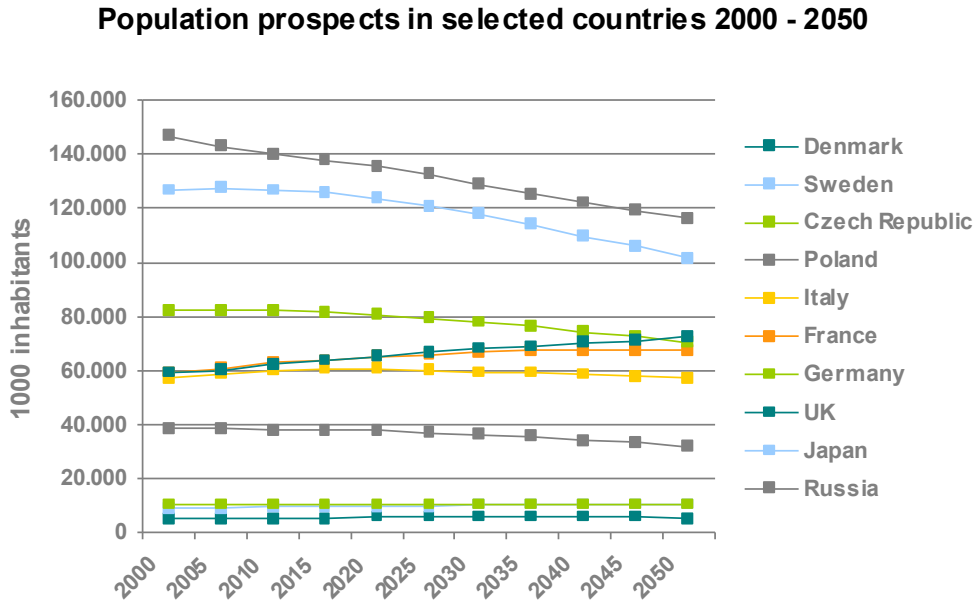

Figure 41: Population prospects for selected countries

Population will decrease the most in the countries of Eastern Europe and in Japan. It will grow slightly in Sweden, the UK and France. A significant exception is the population in the

US, which will experience massive growth from 300 mio in 2005 to 346 mio in 2020 and even 403 mio inhabitants in 2050, most of it generated by immigrants of hispanic origin.

Ageing population: The ageing of the population is caused by two factors:

1. Increasing life expectancy: On a global average, life expectancy will rise from 66 years today to 75.4 years in 2050. In developed regions it will rise from 76 years today to 83 years in 2050.

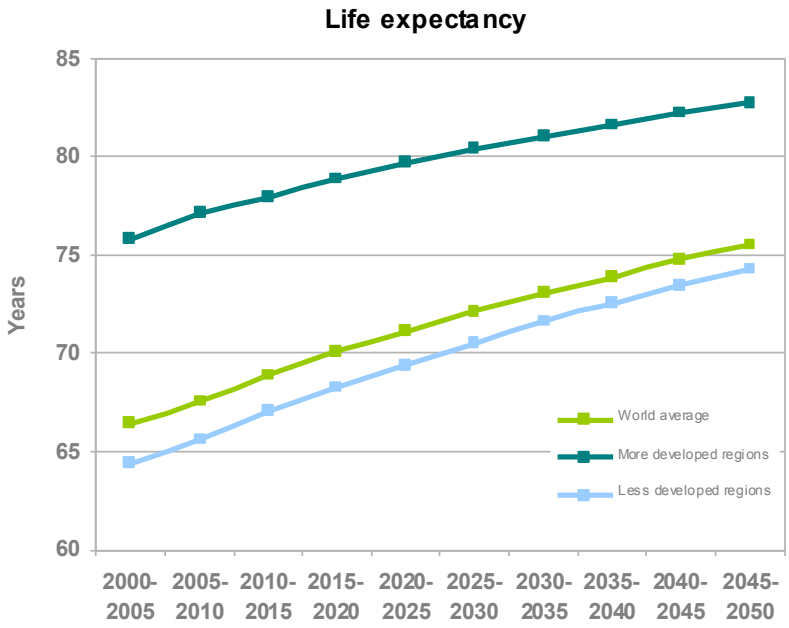

Figure 42: Life Expectancy

2. Low birth rates: Most industrialised countries have fertility rates far below the replacement ratio of 2.1 children per woman. The slight growth until 2050 (which causes it to converge with the high, but declining fertility rates of developing countries) will hardly prevent the overall ageing and shrinking of the population.

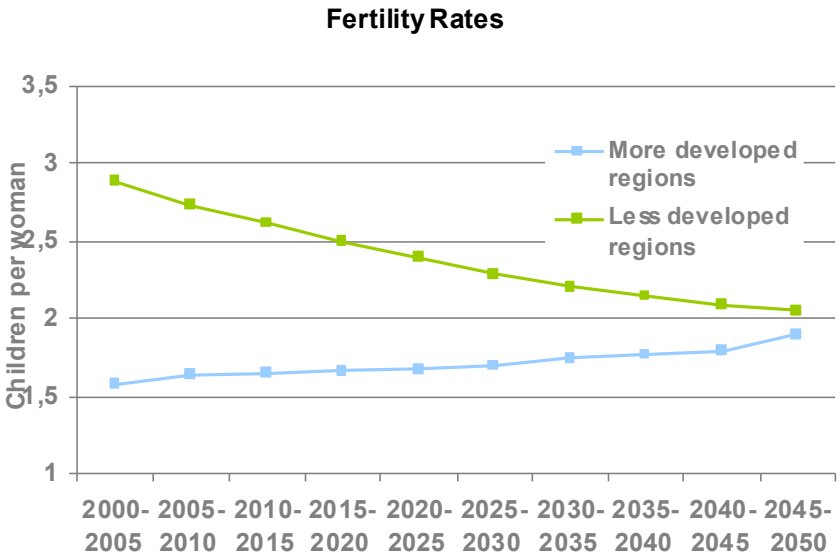

Figure 43: Fertility rates

Both factors result in a growing median age (37.3 years in 2008 to 41.9 years in 2020 and 44.1 years in 2030) and a higher share of elderly people. As a result, the share of the working population (25-59 years) decreases from 48 % in 2000 to 41.5 % in 2050, putting major stress on social systems and innovation capacities.

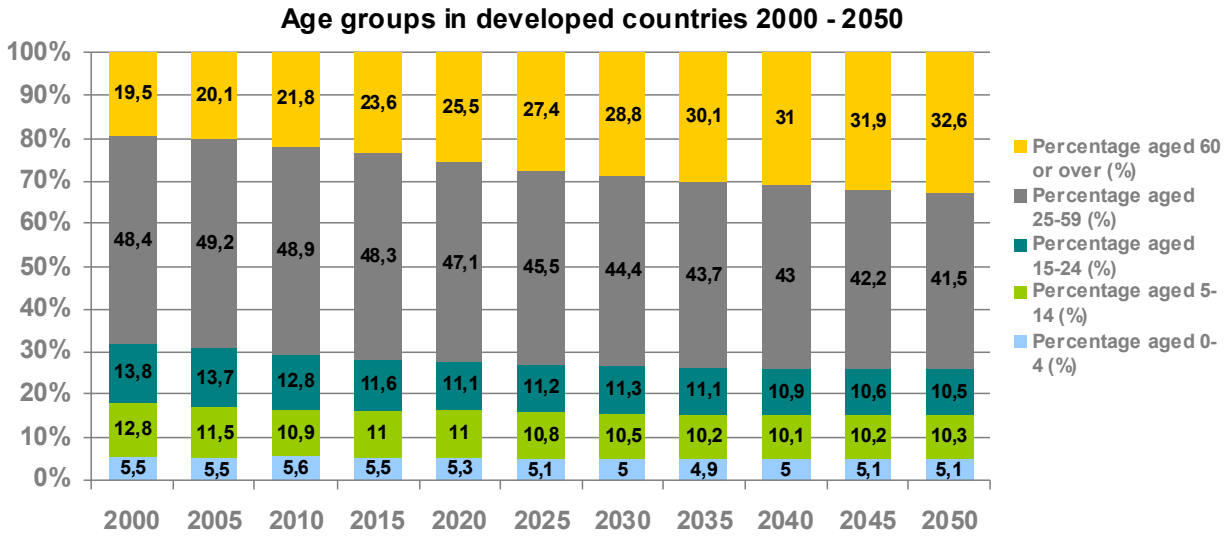

Figure 44: Age groups in developed countries 2000–2050

Migration: Developed regions receive most of the migrants around the world. 10 per cent of the inhabitants in developed countries have a migration background.[337] It is expected that the influx of highly skilled immigrants into developed countries will increase. Depending on to "what extent the European Union will be able to attract migrants with sufficient qualifications from outside Europe [...] migration might be helpful in balancing short-term shortages on the labour market".[338] But migration is not a cure-all for the ageing, shrinking countries of the West. The only exception is, as already stated, the US which will experience massive population growth due to high immigration from Central and Latin America, most notably Mexico. The countries with the highest migration rates are in the Caribbean, Latin America, and in the post-socialist transitional states. These countries are neither the poorest nor the fastest growing countries but they are all located in areas of social and economic integration

The effects of demographic change (ageing, decreasing population) and individualisation are contradictory (see table below). Despite a declining absolute population car ownership rates will rise due to higher mobility of aged people and to smaller households. Growing social disparities will split the population more and more into captive riders and privileged global travellers, the latter of them causing much higher externalities than the former.

Impacts of demographic change on transport infrastructure and mobility	
Decreasing overall population, decline of younger population (0-18 yrs)	• Lower capacity loads due to lower share of students • Increase of population with driving licence • Public transport becomes less profitable
Ageing population, increase of very	• Future silver agers have higher car ownership rates

[337] UN 2006
[338] Frouws/Buiskool 2010:1

old people	• Growth of household-oriented services
Increase of small households (1-2 persons)	• Growth of car ownership rates • Growth of trips/person • Decrease of car occupancy rates

Table 9: Impacts of demographic change on transport infrastructure and mobility[339]

Outlook to 2020

- With the exception of UK, France, Denmark and Sweden, all EU-15 countries will experience a decline in their population, leading to a total population decrease in the EU-15 region.
- Ageing society: The share of elderly increases due to low fertility rates and rising life expectancy.
- Immigration will relieve population decline only slightly.

Impact on mobility services:

- Lower capacity loads in public transport due to the decline in the younger population might lead to a decreasing supply in public transport. This calls for individually tailored mobility services.
- Mobility services will need to respond to the needs of the older generation.
- High access to vehicles and driving licences due to cohort effects[340] supports the pervasive use of cars. Cars will remain a stable element of urban mobility but the way they are used, taxed, and appropriated will change.

3.3.3. Mobility behaviour

Definition:

Mobility behaviour is concerned with the different ways and manners in which people realise their mobility needs and desires, including the factors influencing their choices and attitudes.

Description:

Introduction

Mobility behaviour finds its expression mainly in mode choice, but also in distances travelled, in the number of trips taken and the point of time for a trip chosen by an individual. This is the mid-term aspect of mobility and will be the focus of this chapter. Aspects of short-term mobility behaviour (e. g. driving style, speed) will not be addressed, and long-term aspects (e. g. choice of residential area, purchase/ownership of vehicles) will play only a secondary role.[341] Various factors on the macro- and micro-level influence mobility behaviour and attitudes.[342] Individual attitudes and habits are important factors in transport and business planning as

[339] BMVBW 2004, Canzler 2009:14
[340] Beckmann 2005:125
[341] On the hierarchic structure of mobility behaviour see Schade/Schlag 2007:28
[342] Nuhn 2006:329, 331; Grischkat 2008:47f.; for a detailed list see chapter 2.3.3.1

they can be a main barrier to implementing innovative solutions.[343] Today's society is marked by parallel mobility needs (or forces) and mobility opportunities.[344]

Significant trends in mobility behaviour

Today's mobility behaviour is marked by the following trends:

Saturated car markets: The car markets of Europe are mostly saturated with the exception of the countries in transformation (Eastern Europe).[345] Car ownership rates are growing only slowly, mainly due to smaller household sizes and higher flexibility needs.

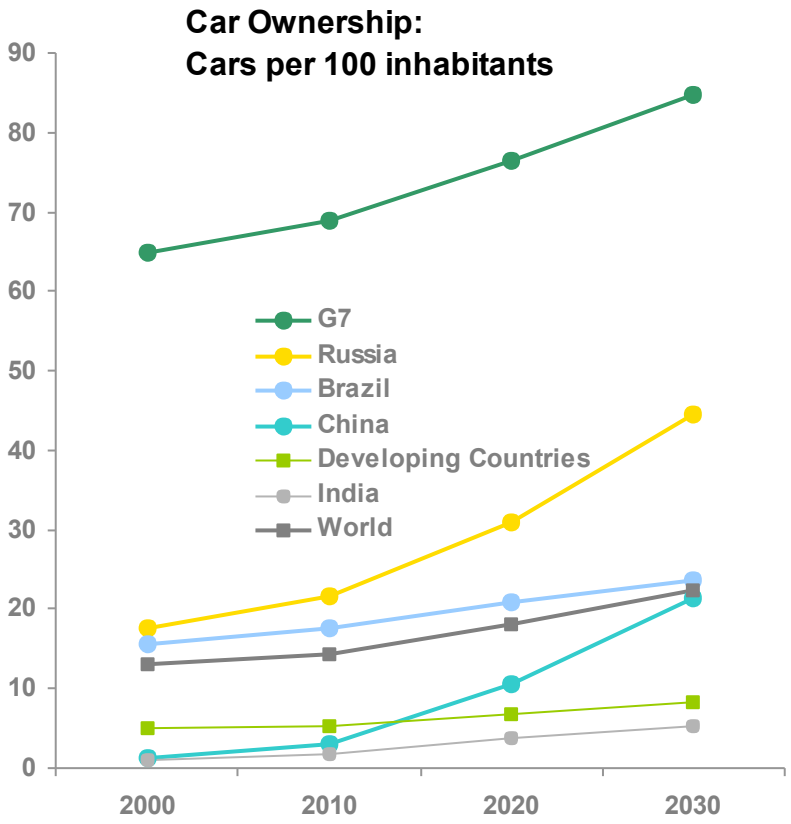

Figure 45: Car ownership forecast by region[346]

[343] Kennedy 2005:395
[344] Tully 2007:36
[345] EEA 2008:23
[346] OECD 2006

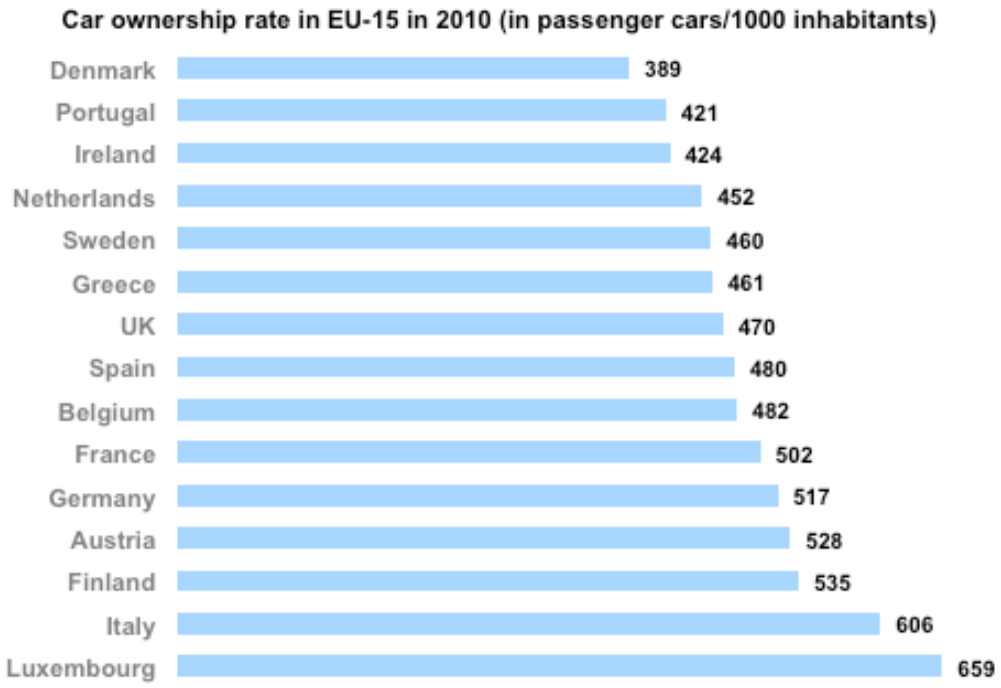

Figure 46: Car ownership rate EU-15 (2007)[347]

In the EU-15, car ownership ranges from 349 vehicles/1000 vehicles (Greece) to 638 vehicles/1000 capita (Luxembourg).

Multioptional mobility: Individuals vary their mode choice, destinations, trips, and trip lengths much more often.[348] Flexibility requirements of the society and the labor market force people to behave multioptionally.[349] Meeting these requirements can be facilitated by real-time traffic information and by integrated mobility services.

Stable modal split shares: Over the course of time, modal split shares have remained rather stable due to habitualised mobility behaviour.[350] Yet, individual modes are experiencing smaller increases because car travel is loosing shares to NMT (which is considered as an individual mode) and public transport is struggling to retain its shares.[351] Significant variations only occur when strong policies are implemented (e. g. zoning, tolls), when prices increase significantly (esp. gasoline prices, but also public transport fares), and when new infrastructure solutions are introduced (e. g. new underground lines, improved bicycle lane networks). On the individual or household level, behavioural changes can only be achieved during significant life-changing events like job change, relocation, or changes in marital status and household size.

Growing mobility needs: The total mobility activities in EU-27 have been growing by 21 % from 1995 to 2010 (1.3 %/a), while the modal split has remained more or less the same (relative to the total passenger kilometres, see figure below). Absolute passenger car use grew by 22 % between 1995 and 2010, its share of total passenger transport remaining at around 74 % in the same time period (EU-25).[352] Metro and tram grew by even 27 %, their share remaining by around 1.4 %. The largest increase was noticed in air travel which grew by 51 % and was able to increase its modal split share from 6.5 to 8.2 %.

[347] European Commission 2012
[348] Axhausen 2006:16
[349] Tully 2007:139
[350] For current modal split share see Figure 19 (p. 51).
[351] infas 2009
[352] European Commission 2012

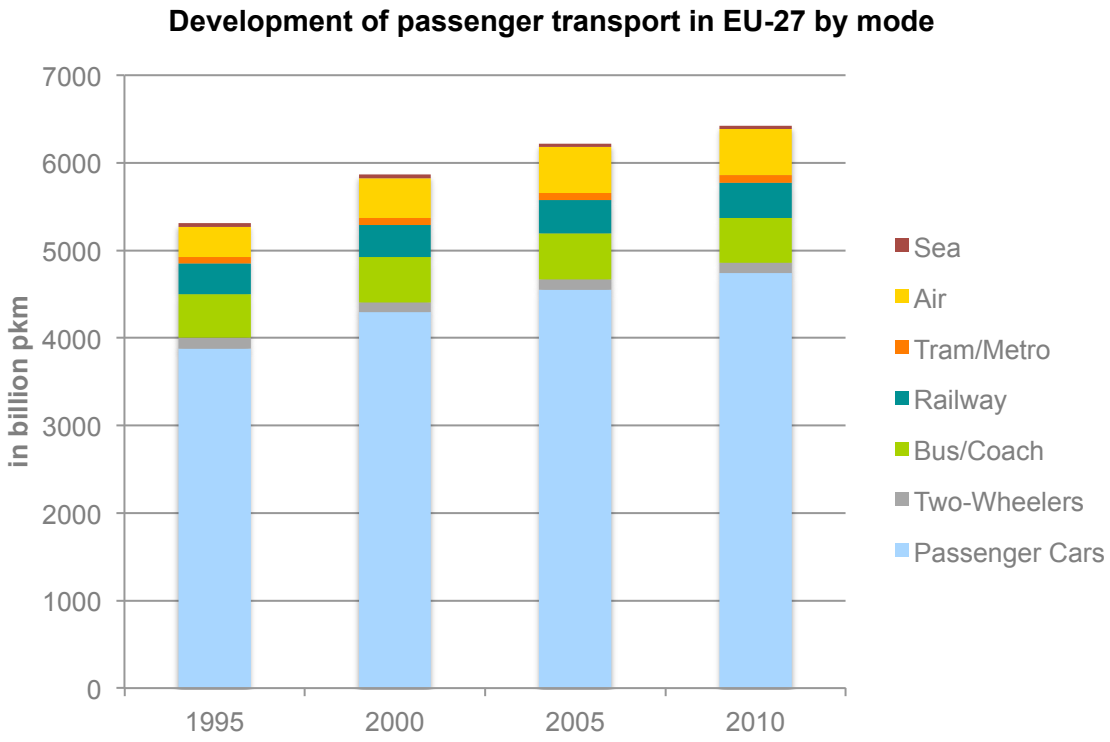

Figure 47: Passenger transport – modal split development in EU-27 from 1995 to 2010[353]

There are, however, substantial regional differences. In EU-15, rail transport volume grew by 17 %, while it decreased by 49 % in the new Member States (1995 to 2005). A similar trend was observed for bus transport where EU-15 Member States saw a growth of 10 %, whereas EU-12 saw a decrease of 11 % between 1994 and 2004.[354] Total passenger travel in OECD countries by motorised modes is projected to increase by around 35 % until 2050, while travel per capita is expected to rise by only 20 % (from 16,000 pkm/a in 2005 to 20,000 pkm/a in 2050).[355]

The main causes are flexibility needs (for professionals) and dispersed settlement patterns, but also technology which enables easier and faster travel.[356] Related to use cases, passenger transport kilometers for leisure are growing the most while volumes for educational and work trips are stabilising. In the EU, the total passenger kilometers amounted to 6,277 billion in 2008.[357] On average, more than two thirds were attributable to transport by passenger cars (see following figure).

[353] European Commission 2012
[354] EEA 2008:14
[355] IEA 2009:203
[356] Banister 2005:65
[357] European Commission 2009

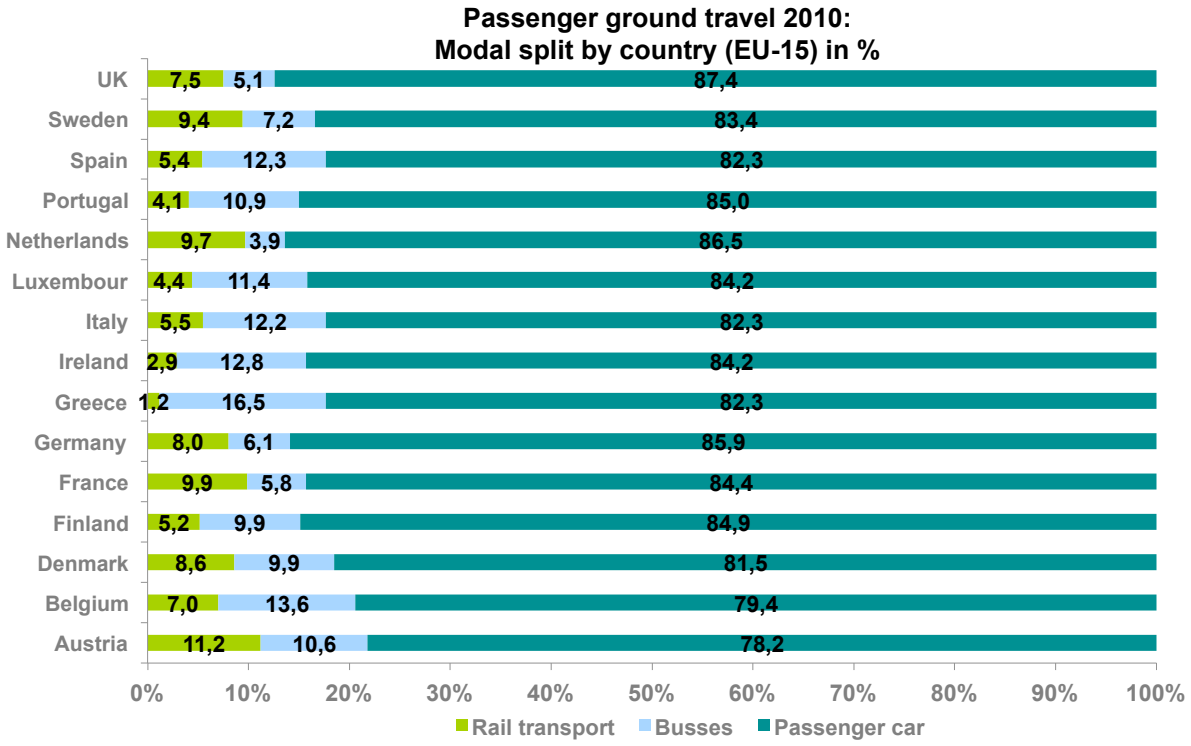

Figure 48: Passenger ground travel – modal split in the EU-15 (2010)[358]

Rising household expenditure on transport: Household expenditures for transport in the EU are rising as are shares for communication, housing, recreation and health but contrary to shares for food and clothing.[359] Disposable incomes influence the choice of modes, number of trips and trip lengths. In the EU-15, the middle class is shrinking while the fringes are growing.[360] With other expenses rising, disposable incomes for mobility which are at 15 % of household budgets are likely to shrink.[361] With rising fuels prices expenses for vehicle purchase need to be limited, illustrated by the rising share of low-cost vehicles and the decreasing disposition of customers to pay surcharges for technological innovations.[362]

Constant travel time budgets: Individuals invest travel time saved by technology or infrastructure improvements in travelling longer distances.[363] Individual travel time budgets have remained at a constant 90 minutes during the course of human history (so-called "Marchetti constant") and are not expected to change significantly (see Figure 49).[364] In cities, especially growing megacities or rapidly sprawling ones, where the travel time budget for an increasing proportion of people can be exceeded, people may adapt by moving closer to their work or finding a better transportation option.[365] Transit oriented development and re-densification of cities, two concepts adopted by an increasing number of cities in Europe and, surprisingly, North America, help to reduce travel time.[366]

[358] European Commission 2012
[359] EEA 2007:252
[360] Canzler 2009:14
[361] Metz 2008:104
[362] Baum/Hüttenrauch 2008:63
[363] Borken/Fleischer 2006:35
[364] Metz 2008; UBA 2010:24; Gather/Kagermeier 2008:174
[365] Newman/Kenworthy 2007:71
[366] Kenworthy 2009:4

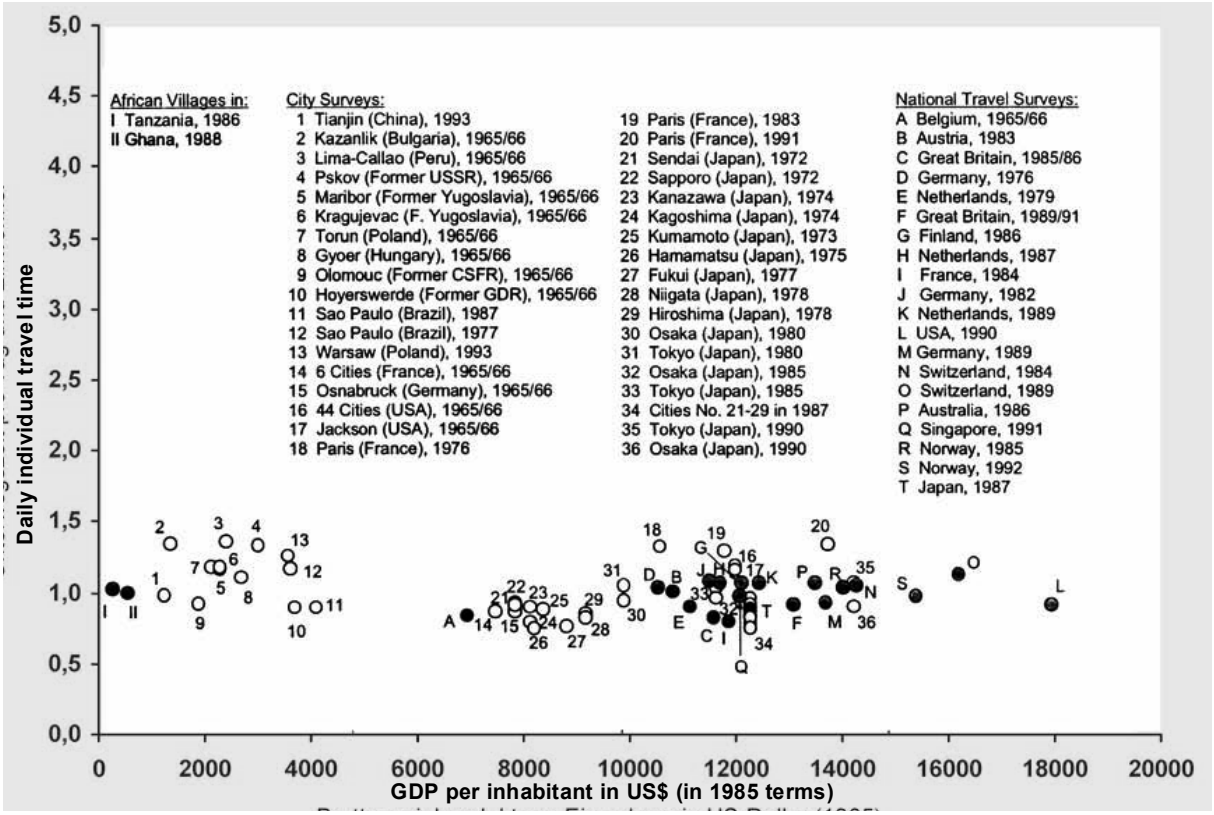

Figure 49: Travel time budgets and GDP over time[367]

Changed preferences: The factors which determine mode choice, trips and trip lengths change over time. Time, costs, and quality/comfort are top on the list, but priorities change.[368] Currently and in the future, environmental concerns and financial restraints will compete for the pole position.[369] Economic hardship automatically puts costs on the top of the list but inertia and routines prevent frequent changes in mobility behaviour.[370] Environmental concerns cause car owners to be more open to changing driving habits and environment friendly vehicles but barriers like additional costs and a negative image of car alternatives prevent fundamental, wide-ranging changes.[371]

The mentioned trends result in chronologically rather constant, but geographically and individually highly disparate mobility behaviour patterns. Any figures and indicators used for describing mobility behaviour therefore need to be on the city level or according to socio-economic groups.

Cultural significance of the car

The car as a transport mode has a specific function in the analysis of mobility behaviour. Its role as a symbol and indicator for individual and collective progress and wealth has shaped the attitude of modern society towards cars.[372] Recognising its adverse impacts (see chapter 2.2.2), individuals, planners and businesses are slowly changing their attitudes towards the car. A survey among 5000 European car owners in 2009 found that

[367] Schafer 1998:459
[368] Götz 2007:764
[369] Ipsos 2009:7
[370] Canzler 2008:161
[371] Engel 2008:194
[372] Rammler 2008:70

- the majority (93 %) likes owning a car because it provides freedom and independence, but 3 out of 4 drivers consider owning a car to be very expensive (10 % even consider it not reasonable)
- over 90 % have altered driving habits for cost-related reasons: 70 % had altered the way they drive, and 60 % decided to use their car less
- 4 out of 10 consider giving up their car within the next year, 83 % for economic reasons and 48 % for environmental reasons
- 41 % of car owners can imagine a life without a privately owned car, half of them opting for multimodal travel including car rental or sharing while the other half would organise their mobility exclusively by public and non-motorised transport.[373]

A paradigmatic change in the cultural significance of the car can be observed. The most prominent change is the general departure from an emotional, status-oriented attitude to a rational, functional attitude towards the car.[374] Attitudes towards the car are slowly switching from "modern" which embraces speed, progress and technology to "post-modern" which attempts to find a balance between technology, humanity and nature, as the following table shows:

Modern attitudes	**Post-modern attitudes**
The car as the dominant "leitbild" of mobility[375]	Multiple "leitbilder" of mobility
Car dependency	Multimodality
Power, top speed	Efficiency
Size, quantity	Adequacy, small is beautiful, quality
Luxury equipment	Networked IT infrastructure
Ownership	Use
Emotional	Functional, rational
Status	Understatement

Table 10: Attitudes towards the car – past and present

Fuelling this paradigmatic shift are mainly the observed trends in mobility behaviour above. It has to be kept in mind though that the underlying attitudes and behaviour patterns are rather constant and will not change significantly very soon except drastic changes in external factors, esp. regarding costs and regulations, occur. Last but not least, even more drastic changes in behaviour will likely be overcompensated by growing needs for travel.[376]

Outlook to 2020

Despite some minor changes in mobility behaviour – intermodal transport, lower importance of car ownership – the leitbild of automobility will not be eliminated from European society until 2020.[377] This is mainly due to structural factors like job flexibility and urban settlement patterns (suburbanisation). However, the share of multimodal users will increase.[378]

Impacts on mobility services

[373] Ipsos 2009
[374] Gaide 2009; Hunsicker/Karl 2008:23; Baum/Hüttenrauch 2008:63
[375] Canzler 2006:18; Rammler 2005:3; Schellhase 2000:273; Dierkes 1998:23
[376] Adams 2000:106; Martin 2009:227
[377] Kruse 2009; EEA 2008
[378] Beckmann 2005:87; Canzler/Hunsicker 2007:6

- Mobility services should serve multioptional behaviour, i. e. allow for flexible, convenient switches in travel mode, destination, and trip length.
- Mobility services are attractive to the post-modern society as they pronounce use over ownership and functionality over emotional attachment.
- Constant or even slightly increasing shares of individual travel mean that the need for cars and car travel will not decrease.
- Mobility services need to mirror and address common mobility behaviour. They need to blend in with acquired routines.
- Mobility services need to offer an added value for individuals and not just figure as an adequate substitute.
- They need to be designed for specific user groups because the average customer does not exist.
- Because the status value of a (privately owned) car is on the decline car usage and ownership will drop slightly and alternatives become more attractive.
- As in other sectors, people will focus more on the service a product provides than on the product itself.[379] Mobility will be perceived as a means to an end and not as an end in itself. This increases the demand for and attractiveness of mobility services which function without vehicle ownership.

3.3.4. Vehicle technology and portfolio of car manufacturers

Definition:

This factor describes future developments within the automobile industry, especially the future range of products and services offered by car manufacturers (segments, bodystyles, service packages etc.), the development of drive trains and fuels and the integration of information technology into vehicles.

Description:

Vehicle technology and the automobile industry are characterised by a high level of innovation dynamics. The average lifecycle of car models shrank from 4 years in 1987 to 2.5 years in 2005.[380] This rapid product replacement is fuelled by technology development, regulation/policy, and consumer demands. The resulting problem is the "hypermobility"[381] generated by innovation: "Over 30 per cent of the costs of any new vehicle are related to technology and this will increase."[382]

Portfolio: Segments and body styles and new business areas

The development of car manufacturers' portfolios is characterised by a) a further differentiation of portfolio strategies of individual OEM with a continuing increase in body styles, especially crossover styles, and drive trains, b) a consumer-demand derived growth of the lower segments, and c) an expansion of the value chain towards front-end processes which include services. Competition will be won more by design and management aspects than mere product characteristics; at the same time, consumers are seeking for more rational, efficient cars. Merging these opposite requirements or responding to both independently will be the

[379] Böhler/Hunecke 2008:31
[380] Radtke 2004
[381] Adams 2000; Adams 2001; Bruun 2010:6
[382] Banister 2005:65

main challenge of the next car generation.[383] Already, there are some car manufacturers which address special needs by offering e. g. low-cost, low-tech cars. Low-cost car sales (< 6.000 €) in 2020 are expected to be eight times as high as in 2009, most of which will be sold in non-OECD countries.[384]

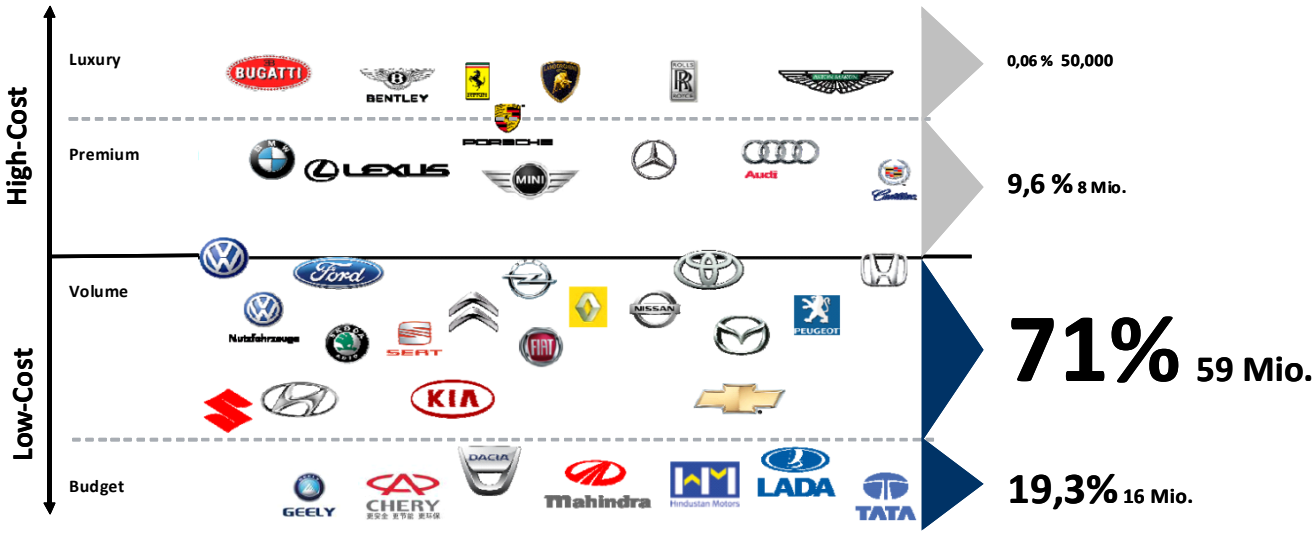

Figure 50: Price segments in the automotive market (vehicles sold in 2008)[385]

Product-related (e. g. financing, insurance) and value added services (mobility guarantees, routing, integrated mobility services etc.) will experience a significant growth in the coming decade as return on investments in the vehicle production phase are much lower (8 %) than in the service phase (46 %).[386] Until now, no clear path regarding service range, pricing, and organisational aspects can be identified. The development will depend on the activities of major players in the business, some of which may come from outside the automotive industry as value-added services will also address other modes of travel and therefore need to include and integrate different mobility providers.

Drive train technology

While internal combustion engines (ICE) dominate the drive train portfolio of today's cars, tomorrow's drive train portfolio will diversify. The individual share of each technology will depend on costs, policies, and fuel supply. By combining drivetrain efficiency technologies, hybrid engines, alternative fuels, change of vehicle design, and also intelligent information systems that support modal split the quality of transport will be improved and its negative impacts on the environment will be reduced. With absolute numbers in transport growing steadily, these efficiency gains are likely to be overcompensated though.[387]

[383] Baum/Hüttenrauch 2008:99f.
[384] AT Kearney 2008
[385] AT Kearney 2008
[386] Focus 2008:35; for more details see chapter 1.1
[387] Metz 2008:20; Borken/Fleischer 2006:5; Martin 2009:227

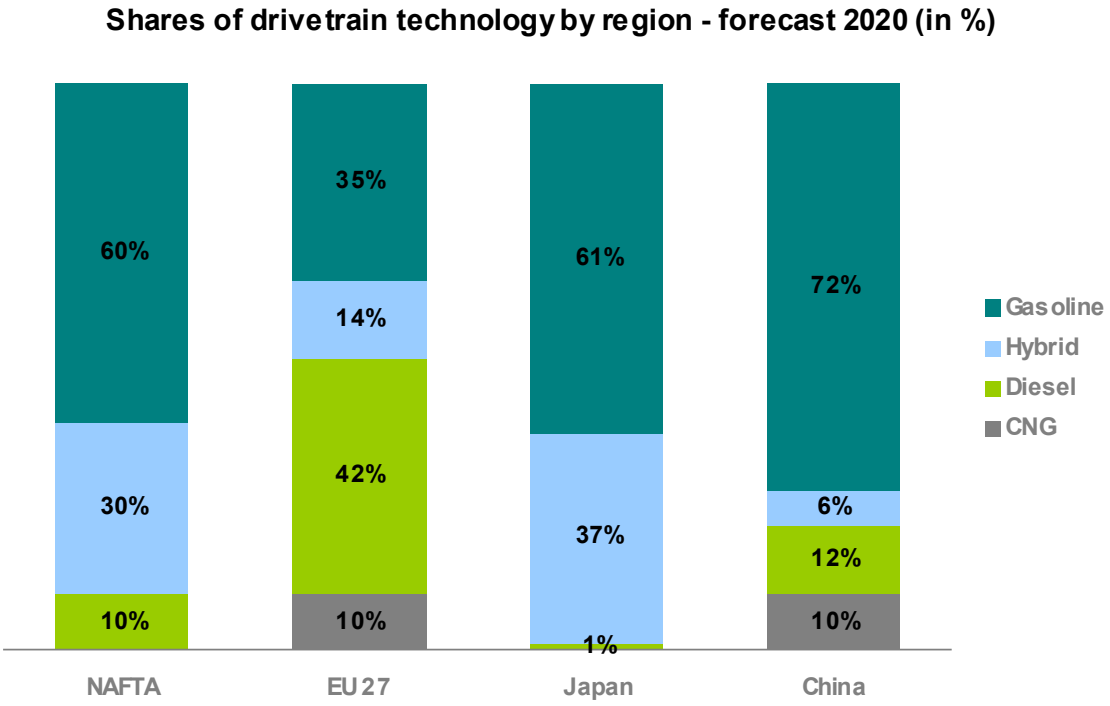

Figure 51: Forecast of drive train technologies in 2020[388]

All major car manufacturers are "going green" because they expect huge market potentials and savings.[389] Due to government regulations esp. in EU and Japan the car industry will significantly improve the fuel efficiency in petrol and diesel cars in the near future. Diesel fuels, which constitute 50 % of the car fleet in Europe, are becoming cleaner through improved NO_x burners and improved diesel fuel with low sulphur content. The highest gains in fuel efficiency and environmental performance are possible when engine, fuel and vehicle construction and design (like ultra-light weight, ultra-low drag design) improvements are combined. As ICE technology will dominate the car market for the decade to come, improving its efficiency will remain a core research field of automotive R&D. Gasoline engines still can gain 26 % in efficiency by engine and autobody downsizing and by introducing Homogenous Charge Compression Ignition.[390]

[388] Winterhoff 2009
[389] Bratzel 2008:2
[390] Fischedick/Ott 2006:60

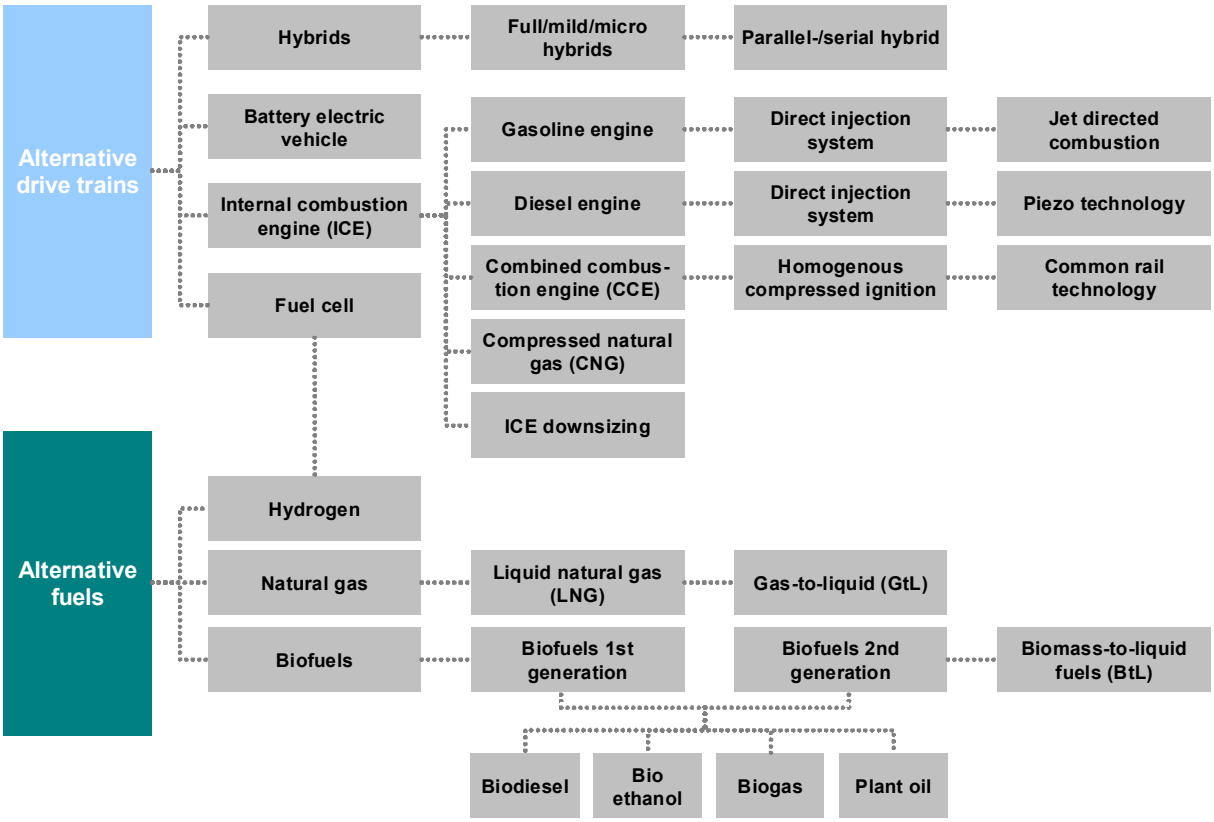

Figure 52: Alternative drive train and fuel technologies[391]

The most important alternative fuels and drive train technologies discussed for the future are:

Battery electric vehicles (BEV): Currently, governments and manufacturers favour battery electric vehicles (BEV) as the future drive train technology for road vehicles. The main motivation is the potential of BEV to decrease the dependence on fossil fuels and their zero-impact on local emissions. Other emissions, like CO_2 in the energy generation process, depend on the energy portfolio used. With a conventional energy mix, they undercut average CO_2 levels of ICE powered vehicles (75–80g/100 km vs. 165g/100 km) but will not contribute significantly to climate protection unless an alternative energy mix is used to power BEV. Critical factors, also from the customers' perspective, are range and costs of the batteries, as well as new infrastructure required.[392] Advanced diesels with CO_2 emissions below 100g/100km will present strong competition to electric vehicles in the coming years. Governments have introduced large programs to support BEV development, amounting to several billion dollars, in order to achieve a breakthrough in technology development and to optimise the political framework conditions for BEV (see Table 11) even though there are other more cost- and resource efficient solutions to lower vehicle emissions.[393] Currently, all EU-15 countries provide tax incentives (including tax reductions and exemptions, as well as bonus payments for buyers) for BEV. In 2011, 0.9 % of vehicles in Western Europe were BEV (11,563 vehicles total), with France and Germany leading the count.[394] However, their share in new registrations was much lower, as the numbers for the major vehicle markets in Figure

[391] PWC 2009:90
[392] Kucz [forthcoming]; BCG 2010:10; Wallentowitz 2010:161
[393] European Commission 2009
[394] AID 2012

53 show. Electrified vehicles are expected to have a 10% higher CAGR growth rate than the overall vehicle market between 2011 and 2017.[395]

Country	Incentives for vehicle buyers	Programs for R&D, infrastructure, framework conditions
Germany	• Exemption for BEV from the annual circulation tax for a period of five years; no sales subsidies	• National development plan "Electric mobility": Funding for research and charging stations with the objective to have 1 mio. BEV on the streets by 2020 (funding volume 2009–2013: 700 mio €)
France	• 5.000 € premium for vehicles emitting less than 60 g CO_2/100 km	• 400 mio € (2008-2012) for zero-emission vehicle R&D • Nationwide construction of infrastructure for BEV (cooperation Electricité de France and Renault-Nissan) • Public procurement: government and 6 large companies intend to purchase 100.000 vehicles • Paris: public vehicle fleet AutoLib with electric vehicles (2010)
GB	• BEV are exempted from the London congestion charging scheme. • In 2011, GB started a plug-in car grant, providing a 25% grant towards the cost of new plug-in cars capped at GB£ 5,000 (volume of the grant scheme: 43 mio GB£)	• Pilot project: BEV provision for sample users • Public procurement: small BEV-trucks for state-owned companies • Financial aid for low-emission vehicle R&D at universities
Italy	• € premium for BEV and HEV • Electric vehicles are exempt from the annual circulation tax or ownership tax for five years; after that, EV benefit from a 75% reduction of the tax rate	%
Sweden	• 880 € premium for "green" (includes BEV) vehicles • "green" vehicles are exempted from vehicle tax for 5 years beginning 2010	%

Table 11: National development schemes for sustainable drive train technologies in selected OECD countries[396]

[395] Pike Research 2011
[396] European Commission 2009

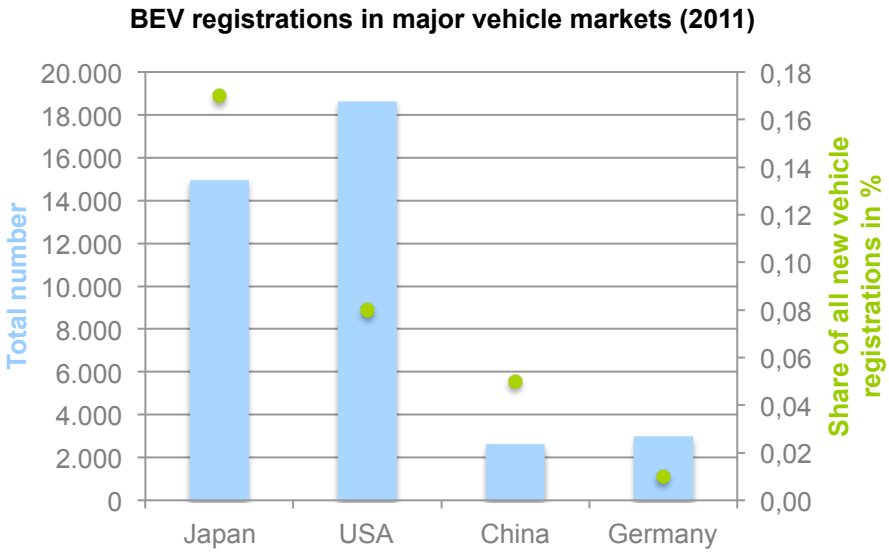

Figure 53: Electric vehicle registrations 2011[397]

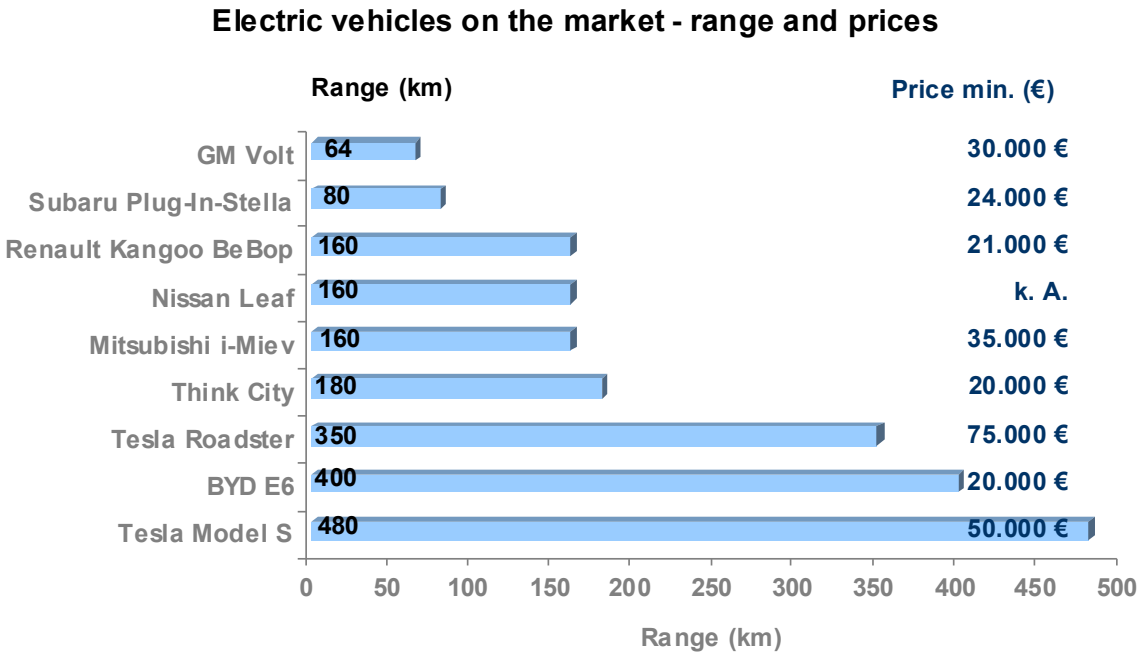

Figure 54: Range and prices of electric vehicles on the market 2009[398]

Hybrids: Improving fuel efficiency dramatically, Hybrid Electric Vehicles (HEV) and Plug-in Hybrid Electric Vehicles (PHEV) have the potential to curb carbon emissions by half. HEVs like the successful Toyota Prius combine an electric-drive engine with an internal combustion engine, using surplus electricity in the car. PHEVs rely on stored charge for short trips and revert to gasoline when the battery is depleted. Both HEVs and PHEVs optimise energy use

[397] Handelsblatt 2012
[398] FAZ 2010

in city traffic where most of the daily rides take place. Challenges still exist in improving battery efficiency and longevity, but research is ongoing and promising. Likewise, the cost of batteries is expected to drop as they enter mass production. In Europe, only 60.000 HEV were sold in 2008, compared to 300.000 in the US (200.000 of them Toyota Prius and Camry).[399]

Biofuels: Fuel derived from organic biomass is a substitute for fossil fuels. On a global scale, biofuels had a share of 4 % of transport fuels in 2010, up from 1 % in 2007.[400] This share was the same in the EU in 2010. However, while the share will remain the same globally, it is expected to double (to 8 %) in the EU by 2020, even though the EU was not on track yet for a 5.75 % biofuel share in 2010.[401]

As the GHG emitted by biofuels corresponds to the GHG bound during the growing process they are considered to be climate neutral. Their efficiency and climate balance depends on the type of raw material used.[402] Yet, recent studies suggest that GHG emissions by biofuels, depending on the type, may range above zero because land-use and land-use change (LU-LUC) effects affect the carbon balance negatively. Together with the danger for competition for land with the food sector, biofuels are not per se a sustainable option. Second generation biofuels from residues or cellulose are more promising, not only regarding their eco-efficiency but also resource and cost efficiency.[403] Some Biofuels can reduce GHG emissions significantly, e. g. biogas by 75 % or second-generation biofuels.[404] But: whatever their savings on GHG emissions, biofuels will be no substitute for fuel efficiency.[405]

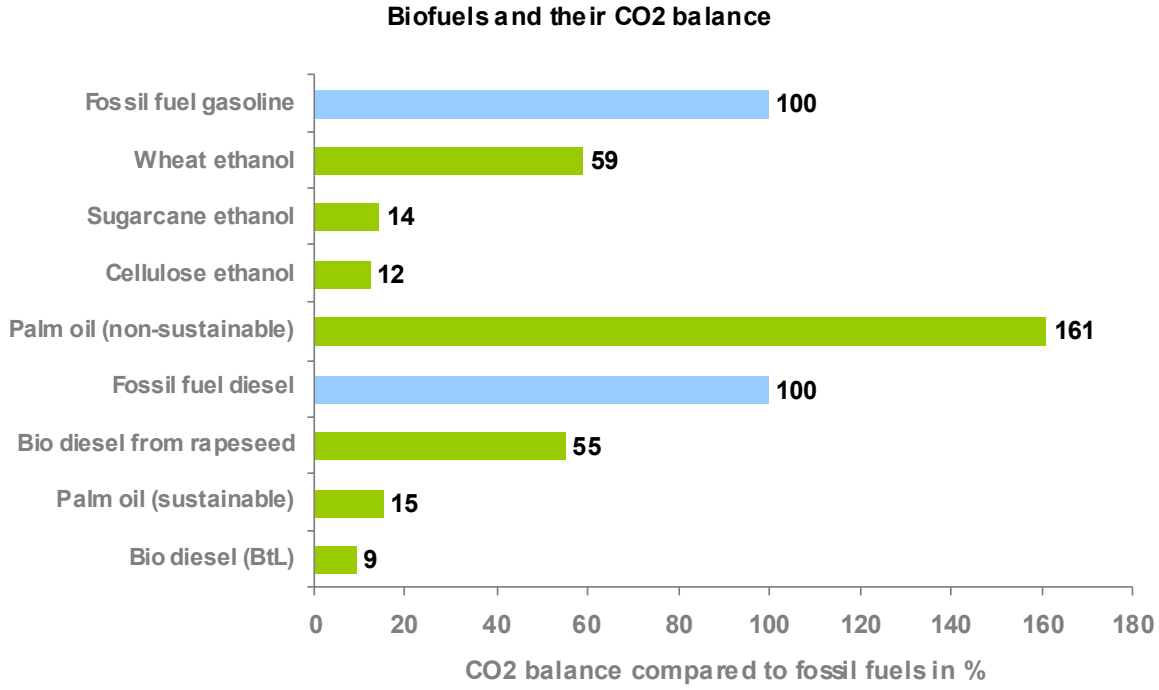

Figure 55: CO_2 balance of biofuels compared to fossil fuels[406]

[399] US Department of Energy HEV Sales by Model http://www.afdc.energy.gov/afdc/data/docs/hev_sales.xls
[400] IEA 2012:552
[401] EEA 2008:20
[402] Fischedick/Ott 2006:52; Bräuninger/Schneider 2009:29
[403] IEA 2009:70; Bräuninger/Schneider 2009:29; EEA 2008:20
[404] EEA 2008:5
[405] Leifheit/Krinke 2009; Bräuninger/Schneider 2009:48; EEA 2008:20
[406] Bräuninger/Schneider 2009:30

Coal-to-Liquid (CtL): Liquefied coal has lifecycle greenhouse gas footprints that are generally greater than those released in the extraction and refinement of liquid fuel production from crude oil. This is an alternative discussed heavily in China where transport fuel demand is rising sharply and coal resources are abundant. It has also been widely used in South Africa which due to its rich coal resources used it to compensate for fuel shortages during apartheid embargo times. Currently, it is not an option discussed in the EU.

