



# **A Housing and Mobility Cost Calculator for the Province of Salzburg**

## **Master Thesis**

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Salzburg, 9<sup>th</sup> December 2013

## **Science Pledge**

The results and findings presented in this thesis are based on my own research at the Interfaculty Department of Geoinformatics of the Paris-Lodron University in Salzburg. I have properly documented literal citations and thoughts of other authors. Also, this thesis has not been submitted previously for a degree at any institution.

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**Sebastian Cadus**

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## Abstract (English)

Over the last decades, the development of housing estates and mobility in the Alpine area has been characterised by growing land use and landscape fragmentation on the one hand as well as increasing commuting distances and motorised individual traffic on the other hand. Both realms mutually influence each other since location choice is a central determinant for the everyday mobility behaviour of a person. However, housing decisions are usually made without a comprehensive knowledge about their far-ranging effects.

It is the purpose of this work to elaborate on the relationship between housing and mobility as well as to indicate the impact of housing locations on mobility opportunities. This shall make induced cost patterns more transparent and in turn raise the awareness of households on existing interdependencies. In the end, this shall contribute to long-sighted housing and mobility decisions, fostering structurally integrated areas together with less traffic and more environmentally sound modes of transport. The method that was applied to achieve this objective comprised the development of a housing and mobility cost calculator, which was implemented for the province of Salzburg. For the conceptualisation of the Web-based tool, existing cost structures in space were analysed, dependencies and interrelations between housing and mobility explored, and state of the art communication strategies investigated. In addition, the application was contextualised with respect to both the administrative spatial planning process and the private decision-making process on housing. As a result of the work, the cost calculator is available on-line and free of charge at [www.moreco.at/haushaltsrechner](http://www.moreco.at/haushaltsrechner). It allows its user to compare alternative housing locations and distinct mobility behaviours regarding monetary costs as well as respective travel time and distance expenditures.

As a conclusion it can be found that in the long run, the share of mobility costs in a household's budget gains importance. Cheap land prices often face high mobility costs and hence overall costs may even be more expensive in peripheral regions, compared to well integrated locations. The cost calculator that was developed shall contribute to illustrate this finding, breaking the fixation on pure land prices during the decision-making process.

**Keywords:** awareness-raising, geo-application, housing decision, mobility behaviour, spatial cost patterns

## Abstract (German)

Die Entwicklung von Wohnsiedlungen und Mobilität im Alpenraum war über die letzten Jahrzehnte hinweg gekennzeichnet von steigender Flächeninanspruchnahme und Zerschneidung der Landschaft einerseits sowie einer Zunahme von Pendeldistanzen und motorisiertem Individualverkehr andererseits. Beide Entwicklungen beeinflussen sich gegenseitig, da die Wahl des Wohnstandortes ein zentraler Bestimmungsfaktor für das Mobilitätsverhalten einer Person darstellt. Wohnstandortentscheidungen werden in der Regel jedoch ohne umfassendes Wissen hinsichtlich ihrer weitreichenden Konsequenzen getroffen.

Ziel dieser Arbeit ist es, das Verhältnis zwischen Wohnen und Mobilität herauszustellen und den Einfluss des Wohnstandortes auf den Mobilitätsspielraum aufzuzeigen. Dies soll dazu beitragen, induzierte Kostenstrukturen transparenter zu gestalten und somit das Bewusstsein der Haushalte in Bezug auf bestehende Wechselwirkungen zu schärfen. Letztendlich soll dadurch ein Beitrag zu weitsichtigen Entscheidungen geleistet werden, bei denen Wohnstandorte in siedlungsstrukturell integrierten Lagen, verbunden mit weniger Verkehr und umweltfreundlicher Verkehrsmittelnutzung, gefördert werden. Die Methode, die für das Erreichen dieser Zielsetzung gewählt wurde, umfasst die Entwicklung eines Wohn- und Mobilitätskostenrechners für das Bundesland Salzburg. Für den Entwurf der webbasierten Anwendung wurden bestehende Kostenstrukturen im Raum analysiert, Abhängigkeiten und Zusammenhänge zwischen Wohnen und Mobilität herausgearbeitet und moderne Kommunikationsstrategien untersucht. Darüber hinaus wurde der Rechner sowohl in den Prozess der öffentlichen Raumplanung als auch in den Ablauf der privaten Wohnstandortentscheidung eingeordnet. Als Ergebnis der Arbeit steht der Kostenrechner kostenlos unter der Webadresse [www.moreco.at/haushaltsrechner](http://www.moreco.at/haushaltsrechner) zur Verfügung. Er ermöglicht es dem Benutzer, alternative Wohnstandorte und unterschiedliche Mobilitätsverhalten unter Berücksichtigung finanzieller Kosten sowie entsprechender Reisezeit- und Entfernungsaufwändungen miteinander zu vergleichen.

Als Fazit lässt sich festhalten, dass der Anteil der Mobilitätskosten am Haushaltsbudget auf lange Sicht an Bedeutung gewinnt. Günstige Grundstückspreise bedingen häufig hohe Mobilitätskosten und die Gesamtkosten eines Haushalts können in abgelegenen Gebieten somit höher sein, als in gut integrierten Lagen. Der entwickelte Kostenrechner soll dazu beitragen, diese Erkenntnis zu verdeutlichen und eine Fixierung auf die reinen Grundstückspreise bei der Wohnstandortwahl aufzubrechen.

**Keywords:** Bewusstseinsbildung, Geo-Applikation, Wohnstandortwahl, Mobilitätsverhalten, räumliche Kostenstrukturen

## 1. Introduction

At the present time, where modern society is based on the division of labour, a substantial part of actions is accompanied by the change of location of people and goods. Various means of transportation facilitate the coverage of large distances within a reasonable time and therefore create new ways of structuring personal and professional life. The mobile society has long since become reality and mobility is seen as an important condition for a fulfilling life. Being mobile is taken for granted and it is almost inconceivable to live in a place which is neither served by public transport nor connected in any other way. However, the mobility of an individual person considerably depends upon where and how he or she lives. Numerous interdependencies exist between the type of housing, the structural environment and transport connection. Thus, everyday mobility is to a high degree determined by previously made long-term decisions, one of them being the choice of residential location.

The choice of residential or business locations is a key decision in the life of people and crucial for the success of companies. It directly influences the individual mobility behaviour of people over many years. For this reason, the decision and especially the consequences it implies should be considered carefully. Yet, it is very difficult to comprehensively assess the range of medium- and long-term effects of this choice. Most people do not have a precise idea about the money they spend on housing and mobility and how these costs are interrelated. Less expensive real estate in the surrounding areas of larger cities seems attractive at first glance; poor accessibility of different infrastructure facilities and higher mobility costs in the long run are not considered in most cases. Hence housing decisions are often made without complete knowledge about their effects. In the end, the daily travel of long distances and the intensive use of transport come along with numerous undesirable side effects. Car dependencies, high private and public costs, congestion and emission are just a few of them, causing increasing pressure on natural resources and a decrease in the quality of life.

### 1.1. Motivation and Context of the Work

This work is framed by the *Alpine space* project “*MOR€CO – Mobility and Residential Costs*”. The project is an international cooperation of ten project partners from five EU member states, located in the Alpine space (Austria, France, Germany, Italy and Slovenia). The main part of *MOR€CO* is funded by the *European Regional Development Fund (ERDF)*; the project period runs from July 2011 until June 2014 (BISCHOF 2013).

The starting point of *MOR€CO* are current economic and demographic dynamics being encountered in the Alps, which foster the growth of peri-urban areas, landscape fragmentation, unsuitable structures for public transport and a dramatic rise of motorised individual traffic. Given the limited settlement space in the area, this causes substantial problems, including accessibility constraints, high time expenditures and



vulnerability of real estate values (BISCHOF 2013). Therefore it is the aim of *MORECO* to tackle these issues by supporting sustainable and resource-friendly settlement developments: Existing infrastructure and transport axes shall be fostered, environmentally friendly mobility promoted and urban sprawl contained. In order to achieve these goals, several tools and strategies are being developed, focusing on three main target groups (FRANZ&BÜTTNER 2012):

### **House-hunting citizens and other private households**

Peoples' awareness of the relation between residential housing decision and induced mobility costs should be strengthened. This includes more transparent short-term and long-term costs as well as more sustainable mobility behaviour.

### **Planners and public transport organisations**

Spatial planners and transport associations should be supported in making elaborated decisions with respect to the assignment of building land, settlement structure as well as induced mobility behaviour and needs.

### **Politicians, decision makers and municipalities**

This group of political decision makers requires meaningful and reliable information to facilitate good governance for sustainable settlement and traffic development in the pilot sites.

As a contribution to the *MORECO* project, this thesis focuses on the development of a *Housing and Mobility Cost Calculator* for the group of house-hunting citizens and private households in the region of Salzburg. As a result, a Web-based tool is provided, facilitating households to calculate their individual costs for both housing and mobility. Based on this, housing location sites may be assessed regarding their specific long-term implications.

## **1.2. Thesis Structure**

This thesis is divided into eight chapters; a graphical illustration of this structure is provided in Figure 1. The first chapter serves as an introduction into the content being investigated, namely the linkage between housing and mobility costs. Therefore the motivation for the topic is illustrated as well as the context in which the study is embedded. In the second chapter, a detailed outline is presented of the overall approach being followed. In this regard, a description of the issues and problematic developments which have evolved in the field of housing, mobility and traffic is given. Further, taking account of these these problems, three major hypotheses are derived, which shall be examined in more detail. This in turn provides the guideline for the structure of the theoretical and practical analysis later on. Moreover, the methods, tools, and technologies are described which are applied in order to practically elaborate on the topic. In brief, this encompasses the development of the *Housing and Mobility Cost Calculator* as a Web-based tool, to be used by private households and other potential user groups. Subsequent to this, the overall objective of the work is specified, being pursued by both the theoretical work and the resulting application. Amongst other things, this includes a raised awareness of households on the interdependencies between housing and mobility. Furthermore, as a last step in the approach, particular

aspects which are related to the topic but not further explored are delineated from the investigation. The third chapter summarises important literature with respect to the work's topic. For this purpose, seven studies are briefly outlined and their respective contribution to this thesis is highlighted. Next, chapter four represents the theoretical foundation of the thesis. It includes the definition of relevant terms and inquires into the three hypotheses that were put forward. Hence the relation of mobility and housing cost structures in space are investigated and different levels of influence on mobility are examined. This includes both public and private influencing factors such as spatial planning and long-term household decisions. In this context, the starting point of the *Cost Calculator* is defined, contextualising it in both the spatial planning process and the decision-making process on housing. Thus in sum, the chapter pinpoints the relationship between housing and mobility, existing interrelations and possible starting points to take influence on mobility behaviour. Turning to chapter five, the practical part of the work is illustrated. More precise

ly, this includes the implementation of the calculator for the province of Salzburg. This comprises an introduction into the pilot study as well as the approach that is followed for the tool development. The latter part involves a state of the art review of current housing/mobility calculators, the tool conceptualisation, based on determined requirements as well as the realisation. The result of this undertaking is described and evaluated in the sixth chapter. Moreover, the potential usage and benefits of the calculator are presented in a brief test case in chapter seven. Finally, chapter eight rounds off the work by summarising major findings from the theoretical and practical investigation, discussing aspects that are to be taken in mind with respect to the outcome and providing a perspective on the future work that is to be undertaken.