Hydrogen: Hydrogen is not a fuel but an energy carrier. Hydrogen-powered vehicles convert the chemical energy of hydrogen to mechanical energy either by burning hydrogen in an internal combustion engine, or by reacting hydrogen with oxygen in a fuel cell to run electric motors. There would be no pollutants emitted during the combustion process. The production of hydrogen is highly energy-intensive and is usually generated by fossil fuel plants; however, it could also be potentially generated by renewable energy plants, thus eliminating GHG emissions of transport. Besides the energy inefficiency of hydrogen production, other drawbacks of hydrogen are the low energy content per unit volume, high tankage weights, the problems associated with storage, transportation and filling of gaseous or liquid hydrogen in vehicles, and the enormous investments in infrastructure that would be required to fuel vehicles. Opponents of the "hydrogen economy" charge that the time frame for overcoming the technical and economic challenges to implementing wide-scale use of hydrogen vehicles is to be at least several decades, and hydrogen vehicles may never become broadly available

Disregarding all these developments, the current status quo of vehicle fuel efficiency varies greatly in the concerned regions.[407] Whereas European fleets already average 43 miles per gallon (mpg) and Japanese fleets reach 50 mpg, the US remain stubbornly at 35 mpg.[408] This motivated the current presidency of the US to announce a target of 54.5 mpg until 2025. Surprisingly, the target is supported by most major US automakers, mainly because the program results in a long-term regulatory certainty and compliance flexibility for the industry and offers incentives for early adoption of advanced technologies.

The joint IEA/UNEP "Global Fuel Efficiency Initiative" supports governments in implementing fuel economy goals for passenger cars. Its goals for 2030 (see table) are far from being reached, especially due to the quickly growing, fuel-inefficient non-OECD car fleet, but they show what could and should be achieved. They are also a basis for the European CO_2 emission goals (see chapter 3.3.10) since CO_2 emissions and fuel efficiency are directly linked.

	2005	2008	2030	Annual Change 2005–2030	Required Annual Change 2005–2030
	in l/100km			in %	
OECD Average	8.21	7.66		–2.1	
Non-OECD Average	7.49	7.68		0.3	
Global Average	8.07	7.67		–1.7	
GFI Objective	**8.07**		**4.03**		**–2.7**

Table 12: Fuel economy objectives of the joint IEA/UNEP "Global Fuel Efficiency Initiative"[409]

Smart Cars

[407] An/Sauer 2011
[408] WBCSD 2004
[409] GFEI 2011

Cars are becoming increasingly connected, wired, electrified, computerised, and ICT-dependent. 90 % of all automotive innovations outside the drive train will be in electronics.[410] IT features will increasingly be used for product differentiation in highly competitive markets.[411]

Among the possible applications that may be realised by electronic features in the future are driver assistance, night view, guided parking, or distance control. Some applications like electronic stabilisation control (ESC), an enhancement of the common anti-blocking system (ABS), are already standard features of new vehicles on the market. Mechanical elements are increasingly being replaced by electronic counterparts (X-by-wire technologies). Another relevant application is distance monitoring and maintenance. Car-to-car and car-to-infrastructure communication can supplement and improve existing traffic management systems, but data security, financing, and insufficient data quality are still unresolved problems.

The range of the uses of a car is continually expanding by incorporating new non-vehicle technologies. More and more cars come with integrated navigation and mobile phone units, thus becoming part of the "mobility internet".[412] With the help of on-board media and communication devices cars are turned into offices, living rooms or social spaces and can satisfy the growing and complex demands of the modern "nomads".

IT and media are also used to control traffic and assist mobility organisation: Vehicle telematics (Global Positioning System/GPS technology integrated with computers and mobile communications technology) allow the real-time adjustment of traffic signs and route planning; personal or online mobility agents help individuals in their travel organisation by providing information on travel destinations, parking or public transport timetables. These services allow individuals to optimise their mobility time and money budgets and help them choose more environment and congestion friendly travel modes.

Safety devices are an asset for car drivers and other traffic participants alike. They reduce minor and major accidents and make car driving less stressful. Drivers and engine are tied more and more closely together by intelligent safety devices, e. g. Assisted Parking Distance Control, Autonomous Cruise Control, Lane Departure Warning System, Forward Collision Warning System, Brake Assist Plus. Even if some engineers dream of the automated driverless car, the present technologies aim at assisting, not substituting the driver. When it comes to preciseness, technology-aided systems work better than human control, but in fuzzy and complex situations technology can merely help to reduce complexity but not manage it or make appropriate decisions.

Outlook to 2020

- Increasing competition will force OEM to reposition their portfolios. It's not clear yet whether diversification or monostructural organisations will dominate.
- Drive train technology will diversify depending on legislation and technological progress. BEV are likely to become an important niche in urban markets.
- Smart Car technology will become more widespread. Vehicles will become much more computerised and connected. Some of today's additional functionalities will become standard until 2020.

Implications for mobility services

[410] Focus 2008
[411] Baum/Hüttenrauch 2008:71
[412] Mitchell 2010

- A lot of the technologies to be employed in vehicles in the future will support the use of mobility services, esp. the smart car technologies, telematics and real-time traffic information.[413]
- The increasing attractiveness of the value chain of mobility services will motivate more car manufacturers to include them in their product and service portfolio.
- Increasing market shares of low-cost vehicles will make vehicle ownership more attractive for social groups who could not afford to own a car so far. This reduces the demand for mobility services.

3.3.5. Urban transport infrastructures

Definition

Physical and virtual infrastructures necessary for urban transport.

Description

Well functioning infrastructures, especially for transport, are the most important factor for attracting investment.[414] Urban infrastructures – transport, water, energy – will require major investments in the decades to come, either due to maintenance and renewal (developed countries) or due to expansion of cities (developing countries). Until 2030, US$ 40 billion need to be invested in urban infrastructures globally, the highest share of it in water and energy/electricity infrastructure.[415] In the transport sector though, an increase in infrastructure is not a cure-all for capacity problems as larger road networks may also induce traffic. Thus, demand management concepts are becoming more important for solving urban infrastructure solutions,[416] along with a thorough revitalising of existing infrastructure.[417] Quite different challenges are faced by shrinking cities which have to adapt their large infrastructures to reduced needs in order to operate efficiently.[418]

Infrastructures for urban transport consist of roads, rails, hubs/stations and NMT infrastructure. Their quality and extent are important factors influencing mobility behaviour.[419] With the rise of the automobile city in the 1950ies significant shares of public expenditures were spent on roads while neglecting public transport and NMT infrastructure investments. Since the 1970ies this ratio has begun to turn around slowly as some municipalities start to acknowledge the long-term benefits of a more balanced modal shift and the need to decouple transport from economic growth.

Road infrastructure

The total road network in the EU-15 has been growing permanently since 1990. Baseline forecasts of transport volume growth indicate a 60 % increase of vehicle kilometres until 2030 (for OECD, see Figure 58). This growth alone will require major investments in transport infrastructure, even though population and cities are hardly growing or even shrinking. The largest component of road infrastructure requirements will arise from the need to replace or upgrade existing infrastructure which deteriorates over time.[420]

[413] Grünig/Marcellino 2009:20
[414] Carsten 2005:148; GlobeScan 2006:22
[415] OECD 2006
[416] Gwilliam 2003:2002; Kenworthy 2002:15
[417] GlobeScan 2006:30
[418] Canzler 2007:14
[419] Grischkat 2008:50f.
[420] OECD 2006:186; Grischkat 2008:52

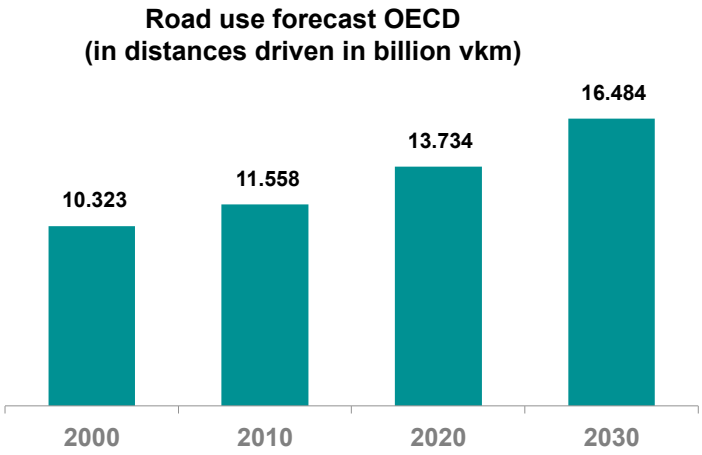

Figure 56: Road use forecast OECD[421]

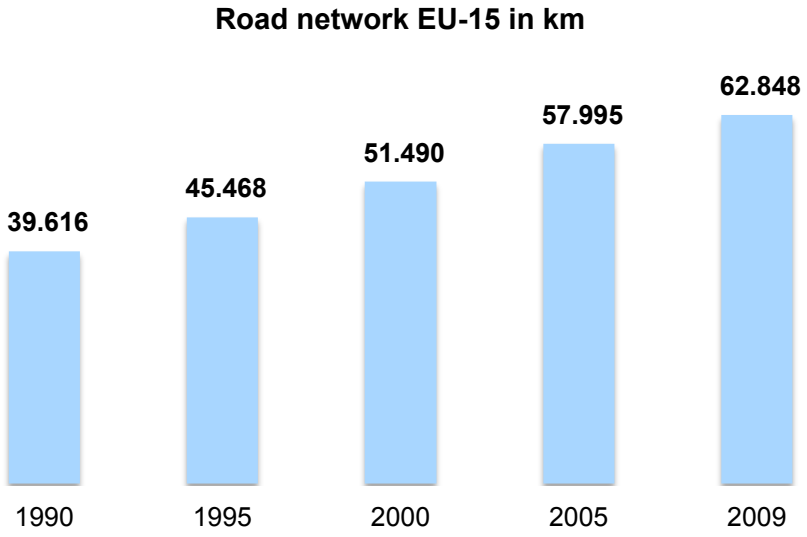

Figure 57: Development of total road network in EU-15 (1990–2009)[422]

Public transport infrastructure

"Public transport systems such as tram and metro have a positive impact on both safety and air quality in cities and overall on the quality of life of urban dwellers. Developing competitive urban transport solutions is therefore an effective way of tackling traffic congestion and air quality problems and improving transport safety. For this reason, public transport should be a key priority, along with safe walking and cycling."[423] This claim of the European Environment Agency is not mirrored in the budget priorities of most European governments (see Figure 58). Such a policy bias is prevalent in most cities around the world; only a few successful cities – e.g. Tokyo, Singapore, Copenhagen – have shifted policy and budget priorities towards public transport and NMT infrastructure in order to achieve sustainable urban development.[424] They have recognised that an efficient and flexible transport system is one of the key attributes of "major world cities […] which can compete globally".[425]

[421] OECD 2006:194
[422] European Commission 2012:55
[423] EEA 2007:322
[424] Vasconcellos 2003; Banister 2005
[425] World Bank 2007:2

Public transport infrastructure comprises infrastructure for buses (esp. lanes, stations, depots), trams (rails, stations, depots), subways (rails, tunnels, stations, depots) and suburban rail (rails, stations, depots). The increasing role of information technologies improves the reliability and connectivity of these transport modes. In most cases, public transport infrastructures are not competing for space with road infrastructure, except for separate bus lanes which are becoming more popular with Bus Rapid Transit systems being implemented world wide.[426]

Investments in rail and road infrastructure (in mio. Euro)

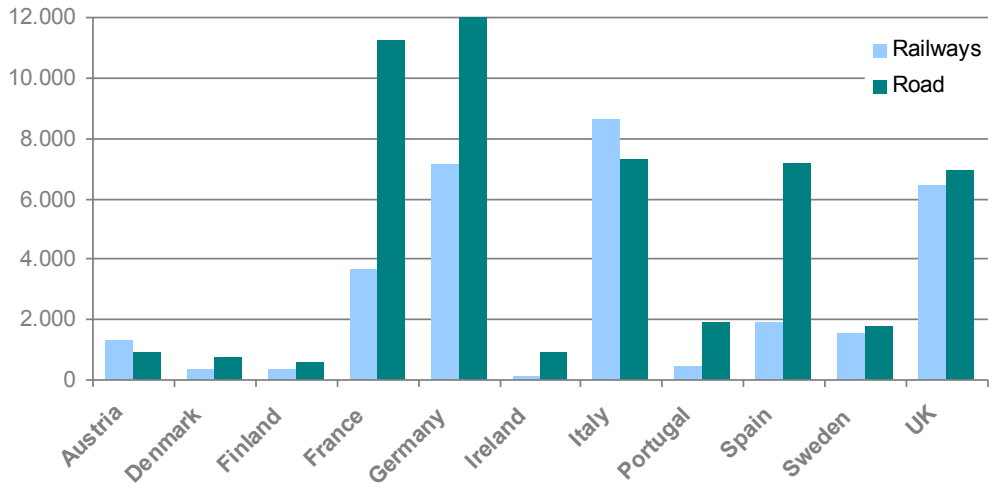

Figure 58: Investments in rail and road infrastructure 2008[427]

NMT infrastructure

The significance of non-motorised transport in urban areas has experienced several changes over time. While modes of NMT were considered as backward in the post-war era of motorisation they have slowly regained significance since 1970, partly due to the paradigm shift in public policy and an increasing rationalism in mobility behaviour (see Figure 60). Today, NMT receive a higher recognition by planners and decision makers not only because of their potential to relieve burdens of urban mobility but also to improve the attractiveness and image of cities. In some cities, bike lanes are laid out like motor roads, e. g. with separate lanes on highly frequented routes and complete biking master plans for entire cities. Several European cities are known as "bike towns", e. g. Copenhagen, Amsterdam, Muenster, as the modal split of bikes in these cities is significantly higher than in average cities (see Figure 18). Especially after 2005, biking has experienced a renaissance with bike sales rocketing and in some cases surpassing car sales. This development is accompanied by the rise in public bicycle services in European cities, most prominently the Velib' system of Paris (see chapter 2.3.2), some of the schemes offering also electric bikes (like the bike sharing scheme planned for Copenhagen).

[426] GTZ 2007
[427] EEA 2008:52

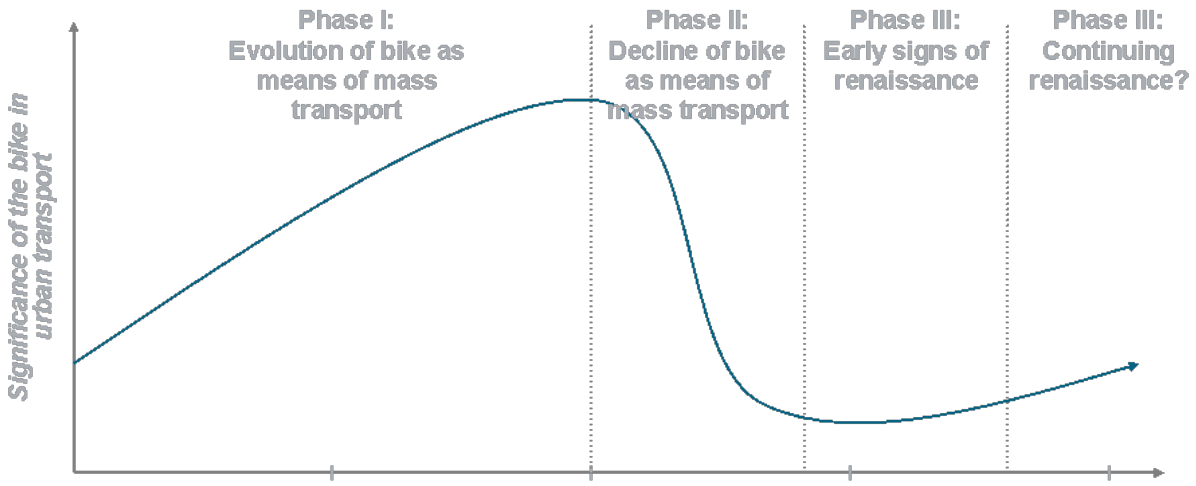

Figure 59: Development of the significance of the bike in urban transport[428]

Infrastructure for BEV

Currently, there are three different kinds of charging BEV being discussed: recharger cable, cable-free charging, and battery swapping. Stations and poles with recharging cables seem to be the preferred option because they are more energy-efficient than cable-free charging and require a lower level of standardisation than battery swapping.[429] While some studies assume that the lacking public recharging infrastructure is a barrier to the wide-spread use of BEV, others conclude that for most BEV drivers the existing private and semi-public charging infrastructure (in homes or offices) is sufficient. Also, BEV drivers tend to get used to limited reach of the vehicles.[430] Still, a lot of government resources targeted at e-mobility will need to flow into setting up an adequate charging infrastructure in order to make BEV attractive for users and manufacturers alike. For installing this infrastructure, manufacturers, municipalities and electricity suppliers will need to cooperate and form new liaisons.[431] At least the current forecast for charging stations prices – assuming a learning curve based on a goal of 2 charging stations/m^2 in 2020 and a 10 %/a price reduction – looks promising:

[428] Gather 2008:237
[429] Fraunhofer 2011
[430] Elkind 2012; Fraunhofer 2011; DB Research 2011
[431] Leschus/Stiller 2009:76

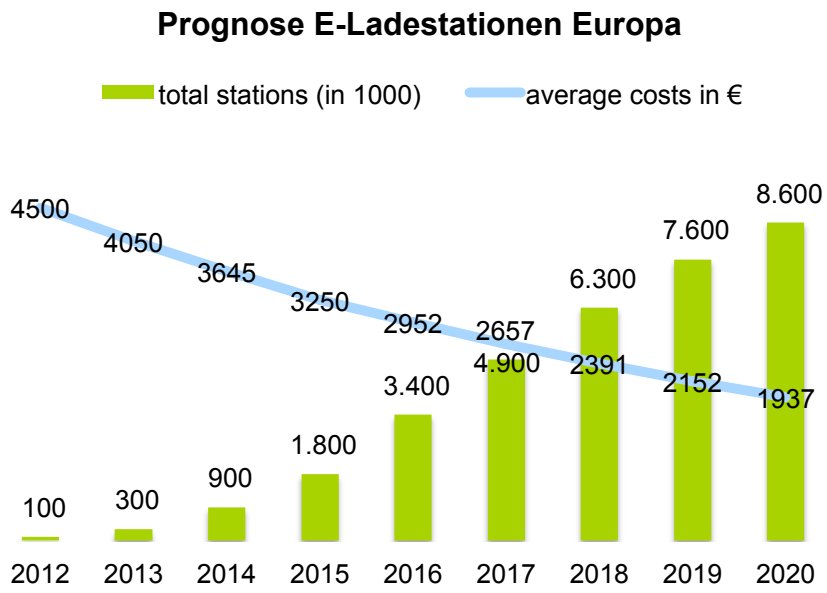

Figure 60: BEV charging stations forecasts for Europe[432]

ICT in urban development

Information and communication technologies are playing an ever more important role in urban infrastructure development. Based on citywide broadband infrastructure, they are catalysts of structural change for personal, work, and community life that will result in the development of more distributed, compact, and mixed-use urban forms. They will promote innovative practices for sustainable transport such as next-generation infrastructures for energy (smart grids, BEV charging), congestion charging, dynamic traffic management, and real-time traffic information. Along with municipalities, the IT sector is the most important promoter and beneficiary of this development.

Financing and governance

Transport infrastructures are usually financed by public funds. At the same time, they are also burdened by taxes which flow back to public transport funds. Financial burdens on transport modes do not always reflect their true costs. Not only is there an imbalance in traffic funding and taxing – e. g. rail transport being taxed heavily while the air travel sector is exempt from many taxes (esp. on fuels)[433] – but it is also difficult to internalise external costs in the transport sector (see chapter 3.3.9). In general, costs for construction and maintenance of transport infrastructure are expected to rise, the proportional increase being higher for road infrastructure than for rail.[434]

[432] Castellan 2011
[433] Cwerner 2009:19; IEA 2009:313ff.
[434] Canzler 2009:8

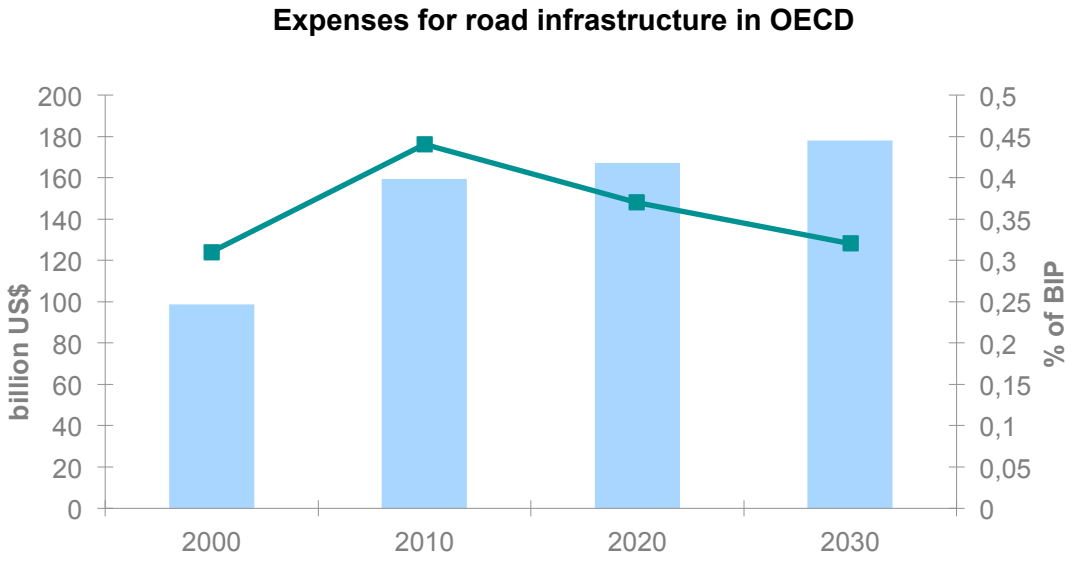

Figure 61: Projection of expenses for road infrastructure in the OECD[435]

Since the 1980ies there has been a trend towards liberalisation and privatisation in the transport sector. In Europe, effects have been mixed (positive experiences e. g. in Denmark, negative experiences in the UK). In Europe, there is also an increased interest in toll financing of infrastructure (not to be confused with regulatory tolls like congestion charges which have the objective to manage demand).[436] Despite these attempts to privatise the planning, constructing and maintaining of transport infrastructure largely remains a public responsibility. Urban transport infrastructure is mainly managed on a municipal level while other roads and infrastructure are administrated on higher political levels. On the European level, the Transeuropean Network (TEN) plan is the leading instrument for expanding infrastructure, especially cross-border projects.[437]

Outlook to 2020

- As traffic volumes continue to grow, expenses for transport infrastructure will increase, too. However, they will make up lower shares of public budgets.
- Most of the investments will be needed for renewal and maintenance of existing transport infrastructure.
- The policy bias of road versus public/NMT transport infrastructure will remain an element of transport policy of many municipalities.
- Progress in ICT and the advent of BEV will promote technologies for sustainable urban transport management.

Implications for mobility services

- The prevalence of ICT in urban transport infrastructures will make seamless travel more feasible and thus more attractive.

[435] Leschus/Stiller 2009:21
[436] EEA 2007:311; IEA 2009:252f.; Gehlert 2009; Pällmann 2009
[437] Gather 2008:71

- Public-private partnerships can assist municipalities in introducing mobility services such as car sharing systems.[438]

3.3.6. Economic development

Definition:

Future macroeconomic trends in Europe, including GDP, inflation, unemployment and national budget policies.

Description:[439]

Global financial crisis

The most significant event in the economic development of the last decades was the global financial crisis (or subprime mortgage crisis) of 2008/2009. While global GDP growth had remained at an average 3.4 % p.a. between 1997 and 2007, in 2009 it was negative (-3.0 %) for the first time in decades. The global economic crisis of 2008 was caused by a liquidity shortfall of the US financial market due to an overvaluation of assets ("housing bubble" and "subprime crisis"). It resulted in the collapse of large financial institutions, culminating with the bankruptcy of Lehman Brothers on September 15th 2008, the bailout of banks by national governments and downturns in stock markets around the world. Considered by many economists to be the worst financial crisis since the Great Depression of the 1930s, it contributed to the failure of key businesses, declines in consumer wealth, substantial financial commitments incurred by governments, a significant decline in economic activity worldwide (e. g. international trade decreased by 12.3 %), high unemployment (see Figure 63) and growing social disparities. Despite unprecedented financial stimulus packages by governments to even out the short-term peaks of the crisis, significant risks remain for the world economy over the 2010–2011 periods because credit rating agencies and investors have failed to accurately price the risk involved with mortgage-related financial products, and governments have not adjusted their regulatory practices to address 21st century financial markets.

Europe was not hit as hard and suffered only a negative growth of -0.53 % in the critical period 2008/2009. The following table presents the quarterly GDP growth rates in Europe since 2006:

[438] Grünig/Marcellino 2009:20

[439] Note: If not stated otherwise, all data in this chapter are based on the following sources: IMF 2010; OECD 2010; OECD 2012; World Bank 2010; Eurostat Online Database

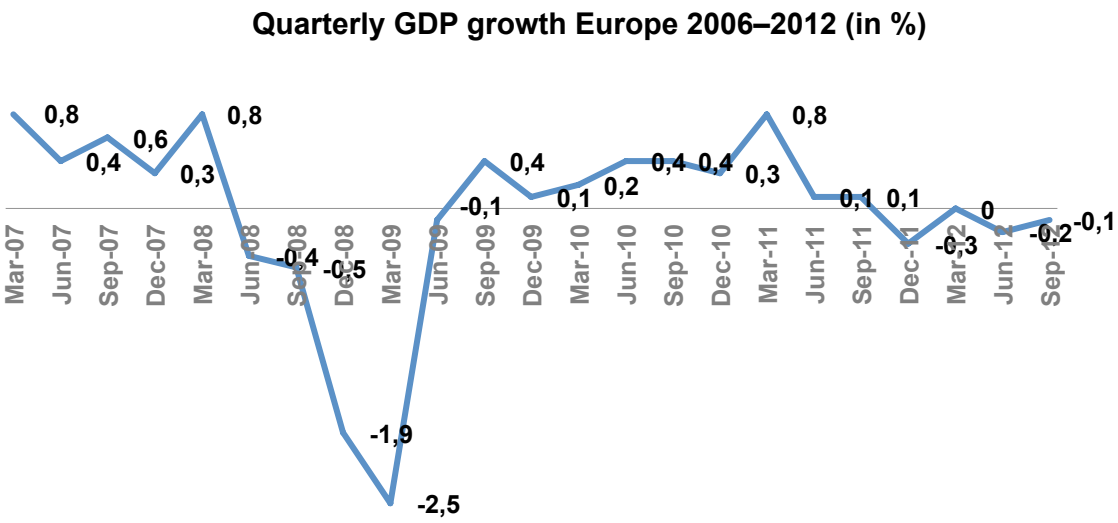

Figure 62: Quarterly GDP growth in Euro area[440]

The figures demonstrate clearly that the economic crisis caused a critical downturn in the central indicator for economic development, the gross domestic product (GDP), in the years 2008 and 2009 but that economy has started recovery in mid-2009.

European sovereign debt crisis

In 2010, the European sovereign debt crisis (Euro crisis) followed as a long-term consequence of the global economic breakdown, relating especially to Greece where there is concern about the rising cost of financing government debts. The crisis has reduced confidence in other European economies. Greece, Italy, Ireland, and Portugal have the highest state budget deficits.

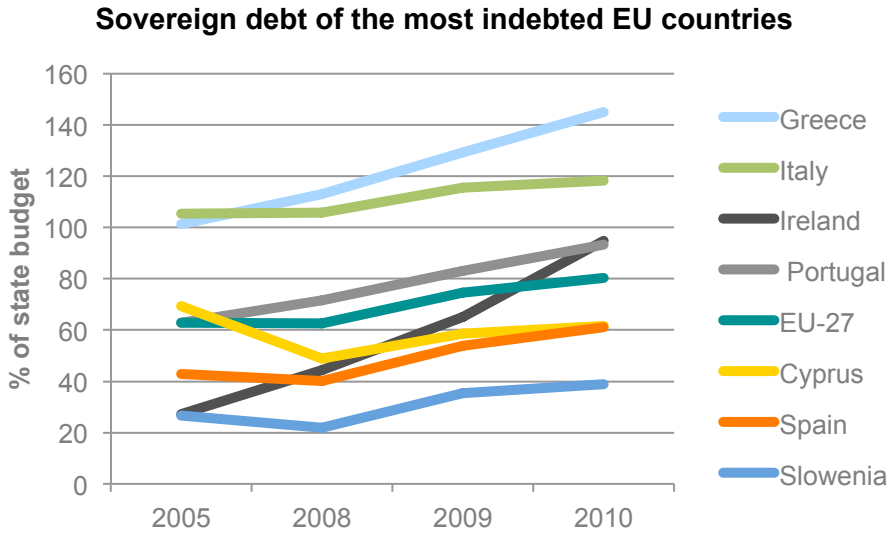

Figure 63: Sovereign debt of the most indebted EU countries[441]

[440] Eurostat Online Databas developede
[441] BMF 2011

While a few countries were able to lower their unemployment rates after the economic downturn in 2008/2009, in many they remained high or even increased (esp. Spain, Greece, Portugal), reflecting the deep crisis of these countries:

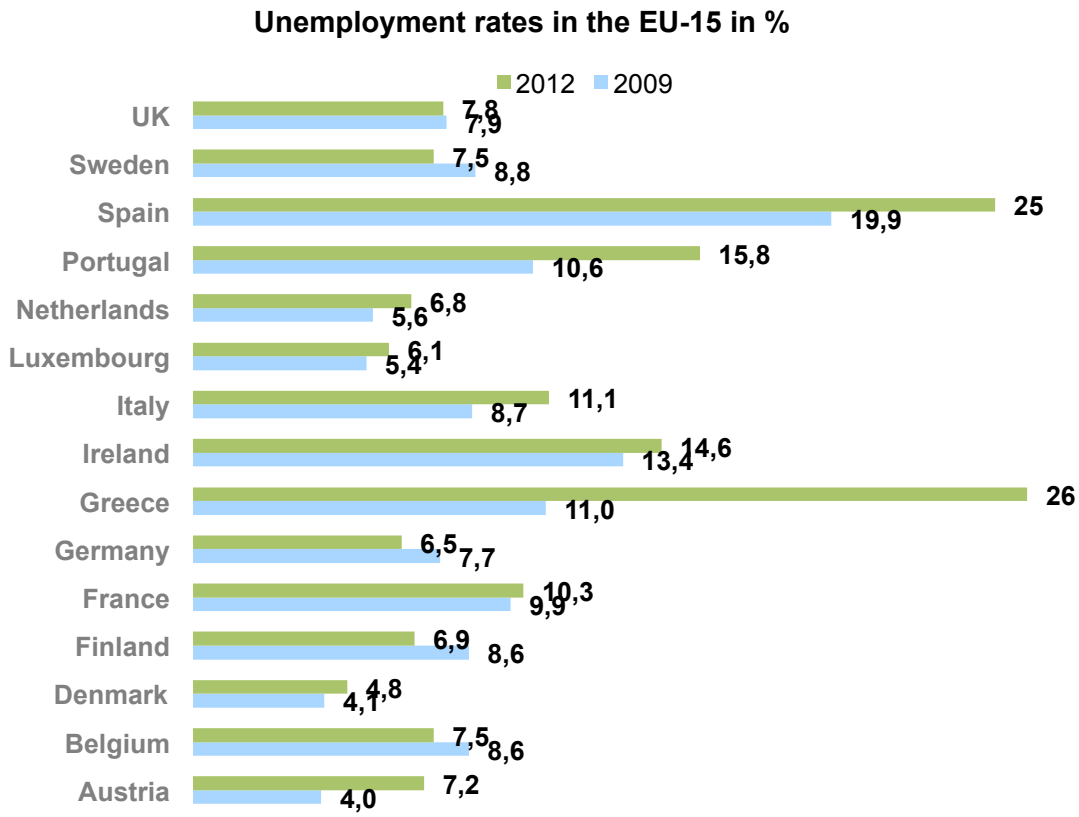

Figure 64: Unemployment rates in EU-15[442]

The economic downturn caused a slowdown of the commodity price hike and of the inflation rates in Europe. By 2011, inflation rates went up again, as did consumer spending.

[442] Eurostat Online Database

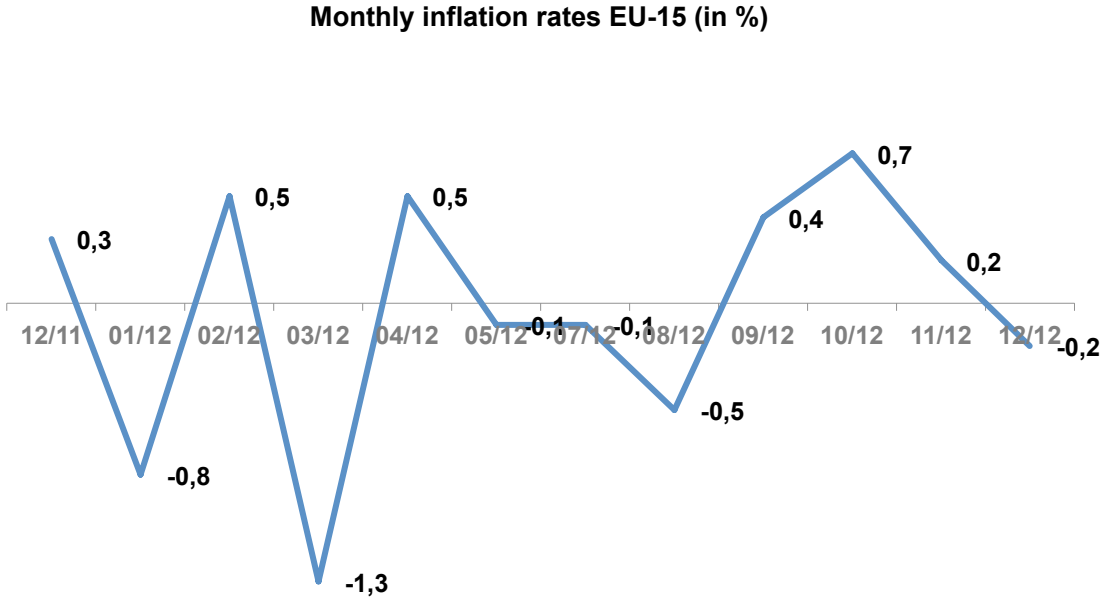

Figure 65: Monthly inflation rates in EU-15[443]

On 2 May 2010, the Eurozone countries and the International Monetary Fund agreed to a € 110 billion loan for Greece, conditional on the implementation of harsh Greek austerity measures. Only a week later, Europe's Finance Ministers approved a comprehensive rescue package worth almost a trillion dollars aimed at ensuring financial stability across Europe by creating the European Financial Stability Facility and the European Stability Mechanism. A variety of regulatory changes to minimise the impacts of the current crisis and prevent recurrence have been proposed by economists, politicians, the media and business leaders, among them financial market transaction taxes and moderation of executive compensations as well as general austerity measures and no-growth philosophies. Only a few have been implemented, most of them short-term cushion measures to even out the worst peaks of the crisis and stimulate the economy. Widely used government stimulus measures were so-called scrapping premiums which stimulated vehicle production, an important sector of the economy in many nations (for details see chapter 1.1). This was criticised as a step back towards conventional models of economy and mobility. Since the beginning of the crisis, many more financial commitments and structural and institutional adjustments have followed.

Outlook

The complexity of the crisis and the ensuing measures make it difficult to identify long-term consequences of the Euro crisis. However it is certain to say that they will continue to present significant risks for investors and consumers.

Impacts on mobility services

- With less money at hand to spend for mobility, alternatives to costly car ownership and use will become more attractive to individuals.

[443] Eurostat Online Database

- Even though oil prices declined during the economic crisis prices will increase in the years to come and be very volatile (see key factor "Energy resources – price and availability", chapter 3.3.7). Consumers will become more reserved about gasoline consumption, thus becoming more open for alternatives in public or non-motorised transport.
- Future economic crises, budget deficits and austerity measures will reduce government spending, e. g. on costly infrastructure in the transport sector. This can reduce road space or the quality and service of public transport, depending on transport policy paradigms.

3.3.7. Energy resources – price and availability

Definition:

The availability and price of resources used for energy generation, most of which are of fossil origin (coal, oil, natural gas) are the focus of this key factor.

Description:[444]

Prices for fuel and energy are expected to continue to rise due to increasing global demand from emerging markets and due to a declining physical and technical availability. In pre-crisis years, supply was hardly able to satisfy demands; the reduced production and exploration capacities during the economic crisis will worsen the shortage once economy has recovered. The high dependence of the transport sector on oil makes it highly vulnerable to volatile prices and shortages. A diversification of the fuel base will be necessary to reduce vulnerability but can produce new dependencies on the electricity generation sector and coal or on resources for biofuels.

Trends in energy resource use and production

In 2011, oil production had reached 84 mb/d (0.7 % increase compared to 2010) while global demand was slightly higher at 87.4 mb/d. By 2020, global oil demand will rise to 94.2 mb/d. While demand is now higher in OECD countries (42.1 mb/d) compared to non-OECD countries (38.4 mb/d), this relation will be reversed by 2020 (39.4 mb/d in OECD countries, 47.1 mb/d in non-OECD countries).[445]

Oil will remain the main energy source but its share of the primary energy use will drop from 34 % to 30 % by 2030. Yet, daily oil consumption will rise from 85 million barrel per day (mb/d) to 106 mb/d by 2030.[446]

[444] Note: If note stated otherwise, all data of this chapter are based on OECD 2009
[445] IEA 2012:83
[446] IEA 2012:552

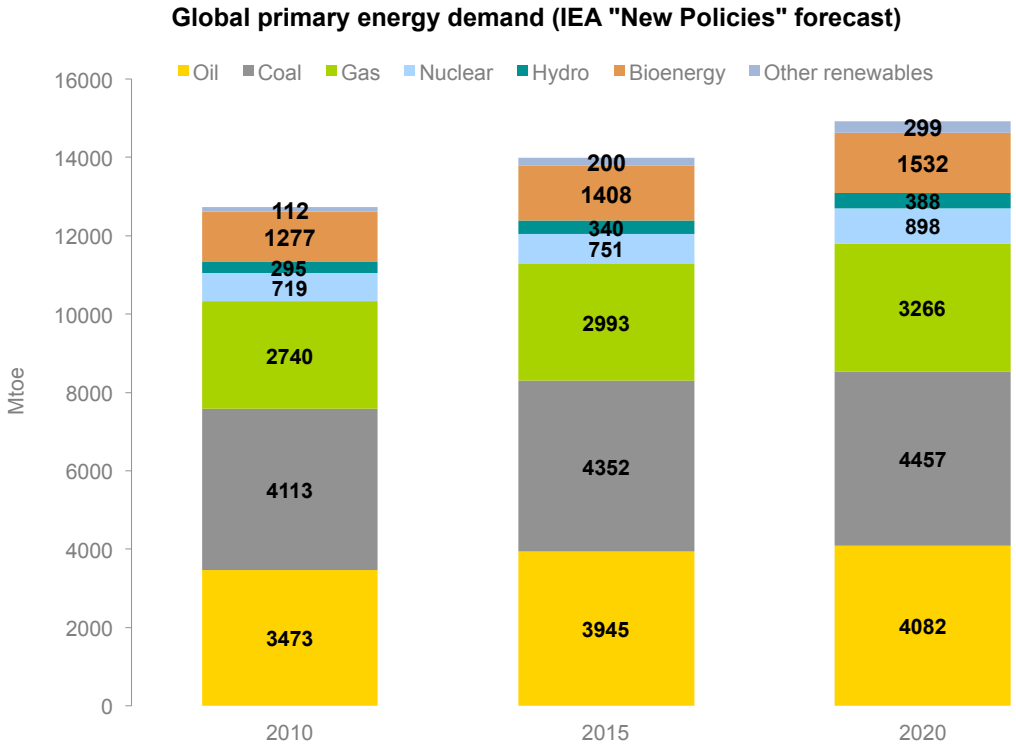

Figure 66: Primary energy use until 2020[447]

Oil, which accounts for the largest part of global energy use, is used mainly for the transport sector. 74 % of global oil production is converted into transport fuel (see next figure), and 98 % of transport fuels are derived from oil.[448]

[447] IEA 2012
[448] IEA 2012

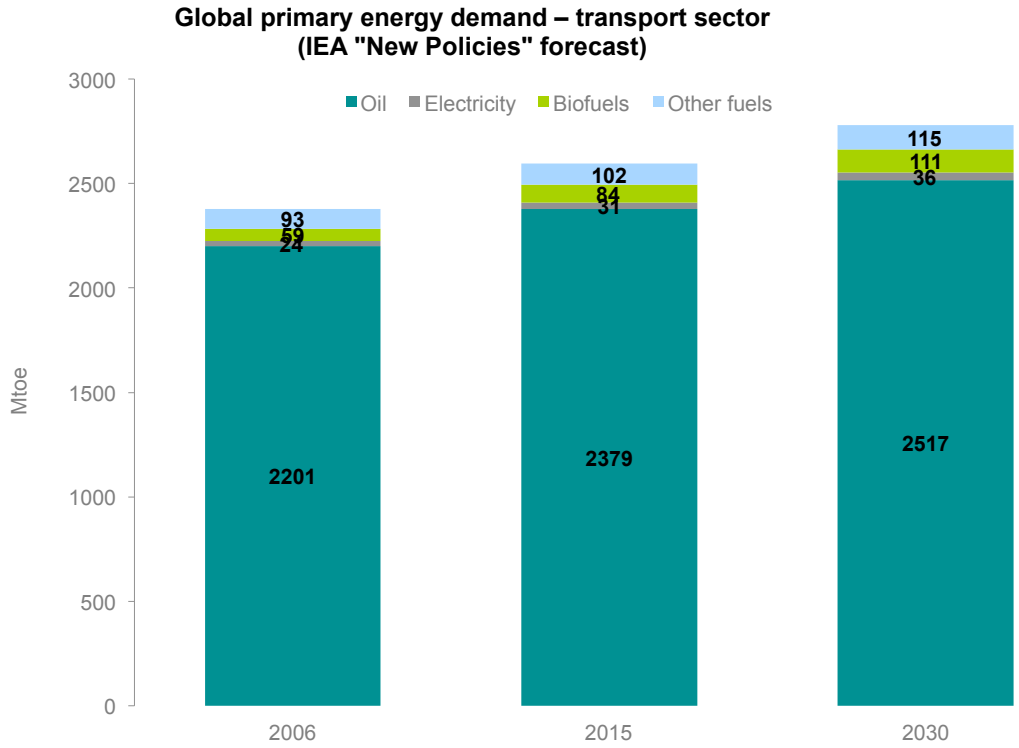

Figure 67: Global transport sector energy demand until 2020[449]

In the European Union, energy demand for transport is expected to decline until 2020, with electricity rising from 6 to only 7 % of the fuel mix, but biofuels doubling their share from 13 to 26 %:

[449] IEA 2012

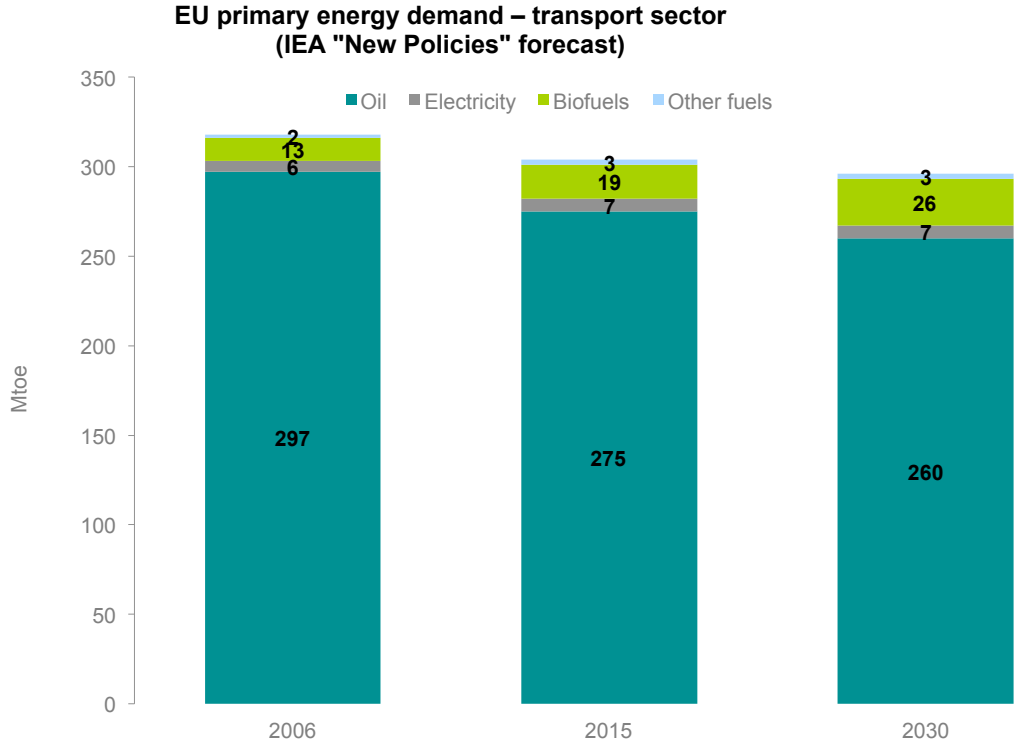

Figure 68: European Union transport energy demand until 2020[450]

The high dependency of the transport sector on oil and its rapid growth especially in the emerging market threatens the availability also for other uses, esp. in the petrochemical industry which has greater difficulties to find substitutes for oil than the transport sector.

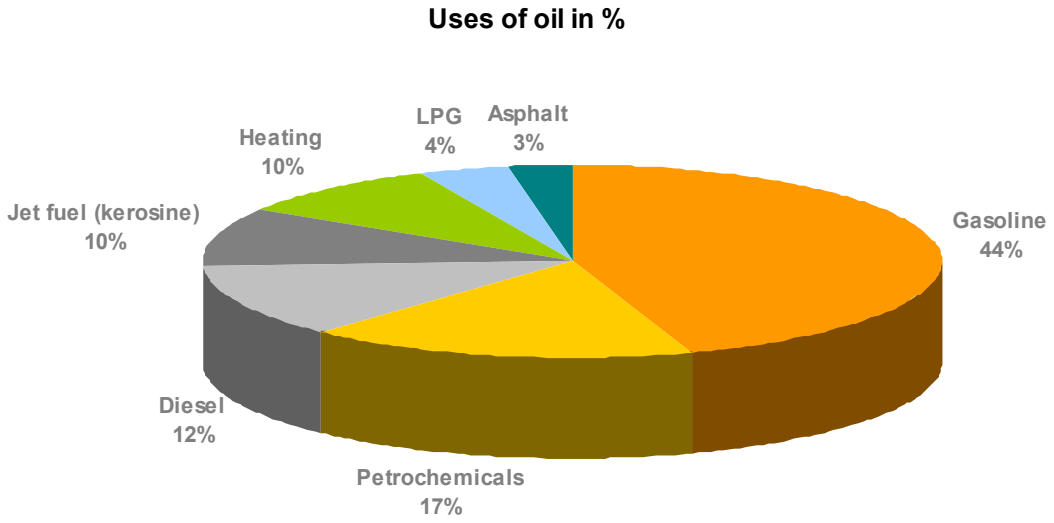

Figure 69: Uses of oil (2006)[451]

[450] IEA 2012
[451] Newman/Beatley 2009:25

Facets of oil availability

The availability of oil is determined by their natural availability, by production and expoloration capacities, and by supply and trade.

a) Physical: Peak Oil

Global oil production peaked in 2006 with a maximum of 81 mb/d, according to an independent analysis of the NGO Energy Watch Group.[452] This fact is contested by major oil companies and associations like the International Energy Agency but there is a growing consent over the looming peak of oil.[453] Even if global peak oil might not have been reached yet, local peaks of major oil fields ("giants") in OPEC countries have occurred. 54 of the 65 largest oil-producing countries have already experienced their peak oil.

Author/Institution	Termination of peak-oil
International Energy Agency (IEA)	after 2030
Shell	Between 2020 and 2030
Association for the Study of Peak Oil (ASPO)	Between 2010 and 2013
Energy Watch Group (EWG)	2006

Table 13: Peak-oil forecasts of various institutions/authors

b) Production and exploration

In the coming decade, shortages in oil supply will mainly be due to limited production capacities and less to limited physical resources. Global oil production and exploration peaked in 2006 (see next figure). The IEA therefore warns of a potential production peak until 2015: "World oil resources are judged to be sufficient to meet the projected growth in demand to 2030, with output becoming more concentrated in the OPEC countries – on the assumption that the necessary investment is forthcoming. (…) Although new oil-production capacity additions (…) are expected to increase (…) it is very uncertain whether they will be sufficient to compensate for the decline in output at existing fields and keep pace with the projected increase in demand. A supply-side crunch in the period to 2015, involving an abrupt escalation in oil prices, cannot be ruled out."[454] Global production of current oil fields has stagnated at 86 mb/d since 2004 and will drop by 60 % until 2030. The deep ocean, oil shales, and oil sands are all potentially major sources of future oil production, but they are often expensive to access and their development may significantly increase the environmental costs of fossil fuel use. Interestingly, high oil prices pushed production from the Canadian oil sands to 1.2 million barrels per day (mb/d) in 2008, up from 1.0 mb/d in 2005."[455]

[452] EWG 2008:14
[453] Metz 2008:50
[454] World Energy Outlook. IEA. 2008. S. 43
[455] Russell 2009

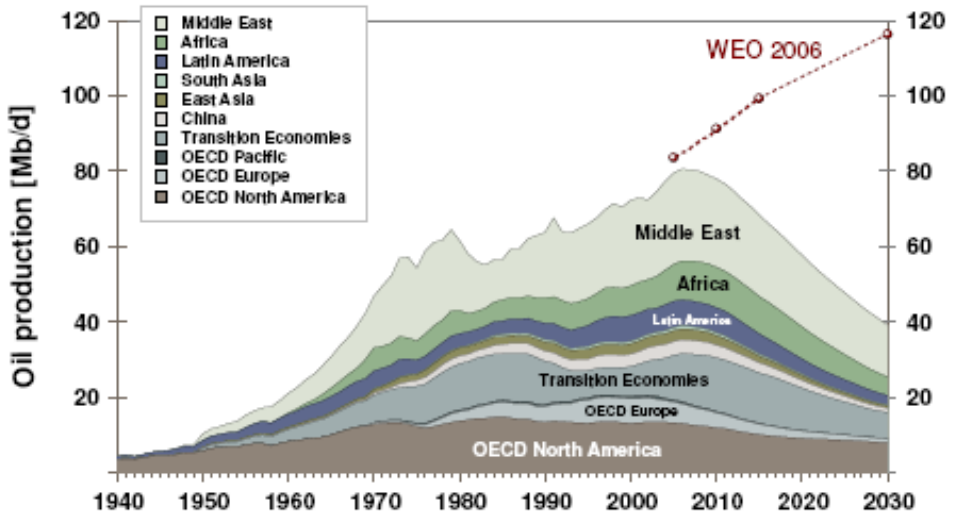

Figure 70: Global oil production until 2030[456]

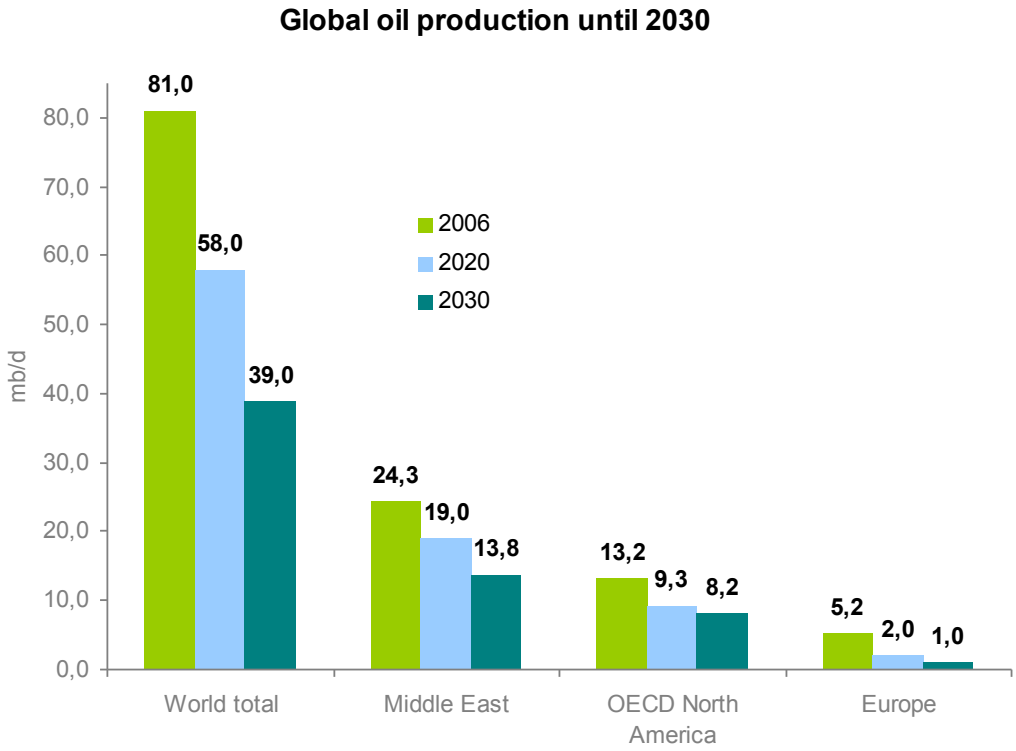

Figure 71: Global oil production in mb/d by region[457]

c) Protectionism of oil exporting countries

Most of the oil reserves and production capacities are located in countries where state-owned companies control the resource (such as Russia and Saudi Arabia) or where political instability increases the investment risk (such as Nigeria and Venezuela) (see Figure 70 for

[456] EWG 2008:10
[457] EWG 2008:10f.

current OPEC production capacities). Even the Arctic, now seen as a potentially large store of oil resources, has a history of conflicting national claims to ownership that portends a contentious future for production. The less politically risky deposits present formidable technical challenges. In the future, the market dominance of state-owned oil companies will rise. State-owned oil companies (esp. in the Middle East, Russia, Latin America) own 88 % of global oil reserves and produce 62 % of global oil. Increasing global demand and price hikes motivates oil producing states to nationalise the oil industry and to increase protectionist measures (e. g. Venezuela). It also motivates esp. emerging markets to secure oil fields in markets that are not yet exploiting the maximum of their oil fields. This can be observed in African countries like Sudan, Nigeria and Angola where China is trying to take over parts of the local oil industry.[458] An additional threat is the increasing domestic demand of the oil exporting countries in the Middle East due to their own economic progress.

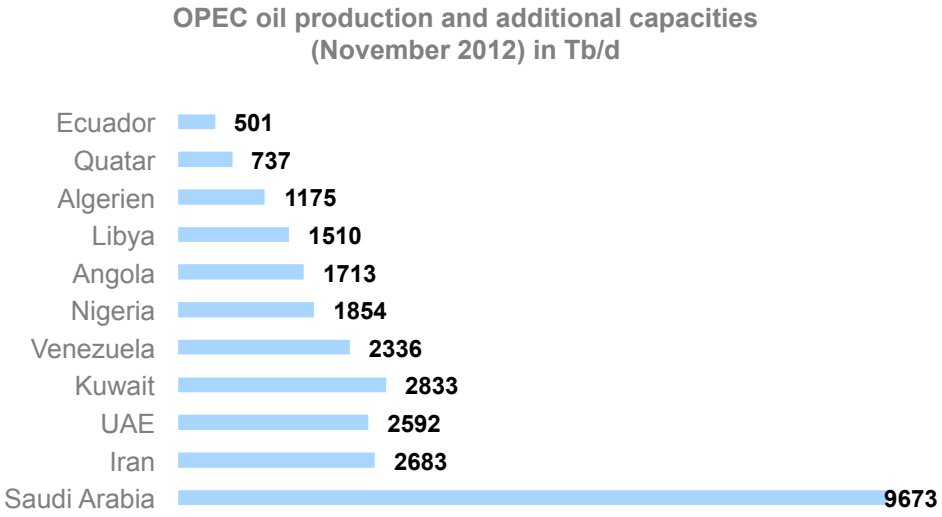

Figure 72: OPEC oil production capacities[459]

Prices: volatile growth

Depending on the condition of global economy the development of oil and fossil fuel prices may take on very different forms. Given the generally increasing shortage of and rising demand for these resources, it is safe to say that prices will rise but unsure how much and with which range of volatility. In 2008, the volatility of the oil price figured at 200 %.[460] The International Energy Agency (IEA) and the US Energy Information Agency (EIA) both predict an oil price of 180 USD/barrel for 2030. The main threat were the low investment rates during the 2008/2009 global economic crisis which will tighten the schedule for price hikes; however, investment resumed pre-crisis levels in 2012, when they reached US$ 619 billion. It has to be noted though that higher upstream costs explain part of the increase. Until 2020, oil prices are expected to rise moderately, depending on the amount of new policies being implemented ("New Policies" vs. "Current Policies" scenario):

[458] Deutsche Bank Research 2009
[459] OPEC 2012
[460] In the first half of the 2008, producers strained to meet global demand, but by year's end the global recession left the market swamped by excess supply, causing oil prices to fall to from $144 per barrel in July to $34 per barrel in December.

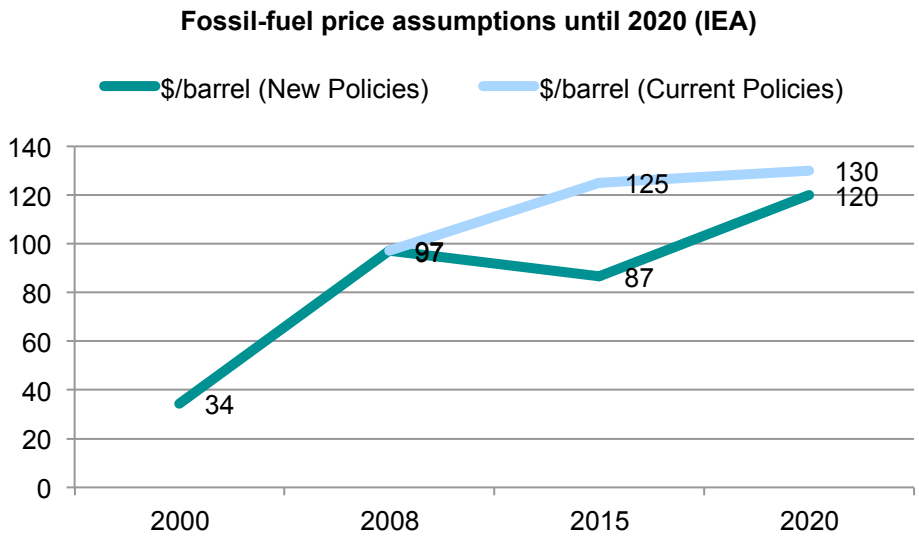

Figure 73: Fossil-fuel price assumptions of the International Energy Agency[461]

Liquid fuel alternatives

Oil supply shortages are unlikely to stop climate warming because current supplies will allow us to increase ppm levels to 750,[462] and in face of supply shortages industries will turn to enhanced oil recovery (EOR) and other unconventional sources of fossil energy like oil tar sands or coal-to-liquid technology which aggravate carbon dioxide emission levels even more.[463] More recently, the transport sector is developing and deploying non-fossil alternatives (see chapter 3.3.4). The main alternatives to conventional oil-based fuels are:

Source	Obstacles for sustainable application
Non-conventional oils: Deepwater drilling, tar sands, oil shale	Environmental implications; energy intensive; high GHG emissions; low ERoI
Gas-to-liquid	Converting process is energy and capital intensive; high GHG emissions
Biofuels	Competition for arable land; ERoI can be very low
Coal-to-liquid	High GHG emissions; peak coal by 2025; low ERoI
Electricity	Vehicle, battery and engine development needs to progress; new infrastructure and standards needed; non-renewable energy sources render GHG level of electrical cars not much lower than fossil fuel cars
Hydrogen	Converting process is energy intensive

Table 14: Alternatives to conventional oil extraction[464]

[461] IEA 2009:64
[462] Metz 2008:53
[463] Metz 2008:50
[464] Newman/Beatley 2009:28f.

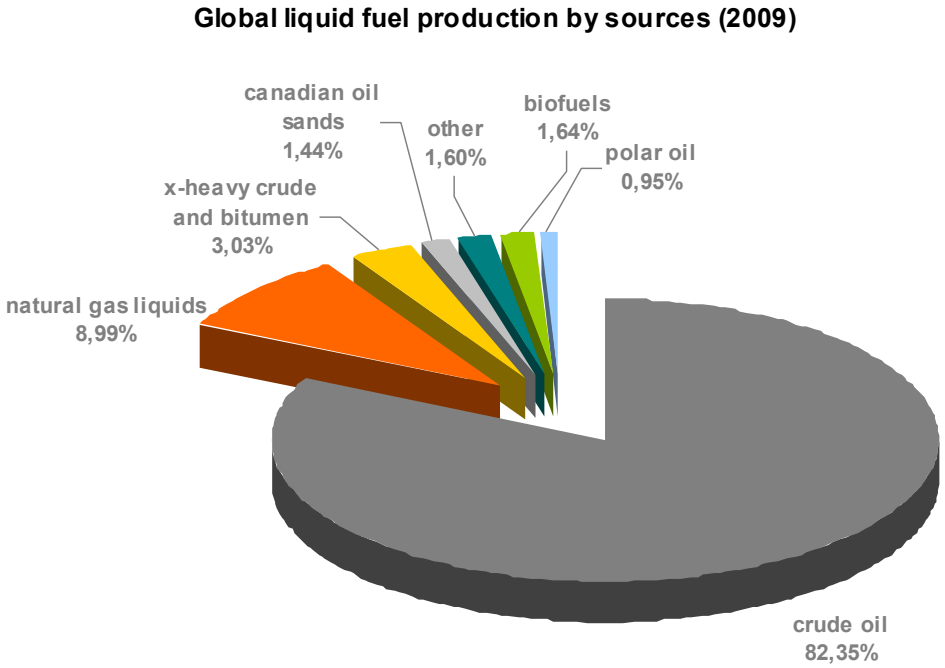

Figure 74: Global liquid fuel production by sources (2009)[465]

From a sustainability perspective, only vehicles powered by electricity from renewable resources show real potential for reducing GHG emissions from transport. But this alternative still requires much technology development and new political frameworks (battery, engines, vehicle concepts, and infrastructure), and it requires large investments.[466] Governments around the world have initiated large programs to establish favourable conditions for BEV and to support R&D, esp. for battery development. This is often accompanied by programs to increase the share of renewable energy.[467] The remaining alternatives are either too energy or capital intensive or have very negative environmental or social implications.

Outlook to 2020

- Prices for energy resources from fossil fuels will rise significantly. The price level and volatility will depend on economic development, esp. in emerging economies, trade policy (protectionism) and investments in exploration and refining infrastructure.
- Alternatives for fossil fuels will be able to substitute only minor shares of fossil fuels.

Implications for mobility services

- If fuel prices continue to rise customers will reduce their fuel use or trips by personal vehicles. Depending on price sensitivity and availability they might instead switch to less expensive means of travel like NMT or public transport. This can increase the demand for mobility services that assist individuals in organising intermodal trips.

[465] ASPO Netherlands: The Oil Drum – Oilwatch Monthly November 2009 http://europe.theoildrum.com/node/5972

[466] Dings 2009:18, 45; compare also key factor “Vehicle technology and portfolio of car manufacturers” (chapter 3.3.4)

[467] E. g. Germany plans to have a share of 30 % renewable energy by 2020.

- BEV with their battery systems could be offered to individuals as battery-lease vehicles, similar to the business model of mobile phones.

3.3.8. Climate change

Definition
The signs and impacts of climate change, induced mainly by a rise in greenhouse gases in the atmosphere (GHG).

Signs of climate change

Man-made additions to the greenhouse gas content of our atmosphere have caused a rise of the carbon dioxide (CO_2) concentration from about 280 parts per million (ppm) in pre-industrial times to currently 392.8 ppm (December 2012) and a growth rate of 1.76 ppm/year since 1990.[468] CO_2 emissions are expected to increase by 45 % until 2030, with the highest growth rates in the emerging economies.

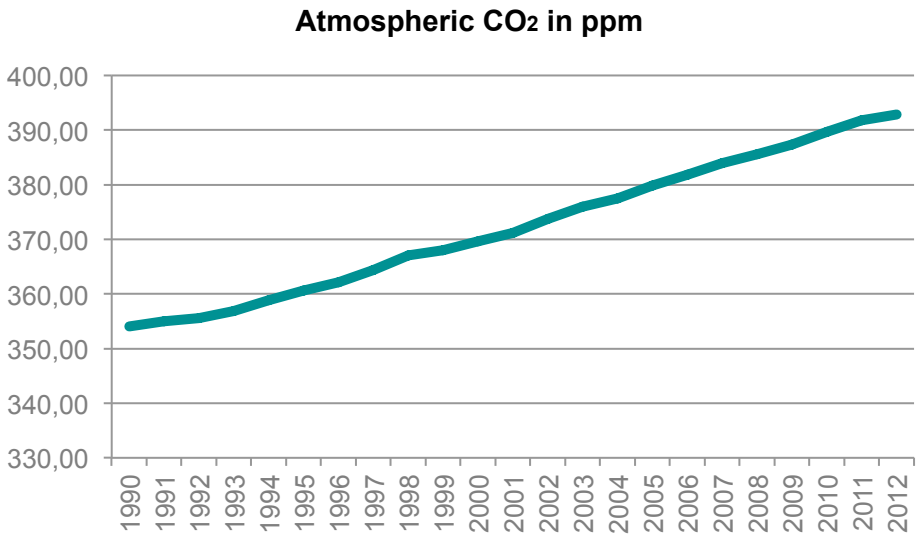

Figure 75: Development of atmospheric CO_2[469]

[468] Metz 2008:21
[469] Source: National Oceanic and Atmospheric Administration, Mauna Loa Observatory Data, ftp://ftp.cmdl.noaa.gov/ccg/co2/trends/co2_mm_mlo.txt

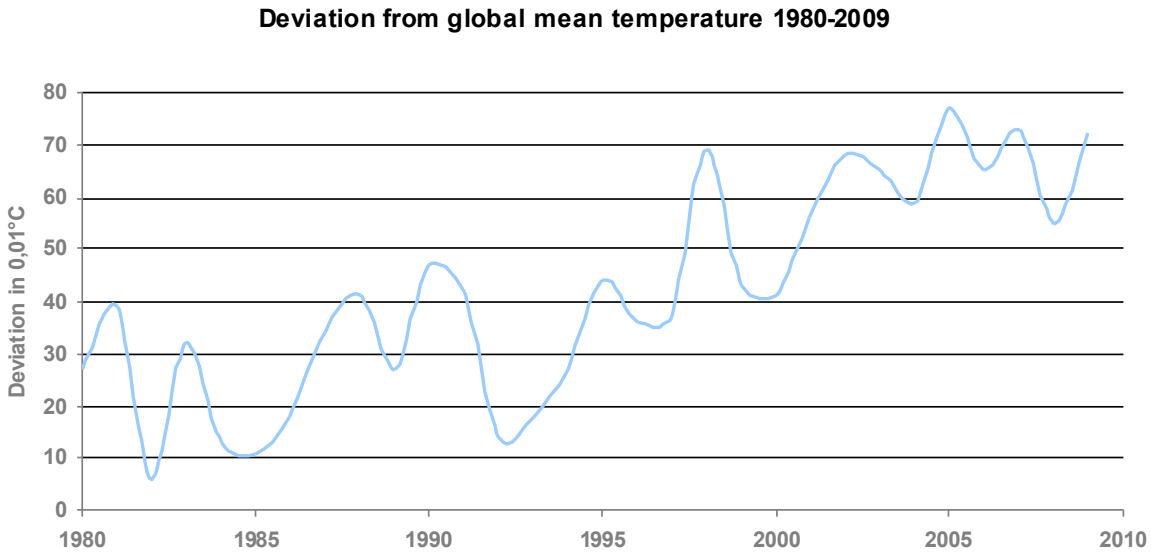

Figure 76: Deviation from global mean temperature 1980–2009[470]

In order to keep global warming below the critical 2 °C a ppm level of 350 would be necessary (see Table 15); higher concentrations will inevitably lead to detrimental changes in global climate that will require high adaptation costs.[471] The current business-as-usual scenario would lead to a CO_2 equivalent level of ~600 ppm by the end of this century, leading to temperature increases of 3.2 to 4.0 °C and a 0.6 to 2.4 m sea level rise.

IPCC Scenario	Stabilised CO_2 level (ppm)	Stabilised CO_2e level (ppm)	Ø increase of global temperature (°C)	Ø sea level rise (m)
I	350–400	445–490	2.0–2.4	0.4–1.4
II	400–440	490–535	2.4–2.8	0.5–1.7
III	440–485	535–590	2.8–3.2	0.6–1.9
IV	485–570	590–710	3.2–4.0	0.6–2.4
V	570–660	710–855	4.0–4.9	0.8–2.9
VI	660–790	855–1130	4.9–6.1	1.0–3.7

Table 15: IPCC climate change scenarios[472]

The increase in CO2e emissions will depend on a mix of factors, most importantly:

- Population growth (energy demand)
- Resource availability (energy consumption: fossil vs. renewable)
- Economic growth, esp. in emerging countries
- Innovation and progress (availability and use of technologies)

Due to atmospheric processes global average temperature will rise by 0.4°C until 2027 and by 0.6–4.0°C until 2100 – depending on absorption capacity, tipping points, and policy intervention – most heavily on the poles. Sea levels will rise by 0.4–3.7 meters. This will inevitably lead to a rise in extreme weather events and anomalies, e. g. a change in the hurricane season in North America and a rise in heat waves and droughts in Europe. Even if GHG emissions could stabilise at current rates, global temperature would still rise by 0.1° C and sea

[470] Source: NASA Goddard Institute for Space Studies – Surface Temperature Analysis http://data.giss.nasa.gov/gistemp/tabledata/GLB.Ts.txt
[471] Stern 2006
[472] IPCC 2007

level by 0.6 m per decade, due to the long-term climate change effects of accumulated GHG in the atmosphere.[473]

Tipping points

Climate change is accompanied by so-called tipping points, irreversible processes which initiate completely new weather and climate conditions.[474] Examples of such tipping points are the rapid release of methane due to the unfreezing of permafrost soil in the Northern hemisphere, the irreversible melting of the Greenland icesheet or the slowing down resp. stopping of the North Atlantic Current which would irrevocably cool down the European climate and lead to severe food shortages.[475] If and when such tipping points occur can not be forecast due to the high complexity and high amount of unknown or uncertain facts in the climate change process.[476] This is intensified by so-called positive feedback loops, changes in the climate system which reinforce further changes, e. g. the rising ocean temperatures which decrease the oceans' capacity to absorb carbon dioxide.

The contribution of the transport sector to climate change[477]

81% of greenhouse gas emissions (GHG) originate from the burning of fossil fuels; 23 % of GHG are generated by the transport sector. The following figure shows that the share of transport-related CO_2 emissions in developed countries is higher (27 % in 2007) than for the global average (23 % in 2007). For the US this share is even higher with 31 % in 2007.

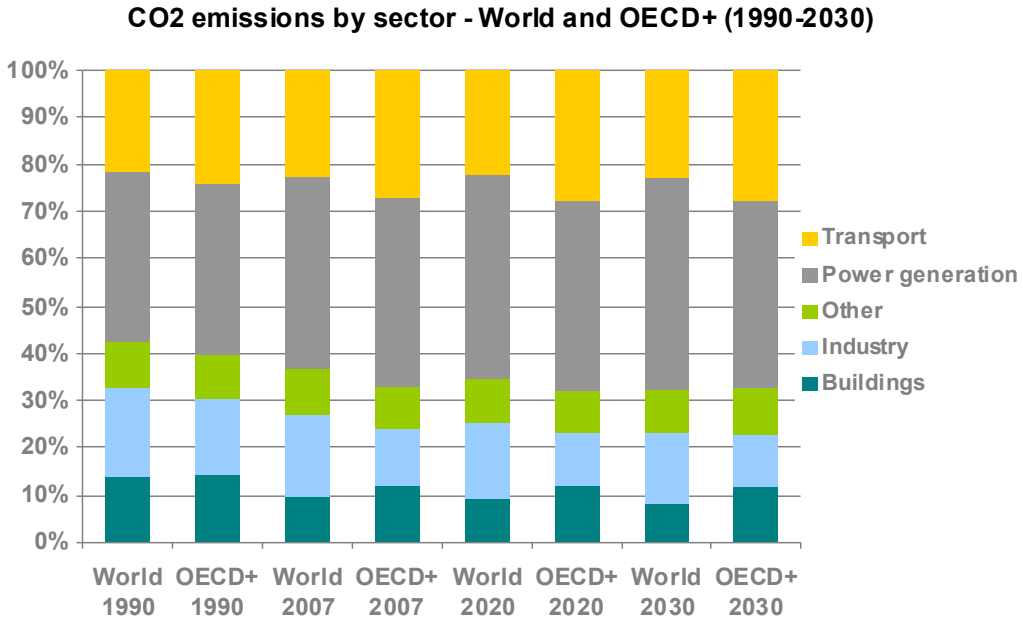

Figure 77: Energy-related CO_2 emissions by sector[478]

The rapid growth of transport related GHG remains the main obstacle for Europe to achieve the reduction goals of the Kyoto protocol. Contributing to this problem is Eastern Europe which will reach the same level of per capita transport activity as Western Europe in 2050.

Impacts of climate change

[473] IPCC 2007
[474] UNFPA 2009:13f.
[475] UBA 2006; Rahmstorf/Schellnhuber 2007:67f.
[476] Homer-Dixon 2006
[477] see also chapter 3.3.9
[478] IEA 2009:21

The burdens of climate change will be distributed very unevenly. The most vulnerable areas are "coastal and river flood plains [...] especially where rapid urbanisation is occurring."[479] Geographic fate has it that those countries which contributed the least to climate change will suffer most from its impacts.[480] Arable lands will diminish even more, water resources will fail and resource conflicts will increase, causing people to migrate. The number of people replaced by climate change could amount to 150 million in 2050.[481] Administrations and governments worldwide are already discussing the security impacts of severe climate change, leading to shifts in global politics and culture.[482] Yet, climate scientists admit that "the world is now on a path to a very unpleasant future and it is too late to stop it. […] We can no longer prevent global warming even if the most optimistic assessment of how the world might respond to the climate disruption is validated. We simply are not going to act with anything like the urgency required."[483]

In Europe, climate change impacts are split in a north-south direction: southern Europe will become (and already is becoming) drier, northern Europe is getting wetter. The water scarcity in the Mediterranean raises fire risks and reduces suitable cropping areas and hydropower potential. Extensive species extinction will affect all biogeographic regions in Europe. On the Atlantic coasts, increased winds and storms will raise the vulnerability of transport.[484] A hotter climate is also bad for air quality. In Europe, summer smog from low-level ozone in cities is expected to increase strongly, worsening respiratory diseases and heart problems.[485] The following map gives an overview of the impacts of climate change on the biogeographic regions in Europe:

[479] IPCC 2007
[480] International Alert 2008
[481] Jakobeit/Methmann 2007
[482] Leggewie/Welzer 2009; Homer-Dixon 2006
[483] Hamilton 2010:10
[484] Archer/Rahmstorf 2010:181f.
[485] Archer/Rahmstorf 2010:178

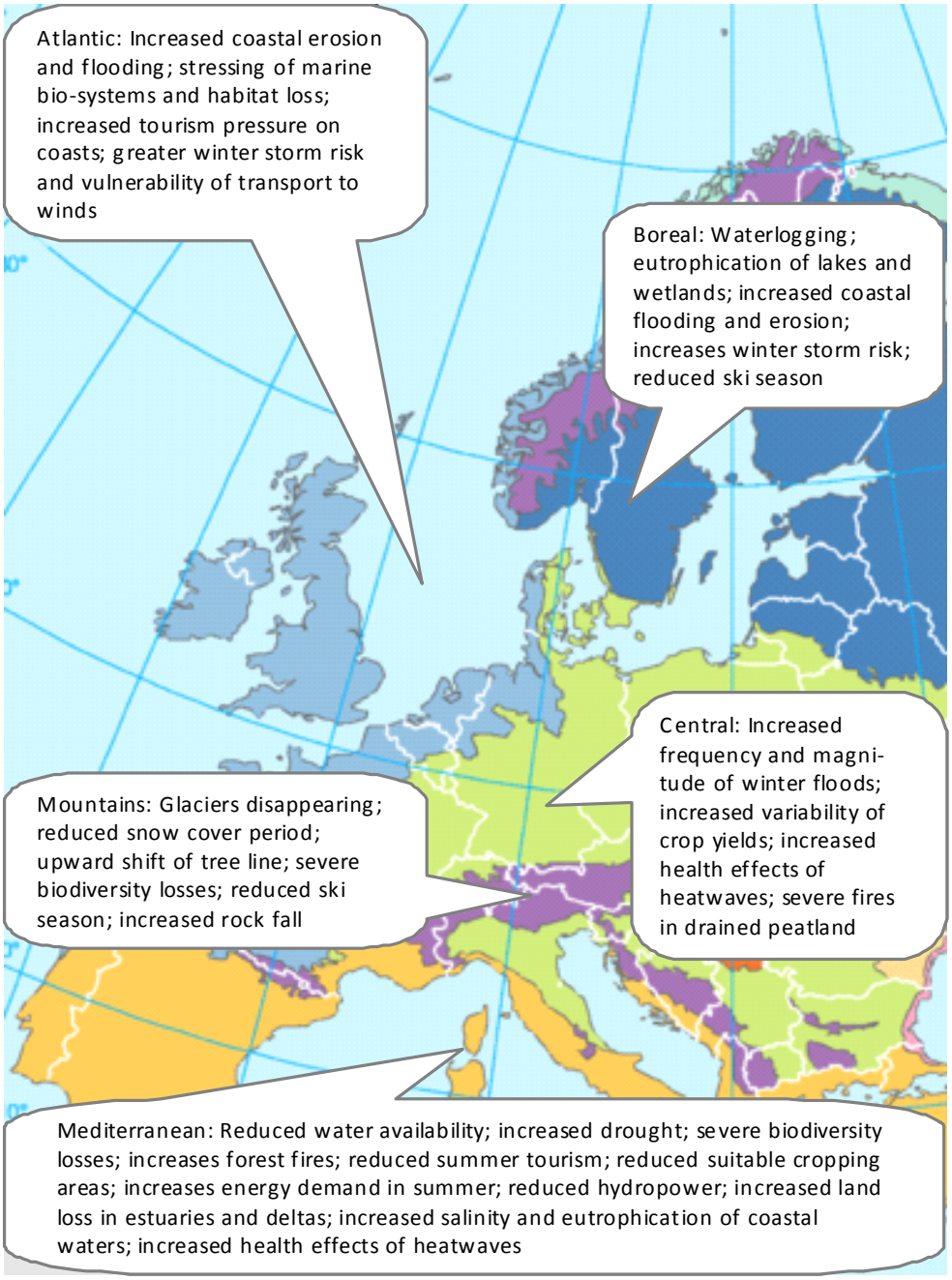

Figure 78: Map of key vulnerabilities to climate change in biogeographic regions of Europe[486]

Outlook to 2020

- Climate change is a long-term trend. Even if anthropogenic GHG would be eliminated immediately the impacts of the accumulated GHG would still be noticed for decades.
- Climate change will be addressed by mitigation and adaptation policies on all levels and in all sectors.
- Adaptation to climate change in Europe will be necessary especially in coastal regions and in the agricultural sector.

[486] Archer/Rahmstorf 2010:182

Implications for mobility services

- Rising levels of CO_2 concentration and growing negative impacts of climate change will influence the environmental awareness of people and thus increase the demand for alternative, low-carbon modes of travel.
- Rising levels of CO_2 concentration and growing negative impacts of climate change will motivate governments to establish stricter rules on carbon emissions. This might make owning and using a car less attractive. (see key factor 3.3.10 – Environment and transport polic)

3.3.9. Burdens of urban mobility

Definition

This section describes the side effects of urban mobility activities and their future development. The political measures aiming at reducing these effects are discussed in key factor "Environment and transport policy" (chapter 3.3.10).

Description

While mobility is a central factor for the functioning of cities and their socio-economic development it is also the cause of many burdens, be they of an ecological, economic, or social nature.[487] These side effects need to be managed by an integrated urban transport planning approach which combines mitigation and adaptation strategies. While some side effects are inevitable and only adaptation measures can help, other effects can successfully be reduced or eliminated (mitigation). The most prevalent burdens of mobility in cities until 2020 will be:[488]

1. Space: Congestion, parking, land consumption
2. Health: local emissions, noise
3. GHG emissions
4. Energy use
5. Safety
6. Equity/Access
7. Costs

1. Space-related burdens

Burdens of mobility related to space are congestion and parking problems in the short term, and land consumption in the long term.

Short term: congestion and parking problems

Transport, which makes cities viable, also threatens their viability.[489] This paradox is most evident in the case of congestion. Congestion arises from the mutual disturbance of users competing for limited transport system capacity. Depending on the mode of transport, type of users, infrastructure characteristics, local travel time and activity alternatives, excess demand can cause travel time increases, rising vehicle provision and operating costs, including depreciation, disamenities in crowded systems, additional fuel costs, reduced reliability, and

[487] Hotzan 1994:134; Potter/Bailey 2008:29f.; see Figure 15
[488] Newman/Kenworthy 2007; Gudmundson 1996; Wolf 2007; WBCSD 2004; Gather 2008:119f.
[489] Banister 2005:210

scarcity of slots on access regulated infrastructures.[490] Urban congestion is expected to grow by 188 % in Western Europe by 2020.

Parking problems can come in two shapes: a) Scarcity of total parking lots (high competition for parking lots) and b) inefficiency of finding open parking lots. Both types cause additional traffic as vehicle owners need to take longer deviations for finding parking lots which incurs time losses.

Land consumption

Land consumption is the most neglected but most visible burden of mobility. Transport has always affected the spatial organisation of cities (see chapter 2.2). In urban areas, space is scarce, and urban transport (parking space, roads, petrol stations, etc.) takes up increasing proportions of land. Motorisation fuels spatial decentralisation (e. g. suburbanisation) which then further drives motorisation.[491] As settlement patterns are hard to reverse, land-use planning has to operate in a preventive manner.[492] High urban densities are considered to be the key for efficient transport systems even though the correlation is contested.[493] Building new roads in urbanised areas will in many cases not reduce congestion, because the extra road space is quickly filled up by new traffic ("induced traffic").[494] E. g. in Germany, 15 to 20 % of growth in transport volume is estimated to be caused by road building.[495] Having recognised this, especially sprawling cities in the USA have begun to reurbanise their inner cities. The "New Urbanist" (also "Traditional Neighborhood Design" or "Smart Growth") agenda which promotes walkable, higher density, mixed-use communities and advocates a return to small-town urban forms with human-scale, pedestrian-friendly streets, a reinvigoration of cities, and a stop to suburban sprawl can help contain land use and address other problems in urban transport planning as well.[496]

The potential environmental impact of transport infrastructure depends strongly on the type of land affected (including its immediate surroundings). Important factors are the infrastructure characteristics, which determine, for example, the visual impact on the landscape and the extent to which the infrastructure constitutes a barrier hampering the movement of animals or people. Land taken by transport is withdrawn from other uses, e. g. green spaces or housing. In most of the new housing developments of the last 40 years, 30 to 50 % of the area is used for moving and parking cars, land subsequently unavailable for housing and recreation. A single motorway intersection takes up as much space as the centre of a small town. The following table shows that the car consumes by far the most land compared with other modes of transport:

[490] Maibach/Schreyer 2008:23; Leape 2010:158
[491] Zegras 2006:9; Holz-Rau 2007:21; Rammler 2005:9; Hogan/Ojima 2008:210
[492] Banister 2008:73; Potter/Bailey 2008:37
[493] Banister 2005:97
[494] Dietrich/Pfleiderer 2003:147-150; Banister 2005:7; UBA 2005; Gather/Kagermeier 2008:155f.
[495] UBA 2010:23
[496] Newman/Beatley 2009:48, 97; Gorham 2002:21; Martin 2009:226; Schellhase 2000:54; EEA 2007:312f.; Henderson 2009:147; Cox 2010:68; see also "The Charter for New Urbanism" http://cnu.org/sites/files/charter_english.pdf

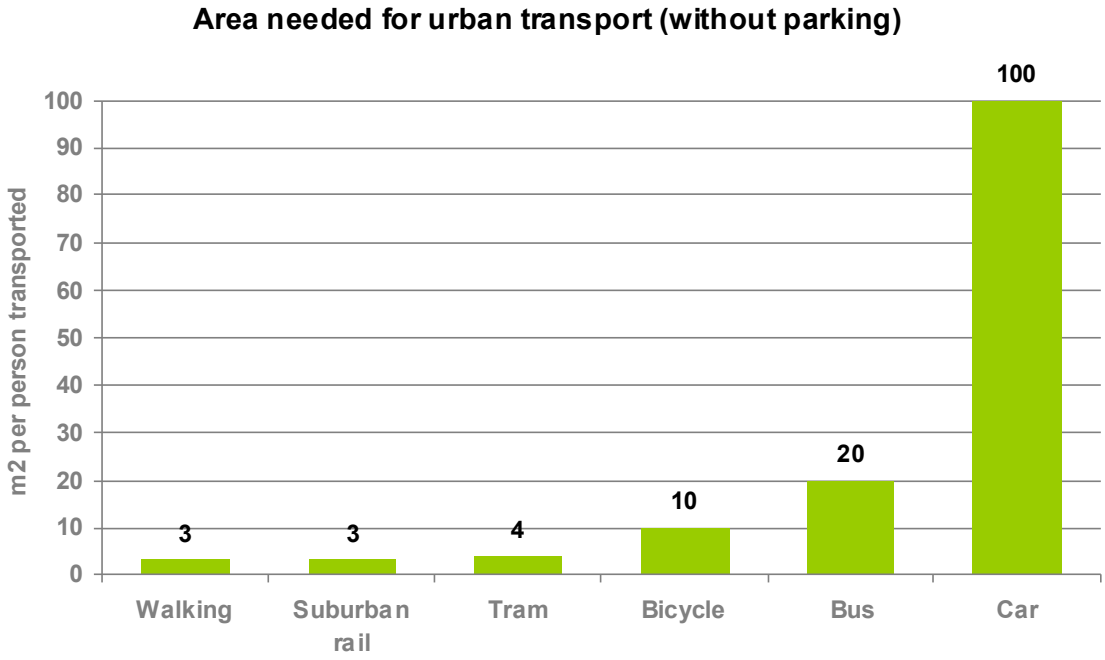

Figure 79: Area needed for urban transport by mode[497]

An additional effect of land take by road transport is a loss of street life and community and the cutting up of neighbourhoods by roads.[498] Besides reducing the urbanity and attractiveness of a city it increases social problems caused by non-integrated neighbourhoods.[499]

2. Health effects

Road traffic affects health directly via toxic air emissions and noise emissions; indirect effects concern lifestyle health (esp. obesity, lack of exercise).

Toxic air emissions

Vehicles with internal combustion engines emit toxic emissions which pollute the air. The main fuel sources petrol, diesel and kerosene (aircrafts) are not only sources of the greenhouse gas CO_2 (which does not harm human health directly) but also of air pollutants like carbon monoxide, unburnt hydrocarbons, sulphur oxides and nitrogen oxides which are all harmful to human health and/or the environment (see Table 16). Even though the interrelation between human health and pollution from transportation is not straightforward, the calculated death toll due to diseases caused by air pollution (respiratory system) is six times higher than that for road accidents. In the European Union, the combined effects attributable to traffic pollution amount to >0.4 % of EU GDP.[500] Atmosphere and climate, together with urban form, population densities and traffic densities, but also vehicle and fuel technology influence the extent to which populations are exposed to primary and secondary pollutants.[501]

Pollutant	Traffic relation	Impacts on human health
Oxides of Nitrogen (NO_x)	Released in combustion process because molecular nitrogen (N_2)	Precursor of groundlevel ozone. Damage to respiratory tracts (bronchitis,

[497] Mohnheim/Mohnheim-Dandorfer 1990:36
[498] Peñalosa 2003:xxvii
[499] Martin 2009:225; Gorham 2002:25
[500] Potter/Bailey 2008:33; Gorham 2002:28
[501] Potter/Bailey 2008:31; Gorham 2002:26; Note: secondary pollutants levels are mainly determined by local atmospheric and climate conditions.

	present in the air/fuel mixture splits and is oxidised	asthma, lung diseases); cause of acid rain
Hydrocarbons (HC)	Released in combustion process	Precursor of groundlevel ozone. Irritation of mucous membranes, carcinogenic
Lead	Fuel additive no longer used in OECD countries	Cardiovascular disease, premature death, and behavioural and development problems in children.
Sulphur oxides (SO_x)	SO (particulates) released during fuel combustion; SO_2: contribution of the transport sector tends to be secondary to that of manufacturing and/or electricity production.	Irritation of skin and mucous membranes, respiratory trouble
Carbon monoxide (CO)	Correlated with hydrocarbon (HC) emissions	Ozone precursor. Reduces oxygen uptake in blood (dizziness, headaches, nausea), impairment of learning ability, dexterity and sleep
Groundlevel ozone	Prevalent on sunny summer days when other pollutants react under the action of sunlight	Exposure to ozone mainly affects the lungs, but it can also affect the eyes, and worsen respiratory allergies.
Particulate matter (PM)	Unclean burning processes, esp. diesel	Long-term lung and respiratory degradation, asthma[502]
Volatile organic compounds (VOC)	Released during combustion because of incomplete burning of the fuel	Ozone precursor. Short-term impairment of the respiratory function

Table 16: Impacts of transport emissions on human health[503]

The World Health Organization (WHO) has therefore fixed limits of air pollutants at ambient and urban level. Air quality (road-side and ambient) is being monitored in all major cities in the EU. Air pollution has been reduced to a minor problem in most EU cities: Out of 70 cities monitored only 4 did not comply with EU air pollution standards in 2008.[504] Cities in OECD usually meet WHO pollution standard requirements and are expected to reduce transport-related pollutants further.[505] This has been achieved by reducing emissions at the tailpipe (catalysts, EU emission standards) and, to a lesser extent by urban form (avoiding narrow streets with high buildings, emission absorbing materials, etc.).

Depending on the mode of transport, the emission levels vary significantly. While non-motorised transport typically does not cause any emissions, motorised vehicles produce emissions that vary depending on engine type, occupancy, and speed. For standardisation purposes, the emissions of vehicles are usually averaged:

Parameter	unit	LDV	Coach	Train	Plane	Bus	Tram	Suburban railway
CO	g/pkm	1,45	0,06	0,02	0,39	0,21	0,02	0,06
CO_2	g/pkm	144	32	52	369	75	72	95
VOC	g/pkm	0,18	0,02	0,01	0,09	0,08	0,00	0,02
NO_x	g/pkm	0,29	0,34	0,07	0,58	0,83	0,07	0,36
PM	g/pkm	0,009	0,008	0,001	0,002	0,017	0,000	0,004
Fuel efficiency (gasoline	l/100 km	6,2	1,4	2,7	5,8	3,3	3,9	4,8

[502] The extent of health effects depends on the composition of the particulate matter. There is increasing evidence that smaller particles cause more damage to human health than large particles. (Gorham 2002:29)
[503] Gorham 2002:76; EEA 2007:89
[504] http://airqualitynow.eu/comparing_year_average.php (update 11/19/2009)
[505] WBCSD 2004:38

equivalent)								
Occupancy		1,5 p/vehicle	60%	44%	73%	21%	20%	21%

Table 17: Standardised emissions of different transport modes[506]

Noise emissions

Transport related noise is the most widespread form of noise disturbance in cities,[507] most of which caused by road traffic. Noise effects consist of annoyance and health aspects.[508] The main activity disturbed by traffic is sleeping. Night-time noise can impair learning, alter moods and reduce performance.[509] Noise pollution is felt unevenly across the population and creates geographical inequalities. Vehicle and engine design can be used to mitigate noise levels, along with road surface improvements.[510]

Lifestyle health impacts

Motorised travel causes subtle but cumulative changes in behaviour and lifestyle. Health issues like obesity, poor fitness, and heart problems are increasingly linked to a lack of exercise promoted by omnipresent motorised travel. “Obesogenic environments” resulting from the reduction in NMT and public transport use correspond directly to cardiovascular ill health and to increasing risk of obesity.[511] As correlations are neither straightforward nor static solutions to improve secondary health effects need to take into account multiple aspects.

3. GHG emissions

As already mentioned in key factor 8 “Climate change” (chapter 3.3.8), the transport sector is the single largest source of energy-related GHG, mainly CO_2 emitted at the tailpipe. It is generated in the combustion process of fossil fuels. It is also the fastest growing sector. Efficiency gains and cleaner vehicle standards are compensated by absolute transport growth. CO_2 emissions can not be reduced by tail pipe solutions (after treatment) or physical structures (buildings, street layout) but are entirely dependent on fuel type and efficiency. Reducing the CO_2 emission levels of the transport sector can therefore be achieved only by fuel efficiency gains, alternative (zero-emission) drive trains, and a reduction of trips or trip lengths.

[506] Becker/Gerike 2009
[507] This includes noise from aircraft.
[508] Maibach/Schreyer 2008:31
[509] Potter/Bailey 2008:33
[510] Cox 2010:40
[511] Cox 2010:39

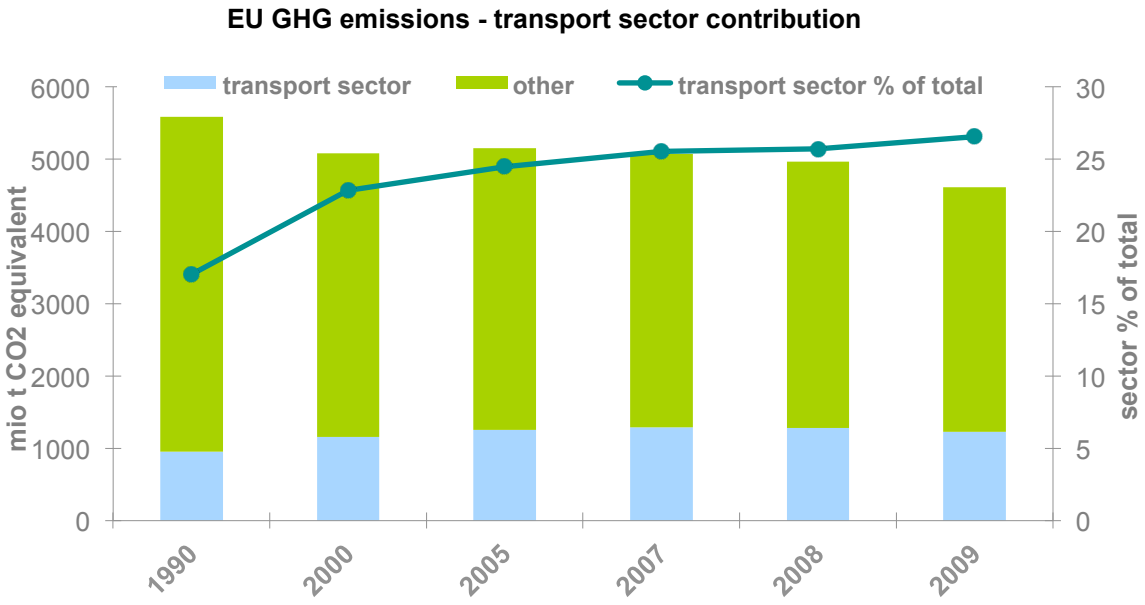

Figure 80: The contribution of the transport sector to EU-27 GHG emissions[512]

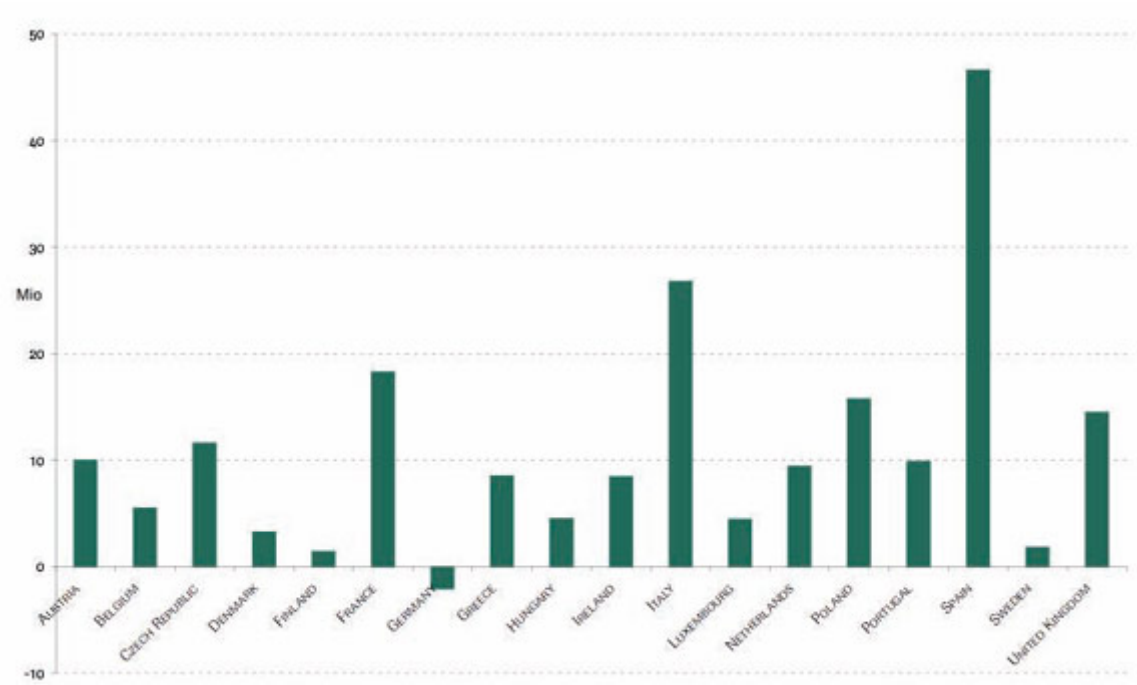

Figure 81: Change in CO_2 emissions from road traffic in the EU (1990–2006)[513]

Figure 80 shows the share of transport sector related fuel GHG emissions in the EU which have increased over the last two decades from 18 % to almost 25 %. Depending on the

[512] EU Pocket Book 2009:184
[513] http://www.vda.de/de/arbeitsgebiete/co2-verkehrssektor/index.html

country, the current transport sector contribution ranges from 15 to 40 %.[514] The share of road transport emissions has declined slightly because of growing shares of aviation.[515]

4. Energy use

Urban transportation systems depend to 98% on oil-based fuels besides natural gas (especially taxis and fleets) and electricity (rail-based systems).[516] The problems related to the use of energy resources are 1) resource depletion and 2) resource dependency:

1) The high dependency of the transport sector on oil threatens the availability of oil for other uses, esp. in the petrochemical industry which has greater difficulties to find substitutes for oil than the transport sector.
2) A transportation system which depends on a single source of energy for most of its vehicles is vulnerable to resource shortages and price hikes. Most of the oil reserves are located in countries where state-owned companies control the resource or where political instability increases the investment risk.

5. Safety

"A civilised city is not that one with highways but rather one where a child on a bicycle can safely go anywhere." This quote by Enrique Peñalosa, urban planning pioneer and former mayor of Bogotá reflects the current discontentment of many citizens and planners with the damage on the urban environment caused by traffic. Accidents incur social costs for those aspects which are not covered by risk-oriented insurance premiums. Accidents cause material damages, administrative costs, medical costs, production losses and pain, grief and suffering.[517]

While road-related death and serious injury rates are declining in the developed world, they will rise in less-developed countries.[518] In the OECD Europe, 50 % of the victims of road related deaths are LDV occupants, while this number rises to 80 % in OECD North America.

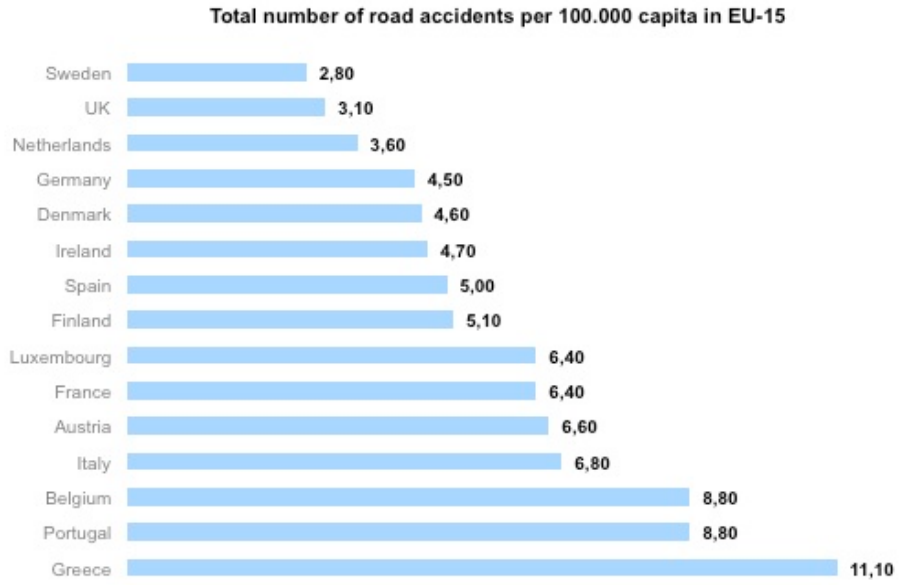

Figure 82: Road accidents in EU-15[519]

[514] EU Pocket Book 2009:190
[515] EU Pocket Book 2009:194
[516] IEA 2008
[517] Maibach/Schreyer 2008:38
[518] WBCSD 2004:42

6. Equity and accessibility

The former mayor of Bogotà, Enrique Peñalosa, who contributed much to closing the social mobility divide in Columbia's capital by introducing a first-class Bus Rapid Transit system and improving non-motorised transport infrastructure, poignantly asks: "Do we want to create a city for children and the elderly, and therefore for every other human being, or a city for automobiles? […] A city is more civilised not when it has highways, but when a child on a tricycle is able to move about everywhere with ease and safety."[520] This is the umbrella statement for discussing social mobility divide in any city.