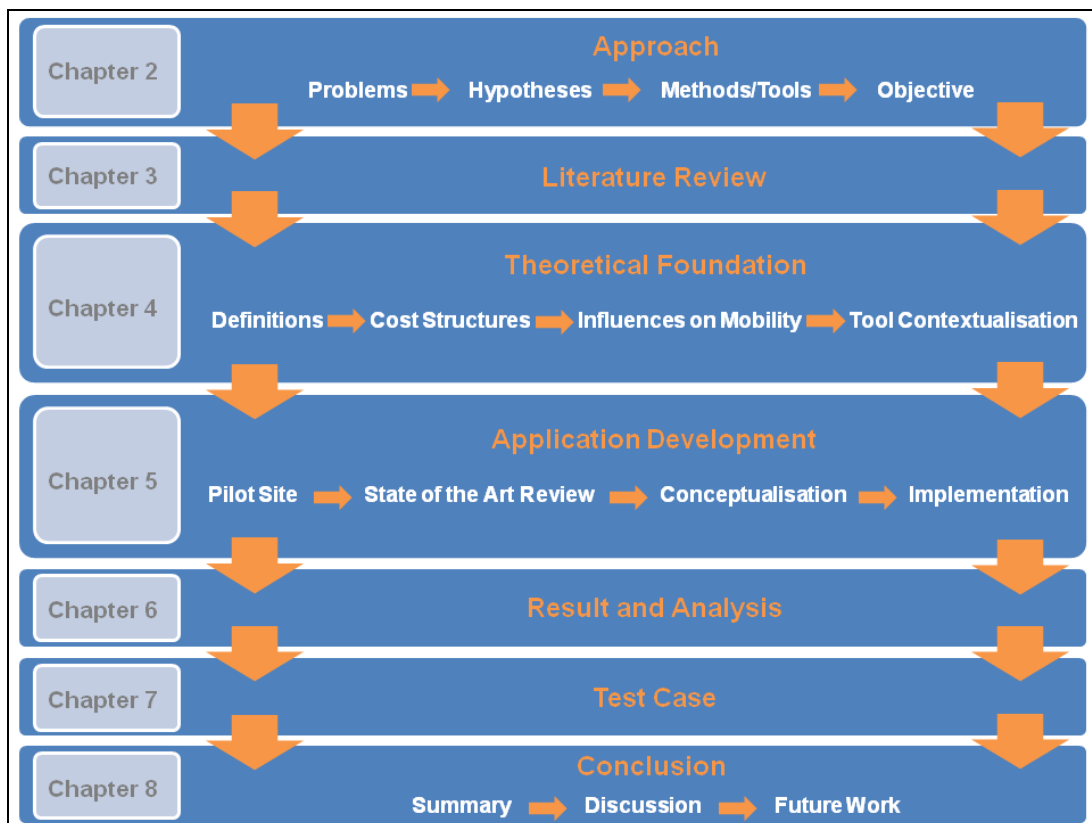


Figure 1: Graphical representation of the work's structure (author's own design).

## 2. Approach

This chapter provides a more detailed overview on the subject and the content of the thesis, creating the frame for the following theoretical and practical parts. First, the problem is described, which the work builds up on (chapter 2.1.). This covers the past development of housing and transport, the self-induced dynamics and problems which evolved from this development and finally the challenges that are to be tackled today. Second, the section on hypotheses acts on the assumption that particular cost structures exist in space (chapter 2.2.). It is claimed that these patterns are difficult to identify due to their constant change, the externalisation of costs, the lack of political guidance and short-term considerations. Further, it is assumed that a more sustainable development in terms of housing and transport may be achieved by influencing the behaviour of households through systematic communication and problem transfer. Third, the description of the methods presents the methodological approach which was chosen to both investigate the hypotheses and in consequence tackle the problems described (chapter 2.3.). In particular, this encompasses the conceptualisation and prototypical implementation of the *Housing and Mobility Cost Calculator*. In this context, different types of costs are outlined, the intended outcomes of the tool are listed and the approach for the conceptualisation of the calculator is introduced. This comprises a state of the art review of current cost calculators, the identification of limitations, and respectively the derivation of requirements, as well as the implementation and the testing of the tool. Next, the tools and technologies are specified, which were applied for the tool development (chapter 2.4.). Amongst others, this covers markup and scripting languages, scripting frameworks, application programming interfaces and a database system. In this context, utilised integrated development environments and software programs are described. Further, the objectives of the work are presented (chapter 2.5.). As a major aim, private households shall be supported by offering qualified information and cost transparency on cost relationships and long-term effects. This shall contribute to more rational and conscious decisions. Besides, it is shown how other groups, namely spatial planners and decision makers may use and profit from the tool. Last, the scope of the work is defined by delimiting the topic from other approaches and further issues (chapter 2.6.).

### 2.1. Problem Description

For many decades, housing and transport development have countervailed a sustainable development: Investments in road construction as well as building land designation increased steadily (WÜRDEMANN&HELD 2009, 752). In addition, travel speed rose and the desired permeability of space allowed further distances at almost constant travel time. Thus, space shrank and the locations of residences and businesses became more or less arbitrary (WÜRDEMANN&HELD 2009, 752). As a consequence, housing development was (and today still is) characterised by persistent land use and landscape fragmentation (VCÖ 2007, 11). First and foremost, these processes take place in dispersed, rural regions in the surroundings of urban areas.

The development of transport activities on the other hand may be described by growing motorisation, longer distances (Figure 2) and increasing use of motorised individual transport at the expense of travels on foot and public transport. Changing spatial offers (and deficits) created an individual travel behaviour, allowing citizens to reach farther destinations quickly and at low cost (WÜRDEMANNS&HELD 2009, 752). At the same time, concentration processes of the retail industry and (public) services continued, leading to a decreased quality of mobility and the constitution of car-dependent settlements.

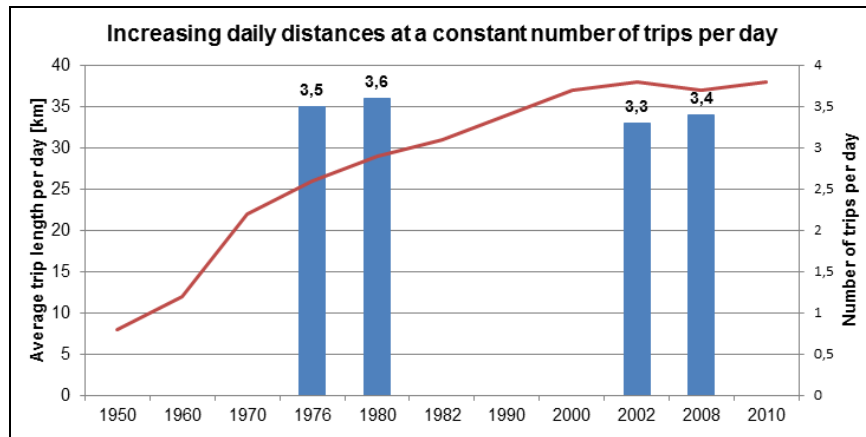


Figure 2: Number of trips and average distances per day in Austria (author's design, based on VCÖ 2013, 22).

It must therefore be recognised that both housing and transport development are closely related to each other and substantially influenced by suburbanisation processes. These processes continue until today and were initialised by the success of cars in the last 50 years and the induced individual mobility. Despite the fact that significant re-urbanisation trends have been detected over the last years (ADAM ET AL. 2008, 399f.), these cannot be interpreted as stable trend of settlement development yet (HOLZ-RAU ET AL. 2010, 11f.). Thus, neither in shrinking nor in growing regions a 'renaissance' of urban areas will happen by itself and the development of strategies to mitigate urban-rural migration remains a current challenge.

The problems which arise from these suburbanisation processes in the long-run are several self-induced dynamics. On the one hand, these dynamics reinforce the peripheral development and consequently the volume of traffic; on the other hand, they provoke a range of other negative consequences for both public and private parties. A schematic illustration of the self-induced cycle and existing interdependencies is shown in Figure 3. As GUTSCHE ET AL. (2006, 16) perceptively state, suburbanisation causes disperse settlement structures where decreasing settlement densities make profitable public transport difficult. Besides, social infrastructure facilities can hardly be reached by bike or foot. As a consequence, longer distances need to be covered to carry out daily activities, which in turn require faster transport systems. Therefore SIEDENTOP ET AL. (2013, 330) correctly argue that decentralised, disperse settlement structures are accompanied by higher motorisation rates, and raising car mileage. The high level of motorisation in suburban and rural areas on the other hand reduces the sensibility of households, planners and investors, strengthening again the acceptance of peripheral locations. The indications are therefore that the possibility of overcoming space with a private car fosters peripheral settlement, which in turn reinforces the dependence on motorised transport (KIM 2004, 9). This is also referred to as 'forced mobility' (GUTSCHE

ET AL. 2006, 16). Therefore, some kind of paradox can be identified: The private car which is commonly seen as means of allowing a higher degree of individual freedom of action, fosters peripheral locations and thus leads to a higher dependence on it (SIEDENTOP ET AL. 2013, 330).

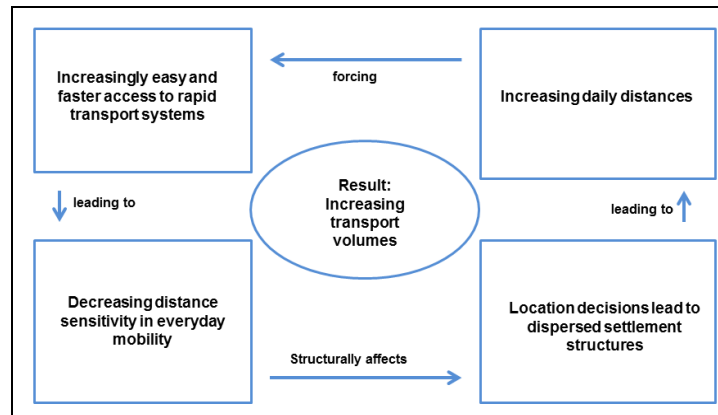


Figure 3: Self-induced dynamic of regional traffic (author's design, based on GUTSCHE&KUTTER 2006, 16).

In addition to these self-inducing dynamics, consequences of considerable economic, political, social and environmental importance arise from suburbanisation processes. Some of them are outlines in the following.

### Financial costs

Various kinds of monetary costs evolve for the public. First, this includes costs for the provision of new infrastructure in growing peri-urban areas. Thereby not only costs for construction but also for maintenance binds a significant amount of public money, which is often ignored (GUTSCHE ET AL. 2006, 16). Second, areas of former suburbanisation activities, which are shrinking today, constitute financial burdens, as social and technical infrastructure still need to be maintained in these places (HOLZ-RAU ET AL. 2010, 12). Third, the increasing traffic results in substantial external expenses, comprising direct monetary costs (e. g. for infrastructure) and indirect costs through damages. As demonstrated in Figure 4, this includes expenditures associated with noise, emissions, climate, accidents and health. These indirect costs sum up to a considerable amount. To exemplify this, in Austria more than 20 billion Euro are spent on average per year. If, in addition to this, costs for counter-productive subsidies such as commuter tax relief and kilometre allowance are included, costs and damages of more than 30 billion Euro can be expected (VCÖ 2010a, 17).

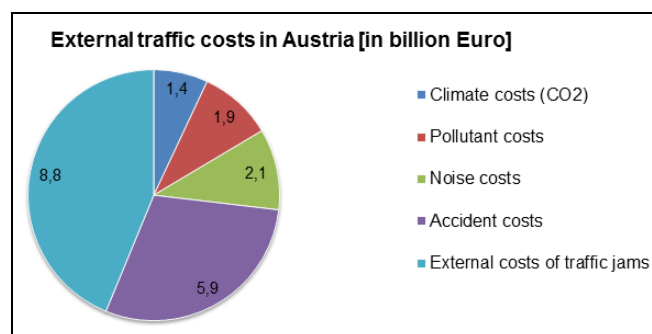


Figure 4: 20 billion Euro external traffic costs in Austria (author's design, based on VCÖ 2010a, 17).

## Dependencies

The increasing importance of motorised individual transport and the induced settlement structures cause a growing dependence of the urban system on cars. Hence the choices of households i. e. their financial and organisational freedom to reach certain places, becomes more and more restricted (GUTSCHE ET AL. 2006, 16; GERTZ&ALTENBURG 2009, 785f.) Moreover, when comparing the development of prices for mobility with the development of income (Figure 5), the question of social justice (ARL 2011, 1f.) and social segregation (HOLZ-RAU ET AL. 2010, 12) regarding mobility and the opportunity to participate becomes increasingly urgent. This includes the issue of growing mobility demands.

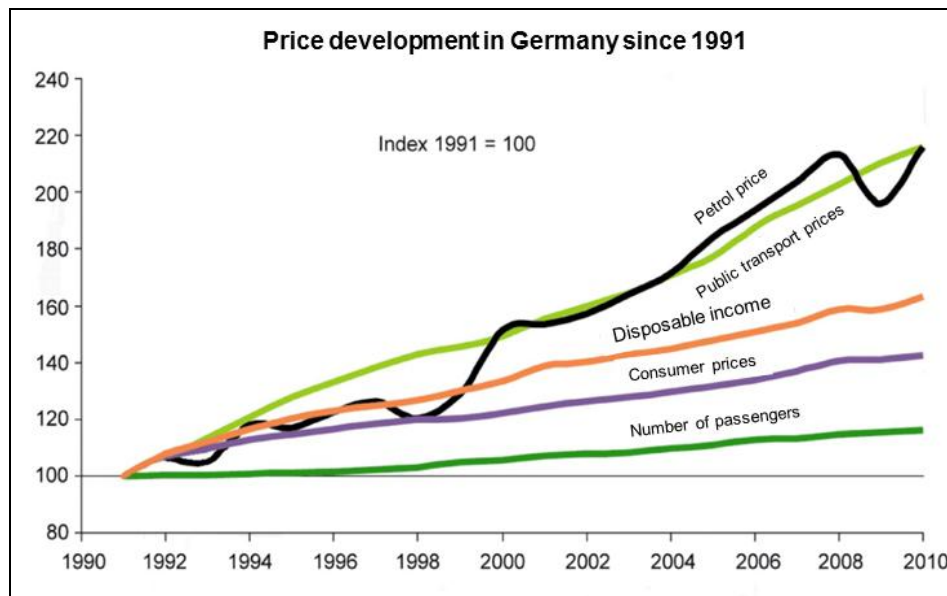


Figure 5: Price developments in Germany since 1991 (adopted from ARL 2011, 2).

## Environmental impact

The spread of urban areas into the open landscape has also an impact on global climate: increasing land use, loss of open space, increasing risk of flooding, as well as loss of biodiversity and vegetation are only some of the problems (HOLZ-RAU ET AL. 2010, 12). Besides, heating up increasingly larger living space, the purchase of a (further) car and increasing distances travelled by individual motorised transport comes along with rising energy consumption, greenhouse gas emission, air pollution and congestion (ALBRECHT ET AL. 2008, 93; GUTSCHE ET AL. 2006, 16; MEGA 2013, 175). This in turn causes high costs, global warming, health threats and eventually decreasing quality of life (STÖHR 2009, 806).

## Decreasing quality of life

Commuting activities in metropolitan areas are very high (VCÖ 2008, 17). Thus, with growing population in these areas, commuting and traffic increase significantly. In addition, research by GUTH ET AL. (2012, 485) indicates higher shares of cross-municipal commuting and rising commuting distances over time. As a result, considerable traffic loads emerge in the core city. This is especially due to the fact that people who moved to suburban areas commute to the city to perpetuate different

activities such as work, education, supply and leisure (HOLZ-RAU ET AL. 2010, 12). The high traffic volumes in urban areas may thus lead to a significant loss of quality in public and private space due to the demand for space and induced noise (GUTSCHE ET AL. 2006, 16).

All of these problems will essentially be reinforced by two matters. On the one hand, this concerns the issue of peak oil, scarcity of fossil fuels, political crisis and the economic rise of countries like India and China. These developments will lead to both volatile and long-term increases of fuel prices and respectively mobility costs (BÜTTNER&WULFHORST 2012, 1). As illustrated in Figure 6 the general direction of this development is obvious; only the rate is unknown. Thus, it will be necessary to adopt to permanently higher price levels (GERTZ&ALTENBURG 2009, 785). Closely related to this matter is the challenge of climate change. The increasing awareness of this topic has led to ambitious greenhouse gas reduction goals in many countries: the *European Union* joined the resolution of reducing their emissions by at least 80% by 2050. If these goals are to be reached, this will cause significant implications for both transport and the spatial structure in regions and cities (ARL 2011, 1f.). As the TRAFFIC ASSOCIATION OF AUSTRIA (VCÖ) (2013, 23) points out, new technologies can contribute to 60% to reach this goal, the contribution of changes in transport behaviour may sum up to 40%.

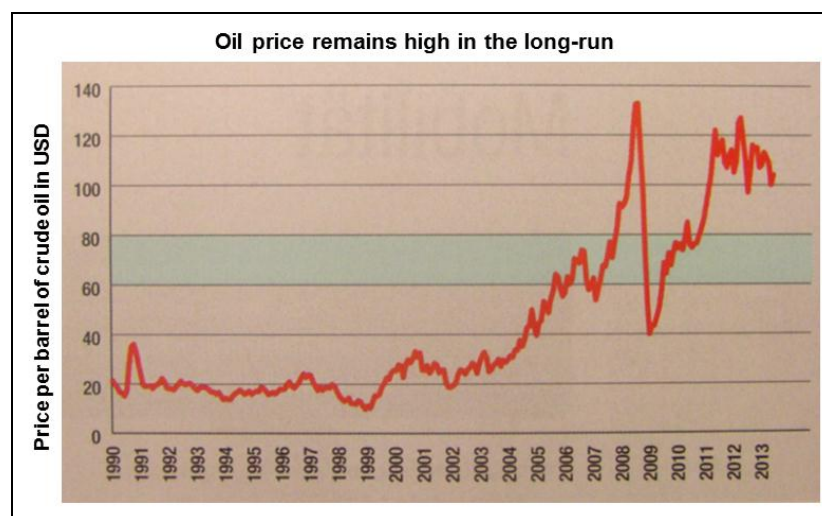


Figure 6: Oil price remains on a high level in the long-run (adopted from VCÖ 2013, 23).

A major problem that can be observed in this context is the fact that progress made in resource and energy conservation (e. g. new motive power and vehicle applications) is essentially foiled by growing velocities and increasing distances being travelled (DANGSCHAT&SEGERT 2011, 59f.). Besides, this approach will neither decrease the amount of cars nor reduce land use (ARL 2011, 1f.; LAMBRECHT ET AL. 2013, 65f.). Thus, in order to cover the demand on energy for mobility in a sustainable way, a combination of technological progress, use of renewable energy sources as well as changes in mobility behaviour and mobility lifestyles is required (VCÖ 2013, 22). Given the enormous problems and upcoming developments, it is necessary to initiate serious rethinking processes in spatial planning and in particular in the individual mobility behaviour. Until now, respective incentives for rethinking transportation behaviour are missing.



## 2.2. Hypotheses

Most decisions which impact on housing and mobility are made without a comprehensive consideration of the implications they cause. One type of decision, which is of crucial relevance with respect to mobility expenditure and traffic generation, is the decision on housing location (GUTSCHE 2003, 1). Amongst other reasons, this is due to the fact that the location of housing determines the respective opportunities of citizens' everyday mobility (e. g. transport mode and distances) for a long period of time. In order to elaborate on this matter, the work at hand is based on three major hypotheses which are related to private households' decisions on housing and mobility. By investigating these hypotheses, the development of different costs in space is analysed. Besides, the complexity and interdependencies between housing decisions and traffic implications are elaborated and starting points of communication strategies as well as their potential of influencing peoples' decisions are explored. The three hypotheses, as well as a brief description of each are presented in the following.