While "the transport infrastructure, together with the resources available to individuals, determines each individual's level of *mobility* (the capability for physical movement), the spatial arrangement of activities and households determines *accessibility* (the availability of employment, educational, social, and cultural opportunities)."[521] Access equals social inclusion[522] and is the foremost responsibility of urban planning and transport policy.[523] Access problems are most prevalent in emerging and developing cities,[524] but there is a growing mobility exclusion of parts of the population in OECD cities as well.[525] Poor people spend a higher proportion of their income on mobility and thus can afford only low-cost alternatives; often they live in places that are either too remote from major traffic nodes or too close to major traffic axes where they suffer from pollution and noise, thus being affected by burdens of mobility more than wealthier people.[526]

Car-oriented urban planning involves a car-oriented land-use strategy and neglects those transport modes that account for a high share of trip among young, elderly, and poor people. On the other hand, an equitable urban transport planning paradigm "implies developing urban regions that offer people and firms the means to reach *more* opportunities (such as jobs, services, social contacts) with *less* mobility" [527] and a focus on public transport and NMT modes. This improves social, environmental and economic sustainability of transport systems.[528]

In the EU, the social mobility divide is characterised by a lower car ownership rate, lower trip rates and lower trip lengths of poorer social strata compared to wealthier ones.[529] Those from households with access to a car travel more frequently, further, and for longer durations. Thereby they increase the number and variety of destinations to which they have access.

7. Macroeconomic costs

Traffic generates many different costs: direct costs from infrastructure (construction and maintenance) and so-called external costs, i. e. costs of side-effects from congestion, accidents, pollution etc. It also generates individual financial outlay required to obtain desired personal and goods transport services.[530]

Even though internalising external costs (e. g. costs arising from accidents, pollution, congestion, see Table 18) is a clear objective of the European transport agenda there has been only slow progress in achieving this goal.[531] One reason for this persistent market distortion is that it provides access to cheap (road) mobility for a large share of society. Another reason

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519 IRTAD 2011:15
520 Peñalosa 2003:xxvii, xxxi
521 Docherty 2008:84
522 Hine 2008:49; WBCSD 2004:22; for the categories of exclusion see Hine 2008:51-52
523 Cox 2010:69; Holz-Rau 2007:22
524 Zegras 2006
525 Tully 2006:230
526 Martin 2009:223; Axhausen 2006:16
527 Bertolini 2008:71
528 Docherty 2008:84
529 Stradling/Anable 2008:184; WBCSD 2004:35
530 WBCSD 2004:19
531 EEA 2008:15

is of a more methodological nature: the difficulty to assess external effects, transform them into monetary values and then find adequate measures for their internalisation.

External effects of road transport – main issues	
Congestion costs (road)	Time and operating costs Add. safety and environmental costs
Scarcity costs (scheduled transport)	Delay costs Opportunity costs Loss of time for other traffic users
Accident costs	Medical costs Production losses Loss of human life
Air Pollution	Health costs Years of human life lost Crop losses Building damages Costs for nature and biosphere
Noise costs	Rent losses Annoyance costs Health costs
Climate change	Prevention costs to reduce risk of climate change (mitigation) Damage costs of increasing temperature (adaptation)
Costs for nature and landscape	Costs to reduce separation effects Compensation costs to ensure biodiversity
Additional environmental costs (water, soil)	Costs to ensure soil and water quality
Additional costs in urban areas	Separation costs for pedestrians Costs of scarcity for non-motorised traffic
Up- and downstream processes	Costs of the whole energy cycle (environmental and riskeffects of energy supply)

Table 18: External effects of road transport[532]

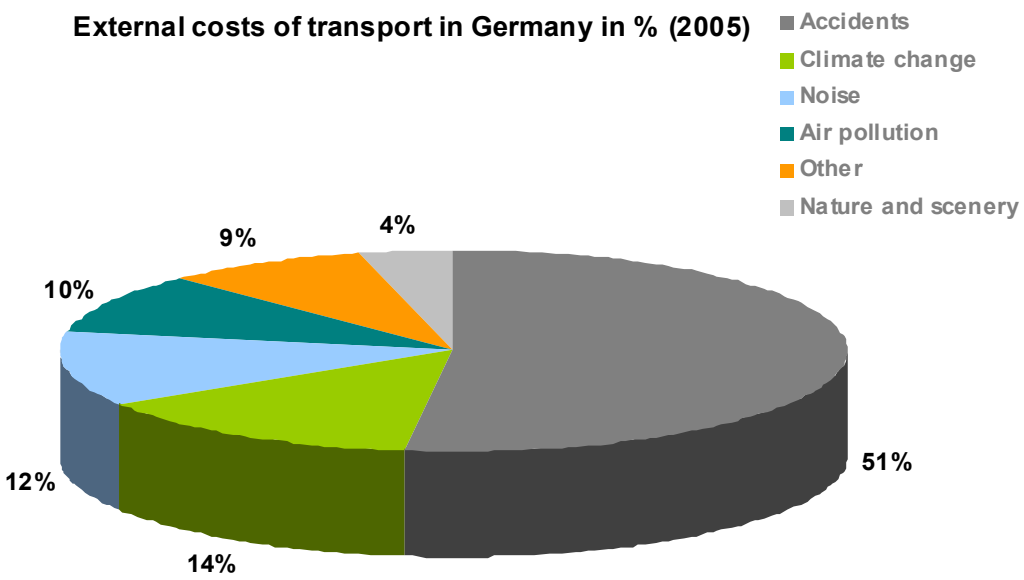

Figure 83: External costs of transport in Germany by sector affected[533]

[532] Maibach 2008:24-25

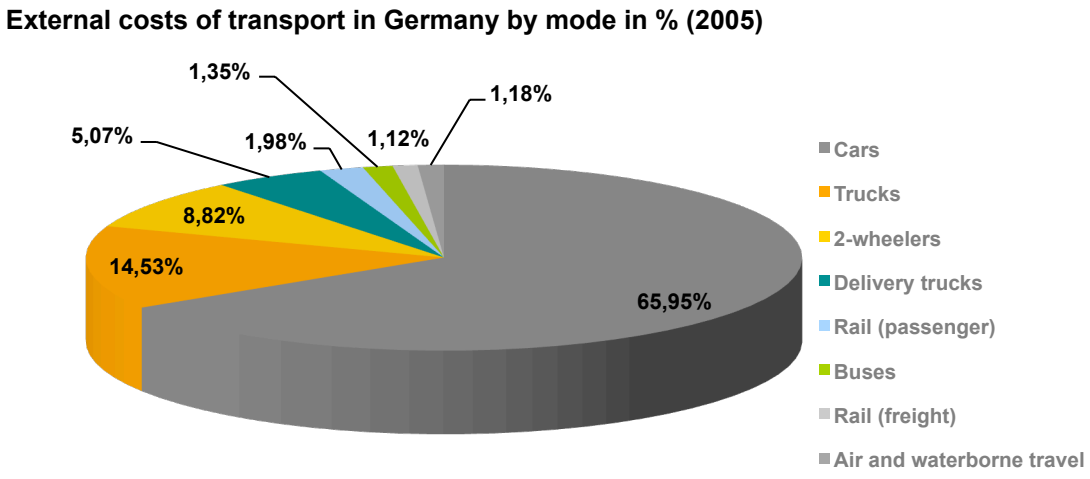

Figure 84: External costs of transport in Germany by transport mode[534]

As the example for Germany shows, half of the costs are safety related, while the rest is related to resources and nature. About two thirds of external costs have their origin in passenger car transport, followed by road freight transport. Depending on the methodology of calculating external costs these figures can vary significantly.

Outlook to 2020

- Space- and accessibility-related burdens of mobility will aggravate the most until 2020.
- Macroeconomic costs of negative traffic impacts will strain public budgets and lead to a priority of cost-effect analyses in transportation planning.

Implications for mobility services

- Due to increasing burdens of mobility, especially affecting traffic flows, citizens might decide to dispose of their car and use faster modes of transport instead. In many cases, rail-based urban transport is faster than road-based transport. This increases the need for integrated mobility services (assistance and information). It also increases the demand for vehicle provision services for those purposes where individuals can not do without a car.
- With increasing problems affecting the urban population individuals may increase their awareness and thus their willingness to change their mobility behaviour. This may include using mobility services, public transport and the like.
- Many of the side effects of mobility can be mitigated by increasing public transport and NMT shares. As cities and governments encourage citizens to use these modes and discourage car travel the demand for mobility services will automatically rise.
- Some mobility services reduce the access barriers for less-mobile groups. E. g. public car or bicycle fleets provide access to vehicles for those who do not own any.

[533] Schreyer/Maibach 2005:5
[534] Schreyer/Maibach 2005:6

3.3.10. Environment and transport policies

Definition

Policies relevant for the transport sector

Description

Policies relevant for the transport sector are derived from environment, energy, economic or special transport policy programs and have the objective of mitigating the burdens of mobility (see key factor 9 “Burdens of urban mobility”, chapter 3.3.9), most prominently GHG emission and local emission (pollution) reduction. Most policies relevant for urban transport are legislated on the national or, in the case of the EU, on the supranational level. Especially GHG emissions are also addressed by international treaties.

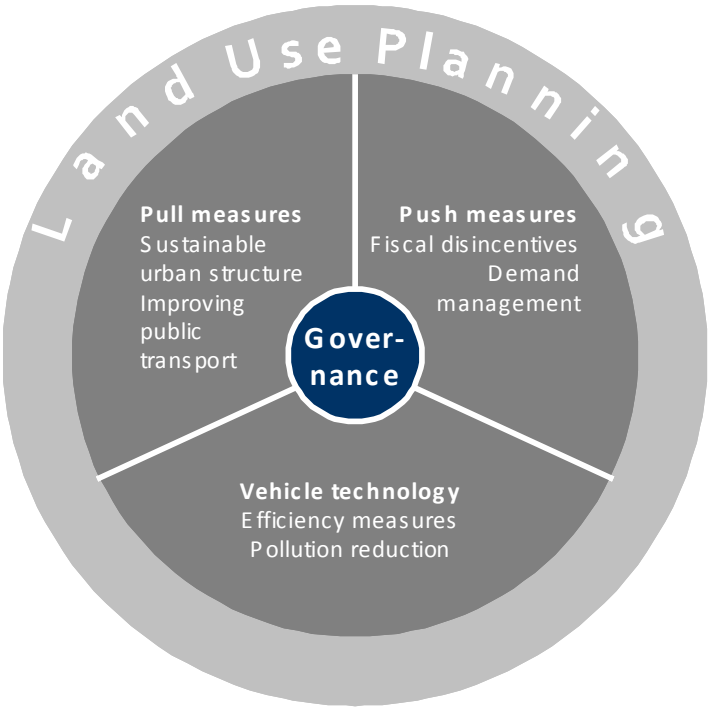

Figure 85: Elements of integrated urban transport planning[535]

Policies relevant for urban transport can be divided into four categories (see figure above):

1. Pull measures: incentives for using sustainable means of transport (fiscal and non-fiscal), e. g. improved public transport, fare subsidies, exclusive pedestrian zones, integrated mobility services
2. Push measures: measures which make unsustainable means of transport less attractive (fiscal and non-fiscal), like fuel taxes, congestion charges, parking fees, demand management, bans on vehicles
3. Vehicle technology: regulation of technical standards in vehicles, e. g. emission levels, CO_2 limits, safety regulations
4. Land use planning: policies and programs addressing the sustainable use of land (integrated transport planning)

[535] Proprietary illustration of the author

The four elements need to be addressed evenly in order to increase acceptance levels and achieve sustainable transport patterns in the long term.[536]

The following fields are central to mobility policy today:

Climate change mitigation

In order to mitigate climate change, air pollution and to reduce fuel use but also to generate additional revenues, most countries in the world have introduced fuel taxes. They vary by country and by fuel:

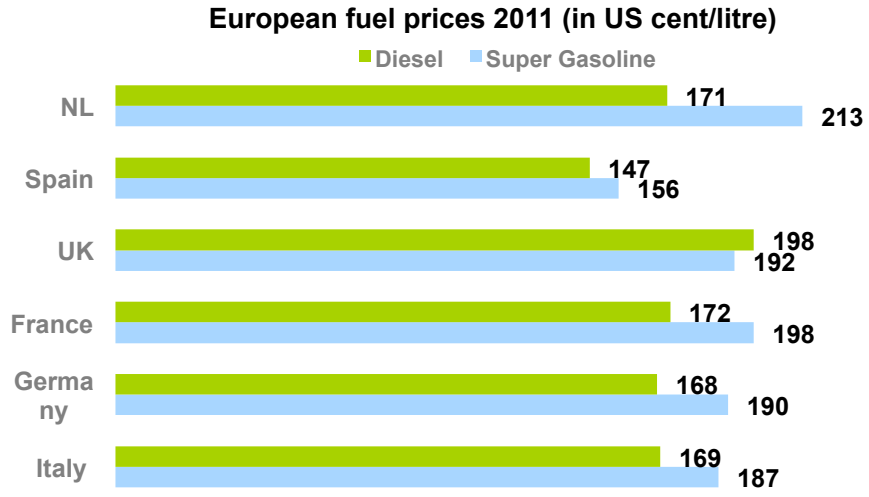

Figure 86: Comparison of fuel prices (including taxes)[537]

As climate change has become the main driver for transport policy, esp. vehicle technology regulation, additional measures are being developed and employed. The EU has set a goal to reduce GHG by 20 % until 2020 (compared with 1990 levels) resp. even 30 % if developing countries would join in the efforts. The objective for 2050 is to halve GHG emissions but for achieving the 2°C goal agreed upon in the Copenhagen Accord (2009), a reduction of 80 % of GHG would be necessary.[538]

In order to reduce transport related GHG emissions the EU has commissioned a policy package consisting of:

- Vehicle taxes and registration fees based on CO_2 emissions
- Contribution of the transport sector to the emission trading scheme
- Limiting passenger vehicle CO_2 emissions to 130 g/km (vehicle fleet average of manufacturers)

EU member states are divided over the vehicle fleet CO_2 limits. Countries home to car manufactures of small efficient vehicles (e. g. France, Italy) welcome the strict limit while those home to manufacturers of larger cars (e. g. Germany, UK) oppose it and suggest a limitation based on vehicle class for levelling competition. As to now, the goals of the EU are likely to become more ambitious: By 2012, 65 % of new vehicles have to emit less than 120 g/km CO_2; and by 2015, this limit will apply to the complete vehicle fleet. The 120g/km CO_2 emis-

[536] compare Newman/Kenworthy 2007:66f.; EEA 2007:314; IEA 2009:237ff.; for an overview of alternative categorisation concepts see Schellhase 2000:59
[537] GIZ 2011:50f.
[538] EEA 2007:169f.

sion target would contribute to a 35 % reduction of transport related carbon emissions over 1995 levels. Car manufacturers not complying with the policy have to pay a sanction fee of 95 € per additional gram CO_2 emitted by their fleet. 10 g of the 130 g/km goal can be achieved through improved air conditioning, lower rolling resistance of tyres, tyre pressure monitoring systems, and gear shift indicators.[539]

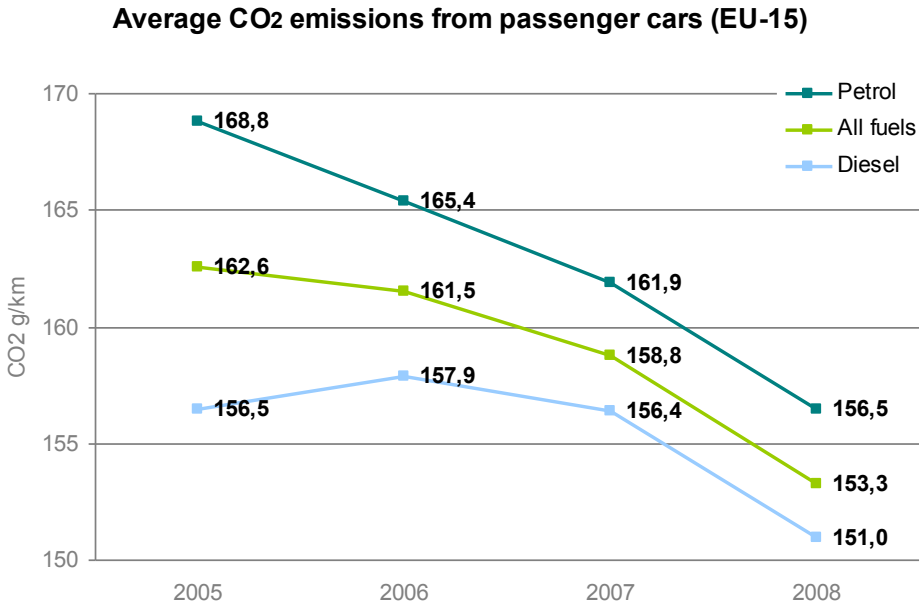

Figure 87: Development of passenger car emissions[540]

[539] European Commission 2008
[540] European Commission 2010

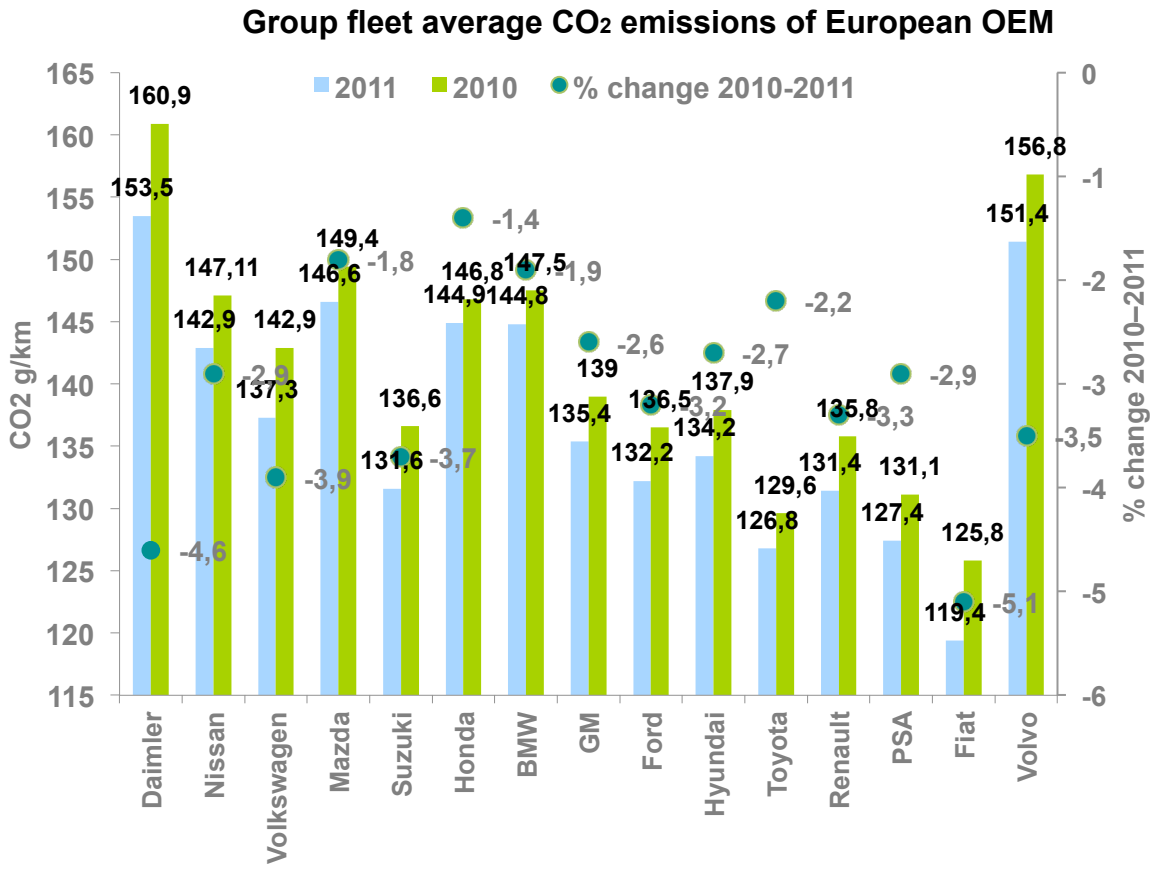

Figure 88: Group fleet average CO_2 emissions[541]

The CO_2 emissions of alternative fuels and drivetrains can and need to be taken into account as well. While the CO_2 balance of biofuels depends on the raw material and production processes used the balance of BEV (see chapter 3.3.4 for governments' BEV market innovation programs) depends on the energy mix used to generate the electricity:

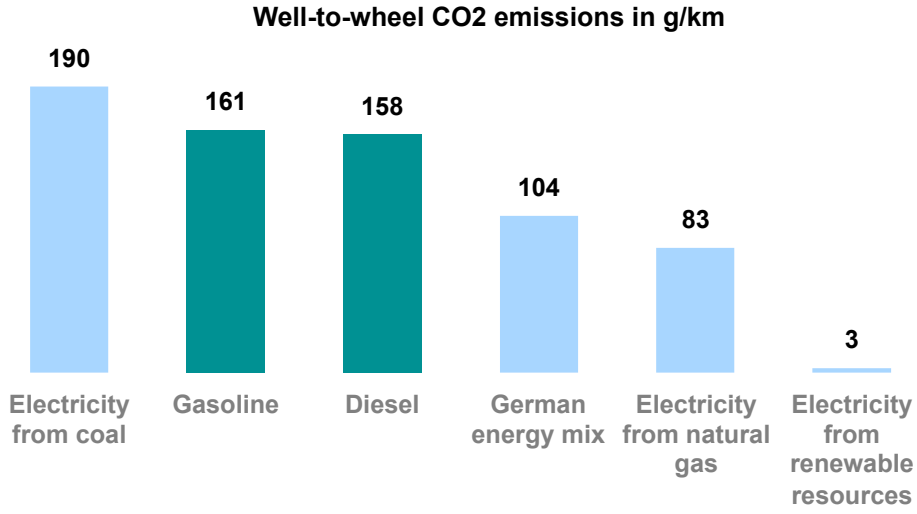

Figure 89: CO_2 balance of battery electric vehicles[542]

[541] T&E 2011:18

Another option would be to include cars in the European emissions trading system, a widely discussed issue in Europe. This would add only a few cents to fuel prices and provide no meaningful incentive to improve fuel efficiency. It is therefore unlikely to be implemented in the near future.

Demand management measures

Burdens of urban mobility like congestion and pollution have motivated decision makers to impose several demand management measures under the umbrella term *congestion pricing/charging*. This measure is a way of harnessing the power of the market to reduce the waste associated with traffic congestion.[543] There are different types of congestion charging:

1. Variably priced lanes, involving variable tolls on separated lanes within a highway, such as Express Toll Lanes or High Occupancy Toll Lanes ("HOT" lanes)
2. Variable tolls on entire roadways – both on toll roads and bridges, as well as on existing toll-free facilities during rush hours
3. Cordon charges – either variable or fixed charges to drive within or into a congested area within a city
4. Area-wide charges – per-mile charges on all roads within an area that may vary by level of congestion

Charging vehicles for entering a zoned area of a city (3. Cordon charges) can reduce traffic significantly in a given area, but it rarely reduces overall traffic volumes of a city. Its effects on modal split are limited but can be enhanced by improving the quality of the public transport system and of NMT infrastructure.[544] Another goal of congestion charging is to generate revenues for the public sector.[545] So far, congestion charging has been introduced in the following cities:

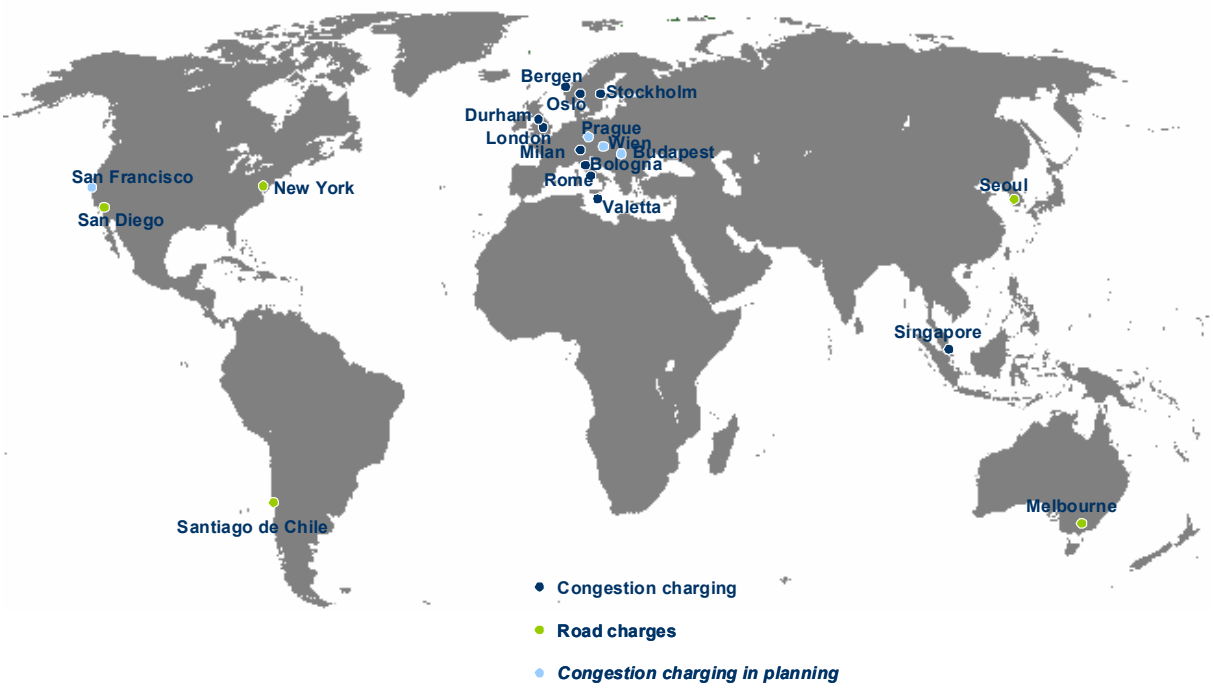

Figure 90: Cities with congestion charging or road charging

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542 Leschus/Stiller 2009:33
543 US DoT 2008:4
544 Becker/Gerike 2009:184
545 Leape 2010:159

In the EU, the Netherlands were even planning to introduce area-wide charges by 2011. The scheme was supposed to use satellite technology to track every vehicle in the country and charge them per-mile driven according to a flexible rate schedule, differentiated by time, place and environmental characteristics while proportionally eliminating fixed charges. Initially the program would have covered just commercial trucks, expanding to all vehicles by 2018. Due to a change of government in the Netherlands in early 2010 the introduction of area-wide charges was abandoned. Since area-wide charges replace a straight vehicle tax for a per-mile fee, car purchase would become cheaper and car ownership were likely to grow. On the other hand, distances driven would drop, thus making "mobility as a service" arrangements more attractive.

After this policy initiative failed, another innovative measure in the Netherlands made the headlines in 2011. In two metropolitan areas in the Netherlands, around Utrecht and Rotterdam, an inverted congestion charge for frequent commuters has been introduced. Commuters receive a cash credit in the beginning of each month (transferred onto a chip card installed in an so-called "S-Box" in their cars) and are charged every time they use highways during rush hours. If they use the highway during low traffic hours, the credit remains on their S-Box, earning them an attractive extra income. As only frequent commuters are eligible for the measure, the effect has been small but not without effect on congestion. Rewarding favourable behaviour instead of punishing negative behaviour seems to be a feasible option for managing traffic.

There are also downsides of demand management measures. The costs and effects of these measures have to balanced thoroughly in order to avoid acceptance gaps. The following table provides an overview of the advantages and disadvantages of road and congestion pricing measures:

Advantages	Disadvantages
• Reduction of traffic volumes • Reduction of travel times • Internalisation of costs • Financing instrument for transport sector • Reduction of demand for parking spaces in charging areas • Reduced land use • Reduced emissions and resource use	• High costs of installation and maintenance • Acceptance gaps • Higher costs for good transport • Lower frequentation of stores and facilities in charging areas • Higher demand for parking spaces on roads bordering the charging area • Shift of traffic to lower-level roads • Discrimination of low-income population • Privacy issues

Table 19: Congestion and road charges: pro and contra[546]

Parking fees: Pricing parking spaces has the objective of reducing car traffic in a given area, making public transport more attractive and preventing irregular parking practices. It is also a means to raise revenues, to improve the urban quality of life and to reduce the need for expansion of parking spaces. As with congestion charges, modal split effects are only significant if alternatives to using a private vehicle are rendered more attractive. Parking fees are pervasive in most city centres in EU-15 countries.[547]

Air pollution

Air pollution is regulated by the EU directive 2008/50/EG which aggregates the former directives 1999/30/EG (SO_2, NO_2, NO_x, PM_{10}, lead), 2000/69/EG (CO, benzene), and 2002/2/EG (ozone). The threshold values are updated continually. Cities and communities are required

[546] Becker/Gerike 2009:183 and contributions of the author
[547] Becker/Gerike 2009:222f.

to develop air pollution mitigation plans which include appropriate measures for achieving the goals set by the EU directive. Cities are monitoring ambient and roadside air quality closely. If necessary, e. g. during summer smog, moderate driving bans can be established in order to avoid hazardous pollution levels. On a more long-term basis, solving local air pollution problems from traffic can be achieved by the following strategic approaches:[548]

- Vehicle technology and maintenance regulations: Vehicle emissions standards that limit the amount of certain pollutants are being raised steadily in the EU. Currently, new vehicles have to meet the Euro 5 standard and in 2015, the Euro 6 standard. Vehicles in use have to pass biannual emission checks. A very popular technology for reducing urban air pollution in the future will be BEV which – also for other reasons like oil independency – are being promoted by all major European governments (see chapter 3.3.4).

- Fuel technology: Fuel standards in the EU are the highest in the world. Lead has been phased out of fuels in all OECD countries in.

- Systemic approaches (driving conditions): Encouraging or forcing citizens to drive at lower speeds is an efficient measure to lower air pollution.

- Traffic management: Smoothing traffic flows lowers air pollutions levels significantly.

- Behavioural strategies: Encouraging modal shift and improving accessibility influences mode choice and route planning.

Low-pollution or green zones: Excluding highly polluting vehicles from certain urban areas seems to be a popular but ineffective measure for reducing local air pollution. So far, this approach has only been applied in some cities in Germany (since 2008), and first results find that local air pollution has hardly improved. The reason is that only cars with high relative pollution levels are addressed, not absolute emissions. As the bill excludes older cars but not gas guzzling ones the total pollution figure is rarely lower than before the introduction of the zone.[549]

Noise pollution

In the EU, there is no general noise limit for road traffic. The EC directive 2002/49/EC mandates a quantification of environmental noise caused by traffic and other noise emissions. Large agglomerations and highways are obliged to develop strategic noise plans. Measures to reduce noise levels are mandated locally and include use of noise barriers, limitation of vehicle speeds, alteration of roadway surface texture, limitation of heavy vehicles, use of traffic controls that smooth vehicle flow to reduce braking and acceleration, and tire design.

Safety

Safety hazards cause the largest external costs of road transport (see Figure 81). Safety regulations for traffic and vehicles have been prominent in legislation since the beginning of automobile transport. Increasing safety regulations for cars already reduce design options and often contradict other requirements, e. g. resource efficiency. The EU has adopted the "Vision Zero", i. e. a maximum reduction of side effects of accidents and hazards. The following measures and policies can contribute to the reduction of safety hazards:[550]

- Infrastructure improvement, e. g. separation of transport modes, protection of lanes, shared space, roundabouts
- Non-fiscal measures, e. g. speed limits
- Vehicle features, including measures for active and passive safety
- Traffic education, esp. for children and youth

[548] Gorham 2002:53f.; EEA 2007:316; Becker/Gerike 2009:166
[549] Wisbert 2009:41
[550] Becker/Gerike 2009:123

Subsidies and market distortions

While many of the environment and transport policies aim at curbing car ownership and use, others are the origin of price distortions that favour car use: These might include: fuel subsidies to other sectors with unintended but predictable effects on the transport sector; general subsidies to road users built into the financing of how roads are constructed and maintained, and ancillary services delivered; hidden and fixed costs in road infrastructure and land-use provision, which send unclear price signals to potential travellers; and secondary price distortions in land values that incorporate or capitalise these other (primary) distortions.[551]

Supporting behavioural change

Measures to influence individual mobility behaviour range from basic information measures to full-cost recovery measures. [552] More specifically, these include

- Creating new mobility options for users
- Regulatory measures combined with sanctions
- Financial incentives
- Consumer education and communication
- Ideological support for model behaviour
- Change of the organisation of transport
- Influencing values and norms

The evaluation of the effectiveness of behavioural measures is more difficult than evaluating technological advances but it is widely acknowledged that the introduction of behaviour changing measures is paramount for achieving sustainable transport development.

In summary, the effects of different transport policy measures are as follows:

	Impacts on …			
Measure	**Reduction of traffic volumes**	**Shift in transport modes and routes**	**Improvement of transport vehicles and infrastructure**	**Direct reduction of emissions**
Land use planning				
Compact city	X	X	X	
Integration of land use and transport planning	X	X		
Reduction of road expansion	X	X		
Promotion of local economies	X			
Funding of environmental friendly transport modes				
Rail		X	X	X
Inland waterways		X	X	X
Public transport		X	X	X
NMT		X		
Car sharing		X	X	X
Fiscal measures				
Taxes on kerosene	X	X	X	X
Truck tolls	X	X	X	
Adaptation of vehicle and fuel taxes	X	X		X

[551] Gorham 2002:3; Becker/Gerike 2009:30f.
[552] Blythe 2008:6

Reduction of traffic inducing tax privileges	X	X	X	
Vehicle technology				
CO_2 limits for LDV				X
CO_2 limits for commercial vehicles				X
Alternative fuels and drive trains				X
Increased energy efficiency of trains			X	X
Driving and consumer behaviour				
Fuel economy information for customers				X
Fuel efficient driving methods				X
Speed limits				X
Car pooling	X			X

Figure 91: Impacts of transport policy measures[553]

Outlook to 2020

- Harmonisation of transport policy in the EU is likely to increase.
- Due to worsening environmental conditions and burdens of mobility, transport regulation will intensify.

Impacts on mobility services

- Regulatory constraints will make car ownership and use less attractive.
- As most of the policies mentioned concern vehicle technology they have an indirect impact on mobility services: Many policies lead to higher costs of owning and using private vehicles; therefore, some individuals might opt at alternative modes of travel or at giving up their private vehicles.
- Government programs that promote BEV, esp. with battery exchange systems, can be an incentive for establishing vehicle sharing systems.
- Depending on their effectiveness, consumer education programs and image campaigns can increase the acceptance for mobility alternatives.

[553] UBA 2010:14; Becker/Gerike 2009:150ff.; and proprietary contents of the author

3.4. Conclusion: Implications for mobility services

The key factor analysis shows clearly that the demand and feasibility of mobility services will increase in the next decade. Not only will the demand for alternative transport modes per se be increased but also for services which assist people in managing their intermodal mobility lifestyle. Another group of factors will result in a decline of the conventional car ownership model and will give rise to "use, don't own" concepts.

The reasons for the increasing **demand** for mobility services are:

- Policies infringing car ownership and use and encouraging the use of alternative modes of travel
- Rising fuel prices which make private car ownership and use less attractive
- Burdens of urban mobility which make alternative modes of travel imperative
- Postmodern societal trends of utilitarian ethics which promote use (service) over ownership (product) and functionality/rationality over emotionality/status
- Rising environmental awareness and consumer education programs

Factors which enhance the **feasibility** of mobility services are:

- Technological development (esp. smart car technologies) promotes the feasibility of convenient mobility services.
- The attractiveness of the service value chain will motivate more businesses (and esp. manufacturers) to include mobility services in their portfolio.
- BEV technology is best fit for use in fleets esp. if battery exchange technology becomes established. Government programmes that promote BEV technology can foster the diffusion of public BEV fleets.
- Policy focus on sustainable transport fosters the acceptance and spreading of low-impact alternatives to conventional transport modes which burden transport systems heavily.

The key factor analysis also identifies features and requirements for the **design** of mobility services in the future:[554]

- A tailored design for specific user groups, esp. in regard to demographic change is needed.
- Mobility services should respond to the challenges which cause the increasing demand for mobility services, e. g. rising fuel prices and regulatory policies.
- Even though TCO will rise, esp. due to rising fuel prices, purchasing prices may decrease with the advent of low-cost cars. Pricing structures for mobility services need to compete with low-cost vehicle ownership.
- Continuing urbanisation will increase the demand for intermodal mobility. Thus, a priority should be set on mobility services that foster intermodality, i. e. integrated information and assistance services.
- Vehicle provision services can reduce the access barriers for less mobile groups. When planning vehicle provision service stations they should cater to the needs of these groups (station design and location).

[554] For implications relating to the mobility behaviour of individuals see chapter 2.3.5.

Yet, the key factor analysis also shows that there is stability, if not slight growth, in car ownership due to demographic effects and societal trends of individualism and flexibility. This may stall the increase in demand for mobility services. Nevertheless, political, resource and environment trends are likely to lead to a different car "system" which will include different approaches to appropriation and use of cars, especially in cities.[555]

[555] Dennis/Urry 2009

4. Car manufacturers and the mobility services market

As elaborated in chapter 2.2.2, a paradigmatic shift is anticipated in urban transport and the role cars will play in it. Nowhere are the burdens of car-based mobility higher than in cities, and nowhere are alternatives more attractive and feasible. In a sustainable transport system, the car will play a different, more specific role than it does today. Its uses will be well-defined, and its overuse will likely be restricted in order to make room for other modes. As these restrictions will inevitably cause a decrease in car use, new options for individual mobility need to be offered.[556] Even if individuals might no longer want to own a car, they still might occasionally want to use one. Likewise, a reduction in car use will lead to a rise in the use of other modes of transport, i. e. intermodal mobility will increase. Whether these assumptions are true has been analysed in chapters 3 and 2.3.3.

In the past, mobility services were no or only a very marginal area of interest for car manufacturers. Some manufacturers used to own car rental companies, while others cooperated with car sharing companies. However, in 2009 the scene changed when car manufacturers started to engage in innovative vehicle provision services, starting with Daimler's public vehicle fleet "Car2Go", Peugeot's rental system "Mu", and BMW's "DriveNow"; later, other OEM followed suit (for a complete list see chapter 4.3). As most of these mobility services function according to the principle of "instant access, one way, open end" or include other innovative features, their acceptance was high from the beginning. Despite this remarkable success – for car manufacturers, offering mobility as a service represents a paradigm shift from the conventional product-oriented strategy towards service and customer orientation –, the following shortcomings can be noticed:

- Profitability: So far, mobility services by car manufacturers are not or only little profitable.
- Intermodality: The vehicle provision services do not facilitate intermodal mobility (except Citroen Multicity).
- Information and assistance services: Information and assistance services, which enable seamless intermodality, are offered only by a minority of car manufacturers, and often have only a limited application range.
- Consolidation: As for the whole mobility services market, the car manufacturers-owned mobility services could benefit from some consolidation in order to pool markets and customers.

After chapter 3 argued that external factors will drive the demand for mobility services in the future and therefore car manufacturers should engage in this new promising business area before somebody else will[557] – and they rightly have done so – this chapter will take a look at existing activities of the automotive industry in the mobility services market and then identify and describe six potential service concepts that could be deployed by car manufacturers. Both existing and potential services will be assessed according to the catalogue of requirements below, followed by recommendations for selecting appropriate services. They will be the basis for the strategic options and conclusions which will follow in chapter 5.

[556] Winterhoff 2009; Canzler/Knie 2009; Herdegen 2006; Grünig/Marcellino 2009; Karl/Maertins 2009
[557] Levitt 1975 [1960]:7; Inkinen 2009:4

4.1. Catalogue of requirements

The catalogue of requirements operationalises the findings of the key factor analysis (chapter 3) and the mobility services user analysis (chapter 2.3.3.3) related to the design of mobility services. Those factors that occurred repeatedly and have the highest importance for the future development of urban development and mobility services were included in the catalogue. The catalogue of requirements will be used for checking the market acceptance of potential mobility services in chapter 4.2 and existing services in chapter 5:

Requirement	Description	Indicators for rating
Simplicity	The level to which a service can be used without further instruction or preparation	Low: The service is complicated to understand and requires substantial registration etc. procedures. Medium: The service requires an acceptable level of registration procedures etc. and of instruction. High: The service requires none or only one step of registration etc. and its usage is self-explanatory.
Reliability	The level to which a user can rely on the proposed service characteristics, e. g. punctuality.	Low: The user can rely only randomly on the proposed service characteristics. Medium: The user can relay about half of the time on the proposed service characteristics. High: With rare exceptions, the user can always rely on the proposed service characteristics
Flexibility	Indicates how much usage patterns can be adapted to individual needs (spontaneously).	Low: The given service needs to be used by the means and patterns prescribed by the service provider. Medium: With some interaction with the service provider, usage patterns can be adapted spontaneously. High: The user determines his/her individual usage pattern.
Access[558]	Indicates the accessibility (e. g. physical proximity) of a service	Low: The service can be used only in selected (parts of) communities. Medium: The service can be used in a larger section of communities. High: The service is ubiquitous.
Availability	The level to which a service is available at a given point of time	Low: The service is rarely available when needed (due to opening hours or fully booked units) Medium: The service is available during regular hours/days but can be unavailable during rush hours High: The service is always available, no matter the time of the day or day of the week etc.

[558] For mobility services of the „information and assistance“ type, the category „access“ (physical access) does not apply.

Requirement	Description	Indicators for rating
Transparent fare and payment system	The level to which a fare and payment system can be understood and tracked and the level of instruction needed for this.	Low: The range of fares is so large and complicated that users need instruction for understanding them; the same goes for the payment system which is not intuitive. Medium: Each service element has a different price tag. Payment is made by widely accepted modes. Users receive a regular overview of their expenses. High: For standardised services, fares are uniform. Only extra services are labelled with extra fares. The payment procedure is intuitive. Users can continually track their expenses (real-time).
Attractive image	The degree to which a service reveals an attractive, popular image that raises the status of the user	Low: The service is rather unpopular or unknown, and users achieve a significant degradation of their own status. Medium: The service is not unpopular, but a user does not improve his/her status by using it either. High: The service is very popular. By using a given service, the user achieves a significant improvement of his/her own status.
Added value for users	The level to which using a given service provides a value to a user which cannot be achieved otherwise or by using conventional services	Low: The value the service provides is lower than the value of conventional services. Medium: The value the service provides is the same as the value of conventional services. High: The value the service provides is higher than the value of conventional services.
Usefulness	The number of use cases the service applies to	Low: The service applies only to a single use case. Medium: The service applies to a limited number of use cases. High: The service applies to a large number of use cases.
Intermodality	The degree to which the service facilitates intermodal mobility.	Low: The service applies to only one mode of transport and does not help the user when switching to another mode. Medium: The service implicitly encourages the use of different transport modes; however, the service itself does not facilitate intermodality actively. High: The service serves primarily intermodal mobility patterns.

Note: Another factor deduced from key factor analysis (chapter 3) is the degree to which a service responds to society's challenges, esp. the burdens of urban mobility. It can be addressed by a sustainability assessment as is common for the evaluation of transport measures. If used for evaluation, an assessment helps to analyse the degree to which a given service actually decreases the burdens of mobility or not.

4.2. Potential mobility services by car manufacturers

Disregarding the constraints regarding the opportunities for car manufacturers to engage in the mobility services market, this chapter will present potential mobility services that could be offered by or involve car manufacturers. A car manufacturer can have the role of full-service

provider, partner, or mere car fleet provider (see chapter 5.3). Besides the condition that such mobility services must in some way address the use or ownership of cars – thus eliminating traditional public transport services as a business option – there are no restraints to the design and scope of such services. Based on feasibility and customer acceptance criteria the following potential mobility services that could be offered by car manufacturers – three of them vehicle provision services, three others information and assistance services – are recommended to car manufacturers:[559]

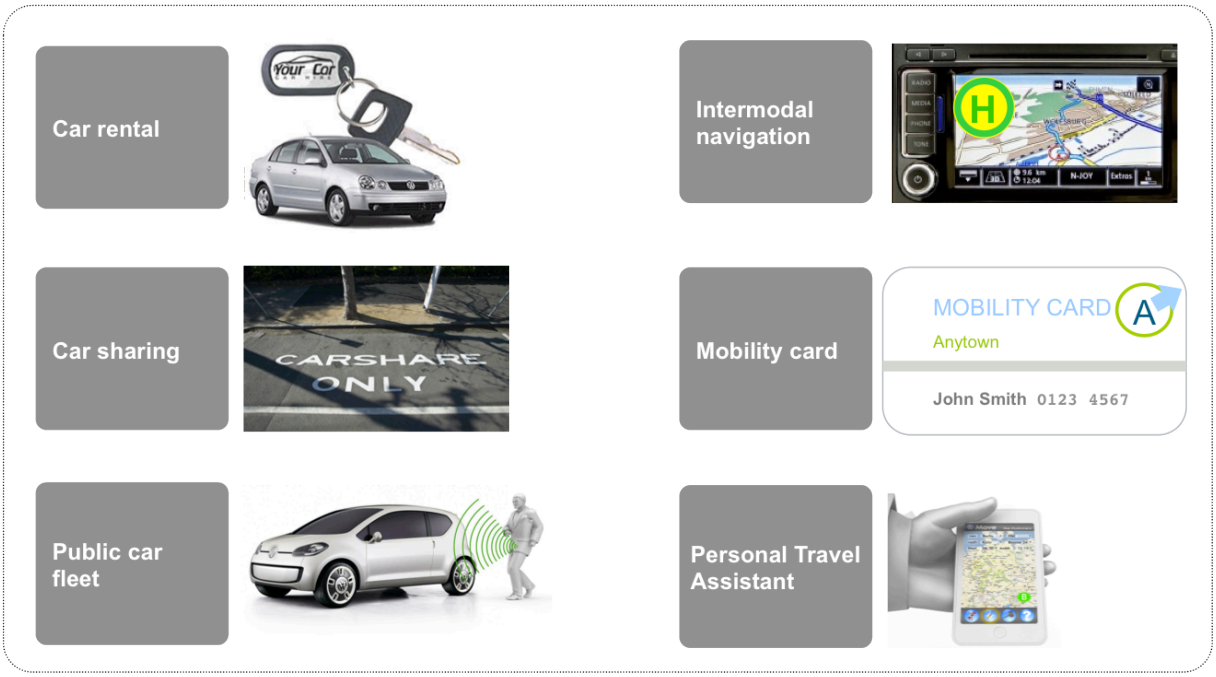

Figure 92: Potential mobility services by car manufacturers

According to the typology developed in chapter 2.3, the selected services can be characterised as follows:

	Type	**Appropriation of vehicle**	**Usage modus**	**Integration of different modes**
Car Rental	Provision of the means to be mobile	Public ownership	Individual	Monomodal
Public car fleet	Provision of the means to be mobile	Public ownership	Individual	Monomodal
Car sharing	Provision of the means to be mobile	Public ownership	Individual	Monomodal
Intermodal navigation	Information & assistance	n. a.	n. a.	Multimodal
Mobility Card	Information & assistance	n. a.	n. a.	Multimodal
Personal Travel Assistant	Information & assistance	n. a.	n. a.	Multimodal

[559] For more mobility service ideas for car manufacturers see e. g. HBK Braunschweig 2007:30f.

Table 20: Mobility services - options for car manufacturers

In the following, the six selected services will be described in detail and evaluated according to the criteria in the catalogue of requirements.[560]

4.2.1. Vehicle provision services

Car rental

A car rental provider lends vehicles on a day-to-day basis on a paid basis. Prices vary depending on the vehicle class, seasons and weekdays. Users need to return the vehicle to the same or another station of the rental network, most of which are limited by office hours. Some car rentals offer hour-by-hour rental or long-term rental (>1 month), the former potentially competing with car sharing services and the latter with vehicle leasing. Users need to register every time they rent a car, making the process rather complicated but relieving them from monthly membership fees or the like (as is necessary for car sharing). Users pay for this independence with comparatively high rental fees.

Car rental is attractive for users who are in need of enlarging a personal or company fleet occasionally resp. those who do not have a private or public vehicle at hand. The mobility types silver drivers, sensation seekers, and global jetsetters benefit most from the service because they need a private car occasionally when there is no other car at hand resp. because they like to rent special purpose vehicles (esp. sensation seekers). The added value for users in comparison to taking a taxi or car sharing lies in lower costs and higher independency: a rental car allows users to go farther for less money, esp. when shared among several users, and they are not in need of a driver. Rental cars are also a cost-efficient option for vehicle fleet managers.

Rental cars hardly compete with other modes of transport. There are only few substitutional effects: If several people share a rented vehicle the costs can be lower than taking the train or plane. However, even though rental cars can substitute the use of private vehicles, they rarely substitute their ownership. Rental car services are often linked to other modes of transport, e. g. they can be booked along with plane or train tickets, and rental car stations are typically located at airports or train stations. They are one option for closing the door-to-door mobility chain.

Car rental is a very well established service on the mobility market. It caters to the needs of a broad range of use cases which represent a mix of occasional usage patterns (private customers) and regular patterns (business customers). The market is very well defined but also very competitive. OEM benefit from incorporating a car rental service in their portfolio because it can be used as an additional distribution channel for vehicles and as a test market for new vehicles or technologies.[561] Additionally, a car rental is a means to introduce non-customers to the brand. For setting up a rental car service, a car manufacturer can use a lot of existing resources (e.g. vehicle fleet, car dealerships as stations, and existing booking systems), but also needs to establish new physical infrastructures. Since car dealerships are not always located at locations which would be useful for the use cases above they can not be used as the only source for rental stations. Other competencies needed for car rental are billing and customer management skills and vehicle maintenance. A higher flexibility of the features of a rental car service would automatically make it more similar to (flexible) car sharing and would increase its attractiveness significantly.

Indicator	Rating	Explanation
Simplicity	Low	Car rental requires substantial registration efforts.
Reliability	High	With rare exceptions, the user can always rely on the proposed service characteristics

[560] See annex 6.1 for the same information in tables.
[561] e. g. Peugeot uses its rental “Mu“ for releasing its BEV “iOn“

Flexibility	Medium	Usage patterns (e. g. change in vehicle type or time of rental process) are limited by office hours, time constraints and the need to return the car at the same station.
Access	Medium	Rental car stations, if located near public transport stations, provide access to the service in larger sections of communities.
Availability	Medium	The service availability can be limited during certain days or times of the week, e.g. holiday seasons.
Transparent fare and payment system	Medium	Each vehicle segment has a different price tag and there are a lot of package prices.
Attractive image	Medium	Rental car service is not unpopular, but a user does hardly improve his/her status by using it either.
Added value for users	Medium	Rental cars provide a service which can sometimes substituted by other services (e. g. car sharing, public transport).
Usefulness	Medium	The service applies only to a limited number of use cases, mainly business trips, holidays, and goods transportation needs.
Intermodality	Medium	Car rental is often used together with other modes of (long-distance) transport; however, the service itself does not actively encourage or facilitate Intermodal mobility behaviour.

Car sharing

Car sharing allows registered individuals to use vehicles on a pre-booking basis. Car sharing[562] is often organised as a club or in cooperatives, but can also be run as a commercially oriented business.[563] The elements membership registration, booking, and fixed stations are constitutive to car sharing and therefore do not vary significantly. Vehicles are located at fixed stations, typically close to neighbourhoods or transit stations, and usually need to be returned to the same station. As some systems offer one-way options they can be called flexible car sharing or even attributed to the public car fleet category. The borders between the two systems are fluid. Vehicles can be used on an hour-by-hour basis. Tariffs vary depending on vehicle class and contain a time and a distance element. In contrast to a public car fleet, car sharing is less flexible because it involves fixed costs and usually fixed stations on a trip-return basis. Compared to car rental, car sharing is not limited by office hours because it is all self-service. Once registered as a member, booking procedures are quite simple as they have evolved over time.

Car sharing is an alternative to the urban transport modes walking, cycling, and public transport, e. g. for moving large items, trips out of town or special occasions. Car sharing is typically used most by customer segments who do not own a vehicle, do not use their car very often or occasionally need a second car. Up to a limited amount of mileage car sharing is less expensive than owning a car. It is not attractive for daily usage and high mileages. Another factor that increases its attractiveness is the fact that users do not need a personal parking place in case car sharing substitutes a privately owned car. Car sharing appeals therefore most to the mobility types greenovators, family cruisers, silver drivers and the low-end mobility segment.

As car sharing is supplementary to NMT and public transport, it usually only substitutes for (and therefore reduces) private car use. However, it can also introduce non-drivers to car use, reduce their usage of public transport and NMT and even pave the way to car ownership.

[562] For detailed information on car sharing see momo Car-Sharing 2010; Hoffmann 2002; Schwieger 2004; Loose 2007; Fliegner 2002; Grünig/Marcellino 2009; Wilke 2007; Shaheen/Cohen 2013; see also chapter 2.3.2

[563] Grünig/Marcellino 2009:14

The collaboration between car sharing organisations and other modes of transport is crucial for its success. Joint marketing and ticketing activities with public transport operators, NMT friendly location and design of car sharing stations and location of stations close to public transport hubs are the most prominent and important activities of collaboration. Local transport providers are important partners in implementing a car sharing service. Likewise important is collaboration with communities and municipalities in order to facilitate the procurement of designated parking places for car sharing vehicles.

So far, car manufacturers have been involved in car sharing services as fleet procurement partners for CSO, e. g. Ford's partnership with GoCar (Belgium) and ZipCar (US), General Motors' partnership with Relay Rides (US, Canada), Mitsubishi's partnership with "Hertz on Demand" (UK) and Volkswagen's partnership with Streetcar (UK). OEM can benefit from car sharing in the same ways as they would from car rental. In order to set up a car sharing service car manufacturers need the following competencies: billing competencies, vehicle maintenance skills, and the willingness to cooperate with communities and other transport providers. As it is crucial to choose the right location and stations the advice of experienced CSO should be integrated in the planning process. A simpler but costlier option would be to purchase a turnkey car sharing solution from a trusted white label provider and then market it under the OEM's brand. It can also be wise to join an existing car sharing network in order to offer members a wider (e. g. nation wide) access to the vehicles.

Indicator	Rating	Explanation
Simplicity	Medium	The registration procedure is simple but the booking procedure requires some effort by the user.
Reliability	High	With rare exceptions, the user can always rely on the proposed service characteristics
Flexibility	Medium	It requires some interaction with the provider in order to change bookings.
Access	Medium	Access level depends on the system's penetration of the market but usually car sharing systems are not ubiquitous.
Availability	High	Experience shows that availability of car sharing vehicles is not a problem because subscribers use the vehicles for irregular trips.
Transparent fare and payment system	Medium	Monthly subscription fees and time- and distance-related usage fees that vary according to vehicle make the fare system rather complicated. However, monthly bills make fees transparent.
Attractive image	Medium	The image of car sharing has improved over time. It used to be a service used only by environmentally oriented groups. However, with the evolution of car sharing technology and the change in the status symbol of cars, the image of car sharing has improved, even though not to a level where it is very popular.[564]
Added value for users	Medium	Car sharing makes car usage independent of vehicle ownership but due to its constraints in flexibility and the high price tag the added value is higher only for certain mobility types.
Usefulness	Medium	The service is only useful for irregular trips. It can not be used for daily commuting or long-distance trips.
Intermodality	Medium	Many carsharing trips are monomodal because they usually require the return of the vehicle to the original location; however, carsharing users tend to have a multimodal mobility behaviour. The carsharing service does not necessarily encourage the use of other transport modes, but memberships can be connected e.g. with monthly public transport subscriptions.

Public car fleet

[564] see chapter 2.3.2

For a public car fleet (also called flexible car sharing), a provider places public cars in a given area for public use. After initial registering, users can access the vehicles via a digital identification system (keyless access). There are no limits on trip length or usage time; the only limit is that vehicles need to be returned within the given area. Optionally, exclusive parking lots can be provided. Payment is automatic; costs are based on pay-as-you-go tariffs, there are no fixed costs. Designed in this manner, a public car fleet fulfils the principles of "instant access, one way, open end" which are so crucial for customer acceptance because they imitate private car ownership and use.

Public car fleets are very simple to use. There are no monthly subscription or membership fees. Payment is automatic; costs are based on pay-as-you-go tariffs, there are no fixed costs, and pre-booking is optional. Tariffs should be kept transparent and simple; a single fee structure for use per time has proven as very efficient (e. g. minute tariffs, hourly tariffs).

Public vehicle fleets can work with fixed stations or without but can always be used one-way. Fixed stations mean lower flexibility for the user, but less effort for locating vehicles and for finding a parking lot. It is more similar to conventional car sharing. A comparable existing service on the market is the Autolib' fleet in Paris operated by the Paris municipality, to be opened in late 2011. Without fixed stations, vehicles can be parked anywhere or, if provided, on exclusive parking lots. They are located via GPS. This offers higher flexibility for the user, but more effort is needed for locating vehicles; if no exclusive parking lots are provided, efforts for finding a parking place in inner city areas can be high.[565] For comparable existing services by car manufacturers currently on the market see chapter 4.3.2.

Public vehicle fleets are used for spontaneous short trips within a city and for closing door-to-door mobility gaps. As there are no fixed costs and the access to the vehicles can occur easily and spontaneously public vehicle fleets are attractive for all mobility types with the exception maybe of the sensation seekers. Trips by public car can substitute trips by bike, public transport, private car, or taxi. They do therefore not necessarily balance an individual's modal split. However, if used as a substitute for a private car users tend to have a comparatively higher share of public transport and NMT in their modal split.

Car manufacturers would benefit from integrating a public vehicle fleet very much like from the other vehicle provision service types suggested. The largest benefit is definitely the opportunity to address the needs of non-car owners and to introduce them to the vehicle brand. As public vehicle fleets have a higher visibility in cities than the other two services the corporate image related effect of introducing such a service will be significantly higher.

Like for car sharing, the most important partners for introducing a public vehicle fleet in a city are local governments and public transport providers. Competencies needed for providing the service are customer relationship management, billing, and vehicle maintenance. It is crucial to choose the right locations and stations; therefore, the advice of experienced public fleet providers should be integrated in the planning process. A simpler but costlier option would be to purchase a turnkey solution from a trusted white label provider and then market it under the OEM's brand. Once established, it is promising to join an existing public vehicle network in order to offer members a wider (e. g. nation wide) access to public vehicles.

Indicator	Rating	Explanation
Simplicity	High	Public car fleets require only one step of registration. Their usage is self-explanatory.
Reliability	High	With rare exceptions, the user can always rely on the proposed service characteristics.

[565] Grünig/Marcellino 2009:19

Flexibility	High	In contrast to the other two proposed vehicle provision types (car rental, car sharing) the user determines his/her individual usage pattern and can change plans spontaneously because the system fulfils the criteria of a privately owned car: one way, open end, instant access.
Access	High	The service is not likely to be ubiquitous; however, in the locations where it is installed it provides very high access levels.
Availability	Medium	Even though vehicles tend to spread evenly across the city availability can be a problem in certain areas.
Transparent fare and payment system	High	Simple tariff systems and automatic fee collection via credit card make payment procedures easy to understand, transparent and intuitive.
Attractive image	High	Because the service appeals to the new mobility paradigm (see chapter 2.3.3.1) the service is very popular and improves the status of its user.
Added value for users	High	The value the service provides is higher than the value of the other vehicle provision services as it offers maximum flexibility, high access levels and no fixed costs.
Usefulness	Medium	The service applies only to shorter trips within cities and is less useful for regular commutes or long-distance trips.
Intermodality	Medium	Trips with a public vehicle can be mono- or intermodal as the vehicles do not need to be returned to the original location. A public vehicle fleet encourages a diversified (multimodal and Intermodal) mobility behaviour only implicitely, but not actively.

4.2.2. Information and assistance services

Intermodal navigation

Common navigation systems assist in route planning and guidance for trips by car. Incorporating information about other modes of transport could help car drivers improve their modal split. This includes mainly information about schedules and fares of the public transport and mobility services within a given area. Intermodal navigation would also assist users in choosing the most convenient, cost-efficient, and/or time-efficient means of travel. Advanced versions could include the ordering of tickets or the booking of publicly available vehicles; portable versions could substitute for paper tickets and render the system very similar to the smart phone application “personal travel assistant” suggested below. Ideally, intermodal navigation systems would be either portable or could be synchronised with other portable devices (e. g. smart phones).

Intermodal navigation system would be perfect for combined car trips and non-routine trips when there is the need of switching transport modes spontaneously. All mobility types, especially those highly dependent on cars (family cruisers, global jet setters, but not necessarily sensation seekers), benefit from intermodal navigation as it assists them in making smart choices with less effort. Depending on the preferences of the user on convenience, time or cost efficiency, the system may shift users' travel behaviour and thus will cause substitution effects.

Offering an intermodal feature along with conventional navigation systems is an attractive extra for those considering purchasing a vehicle. It appeals especially to intermodal customer groups. Because an intermodal feature represents a manufacturer’s openness toward new mobility patterns it would also improve its public image.

Collaboration with other transport providers is essential for the success of intermodal navigation systems. Competencies a car manufacturer needs for providing this service are profound knowledge in interface R&D and experience in collaboration with other mobility providers.

Indicator	Rating	Explanation

Simplicity	High	In case a booking feature is included, a single-step registration procedure would be sufficient. The usage is mostly self-explanatory, but people used to normal navigation systems need some instruction in order to use the system appropriately.
Reliability	High	The user can always rely on the proposed service characteristics.
Flexibility	High	An intermodal navigation system does not need to be used according to any fixed patterns.
Access	n.a.	
Availability	High	With rare exceptions (e.g. when GPS connections do not work correctly) the service is always available.
Transparent fare and payment system	Mixed	The services can potentially be free of charge. The rating for this indicator therefore has to be mixed.
Attractive image	Medium	The user's status is neither improved nor downgraded by the service.
Added value for users	High	The value the service provides is high because it combines the functions of conventional navigation systems and a mobility card.
Usefulness	High	As intermodal navigation integrates all transport modes except NMT (depending on the extent of the services) the service applies to many use cases.
Intermodality	High	An intermodal navigation intends to remove actively many obstacles that occur in intermodal mobility.

Mobility Card

A mobility card allows users to book and pay different means of transport (public transport, vehicle provision services) and associated vehicle services (fuelling, repair and maintenance of vehicles) via a single customer card. Provided by an OEM, it would combine all booking procedures in one single "label". Users would receive monthly bills from the OEM (not from the other providers) with a detailed overview of all tickets and services purchased. Because ticket purchases are cash-free and only a single registration is needed, a mobility card fosters intermodal trips, especially non-routine trips. It would appeal most to the mobility types greenovator, silver driver, high-frequency commuter, and low-end mobility users.

Partners needed for establishing this service are public transport providers and providers of other mobility services. A comparable existing service on the market is the Bahncard 100 by the German Railway (DB), a yearly subscription for free train rides, free use of public transport in major German cities, and flat rates for DB CarSharing and DB Call a Bike. Other comparable services – limited to use in a single city – are the Üstra MobilCard (Hannover/Germany) and Yélo (LaRochelle/France).[566]

Car manufacturers will benefit most from offering a mobility card if they integrate it closely into their product portfolio, e. g. by including mobility cards by default in a vehicle purchase. Secondary benefits will arise from the close collaboration with other transport providers. Besides a willingness to cooperate with other mobility providers and knowledge about business models there are no special competencies a car manufacturer needs to build up in order to introduce a mobility card.

Indicator	**Rating**	**Explanation**
Simplicity	High	Once registered, the usage of the mobility card is intuitive.
Reliability	High	The mobility card characteristics are always available.
Flexibility	High	The mobility card does not need to be used by any prescribed patterns.

[566] see chapter 2.3.2 for more information

Access	n.a.	
Availability	High	The services a mobility card offers are always available, no matter the time or day.
Transparent fare and payment system	High	Users receive a monthly bill listing all their mobility expenses, rendering their budget more transparent.
Attractive image	Medium	As the usage of the mobility card is not very visible to the outside, users will neither improve nor downgrade their status.
Added value for users	High	The possibility to book and purchase tickets with a single means of payment and the high transparency of individual mobility expenditure is not offered by any other service on the market.
Usefulness	High	The service applies to a large number of use cases: all kinds of car trips, trips by public transport, and usage of vehicle provision services.
Intermodality	High	A mobility card intends to remove actively many obstacles that occur in intermodal mobility.

Personal Travel Assistant (PTA)

A PTA integrates urban transportation services and transactions through various information channels and devices (including PCs, mobile phones, and kiosks); its main user platform is a smart phone application. It streamlines route selection, ticketing and disruption management (such as response to traffic congestion), and is linked to other non-mobility features like personal schedules and social networks. The number of features and functions of a PTA can be expanded by e. g. on-board arrival information. The interface design allows intuitive usage of the PTA; only a single step of registration is needed which includes personal information necessary for billing. Users will always have access to their PTA account, thus providing maximum transparency of personal mobility costs. Depending on the system, it can be limited geographically to a municipality, region, or even country. The PTA not only combines the digital advantages of the intermodal navigation and the analogue functions of the mobility card but expands the service range by including non-mobility features and real-time traffic information. A comparable existing services on the market is Cisco's Personal Travel Assistant which was piloted in Seoul and Amsterdam in 2010.[567]

The PTA would accommodate the organisational and informational needs of intermodal travel and could include the use of private and public vehicles (cars and bikes). It would be especially attractive for non-standardised trips that cause an extra need of information and assistance. The PTA could be useful for the mobility types greenovator, silver driver, high-frequency commuter, global jet setter, low-end mobility. The intuitive design and the smart phone platform make the PTA highly attractive for progressive customer segments. The PTA removes major obstacles for using public transport, like intransparent tariff systems, complicated user interfaces and lack of real-time information and reliability,[568] thus reducing feelings of insecurity and the lack of orientation experienced during non-standardised trips and situations. Those using a PTA are expected to switch to public transport modes more often because it facilitates planning and booking public transport trips.

The PTA helps car manufacturers to introduce non-customers and even non-car owners to their brand. Packaging a PTA with a vehicle purchase will make manufacturers' products more attractive for intermodal customer groups and improve public visibility and image. In order to launch a PTA service close collaboration with local government and the local mobility providers (esp. public transport) is crucial. Due to the advanced programming skills required for developing the PTA software, the cooperation with software companies is likely to

[567] see chapter 2.3.2 for more information
[568] DIW/infas 2002:103

be necessary. Another option would be to purchase a turnkey solution from a trusted white label provider or to become premium partner of another PTA provider, i. e. packaging their PTA with vehicle purchase or providing priority access or reduced fees when purchasing access to the application via the OEM.

Indicator	Rating	Explanation
Simplicity	High	Intuitive interface design renders the use of the PTA self-explanatory.
Reliability	High	Users can always rely on the service characteristics of the PTA.
Flexibility	High	The PTA does not prescribe any usage patterns. It even enhances the mobility flexibility of its users.
Access	n.a.	
Availability	High	The service is permanently available.
Transparent fare and payment system	High	Permanent access to the personal mobility account allows maximum transparency of personal mobility expenses.
Attractive image	High	The smart phone platform renders the PTA highly attractive for progressive customer groups.
Added value for users	High	By integrating a wide range of functionalities the PTA provides a service that is currently not provided by any other service.
Usefulness	High	The PTA applies to a large number of use cases as it integrates the use of public transport and (private or public) vehicles.
Intermodality	High	A PTA intends to remove actively many obstacles that occur in intermodal mobility.

4.2.3. Selecting mobility services

Now that the potential service types for OEM are identified the next step is to select the most promising service types and develop a strategy for implementing them. Based on the customer acceptance to be expected for different mobility services car manufacturers should first select the most promising mobility service type(s), followed by identifying the appropriate business model and, finally, by aligning their research and development activities.

While all the services listed above are appropriate for a provision by an OEM, some of them have higher market potential or feasibility than others. Their success will be determined by *external* factors, i. e. 1) the usefulness for the mobility types described in chapter 2.3.3.3 and 2) their scores in the catalogue of requirement rating, and *internal* factors, i. e. the strengths and weaknesses of OEM identified in the SWOT analysis in chapter 5.3.2. Combined these assessments result in an outline for action and research for OEM regarding mobility services.

The following table provides an overview of the suitability of each mobility service for the respective mobility types (see chapter 2.3.3.3):

	Vehicle provision services			Information and assistance services		
Mobility type	**Car rental**	**Public car fleet**	**Car sharing**	**Intermodal navigation**	**Mobility Card**	**Personal Travel Assistant**
Greenovator	o	++	+	+	+	++
Family cruiser	o	+	+	+	o	o
Silver driver	+	+	+	+	++	+
High-frequency commuter	o	+	o	+	++	+
Global jet setter	++	+	o	++	o	++

Sensation seeker	+	o	o	+	o	o
Low-end mobility	o	++	++	+	+	++
Key: o *not relevant* + *useful* ++ *very useful*						

Table 21: Mobility types – demand for mobility services by car manufacturers

For sensation seekers and family cruisers, both highly dependent on a privately owned car, none of the services are "very useful" while the low-end mobility and global jet setter type can benefit most from mobility services, followed by greenovators. Highly flexible and integrated services (public car fleet, mobility card, PTA) are the most attractive services but more complicated and less flexible services (car rental, car sharing) appeal only to a small number of mobility types.

As greenovators, silver drivers and high-frequency commuters will be the largest segments by 2020,[569] car manufacturers opting at including mobility services in their portfolios should concentrate on public car fleet, mobility card and personal travel assistant. As the mobility card and the PTA offer similar services, they can probably be designed as a single service with two options for access and usage: a digital (PTA) and an analogue front end (mobility card).

The next step is to integrate the scores of the catalogue of requirements rating:

	Vehicle provision services			**Information and assistance services**		
	Car rental	**Car sharing**	**Public car fleet**	**Intermodal navigation**	**Mobility Card**	**Personal Travel Assistant**
Simplicity	Low	Medium	High	High	High	High
Reliability	High	High	High	High	High	High
Flexibility	Medium	Medium	High	High	High	High
Access	Medium	Medium/ High	High	n. a.	n. a.	n. a.
Availability	Medium	High	High	High	High	High
Transparent fare & payment system	Medium	Medium	High	Mixed	High	High
Attractive image	Medium	Medium	High	Medium	Medium	High
Added value for users	Medium	Medium	High	High	High	High
Usefulness	Medium	Medium	Medium	High	High	High
Intermodality	Medium	Medium	Medium	High	High	High

Table 22: Catalogue of requirements rating – overview

The services of the "information and assistance" type receive higher scores in the catalogue of requirements rating than the services of the "vehicle provision" type. The reason can be found in their integrated character: While vehicle provision services are stand-alone services which have the mere *potential* to be linked to other modes of transport, information and assistance services facilitate intermodal, flexible mobility behaviour. They offer a higher value and can be applied to more use cases than mere vehicle provision services. This shows the necessity of linking any kind of service to other services and transport modes in order to offer acceptable and sustainable mobility services.

The combined analysis of the suitability for mobility types and the catalogue of requirements rating results in the following recommendations for car manufacturers:

Vehicle provision services:

[569] Winterhoff 2009

The option most attractive for users is the public car fleet; yet it is also the most challenging to implement by any provider. Car rental and/or car sharing could work as intermediary steps to deploying a public car fleet. They could serve as a trial period for the more advanced technology and organisation required for a public car fleet. However, the market results (customer acceptance etc.) of car rental or car sharing services should not be transferred completely to the highly flexible public car fleet as their characteristics and target groups deviate significantly from each other.

Manufacturers that do not want to offer a service themselves should opt for cooperation and/or exclusive vehicle supply contracts with existing vehicle provision companies in order to gain a foothold in innovative user segments. This is already being practiced by several OEM which cooperate with CSO worldwide. Another very promising option could be to purchase a turnkey solution from a trusted white label provider.

Information and assistance services

As the suggested information and assistance services receive a higher overall score than vehicle provision services car manufacturers should definitely include these in their portfolios even though they deviate even more from their traditional business model and self-perception. Like with the vehicle provision services, there is one service type that stands out in customer acceptance, innovation level and implementation challenges: the personal travel assistant (PTA). Using existing developments on the market can save car manufacturers the trouble of developing it themselves. Besides the technological challenge, there is the challenge of cooperating with municipalities which would need to integrate the PTA into their transport networks. The mobility card which has similar, but limited functions compared to the PTA could be offered as a supplement or "teaser" for customers who dread the advanced technology or who do not own a smart phone.

Due to the strong link to vehicles the intermodal navigation should be the principal option for car manufacturers when engaging in mobility services even though it receives slightly lower ratings because its main use occurs within vehicles. Its technology can be combined with some of the services of the personal travel assistant. As it could plan trips and book transportation options but can not be used as a ticket it should be combined with the mobility card onto which the booking items would be transferred and which then could be used as a proof of purchase, a function which a fixed navigation system naturally lacks.

The mobility card, in the end, could become the central service option, linking the stationary intermodal navigation and the ubiquitous PTA. Looking at Table 22 above, it also represents best the needs of the largest target groups forecasted for 2020 (greenovators, silver drivers and high-frequency commuters).

4.3. Mobility services: current activities of car manufacturers

Already, several activities by car manufacturers related to mobility services can be observed. They can be divided into research and development activities on the one hand and implemented services on the market on the other hand. In the following, selected projects and services on the market will be described. (For an overview of vehicles specifically designed for urban areas see annex 6.3).

4.3.1. Research activities

As car manufacturers are adopting a more long-term perspective of their business by including foresight analyses into their strategic planning and innovation management tools research projects related to the future of urban mobility and mobility services have become

very common. While they do not necessarily result in actual products most of them provide important stimulus for long-term strategies or feed into further research projects. The following box provides an overview of existing research initiatives or projects of car manufacturers regarding urban mobility

Urban mobility research activities of car manufacturers (selection)

BMW project i

Topics: Innovative, intelligent and international ("i") solutions for future urban (auto-)mobility
Projects: Development of urban vehicles, esp. electric cars, but also motorcycles and trikes (market launch in 2015)
Strategic positioning in the company: Strategic unit at BMW headquarters

Sustainable Mobility and Accessibility Research and Transformation (SMART), sponsored by Ford

Topics: Transformations of mobility/accessibility systems consistent with a sustainable human future
Projects: South Africa: New Mobility Industry Opportunities for the World Cup & Beyond; Pioneering New Mobility in Cape Town; India: New Mobility Hubs in Chennai; other projects in Brazil and selected US cities
Strategic positioning in the company: None; sponsored research project at University of Michigan

Toyota Research Institute of North America, Ann Arbor/Michigan[570]

Topics: Advanced technologies, urban environment, energy, and partnerships with government and academia
Projects:
Strategic positioning in the company: Independent research institute

Daimler Society and Technology Research Group (STRG)

Topics: Research and consulting on trend and future topics
Projects: Several research projects on urban mobility, esp. in emerging countries
The STRG research motivated Daimler to launch the Car2Go service in Ulm/Germany (see chapter 4.3.2)
Strategic positioning in the company: Internal consulting department

Institut pour la ville en mouvement / City on the move, sponsored by PSA Peugeot Citroen

Topics: Research and projects which "facilitate mobilities for individuals and social groups with specific difficulties, improve the performance and quality of urban travel, and contribute to the development of cultures of urban mobility and civilities"
Projects: Expositions, contests
Strategic positioning in the company: None; independent research institute sponsored by PSA Peugeot Citroen

4.3.2. Vehicle provision services

The following tables in this and the following chapter present a selection of mobility services by car manufacturers currently on the market: Daimler's public vehicle fleet Car2Go, Peuge-

[570] http://www.egmcartech.com/2008/04/01/toyota-establishes-research-institute-in-ann-arbor/

ot's rental service Mu, BMW's DriveNow, Citroen's Multicity and Volkswagen's Quicar as well as Volvo's Commute Greener application, BMW's Connected Drive service package and Citroen's Multicity route and travel planning platform. They include a brief description, the applicable use cases and main target groups, and examine the added value for users and impacts on individual mobility patterns. Using the criteria in the catalogue of requirements (chapter 4.1), the services are assessed, followed by recommendations for selecting appropriate services.

Car2Go www.car2go.com			
Description of service	Flexible car fleet (Smart ForTwo cdi) based on the principles of "instant access, one way, open end"		
Available in …	Hamburg, Ulm/Neu-Ulm, Düsseldorf, Köln, Berlin, Wien, Stuttgart; international: Toronto, Miami, Calgary, Birmingham		
Use case	Short trips in town, esp. combined trips with public transport		
Main target group	Citizens of the city of Ulm, most of them non-car owners. Roll-out for Austin/Texas targeted for 2011 Roll-out for other German and US cities planned for 2012		
Added value for users	Spontaneous access and usage of a floating vehicle fleet allows for flexible mobility without the need to own a car. Reserved parking lots in the downtown area relieve users from the search for a parking place. Low-emission cars: Smart ForTwo cdi use only 3.4 l/100km Diesel fuel and emit only CO_2 88 g/km.		
Impacts on mobility	The provider expects some subscribers to dispose of their cars. Trips with Car2Go vehicles can replace trips by private car, public transport or NMT.		
Link to other services	No operative link to other mobility services. Subscribers tend to use public transport more often than average citizens.		
Material footprint	Vehicles; priority parking spaces		
Partners	City of Ulm (preferred parking places)		
Number of customers/users	70.000		
Catalogue of requirements rating	Simplicity	High	Car2Go requires only one step of registration. The usage is mostly self-explanatory.
	Reliability	High	With rare exceptions, users can always rely on the proposed service characteristics of Car2Go.
	Flexibility	High	Instant access, one way and open end options allow spontaneous use of Car2Go, thus enhancing flexible mobility patterns.
	Access	High	Car2Go is not a country-wide service but in the area it serves it provides very high access levels.
	Availability	Medium	Even though vehicles spread evenly across the city availability can sometimes be a problem.
	Transparent fare and payment system	High	The tariff system is very simple and there are no hidden charges or fixed costs. Automatic fee collection via credit card make payment procedures effortless.

	Attractive image	High	The service appeals to a young user group[571] and fosters flexible lifestyles, thus enhancing the status of those using it.
	Added value for users	High	The value Car2Go provides is higher than the value of conventional vehicle provision services (car rental, car sharing) as it offers maximum flexibility, high access levels and no fixed costs.
	Usefulness	Medium	The service applies only to shorter trips within cities and is less useful for regular commutes or long-distance trips.
	Intermodality	Low	Car2Go is a pure vehicle provision service. It does not include assistance when switching to other modes of transport.

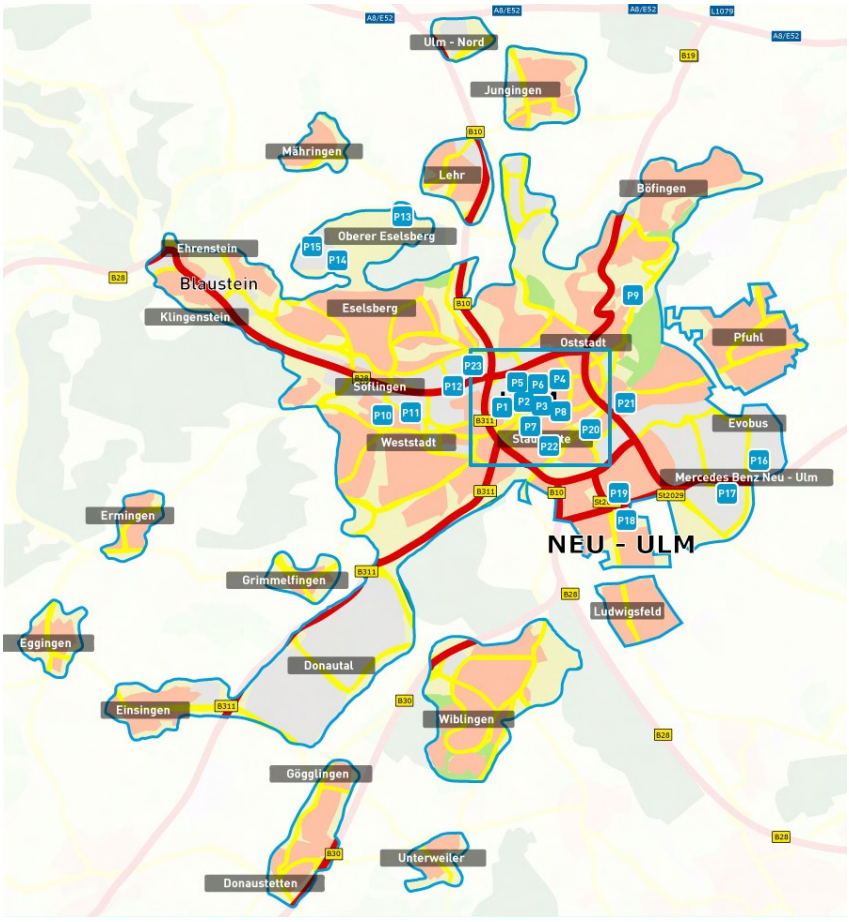

Figure 93: Zoned area of Car2Go service in Ulm/Germany[572]

Peugeot Mu http://www.mu.peugeot.fr/	
Description of service	Drive-and-return rental of vehicles (Peugeot cars, motorcycles, bikes) and accessories. Rental from ½ day to 10 days. Debit via a prepaid card. Pre-booking necessary.[573]

[571] 50 % of all Ulm citizens <35 years are registered with Car2Go.
[572] http://www.car2go.com/de/res/car2go_Geschaeftsgebiet.pdf

Available in …	Brest, Lyon, Nantes, Rennes/France, Berlin, Hamburg, München, London, Madrid, Brussels		
Use case	Occasional trips, e.g. vacation, outdoor sports		
Main target group	Car-owners and non-car owners in urban regions.		
Added value for users	Temporary enlargement of a vehicle fleet or accessory range, ideal for non-routine trips and needs.		
Impacts on mobility	Households might reduce the number or size of cars if they can simply rent special-purpose cars.		
Link to other services or modes	No link to other services or transport modes. Enables non-bike owners to use a bike and to book travelling by train more easily.		
Material footprint	Rental stations (retailers), vehicles and accessories		
Potential/necessary partners	%		
Number of customers/users	Data not available		
Catalogue of requirements rating	Simplicity	High	Simple payment system and a single registration step makes access to the service easy.
	Reliability	High	Users can always rely on the proposed service characteristics of Peugeot Mu.
	Flexibility	Medium	As the service includes neither one way nor open end
	Access	Medium	The service is not yet ubiquitous but only available in selected communities. So far Peugeot Mu can be only accessed at Peugeot car dealerships.
	Availability	High	The service is always available.
	Transparent fare and payment system	High	Payment per pre-paid card makes payment processes transparent and effortless.
	Attractive image	Medium	As the service does address average needs users do neither improve nor degrade their status by using Peugeot Mu.
	Added value for users	Medium	The value the service provides is higher than the value of convential car rental because users can also rent scooters, bikes, and accessories.
	Usefulness	Medium	Peugeot Mu applies to a limited number of use cases.
	Intermodality	Medium	Peugeot Mu can be used for only one mode of travel (mostly car travel), but it also assists users in switching to a limited number of other transport modes (bikes, motorcycles, long-distance train).

[573] Hucko 2010; Theofel 2010

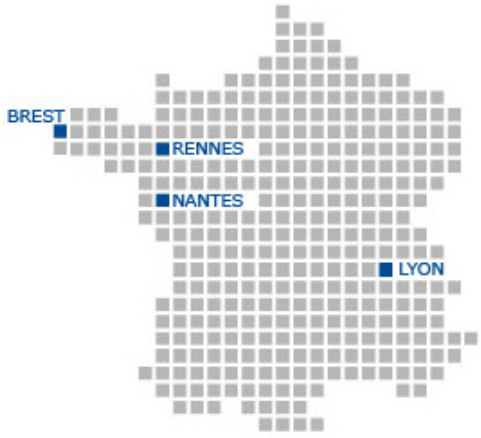

Figure 94: Peugeot Mu – cities for initial roll-out (2009)

BMW DriveNow[574]			
Description of service	A public vehicle fleet without stations based on the principles of "instant access, one way, open end", launched in April 2011 in a cooperation with the car rental Sixt. Users have to register once and then have keyless access to the vehicles.		
Available in …	Berlin, Düsseldorf, Cologne, Munich, San Francisco		
Use case	Short trips in town.		
Main target group	Citizens of the served cities; car owners and non-car owners.		
Added value for users	Spontaneous access and usage of a floating vehicle fleet allows for flexible mobility without the need to own a car.		
Impacts on mobility	Trips with BMW DriveNow vehicles can replace trips by private car, public transport or NMT.		
Link to other services	No operative link to other mobility services.		
Material footprint	Vehicles		
Partnerships	Sixt (car rental)		
Number of customers/users	70.000		
Catalogue of requirements rating	Simplicity	High	DriveNow requires only one step of registration. The usage is mostly self-explanatory.
	Reliability	High	With rare exceptions, users can always rely on the proposed service characteristics of DriveNow.
	Flexibility	High	Instant access, one way and open end options allow spontaneous use of DriveNow, thus enhancing flexible mobility patterns.
	Access	High	DriveNow is not a country-wide service but in the areas it serves it provides very high access levels.
	Availability	Medium	Even though vehicles spread evenly across the city availability can sometimes be a problem.

[574] For more information see http://www.drive-now.com

	Transparent fare and payment system	High	The tariff system is very simple and there are no hidden charges or fixed costs. Automatic fee collection via credit card make payment procedures effortless.
	Attractive image	High	The service appeals to a progressive user group and fosters flexible lifestyles, thus enhancing the status of those using it.
	Added value for users	High	The value DriveNow provides is higher than the value of conventional vehicle provision services (car rental, car sharing) as it offers maximum flexibility, high access levels and no fixed costs.
	Usefulness	Medium	The service applies only to shorter trips within cities and is less useful for regular commutes or long-distance trips.
	Intermodality	Low	DriveNow is a pure vehicle provision service. It does not include assistance when switching to other modes of transport.

Citroen Multicity Carsharing http://multicity.citroen.de/			
Description of service	A public vehicle fleet without stations based on the principles of “instant access, one way, open end”, with online booking and reservation. One-time registration necessary. Users also gain access to DB Flinkster vehicles and DB Call-a-Bike bicycles.		
Available in …	Berlin		
Use case	Short trips within Berlin.		
Main target group	Private users, tourists in Berlin.		
Added value for users	Access to e-vehicles within a given perimeter in Berlin and extended access to DB Flinkster vehicles and DB Call-a-Bike bicycles facilitates individual urban mobility without the need to own a car.		
Impacts on mobility	Trips with Multicity Carsharing vehicles can replace trips by private car, public transport or NMT.		
Link to other services	DB Flinkster, DB Call-a-Bike		
Material footprint	Vehicles (100 Citroen C-Zero e-vehicles)		
Partnerships	IT, fleet and customer management serviced by DB Rent		
Number of customers/users	Due to the recent start in fall 2012, no user data are available yet.		
Catalogue of requirements rating	Simplicity	High	Multicity Carsharing requires only one step of registration. The usage is mostly self-explanatory.
	Reliability	High	With rare exceptions, users can always rely on the proposed service characteristics of Multicity Carsharing.
	Flexibility	High	Instant access, one way and open end options allow spontaneous use of Multicity Carsharing, thus enhancing flexible mobility patterns.
	Access	Medium	Multicity Carsharing is available only within a limited area in Berlin, but it provides access to other mobility services which serve larger areas.

	Availability	Medium	Even though vehicles spread evenly across the city availability can sometimes be a problem.
	Transparent fare and payment system	High	The tariff system is very simple and there are no hidden charges or fixed costs. Automatic fee collection via credit card or direct debiting make payment procedures effortless.
	Attractive image	High	The service and e-vehicles appeal to a progressive user group and foster flexible, sustainable mobility, thus enhancing the status of those using it.
	Added value for users	High	The value Multicity Carsharing provides is higher than the value of conventional vehicle provision services (car rental, car sharing) as it offers maximum flexibility, high access levels, access to other vehicle provision services and no fixed costs.
	Usefulness	Medium	The service applies only to shorter trips within cities and is less useful for regular commutes or long-distance trips.
	Intermodality	Medium	Via the included access to DB Call-a-bike, Multicity Carsharing encourages the use of other transport modes.

Volkswagen Quicar https://web.quicar.de/			
Description of service	A public, station-based vehicle fleet, based on the principles of “instant access, one way, open end”, with online booking and reservation. One-time registration necessary.		
Available in …	Hannover, Germany		
Use case	Short urban trips.		
Main target group	Private users, businesses, families (extra tariffs for businesses and families)		
Added value for users	Flexible access to large vehicle fleet of 200 Volkswagen Golf Blue Motion at currently 50 stations in the Hannover enables individual mobility without the need to own a vehicle. The “Quicar Plus” options allows users to choose from different Volkswagen models. The Quicar online community allows user to take part in discussions and decisions and provides information about new offers and services.		
Impacts on mobility	Trips with Quicar vehicles can replace trips by private car, public transport or NMT.		
Link to other services	No operative link to other mobility services		
Material footprint	Vehicles (200 Golf Blue Motion, other Volkswagen models)		
Partnerships	None.		
Number of customers/users	Due to the recent start in fall 2012, no user data are available yet.		
Catalogue of requirements rating	Simplicity	High	Quicar requires only one step of registration. The usage is mostly self-explanatory.
	Reliability	High	With rare exceptions, users can always rely on the proposed service characteristics of Quicar.

	Flexibility	High	Instant access, one way and open end options allow spontaneous use of Quicar, thus enhancing flexible mobility patterns.
	Access	Medium	Quicar is available only in Hannover.
	Availability	Medium	Even though vehicles spread evenly across the city availability can sometimes be a problem.
	Transparent fare and payment system	High	The tariff system is very simple and there are no hidden charges or fixed costs. Automatic fee collection via credit card or direct debiting make payment procedures effortless.
	Attractive image	High	The service and the low-emission vehicles apeals to a progressive user group and foster flexible mobility, thus enhancing the status of those using it.
	Added value for users	High	The value Quicar provides is higher than the value of conventional vehicle provision services (car rental, car sharing) as it offers maximum flexibility, high access levels and no fixed costs.
	Usefulness	Medium	The service applies only to shorter trips within cities and is less useful for regular commutes or long-distance trips.
	Intermodality	Low	DriveNow is a pure vehicle provision service. It does not include assistance when switching to other modes of transport or access to other transport modes and vehicle services.

Comparison of vehicle provision services by car manufacturers					
	Car2Go	**Mu by Peugeot**	**BMW DriveNow**	**Citroen Multicity Carsharing**	**Volkswagen Quicar**
Instant Access, Open End, One Way	+		+	+	+
Free choice of model		+			(+)
Availability in more than 1 city	+	+	+		

Table 23: Comparison of vehicle provision services by car manufacturers currently on the market

4.3.3. Information and assistance services

Volvo Commute Greener **Gothenburg/Sweden** http://www.commutegreener.com/	
Description of service	SmartPhone application by Volvo IT for calculating individual mobility carbon footprint, including recommendations for improving CO2 balance.
Use case	Urban travel and commutes

Main target group	Gothenburg citizens in roll-out (May 2009); since November 2009 the application is marketed to companies, organisations, public transport providers and cities as well as individuals worldwide (e.g. via Apple's AppStore).		
Added value for users	Control of personal carbon footprint; advice in reducing personal carbon footprint and adapting mobility routines		
Impacts on mobility	The application encourages users to use the most resource-efficient mode of transport which in some cases might motivate them to reduce car use and increase PT and NMT mode share. Tests have shown that users can quickly reduce their carbon footprint by more than 30 %.		
Link to other services	Public transport		
Material footprint	None		
Potential/necessary partners	Local transport providers		
Number of customers/users	n.a.		
Comparable existing services on the market (without OEM involvement)	There are many carbon footprint calculators on the market but none that track daily mobility like the Commute Greener application.		
Catalogue of requirements rating	Simplicity	High	After initial registration and minor instruction the usage of Commute Greener is self-explanatory.
	Reliability	High	The proposed service characteristics of Commute Greener can always be relied on.
	Flexibility	n.a.	
	Access	n.a.	
	Availability	High	The service is always available.
	Transparent fare and payment system	n.a.	(There is only an initial fee for downloading the application.)
	Attractive image	High	Users improve their status by using Commute Greener because it appeals to progressive customer segments.
	Added value for users	High	Because conventional carbon footprint calculators do neither track daily mobility nor assist in improving mobility routines the added value of Commute Greener is high.
	Usefulness	n.a.	
	Intermodality	Medium	The service does not actually assist people in intermodal mobility but it provides feedback on the environmental performance of a user's mobility pattern.

BMW Connected Drive[575] www.BMW.de/BMW_ConnectedDrive	
Description of service	Integrated traffic and vehicle information tool, including traffic information, information desk, internet service and emergency call,; built-in car navigation system. Connected Drive comprises the following services: BMW Assist (traffic information, emergency call), BMW Online (internet-based services) and BMW TeleServices (remote maintenance and repair services)
Use case	The diverse range of services applies to many use cases. They allow organising or rearranging trips spontaneously and assist drivers in processing data and information. The services are useful for short urban trips as well as for long-distance trips.

[575] For more information see www.BMW.de/BMW_ConnectedDrive

Main target group	As this tool comes only with BMW vehicles, it can be only used by BMW drivers.		
Added value for users	Higher reliability of route planning; fall-back option in emergencies; easy maintenance and repair routines for owners		
Impacts on mobility	Reduction in travel times; deviation to routes with lower congestion		
Link to other services	No link to other modes of transport		
Material footprint	None		
Partnerships	None		
Number of customers/users	n. a.		
Comparable existing services on the market (without OEM involvement)	None		
Catalogue of requirements rating	Simplicity	High	No registration necessary; after a simple instruction the service is self-explanatory.
	Reliability	High	Users can always rely on the service characteristics of Connected Drive.
	Flexibility	n.a.	
	Access	n.a.	
	Availability	High	The service is always available.
	Transparent fare and payment system	n.a.	(There is only a yearly subscription fee for the package.)
	Attractive image	Medium	As the usage of Connected Drive is hardly visible to the outside users will neither improve nor downgrade their status.
	Added value for users	Medium	Because Connected Drive includes internet-based services the value is higher than the vaule of conventional telenavigation systems.
	Usefulness	Medium	The service applies to many different kinds of trips and purposes, but only by private car.
	Intermodality	Low	Connected Drive only serves the needs of car drivers.

Citroen MultiCity http://www.multicity.citroen.de	
Description of service	Multimodal transport information and booking platform operated by OEM Citroen, offering users a comparison of different travel modes (except NMT) based on price, time/speed and environmental impact. Currently operating in France and Germany.
Use case	The service applies to many different use cases, from short urban trips to business trips and holidays. As it includes different travel modes, it covers a very wide spectrum of mobility.
Main target group	Not specified, but especially users with multi-/intermodal mobility patterns.
Added value for users	Instant comparison and booking of different travel options with “one face to the customer”
Impacts on mobility	The information and booking service might motivate users to change their mobility patterns from car-centered to multi-/intermodal mobility. It may also encourage non-car owners to use (and ultimately own) a car.
Link to other services	Citroen Multicity Carsharing (see above), DB, car rentals
Material footprint	n. a.

Partnerships	Partnership with travel agencies, German Railway/French Railway, car rentals		
Number of customers/users	n. a.		
Catalogue of requirements rating	Simplicity	High	Even though the service is rather complex it is easy to understand and does not require extensive instruction.
	Reliability	High	As it is an online service, the user can always rely on the proposed service characteristics.
	Flexibility	n.a.	
	Access	n.a.	
	Availability	High	The service is always available.
	Transparent fare and payment system	n.a.	(Free service.)
	Attractive image	Medium	As the usage of Multicity is hardly visible to the outside users will neither improve nor downgrade their status.
	Added value for users	High	Because the platform offers intermodal travel information and booking, its service proposition is highly valuable
	Usefulness	High	The service applies to a large number of use cases (short- and long-distance travel, different modes).
	Intermodality	High	The service facilitates inter-/multimodal mobility by providing information on different travel modes and comparing them.

Conclusion

The vehicle provision services Daimler Car2Go, Citroen Multicity Carsharing, VW Quicar and BMW DriveNow complement Peugeot's Mu system: The advantages of one system are the disadvantages of the other, and vice versa. E. g. Car2Go and BMW DriveNow are marked by high simplicity, flexibility and access while Peugeot Mu features high reliability and availability as well as a free choice of model. The information and assistance services portrayed here have very diverse functions. While the Commute Greener application simply encourages people to reduce their CO_2 emissions without actually supporting modal shift by e.g. providing schedules or ticketing services, the BWM Connected Drive merely assists car drivers but does intent neither to reduce the burdens of mobility nor to encourage modal shift. Citroen Multicity is the most comprehensive service as it applies to the most use cases and encourages inter- resp. multimodality.

	Daimler Car2Go	**Peugeot Mu**	**BMW Drive Now**	**Citroen Multicity Carsharing**	**VW Quicar**	**Volvo Commute Greener**	**BMW Connected Drive**	**Citroen Multicity**
Simplicity	High	High	High	High	High	High	High	High
Reliability	High	High	High	High	High	High	High	High
Flexibility	High	Medium	High	High	High	n.a.	n.a.	n.a.
Access	High	Medium	High	Medium	Medium	n.a.	n.a.	n.a.

Availability	Medium	High	Medium	Medium	Medium	High	High	High
Transparent fare & payment system	High	High	High	High	High	n.a.	n.a.	n.a.
Attractive image	High	Medium	High	High	High	High	Medium	Medium
Added value for users	High	Medium	High	High	High	High	Medium	High
Usefulness	Medium	Medium	Medium	Medium	Medium	Medium	Medium	High
Intermodality	Low	Medium	Low	Medium	Low	Medium	Low	High

Table 24: Overview of catalogue of requirements rating for existing mobility services by OEM

All services receive "high" ratings in the simplicity and reliability categories, and most receive "high" ratings in the categories flexibility, attractive index and added value for users, which should be a main factor for their current success on the market. However, only one of the services receives a "high" rating in the categories usefulness or intermodality, the Citroen Multicity platform. The other services by car manufacturers lack integration with other transport modes. This is one of the aspects which should be improved in order to increase market acceptance even more.

5. Entering the mobility services market: Re-thinking innovation, sustainability, and strategy

The following subchapters will argue that mobility services are sustainable innovations and explain how an environment conducive to sustainable development fosters such sustainable innovations. In the following, a strategic rationale for car manufacturers opting at including mobility services in their portfolios is developed, including the attending risks and opportunities of doing so. The chapter continues with a research and action agenda for car manufacturers which includes recommendations for selecting appropriate mobility services, suggestions for market entry strategies, and research arenas that need to be initiated resp. intensified. The chapter will close with a set of theses which summarise the findings so far and an outlook on the mobility services market.

5.1. Mobility services as a sustainable innovation for car manufacturers

The automotive market is highly competitive, and, besides price and design, innovations can be one unique selling point for winning the competition race. Mobility services can be one such innovation, which is why this chapter looks at the term in general and the specific features of mobility services. It will show that mobility services match the sustainable innovation type and fulfil a lot of the prerequisites of successful diffusion into the market.

There is no concise, commonly agreed upon definition of innovation.[576] So far, research has merely agreed upon the fact that the element of "new" is inherent in innovations[577] and that innovations can be distinguished from inventions: "Research results and inventions can be

[576] Aigle/Marz 2007:19
[577] Faber 2008:10; Vahs 2002:44; Rogers 2003:12

translated into innovations only if they are closely interlinked with commercial interests and economic goals."[578] Innovations are therefore the commercialisation or exploitation of inventions or research results.[579]

There are different types of innovations. Depending on the point of view, the following distinguishing features and categories can be found in literature:

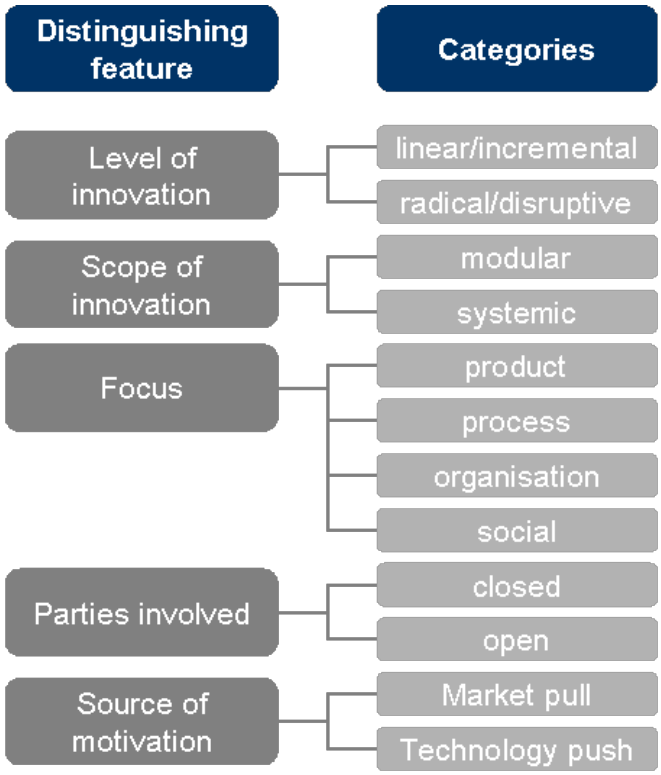

Figure 95: Categories of innovation[580]

Level of innovation: This feature is the predominant level of distinguishing innovation types. The following comparison presents the main differences between the two categories:

	Linear innovation	**Radical innovation**
Goal of innovation	– mainly quantitative (cost reduction, minimal product performance improvement)	– mainly qualitative (maximal product performance improvement)
Source of innovation idea	– inside the productive unit	– inside the productive unit – outside the productive unit (customers, market needs)
Production patterns	– based on established production patterns	– makes established production technologies obsolete

Table 25: Differences between linear and radical innovations[581]

William Abernathy [1978] argues that the natural pattern of transition of a productive unit is from radical (or specific) to linear (or fluid) innovation because radical innovations are highly unpredictable and cost-intensive and need to be substituted by an incremental innovation pattern which allows for cost reduction and higher predictability of outcomes. Usually, the early stages of radical innovation slowly lead to a dominant design which then results in enforced product standardisation as well as competition on the basis of product performance

[578] Inkinen 2009:8, 33
[579] Stamm 2003:19f.
[580] Vahs 2002:72f.; Aigle/Marz 2007:28; Inkinen 2009; and proprietary illustration by the author
[581] Abernathy 1978:69ff.; and proprietary contribution of the author

and cost. However, it is not preferable for firms to have only productive units in the stable linear state; rather they need to establish a mix of patterns in order to escape the cost-competition trap.

The distinction between *incremental* and *disruptive* takes the concept a step further as disruptive innovations apply a different set of values and enter new markets or market segments, compared to incremental innovations which cater to existing needs and customer groups.[582] These "quantum leaps" can be seeds of a larger, more radical change.[583]

Note: In literature, the feature "level of innovation" with its categories linear/incremental vs. radical/disruptive is often used as an umbrella feature or even the only feature necessary for distinguishing innovations because it likely impacts the remaining features of innovation.

Scope of innovation: The scope of innovation refers to the number of elements affected by an innovation. Whereas modular innovations affect only a limited scope of the product and the organisation, system innovations will also have an impact on the input and output structures of an organisation.[584] The latter are "organisation-transcending innovations that drastically alter the relationship between the companies, organisations and individuals involved in the system".[585] Most system innovations require modular innovations.[586]

Focus of innovation: Innovations do not only affect products but can also affect (production or service provision) processes, organisational structures or social aspects within the organisation effectuating the innovation.[587] Process innovations are most dominant in large productive units with high-volume established products because they yield high cost-efficiency gains.[588] Social innovations[589] can also refer to innovations which affect the society, i. e. elements outside the system which produces the innovation.[590] Such innovations can target social needs or unlock new market opportunities. The latter specification will be used here as it is more useful for the topic of mobility services.

Parties involved in innovation process: In the past, innovation built on the idea that a company or organisation possesses all the knowledge and know-how necessary for an innovation.[591] In contrast to this closed innovation model, the recent open innovation model coined by Henry Chesbrough assumes that it is necessary to include external partners in the innovation process as well.[592] These can be companies from other sectors, customer representatives, or even political decision makers.

Source of motivation for innovation process: What initiates innovations? Innovations can either be initiated by market demands (market pull) or triggered by new technological developments (technology push).[593] The latter form of innovations tends to involve higher risks as it is not clear whether market demand will be sufficient.[594]

One important – and currently very popular – type of innovation are sustainable innovations, which are made up of a specific set of categories. By definition, they are non-linear, systemic and developed in an open innovation process; they are initiated by market pull and often ad-

[582] Christensen 2002:18; Faber 2008:12
[583] Aigle 2007:26
[584] Weisshaupt 2006; Aigle 2007:27
[585] Inkinen 2009:11
[586] Aigle et al. 2008:27
[587] Rogers 2003:13; Inkinen 2009:23
[588] Abernathy 1978:168
[589] The term social innovation has not been specified by literature on innovation yet. (see INFU 2010:40)
[590] Vahs 2002:77
[591] This notion is fuelled by Schumpeter's original innovation theory which focuses on the innovative capabilities or "spirit" of company leaders. (Blättel-Mink 1997:23)
[592] INFU 2010; Faber 2008:78; Inkinen 2009:8
[593] Faber 2008:11
[594] Vahs 2002:79

dress social issues rather than mere product, process or organisation issues.[595] Sustainable innovations are consistent with social and ecological welfare and economic stability, thus reaching beyond conventional eco-innovation models which have the mere objective to reduce (or even eliminate) energy and resource consumption at all stages of the product lifecycle.[596] It requires a constant focus on the triple bottom line of economic, social and environmental value creation during the innovation process. This balance is best achieved by the acquisition and development of new knowledge, and by the evolution of better means both of embedding that emerging knowledge in organisations and institutions, and of managing the relevant flows of information, knowledge and wisdom. Companies which invest in sustainable innovations usually want to position themselves as market leaders and innovators, recognise the emergence of a new business paradigm, and desire to act responsibly.[597]

To which extent are mobility services an innovation for the automotive industry? According to the definitions above mobility services are clearly an innovation. They are not in the stage of invention anymore; in general, the scope of invention, esp. technological invention, needed for mobility services is rather limited. Innovations have to be new for the relevant system, not for the "world" (subjective vs. objective innovation).[598] Therefore, even though mobility services already exist on the market and some of them are even offered by OEM including them in their portfolio would be an innovation for most OEM.