*Hypothesis 1: There are particular cost structures in space for both housing and mobility. These patterns variate and may balance each other out.*

Prices for real estate and ground rent trend to decrease with increasing distance from central places (VCÖ 2010b, 9f.). In contrast, mobility costs show a tendency to rise with regions being farther away from a central urban area (REGION HANNOVER 2007, 30). Based on these conditions, the question arises, which impact factors and relationships between housing and mobility costs exist: Do these cost components compensate each other at some point and where are overall costs highest? These questions become even more interesting, given the past occurrences: While over the last decades, housing costs grew at constant rate and mobility costs were on decrease (compared to the general inflation rate), this trend has inverted within the past couple of years (FUCHTE 2006, 37f.). Thus, mobility costs have risen due to growing petrol prices and taxes while at the same time housing costs in many places have remained static or even decreased.

*Hypothesis 2: It is very difficult for private households to comprehensively assess housing and especially mobility costs in the long-run. A lack of cost transparency in the context of various influences and interactions may lead to short-term considerations.*

It is a matter of fact that pure housing costs are usually lower in the countryside than in the city area, comparing the same housing standard. Thus, citizens looking for low priced housing tend to move to peri-urban locations (ADAM ET AL. 2008, 406). However, this aspect may be overrated, as advantages and disadvantages of living in the city or in surrounding area may not be known in full depth: In particular, expenditures and long-term costs of mobility vary considerably at different locations (EIZENHÖFER&SINNING 2009, 135). This relationship may often be missed and the rationality of the decision may therefore be limited. One major reason for this is seen in the lack of cost transparency: While housing costs can rather easily be estimated in advance (SCHRENK ET AL. 2011a, 113), resulting mobility costs and travel times are hard to estimate and therefore may easily be misjudged or entirely ignored. Thereby the main problem with the perception of transport costs may derive from the fact that



possible increases in mobility costs are not only caused by longer distances; follow-on costs may also encompass the purchase of additional cars or expenses such as accompanying transports, e. g. for kids (FUCHTE 2006, 37f.). This becomes even more difficult, as fiscal instruments such as the commuter tax allowance further reduce transparency (FUCHTE 2006, 37f.). Thus, in order to make a decision in such a complex, multidimensional decision situation, it is claimed that decision criteria are often-times reduced to clear dimensions and short-term aspects.

*Hypothesis 3: The decision on housing as well as the mobility behaviour of people may be influenced by individual and objective information provision, being communicated in a systematic way. This may form a contribution to a more effective settlement development and less individual traffic.*

It was found by several studies that to date, there is a lack of independent information which allows households to properly assess the consequences of living in the country side or within a city (ADAM ET AL. 2008, 400). At the same time, the work of EIZENHÖFER&SINNING (2009, 135) indicates that knowledge about the true costs at a certain location is important for a sustainable decision. Thus, considerable potential influence may be seen in appropriate communication strategies and the provision of independent housing information to private households. By contrasting the high cost of housing in the city with much higher mobility costs in the surrounding area, the location decision of households may be influenced in favour of urban locations<sup>1</sup>. The idea is that sustainable urban and regional development is not only a question of spatial structures but also of the actions of people living in these structures: Reliable information in advance of residential location decisions may lead to a higher satisfaction of citizens, more efficient use of residential building areas, less car dependence, less land use, and less energy consumption.

### 2.3. Methods

In order to investigate the hypotheses described, the *Housing and Mobility Cost Calculator* is developed for the province of Salzburg, Austria. Cost calculators offer a convenient way to analyse expenses (VCÖ 2010b, 18) and thus contribute to an increased transparency of costs and a more sustainable development. However, in this context it is necessary to differentiate between the microeconomic perspective of households and the consideration of society as a whole: For private households, the

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<sup>1</sup> It is emphasised at this stage that the underlying dichotomy of urban/suburban does not exactly refer to the administrative level of urban and suburban. Rather, it relates to structurally integrated versus non-integrated locations. Integrated areas thereby encompass sites that are embedded in a settlement structure characterised by mixed land use and a compact appearance. As HOLZ-RAU ET AL. (2010, 15) rightly point out, this definition does not fully coincide with the administrative area of the core city. Vice versa, non-integrated locations are by no means identical to suburban areas. Neither are core cities free of non-integrated places, nor can suburban regions not be characterised by a certain centrality. Nevertheless, for simplicity (taking into account a certain fuzziness), structurally integrated locations are in the following referred to as urban areas, whereas non-integrated regions are set equal to suburban locations.

overall societal cost ratio of their decisions are not significant (DRIESSEN 2010, 43f.). Thus, rather than emphasising social goals such as reducing land use or saving energy, focus is placed on demand-oriented information for private households. This includes the investigation of individual locations and the respective costs. Thereby costs encompass monetary costs for housing as well as expenses and time expenditures for mobility; the latter expenses in turn include both individual motorised traffic and public transport costs.

Therefore the *MORECO Cost Calculator* provides personalised cost estimates of residential locations and respective mobility costs. It informs the user about

- Monetary costs for rent or financing of housing as well as associated charges
- Mobility costs, including fixed and variable expenses of vehicles as well as monthly tickets for public transport
- Distances to be covered with different means of transportation
- Overall travel time expenditures

For each regular trip, expenditures in terms of monetary costs, time and distance for both public transport, and (non-)motorised individual transport are opposed. However, rather than analysing just single trips, the tool also provides information on the respective medium and long-term costs. Based on this information, residential locations and mobility patterns may be tested: On the one hand, the user may compare the costs of different means of transport for the same residence and destinations. On the other hand, different residential locations may be investigated, applying the same mobility behaviour. Thus, as a result, the tool shall facilitate a transparent assessment of monetary costs and expenditures. This applies with regard to different locations and various means of transportation, over a long period of time and based on individual mobility patterns. By emphasizing the long-term effects of residential location, the user shall be able to optimise his/her residential living situation at current time and in future situations.

Given the increasing importance of the information and communication technologies of the Internet and the increasing possibilities for customisation (BMVBS 2012, 149), the *Cost Calculator* is developed as a Web-based tool. As ALBRECHT ET AL. (2009, 149) correctly argue, this offers a good way for users to obtain individual information with comparatively little effort. In order to develop the overall concept and functional structure of the tool, a review of state of the art cost calculators is undertaken. Based on this review, current limitations and shortcomings, but also positive aspects are identified. From these findings in turn, the functional and graphical requirements of the *Housing and Mobility Cost Calculator* are derived and integrated in the tool conceptualisation. The tool itself is developed as a dynamic Web application, based on a client-server model. Subsequent to the actual implementation and coding of the calculator, a test case is used to demonstrate and test the tool. This is done by calculating housing and mobility costs for a peripheral location in the region of Salzburg and opposing it to a structurally integrated place of residence.

## 2.4. Tools and Technologies

Major technologies incorporated in the Web-based *Housing and Mobility Cost Calculator* encompass the following:

- *HyperText Markup Language* (HTML) 5
- *Cascading Style Sheets* (CSS) 3
- Scripting language: *JavaScript* 1.8.5
- JavaScript libraries: *jQuery* 1.9.1, *jQuery User Interface* 1.10.3, and *Highcharts JS* 3.0
- Programming language: *Python* 3.1.1
- Application Programming Interfaces (APIs) and Web services: *Google Maps*, *Traffic Information Austria* (VAO), *Traffic Association of Salzburg* (SVV)
- Database Management System (DMS): *SQLite*

For the development of the tool, two integrated development environments (IDEs), were applied, namely the source code editor *Notepad++* (DON HO 2011) and the *Python IDE IDLE* (PSF 2013). Besides, the *Firefox-Add-on SQLite Manager* (0.8.1) (LAZIERTHANTHOU 2013) was utilized to create, manage, and query a *SQLite* database. In order to test and host the application on the server, *Apache HTTP Server* (2.4.6) was used.

### **HTML and CSS**

The *Hypertext Markup Language* and *Cascading Style Sheets* are two key technologies for composing pages and applications on the Web (W3C 2013). *HTML* is generally used to describe the structure of a page being displayed in a Web browser. Using markup elements such as 'division', 'heading', 'paragraph' or 'table', structured documents can be created. This allows the user to publish documents consisting of text, tables, images and other kind of multimedia. Also, by denoting 'form' elements, interactive transactions can be conducted e. g. to different Web services. Thereby interaction with the *HTML* document takes place through the *Document Object Model* (DOM). The *DOM* represents the *HTML* document in a tree structure which encompasses the hierarchy and properties of the *HTML* elements (REFSNES DATA 2013).

CSS in turn are in charge of the visual layout, i. e. the presentation of a Web page. Thus, rather than using explicit presentational *HTML* to determine the graphical appearance of a Website, it is recommended to use style sheets instead (W3C 2013). This separation of structure and presentation not only facilitates an easier maintenance of a page but also the exchange of styles across pages. CSS can be applied to any *XML*-based markup, including *HTML*. Therefore, using style sheets, fonts, colours, and positions of *HTML* elements can be defined. Moreover, they allow for the visual adoption of the Web page to a variety of devices and environments, including large screens, small displays or even printers (W3C 2013).

Both *HTML* and *CSS* are developed and maintained by the World Wide Web Consortium (W3C). The W3C is the main international organisation defining standards for the World Wide Web (W3C 2013).

### ***JavaScript***

In general, scripting may be used to determine the behaviour of a Web page and allows a page to become more dynamic. To exemplify this, modifications can be conducted on the content or layout of a page by adding or removing elements, without requiring the page to be reloaded. This is also called *Dynamic HTML (DHTML)*. Besides, scripting facilitates the exchange of content i. e. sending or receiving data to/from other sites or programs without the page to reload - a process described as *Asynchronous JavaScript and XML (AJAX)*. Because of the added interactivity, Websites tend to behave like normal software applications and are therefore often referred to as Web applications. (W3C 2013). In contrast to regular programming languages, scripting is used for small programming tasks. The code does not require any compiling, i. e. pre-processing before it is run; it is directly read by an interpreter.

With respect to Web applications that are executed client-side by a browser, scripting generally refers to program code which is written in *JavaScript* (sometimes shortened to *JS*). *JavaScript* is a lightweight language facilitating object-oriented, imperative, and functional programming style (MDN 2013). The script code is executed by the Web browser as soon as a page is loaded or when an event is called (W3C 2013). *JavaScript* is defined by the *ECMA TC39 committee* as *ECMAScript* and is supported by all modern Web browsers (MDN 2013).

### ***jQuery, jQuery User Interface (UI) and Highcharts JS***

*JavaScript* libraries, also referred to as frameworks, consist of pre-written *JavaScript* code, offering a range of functions and methods for common scripting tasks, including event handling, *DOM* operations and *AJAX* applications (REFSNES DATA 2013). The usage of libraries therefore supports and eases the development of applications.