Mobility services offered by car manufacturers can be assigned the following categories of innovation:

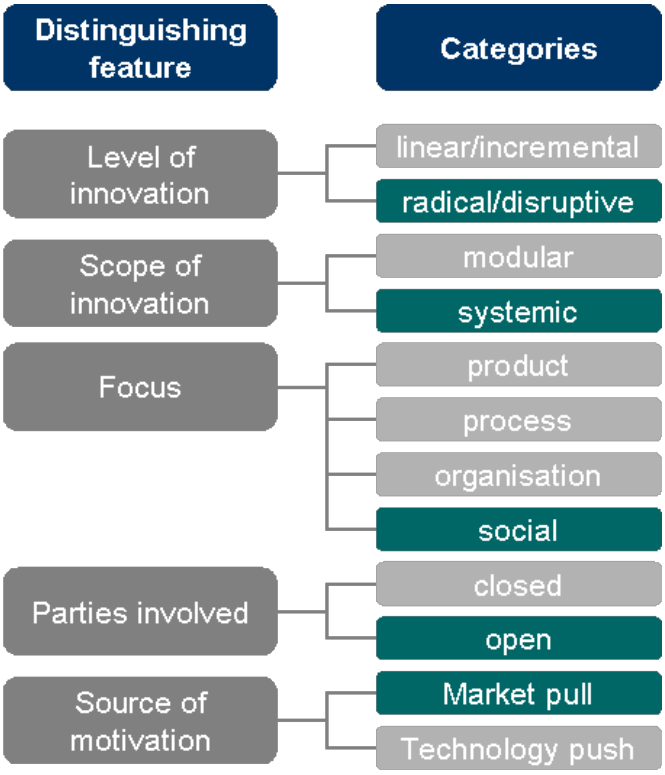

Figure 96: Categories of innovation applying to mobility services offered by car manufacturers

Level of innovation: For OEM to make vehicles available for use and not for ownership and/or to offer services that foster intermodal mobility is a disruption of their basic business model. Even though the vehicle-centred services of manufacturers (e. g. financial services,

[595] Blättel-Mink 2006:87
[596] INFU 2010:30
[597] Stamm 2003:229
[598] Vahs 2002:42f.; Blättel-Mink 2006:30

repair and maintenance) contribute to a large extent to the volume of sales and the turnover of OEM they are based on the purchase and ownership of a car and do not include other modes of transport.

Scope of innovation: Since mobility services do affect several parts (units or functions) of an OEM (e. g. sales and marketing, financing, organisation) and require the cooperation with new external partners (e. g. communities, public transport providers) they are systemic.

Focus of innovation: Mobility services are a social resp. market innovation because they alter the mobility behaviour of potential customers and create a new market which has not been tapped before by manufacturers. They might involve product, process, or organisational innovations but their main focus is on the societal implications. Abernathy's productivity dilemma describes the challenge and necessity for large, efficient organisations to incorporate innovations in their processes (exploitation vs. exploration).[599] This phenomenon is mainly related to *technological* innovations. If such innovations already create a big challenge, it is likely to be more difficult for large organisations to adopt and promote *social* innovations like mobility services.

Parties involved: Car manufacturers tend to have closed innovation processes. Due to their large size they have internalised most of the knowledge necessary for (incremental) innovations. Yet, cooperation in automotive research and development is becoming more common, as exemplified by the intensified cooperation processes due to the introduction of the BEV technology. While mobility services do not require technological research competencies as advanced as for BEV development there are other competencies that have to be sourced from external experts, e. g. customer service, interface design or software development. Depending on the type of service to be offered the range of external knowledge necessary for implementing it on the market varies but almost always will include at least some external expert knowledge. Therefore, the innovation process for mobility services is at least partly open.

Source of motivation: As many innovations in the car industry are of a technological nature they are mostly derived from a technology push and less often from a consumer demand. Even though technology advances like GPS positioning or internet booking have greatly enhanced mobility services technology has not been the main source of motivation for introducing mobility services on the market. Technology plays only a marginal role in this process. Rather, there is an increasing demand from the market due to external forces as analysed in chapter 3.

The innovation type mobility services belong to is in stark contrast to conventional innovations in the automotive industry. They tend to be linear, modular, product or process oriented, closed, and derived from a technology push. It is common for large companies to adhere to this innovation type as it promises high cost-efficiency and competitive advantages. This adherence establishes barriers to other types of innovation which have the goal of product performance improvement but not higher cost-efficiency. However, in order to remain competitive not only on the basis of costs but also of customer acceptance it is crucial for productive units to maintain a balanced mix of innovations, mainly of linear and radical innovations (the other categories naturally fall into place).[600]

According to most definitions, innovations (should, but do not necessarily do) equate progress and improvement.[601] Are mobility services an improvement, and if so, for whom? The systems or stakeholders affected by urban mobility services offered by OEM are 1) the OEM offering it, 2) the users, and 3) the urban transport system. Assuming that mobility services a) do not *replace* conventional organisational forms of individual transport but *supplement* them,

[599] Abernathy 1978; Benner/Tushman 2003:238
[600] Abernathy 1978:171
[601] Blättel-Mink 2006:27; Rogers 2003:11

i. e. the range of options both for providers/manufacturers and users increases, b) balance the modal split, and c) reduce vehicle ownership rates (esp. vehicle provision services), the following exemplary advantages and disadvantages of mobility services illustrate the degree of improvement resp. progress for each stakeholder group:[602]

Stake-holder	Advantages	Disadvantages
OEM	▪ New channel of distribution ▪ Element of CSR, contribution to company image	▪ Danger of cannibalisation of core product portfolio ▪ Need to change conventional ways of production
Users	▪ Wider range of options ▪ Improved access ▪ Higher reliability, planning security ▪ Lower costs (depending on use case)	▪ None
Urban transport system	▪ Reduction of many burdens of mobility ▪ More balanced patronage of transport modes	▪ Land use for vehicle stations ▪ Potentially generation of more traffic

Table 26: Exemplary advantages and disadvantages of mobility services from relevant stakeholder perspectives

From this analysis the next obvious question relates to whether mobility services are a *sustainable* innovation, i.e. to which extent they contribute to sustainable development. According to the characteristics of the innovation type that mobility services belong to they match the categories sustainable innovations belong to. Like many large companies, several automotive manufacturers have included sustainability criteria in their new product development processes.[603] However, companies which have arrived at a stage where disruptive innovations do not fit in their innovation portfolios any longer – which is the case for most large firms and especially car manufacturers[604] – will have difficulties initiating and incorporating truly sustainable innovations.

Beyond the structural characteristics of a sustainable innovation, the contribution of an innovation to sustainable development needs to be assessed. As this question is paramount but also too demanding for the scope of this thesis it is not addressed here. A proper assessment/evaluation system could tell planners in- and outside the automotive industry whether a given mobility service is an "improvement" compared to conventional mobility products and whether it contributes to progress towards sustainable development.

Diffusion of innovations

While the first part of this chapter has touched upon the "input" side of the innovation equation, the second part will take a look at the output side, called diffusion. The diffusion is the process by which an innovation is communicated, accepted and adopted. The speed and success of the diffusion of an innovation depend on 1) the innovation itself, 2) communication channels, 3) time, and 4) the social system it will be embedded in. From the point of the individual or target group, the adoption of an innovation depends largely on perceived attributes, especially:[605]

- Relative advantage: The degree to which an innovation is perceived as better than the former idea.

[602] For more details see chapter 5.3 (OEM) and chapter 2.3.3 (users)
[603] Dewick 2008:7
[604] Abernathy 1978:69ff.
[605] Rogers 2003:229f.

- Compatibility: The degree to which an innovation is perceived as being consistent with existing value sets, past experiences and customer needs.
- Complexity: The degree to which an innovation is perceived as difficult to understand and use.
- Trialability: The degree to which an innovation may be tried out/tested by users.
- Observability: the degree to which the results of an innovation are visible to others.

Those innovations that are perceived to have greater relative advantage, compatibility, trialability, and observability and less complexity will be adopted more rapidly by individuals. Based on the mobility services concept used in this thesis, they fulfil different degrees of these attributes:

- Relative advantage: The advantages of mobility services for its users depend on various individual factors shaping mobility behaviour in general (see chapter 2.3.3). In the case that mobility services supplement and do not substitute other modes of transport, they can always be regarded as a welcome extension of the transport choices available to individuals.
- Compatibility: This is the most challenging aspect of mobility services as they are usually disruptive innovations and apply new value sets, requiring users and providers to transform conventional patterns of mobility and transport sector management. With advanced technology and a thorough understanding of customer needs innovative mobility services can lower the barrier for new users as they try to emulate mobility routines. On the provider side, the barrier is high for those that have not served the transport sector by providing services but products, e. g. vehicle manufacturers.
- Complexity: Depending on the type of service and on the user's experience with other mobility services, mobility services can be perceived as more or less difficult. Smart technology makes it possible to facilitate access and use of services and create simplified, intuitive interfaces and processes.
- Trialability: Even though most mobility services (esp. vehicle provision) require initial registration many do not involve regular fees. Pay-as-you go systems allow users to trial new services and use them spontaneously.[606]
- Observability: The results, i. e. the relative advantages and disadvantages of mobility services are easy to experience for each user as the mobility experience usually deviates strongly from average mobility routines.

The diffusion – acceptance and adoption by users – will depend on the degree to which these diffusion criteria are maximised. An important tool will be the application of advanced smart technology that facilitates intuitive user processes and creates attractive interfaces.

Innovative societies call for a broad range of innovation types in order to meet diversified societal needs. Even though disruptive innovations produce large seeds of change, incremental innovations do not become obsolete; likewise, even though social or market innovations have a large potential to change habits and behaviour, product innovations also play a significant role in the progress of a society. The same is likely to be valid for organisations which want to thrive in turbulent times. A diversification of their product and service range requires a diversification of innovation types. While it is challenging and even risky to introduce new innovation and output structures changing trends in the environment of car manufacturers encourage this shift. A diversification of their innovation portfolio can help them to react more flexibly to changing customer needs and environments. However, this will also entail the need to assess their innovation strategy and question conventional approaches to

[606] Fraunhofer IAO 2010

innovation management. This relates not only to the focus of innovation – social instead of product, process or organisation focus – and the new R&D areas to be addressed but also the parties to be involved in the innovation process, requiring OEM eventually to open them up to outside stakeholders. Finally disruptive innovations have the potential to question the general business model of OEM and may require them to initiate major strategy and restructuring processes.

5.2. Sustainable organisations for sustainable innovations

Since mobility services have the same characteristics as sustainable innovations, they will likely benefit from an environment which fosters principles of sustainable development. Therefore, this chapter will look at the attributes of sustainable organisations and to what extent car manufacturers are prepared to transform themselves into a sustainable organisation.

The organisation or business offering a mobility service therefore will likely profit from following the principles of sustainable development (see chapter 1.2). The organisation represents the meso-level of human interaction whereas the individual is the micro-level, and the state or society represent the macro-level. Sustainable development depends on the application of sustainable principles on all three levels, but with issues relating to business, the meso-level takes on a central position. This fact is a key motivator for exploring the potential challenges and opportunities of transforming car manufacturers into sustainable organisations.

It is common ground in the theory and practice of sustainable economy that a sustainable organisation strives to meet the triple bottom line of ecological, economic, and social balance. It continually reduces or even eliminates its negative impacts on the environment, economy, and society.[607] Basically, a sustainable organisation incorporates principles of sustainability into each of its business divisions and decisions. Its commitment to sustainable practices in its operations is long-term and enduring, based on the conviction that "the inefficient use of environmental and social resources also has the potential to produce economical damage".[608] The transformation ideally begins from within the organisation, i. e. the alignment of organisational structures, processes and paradigms with the paradigms of sustainable development. This includes different aspects of *openness*:

- *Open innovation:* Innovation processes that involve players from outside the organisation and apply a diversified set of innovation methods are at the core of sustainable progress. As sustainable development is only possible when aspects reaching far beyond the organisation are considered it is crucial to involve "stakeholders" from other fields. This will require new cooperation methods, partners and a new self-image of the organisation.
- *Open processes:* Transparency and flexibility of business operations are crucial for sustainable transformation. As Abernathy [1978] points out, volume manufacturers have acquired routines which have proven successful in a volume market but which are unfit for the adoption of new products and markets. Incorporating sustainable innovations in a business organisation will require adapting some of the processes, rules, and indicators of sustainability.
- *Open management practices:* Open management includes openness to possible failures, to unconventional ideas, products and qualifications, and a commitment to involve new partners and employees (participation). As management involves controlling the success of an organisation, a sustainable organisation or unit will need to adapt its controlling methods.

[607] Linne/Schwarz 2003
[608] Hahn 2009:59; Hermann 2005:71

As "the economic effect of sustainability activities can lead to either an improvement or a deterioration"[609] of performance indicators (such as cost and risk, turnover, price and profit margin, innovation, work satisfaction, reputation, intangible values and brand value), sustainability activities have to be selected carefully and focus on the key performance indicators of the organisation. However, key performance indicators themselves might need to be altered in the process of sustainability transformation. Such indicators are available from different sources, e. g. the Sustainability Balanced Scorecard developed by Schaltegger [2004] or the Sustainable Value Approach by Hahn [2004], and usually include market and non-market indicators. The latter can be divided into socio-cultural, legal and political factors and are a new dimension for management; yet, realising that "they can change the rules governing the market [because] in certain cases non-market factors can have a more fundamental character than market variables"[610] it is not unlikely that decision makers may adopt this new perspective.

Obviously, the business community increasingly is acknowledging the beneficial effect of including non-market aspects in their strategies as more and more of them believe that sustainability is crucial for the future success of their business: according to a survey among CEOs worldwide, 93 % of global CEOs consider sustainability as important for their success. Their engagement in the issue is "about achieving high performance measured in terms such as lower costs, stronger customer relationships and increased revenues".[611] Another factor motivating car manufacturers to become more "sustainable" is their public perception as major scapegoats when it comes to blaming businesses for not contributing to sustainable (transport) development.[612] Along with the product they offer, their role in sustainable development and in sustainable urban transport is highly contested (see chapter 2.2.2). The Corporate Social Responsibility paradigm increasingly focuses the attention of the public on businesses' sustainability performance. Car manufacturers therefore have a strong motivation to achieve the transformation into a sustainable organisation.

However, as in most change management processes[613] there are several restraining forces that car manufacturers will face when transforming their businesses into sustainable organisations:

New values and paradigms: As outlined in chapter 1.2, mobility services involve several new paradigms which organisations offering them have to face and to incorporate. The sustainability paradigm requires a balanced view of environmental, social and economic performance, thus challenging the traditional prevalence of economic (esp. financial) aspects of business performance prevalent at car manufacturers.[614] Also, sustainability principles have to be translated into a business model; otherwise the acceptance of leaders and staff will turn out low even if the general acceptance of the paradigm's basic ideas is high.

New controlling tools: As measuring social and environmental performance can prove to be very difficult due to enormous variations in the reliability, comparability and availability of quantitative data, common management theory and practice has traditionally concentrated on economic performance indicators. Sustainable controlling tools need to allow companies' social and environmental performance to be measured and reported in a value-oriented way and to be in tune with modern management practices.[615] New controlling dimensions which challenge conventional ones require the full commitment of an organisation's leadership. Only if organisational leaders recognise the benefits of including new performance indicators

[609] Schaltegger 2010:7
[610] Schaltegger 2010:13
[611] Accenture 2010:18; for an overview of the drivers of sustainable business development in general see Hermann 2005:68
[612] Hermann 2005:67
[613] Vahs 2002:93f.
[614] Hahn 2009:10
[615] Atkinson 2000

and if the measuring systems largely apply conventional (i.e. financial management) logic they will wholeheartedly include them in their performance reports and support measures to improve performance. It is assumed that car manufacturers are still largely focused on and measured by unit output and financial indicators; however, new approaches are slowly finding their way into the corporations. The more these are focused on the conventional processes of car manufacturers, i.e. manufacturing and sales, the more likely they are to be accepted. This is the case e. g. for the Sustainable Value approach by Hahn [2009] which primarily focuses on the sustainability performance of automobile *manufacturing* of 17 global OEM, e. g. the amount of resources consumed in the production processes. Whether such measuring systems will allow resp. motivate manufacturers to measure success of activities beyond manufacturing and sales – such as mobility services and other sustainable innovations – still needs to be assessed.

New Human Resources responsibilities: Human resources play a pivotal role in transforming an organisation into a sustainable organisation because they have to accept new responsibilities in the following areas:

1. Know-how and training: Sustainable innovations require skills and competencies beyond the staff's acquired set of skills. Defining the new skills and then selecting new employers with the needed skills resp. promoting and retaining the new skills in the existing staff become major responsibilities of HR departments. The success of skill enhancement programmes will depend on selecting the most effective methods and even adopting new methods like peer-to-peer learning or involvement in community programmes. A sustainable development perspective in employee and leadership training will alter the way people think and act in critical business areas as they will automatically build skills which are relevant for leadership, team-working, negotiating and problem-solving.
2. Employer attractiveness: Especially top-level employees have a broader range of selection criteria for their workplace, often including non-tangible factors. A company's commitment to sustainability values is likely to increase their attractiveness among skilled people. Retaining employees depends largely on the degree to which sustainable development objectives are reflected in personal targets and rewards: "Performance appraisal must take into account the contribution of individuals and teams to longer-term social and environmental goals as well as short-term financial objectives."[616]
3. Reputation: A company's credibility regarding sustainability can become damaged if its employees are not "walking the talk". Therefore, HR departments have to motivate employers and leaders to act according to the sustainability objectives a company claims to pursue and, together with strategic management, ensure their compliance with sustainability guidelines.

Currently, car manufacturers' HR activities largely concentrate on improving employees' performance in the conventional functions and on leadership training. Performance appraisal largely focuses on short-term financial and economic performance of employees. Promoting sustainable know-how, employer attractiveness and reputation are new responsibilities which only will be completed successfully if HR departments are provided with the background and tools that enable them to fully understand and manage the new sustainability dimension.

Cooperation: Sustainable products are more likely to require services, materials and competencies from outside the organisation;[617] therefore, a sustainable business needs to cooperate with businesses from unfamiliar partners along the value chain. Finding a modus in which both sides can benefit from the cooperation and removing communication barriers between inexperienced partners are likely the biggest challenges of new cooperations. Car manufacturing is a highly separated production process which already involves several tiers of suppli-

[616] University of Cambridge 2006:10
[617] Arnold 2007:156f.

ers. There are longstanding criteria for selecting suppliers and developing supplier relationships some of which might not be fit for sustainable supply chains and cooperations. Developing and implementing new criteria and processes will be a major challenge for car manufacturers.[618]

Stakeholder involvement: As non-market aspects have a fundamental impact on market aspects when it comes to sustainability activities, stakeholders relevant to socio-cultural, political and legal factors will need to be involved in an organisation's activities, especially as some will explicitly expect or are even entitled to get involved. Stakeholders are any group or individual who can affect or are affected by the achievement of the firm's objectives.[619] Identifying the relevant stakeholders is one of the main tasks of corporate management.[620] If appropriate techniques are selected,[621] it will likely enhance the credibility of decision-making processes. Stakeholder involvement reaches beyond mere information and communication as it typically goes as far as empowering stakeholders in the decision making process or even actively involving them in innovation and product development processes. Car manufacturers have a short tradition of stakeholder involvement; however, along with their increasing acceptance of sustainability principles and the growing practice of sustainability reports there is a rising number of stakeholder dialogues and other methods to involve stakeholders. However, involving stakeholders in innovation or even decision-making processes is still rare in the business and will present a major obstacle for manufacturers.

Uncertainty: The uncertainty about the success of sustainability activities might be the biggest obstacle on the path to a sustainable organisation. It is caused by a lack of experience with sustainable activities and the non-existence of proven business models.[622] Developing appropriate business models – the rationale of how an organization creates, delivers, and captures value[623] – presents the biggest obstacle for car manufacturers when entering the mobility services market as their conventional business models are based on unit output and decreasing unit costs. Mobility services require completely new business models and will likely not match car manufacturers' prior experiences with income generation because they decouple the product from the service and thus replace the product as the major source of revenue generation. Business model generation for sustainable products and services will likely require involving expertise from without the organisation, a step that involves overcoming prejudices and building trust. Best-practice examples from similar companies can help business leaders to have more confidence in sustainable innovations.

Customer acceptance: Whether customers are ready to embrace and expect sustainable values or not will largely influence (but not necessarily determine) a company's willingness to engage in sustainability activities. Regarding sustainability, customers can be divided into three groups: 1) Those that have higher sustainability expectations than the company; 2) those whose expectations regarding sustainability performance match a company's commitment; and 3) those who have lower expectations or even resist sustainability values (traditional customer groups). There are companies whose customer groups represent fair mixtures of these three groups, and if their product variety allows they can offer products and services for every taste. However, transforming a company's basic paradigms and complete portfolios might overwhelm those of group 3 of which many of OEM's customers belong to. This will likely cause business leaders to scale down their change objectives. Their fear of losing their customers could only be diminished if they were able to find ways of consolidating "traditional" with "sustainable" values, which seems difficult given that sustainability for the most part matches post-modernism. However, some aspects of the sustainability para-

[618] Koplin 2006:348f.
[619] Hermann 2005:97
[620] Dubs 2004:331
[621] For stakeholder involvement techniques see OECD 2004
[622] Inkinen 2009:39; Schaltegger 2010:7; University of Cambridge 2006:15
[623] Osterwalder 2010:14

digm also represent a return to traditional values. Businesses with traditional customer structures are advised to focus on these elements. OEM entering the mobility services market will automatically maintain a broad product and services portfolio that serves the needs of all three customer groups. However, as they increase their focus on sustainable mobility services they should carefully select appropriate target groups and methods of addressing them in order to avoid overwhelming traditional customer groups with unexpected or even undesired offers.

To sum up, the shifts from product orientation to service orientation and from the economic/financial performance perspective to non-tangible performance indicators will be the biggest obstacles for car manufacturers when becoming a sustainable organisation.[624] While the latter will depend on the ingenuity of accountants and managers to come up with reliable, understandable tools, the former will depend on the commitment and conviction of a company's leadership and promising business models. Given the uncertainty due to the lack of business models and the huge demands this will put on leadership, a comprehensive shift to a sustainable organisation seems unlikely (but not impossible). This will be a major obstacle for OEM to engage in mobility services at large, requiring them to limit this shift to certain units of their organisation and selected aspects of their business.

5.3. Urban mobility services: Strategic options for car manufacturers

Mobility services as sustainable innovations can become an opportunity, but also a challenge for car manufacturers. So far, their business model used to be determined by market demand and technological innovation, both of which OEM have become experts in by establishing vast R&D and marketing activities. Their value does not lie in the production, provision and delivery of a manufactured vehicle alone but also in the incorporation of complex technology and in their ability to sell dreams and emotions related to driving. However, with a decreasing demand for car ownership and higher burdens on and of mobility, esp. in Western urban areas, these value propositions become less valuable and need to be replaced by the promise of seamless mobility, a task vehicle manufacturers are hardly prepared for. Another value that is gaining importance on the market is the (ecological) sustainability of a vehicle. While some manufacturers are successful in focusing their innovations on low-emission machines, others are selling these features only as a by-product. In the future though, these aspects will likely be more in the focus of customers' attentions, as well as the range of services and extent of mobility guarantee a manufacturer offers.[625] It even might be possible that a partial shift of attention from a manufacturer/brand focus towards a provider/service focus will take place.

This chapter will explore the strategic options a car manufacturer can chose from when planning to participate in the mobility services market, the driving forces and barriers it faces, and the resulting research and action agenda.

5.3.1. Strategic pathways

Even though the evidence for a growing mobility service demand is compelling and the market is flourishing, it is not obvious whether and how car manufacturers could seize these opportunities. To which extent this paradigm shift towards higher service orientation will alter the landscape of the automotive industry will depend on the pathways car manufacturers choose (resp. have already chosen) upon entering the market. The strategic shift required is of a double nature, including the extent of service orientation on the one side and the decou-

[624] Schreiner 2005:34f.
[625] Shankar 2012

pling of product and mobility on the other side – even if only a small part of the company experiences this shift. Along these axes, Winterhoff et al. [2009] propose four strategic options for automotive manufacturers:

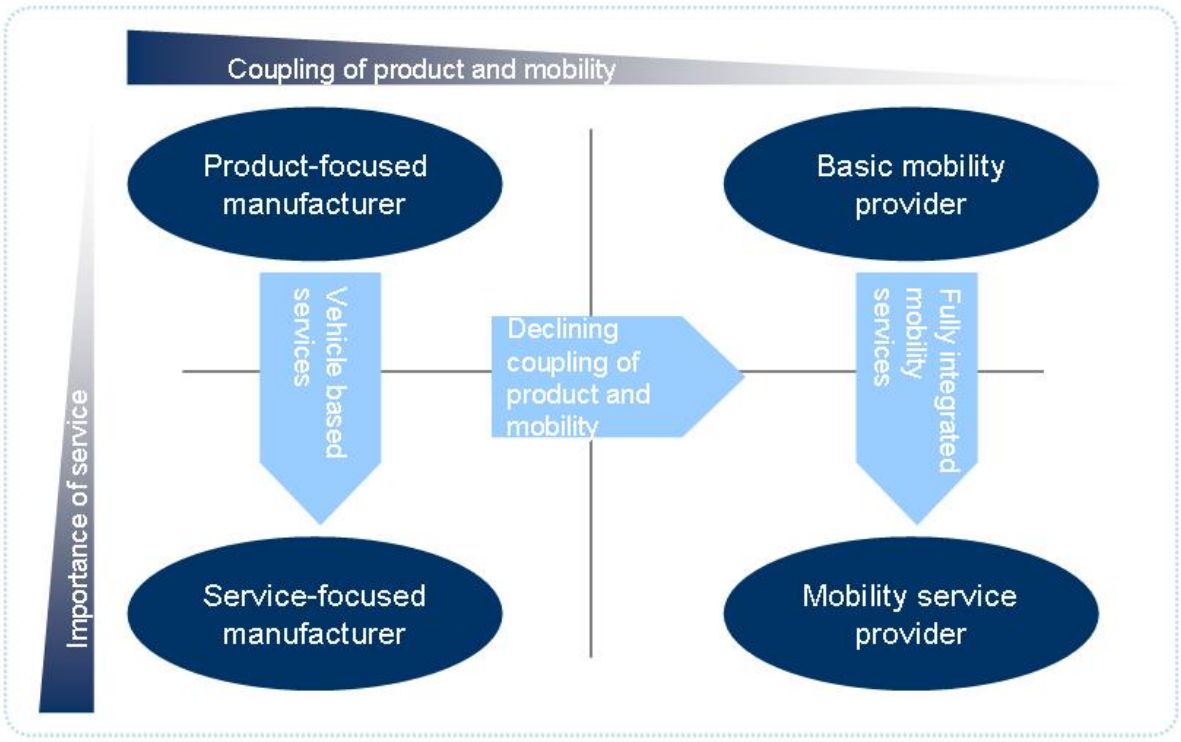

Figure 97: Strategic options in the future mobility market[626]

The product-focused manufacturer represents the dominant model of the automotive industry, whereas the service-focused manufacturer is concerned as much with innovative service concepts for delivering its vehicles as with technology development. The basic mobility provider and mobility service provider both decouple individual mobility from the car, with the former focusing on basic mobility needs and the latter including a wide range of services (deep support).

The **product-focused manufacturer** will be best able to deliver low-cost, low-emission and smart vehicles to both vehicle-focused and highly environmentally and cost conscious customer groups, thus addressing the needs of the mobility types sensation seekers, silver drivers, greenovators and low-end users (see chapter 2.3.3.3). Since the contribution to earnings would be achieved mainly by selling highly innovative products, this strategy will be promising for premium manufacturers in niche markets, a few volume manufacturers, and low-cost manufacturers.

Together with the product-focused manufacturer, the **service-focused manufacturer** will cover the largest part of the future mobility market. Both provide mobility via a strong connection to the car and to a certain brand. However, the technology orientation of the service-focused manufacturer is moderate and it concentrates on reproducing existing technology. The car is regarded more as an enabler for services marketed to the customer during the

[626] Winterhoff 2009:63. Even though including a much wider array of activities from the field of integrated mobility, Matthies/Stricker/Tsang [2012] are also suggesting four similar strategic options for car manufacturers planning to participate in the mobility services market, varying according to a) the extent of an OEM's activities in integrated mobility and b) the level of value creation involved in these activities. The extreme options are a fully integrated mobility service provider on the one end of the spectrum and a "minimalist" service approach on the other end, plus two medium level approaches with varying degrees of involvement and value added, employing a procurement/operator strategy.

whole lifecycle. The service-focused manufacturer best addresses the needs of those who desire to be freed from all additional mobility tasks because they already spend an extraordinary amount of time for travel. This is the case for the mobility types *global jet setters, family cruisers* and *high-frequency commuters*. This strategic option is similar to the strategy pursued by the IT and software giant Apple which evolved from an IT hardware manufacturer to a service provider which ties its services closely to its products.

The market for companies that decouple mobility from the car will be smaller but will experience a higher growth than the markets served by the first two strategic options. The **basic mobility provider** offers services for basic mobility needs, including new ownership/use approaches, and integrates other modes of transport as it addresses mainly the needs of urban travel. Cars are regarded as only one element within an array of vehicle and transport options. Accordingly, they will be selected along practicability and cost indicators. Shared use and pay-per-use services will reduce mobility expenses for individuals significantly. Typical customers of the basic mobility provider are low-end users. This strategic option is already being pursued by several carsharing providers on the market, especially those who offer integration with other modes, like DB CarSharing (the car sharing service of the German Railway) or Mobility Car Sharing in Switzerland.

The **mobility service provider** operates according to the principles of deep support:[627] it frees users from all tasks regarding mobility and even includes tasks reaching beyond it. This premium, all-inclusive, carefree service addresses the needs of the post-car society in which vehicle ownership is regarded as unnecessary or even burdensome and sustainability and convenience are valued. The services offered by the mobility service provider are most attractive for greenovators with global mobility needs and for global jet setters. Beyond the mere mobility provider, the mobility service provider becomes a lifestyle provider and can set up a global super brand for sustainable lifestyle. The services of an mobility service provider could also be offered by a basic mobility provider, simply as a premium version. However, in order to create a premium feel for the customer, it might be advisable to separate basic mobility provider and mobility service provider brands via two faces to the customer.

The two latter strategic options which decouple mobility from the car deviate most from the prevailing business model of the automotive industry. Winterhoff [2010] assumes that they will constitute not even a quarter of the total mobility market in 2020; however, the key factor analysis results (see chapter 3.3) indicate that this market might turn out to be larger. Yet, as mobility services still lack reliable business models, it is unlikely that many car manufacturers will decouple mobility from the vehicle very soon. Due to ongoing consolidation processes – the number of independent OEM decreased from 30 in 1970 to only 13 in 2005, a process which is likely to continue into the future – only volume manufacturers with high profit margins will survive in the coming decade. This will leave niche markets – which might gain some momentum in the near future given the increasing diversification of urban mobility concepts and vehicles[628] – to niche manufacturers.[629] Car manufacturers will be mainly divided into product-focused and a smaller fraction of service-focused manufacturers. It is much more likely that new players which are already service-oriented and integrated will seize the opportunities of this business area. If car manufacturers still want to profit from the small, but growing service provider market they can cooperate with these new players, e. g. by contracting exclusive vehicle provision and adapting their vehicles and technology to the specific needs of shared, grid-connected vehicle infrastructure.

However, higher competition on the mobility market has already motivated car manufacturers to get involved more closely in mobility services, bearing in mind that other industries will seize the market before they can: “If a company's own research does not make [a product]

[627] Zuboff 2004

[628] see overview on urban vehicles in annex 6.3

[629] Wallentowitz 2010:25

obsolete, another's will."[630] Since the nature of mobility services – and especially those involving electric vehicles – differs significantly from conventional car ownership, the industry model will differ as well. As the "face to the customer" no longer needs to be the car itself but the "service package", the range of new companies entering the market is extensive and reaches beyond the conventional car manufacturing value chain. Car manufacturers might not be needed for the mobility services market, at least not their brand as a value proposition.[631] However, it is unlikely that car manufacturers might be eliminated from the mobility market as some overzealous expert studies suggest; rather, they will retain their traditional role and get involved in the new mobility service business occasionally, serving as a module manufacturer, assembler or service provider themselves, benefiting from their brand values.

In order to achieve a higher level of involvement without undergoing the full shift from manufacturer to service provider, OEM can outsource mobility service businesses, as Daimler has done successfully with its Car2Go service. "Subunits that are internally tightly coupled, but loosely coupled to each other"[632] can overcome Abernathy's productivity dilemma [1978] which suggests that the "ambidexterity" of high efficiency (exploitation) and high flexibility/innovation (exploration) is hard to achieve for large organisations.[633] Exploitation-oriented production units with high-volume established products and production processes aim at reducing costs, improving productivity, perfecting product features and assuring quality while exploration-oriented units have the objective of qualitative product improvements, often involving radical innovations triggered by evolving customer needs. In contrast, in exploitation-oriented productive units outside stimuli are only provided by technology progress or government regulation. They are the only stimuli that encourage major product innovation; otherwise, incremental/linear innovations dominate progress.

As "neither extreme stage represents an attractive stable state for a firm"[634], Abernathy and related literature sources recommend the active establishment of exploration-oriented (sub-) units in order to harvest the benefits of non-linear innovations and thus remain competitive. However, such subunits are not without risks for two reasons: 1) As "there is a real danger that if both types of innovative capability are sought in one productive unit, effectiveness will not be realized in either", and as "corporations are limited in their ability effectively to manage several productive units that are in widely different stages of development"[635], productive units with different orientations should be separated from each other. 2) Even if such business units will be profitable they will constitute only a small fraction of a company's earnings. At best, they can contribute to the stabilisation of market shares in saturated markets.

Paradigmatic change in any organisation will have to deal with several barriers, many of them caused by the so-called *path dependence*. The term path dependence describes how present options in decision-making processes are limited by the decisions of the past, even though those past circumstances may no longer apply. An important role is played by positive feedback loops where the outcome of a decision or action reproduces this decision or action over and over.[636] The concept of path dependence used to be applied mainly to macro-economic, social and technological questions. While it was able to explain technology adoption processes and industry evolution in the past, the fact that change and change management have become constants of the economy has made it attractive to apply the concept also to businesses and organisations. It is assumed that it can help explain the seemingly strong reluctance towards change in many organisations. As path dependence tends to be

[630] Levitt 1975 [1960]:7
[631] Becker/Dietz/Göring 2010:31
[632] Adler 2009:101
[633] Abernathy 1978; Benner/Tushman 2003:238
[634] Abernathy 1978:72
[635] Abernathy 1978:168
[636] For the different mechanisms behind positive feedback loops see Schäcke 2005:54f.

stronger in larger organisations it most certainly applies to car manufacturers.[637] The most prominent example is the exploitation (efficiency) focus of car (and other industrial) manufacturers which poses a barrier to exploration (innovation), i. e. Abernathy's productivity dilemma described above.

As most of the causes of path dependence are found in interior rather than exterior factors, the organisational setup and processes of a manufacturer should be the focus of attention when trying to implement change processes and overcome related barriers. Since neither the ambivalent signs of change nor the moderate prospects for car manufacturers' stakes in mobility services relieve car manufacturers from the need to reposition and adjust their strategies and organisational setup, a SWOT analysis appears to be an adequate tool to assess car manufacturers' fit for the mobility services market and a starting point for finding solutions for overcoming barriers to change.[638]

5.3.2. SWOT analysis

Car manufacturers planning to engage in the new business area of mobility services are venturing into diversification because, according to the Ansoff matrix of product market combination, they put a new product/service on a fairly new market:

	Existing market	**New market**
Existing products	Market penetration	Market development
New products	Product development	Diversification

Table 27: Ansoff matrix (product market combination)[639]

Therefore, OEM should analyse carefully the internal and external factors that are favourable or unfavourable to achieving that objective. This so-called "SWOT analysis" (**s**trengths, **w**eaknesses, **o**pportunities, **t**hreats) is a tool for strategic decision making because it reveals hidden threats and unexpected opportunities. The four SWOT fields are defined as follows:

Internal	**S**trengths: attributes of the person or company that are helpful to achieving the objective.	**W**eaknesses: attributes of the person or company that are harmful to achieving the objective.
External	**O**pportunities: external conditions that are helpful to achieving the objective.	**T**hreats: external conditions which could do damage to the business' performance.

Table 28: SWOT analysis – conceptual overview[640]

For the analysis of the internal strengths and weaknesses of a company, the following categories need to be considered: Product, production system, logistics, technology know-how, R&D, sales and marketing, distribution, human capital, organisational structure, management and leaders, information and knowledge systems, company culture, self conception, and financial structure and prospects.[641] The analysis of external factors (opportunities and

[637] Schäcke 2005:341f. explains how to identify path dependence in organisations.
[638] Matthies/Stricker/Tsang 2012:17f.
[639] Nagel/Wimmer 2009:206
[640] Krogerus/Tschäppeler 2008:12
[641] Nagel/Wimmer 2009:182f.

threats) should include societal, technological, economic, ecological and political (STEEP) aspects as well as competitors and the business sector in general. This analysis has been covered mainly by chapter 3 and will be recapitulated only briefly here.

The SWOT analysis for the objective "integrating mobility services into car manufacturers' portfolios" looks as follows:

SWOT Analysis **Integrating mobility services into car manufacturers' portfolios**	
Strengths • Know-how about vehicles, technology, and financing/banking • Quick access to cheap vehicle fleets[642] • (Partial) openness to new mobility behaviour • High customer orientation • Established, renown brands • Distribution network, Point-of-sale network	**W**eaknesses • Little experience with mobility services (flexible billing, customer relation etc.), only car-oriented services (financing, maintenance) • New competencies and human resources needed[643] • Partial unwillingness to cooperate with other providers • Little experience in cooperation with other providers • Business models largely unknown[644] • High opportunity costs (risk of sunk costs) • Capacity load of production sites jeopardised if increase of services in the portfolio leads to lower unit output • Inertia, low flexibility and path dependency of large organisations • Insufficient knowledge about intermodal mobility behaviour • Possible lack of support by top management due to exploitation focus • Possible lack of institutionalisation of exploration of mobility service innovations • Self-conception as a manufacturer, not as a mobility provider • Blurring of brand image
Opportunities • Via mobility services car manufacturers can benefit from changes in the mobility sector (see chapter 3) which leads to a lower ownership/use of cars[645] and a new role of the car in the transport system[646] • Competitive advantage: Other providers do not have access to cheap vehicle fleets • Bridging access gaps: even sustainable urban transport systems will not be able to exist entirely without cars[647] • Development of new markets	**T**hreats • Other providers might not be willing to cooperate • Competition by other providers • Customer acceptance/demand of mobility services lower than expected

Table 29: SWOT analysis "Integrating mobility services into car manufacturers' portfolios"

This SWOT aims at sensitising the reader for potential opportunities and threats encountering adventurous car manufacturers. It is not intended to be comprehensive as identifying a

[642] Next to parking/station costs, the largest expenses for car sharing organisations are fleet costs. (Kellenberger 2009)
[643] University of Cambridge 2006:12
[644] Inkinen 2009:39
[645] Ulrich/Duranton/Köhler 2009:2
[646] Dennis/Urry 2009
[647] Maertins 2006:2

business model or a working strategy is not the objective of this thesis; nor is it specialised enough because it has a general objective and does differentiate neither between vehicle provision services and information and assistance services nor between the four business models outlined above. The results of this SWOT analysis will be integrated in the development of the research and action agenda below.

5.3.3. Research and action agenda for OEM

After selecting the most appropriate mobility services and determining their strengths and weaknesses, OEM need to develop a general strategic research and action agenda regarding mobility services. The items on the agenda should consider business models and internal organisation issues, innovation, and new research topics. The proposed action and research agenda is not supposed to be a blueprint but presents modules which have to be selected and adapted for each manufacturer individually.

Business models and organisation

The results so far demonstrate that the demand for innovative mobility services is rising but that their share in the total mobility market will remain comparatively small. Therefore, it is neither likely nor advisable for volume car manufacturers to completely transform their business from vehicle production towards mobility services (compare the strategic options above). Rather, they are recommended 1) to outsource mobility service sub-units, 2) offer white label services, 3) package their products with services by other providers or 4) provide vehicles for mobility service providers. If neither of the options 1) to 4) seem appealing to a manufacturer they still can 5) incorporate enabling technologies into its vehicles or 6) enlarge the service range of traditional vehicle sales.

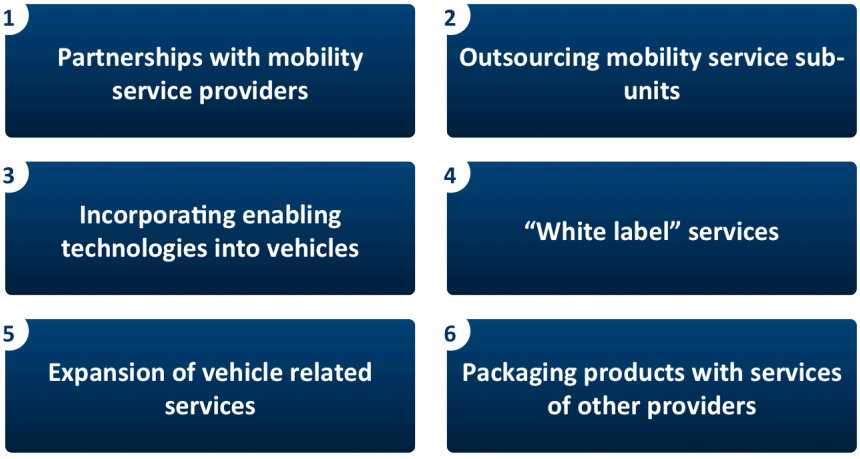

Figure 98: Six options for entering the mobility services market

1) Outsourcing mobility service sub-units: This strategy requires the same research and action that needs to be performed by full mobility service providers, just on a smaller scale. A sub-unit can be used as a test bed for innovation and later, in case of economic success during the trial period, be fully integrated into the company or outsourced. Independent, but internally tightly coupled sub-units can best achieve a high innovation level within a productivity- and profit-oriented organisation.[648]

2) "White label" services: Car manufacturers could buy turnkey solutions from existing service providers on the market who offer their systems or software as a "white label" service, including development and operation. The OEM's service would run on the same platform or system as the original service and would merely be labelled with the OEM

[648] Adler 2009; see also chapter 5.3

logo; the white label provider would also operate the service but the OEM would be the "face to the customer". This approach has proven successful in the consumer goods industry and for web applications. It would relieve OEM from the burden of developing and operating a service where they still lack experience, know-how and human resources.

3) Packaging products with services of other providers: Car manufacturers can reap rich benefits from packaging their own product with the offers of other service providers, especially when they are already providing vehicles for another mobility service provider (see option 4 above). Access to existing vehicle provision services would allow car owners to enlarge or alter their vehicle fleet occasionally, thus reducing the need to buy a vehicle for maximum needs. Likewise, services from the information and assistance category could be an interesting extra when purchasing a vehicle. Whether as an exclusive partner or not, service providers would benefit from this strategy as well, thus resulting in a win-win situation. This strategy would greatly expand the reach of existing mobility services.

4) Providing vehicles for mobility service providers: Partnerships with mobility service providers already exist but not to the extent desired by most providers. Service providers could benefit from lower vehicle prices while car manufacturers could benefit from the positive image created by the cooperation and from an additional distribution channel for their vehicles.

5) Incorporating enabling technologies into vehicles: Car manufacturers are better able to offer vehicle provision services than information and assistance services; yet, the latter are indispensable for integrated mobility services. One option to solve this dilemma would be to incorporate smart technology (which supports intermodal travel) into their vehicles, especially those used for vehicle provision services.

6) Expansion of vehicle related services: The product related service range of car manufacturers already is quite extensive, yet most services are add-on services and not a genuine element of the vehicle purchase process. Providing insurance and taxing services and mobility guarantees (in case of failure, repair or maintenance) are still extra items on vehicle manufacturers' service lists. Along with access to extra vehicles via a car pool subscription and re-marketing services car manufacturers can complete their service packages and even become competitive with full service providers, especially among those user segments which will remain focused on car use and ownership.[649]

Option 1) – outsourcing subunits – will be the most challenging route a car manufacturer can take when embarking on the mobility services boat because it challenges conventional approaches to business in the automotive industry. However, coupled with a smart business idea and a consistent strategy, it will hold the largest benefits because it will allow the OEM to get established as a (partial) mobility service provider. Less challenging and almost as beneficial is option 2) – white label services. It relieves OEM from the efforts required for outsourcing subunits (1) but still allows them to build their image as a (partial) mobility service provider. More than option 4), option 3) – packaging vehicles with non-proprietary services – requires a shift in the self-conception of car manufacturers as they need to acknowledge and praise the benefits of intermodal mobility for marketing such packages. Option 4) – providing vehicles for service providers – touches upon a discussion which has been around ever since car sharing started. Even though for OEM the benefits of this simple option are large it is still widely neglected, thus thwarting possible profits from mobility services. Option 5) – incorporating enabling technologies into vehicles – can become a door-opener for intermodal mobility services while option 6) – expanding vehicle related services – is the default option every manufacturer should implement disregarding its overall mobility services strategy.

Transforming weaknesses into strengths

[649] Winterhoff 2009:65

As the SWOT above demonstrates, opportunities in the mobility service business for car manufacturers are high but internal weaknesses might prevent them from seizing these opportunities. Turning these weaknesses into strengths will be the most important task for OEM. After the strategy regarding mobility services (including the selection of the appropriate mobility service(s) and the extent to which the involvement is planned) is set up, a specific SWOT analysis has to be conducted by each manufacturer individually. The process of turning the weaknesses into strengths can unfold subsequent change processes which might then invigorate the company as a whole. Therefore, the weaknesses can literally be regarded as a challenge yielding potential for positive change. For example, addressing the weakness "insufficient knowledge about intermodal mobility behaviour" by expanding the research on these topics will lead to an improvement of knowledge about mobility behaviour in general and benefit vehicle design and marketing processes as well.

Innovation

Companies with short innovation cycles and strong customer orientation have a clear advantage when engaging in a new business area. Car manufacturers should therefore conserve and foster this asset, but they should also examine closely their innovation processes and types. It needs to be kept in mind which type of innovation most mobility services belong to: they are radical, systemic, social innovations, ideally developed in an open innovation process and emerging upon market pull while conventional innovations in the automotive industry tend to be on the opposite end of the innovation spectrum: linear, modular and product- or process-focused, developed in a closed innovation process upon market push. Fostering the appropriate innovation paradigm within a company and its culture might be one of the biggest challenges to face[650] because it will likely involve shifts in the company's structure and organisation.[651]

Politics for mobility services

The success of mobility services on the market depends heavily on the political framework conditions.[652] If car manufacturers want to engage in mobility services they need to include the relevant policy options into their lobbying efforts and demand clear commitments from policy makers. Synergy effects can arise from joining other interested stakeholders in lobbying efforts.[653] Depending on the services in question and the regional level, these include, among others, harmonisation aspects (technical and organisational harmonisation of transport modes), legal aspects of parking regulations and privacy, but also, on a more general level, the overall transport strategy of a government. As the latter will likely include regulations that make the use and ownership of cars less attractive the position of car manufacturers will probably remain ambiguous.

For the implementation of mobility services local administrations and community groups are important allies of providers and need to be involved early in the process of development and implementation. Political support raises the image and acceptance level of mobility services and facilitates the implementation of infrastructure measures, e. g. parking spaces for vehicle provision services.[654]

New research areas

As the conventional innovation focus of OEM addresses technological and incremental innovations, OEM will have to add several topics to their conventional range of research. Looking

[650] Christensen 2002; Inkinen 2009; see chapter 5
[651] compare Kucz [forthcoming]
[652] Böhler 2010:145; Harms 2003:77; see chapter 3.3.10
[653] compare Shaheen/Cohen 2013, which call for a global car sharing organisation in order to concentrate lobbying and policy efforts
[654] momo Car-Sharing 2010:93

back at the key factor analysis (chapter 3.3) and the SWOT analysis above, it is suggested that OEM initiate resp. intensify their research efforts in the following areas:

- Impacts on structure and organisation of car manufacturers: An analysis of the potential impacts of a systemic innovation on car manufacturers has been performed by Kucz [forthcoming]. Along this model which uses backcasting, an analysis of the impacts of mobility services on car manufacturers should be performed before entering into this new field. Results can provide insights about organisational structures, networks and exchange of information and communication.
- Service science: The concept of service-dominant logic is founded on the premise that service is the fundamental basis of any exchange.[655] The service-dominant logic can provide a frame of reference for research and management which is more effective than a frame of reference based on tangible goods, even if the major focus of a company remains on the manufacturing of tangible goods. This logic also includes the service design approach as a basis for initiating innovation.[656] Analysing the customer experience in a service process this approach highlights the user perspective and adapts services (or products) to their needs. In current innovation processes, often the opposite direction is pursued as new technologies are put on the market without corresponding customer needs.
- Intermodal mobility: Car manufacturers who intensify their efforts in studying intermodal mobility behaviour will be able to tailor solutions to target group specific needs.[657] The segments most prone to using mobility services offered by OEM will be multimodal user groups who use or own cars, e. g. the metromobiles identified by Canzler/Hunsicker [2007] or the greenovators identified by Winterhoff [2009]. Pilot projects should be aimed at user segments which are narrowly defined in order to improve predictability and which are challenging in order to be easily attractive to a broader public later on.
- Impacts of mobility services on mobility behaviour and SUTP: Chapter 2.3.3.2 presented a brief overview of the potential impacts of mobility services on mobility behaviour. Yet, a comprehensive analysis is still to be done. The same is necessary regarding the impacts of mobility services on the urban transport system as a whole. Therefore, it is strongly recommended to decision makers to develop and apply assessment systems for evaluating the impacts of any measure including mobility services on the performance of urban transport systems and on environmental health.[658] This is necessary in order to prevent the implementation of seemingly innovative services that actually contradict established goals of sustainable urban transport planning (SUTP).[659] Even though this question is paramount it is at the same time too demanding for the scope of this thesis (see definition of the scope of the thesis in chapter 1.4).

5.4. Competition, pathways and adaptation: Concluding theses on OEM and the future mobility services market

Looking back at the results of the key factor and user analysis and the insights on car manufacturers' opportunities in the mobility services market, the synthesis will present the author's conclusions regarding the actual opportunities and challenges OEM will encounter on the

[655] Vargo/Lusch 2004; Vargo/Lusch 2008
[656] Moritz 2005; Schulz 2010
[657] Kristof 2010:54
[658] For examples of mobility services assessment see Wilke 2007; Bundesverband CarSharing (2008); Haefeli 2006; Hoffmann 2002; Loose 2007; Maertins 2006; Böhler/Hunecke 2008
[659] Rammler 2005:15

mobility services market. It will close with an outlook on the future of mobility services and the future role OEM can play in this dynamic market.

Mobility services and intermodal mobility are the keywords of the new urban mobility paradigm (see chapter 2.3.1). Their importance for the development of mobility cultures will increase substantially until 2020. The question is not whether OEM will adopt this new mobility agenda – many of them have already shown their willingness and ability to do so –, but how they can best benefit from it. This depends on external and internal factors. The following theses summarise the findings so far and are concerned with the question whether and how the automotive industry will be able to successfully engage in mobility services and which challenges and opportunities are involved in this step.

Competition and business models

1. *Low adoption rate of mobility service business model by OEM:* Car manufacturers are not likely to venture into unknown business models at large for three reasons: 1) Trapped in the productivity dilemma,[660] the main objectives of car manufacturers will remain cost reduction and productivity improvement because competition in the high volume automobile market is still mainly based on price and less so on major product innovations. 2) The shift to a sustainable organisation which is necessary for including mobility services into a company's product range and includes the shift from mere product to service orientation as well as from an economic performance focus to non-tangible performance indicators will be a very big challenge for the average car manufacturer. 3) Even though the key factor analysis indicates a growth in the demand for mobility services, the market might remain too small to be attractive for (volume) car manufacturers. Therefore, car manufacturers will merely opt at the strategic options product-focused manufacturer and service-focused manufacturer described in chapter 5.3 rather than becoming full-grown mobility providers themselves. This path corresponds best to the OEM's self-conceptualisation as vehicle manufacturers. It will protect OEM from the risks and challenges involved in becoming full service providers, such as acquiring new human resource potential, risks of sunk costs and of blurring the brand image (see "weaknesses" in the SWOT analysis in chapter 5.3.2).
2. *Competitive advantage of connected and cooperative transport providers:* Transport providers which are already flexibly connected and cooperating with other transport modes and services will be able to adopt the new mobility agenda more easily than those focussing on only one core business. Companies like OEM with a focus on a single mode might be more reserved when it comes to initiating cooperation and integrating other (allegedly competitive) modes into their service portfolio. For example, the Deutsche Bahn (German Railway) is already well positioned in car rental/sharing, bike sharing, logistics and even cooperation with airlines. Likewise local public transport providers have diversified cooperation structures, e. g. the GVH in Hannover/Germany which cooperates with local taxi and car sharing providers as well as with the Deutsche Bahn (see chapter 2.3.2). On the other hand, most car manufacturers' mobility services lack intermodal connectivity and are weak on the information and assistance services side (see chapter 4.3).
3. *Competitive advantage of organisations with short innovation cycles and high customer orientation:* The more customer-oriented and the shorter the innovation cycles of a company the more it will be able to adopt the new mobility agenda, required that innovation processes do not focus on technology innovations only. For example, public transport providers, especially regional/local ones are not very customer oriented, are highly subsidised, and their innovation cycles are very long whereas OEM and the IT sector have shorter innovation cycles and are more customer-oriented. OEM can build on this asset

[660] Abernathy 1978, see also chapter 5.3

and intensify their customer orientation and product/service development turnover rate in order to react flexibly and adequately to radically changing customer needs.

4. *IT sector as new player on the mobility market:* As the IT sector has a headstart on smart technologies it will play a larger role than presently. Smart technologies are the key to increasing the attractiveness of alternatives to individual motorised transport and to delivering real-time traffic information to end-users (see key factor "Vehicle technology and portfolio of car manufacturers", chapter 3.3.4). Therefore, the role of the IT sector can evolve from mere software developer to service integrator. As it is not tied to a certain mode, it can operate more independently and rationally. OEM should intensify their collaboration with the IT sector in order to benefit from their progress regarding smart mobility solutions. IT companies can also become powerful white label providers.
5. *Danger of missing out on innovative segments:* Companies that do not offer innovative mobility services will not appeal to innovative, demanding user groups like the greenovators or high-frequency commuters (see chapter 2.3.3.3), thus being forced to concede this market to other providers and to jeopardise their own "innovative" brand image. Depending on the size and image of the remaining conventional market OEM risk staying behind the overall progress of the mobility sector.
6. *Added value dilemma:* OEM will hardly be able to provide an added value to users which other providers could not provide also. The benefit of access to cheap vehicle fleets can also be harnessed by other providers by contracting exclusive vehicle provision. The benefit of integrating information and assistance systems with vehicle functions can also be achieved by the IT sector. However, one asset other providers do not possess to the extent car manufacturers do is the trust people have in car brands. This trust gives OEM a headstart when entering the mobility services market – even with more daring features than other providers which have to develop brand trust first.[661] This has been exemplified by Daimler which was the first provider of a public vehicle fleet without fixed stations. The trust the brand owns allowed them to venture into a largely unknown service model.

Opportunities and pathways for OEM

7. *Outsourcing of innovative mobility service units:* Independent, but internally tightly coupled sub-units can best achieve a high innovation level within a productivity- and profit-oriented organisation.[662] They are part of a strategy to maintain the balance between the exploitation (incremental innovation, cost-efficiency) and exploration (radical innovation) focus within a firm but allow to separate these highly inconsistent stages of product unit development.[663] An example is the Car2Go sub-unit of the Daimler Group which successfully deployed a highly innovative public vehicle fleet in Ulm/Germany. It was able to develop its service innovation independently from the Daimler core processes and to experiment freely. As the break even was achieved comparatively quickly, Daimler decided to outsource Car2Go as a subbrand in spring 2010. It now operates independently and successfully, even though the level of its profitability is unknown.
8. *Overcoming internal weaknesses:* The SWOT analysis (chapter 5.3.2) demonstrates that opportunities are big but internal deficiencies might prevent car manufacturers from seizing these opportunities. Internal factors are much easier to be influenced than external threats, yet barriers for change can be high due to the strong path dependency of organisations;[664] therefore there are chances that car manufacturers eliminate their weaknesses and thus open the way to seize the opportunities of the mobility service market. The process of turning the weaknesses into strengths can unfold subsequent change pro-

[661] Schreiner 2005:83f.
[662] Adler 2009
[663] Abernathy 1978:164; see also chapter 5.3 and Table 26 in chapter 5
[664] Schäcke 2006

cesses which might invigorate the company as a whole. Therefore, the weaknesses can literally be regarded as a challenge yielding potential for positive change.

9. *Mobility services as additional channel of distribution for vehicles:* Vehicle provision services will provide an additional channel of distribution for vehicles, no matter whether the service is provided by the OEM, by a joint project of (several) OEM and transport providers, or by non-OEM providers like CSO. Additional outlets can assist in evening out the impacts of volatile markets.
10. *Mobility services for launching BEV:* OEM will use mobility service solutions for testing new vehicles and technologies, esp. BEV.[665] Since BEV require a different infrastructure and are less likely to enter into private ownership due to high purchase prices (see chapter 3.3.4), a shared approach promises to be most successful initially. BEV vehicle provision services will need to address battery recharging issues by involving a) electricity suppliers for purchasing electricity and b) municipalities for equipping parking spaces with battery recharging systems. Besides that, OEM will be more appropriate BEV fleet providers than conventional car sharing providers as the latter are not able to incorporate high fixed costs for BEV into their tariff structures and usually have customer groups which find adopting a new vehicle technology rather difficult (see chapter 2.3.2).
11. *Mobility services as a means for reducing portfolio complexity:* Customised mobility service packages might be an option for car manufacturers to manage and reduce the costly complexity of their ever growing product portfolios (see chapter 1.1). Instead of increasing their product range manufacturers can simply diversify their service ranges based on a less diversified product portfolio. However, this implies a more long-term strategy of addressing diversifying customer needs in a new fashion. Successful examples can be found e. g. in the chemical industry.

Adapting mobility services for OEM

12. *Ability of OEM to imitate existing mobility behaviour:* Mobility services that imitate existing mobility routines – most of them based on individual motorised mobility – by reducing transaction costs will have the highest market acceptance.[666] OEM will be best able to serve these customer needs because they have plenty of experience with car-based mobility behaviour. However, imitating mobility routines by services requires a substantial amount of creativity for which an environment conducive to disruptive innovation will be necessary. This seems to have been achieved by most of the mobility services by car manufacturers currently on the market as they incorporate the principle of “instant access, one-way, open end”, a major reason for their good market acceptance.
13. *Vehicle provision services more promising for OEM than information and assistance services:* OEM will be more successful in vehicle provision services as these are closest to their current portfolio and match their competencies. When it comes to information and assistance services, OEM should opt at cooperating with service providers or integrating smart technologies developed by and purchased from other (white label) providers into their cars (see chapter 5.3.1).
14. *Higher attractiveness of large solutions:* Local solutions will not be very attractive for users; they demand seamless mobility everywhere. At least on a national level, mobility services (esp. vehicle provision services) need to be harmonised. The same is true for the highly consolidated automotive industry which cannot afford to invest in niche markets. Strategic options for designing large solutions are a) rolling out mobility services nationwide, as e. g. done by DB Rent (Germany), or b) joining a network of providers, as e. g. done by some car sharing providers (StadtMobil in Germany, ZipCar in the US/UK) (see overview in annex 6.2).

[665] Kucz [forthcoming]
[666] Wilke 2002b:14, 26; Canzler/Hunsicker 2007:5

Even though the picture is mixed, car manufacturers are not likely to transform their product- and production-based business model completely into a mobility service provider business because the volumes to be expected on the mobility services market are growing but only on a low level, and the associated risks (e. g. sunk costs) are likely to be higher than the associated benefits. Their competitive advantages regarding short innovation cycles, strong customer orientation and high capacities to imitate existing mobility routines are likely to be outweighed by the competitive disadvantages of low levels of experience of and disposition to cooperation with other transport providers and the lacking capacity of OEM to provide an added value to users (added value dilemma). This assumption is made on the background of the SWOT analysis (chapter 5.3.2) which reveals a wide array of internal weaknesses presenting barriers to OEM's success on the mobility services market. Even though *internal* weaknesses are easier to overcome than *external* threats, the path dependency of OEM and the related productivity dilemma – once a company has shifted its focus on the efficiency of production (exploitation) its resources for innovation (exploration) are diminishing[667] – will make it difficult (but not impossible) to overcome them simply because the resources (human and financial) and the willingness necessary for such a change process might be missing.

However, in order to access innovative user segments car manufacturers can choose smart alternatives: They can outsource innovative mobility service units, purchase white label solutions, or cooperate with other service providers. This is especially beneficial for launching new vehicle technologies like BEV. Whatever pathway OEM chose to engage in the mobility services market, they should prioritise vehicle provision services over information and assistance services without completely neglecting the latter and engage in large (ideally national) solutions. Despite all the risks and weaknesses involved, car manufacturers have the same chances for succeeding on the mobility services market, provided they develop smart business models and put customer acceptance first.

5.5. Outlook

The demand and need for mobility services will continue to grow – as will the opportunities for car manufacturers. The analysis of this thesis started out with a closer look at how mobility services help achieving the goals of sustainable urban transport. So far mobility services play only a minor, but rapidly growing role in the concert of urban mobility. Recent market entries demonstrate that car manufacturers are hopping on the mobility services train, and their success in terms of market shares is remarkable; however, it is not public how much direct profit they are earning from these services – besides the gain in image.

One of the most challenging developments of transport in the future will be the growth of traffic volumes. It is likely to compensate efficiency gains as has happened in the past.[668] As mobility services can potentially generate more traffic by enlarging the mobility options and access for individuals their contribution to sustainable transport remains ambiguous. This dilemma calls for a sound integration of mobility services into urban and transport planning concepts which reduce traffic volumes, shift transport modes and eliminate burdens of mobility. As cars are the main contributors to traffic volumes and burdens of mobility such a strategy will likely include the reduction of vehicle use or even ownership, either by encouraging the use of alternative modes or by regulating vehicle use/ownership. Mobility services can contribute to this objective by a) encouraging modal shift and b) deprivatising vehicles. While the latter has already caught the attention of OEM the former is not in their main focus yet. This thesis has shown that the intermodal and seamless aspect of mobility services – as provided especially by information and assistance services – is essential for achieving the goals of sustainable transport.

[667] Abernathy 1978
[668] Mehlin/Zimmer 2010:14

In order to have a significant impact on urban mobility, mobility services will need to maintain high customer acceptance levels. The following features and qualities will need to be incorporated now and in the future:[669]

- Customer experience:
    - Instant access, one way, open end: The principles of "instant access, one way, open end"[670] are certainly the most important message regarding the design of vehicle provision services. Because they imitate the car ownership model behaviour they are likely the central factor for the current success of (auto-)mobility alternatives offered by OEM.[671] In case not all the principles can be incorporated into a service concept at least one or two of them should be realised.
    - Seamless: For those trips where the mobility flow is interrupted by a modal shift the user experience should nonetheless be seamless. This requires the close collaboration between different transport providers but also the virtual integration of data flows into simple, user-friendly applications. This is an area where car manufacturers still lack activities and solutions, mainly due to their focus on one mode of transport and their lack of experience in cooperating with other transport providers.
    - Ubiquitous: Today, many mobility services are limited geographically. However, as mobility patterns expand more and more, not only nationally but even internationally, access should not be restricted by geographical limits. Some of the car manufacturers' services already are available on a national or even multi-country scale, one step in the right direction.
- Real-time information: Information services need to include real-time traffic information in order to reduce uncertainties. Uncertainties in travel time and planning are even more disturbing to travellers than the absolute amount of travel time. As long as transit is predictable travel time is even welcomed as a chance to relax, as an "in-between places".[672] The stationary availability of real-time traffic information – as already provided on many transit stops – should be extended by on-trip real-time information provided on board of the vehicles and via mobile devices. It helps travellers to make informed decisions and react flexibly during any phase of a trip.
- Efficiency:
    - Time-efficient: As mobility is a means to an end and no end in itself individuals do want to spend as little time as possible on their transit. Features and functions which reduce travel times (e. g. time-optimising route planning, disruption management) are therefore highly welcome and could attract even sceptic customers.
    - Cost-efficient: For a growing number of travellers, cost-efficiency comes first when choosing a mode of transport and when organising trips. However, optimising expenditures on travel is sometimes restricted by intransparent fares and charges. Mobility services that offer a high transparency of their fees or increase the transparency of individual travel expenses will have high customer acceptance levels.
    - Target-group specific: Solutions need to be tailored to the needs of the targeted customer groups.[673] The mobility types in chapter 2.3.3.3 – if being updated according to changing trends – are a useful starting point for customising features and functions of mobility services. Rather than addressing very narrow target

[669] For the link between service quality and customer acceptance/satisfaction see Schreiner 2005:89f.
[670] Canzler/Hunsicker 2007:17
[671] Wilke 2002b:14, 26
[672] Cox 2010:42
[673] Kristof 2010:54; Schreiner 2005:79

groups services should be designed in a modular manner so they can be adjusted to the needs of different target groups.

- Communicative: As the importance of virtual social networks will increase in the future, mobility services that include social networks – real or virtual – might be even more attractive than those that are solitary and have not arrived in the digital age.

The features and their integration into a larger sustainable transport policy framework will make visionary decision makers and entrepreneurs indispensable. Communities and organisations which push forward innovative applications and successfully increase customer acceptance are essential for advancing the paradigm shifts needed in society, innovation and the transport sector. Car manufacturers can and must decide whether they adopt the role of fast followers or of visionary leaders. Besides following the recommendations on success features above, OEM that will have become visionary, successful leaders on the mobility service market in the future, adhere to the following principles:

- Realistic expectations: They have realistic expansion plans for the mobility services market without exaggerated hopes for market shares.
- Unique selling point: They have developed and follow a clear strategy for entering the mobility services market that helps customers to distinguish them from other manufacturers/providers.
- Technology leadership: They develop and use state-of-the-art technology for mobility services and focus on “deep support” features.
- Mobility research: They study future developments in mobility behaviour and customer preferences in order to cater to individual needs appropriately.
- Cooperation and alliances: They initiate and nourish alliances with communities and supplementary mobility providers.
- Market monitoring: They monitor closely best practice examples on the market and learn from them.
- Openness to changes: They have benefited from transforming their weaknesses into strengths by initiating comprehensive change processes within the organisation.
- Adaptation of innovation: They continually expand their understanding of innovation processes.

Even though the mobility services market poses some challenges and the opportunities for OEM are not enormously large targeting this dynamically developing market will continue to provide significant competitive advantages for OEM. Their inherently high brand trust has already smoothed out the crooked path into new markets. Not only will leadership enable OEM to tap into new market segments, respond to actual customer needs and stabilise their sales balance but it will also help them to reposition themselves as mobility providers, a crucial step in a highly competitive vehicle market – and a step called for by many stakeholders. Such realignment will automatically force car manufacturers to address their internal weaknesses that might prevent them from adopting the new mobility agenda more fully, thus initiating long-term corporate change processes. The recommendations in chapter 5.3 and the theses in chapter 5.4 have demonstrated clearly that car manufacturers do not only have weaknesses when it comes to mobility services but also strengths; and that they do not only face threats but also opportunities. Benefiting from these opportunities will largely depend on the quality of the mobility services they will offer and the pathway each OEM will choose in the future but also on the degree to which innovation and strategy development processes are open-minded and progressive.

6. Annex

6.1. Potential mobility services by car manufacturers – overview

The following tables provide a structured description of the potential mobility services that could be offered by car manufacturers mentioned in chapter 4.2. Besides the catalogue of requirements rating, the tables contain the following items:

Description of service: Describes the service in brief.

Subtypes: Lists possible variants or subtypes of the service.

Use case: Lists the situations in which the service can be used.

Mobility type: Identifies the mobility types (see chapter 2.3.3.3) which will probably find the service to be useful for their respective mobility needs and desires.

Added value for users: Specifies the extra value a user can obtain which could not be obtained by using conventional services/products. This implies that using a given service substitutes for other services or products.

Substitutional effects for other transport modes: Identifies other modes of transport which are substituted by using the service (esp. for vehicle provision services).

Link to other services: Lists other transport services that the given service is connected with (esp. public transport).

Material footprint: Lists the items needed to deliver the service which involve material footprint, i. e. its dependence on products, infrastructures, resources etc.

Potential/necessary partners: Identifies partners that are necessary or desirable to offer the service

Comparable existing services on the market (without OEM involvement): Provides a selection of existing services on the market which operate without OEM involvement.

Comparable existing services on the market (with OEM involvement): Provides a selection of existing services on the market which operate with major OEM involvement.

Competencies needed for providing the service: Names the business competencies (capacities) which are needed for a successful operation of the service.

Catalogue of requirements: The ratings are preliminary and are contingent on the details of an actually implemented service.

6.1.1. Vehicle provision services

Car rental	
Description of service	Car rental allows individuals to rent a car, usually on a day-to-day basis. Prices vary depending on the model or vehicle class. Cars need to be returned to the same or another station of the rental network.
Subtypes	Some car rentals offer hour-by-hour rental or long-term rental (>1 month). Not all car rentals are limited by office hours.

Use case	When in need of enlarging a personal or company vehicle fleet; when a private or public vehicle is not at hand; for individuals in need of privacy and a temporary car of their own	
Mobility types	Silver drivers, sensation seekers, global jetsetters	
Added value for users	In comparison to taking a taxi, a rental car allows users to go farther for less money and they are not in need of a driver. If several people share a rented vehicle the costs can be lower than taking the train. Rental cars are also a cost-efficient option for vehicle fleet managers.	
Substitutional effects for other transport modes	Train: If several people share a rented vehicle the costs can be lower than taking the train. Rental cars can substitute the use, but rarely the ownership of private vehicles.	
Link to other services	Rental cars can often be booked along with plane or train tickets; rental car stations are typically located at airports and train stations.	
Material footprint	Car fleet, rental stations	
Potential/necessary partners	Car manufacturers for equipping the car fleet. Usually, car rentals can negotiate very low prices with car manufacturers.	
Comparable existing services on the market (without OEM involvement)	Rental car services like Europcar, Avis, Sixt, Hertz	
Comparable existing services on the market (with OEM involvement)	Peugeot Mu Renault Nissan: Partnerships with Hertz, Avis, Europcar	
Competencies needed for providing the service	Know-how about vehicles Quick access to vehicle fleets, incl. rebates (Partial) openness to new mobility behaviour Close contact to the customer; billing competencies Point-of-sale network Vehicle maintenance skills	
Catalogue of requirements rating	Simplicity	Low
	Reliability	High
	Flexibility	Medium
	Access	Medium
	Availability	Medium
	Transparent fare and payment system	Medium
	Attractive image	Medium
	Added value for users	Medium
	Usefulness	Medium

Car sharing[674]	
Description of service	Members of a car sharing club can use vehicles on a pre-booking basis. Vehicles are located at fixed stations, typically close to neighbourhoods or transit stations, and can be used on an hour-by-hour basis. Tariffs vary depending on vehicle class and have a time and a distance element. In contrast to a public car fleet, car sharing is less flexible because it involves fixed costs and usually fixed stations on a trip-return basis. Compared to car rental, car sharing is not limited by office hours because it is all self-service. Once registered as a member, booking procedures are quite simple as they have evolved over time.
Subtypes	There are a lot of differences in the organisational structure of the providers. Some are cooperatives, some are commercially oriented businesses etc.[675] The elements membership registration, booking, and fixed stations are constitutive to car sharing and therefore do not vary significantly. As some systems offer one-way options they can be called flexible car sharing or even attributed to the public car fleet category.
Use case	Car sharing is an alternative to the urban transport modes walking, cycling, and public transport when a car is needed e. g. for moving large items, trips out of town or special occasions.
Mobility types	Greenovators, family cruisers, silver drivers, low-end mobility
Added value for users	If car sharing substitutes a privately owned car, users do not need a personal parking place. Up to a limited amount of mileage car sharing is less expensive than owning a car.[676]
Substitutional effects for other transport modes	As car sharing is an addition to NMT and public transport it usually only substitutes for (and therefore reduces) private car use.
Link to other services	Public transport access to car sharing stations is important for access.[677]
Material footprint	Vehicle fleet, stations
Potential/necessary partners	Local government for procurement of stations; car manufacturers for fleet procurement
Comparable existing services on the market (without OEM involvement)	For an up-to-date list of car sharing operators in Europe see the website of the Intelligent Energy Europe project "*momo* – more options for energy efficient mobility through Car-Sharing": http://www.momo-cs.eu/
Comparable existing services on the market (with OEM involvement)	Ford: Partnership with GoCar VW: Partnership with Streetcar (UK)

[674] For detailed information on car sharing see momo Car-Sharing 2010; Hoffmann 2002; Schwieger 2004; Loose 2007; Fliegner 2002; Grünig/Marcellino 2009; Wilke 2007

[675] Grünig/Marcellino 2009:14

[676] Car sharing is usually only cost-efficient for a driving range of <10,000 km/year.

[677] Grünig/Marcellino 2009:20

Competencies needed for providing the service	Know-how about vehicles and vehicle technology Quick access to vehicle fleets, incl. rebates Close contact to the customer; billing competencies Vehicle maintenance skills Willingness to cooperate with communities	
Catalogue of requirements rating	Simplicity	Medium
	Reliability	High
	Flexibility	Medium
	Access	Medium/High[678]
	Availability	High
	Transparent fare and payment system	Medium
	Attractive image	Medium
	Added value for users	Medium
	Usefulness	Medium

Public vehicle fleet[679]	
Description of service	A provider places public cars in a given area for public use. After initial registering, users can access the vehicles via a identification system (e. g. RFID chip). There are no limits on trip length or usage time. Vehicles need to be returned within the given area. Optionally, exclusive parking lots can be offered. Payment is automatic; costs are based on pay-as-you-go tariffs, there are no fixed costs.
Subtypes	Fixed stations: Vehicles can be parked only on fixed stations. (Lower flexibility for the user, but less effort needed for locating vehicles and for finding a parking lot.) This is similar to conventional car sharing. Fleeting fleet: Vehicles can be parked anywhere or, if provided, on exclusive parking lots. They are located via GPS. This offers higher flexibility for the user, but more effort is needed for locating vehicles; if no exclusive parking lots are provided, efforts for finding a parking place in inner city areas can be high.[680]
Use case	Spontaneous short trips within a city; last-mile trips
Mobility types	All except sensation seekers
Added value for users	No fixed costs; spontaneous, easy access; less parking problems (in case parking places are provided)
Substitutional effects for other transport modes	Trips by public car can substitute trips by bike, public transport, private car, or taxi.
Link to other services	No direct link.
Material footprint	Vehicle fleet; if provided exclusive parking lots/stations.

[678] Access level depends on the system's penetration of the market. Generally, car sharing is deemed to improve access levels in urban areas for those not owning a car. (IEA 2009:249f.)
[679] also called flexible car sharing
[680] Grünig/Marcellino 2009:19

Potential/necessary partners	Local government for procurement of exclusive parking lots/stations	
Comparable existing services on the market (without OEM involvement)	Fixed stations: Autolib' (Paris) (starting in 2010)	
Comparable existing services on the market (with OEM involvement)	Fleet without fixed stations: Car2Go (Ulm, Germany)	
Competencies needed for providing the service	• Know-how about vehicles and vehicle technology • Quick access to vehicle fleets, incl. rebates • Close contact to the customer; billing competencies • Vehicle maintenance skills • Willingness to cooperate with communities	
Catalogue of requirements rating	Simplicity	High
	Reliability	High
	Flexibility	High
	Access	High
	Availability	Medium
	Transparent fare and payment system	High
	Attractive image	High
	Added value for users	High
	Usefulness	Medium

6.1.2. Information and assistance services

Intermodal navigation	
Description of service	A software enhancing a car navigation system in order to provide information about other modes of transport, mainly public transport. It also assists users in choosing the most convenient/cost-efficient/time-efficient means to travel.
Subtypes	GPS location booking of tickets
Use case	For combined car trips; for non-routine trips
Mobility types	All types, especially those highly dependent on cars (family cruisers, global jet setters, but not necessarily sensation seekers)
Added value for users	Depending on the subtype, switching transport modes is facilitated and less efforts for retrieving information and purchasing tickets need to be made.
Substitutional effects for other transport modes	Depending on the preferences of the user on convenience, time or cost efficiency, the system may shift users' travel behaviour.
Link to other services	Public transport; optionally non-motorised transport or other mobility services like car sharing, taxi etc.
Material footprint	Navigation system

Potential/necessary partners	Public transport operators	
Comparable existing services on the market (without OEM involvement)	%	
Comparable existing services on the market (with OEM involvement)	Similar: BMW ConnectedDrive	
Competencies needed for providing the service	• Know-how about vehicle technology • Willingness to cooperate with other mobility providers	
Catalogue of requirements rating	Simplicity	High
	Reliability	High
	Flexibility	High
	Access	n.a.
	Availability	High
	Transparent fare and payment system	Mixed[681]
	Attractive image	Medium
	Added value for users	High
	Usefulness	High

Mobility Card	
Description of service	Users can book all their means of transport via a single customer card. The provider can either be a public transport provider, an OEM, or other.
Subtypes	Some mobility cards may allow to use/book only certain types of transport services, as indicated by the provider. Some mobility cards have an integrated cash chip which allows to pay directly with the card.
Use case	For intermodal trips, short or long distance; standardised trips with low need of information/assistance
Mobility types	Greenovator, silver driver, high-frequency commuter, low-end mobility
Added value for users	Cash-free ticket purchasing; no multiple registration needed; one single cash flow
Substitutional effects for other transport modes	Those using a mobility card are expected to switch to public transport modes more often as it facilitates booking public transport trips.
Link to other services	Ideally, a mobility card links to all transport services available to the user.
Material footprint	Credit-card like chip cards. Material necessary for billing
Potential/necessary partners	Mobility providers, esp. in public transport, taxis.

[681] Depending on fare and payment system. Such services can also be free of charge.

Comparable existing services on the market (without OEM involvement)	Bahncard 100, Üstra MobilCard, Yélo (LaRochelle) (see chapter 2.3.2 for more information)	
Comparable existing services on the market (with OEM involvement)	%	
Competencies needed for providing the service	Willingness to cooperate with other mobility providers	
Catalogue of requirements rating	Simplicity	High
	Reliability	High
	Flexibility	High
	Access	n.a.
	Availability	High
	Transparent fare and payment system	High
	Attractive image	Medium
	Added value for users	High
	Usefulness	High

Personal Travel Assistant (PTA)	
Description of service	Through various information channels and devices (including PCs, mobile phones, and kiosks, a PTA integrates urban transportation services and transactions. PTA streamlines route selection, ticketing and "disruption management" (such as response to traffic congestion), and is linked to other features such as personal schedules and social networks.
Subtypes	The number of features of a PTA can be expanded by e. g. on-board arrival information. Depending on the system, it can be limited to a municipality, region, or country.
Use case	(Urban) intermodal travel, including private and public vehicles; non-standardised trips with high need of information/assistance
Mobility types	Greenovator, silver driver, high-frequency commuter, global jet setter, low-end mobility
Added value for users	The PTA removes major obstacles for using public transport, like intransparent tariff systems, complicated user interface and lack of real-time information and reliability[682]
Substitutional effects for other transport modes	Those using a PTA are expected to switch to public transport modes more often as the PTA facilitates planning and booking public transport trips.
Link to other services	As the PTA ideally integrates all modes of transport it will provide direct access to other mobility services in the given area. Could be combined with mobility card (if paperless ticketing is not possible).

[682] DIW/infas 2002:103

Material footprint	Material necessary for billing (if paperless billing is not accepted by user)	
Potential/necessary partners	Municipalities, local, regional and national mobility providers (esp. public transport)	
Comparable existing services on the market (without OEM involvement)	CISCO Personal Travel Assistant[683]	
Comparable existing services on the market (with OEM involvement)	%	
Competencies needed for providing the service	• Programming skills • Cooperation with software companies, with other mobility providers and communities	
Catalogue of requirements rating	Simplicity	High
	Reliability	High
	Flexibility	High
	Access	n.a.
	Availability	High
	Transparent fare and payment system	High
	Attractive image	Medium
	Added value for users	High
	Usefulness	High

6.2. *Non-OEM mobility services on the market*

The following table gives an overview of a few selected services from the two mobility service categories "Information and assistance" and "Vehicle provision" which are currently on the market.

Name	Description	Users/subscribers
Information and assistance		
HannoverMobil Card (Hannover, Germany)	For a small premium, full subscribers receive a 25% cut on train trips, 20 % rebate on taxi rides and discounts on associated car sharing companies. Transactions via one customer card.	2009: 1,000 subscribers[684]
Bahncard100 (Germany)	Free rides on all DB trains in Germany and on public transport in cities for a yearly fee. Reduced tariffs or free offers for additional DB mobility services (car sharing, bike sharing). Transactions via one customer card.	2008: 29,000 subscribers[685]

683 http://www.connectedurbandevelopment.org/connected_and_sustainable_mobility/personal_travel_assistant
684 Source: http://www.gvh.de/fileadmin/gvh/downloads/Bilanz/Bilanz_2008_Web.pdf
685 Source: http://www.spiegel.de/reise/aktuell/0,1518,519967,00.html

Yélo (La Rochelle, France)	The Yélo scheme enables users to use all modes of transport in La Rochelle with one customer card. It includes Liselec, a one-way, station-based BEV fleet in the city of La Rochelle (France). Via a customer card users can easily access the 50 vehicles with or without booking.	2009: 500 users (Liselec)[686]
Generalabo (Switzerland)	Free rides on all SBB trains and on public transport in cities in Switzerland for a monthly fee. Transactions via one customer card.	2009: 375,000 subscribers[687]
Freiburg RegioMobilCard[688]	For a small premium, full subscribers receive reduced service offers like taxi, car sharing, bike rental. Transactions via one customer card.	n. a.
Personal Travel Assistant/PTA (pilot projects in Amsterdam and Seoul, 2010), Cisco[689]	Through various information channels and devices (including PCs, mobile phones, and kiosks), a PTA integrates urban transportation services and transactions. PTA streamlines route selection, ticketing and "disruption management" (such as response to traffic congestion), and is linked to other features such as personal schedules and social networks.	Pilot project with 1000 users
Vehicle provision services		
DB Carsharing (Germany)	The largest car sharing provider in Germany, DB Carsharing provides drive-and-return car sharing at train stations and airports. A customer card allows accessing the prebooked cars.	100,000 users[690]
Mobility Carsharing (Switzerland)	Nationwide station-based car sharing program in Swiss cities; integration with public transport subscriptions	2010: 93.700[691]
ZipCar[692] (US, UK)	ZipCar provides drive-and-return car sharing in major cities in the US and GB. A customer card allows accessing the prebooked cars. ZipCar has acquired major carsharing companies around the world, among them Flexcar (2007) and Streetcar (2010) and has thus become the world's largest provider of car sharing. Currently, ZipCar accounts for 46.5 % of worldwide car sharing membership.	300,000 users[693]
DB Call-a-Bike (Germany)	Flexible bike sharing scheme in larger German cities. After registration, users can access the bikes via access codes which are received via mobile phone. Users can then park the bike anywhere in the city and are charged based on the time used.	110,000 registered users[694]
Vélib (Paris, France)	Station-based bike sharing system which offers 20.000 bikes at over 1.450 stations (one station every 300 m) since 2007	Daily usage: 60,000 to 95,000 trips[695]

686 http://www.liselec.fr/bin/DossierDePresse.pdf; http://www.yelo-larochelle.fr/
687 Source: http://mct.sbb.ch/mct/gb08_personenverkehr_d.pdf
688 http://www.regiomobilcard.de/
689 http://www.connectedurbandevelopment.org/connected_and_sustainable_mobility/personal_travel_assistant
690 Source: http://www.carsharing-berlin.de/db-carsharing/
691 Source: http://www.mobility.ch/
692 ZipCar was acuired by the car rental company Avis for 550 US$ in January 2013. (Piper 2013)
693 Source: http://www.zipcar.com/
694 Grünig/Marcellino 2009:17
695 Grünig/Marcellino 2009:16

WhipCar (London, UK)[696]	Peer-to-peer car rental in London/UK. WhipCar provides insurance cover that does not affect the owner's insurance in case damage is caused during rental.	n.a.[697]

Table 30: Selected mobility services on the market

6.3. *Vehicles for the urban market*

Besides research into mobility services and urban mobility and implementing mobility service projects many car manufacturers are primarily offering vehicles specifically designed for urban travel. Their main features are a small size and zero emissions, but also connectivity applications. Their design is supposed to appeal to young urban elites. The following overview represents a selection of urban vehicles currently on the market (2012) or soon to come:

Toyota iQ	
Market launch	January 2009
Size	Length: 2,985 mm Width: 1,680 mm # of seats: 4
Drive-train technology	Internal combustion engine (gasoline, diesel)
Fuel efficiency	urban: 5.7l extra urban: 4.1l
CO_2 emissions	110g/100km
Markets	Japan
Sales p.a.	10,223 (2009)
price	12,900 €

Tazzari Zero	
Market launch	Europe: 2009 USA: 2010
Size	Length: 2,880 mm Width: 1,560 mm Height: 1,425 mm # of seats: 2
Drive-train technology	Electric
Fuel efficiency	0,135 kW/h pro km
CO_2 emissions	ZEV
Markets	Europe, North America, Mexico and the Caribbean islands
Sales p.a.	n.a.
price	23,900 €

THINK City	
Market launch	First version in 1991, re-launch: 2009

[696] http://www.whipcar.com/
[697] WhipCar launched in April 2010

Size	Length: 3,143 mm Width: 1,658 mm Height: 1,596 mm # of seats: 2 + 2 children's seats
Drive-train technology	Electric
Fuel efficiency	-
CO_2 emissions	ZEV
Markets	Norway, Austria, The Netherlands, Spain, pre-launch activities: Denmark, Sweden, UK, Belgium, Switzerland, USA, France
Sales p.a.	300-800 (planned 2010)
price	24,500 € + battery leasing fee

Mitsubishi i-MiEV	
Market launch	April 2010 (Japan)
Size	Length: 3,395 mm Width: 1,475 mm Height: 1,610 mm # of seats: 4 seats
Drive-train technology	Electric
Fuel efficiency	-
CO_2 emission	ZEV
Markets	Hong Kong, Australia (July 2010), UK (Jan. 2011)
Sales p.a.	5,650 units (2012)
price	In Japan ~34,000 €

Citroën C-Zero	
Market launch	End of 2010
Size	Length: 3,480 mm Width: n.a. Height: n.a. # of seats: 4 seats
Drive-train technology	Electric
Fuel efficiency	-
CO_2 emissions	ZEV
Markets	n.a.
Sales p.a.	n.a.
price	35,165 €

Peugeot iOn	
Market launch	October 2010
Size	Length: 3,480 mm Width: n.a. Height: n.a. # of seats: 4 seats
Drive-train technology	Electric
Fuel efficiency	-
CO_2 emissions	ZEV
Markets	n.a.
Sales p.a.	n.a.
price	29,393 €

Volkswagen E-Up!	
Market launch	Summer 2013 (planned)
Size	Length: 3,200 mm Width: 1,600 mm Height: 1,500 mm # of seats: 3+1 seats
Drive-train technology	Electric motoer (60 kW)
Fuel efficiency	-
CO_2 emissions	ZEV
Markets	n.a.
Sales p.a.	n.a.
price	22,000–24,000 € (planned)

Smart fortwo electric drive	
Market launch	2012
Size	Length: 2,695 mm Width: 1,559 mm Height: 1,542 mm # of seats: 2 seats
Drive-train technology	Electric motor (battery capacity: 16.5 kWh)
Fuel efficiency	-
CO_2 emissions	ZEV
Markets	n.a.
Sales p.a.	n.a.
price	23,680 €

Nissan Leaf	
Market launch	End 2010
Size	Length: 4445 mm Width: 1770 mm Height: 1550 mm # of seats: 5 seats
Drive-train technology	Electric
Fuel efficiency	-
CO_2 emissions	ZEV
Markets	Japan, USA, Portugal, Ireland, Denmark, Germany (2011)
Sales p.a.	20,000 pre-orders (July, 2010)
price	32,000 €

Renault Twizzy	
Market launch	2012
Size	Length: 2337 mm Width: 1191 mm Height: 1461 mm # of seats: 2 seats
Drive-train technology	Electric (starting at 4 kW)
Fuel efficiency	-
CO_2 emissions	ZEV
Markets	Europe
Sales p.a.	March–Nov 2012 (9 months): 8727 units
price	6990 € + 50 € monthly battery leasing fee

Bolloré-Blue Car	
Market launch	2011
Size	Length: 3650 mm Width: 1720 mm Height: 1600 mm # of seats: 4 seats
Drive-train technology	Electric motor (50 kW)
Fuel efficiency	-
CO_2 emissions	ZEV
Markets	Europe
Sales p.a.	As of November 2012, 1,942 units have been sold, of which 1,750 are used in the Autolib' programme in Paris.
price	500€/month leasing fee

Hiriko Fold	
Market launch	2014 (plan)
Size	Length: 2500 mm (unfolded), 1500 mm (folded) # of seats: 2 seats
Drive-train technology	Electric
Fuel efficiency	-
CO_2 emissions	ZEV
Markets	The consortium plans to sell the vehicle primarily to municipalities and CSO in the US and Europe.
Sales p.a.	
price	12,500 € + battery leasing fees (planned)

7. References

Abernathy, William (1978): The Productivity Dilemma. Roadblock to Innovation in the Automobile Industry. Baltimore: John Hopkins University Press.

ACEA (European Automobile Manufacturers' Association) (2010): EU Economic Report 2010. Brussels.

ACEA (2012): New vehicle registrations by country. Online source: http://www.acea.be/images/uploads/files/20120805_01_2012_vo_By_Country_Enlarged_Europe_format.xls

Adams, John (2000): The Social Implications of Hypermobility. In: OECD ENVIRONMENT DIRECTORATE (ed.): Project on Environmentally Sustainable Transport (EST). The economic and social implications of sustainable transportation (ENV/EPOC/PPC/T(99)3/FINAL/REV1), pp. 95–134.

Adams, John (21.11.2001): The Social Consequences of Hypermobility. Date: 21.11.2001. London. Online source: http://john-adams.co.uk/wp-content/uploads/2006/hypermobilityforRSA.pdf.

Adelle, Camille; Pallemaerts, Marc (2009): Sustainable Development Indicators. An Overview of relevant Framework Programme funded research and identification of further needs in view of EU and international activities. Edited by European Commission. Online source: http://ec.europa.eu/research/sd/pdf/sdi_review.pdf#view=fit&pagemode=none.

Adey, Peter (2010): Mobility. London: Routledge.

Adler, Paul; Benner, Mary; Brunner, David James; MacDuffie, John Paul; Osono, Emi; Staats, Bradley et al. (2009): Perspectives on the productivity dilemma. In: Journal of Operations Management, no. 27, pp. 99–113.

Adler, Michael (2011): Generation Mietwagen. Die neue Lust an einer anderen Mobilität. Munich: oekom verlag

Aigle, Thomas; Marz, Lutz (2007): Automobilität und Innovation. Versuch einer interdisziplinären Systematisierung. Edited by Wissenschaftszentrum Berlin für Sozialforschung. Berlin. (WZB – discussion paper, SP III 2007-102).

An, Feng; Sauer, Amanda (2011): Comparison of Passenger Vehicle Fuel Economy and Greenhouse Gas Emission Standards Around the World. Prepared for the Pew Center on Climate Change. Online source: http://www.pewclimate.org/docUploads/Fuel%20Economy%20and%20GHG%20Standards_010605_110719.pdf

Archer, David; Rahmstorf, Stefan (2010): The climate crisis. An introductory guide to climate change. Cambridge: Cambridge Univ. Press.

Arnold, Marlen (2007): Strategiewechsel für eine nachhaltige Entwicklung. Prozesse, Einflussfaktoren und Praxisbeispiele. Marburg: Metropolis-Verlag. (Theorie der Unternehmung, vol. 36)

Automotive Industry Data (AID): Newsletter Number 1215, August 15, 2012

Axhausen, K.W. (2006): Social factors in future travel. A qualitative assessment. Foresight Intelligent Infrastructure Systems Project. UK Office of Science and Technology. Zürich. (Arbeitsbericht Verkehrs- und Raumplanung, 294).

Bamberg, Sebastian (2004): Verkehrsmittelwahl: Eine Frage des Eigennutzes, der Moral oder der Gewohnheit. In: Gaus, Hansjörg; Habscheid, Stephan; Zanger, Cornelia (ed.): Bleibt das Auto mobil. Mobilität und Automobil im interdisziplinären Diskurs. Frankfurt am Main: Peter Lang, pp. 241–259.

Banister, David (2005): Unsustainable transport. City transport in the new century. London, New York: Routledge (Transport, development and sustainability).

Banister, David (2008): The sustainable mobility paradigm. In: Transport Policy, vol. 15, no. March, pp. 73–80.

Baum, Markus; Hüttenrauch, Mathias (2008): Effiziente Vielfalt. Die dritte Revolution in der Automobilindustrie. Berlin: Springer.

Becker, Dieter; Dietz, Willi; Göring, Stefanie (2010): Brand and Ownership in the European Automotive Industry. Possible Scenarios for 2025.

Becker, Udo; Gerike, Regine; Winter, Matthias (2009): Grundwissen Verkehrsökologie. Dresden: Eigenverlag Dresdner Institut für Verkehr und Umwelt (DIVU e.V.) (8/2009).

Beckmann, Klaus; Chlond, Bastian; Kuhnimdorf, Tobias; Rindsfüßer, Guido; Ruhren, Stefan von der; Zumkeller, Dirk (2005): Bestimmung multimodaler Personengruppen. Schlussbericht. Edited by RWTH Aachen and TH Karlsruhe. Online source: http://verkehrspanel.ifv.uni-karlsruhe.de/download/INVERMO_Abschluss_Praesentationen/20050609_INVERMO_Abschluss%2008%20(Von%20der%20Ruhren).pdf.

Benner, Mary; Tushman, Michael (2003): Exploitation, Exploration, and Process Management. The Productivity Dilemma Revisited. In: Academy of Management Review, vol. 28, no. 2, pp. 238–256.

Bergmann, Sigurd; Sager, Tore (ed.) (2008): The Ethics of Mobilities – Rethinking Place, Exclusion, Freedo and Environment. Farnham: Ashgate

Bertolini, Luca; Le Clerq, Frank; Straatemeier, Thomas (2008): Urban transportation planning in transition. Editorial. In: Transport Policy, vol. 15, no. March, pp. 69–72.

Beutler, Felix (2004): Intermodalität, Multimodalität und Urbanibility. Vision für einen nachhaltigen Stadtverkehr. Wissenschaftszentrum Berlin für Sozialforschung. (WZB – discussion paper, SP III 2004-107).

Bishop, Peter; Hines, Andy; Collins, Terry (2007): The current state of scenario development: an overview of techniques. In: Foresight, vol. 9, no. 1, pp. 5–25.

Blättel-Mink, Birgit (1997): Elemente einer sozioökonomischen Theorie der Innovation. In: Blättel-Mink, Birgit; Renn, Ortwin (ed.): Zwischen Akteur und System. Die Organisierung von Innovation. Opladen: Westdeutscher Verlag, pp. 19–37.

Blättel-Mink, Birgit (2006): Kompendium der Innovationsforschung. Wiesbaden: VS Verlag für Sozialwissenschaften.

Blythe, Phil; Bryan, Hannah; Sampson, Eric; Edwards, Simon (2008): Future intelligent infrastructure. Developing scenarios to look at future road charging options. Date: 2008. Newcastle. Organised by: Transport Operations Research Group, Newcastle University.

Böhler, Susanne (2010): Nachhaltig mobil : Eine Untersuchung von Mobilitätsdienstleistungen in deutschen Großstädten. Dortmund: Institut für Raumplanung, Technische Universität Dortmund (Dortmunder Beiträge zur Raumplanung: Verkehr, 8).

Böhler, Susanne; Bongardt, Daniel (2007): Sorgenkind Verkehr. Maßnahmen zum Klimaschutz. In: Aus Politik und Zeitgeschichte, no. 29-30, pp. 15–20.

Böhler, Susanne; Hunecke, Marcel; Grischkat, Sylvie; Haustein, Sonja (2008): Mobilanz. Möglichkeiten zur Reduzierung des Energieverbrauches und der Stoffströme unterschiedlicher Mobilitätsstile durch zielgruppenspezifische Mobilitätsdienstleistungen. Endbericht. Edited by BMBF. Bochum; Lüneburg; Wuppertal.

Borken, Jens; Fleischer, Torsten; Halbritter, Günter (2006): Zukunftsfähige Verkehrspolitik. Ansätze für den Personenverkehr. In: Technikfolgenabschätzung, vol. 15, no. 3, pp. 4–11.

Boston Consulting Group (2009): Deutschland 2015 – Szenarien für den Industriestandort.

Boston Consulting Group (ed.) (2010): Batteries for Electric Cars. Challenges, Opportunities, and the Outlook to 2020. Online source: http://www.bcg.com/documents/file36615.pdf.

Botsman, Rachel; Rogers, Roo (2010): What's mine is yours. The rise of collaborative consumption. New York NY: HarperBusiness.

Bratzel, Stefan (2008): Die Innovationen der globalen Automobilkonzerne. Eine Analyse der Zukunftstrends und Innovationsprofile der 18 bedeutendsten Hersteller. Center of Automotive. Bergisch Gladbach. (Arbeitspapier, 2008-5).

Bräuninger, Michael; Schneider, Daniel (2009): Der Automobilmarkt in Deutschland. Edited by HWWI. (HWWI Policy Paper, 1-15).

Brög, Werner; Erl, Erhard (14.08.2003): (Auto)Mobilität in Agglomerationen. Dominiert das Auto die Mobilität. Date: 14.08.2003, aus der Reihe "Alpbacher Architekturgespräche". Alpbach, Österreich. Online source: http://www.socialdata.de/info/(Auto)%20Mobilitaet%20in%20Agglomerationen.pdf.

Brook, David (2004): Carsharing – Start Up Issues and New Operational Models. Date: 2004, aus der Reihe "Annual Meeting". Washington. Online source: http://www.carsharing.net/library/StartUp_Issues_TRB04_DBrook.pdf.

Bruun, Eric; Kenworthy, Jeff; Schiller, Preston (2010): An Introduction to Sustainable Transportation. Policy, Planning and Implementation. New York: Earthscan.

Bundesministerium für Finanzen (BMF) (2011): Monatsbericht November 2011. Online source: http://www.bundesfinanzministerium.de/nn_17844/sid_E9F778F2823001C1CCCD2F20213C6CAC/DE/BMF__Startseite/Publikationen/Monatsbericht__des__BMF/2011/11/inhalt/Monatsbericht-November-2011,templateId=raw,property=publicationFile.pdf

Bundesministerium für Verkehr, Bau- und Wohnungswesen (ed.) (2002): Bericht Integrierte Verkehrspolitik. Endbericht. Unter Mitarbeit von Klaus Beckmann und Herbert Baum. Aachen; Köln.

Bundesministerium für Verkehr, Bau- und Wohnungswesen (ed.) (2004): Demographische Veränderungen. Konsequenzen für Verkehrsinfrastrukturen und Verkehrsangebote. Papier des Wissenschaftlichen Beirats beim Bundesminister für Verkehr, Bau- und Wohnungswesen. Online source: http://www.bbr.bund.de/nn_22018/DE/ForschenBeraten/Fachpolitiken/VerkehrMobilitaet/StadtRegionalverkehr/Wiss__Beirat,templateId=raw,property=publicationFile.pdf/Wiss_Beirat.pdf.

Bundesverband CarSharing (2008): Klimaschutz durch CarSharing. Online source: http://www.carsharing.de/images/stories/pdf_dateien/klimaschutzbroschuere_endversion.pdf.

Bundesverband CarSharing (ed.) (2010): CarSharing für gewerbliche Kunden. Gute Beispiele der CarSharing-Nutzung in Unternehmen, Verwaltungen, Organisationen und Vereinen. Hannover.

Bundesverband CarSharing e.V. (ed.) (2009): Die Offensive CarSharing gestalten. (Jahresbericht, 2008).

Burckhart, Kerstin; Blair, C. (2009): Urban intermodality: potentials for connecting the cities' public transport. In: Brebbia, C. A. (ed.): Urban transport XV. Urban transport and the environment in the 21st century. Southampton: WIT (WIT transactions on the built environment), pp. 63–72.

Burmeister, Klaus; Neef, Andreas; Albert, Bernhard; Glockner, Holger (2002): Zukunftsforschung und Unternehmen. Praxis, Methoden, Perspektiven. Essen.

Büttner, Janett; Knie, Andreas (2006): Vom Kopf auf die Füße: Randbedingungen und Gedankenmodelle zu neuen Betreibermodellen im öffentlichen Verkehr. In: ifmo (ed.): Öffentlicher Personennahverkehr. Herausforderungen und Chancen. Berlin u.a.: Springer, pp. 57–73.

Canzler, Weert (2006): Designperspektiven innovativer Mobilitätsdienstleistungen - Soziologische Grundlagen. In: Herdegen, Korinna; Rammler, Stephan (ed.): Designperspektiven innovativer Mobilitätsdienstleistungen. Braunschweig: Hochschule für Bildende Künste (Discussion Papers Transportation Design and Social Sciences / HBK Braunschweig), pp. 13–30.

Canzler, Weert (2008): Last und Freud des Privatautos. Chancen und Grenzen einer Umdeutung des Autos. In: Canzler, Weert; Schmidt, Gert (ed.): Zukünfte des Automobils. Aussichten und Grenzen der autotechnischen Globalisierung. Berlin: ed. sigma, pp. 145–165.

Canzler, Weert; Hunsicker, Frank; Karl, Astrid; Knie, Andreas; König, Ulrich; Lange, Karl Günter (2007): DB Mobility: Beschreibung und Positionierung eines multimodalen Verkehrsdienstleisters. Edited by Innovationszentrum für Mobilität und gesellschaftlichen Wandel (InnoZ) GmbH. (InnoZ-Baustein, 1).

Canzler, Weert; Hunsicker, Frank; Knie, Andreas; Peters, Jürgen (2009): Blockierte Moderne. Die Auswirkungen des demografischen und wirtschaftsstrukturellen Wandels auf die Verkehrsinfrastruktur in Deutschland bis zum Jahre 2030. Berlin. (InnoZ-Baustein, 6).

Canzler, Weert; Knie, Andreas (2009): Grüne Wege aus der Autokrise. Vom Autobauer zum Mobilitäsdienstleister. Ein Strategiepapier. Heinrich-Böll-Stiftung. (Schriften zur Ökologie, 4).

Canzler, Weert; Knie, Andreas; Schöller-Schwedes, Oliver (2007): Demographie und Verkehrspolitik. In: Aus Politik und Zeitgeschichte, no. 29-30, pp. 9–14.

Carsten, Stefan (2005): Zukunftsfähiges Handeln in Stadtregionen. Ein handlungsorientierter systemischer Ansatz. Dissertation. Norderstedt: Books on Demand GmbH.

Castellan (ed.) (2011): Market Study E-Mobility. Online source: http://www.castellan-ag.com/tl_files/castellan/content/downloads/Castellan_Market_Study_E_Mobility.pdf

Christensen, Clayton M. (2002): The Innovator's Dilemma. The Revolutionary Book that Will Change the Way You Do Business. New York: HarperCollins.

Cox, Peter (2010): Moving People. Sustainable Transport Development. London: Zed Books.

Crawford, J. H. (2000): Carfree cities. Utrecht: International Books.

Cwerner, Saulo; Kesselring, Sven; Urry, John (ed.) (2009): Aeromobilities. Abingdon: Routledge.

Deakin, Elizabeth (2001): Sustainable Development and Sustainable Transportation. Strategies for Economic Prosperity, Environmental Quality, and Equity. Working Paper. Berkeley. University of California, Department of City and Regional Planning and UC Transportation Center. Online source: http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1012&context=iurd.

Dennis, Kingsley; Urry, John (2009): After the car. Cambridge: Polity.

Denzau, Arthur; North, Douglass (1994): Shared Mental Models. Ideologies and Institutions. Online source: http://129.3.20.41/eps/eh/papers/9309/9309003.pdf.

Deutsche Bank Research (ed.) (2009): Chinas zunehmende Verflechtung mit Schwellenländern weltweit: Eine Bestandsaufnahme. Online source: http://www.dbresearch.de/MAIL/DBR_INTERNET_DE-PROD/PROD0000000000249482.xhtml.

Deutsches Institut für Wirtschaftsforschung, infas Institut für angewandte Sozialwissenschaft (02.09.2009): Alltagsverkehr in Deutschland. Erhebungsmethoden - Struktur - Aufkommen - Emissionen - Trends. Anwenderworkshop. Date: 02.09.2009. Berlin. Online source: http://www.mobilitaet-in-deutschland.de/pdf/weitere%20Materialien%20MID2008.zip.

Deutsches Institut für Wirtschaftsforschung (DIW); infas Institut für angewandte Sozialwissenschaft (2002): Mobilität in Deutschland. Edited by Bau-und Wohnungswesen Bundesministerium für Verkehr. Online source: www.kontiv2002.de.

Deutsches Institut für Wirtschaftsforschung (DIW); infas Institut für angewandte Sozialwissenschaft (2008): Mobilität in Deutschland. Struktur – Aufkommen – Emissionen – Trends. Ergebnisbericht. Online source: http://www.mobilitaet-in-deutschland.de/pdf/MiD2008_Abschlussbericht_I.pdf.

Dewick, Paul; Pietikäinen, Aino (2008): Integrating sustainability into the innovation process. Date: 2008. Farnham, UK. Organised by:The Centre for Sustainable Design. Online source: http://www.cfsd.org.uk/events/tspd13/abstracts/13%20-%20Paul%20Dewick.pdf.

Dick, Michael (ed.) (2009): Mobilität als Tätigkeit. Individuelle Expansion – alltägliche Logistik – kulturelle Kapazität. Lengerich, Wien u.a.: Pabst Science Publ. (Arbeitsforschung multidisziplinär).

Die Bundesregierung (2009): Nationaler Entwicklungsplan Elektromobilität der Bundesregierung. Berlin. Online source: http://www.bmwi.de/Dateien/BMWi/PDF/nationaler-entwicklungsplan-elektromobilitaet-der-bundesregierung,property=pdf,bereich=bmwi,sprache=de,rwb=true.pdf.

Dierkes, Meinolf; Hoffmann, Ute; Marz, Lutz (1992): Leitbild und Technik. Zur Entstehung und Steuerung technischer Innovationen. Berlin: Edition Sigma.

Dierkes, Meinolf; Marz, Lutz (1998): Leitbildzentriertes Organisationslernen und technischer Wandel. Edited by Wissenschaftszentrum Berlin für Sozialforschung. Berlin. (Schriftenreihe der Abteilung „Organisation und Technikgenese", FS II 98-103).

Dietrich, Martin; Pfleiderer, Rudolf (2003): New Roads Generate New Traffic. In: Whitelegg, J.; Haq, Gary (ed.): The Earthscan reader on world transport policy and practice. London: Earthscan, pp. 146–150.

Diez, Willi; Kohler, Markus; Mayer, Jan (2010): Mobility Services - Chancenpotenziale für herstellergebundene Finanzdienstleister. Eine Untersuchung im Aurtrag der VW Financial Services. Institut für Automobilwirtschaft (IFA) an der Hochschule für Wirtschaft und Umwelt Nürtingen-Geislingen. Nürtingen-Geislingen.

Dings, Jos (2009): How to avoid an electric shock. Electric cars: from hype to reality. Edited by European Federation for Transport and Environment (T&E). Brussels.