*jQuery* is a free and open source library, particularly focusing on the manipulation of *DOM* elements, the creation of animations and the handling of *AJAX* (JQUERY FOUNDATION 2013b). Its modular approach and feature-richness facilitate the development of powerful, cross browser Web applications. Built on top of the *jQuery* framework, *jQuery UI* provides a range of widgets, effects and themes to be used for the creation of interactive user interfaces. Thus, in contrast to *jQuery*, which is rather related to *DOM* manipulation, *jQuery UI* is mainly concerned with the graphical user interface. Analogous to *jQuery*, *jQuery UI* is free for usage, belonging to the software license of the *Massachusetts Institute of Technology* (JQUERY FOUNDATION 2013a).

*Highcharts* is designed as a charting library, consisting of pure *JavaScript* (HIGHSOFT AS 2013). The library provides a comfortable way to add interactive charts to a Web application. Thereby various chart types are supported, including (among others) line, column, bar, pie, but also more complex types such as polar, columnrange, areasplinerange, and funnel. In contrast to other libraries of this kind, the advantages are that *Highcharts* works across all modern Web browsers and can be used free of charge in non-commercial projects (HIGHSOFT AS 2013).

## **Python**

The programming language *Python* is a high-level language which accounts for various programming paradigms: imperative, functional and procedural programming, as well as object orientation (PSF 2013). Major strengths of *Python* encompass a clear and readable syntax due to intuitive expressions and the use of indentation instead of braces. Its dynamic data types and exception-based error control allow for a convenient handling of data structures. Besides, the possibility of embedding it as scripting in other applications and the availability of comprehensive libraries makes it useful for various domains. *Python* runs under an open source license, being administered by the *Python Software Foundation* (PSF 2013).

## **Google Maps API and VAO/SVV Web services**

An *Application Programming Interface (API)* is defined as a set of functions and routines (i. e. building blocks) to be used for software application development (OUP 2013). The use of *APIs* allows for the access of data or services from different sources such as databases, operating systems or other applications. Thereby the *API* specifies, how these systems and components communicate with each other (QUIN STREET INC. 2013).

The Web search engine company *Google Inc.* offers several *APIs* to embed different Web services and geographical data of their *Google Maps* product into Web pages and on-line applications. The services are offered as an interface to request the data and to use it in combination with a map (GOOGLE INC. 2013). Particular *Google* services that were applied in this work encompass the *Geocoding API*, the *Places Autocomplete API* as well as the *Directions API*. The *Geocoding API* was used to both transform addresses (e. g. Schillerstraße 8 5020 Salzburg Austria) into geographic coordinates (e. g. 47.8 latitude and 13.03 longitude) and to convert coordinates into human readable addresses. The *Google Places Autocomplete API* in turn was integrated to provide suggestions on complete addresses, based on partial address strings entered by the user. Last, the incorporation of the *Directions API* allowed for the calculation of routes (i. e. travel time and distances) between different locations, accounting for different modes of transport, including car, bike and foot (GOOGLE INC. 2013).

A second source of information which was incorporated as a Web service into the application encompasses the *Traffic Information Austria (Verkehrsauskunft Österreich - VAO)*. VAO is an Austrian wide system providing comprehensive information on traffic (MÜLLER 2013, 2ff.). The basis of this system forms the *Graph Integration Platform (GIP)*, an official reference graph with a consistent, nationwide standard. The graph replaced the individual traffic networks of each federal state, consisting of various reference systems and different acquisition dates (HEIMBUCHNER n. d., 2). It therefore facilitates consistent cross-border routing within Austria. The VAO builds up on this graph, offering collaborative traffic and routing information for all modes of transport (passenger car traffic, public transit, bike, foot) as well as inter-modal combinations (HEIMBUCHNER n. d., 2). The reason for using both the *Google Directions API* and VAO is that the *Google API* offers comprehensive routing information for car-driving, cycling and walking, while it lacks of complete information for public transport (especially bus connections). VAO on the other hand is not yet consistent for car, bike and foot travels, but provides reliable and detailed information on public transit.

In addition, a third Web service was employed to include information on ticket prices for public transport into the application. Based on a chosen route, the respective price for a monthly ticket for adults is queried from the Transport Association of Salzburg (SVV) through the *SVV API*. The operation area of SVV covers the province of Salzburg, as well as parts of neighbouring provinces such as Upper Austria, Tyrol, Styria, Carinthia, and the German administrative district of Berchtesgaden (SVV 2012).

### **SQLite DBMS**

The incorporation of car maintenance expenses for different vehicle categories was achieved through the integration of the *SQLite Database Management System*. *SQLite* is a software library embedded in a relational SQL database engine (HIPP, WYRICK & COMPANY, INC., 2013). In contrast to many other SQL databases, *SQLite* does not involve a separate process being accessed by the client application. Rather, *SQLite* is an integral component of the client application (e. g. the Web browser). All parts of the database, including tables, indices and views are stored in one single database file which can easily be exchanged between different systems and architectures (HIPP, WYRICK&COMPANY, INC., 2013).

### **Server (Apache Web server)**

*Apache* is a software project of collective developers under the auspices of the *Apache Software Foundation* (ASF 2013). The project is targeted on the creation of a stable, high quality and powerful *HTTP* server software. *Apache* runs on modern *UNIX* and *Windows NT* operating systems and goes in line with current *HTTP* standards (ASF 2013).

## **2.5. Objective**

It is the purpose of this work to provide a *Housing and Mobility Cost Calculator* for the province of Salzburg. This Web tool shall demonstrate the relationship between residential locations and induced mobility costs. Thereby not only a qualitative but also a quantitative relation shall be calculated and presented. Besides, the long-term effects of housing and mobility decisions, i. e. the respective long-term development of the costs and their relationship are to be illustrated.

The underlying intention of the tool is to provide residents with independent and qualified information on their possible residential location. Based on their individual travel behaviour and preferences, households shall be given an impression, not only of future housing costs, but especially of mobility costs to be expected. Hence transparency of cost structures and their interdependences shall be enhanced in order to clarify fuzzy cost perceptions. This also includes an increasing awareness of the consequences of a drastic increase of mobility costs (e. g. through raising petrol prices). It is important at this stage that cost transparency is achieved before households actually make their housing decision. This way, the decision process shall be influenced in a sense that it becomes more rational and conscious. Thus, residential relocation shall be induced to reflect the respective location preferences of a household and its members: Households moving to a suburban location should generally be

interested in accessibility by car and green living environments; families moving to urban areas in turn should rather focus on nearby utilities, public transport, and the accessibility of the city centre (HOLZ-RAU ET AL. 2010, 32). In the end, the tool shall motivate households to think about alternatives to peripheral locations. By filling in any perceptual gaps, the strategic goal is to channel peoples' moving behaviour towards structurally integrated settlement structures with good public transport access. Therefore, this approach also supports the general planning demand of concentrating living and working on the cities (ADAM ET AL. 2007, 126). Indirectly, this may also contribute to improved utilisation levels of public transport so that service can be offered profitably (BAUER&WOHLTMANN 2010, 9). However, rather than pointing out these advantages from an overall societal point of view, arguments from the perspective of private households shall be highlighted. In consequence, this shall not only contribute to a more energy and cost-efficient mobility behaviour, but also to an increased residential satisfaction.

Although the *Housing and Mobility Cost Calculator* is primarily aimed at the behaviour and decision of private households, it may also be of interest to stakeholders in the realm of spatial planning. BÜTTNER ET AL. (2012, 508) correctly argue that the interdependencies and relations between locations and induced mobility costs are of high relevance to spatial planners, traffic consultants, regional developers, and public transport agencies. These groups need to be aware of the induced impacts of their planning (VCÖ 2010b, 10). The point is to reduce distances and to increase quality of life in the immediate residential environment through bike and foot paths as well as public services close to the settlements. In this context, the calculator may be used to investigate areas with long daily distances or high mobility costs. To exemplify this: If mobility costs tend to be generally higher in one area compared to another, it might be that public transport is not efficient enough (FRANZ 2010, 25). Hence the calculator may contribute to an assessment of settlement structures and public transport services.

As a third user group, even politicians and public administrations being in charge of zone planning and other official determinations may profit from the *Cost Calculator*. Similarly to the group of planners, these decision makers have to account for mobility effects in order to determine sustainable solutions (BÜTTNER ET AL. 2012, 508). As EIZENHÖFER&SINNING (2009, 140) have indicated, cost calculators may therefore serve internal discussions on land dedication, counteracting peripheral locations and promoting integrated areas. Moreover, the tool may be used to evaluate and adopt current incentive systems. Housing subsidy, for example, influences residential development in Austria significantly (VCÖ 2007, 32) and also impacts on the choice of transport (VCÖ 2010b, 21). While today, the height of this subsidy depends mainly on the energy efficiency of buildings (BLUM 2010, 3), it does not account for the location of the building and induced traffic (VCÖ 2007, 32). This fosters urban sprawl and is particularly a problem, as mobility requires almost as much energy as housing (VCÖ 2010b, 10). SCHRENK ET AL. (2011a, 119) therefore perceptively state that the energy certificate and in consequence housing subsidy should be extended to the mobility component. Thereby the *Cost Calculator* may assist in the process of mobility judgement. In addition to housing subsidy, the concept of commuter tax allowance should be reviewed from an environmental and transport perspective. Currently, it distorts the decision on housing, fostering individual motorised traffic as well as uncontrolled urban development (VCÖ 2010a, 24f.). Thus GANSTERER (2012, 1) makes

clear that it provides wrong incentives and signals, increasing the pressure on commuters and creating dependencies in the long run (GANSTERER 2012, 1f.). In this context, the tool may again be used to evaluate public transport services and the possibility of people to change the mode of transportation. As a result, more sustainable settlement development and a reduction of land-use may be achieved. This is also important in order to safeguard the significant investments that were made in the context of urban restructuring to upgrade core cities (BAUER ET AL. 2009, 122).

## 2.6. Issues not being discussed

With respect to the topic of this work - housing and mobility costs – there is a range of aspects that have relevance or even importance. However, in order not to exceed the scope of this work, not all of these aspects can be covered. Instead, a major focus is set on the exploration of the three hypothesis described earlier, as well as on the conceptualisation and implementation of the calculator. The following aspects are not discussed in this work, despite their close relation and relevance regarding the topic.

Over the last years, a growing body of research has evolved, elaborating on the changing travel behaviour of individual persons over their life course. This emerging field of research is referred to as the ‘mobility biographies approach’ (SCHEINER&HOLZRAU 2013, 432). Thus, according to KREITZ ET AL. (2002, 155) individuals reach certain points in their lives (such as driving licence, household structure or retirement), where certain long-term decisions are made (e. g. purchase of a vehicle, housing decision, change of workplace). These changes and especially their influence on transportation modes, travel distances, and car ownership may directly impact on the daily mobility behaviour. However, specific influences and interdependencies with respect to housing and mobility costs are neither further investigated nor integrated in the calculator. Furthermore, lifestyles, i. e. different ways of life, in combination with certain social factors (age, education, income) and preferences impact on the mobility behaviour of individuals (FRANZ 2010, 70f.). In order to account for this in the calculation of mobility costs, a comprehensive collection and categorisation of lifestyles would be necessary, classifying them according to their daily activities. Especially because of the great variety of today’s lifestyles, this is considered as a separate research field of sociology. Lifestyles are therefore neither covered in this work nor accounted for in the calculator.

Apart from the delineation of the theoretical foundation of this work, there are also some constraints with respect to the *Housing and Mobility Cost Calculator* and its further usage. In the scope of this work, no specific strategies are developed on how the resulting Web application may be published and promoted. This also means that no suggestions are made as to how this tool may be used in conjunction with other consulting services, including personal advisory consultations, a Web page or brochures. In consequence, it cannot be ensured or proven that the result and outcomes of this work provoke any impact in deed. This makes it also difficult to determine, whether or not all of the objectives outlined earlier (e. g. contribute to more rational and conscious decisions) are actually reached.



### 3. Literature Review

This chapter gives an overview on important literature with respect to the topic of this work. For this purpose, a selection of eight publications was chosen; each of these is briefly outlined in the following. Besides, it is illustrated, how the respective study contributed to the foundation and the development of is work.

First, the article of ADAM ET AL. (2008), focusing on the question 'how cities may defy their surrounding area' provides valuable information. In this study, ADAM ET AL. present the results of their research in which they investigate the processes of migration, including the respective reasons, consequences and experiences. Thereby interviews with migrants in different German regions are analysed, focusing on mobility behaviour, the process of migration decisions as well as on later reflections of the decisions. Some of the findings are that most emigrants from urban areas either did not account for increasing mobility expenditures or simply accepted it. In consequence, additional housing and mobility costs were often much higher in the long-run than expected. Besides, problems arose from car dependence and the lack of infrastructure facilities. On the other hand, it is shown that returning emigrants are more aware on their new location and can better assess the consequences of their decision. Among other things, this concerns the close vicinity of a location, infrastructure provision as well as the consideration of future living conditions. Thus, these findings demonstrate the necessity of consultation services. Also, they indicate possible starting points for strategies that aim for a reduction of urban-peripheral movements: By providing relevant information to potential emigrants at the right point of time, the decision of these households may be influenced in a way that it becomes more far-sighted.

Second, BAUER ET AL. (2006) made an important contribution to the collected edition of GUTSCHE&KUTTER – 'Mobility in urban areas. Actor-oriented planning strategies for mobility-efficient conurbations'. Thereby BAUER AT AL. concern themselves with specific decision-making processes of different actors, including municipalities, enterprises and private households. On the one hand it is found that there is a systematic relation between traffic decisions, organisational decisions and location decisions; each of these decisions differs with respect to quality and maturity. In this context, the authors categorise decisions into different levels and illustrate that a decision on a higher level directly impacts on the decisions of a lower level. On the other hand, attention is drawn to the fact that different actors (i. e. municipalities, enterprises and private households) influence each other through their respective decisions relevant to traffic. Hence, in order to foster more sustainable mobility and housing, first of all, the right level of decisions needs to be focused on. Besides, a coordination and cooperation of the different actors' decisions is necessary: Planning intentions that aim for more efficient traffic structures need to be accompanied by the respective usage of these structures. This is where appropriate information and consulting strategies set in. Thus, based on a further elaboration on these relations and interdependences, the criteria and starting points of the *Housing and Mobility Cost Calculator* can be specified.

Third, the investigation of BÜTTNER&WUFHORST (2012) on future housing and mobility costs for private households in the region of Munich provides an interesting approach with respect to scenario use and problem presentation. The authors argue that by

means of striking and comprehensible analyses, awareness on long-term effects of individual housing decisions can be raised. Basing their examination on the 'vulnerability approach', i. e. the indication of risk exposure, the analysis of sensitivity and the assessment of resilience, different districts of Munich are investigated. This facilitates the development of indicators which in turn are used to compare different areas with each other. Finally, using scenario techniques, most affected locations in case of severe price increases for mobility are identified. Thereby various assumptions are tested for three different investigation municipalities, demonstrating significant differences in vulnerability. It becomes clear that the characteristics of surrounding settlement structures, the availability of infrastructure facilities as well as the everyday mobility behaviour of the family members have a great influence on costs. Thus, in summary, this study illustrates an impressive way of communicating possible future developments and respective consequences. It demonstrates a suitable way to catch the attention of citizens and to sensitise them on the topic of mobility costs. Therefore, this approach is used as a foundation for presenting the results of this study.

Further, GERTZ&ALTENBURG (2009) elaborated on the chances and risks of increasing mobility costs for urban and regional development. Acting on the assumption of growing dependences on cars and steadily raising costs for mobility in the future, the affectedness of households is analysed. Besides, a description is given of households' reactions that are to be expected due to these increases. Based on these conditions, challenges for transport policy and the political pressure to act are emphasised. Thereby GERTZ&ALTENBURG also make clear that a post-fossil change may come along with new possibilities: Different options of an integrated traffic and settlement planning are outlined. Moreover, post-fossil strategies with respect to a more sustainable development are proposed. In summary, it can be concluded that the article provides some valuable approaches with respect to the topic at hand. In particular, it offers a base for the investigation of spatial planning and its influence on mobility, as well as for the identification of households' influence on mobility.

Furthermore, HOLZ-RAU ET AL. (2010) published a book on residential location information for private households, where foundations and experiences from their research project 'Integrated residential location information as a contribution to the reduction of land use' are described. Therein HOLZ-RAU ET AL. elaborate on the topic of settlement development and location decision, looking into the changes that happened over the last decades. Besides, the study inquires into reasons for structurally integrated locations from a household's point of view. This comprises research on location preferences, location satisfaction and on the question whether suburban migration arises from a wrong perception of space. Further, different experiences that were gained from location and mobility consultations are outlined. Thereby different kinds of consultation approaches are described. Finally, a major focus of the work is put on instruments that have been developed for municipalities during the project period. Framework conditions, communication approaches and an evaluation of the instruments are presented. Thus, given these investigations, this work provides relevant findings for both the theoretical foundation as well as the practical implementation of this thesis. Especially for the identification of possible approaches to influence the location decision of households, this study offers useful arguments.

In his dissertation, KIM (2004) focuses on the 'Location Efficient Value as a tool for influencing home location choice towards public transport corridors'. Referring to a

financial incentive system in the US, the work is concerned with ways of directing the housing decision of citizens: In some American cities, mortgage lending accounts for transport cost savings, resulting from the location of real estate nearby public transport services. Thus, the closer a real estate being bought is located to public transport the cheaper a mortgage can be lent. Given this concept, German housing markets and their relation to transport accessibility are analysed. Based on the findings, possibilities are explored of transferring this incentive system to German cities. With respect to his theoretical analysis, KIM expands upon various interdependences between land use and traffic. In this context, the relation of public transport accessibility, land prices and mobility costs is examined. This encompasses previous research findings of relationships and the dependence of housing costs on public transport accessibility. The methods and models which KIM applies as well as his findings on the different relationships are especially useful for the investigation of cost patterns in space. Furthermore, they provide valuable information on the influence of spatial planning and households' decisions on mobility aspects.

ALBRECHT ET AL. (2008) wrote an article on housing decision, mobility costs and climate change, illustrating results from a REFINA research project on cost transparency. The authors argue that housing costs have a strong influence on the decision-making process on housing, while mobility costs, land use and environmental effects are often suppressed. By trying to make mobility costs more transparent to households, the intention is to positively influence land use, CO<sub>2</sub>-emissions and other environmental impacts. Therefore ALBRECHT ET AL. research on the relation of housing decisions and mobility costs as well as on influences on the mobility behaviour of both household and location specific factors. The interpretation of empirical surveys in the city of Hamburg thereby facilitates the comparison of costs at different locations, namely in the core city, surrounding municipalities, and rural communities. In addition, using model calculations for the accounting of costs, various types of housing at diverse sites and with different square meters of living space are opposed to each other. Thus, dealing with the same problem and following a similar approach, the article contributes to the investigation of cost relations in this work. Also, it provides an example of illustrating cost differences, depending on different locations to households.

Last, the study of FRANZ (2010) deals with a very similar topic and task, as the thesis at hand does. In her work entitled as 'The Mobility Pass for Real Estate', FRANZ is concerned with the conceptualisation of a mobility cost calculator. In order to define the concept of the tool, a comprehensive review of existing mobility calculators is undertaken and respective shortcomings are identified; based on that, further enhancements are developed. That approach brings a lot of advantages, as there is already a range of housing and mobility cost calculators available and in use. Despite the fact that some of these differ quite significantly from each other, there are useful elements and features to be found in most of them. Thus, rather than developing the calculator from scratch, solutions and approaches that prove beneficial can be taken and developed further. This is also the intention of this work. Therefore the method of FRANZ provides guidance to the conceptualisation of the *Housing and Mobility Cost Calculator* for the province of Salzburg. However, rather than implementing the same concept as FRANZ, additional thoughts and ideas are developed on put on top.

## 4. Theoretical Foundation

This fourth chapter represents the theoretical foundation of the thesis. It elaborates on expressions, relations, and influences with respect to mobility and therefore provides the frame for the practical implementation of the *Housing and Mobility Cost Calculator*. In the first section, relevant terms are clarified (chapter 4.1.). This encompasses the definition of a 'household', the semantics and levels of 'mobility' (including trips, trip purposes, and modal split), 'traffic' (being caused by public and private transport) as well as the scope of 'costs', consisting of both monetary and other expenditures. In the second section, the hypothesis made concerning cost patterns is investigated (chapter 4.2.). Therefore ALONSO'S model is used to examine the development of prices for both building land and mobility in space. In this context also the relation of the sum of both cost components is inspected in order to explore the assumption that housing and mobility costs may eventually balance each other out. The third section consists of mobility and the different levels that exist, namely the macro, meso, and micro level (chapter 4.3.). Thereby influences, relationships, and actors on these three stages are looked into. Thus, on the macro level, spatial planning (including respective mobility concepts and the determination of settlement structures) is the most crucial influencing factor. Hence a rough overview on the planning system in Austria is provided, including respective actors, instruments, and tasks. On the meso and micro level in turn, individual factors of households as well as different long- and short-term decisions are found to have significant influence. Further, decisions on the place of residence are analysed, covering the decision-making process on housing as well as the identification of most important decision criteria. This is important in order to inquire into the second hypothesis made – the difficulty for private households to comprehensively assess housing and mobility costs in the long-run. Apart from that, possible reactions of households on rising mobility costs in future are outlined. Both of these investigations (on housing decisions and possible reactions) are necessary in order to contextualise the *Housing and Mobility Cost Calculator* in the spatial planning process and to close the application off from other tools and instruments that exist in the field of planning. This temporal and actor-specific allocation of the calculator as well as the definition of its actual starting point is undertaken in the last step (chapter 4.4.).