Docherty, Iain; Giuliano, Genevieve; Houston, Donald (2008): Connected Cities. In: Knowles, R. D.; Shaw, Jon; Docherty, Iain (ed.): Transport geographies. Mobilities, flows, and spaces. Malden MA: Blackwell Pub., pp. 83–101.

Doshi, Viren; Schulman, Gary; Gabaldon, Daniel (2007): Lights! Water! Motion! In: strategy+business, no. 46, pp. 39–55.

Dubs, Rolf; Euler, Dieter; Rüegg-Sütrm, Johannes; Wyss, Christina E. (2004): Einführung in die Managementlehre. Band 1. Bern: Haupt Verlag

Eck, Florian; Stark, Sarah (2009): Mobil sein um jeden Preis? Die (all)tägliche Mobilität des Bürgers. Ergebnisse einer Repräsentativbefragung. In: Internationales Verkehrswesen, vol. 61, no. 7+8, pp. 264–267.

Eckhardt, Carl Friedrich (2006): Marktchancen innovativer Verkehrsangebote im Personenverkehr von Ballungsräumen. In: ifmo (ed.): Öffentlicher Personennahverkehr. Herausforderungen und Chancen. Berlin u.a.: Springer, pp. 91–111.

Ehlers, Eckart (2009): Megacities: Challenge for International and Transdisciplinary Research. A Plea for Communication and Exchange. In: Die Erde, vol. 140, no. 4, pp. 403–416.

Energy Watch Group (EWG); Ludwig-Bölkow-Stiftung (ed.) (2008): Zukunft der weltweiten Erdölversorgung. Online source: http://www.energywatchgroup.org/fileadmin/global/pdf/2008-05-21_EWG_Erdoel_D_kurz.pdf.

Engel, Ralf (2008): Umweltbewusstsein und Lust am Automobil: unvereinbare Gegensätze. In: Canzler, Weert; Schmidt, Gert (ed.): Zukünfte des Automobils. Aussichten und Grenzen der autotechnischen Globalisierung. Berlin: ed. sigma, pp. 183–198.

European Commission (ed.): Eurostat Online Database. Online source: http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/.

European Commission (2004): White Paper European Transport Policy for 2010. Time to decide. Luxemburg.

European Commission (November 2009): European Commissions' and Member States' R&D Programmes for the Electric Vehicle. Report on a European Commission Workshop. Draft Version 1.0. Online source: http://www.google.de/url?sa=t&source=web&cd=1&ved=0CBkQFjAA&url=http%3A%2F%2Fwww.smart-systems-integration.org%2Fpublic%2Felectric-vehicle%2Fec-workshop-r-d-programmes-ev%2FReport_WS_EC-MS_Electric_Vehicle_R-D.pdf%2Fdownload&ei=qy0XTMu_Nc6UOJuXqaYL&usg=AFQjCNGxGA6_aZQphjvlGT2zG7dPqCL2cQ&sig2=F9J7FALU6XxPtDIMAn0_jg.

European Commission (ed.) (2010): Monitoring the CO2 emissions from new passenger cars in the EU: Data for the year 2008. Report from the Commission to the European Parliament and the Council. Brussels. (COM, (2009)713 final). Online source: http://register.consilium.europa.eu/pdf/en/10/st05/st05515.en10.pdf.

European Commission Directorate for Energy and Transport (2009): A sustainable future for transport: Towards an integrated, technology-led and user friendly system. (Commission Communication). Online source: http://ec.europa.eu/transport/publications/doc/2009_future_of_transport_en.pdf.

European Commission Directorate for Energy and Transport (2012): EU energy and transport in figures. Statistical Pocketbook 2012. Luxembourg: Office for official publications of the European communities.

European Commission (2012): Reducing CO_2 emissions from passenger cars. Online source: http://ec.europa.eu/clima/policies/transport/vehicles/cars/index_en.htm

European Environment Agency (ed.) (2001): Scenarios as tools for international environmental assessments. Copenhagen. (Environmental Issue Report, 24).

European Environment Agency (ed.) (2006): Urban Sprawl in Europe. The Ignored Challenge. Copenhagen. (EEA Report, 10/2006).

European Environment Agency (ed.) (2007): Europe's Environment. The fourth Assessment. Copenhagen. (Europe's Environment, 4).

European Environment Agency (ed.) (2008): Catalogue of forward-looking indicators from selected sources. A contribution to the forward-looking component of a shared environmental information system (SEIS/Forward). Copenhagen. (EEA Technical Report, 8/2008).

European Environment Agency (ed.) (2008): Climate for a Transport Change. TERM 2007: indicators tracking transport and environment in the European Union. Copenhagen. (EEA Report, 1/2008).

Faber, Markus (2008): Open Innovation. Ansätze, Strategien und Geschäftsmodelle. Wiesbaden: Gabler (Spektrum wirtschaftswissenschaftliche Forschung).

Federal Environmental Agency Germany (Umweltbundesamt/UBA) (ed.) (2005): Determining factors in traffic growth. Developments, causes and possible future directions. (UBA-Texte, 26/05).

Feldhaus, Stephan (1998): Verantwortbare Wege in eine mobile Zukunft. Grundzüge einer Ethik des Verkehrs / Zugl: München, Univ., Diss., 1996. Hamburg: Abera-Verl. (Abera environment).

Fischedick, Manfred; Ott, Hermann E.; Schallaböck, Karl Otto (2006): Klimawirksame Emissionen des Pkw-Verkehrs und Bewertung von Minderungsstrategien. Edited by Wuppertal Institut. (Wuppertal Spezial, 34).

Flade, Antje (2007): Die sozialen Kosten des Verkehrs. In: Schöller-Schwedes, Oliver; Canzler, Weert; Knie, Andreas (ed.): Handbuch Verkehrspolitik. Wiesbaden: VS Verlag für Sozialwissenschaften, pp. 490–509.

Fliegner, Steffen (2002): Car sharing als Alternative. Mobilitätsstilbasierte Potenziale zur Autoabschaffung. Mannheim: Verl. MetaGIS-Infosysteme (Studien zur Mobilitäts- und Verkehrsforschung, vol. 3).

FOCUS (ed.) (2008): Der Markt der Mobilität. Daten, Fakten, Trends. (FOCUS Marktanalysen, Oktober 2008).

Fraunhofer IAO; PriceWaterhouseCoopers (ed.) (2010): Elektromobilität. Herausforderungen für Industrie und öffentliche Hand. Frankfurt am Main.

Frouws, B.; Buiskool, B. J. (2007): Migrants to Work. Innovative approaches towards successful integration of third country migrants into the labour market. Management Summary. Edited by European Commission. Zoetermeer.

Gaide, Peter (2009): Wie es euch gefällt. In: automotive agenda, no. 03, pp. 16–21.

Gather, Matthias; Kagermeier, Andreas; Lanzendorf, Martin (2008): Geographische Mobilitäts- und Verkehrsforschung. Stuttgart: Gebr. Borntraeger (Studienbücher zur Geographie).

Gegner, Martin (2004): Die Auto-Referenz des öffentlichen Nahverkehrs. Selbst-, Konkurrenz- und Kundenbild im Marketing des Verbands Deutscher Verkehrsbetriebe. Edited by

Wissenschaftszentrum Berlin für Sozialforschung. Berlin. (WZB – discussion paper, SP III 2004-103).

Gehlert, Tina (2009): Straßenbenutzungsgebühren in Städten. Akzeptanz und Mobilitätsverhalten. Wiesbaden: VS Verl. für Sozialwiss. (VS ResearchVerkehrspsychologie).

Glenn, Jerome C.; Gordon, Theodore J. (1999): Forethought. The World in 2050: A Normative Scenario. In: Foresight, vol. 1, no. 5, pp. 453–465.

Glenn, Jerome C.; Gordon, Theodore J. (ed.) (2007): Futures Research Methodology. Version 2.0. United Nations University Millennium Project.

Global Fuel Economy Initiative (GFEI) (2011): Plan of Action 2012–2015. Online source: http://www.iea.org/media/files/GlobalFuelEconomyInitiativePlanofAction20122015.pdf

Global Reporting Initiative (ed.) (2004): GRI Automotive Sector Supplement. Pilot Version 1.0. Amsterdam. (Sustainability Reporting Framework). Online source: http://www.globalreporting.org/NR/rdonlyres/70611BE2-F097-4550-AEC7-D93B1A858D49/0/AutomotiveSectorSupplementPilot.pdf.

Global Reporting Initiative (ed.) (2006): G3 Guidelines. Version 3.0. Amsterdam. (Sustainability Reporting Framework). Online source: http://www.globalreporting.org/NR/rdonlyres/ED9E9B36-AB54-4DE1-BFF2-5F735235CA44/0/G3_GuidelinesENU.pdf.

GlobeScan; MRC McLean Hazel (2006): Megacity Challenges. A stakeholder perspective. A research project conducted by GlobeScan and MRC McLean Hazel; Sponsored by Siemens. Edited by Siemens AG.

Gorham, Roger (2002): Air Pollution from Ground Transportation. An Assessment of Causes, Strategies and Tactics, and Proposed Actions for the International Community. UNDESA; The Global Initiative on Transport Emissions. Online source: http://www.un.org/esa/gite/csd/gorham.pdf.

Götz, Konrad (2007): Mobilitätsstile. In: Schöller-Schwedes, Oliver; Canzler, Weert; Knie, Andreas (ed.): Handbuch Verkehrspolitik. Wiesbaden: VS Verlag für Sozialwissenschaften, pp. 759–784.

Grieb, Deborah (2009): Generation Y Open to New Brands, New Technology and Hybrids. Edited by AutoPacific. Online source: http://www.autopacific.com/news-app/story.44/title.generation-y-open-to-new-brands-new-technology-and-hybrids.

Grieco, Margaret; Urry, John (ed.) (2012): Mobilities: New Perspectives on Transport and Society. Farnham: Ashgate

Grischkat, Sylvie (2008): Umweltbilanzierung von individuellem Mobilitätsverhalten. Methodische und gestaltungsrelevante Ansätze. Mannheim: MetaGIS (Studien zur Mobilitäts- und Verkehrsforschung, 21).

Grünig, Max; Marcellino, Dominic (2009): A Missing Link to Sustainable Mobility. Connecting Public Transportation to Car and Bike Sharing Programs. Best Practice Examples from Europe and the U.S. Edited by Heinrich-Böll-Stiftung and ecologic. Washington D.C. (Schriften zur Ökologie). Online source: http://ecologic.eu/download/projekte/8200-8249/8302/EI_Report_Final_Jan2010.pdf.

GIZ – Deutsche Gesellschaft für Internationale Zusammenarbeit (2011): International Fuel Prices. 7th edition. Online: http://www.giz.de/Themen/en/dokumente/giz-en-IFP2010.pdf

GTZ - Deutsche Gesellschaft für Technische Zusammenarbeit (ed.) (2002): Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities. A Sourcebook. Frankfurt.

GTZ - Deutsche Gesellschaft für Technische Zusammenarbeit (2009): International Fuel Prices, 6th Edition. GTZ - Deutsche Gesellschaft für Technische Zusammenarbeit. Online source: http://www.gtz.de/de/dokumente/en-international-fuel-prices-data-preview-2009.pdf, zuletzt geprüft am 06.04.2010.

GTZ - Deutsche Gesellschaft für Technische Zusammenarbeit; Institute for Transportation and Development Policy (ITDP) (2007): Bus Rapid Transit Planning Guide. Online source: http://www.itdp.org/documents/Bus%20Rapid%20Transit%20Guide%20-%20complete%20guide.pdf.

Gudmundsson, Henrik (2004): Sustainable Transport and Performance Indicators. In: Issues in Environmental Science and Technology, no. 20, pp. 35–63.

Gudmundsson, Henrik; Höjer, Mattias (1996): Sustainable development principles and their implications for transport. In: Ecological Economics, no. 19, pp. 269–282.

Gwilliam, Kenneth (2002): Cities on the move. A World Bank urban transport strategy review. Washington, DC: World Bank.

Gwilliam, Kenneth (2003): Urban transport in developing countries. In: Transport Reviews, vol. 23, no. 2, pp. 197–216.

Hacker, F./Harthan, R./Matthes, F./Zimmer, W. (2009): Environmental impacts and impact on the electricity market of a large scale introduction of electric cars in Europe. Critical Review of Literature. European Topic Centre on Air and Climate Change (ETC/ACC Technical Paper 2009/4)

Haefeli, Ueli (2006): Evaluation Car-Sharing. Schlussbericht. Edited by Verkehr Energie und Kommunikation UVEK Eidgenössisches Departement für Umwelt and Bundesamt für Energie BFE (Switzerland). Online source: http://www.bfe.admin.ch%2Fphp%2Fmodules%2Fpublikationen%2Fstream.php%3Fextlang%3Dde%26name%3Dde_606183202.pdf&ei=Z6mLS-b4D4-WmAO3_5W0BA&usg=AFQjCNGClg_aozW-Pmi_mQYAiJHIfJKxlA&sig2=4z69KN9-ZmVr5PCeG1Mubg.

Hahn, Tobias; Figge, Frank; Barkemeyer, Ralf; Liesen, Andrea (2009): Sustainable Value in Automobile Manufacturing. Belfast/Marseille/Berlin: Sustainable Value Research Ltd.

Hamilton, Clive (2010): Requiem for a Species. Why we Resist the Truth about Climate Change. London: Earthscan.

Handelsblatt (2012): BEV registrations in major vehicle markets (2011). Oktober 2, 2012, p. 7

Harms, Sylvia (2003): Besitzen oder Teilen. Sozialwissenschaftliche Analyse des Car Sharings. Zürich: Rüegger.

Held, Martin (2007): Nachhaltige Mobilität. In: Schöller-Schwedes, Oliver; Canzler, Weert; Knie, Andreas (ed.): Handbuch Verkehrspolitik. Wiesbaden: VS Verlag für Sozialwissenschaften, pp. 851–873.

Henderson, Jason (2009): The Politics of Mobility: De-essentializing Automobility and Contesting Urban Space. In: Conley, Jim; McLaren, Arlene Tigar (ed.): Car troubles. Critical studies of automobility. Farnham Surrey UK, Burlington VT: Ashgate Pub. (Transport and society), pp. 147–164.

Herdegen, Korinna (2006): DB Carsharing als Beispiel für ein ganzheitliches Systemdesign von Mobilitätsdienstleistungen. In: Herdegen, Korinna; Rammler, Stephan (ed.): Designperspektiven innovativer Mobilitätsdienstleistungen. Braunschweig: Hochschule für Bildende Künste (Discussion Papers Transportation Design and Social Sciences / HBK Braunschweig), pp. 31–51.

Hermann, Steffen (2005): Corporate Sustainability Branding. Nachhaltigkeits- und stakeholderorientierte Profilierung von Unternehmensmarken. Wiesbaden: DUV

Hine, Julian (2008): Transport and Social Justice. In: Knowles, R. D.; Shaw, Jon; Docherty, Iain (ed.): Transport geographies. Mobilities, flows, and spaces. Malden MA: Blackwell Pub., pp. 49–61.

Hochschule für Bildende Künste Braunschweig (HBK), Fachbereich Gestaltung Institut für Transportation Design (2007): Volkswagen NET. Analyse & Perspektiven nachhaltiger Mobilität durch innovative Mobilitätsdienstleistungen (confidential). Abschlussbericht zum gleichnamigen Projekt im Auftrage der Volkswagen AG. Edited by Volkswagen AG. Braunschweig.

Hoffmann, Jens (2002): Automobilmarketing im Spannungsfeld von gesellschaftlichen Umweltzielen und Kundennutzen. Frankfurt am Main, New York: P. Lang (Markt und Konsum, vol. 13).

Hogan, Daniel Joseph; Ojima, Ricardo (2008): Urban Sprawl: A Challenge for Sustainability. In: Martine, George; McGranahan, Gordon; Montgomery, Mark; Fernandez-Castilla, Rogelio (ed.): The New Global Frontier. Urbanization, Poverty and Environment in the 21st Century. London: Earthscan, pp. 203–216.

Holz-Rau, Christian; Jansen, Ute (2007): Nachhaltige Raum- und Verkehrsplanung. In: Aus Politik und Zeitgeschichte, no. 29-30, pp. 21–26.

Homer-Dixon, Thomas (2001): The Ingenuity Gap. Facing the Economic, Environmental, and Other Challenges of an Increasingly Complex and Unpredictable Future. Toronto: Random House Canada.

Homer-Dixon, Thomas (2006): The Upside of Down. Catastrophe, Creativity, and the Renewal of Civilization. Washington DC: Island Press.

Homer-Dixon, Thomas (ed.) (2009): Carbon Shift. How the Twin Crises of Oil Depletion and Climate Change Will Define the Future. Toronto: Random House Canada.

Höpfner, Ulrich (2009): Abwrackprämie und Umwelt - eine erste Bilanz. Unter Mitarbeit von Jan Hanusch und Udo Lambrecht. Edited by Naturschutz und Reaktorsicherheit (BMU) Bundesministerium für Umwelt and ifeu. Heidelberg. Online source: http://www.bmu.de/files/pdfs/allgemein/application/pdf/ifeu_abwrackpraemie_bf.pdf.

Hotzan, Jürgen (1994): DTV-Atlas zur Stadt. Von den ersten Gründungen bis zur modernen StadtplanungTafeln und Texte. München: Deutscher Taschenbuch Verlag.

Hucko, Margret (2010): Abschied vom eigenen Wagen. In: Financial Times Deutschland, 05.01.2010.

Hunecke, Marcel (2009): Zielgruppen urbaner Mobilität. Bewertung von Segmentierungsansätzen zur Personenmobilität aus der Perspektive eines sozialen Marketings. In: Bundesministerium für Verkehr, Bau-und Wohnungswesen (ed.): Urbane Mobilität - Verkehrsforschung des Bundes für die kommunale Praxis. direkt, Sonderheft Nr. 65. Bremerhaven: Wirtschaftsverlag NW, pp. 415–430.

Hunsicker, Frank; Karl, Astrid; Lange, Karl Günter; Schmöe, Hinrich (2009): Megatrends und Verkehrsmarkt. Langfristige Auswirkungen auf den Personenverkehr. (InnoZ-Baustein, 4).

infas Institut für angewandte Sozialwissenschaft (2009): Kostenentwicklung und Klimaschutz – Die (all)tägliche Mobilität des Bürgers. Eine Repräsentativbefragung von infas im Auftrag des Deutschen Verkehrsforums. Co-authored by Florian Eck und Sarah Stark. Edited by Deutsches Verkehrsforum. Berlin. Online source: http://www.verkehrsforum.de/fileadmin/dvf/pdf_downloads/reden/Studien/Umfragen/infas_Praesentation_DVF_Mobilitaet_und_Klimaschutz_Vortragsfassung_16-03-2009.pdf.

INFU Innovation Futures Europe (2010): Structured and documented collection of current signals for arising changes in innovation patterns. Co-authored by Ewa Dönitz, François Jégou und Karl-Heinz Leitner et al. INFU Innovation Futures Europe. (Deliverable D 1.1 (WP 1)). Online source: http://www.innovation-futures.org/sites/default/files/INFU%20-%20Deliverable%201.1.%20Signals%20of%20change%20Feb%202010.pdf.

Inkinen, Sam; Kaivo-oja, Jari (2009): Understanding Innovation Dynamics. Aspects of Creative Processes, Foresight Strategies, Innovation Media, and Innovation Ecosystems. Finland Futures Research Centre. Helsinki. Online source: http://www.tse.fi/FI/yksikot/erillislaitokset/tutu/Documents/publications/eBook_2009-9.pdf.

International Energy Ageny (IEA) (ed.) (2012): World Energy Outlook 2012.

International Energy Agency (IEA) (ed.) (2009): Transport, Energy and CO2. Moving Toward Sustainability. Paris.

International Energy Ageny (IEA) (ed.) (2008): World Energy Outlook 2008.

International Traffic Safety Data and Analysis Group (IRTAD) (2011): Road Safety Annual Report 2011. Online source: http://internationaltransportforum.org/irtadpublic/pdf/11IrtadReport.pdf

ipsos marketing (2008): European Transportation & Mobility Observatory 2009. Focus on Germany. Edited by Europcar.

Jakobeit, Cord; Methmann, Chris (2007): Klimaflüchtlinge. Edited by Greenpeace. Hamburg. Online source: http://www.greenpeace.de/fileadmin/gpd/user_upload/themen/klima/klimafluechtlinge_endv.PDF.

Jaeger-Erben, Melanie (2010): Zwischen Routine, Reflektion und Transformation – die Veränderung von alltäglichem Konsum durch Lebensereignisse und die Rolle von Nachhaltigkeit eine empirische Untersuchung unter Berücksichtigung praxistheoretischer Konzepte. Promotion TU Berlin (Prof. Rammert). Berlin.

Jänicke, Martin (2008): Megatrend Umweltinnovation. Zur ökologischen Modernisierung von Wirtschaft und Staat. München: oekom.

Johnson, P.; Leicester, A.; Stoye, G. (2012): Fuel for Thought. The what, why and how of motoring taxation. Royal Automobile Club Foundation for Motoring. Online source: http://www.racfoundation.org/assets/rac_foundation/content/downloadables/fuel_for_thought-johnson_et_al-150512.pdf

Kalmbach, R.; Bernhart, W.; Kleimann, P. (2011): Automotive landscape 2025. Opportunities and challenges ahead. Roland Berger Strategy Consultants – Study.

Karl, Astrid; Maertins, Christian (2009): Intermodales Angebotsdesign: Die Schließung der Angebotslücken zwischen öffentlichem Verkehr und privater Mobilität. Berlin. (InnoZ-Baustein, 5).

Kellenberger, Mary-Beth; Kumar, Aswin; Long, Giff; Singh, Sarwant; Zhao, David (2009): Carsharing to Re-define Personal Mobility and Provide New Opportunities for Industry. Date: 2009. Organised by:Frost & Sullivan.

Kennedy, Christopher; Miller, Eric; Shalaby, Amer; MacLean, Heather; Coleman, Jesse (2005): The Four Pillars of Sustainable Urban Transportation. In: Transport Reviews, vol. 25, no. 4, pp. 393–414.

Kenworthy, Jeff (2002): Traffic 2042—a more global perspective. In: Transport Policy, vol. 9, pp. 11–15.

Kenworthy, Jeff (2003): Transport Energy Use and Greenhouse Gases in Urban Passenger Transport Systems. A Study of 84 Global Cities Presented to the international. Third Conference of the Regional Government Network for Sustainable Development, Notre Dame University, Fremantle/Australia.

Kenworthy, Jeff (2009): Urban Planning and Transport Paradigm Shifts for Surviving the Post-Petroleum Age in Cities. Date: 2009. Organised by: International Transport Forum.

Kenworthy, Jeff; Laube, Felix (2001): The Millennium Cities Database for Sustainable Transport. International Union of Public Transport (UITP); Institute for Sustainability and Technology Policy (ISTP). Brussels.

Kenworthy, Jeff; Newman, Peter (2000): The Ten Myths of Automobile Dependence. In: World Transport Policy & Practice, vol. 6, no. 1, pp. 15–25.

Kirchner, Ulrich; Ruhrort, Lisa (2007): Verkehrstechnik und Gesellschaft. In: Schöller-Schwedes, Oliver; Canzler, Weert; Knie, Andreas (ed.): Handbuch Verkehrspolitik. Wiesbaden: VS Verlag für Sozialwissenschaften .

Klimm, Leo (2010): Deutsche Bahn düpiert Autobranche. Konzern baut Vorsprung in Zukunftsfeldern E-Mobilität und Carsharing aus - Hersteller und Vermieter hinken nach. In: Financial Times Deutschland, 17.08.2010.

Koch, Walter (2006): Zur Wertschöpfungstiefe von Unternehmen. Die strategische Logik der Integration. Wiesbaden.

Kopfmüller, Jürgen (2001): Nachhaltige Entwicklung integrativ betrachtet. Konstitutive Elemente, Regeln, Indikatoren. Berlin: Edition Sigma.

Koplin, Julia (2006): Organisationale Innovationen im Beschaffungsmanagement als Voraussetzung zur Integration von Nachhaltigkeit, in: Pfriem, Reinhard; Antes, Ralf; Fichter, Klaus et al.: (2006): Innovationen für eine nachhaltige Entwicklung. Wiesbaden: DUV, pp. 339-358.

Korff, Rüdiger (2007): Wie urban ist die Welt? Megastädte und die zunehmende Urbanisierung. bpb-Dossier Megastädte. Edited by Bundeszentrale für politische Bildung. Bundeszentrale für politische Bildung. Online source: www.bpb.de/themen/3XWP6D.html.

Kosow, Hannah; Gaßner, Robert (2008): Methoden der Zukunfts- und Szenarioanalyse. Überblick, Bewertung und Auswahlkriterien. Unter Mitarbeit von Lorenz Erdmann und Beate-Josephine Luber. Berlin. (Werkstattbericht / Institut für Zukunftsstudien und Technologiebewertung, 103).

Kraas, Frauke (2007): Megacities and Global Change in East, Southeast and South Asia. In: ASIEN, no. 103, pp. 9–22.

Kraas, Frauke; Nitschke, Ulrich (2006): Megastädte als Motoren globalen Wandels. Neue Herausforderungen weltweiter Urbanisierung. In: Internationale Politik, vol. 61, no. 11, pp. 18–28.

Kristof, Kora (2010): Wege zum Wandel. Wie wir gesellschaftliche Veränderungen erfolgreicher gestalten können. München: Oekom

Krogerus, Mikael; Tschäppeler, Roman (2008): 50 Erfolgsmodelle. Kleines Handbuch für strategische Entscheidungen. Zürich: Kein & Aber.

Kruse, Peter (2009): Der letzte Tanz ums Goldene Kalb. Das Auto als Kultobjekt und klassisches Statussymbol hat ausgedient. / Gedanken zur künftigen Mobilität (4). In: Süddeutsche Zeitung, 02.06.2009, pp. 43–44.

Kucz, Ingo (forthcoming): Das Elektroauto und seine Implikationen für die Organisation. Dissertation. Supervised by Stephan Rammler. Braunschweig. Hochschule für Bildende Künste, Institute for Transportation Design (ITD).

Lahl, Uwe (2009): Zukünftige Antriebe für Automobile aus der Sicht der Bundesregierung. Edited by Naturschutz und Reaktorsicherheit (BMU) Bundesministerium für Umwelt. Online source: http://www.bmu.de/files/pdfs/allgemein/application/pdf/vortrag_lahl_ami.pdf.

Landry, Charles (2008): The Creative City. A Toolkit for Urban Innovators. London: Earthscan.

Leape, Jonathan (2010): Congestion Pricing. Lessons from London. In: Parry, Ian; Day, Felicia (ed.): Issues of the Day. 100 Commentaries on Climate, Energy, the Environment, Transportation and Public Health Policy. Washington D.C.: Resources for the Future, pp. 158–159.

Lee, Kai N. (2007): An Urbanizing World. In: Worldwatch Institute (ed.): Our urban future. State of the World 2006. A Worldwatch Institute report on progress toward a sustainable society. Washington: Earthscan; Norton & Company (State of the World, 2007), pp. 3–21.

Leggewie, Claus; Welzer, Harald (2009): Das Ende der Welt, wie wir sie kannten: Klima, Zukunft und die Chancen der Demokratie. Frankfurt am Main: Fischer.

Leifheit, Susanne; Krinke, S. (2009): Die Nachhaltigkeit der Biokraftstoffe aus ökologischer und sozialer Sicht. Edited by Volkswagen AG (K-EFUP).

Leschus, Leon; Stiller, Sivia; Vöpel, Henning (2009): Strategie 2030 - Mobilität. Edited by Hamburg Institute of International Economics (HWWI). Hamburg. Online source: http://www.hwwi.org/fileadmin/hwwi/Publikationen/Partnerpublikationen/Berenberg/Strategie-2030_Mobilitaet.pdf.

Levitt, Theodore (1975 [1960]): Marketing myopia. In: Harvard Business Review, no. Sept-Oct.

Linne, Gudrun; Schwarz, Michael (ed.) (2003): Handbuch Nachhaltige Entwicklung. Wie ist nachhaltiges Wirtschaften machbar? Opladen: Leske + Budrich

Litman, Todd (2001): Generated Traffic and Induced Travel. Implications for Transport Planning. In: ITE Journal, vol. 71, no. 4, pp. 38–47.

Loose, Willi (2007): Wirkungen und Entlastungspotenziale neuer Verkehrsdienstleistungen. Edited by Bundesverband CarSharing. Online source: http://www.carsharing.de/index.php?option=com_content&task=view&id=151&Itemid=68.

Loveridge, Denis (2009): Foresight. The art and science of anticipating the future. New York: Routledge.

Lüdeke-Freund, Florian (2009): Business Model Concepts in Corporate Sustainability Contexts. From Rhetoric to a Generic Template for “Business Models for Sustainability”. Leuphana University of Lueneburg. Online source: http://www2.leuphana.de/umanagement/csm/content/nama/downloads/download_publikationen/Business_Models_for_Sustainability.pdf

Lyons, Glenn (2006): The role of information in decision-making with regard to travel. Edited by UK Office of Science and Technology. Online source: http://www.foresight.gov.uk/Previous_Projects/Intelligent_Infrastructure_Systems/Reports_and_Publications/Intelligent_Infrastructure_Futures/Reviews/role_of_information.pdf.

Lyons, Glenn; Urry, John (16.10.2007): Foresight: the place of social science in examining the future of transport. UK Department of Innovation, University and Skills/Government Office for Science. Online source: http://www.foresight.gov.uk/Intelligent%20Infrastructure%20Systems/Social_Science.pdf.

Maertins, Christian (2006): Die Intermodalen Dienste der Bahn: Mehr Mobilität und weniger Verkehr. Wirkungen und Potenziale neuer Verkehrsdienstleistungen. Edited by Wissenschaftszentrum Berlin für Sozialforschung. Berlin. (WZB – discussion paper, SP III 2006-101).

Maertins, Christian; Schmöe, Hinrich (2008): Individual Mobility Services: closing the gap between public and private transport. In: Gronau, Werner (ed.): Passenger Intermodality – Current Frameworks, Trends and Perspectives. Mannheim: MetaGIS (Studies on Mobility and Transport Research, 1), pp. 71–89.

Maibach, M.; Schreyer, C.; Sutter, D.; van Essen, H. P.; Boon, H. B.; Smokers, R. et al. (2008): Handbook on estimation of external costs in the transport sector. Produced within the study Internalisation Measures and Policies for All external Cost of Transport (IMPACT). Edited by CE Delft and European Commission DG TREN. Delft. Online source: http://ec.europa.eu/transport/sustainable/doc/2008_costs_handbook.pdf.

Martin, George (2009): The Global Intensification of Motorization and Its Impacts on Urban Social Ecologies. In: Conley, Jim; McLaren, Arlene Tigar (ed.): Car troubles. Critical studies of automobility. Farnham Surrey UK, Burlington VT: Ashgate Pub. (Transport and society), pp. 219–223.

Matthies, G.; Stricker, K.; Tsang, R. (2012): Vom Automobilbauer zum Mobilitätsdienstleister. Wie Hersteller ihr Geschäftsmodell für integrierte Mobilität richtig aufstellen. Munich: Bain & Company. Online source: http://www.bain.de/Images/Bain_brief_vom_automobilbauer_zum_mobilitatsdienstleister.pdf

Matthiessen, J.; Ulrich, P.; Vanne, P. (2012): The Road to Service Excellence. Ten Ways Industrial Goods Companies Can Win in Services. Boston Consulting Group.

Mehlin, Markus; Zimmer, Wiebke (2010): Ein Weg für klimagerechte Mobilität. Das Forschungsprojekt Renewbility. In: Internationales Verkehrswesen, vol. 65, no. 5, pp. 10–15.

Mettler-Meibom, Barbara E.; Bauhardt, Christine (ed.) (1993): Nahe Ferne, fremde Nähe. Infrastrukturen und Alltag. Berlin: Edition Sigma.

Metz, David (2008): The limits to travel. How far will you go. London: Earthscan.

Meyer, M.; Beutel, S. (2012): KPMG‘s Automotive Executive Survey 2012. Manging growth while navigating uncharted routes. KPMG International. Online source: http://www.kpmg.com/GE/en/IssuesAndInsights/ArticlesPublications/Documents/Global-automotive-executive-survey-2012.pdf

Mitchell, William; Borroni-Bird, Christopher; Burns, Lawrence (2010): Reinventing the Automobile. Personal Urban Mobility for the 21st Century. Cambridge: MIT Press.

Mohnheim, Heiner; Mohnheim-Dahndorfer, C. (1990): Straßen für alle. Hamburg: Rasch und Röhring.

momo Car-Sharing; Bundesverband CarSharing (ed.) (2010): The State of European Car-Sharing. Final Report D 2.4 Work Package 2. Online source: http://www.momo-cs.eu/index.php?obj=file&aid=19&id=371&unid=73711c1485cef82c45521b3553910768.

Moritz, Stefan (2005): Service Design. Practical Access to an Evolving Field. Master Thesis. Supervised by Birgit Mager. Köln. Köln International School of Design, Faculty of Cultural Sciences.

Nagel, Reinhart; Wimmer, Rudolf (2009): Systemische Strategieentwicklung. Modelle und Instrumente für Berater und Entscheider. Stuttgart: Schäffer-Poeschel.

Newman, Peter (2003): Global Cities, Transport, Energy and the Future: Will Ecosocialization Reverse the Historic Trends. In: Low, Nicholas; Gleeson, Brendan (ed.): Making Urban Transport Sustainable. New York: Palgrave (Global issues series), pp. 25–41.

Newman, Peter; Beatley, Timothy; Boyer, Heather (2009): Resilient cities. Responding to peak oil and climate change. Washington DC: Island Press.

Newman, Peter; Kenworthy, Jeff (2007): Greening Urban Transportation. In: Worldwatch Institute (ed.): Our urban future. A Worldwatch Institute report on progress toward a sustainable society. Washington: Earthscan; Norton & Company (State of the World, 2007), pp. 66–85.

Nuhn, Helmut; Hesse, Markus (2006): Verkehrsgeographie. Paderborn: Schöningh (UTB; Geographie, 2687).

OECD (2004): Stakeholder Involvement Techniques. Short Guide and Annotated Bibliography. Online source: http://www.oecd-nea.org/rwm/reports/2004/nea5418-stakeholder.pdf

OECD (2006): Infrastructure to 2030. Telecom, Land Transport, Water and Electricity. Paris: OECD.

OECD (ed.) (2010): OECD Economic Outlook: Statistics and Projections.

OECD; International Transport Forum (ed.) (2010): Transport Outlook 2010. The Potential for Innovation.

OECD; International Transport Forum (ed.) (2012): Transport Outlook 2012. Seamless Transport for Greener Growth. Online: http://www.internationaltransportforum.org/Pub/pdf/12Outlook.pdf

Oeltze, Sven; Bracher, Tilman (2007): Mobilität 2050. Szenarien der Mobilitätsentwicklung unter Berücksichtigung von Siedlungsstrukturen bis 2050. Berlin: difu (Edition Difu - Stadt, Forschung, Praxis, vol. 1).

OICA (International Organization of Motor Vehicle Manufacturers): Production Statistics. Online source: http://oica.net/category/production-statistics/

OPEC (2012): Monthly Oil Market Report, November 2012. Online source: http://www.opec.org/opec_web/static_files_project/media/downloads/data_graphs/MI112012.pdf

Osterwalder, Alexander; Pigneur, Yves; Smith, Alan (2010): Business Model Generation. Hoboken/New Jersey: Wiley.

Oswalt, Philipp; Rieniets, Tim (2006): Atlas of shrinking cities. Atlas der schrumpfenden Städte. Ostfildern: Hatje Cantz.

Pällmann, Wilhelm (2009): Verkehr finanziert Verkehr. 11 Thesen zur Nutzerfinanzierung der Verkehrsinfrastruktur. Edited by Friedrich-Ebert-Stiftung. Bonn.

Peñalosa, Enrique (2003): Foreword. In: Whitelegg, J.; Haq, Gary (ed.): The Earthscan reader on world transport policy and practice. London: Earthscan .

Petersen, Markus (2006): Nicht allein, sondern online: Zur Änderung virtueller und realer Nutzeroberflächen durch das Handy. In: Herdegen, Korinna; Rammler, Stephan (ed.): Designperspektiven innovativer Mobilitätsdienstleistungen. Braunschweig: Hochschule für Bildende Künste (Discussion Papers Transportation Design and Social Sciences / HBK Braunschweig), pp. 66–76.

Piper, Nikolaus: Mein Auto ist dein Auto. Sueddeutsche Zeitung online, 3 January 2013. Online source: http://www.sueddeutsche.de/wirtschaft/carsharing-in-den-usa-mein-auto-ist-dein-auto-ist-mein-auto-1.1564546

Potter, Stephen; Bailey Ian (2008): Transport and the Environment. In: Knowles, R. D.; Shaw, Jon; Docherty, Iain (ed.): Transport geographies. Mobilities, flows, and spaces. Malden MA: Blackwell Pub., pp. 29–48.

PriceWaterhouseCoopers (ed.) (2009): Zukunft in Bewegung. Die Automobilindustrie im Spannungsfeld zwischen neuen Chancen und alten Strukturen. Stuttgart.

Raan, Anthony F. (2005): Measuring Science. In: Moed, Henk F.; Glänzel, Wolfgang; Schmoch, Ulrich (ed.): Handbook of Quantitative Science and Technology Research. The Use of Publication and Patent Statistics in Studies of S&T Systems. Dordrecht: Springer Science + Business Media Inc (Springer-11648), pp. 19–50.

Radtke, Philipp; Abele, Eberhard; Zielke, Andreas E. (2004): Die smarte Revolution in der Automobilindustrie. Das Auto der Zukunft, Optionen für Hersteller, Chancen für Zulieferer. Frankfurt: Ueberreuter.

Rager, Alexander (2002): Nachhaltige Organisationsentwicklung im Rahmen einer Weltordnungspolitik. Term Paper supervised by Johannes Müller, Johannes Wallacher. University of Munich, Faculty of Philosophy

Rahmstorf, Stefan; Schellnhuber, Hans Joachim (2007): Der Klimawandel. Diagnose, Prognose, Therapie. München: Beck.

Rammler, Stephan (2001): Mobilität in der Moderne. Geschichte und Theorie der Verkehrssoziologie. Berlin: ed. sigma.

Rammler, Stephan (2005): „So unvermeidlich wie die Käuzchen in Athen“. Anmerkungen zur Soziologie des Automobils. TU Berlin, FB Integrierte Verkehrsplanung. Berlin. (IVP-Schriften, 02).

Rammler, Stephan (2007): Neuer Treibstoff für das Raumschiff Erde. Ein „Apolloprojekt“ für die postfossile Mobilitätskultur. In: Dettling, Daniel (ed.): Die Zukunft der Mobilität. Herausforderungen und Perspektiven für den Verkehr von morgen. Berlin: berlinpolis .

Rammler, Stephan (2008): The Wahlverwandtschaft of Modernity and Mobility. In: Canzler, Weert; Kaufmann, Vincent; Kesselring, Sven (ed.): Tracing mobilities. Towards a cosmopolitan perspective. Aldershot England, Burlington VT: Ashgate (Transport and society), pp. 57–75.

Rogers, Everett M. (2003): Diffusion of Innovations. New York: Free Press.

Roland Berger (2009): Impact of the economic crisis on the automotive industry. Update on selected developments.

Russell, James (2009): Fossil Fuel Production Up Despite Recession. Edited by Worldwatch Institute. Online source: http://www.worldwatch.org/node/6284.

Schäcke, Mirco (2006): Pfadabhängigkeit in Organisationen. Ursache für Widerstände bei Reorganisationsprojekten. Berlin: Duncker & Humblot (Betriebswirtschaftliche Forschungsergebnisse, vol. 134).

Schade, Jens; Schlag, Bernhard (2007): Psychologie des Mobilitätsverhaltens. In: Aus Politik und Zeitgeschichte, no. 29-30, pp. 27–32.

Schafer, Andreas (1998): The global demand for motorized mobility. In: Transportation Research, vol. 6, no. A32, pp. 455–477.

Schäfers, Bernhard; Kunz, Alexa M. (2006): Stadtsoziologie. Stadtentwicklung und Theorien - Grundlagen und Praxisfelder. Soziologie der Architektur und der Stadt. Wiesbaden: VS Verlag für Sozialwissenschaften (Lehrbuch, vol. 2).

Schaltegger, Stefan (2010): Sustainability as a Driver for Corporate Economic Success. Consequences for the Development of Sustainability Management Control. Leuphana

University of Lueneburg. Online source: http://www2.leuphana.de/umanagement/csm/content/nama/downloads/download_publikationen/Sustainability%20Management_Control_2010_06_09_Schaltegger.pdf

Schaltegger, S. (2004): Unternehmerische Steuerung von Nachhaltigkeitsaspekten mit der Sustainability Balanced Scorecard, Controlling, Sonderheft Strategische Steuerung, Heft 8/9, 511-516.*

Schellhase, Ralf (2000): Mobilitätsverhalten im Stadtverkehr. Eine empirische Untersuchung zur Akzeptanz verkehrspolitischer Maßnahmen. Wiesbaden: Deutscher Universitäts-Verlag.

Schöller-Schwedes, Oliver; Canzler, Weert; Knie, Andreas (ed.) (2007): Handbuch Verkehrspolitik. Wiesbaden: VS Verlag für Sozialwissenschaften.

Schöller-Schwedes, Oliver; Rammler, Stephan (2008): Mobile Cities. Dynamiken weltweiter Stadt- und Verkehrsentwicklung. Berlin: Lit (Mobilität und Gesellschaft, 2).

Schreiner, Peter (2005): Gestaltung kundenorientierter Dienstleistungsprozesse. Wiesbaden: DUV

Schreyer, C.; Maibach, M.; Sutter, D.; Doll, C.; Bickel, P. (2005): Externe Kosten des Verkehrs in Deutschland. Aufdatierung 2005. Schlussbericht. Edited by Allianz pro Schiene. Zürich. Online source: http://www.allianz-pro-schiene.de/presse/pressemitteilungen/2007/2007-21/infras-studie-externe-kosten-summary.pdf.

Schulz, Benjamin (2010): Service Design and Design Thinking. Master Thesis. Helsinki. School of Design, Aalto Universität.

Schwieger, Bodo (2004): International Developments towards Improved Car-Sharing Services. Berlin: Pro Business.

Shaheen, Susan; Cohen, Adam (2013): Carsharing and Personal Vehicle Services: Worldwide Market and Emerging Trends, in: International Journal of Sustainable Transportation, 7:1, pp. 5-34.

Shankar, Vishwas (2012): Business Models and Opportunities in the European Traditional and Peer-to-Peer Carsharing Market. Frost & Sullivan. Online source: http://www.frost.com/sublib/display-report.do?id=M813-01-00-00-00

Soron, Dennis (2009): Driven to Drive. Cars and the Problem of 'Compulsury Consumption'. In: Conley, Jim; McLaren, Arlene Tigar (ed.): Car troubles. Critical studies of automobility. Farnham Surrey UK, Burlington VT: Ashgate Pub. (Transport and society), pp. 181–196.

Spreitzhofer, Günter (2007): Megacities: Zwischen (Sub)urbanisierung und Globalisierung. Friedrich-Ebert-Stiftung. Online source: http://library.fes.de/pdf-files/akademie/online/50340.pdf.

Stamm, Bettina von (2003): Managing Innovation, Design and Creativity. Chichester: Wiley.

Steinke, Ines (2007): Gütekriterien qualitativer Forschung. In: Flick, Uwe; Kardorff, Ernst von; Steinke, Ines (ed.): Qualitative Forschung. Ein Handbuch. Reinbek bei Hamburg: Rowohlt-Taschenbuch-Verl. (Rororo Rowohlts Enzyklopädie, 55628), pp. 319–331.

Steinmüller, Angela; Steinmüller, Karlheinz (2004): Wild Cards. Wenn das Unwahrscheinliche eintritt. Hamburg: Murmann Verlag.

Stern, Nicholas (2006): The Economics of Climate Change: The Stern Review. Cambridge: Cambridge Univ. Press.

Stradling, Stephen; Anable, Jillian (2008): Individual Transport Patterns. In: Knowles, R. D.; Shaw, Jon; Docherty, Iain (ed.): Transport geographies. Mobilities, flows, and spaces. Malden MA: Blackwell Pub., pp. 179–195.

Theofel, Nina (2010): Mobilität zu verkaufen. In: Autohaus, no. 07, pp. 50–51.

Topp, Hartmut (2002): Traffic 2042 - mosaic of a vision. In: Transport Policy, no. 9, pp. 1–7.

Townsend, Craig (2003): In Whose Interest. A Critical Approach to Southeast Asia's Urban Transport Dynamics. Doctorate Thesis. Supervised by Jeff Kenworthy. Perth, Australien. Murdoch University, Institute For Sustainability & Technology Policy. Online source: http://wwwlib.murdoch.edu.au/adt/browse/view/adt-MU20040503.142156.

Transport & Environment (T&E) (2012): How Clean Are Europe's Cars? An analysis of car-maker progress towards EU CO_2 targets in 2011. Online source: http://www.transportenvironment.org/sites/te/files/publications/2012_12_TE_cars_CO2_report_web_final.pdf

Tremmel, Jörg (2003): Nachhaltigkeit als politische und analytische Kategorie. Der deutsche Diskurs um nachhaltige Entwicklung im Spiegel der Interessen der Akteure. München: oekom.

Tully, Claus J. (2007): Leben in mobilen Welten. In: Aus Politik und Zeitgeschichte, no. 29-30, pp. 33–38.

Tully, Claus J.; Baier, Dirk (2006): Mobiler Alltag. Mobilität zwischen Option und Zwang. Vom Zusammenspiel biographischer Motive und sozialer Vorgaben. Wiesbaden: VS Verlag für Sozialwissenschaften.

Tully, Claus J.; Baier, Dirk (2007): Die Verschränkung zweier Dynamiken. Jugendliche Mobilität in der Moderne. In: Swiss Journal of Sociology, vol. 33, no. 1, pp. 135–159.

Turton, Hal (2006): Sustainable global automobile transport in the 21st century. An integrated scenario analysis. In: Technological Forecasting & Social Change, no. 73, pp. 607–629.

Uerz, Gereon (2006): ÜberMorgen. Zukunftsvorstellungen als Elemente der gesellschaftlichen Konstuktion der Wirklichkeit. München: Wilhelm Fink Verlag.

Ulrich, Peter; Duranton, Sylvain; Köhler, Martin (2009): Planes, Trains, and Automobiles. Crossing Paths in European Travel. Edited by The Boston Consulting Group. (BCG Opportunities for Action - Consumer). Online source: http://www.bcg.com/publications/files/BCG_Planes_Trains_and_Automobiles_March_2009.pdf.

Umweltbundesamt (ed.) (2010): CO_2-Emissionsminderung im Verkehr in Deutschland. Mögliche Maßnahmen und ihre Minderungspotenziale. Ein Sachstandsbericht des Umweltbundesamtes. (UBA-Texte, 05/2010).

United Nations / Human Settlements Programme: State of the World's cities 2006/2007. The millennium development goals and urban sustainability. 30 years of shaping the Habitat Agenda (2006). London: Earthscan (The state of the world's cities report, 3).

United Nations / Human Settlements Programme: State of the World's Cities 2008/2009. Harmonious cities (2008). London: Earthscan (The state of the world's cities report, 4).

University of Cambridge; World Business Council for Sustainable Development (2006): Driving success: Human resources and sustainable development. Cambridge

Urry, John (2007): Mobilities. Cambridge: Polity.

Urry, John (2008): Moving on the Mobility Turn. In: Canzler, Weert; Kaufmann, Vincent; Kesselring, Sven (ed.): Tracing mobilities. Towards a cosmopolitan perspective. Aldershot England, Burlington VT: Ashgate (Transport and society), pp. 13–23.

US Department of Transport (DoT) (ed.) (2008): Congestion Pricing. A Primer. Washington D.C. Online source: http://ops.fhwa.dot.gov/publications/fhwahop08039/fhwahop08039.pdf.

Vahs, Dietmar; Burmester, Ralf (2002): Innovationsmanagement. Von der Produktidee zur erfolgreichen Vermarktung. Stuttgart: Schäffer Poeschel (Praxisnahes Wirtschaftsstudium).

van der Loo, Hans; van Reijen, Willem (1999): Modernisierung. Projekt und Paradox. München: dtv.

Vargo, Stephen; Lusch, Robert (2004): Evolving to a New Dominant Logic for Marketing. In: Journal of Marketing, no. 68, pp. 1–17.

Vasconcellos, Eduardo Alcantara (1997): The Urban Transportation Crisis in Developing Countries: Alternative Policies for an Equitable Space. In: World Transport Policy & Practice, vol. 3, no. 3, pp. 4–10.

Verband der Automobilindustrie (VDA) (ed.) (2009): Jahresbericht 2009. Frankfurt am Main.

Vester, Frederic (1990): Ausfahrt Zukunft. Strategien für den Verkehr von morgen. Eine Systemuntersuchung. München: Heyne.

Victoria Transport Policy Institute (ed.) (2008): Online Transport Demand Management Encyclopedia. Online source: http://www.vtpi.org/tdm/index.php.

Volkswagen AG (ed.) (2010): Volkswagen Semi-Annual Financial Report I/2010. Wolfsburg.

Wallentowitz, Henning; Freialdenhoven, Arndt; Olschweski, Ingo (2010): Strategien zur Elektrifizierung des Antriebstranges. Technologien, Märkte und Implikationen. Wiesbaden: Vieweg & Teubner.

Weisshaupt, Bruno (2006): systemInnovation. Die Welt neu entwerfen. Zürich: Orell Füssli.

Wilke, Georg (2002): Neue Mobilitätsdienstleistungen und Alltagspraxis. Wuppertal Institut. (Wuppertal Papers, 127).

Wilke, Georg (2002): Professionalisiertes Car-Sharing im Dilemma Ökologie/Ökonomie. In: Internationales Verkehrswesen, no. 12, pp. 608–613.

Wilke, Georg (2005): Konkurrenz belebt das Geschäft. Car-Sharing in Deutschland. In: politische ökologie, no. 91-92, pp. 109–111.

Wilke, Georg (2009): Ressourcenschonung durch Car-Sharing - Aussichten veränderlich. In: Altner, Günter; Leitschuh, Heike; Michelsen, Gerd; Simonis, Udo E.; Weizsäcker, Ernst U. von (ed.): Umwälzung der Erde. Konflikte um Ressourcen. Stuttgart: Hirzel (Jahrbuch Ökologie, 2010), pp. 112–118.

Wilke, Georg; Böhler, Susanne; Bongardt, Daniel; Schäfer-Sparenberg, Carolin (2007): Zukunft des Car-Sharing in Deutschland. Schlussbericht. Edited by Wuppertal Institut. Wuppertal. Online source: http://www.wupperinst.org/uploads/tx_wiprojekt/Zukunft_Car-Sharing.pdf.

Winterhoff, Marc; Kahner, Carsten; Ulrich, Christopher; Sayler, Philipp; Wenzel, Eike (2009): Zukunft der Mobilität 2020. Die Automobilindustrie im Umbruch. Edited by Arthur D. Little.

Wisbert, Helena (2009): Umweltorientierte Produktinnovationen in der Automobilindustrie. Diplomarbeit. Supervised by Gerd Rainer Wagner. Düsseldorf. Heinrich-Heine-Universität, Lehrstuhl für BWL, insbes. Produktionswirtschaft und Umweltökonomie.

Wissenschaftlicher Beirat beim Bundesminister für Verkehr, Bau- und Wohnungswesen (BMVBW) (ed.) (2004): Demographische Veränderungen – Konsequenzen für Verkehrsinfrastrukturen und Verkehrsangebote.

Wolf, Winfried (2007): Verkehr.Umwelt.Klima. Die Globalisierung des Tempowahns. Wien: Promedia-Verl.

World Bank (2007): Strategic Urban Transport Policy Directions for Bangkok. World Bank; Urban Transport Development Partnership (UTDP).

World Bank (ed.) (2010): Global Economic Prospects Summer 2010.

World Business Council for Sustainable Development (2004): Mobility 2030. Meeting the challenges to sustainability. The Sustainable Mobility Project. Full Report 2004. World Business Council for Sustainable Development. Genf.

World Business Council for Sustainable Development (2007): Mobility for Development. Facts and Trends. World Business Council for Sustainable Development. Geneva/Washington. Online source: http://www.wbcsd.org/includes/getTarget.asp?type=d&id=MjY3OTg.

World Energy Council/IBM/Paul Scherrer Institute (2011): Global Transport Scenarios to 2050.

Worldwatch Institute (ed.) (2008): Into a Warming World. State of the World 2008. A Worldwatch Institute report on progress toward a sustainable society. Washington D.C.: Norton & Company (State of the World, 2009).

Zegras, Christopher; Gakenheimer, Ralph (2006): Driving Forces in Developing Cities' Transportation Systems. Insights from Selected Cases. Working Paper. Online source: http://web.mit.edu/czegras/www/Zegras&Gakenheimer_WBCSD3.pdf.

Zuboff, Shoshana (2004): The Support Economy: Why Corporations Are Failing Individuals and the Next Episode of Capitalism. New York: Penguin.

Zumkeller, D.; Chlond, B.; Ottmann, P.; Kagerbauer, M.; Kuhnimhof, T. (2008): Deutsches Mobilitätspanel (MOP). Panelauswertung 2007. Wissenschaftliche Begleitung und erste Auswertungen. Zwischenbericht Erhebungswellen zur Alltagsmobilität (Herbst 2007) sowie zu Fahrleistungen und Treibstoffverbräuchen (Frühjahr 2008). Universität Karlsruhe, Institut für Verkehrswesen. Online source: http://mobilitaetspanel.ifv.uni-karlsruhe.de/index.php?eID=tx_mm_bccmsbase_zip&id=6344617904a93cc50636f6.