### 4.1. Definition of Terms

#### Private household

In the following, a private household is understood as a group of persons who are related or who have at least a personal relationship with each other (ZÄNGER 2000, 27). These persons share an income and consume together; thereby they must have at least one income and have to be fully or at least predominantly supplied through a common housekeeping. Thus, also an individual with his/her own income that keeps house on his/her own is seen as a private household. In addition to these economic conventions, ZÄNGER (2000, 27) found that the private multi-person household provides a social-psychological framework for everyday activities and leisure time.

## Mobility

Mobility is an integral part of citizens' everyday life; in common language it has the meaning of being flexible, capable of acting and getting quickly from one place to another (FRANZ 2010, 19). However, from a scientific perspective, the term becomes more ambiguous. In this respect, mobility may refer to disparate meanings, depending on the context in which it is used. In the following, an overview is given on the various semantics of the term, as well as on the respective levels that exist. Figure 7 illustrates this differentiation and highlights the specific meaning of mobility that is used in the context of this work.

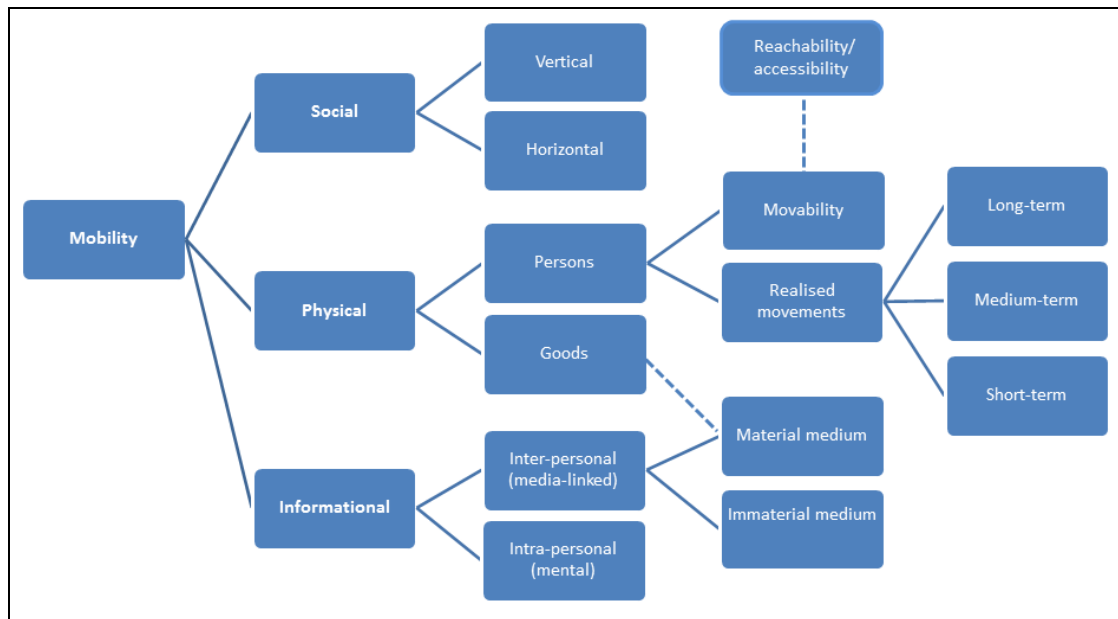


Figure 7: Semantics and levels of mobility (author's design, based on ZÄNGER 2000, 20).

Reference to ZÄNGER (2000, 19) reveals that mobility can be divided into movements of persons/goods in a purely physical as well as in a social or informational way. With respect to social mobility, vertical mobility (between different layers of society) and horizontal mobility (between societal groups within one social layer) can be distinguished (RITTER 2005, 654). In the sense of informational mobility in turn, a separation between mental mobility of an individual (intra-personal) and media-linked information exchange between individual persons (inter-personal) is possible. Further, depending on the kind of media, the information exchange may be realised without the transport of material or it may be tied to physical means of conveyance. In this context, Figure 7 indicates that the latter way overlaps with the actual physical mobility of goods (ZÄNGER 2000, 20). The actual focus of this work is set on the third meaning of mobility, the physical mobility of persons (and goods) in geographic space. As HAMMER&SCHEINER (2006, 18) point out, mobility in this context encompasses both realised movements and movability, that is the potential to move. Thereby the potential arises not only from the movability of actors themselves (as consumers), but also from the accessibility of destinations (i. e. offers) (HAMMER&SCHEINER 2006, 18). This relationship is further described in one of the following paragraphs and indicated in Figure 8. With respect to physical mobility, FRANZ (2010, 19) and ZÄNGER (2000, 20) make clear that a further differentiation regarding the nature of mobility is useful.

Therefore physical mobility of persons can either be long-term, medium-term or short-term. Long-term mobility, also referred to as migration mobility, includes long-term (de-)localisations i. e. movements of households. This covers the willingness and the activity of moving, but also the decision on housing. Medium-term mobility is concerned with temporary and reversible location changes such as holiday trips (also called holiday mobility). Short-term mobility in contrast comprises everyday mobility, which consists of daily or periodic location changes. As RITTER (2005, 655) found, these changes result from the spatial separation of basic life functions such as life, work, shopping and leisure. Both everyday mobility and long-term mobility, more precisely, the decision on housing are further investigated in this work.

In the context of everyday mobility, a trip may be referred to as a single travel of a person that is away from home, moving from one place to another by any means of transportation (INFAS&DLR 2010, 16). Thus, 'going' and 'returning' are seen as two separate trips. In case that means of transportation are changed during one trip (e. g. making use of park and ride), the travel still remains a single trip. Depending on the underlying reason, travels are generally distinguished into travels to work, official/business trips, educational travels/school, travels for shopping, travels back home and other trips (INFAS&DLR 2010, 16). Further, the 'modal split', describes the share of different means of transportation for certain trips (ZÄNGER 2000, 21). Thereby means of transportation generally encompass public transport, motorised individual transport, bike, foot and respective combinations (MITTER 2011, 142).

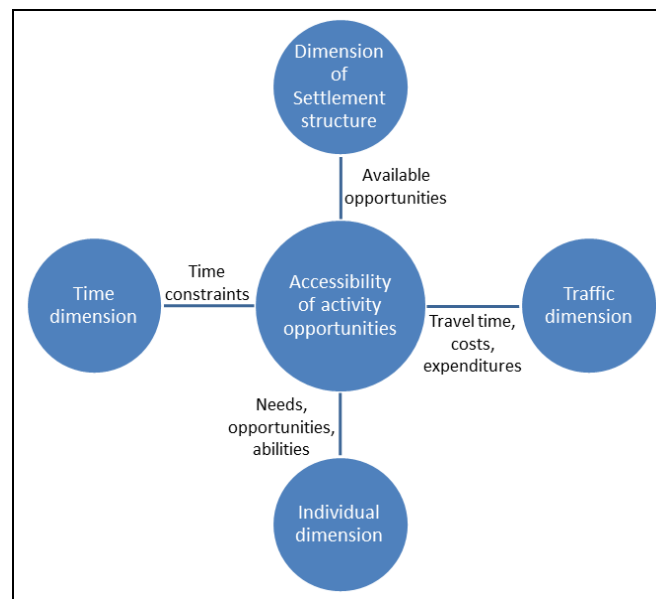


Figure 8: Different dimensions of reachability (author's design, based on GERZ&ALTENBURG 2009, 785).

To sum up, 'mobility of private households' in this work is understood as potential change in the location of household members within a certain time period in order to satisfy specific purposes or needs. Therefore mobility is seen as the possibility of overcoming space. This definition is distinct from the meaning of reachability/accessibility: Turning to GERTZ&ALTENBURG (2009, 785), one finds that reachability refers to concrete activities and assesses the expenses which are necessary in order to reach certain places. Thereby not only geographic distance, but also other aspects such as monetary costs or time expenditures are taken into account.

Figure 8 summarises the different levels of reachability, consisting of the dimension of settlement structure, traffic dimension, individual dimension and time dimension. As GERTZ&ALTENBURG (2009, 785) point out, each of these levels brings particular restrictions regarding the accessibility of certain activities.

### **Traffic**

In contrast to potential movement, 'traffic' is defined as the actually realised changes in location of people and goods (GERTZ&ALTENBURG 2009, 785). ZÄNGER (2000, 21) describes it as the measurable flow of transported units on a particular route within a certain period of time. Based on this definition, traffic may be understood as the resulting size of the mobility of individuals. Hence traffic ratios may be calculated by adding up key figures of the mobility of people in a geographic area, taking account of commuters coming in and going out (ZÄNGER 2000, 22). The work of HAUTZINGER ET AL. (2004, 3) reveals that contrary to many other consumer markets, the vast majority of services being required in the transport sector are in fact produced by the household members themselves (individual traffic), rather than bought on the market (public transport).

Public transport (PT) is a transport system that runs on specified routes and at predetermined times. For these routes and times, being specified in a schedule, operation is obligated (RITTER 2005, 735). In contrast to individual traffic, transport is carried out collectively, i. e. groups of people who do not belong together, are transported in one vehicle. According to RITTER (2005, 735), PT encompasses different subsystems such as regional train, tram, subway, light rail, urban rail, bus, and gondolas. Individual transport on the other hand used to refer to singular motorised traffic, namely passenger car and motorcycle (RITTER 2005, 674). In the 1970s, this understanding further expanded and also comprised non-motorised individual modes of transport, including pedestrian and bicycle traffic. Thus, today, a distinction between motorised individual transport (MIT) and non-motorised transport (NMT) is common (FRICK n. d., 1). From the perspective of users, MIT is the most convenient and fastest means of transport, especially for regional travel. Moreover, MIT can also be used for longer distances (in contrast to NMT) and is available at any time (as opposed to PT). Therefore RITTER (2005, 675) correctly points out that competing with other modes of transport, MIT has the advantages of high spatial and temporal availability. However, as it was outlined earlier, a growing influence of MIT leads to settlement in ill-equipped areas, causing increasing dependence on it. In this context, turning to SIEDENTOP ET AL. (2013, 331), one finds that it still remains unclear, to which extent car dependence can be understood as an objective restriction of the usability of alternative transportation (e. g. walking, biking, public transport). Restriction may be caused for example by the complete lack of alternatives or by essential disadvantages of other modes of transport, compared to MIT (e. g. loss of time). This form of structural dependency on MIT is what can be referred to as 'car dependence' (SIEDENTOP ET AL. 2013, 331). However, studies in Germany (INFAS&DLR 2010, 129) indicate that persons making daily use of their car assess public transport services significantly worse than people who use their car less often. Therefore it may be assumed that car ownership solidifies travel mode choices and thus may come along with the suppression or distorted perception of alternative travel modes. This kind of dependence, resulting from rather subjective impressions, neglecting alternative travel modes is commonly described as 'car reliance' (SIEDENTOP ET AL. 2013, 331).

## Household expenses

The expenses of households may roughly be categorised into three different types. As Figure 9 illustrates, these types include costs for housing, mobility costs and other means of subsistence. The latter costs, comprising (among other things) expenses for food, clothes, leisure time and other goods and services, is not subject to this analysis and therefore not further inspected. Moreover, it needs to be emphasised that starting from all the costs that arise for housing and mobility, only those are listed that directly concern households themselves. As SCHEINER (2008, 53) points out, this only encompasses internalised cost components in contrast to the externalised costs which are borne by the rest of society. For the mobility sector, these costs are shown in Figure 4, in the chapter on the Problem Description.

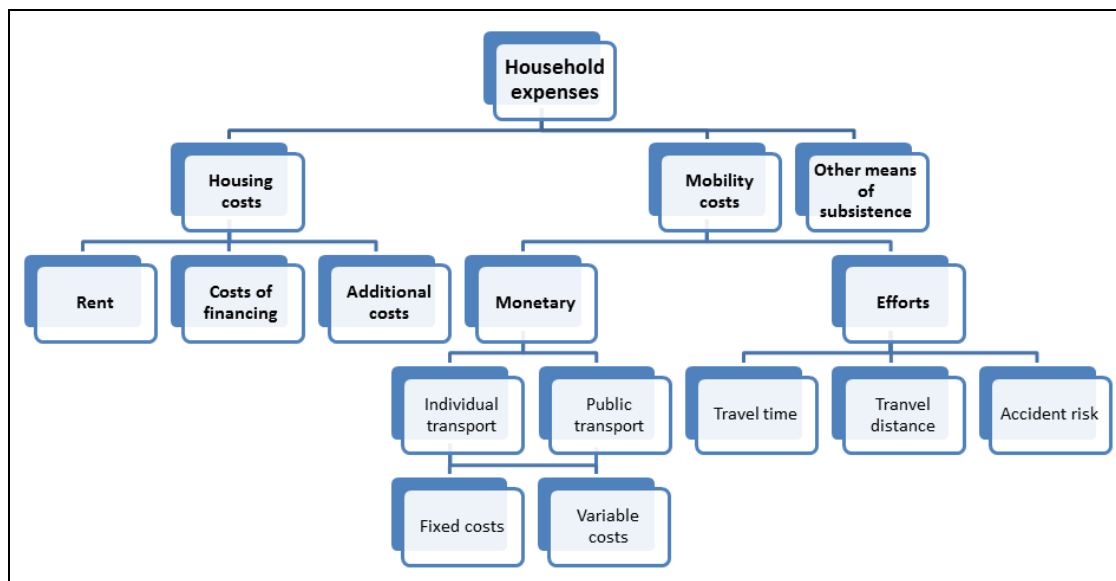


Figure 9: Cost structures of a household (author's design, based on KIM 2004, 31).

## Housing costs

With respect to housing, rental prices or – in the case of real estate purchase – costs of financing as well as additional housing costs may be identified (BSI 2011, 10). Especially rental prices (or respectively costs of financing) are often-times the most important financial criteria for a housing decision. In the event of real estate purchase, the so-called 'land price' refers to the price for the piece of land which is for sale. Research by SINNING ET AL. (2009, 35) suggests that the costs which are included in the land price may vary significantly. As the authors note, they may consist of the land value, land costs (e. g. land transfer tax, notary and register fees, and surveying fees), costs for vacating rights of third parties (such as rights of way), finishing costs (e. g. elimination of contaminated sites, vegetation or old buildings), development costs (supply and disposal, street) and the profit margin of the supplier. Thus, the estimated land price is the sum of several, or even of all mentioned factors. Thereby the overall price is greatly dependent on the size and the equipment of the house/apartment. SINNING ET AL. (2009, 35) correctly argue, that these parameters have no relevance with respect to the transparency of the costs since they do not primarily depend on the location. Nevertheless, for comparing locations with each other, it is still important to account for this factor in order to correctly present the ratio of residential and mobility



costs. In case the purchase is covered by a credit, costs of financing need to be accounted for. This involves the total sum of credit costs, the effective interest rate, and the years of maturity. Moreover, additional housing costs may comprise expenses for heating, phone, and electricity, to name a few.

### **Mobility costs**

As presented in Figure 9, mobility costs can be separated into monetary costs and other expenses. Both of these costs may be seen as follow-up costs of a housing decision since they directly depend on the location of the residence (SINNING ET AL. 2009, 36). Regarding the monetary expenses of mobility, a further distinction between the costs for motorised individual transport and those for public transport can be made. For each of these components again fixed and variable costs can be identified. As KIM (2004, 29) points out, fixed costs for MIT may encompass loss in value, taxes, and insurance. Variable MIT costs in turn may include costs for repairing and running costs such as maintenance, fuel, and oil. Thereby variable running costs directly depend on the distances driven (KIM 2004, 29). With respect to public transport, fixed costs may cover costs for season ticket or any other subscriptions; variable PT charges apply for occasional travels which are not covered by season tickets. Thus variable costs for both MIT and PT rely on the frequency and the length of travels with the respective means of transport. In this context, RITTER (2005, 675) correctly argues that the costs structure of motorised individual traffic, consisting of high fixed costs (e. g. purchase and loss in value) and rather low variable costs fosters the priority use of car. This tendency is further reinforced due to the tariff structure of PT, causing high variable costs for infrequent usage. For trips by bike or on foot, no mobility costs are listed in Figure 9. In a study of these costs, SINNING ET AL. (2009, 36) found that these expenses are rather marginal (e. g. shoes, bicycle tube) and may be neglected in this context. Hence, summing up, monetary mobility costs of households are primarily determined by the number of cars, distances being covered with them and the use of public transport services (ALBRECHT ET AL. 2008, 95).

Various studies were undertaken, investigating the portion of mobility costs on the total budget of a household. While HAUZINGER ET AL. (2004, 198) found that in 1998, households in Germany spent 9 to 11% of their income on mobility, research by MEGA (2013, 91f.) suggests an average spending of European households in 2007 of 13%. SCHRENK ET AL. (2011b, 1310) have expressed a similar view. According to them, 15% of of an Austrian household's budget in 2009/2010 were dedicated on mobility. In terms of absolute numbers, the VCÖ (2013, 22) investigated average household expenses on mobility for the nine provinces in Austria. While least money was spent in Vienna (approx. 4,115€ per year), households in Lower Austria paid about 6,120€ per year. In Salzburg, 5,330€ were invested on mobility, which is equal to 445€ per month. Further, looking at the long-term development of mobility expenses over the last years, it can be observed that these costs have gained importance due to raising oil prices and increasing taxes. SINNING ET AL. (2009, 36) make clear that the trend of the last decades, consisting of increasing housing and stagnating or (compared to the general inflation rate) even declining mobility costs, has changed into the opposite. This is also indicated by an investigation of the (VCÖ 2009, 18): Between 1995 and 2005, spendings on mobility of Austrian households have risen by 3.5% per year on average. Thereby costs for motorised individual traffic have even increased above average.

Beside these monetary costs, mobility comes along with other kind of efforts. In Figure 9, these are listed as expenditures of time and distances, but also accidental risks (SCHEINER 2008, 53). Similarly to variable mobility costs, these expenses depend on the length and frequency of travels. However, SINNING ET AL. (2009, 36) perceptively state that these efforts are perceived and assessed differently by each person. Consequently, they can hardly be expressed in monetary terms. Rather, the sum of time, distances and risk expenditures needs to be interpreted individually and may be assessed with respect to leisure time activities or working hours.

## 4.2. Investigation of Cost Structures in Space

With reference to the hypotheses presented at the beginning of this work, this section investigates the existence of particular cost patterns in space for both housing (land prices) and mobility (public and individual transport). Thereby the dependencies and variations of both components are analysed as well as their mutual relationship. Further, the long-term development of real estate and car equity is inspected.

### Land price patterns

A suitable theoretical approach for investigating the distribution of land prices in space is provided by ALONSO's land use model (ALONSO 1964). The model is based on the assumption of a simple, mono-centric city in a flat area, comprising a transport system that spreads in all directions. All workplaces, goods and services are located in the centre of the city, the central business district (CBD) (ALONSO 1964, 139). Therefore all private households work and consume in the CBD. As presented in Figure 10, these assumptions may be illustrated in a schematic allocation of space: The CBD can be differentiated from areas along the transport axes and the region in between the axes.

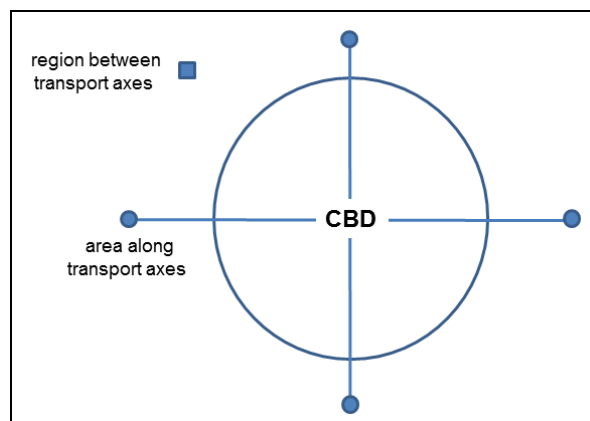


Figure 10: Schematic representation of ALONSO's model of an ideal-typical allocation of space (author's design, based on KIM 2004, 10).

For each location in this space, a particular land price exists (ALONSO 1964, 141). The development of this price structure is represented as curve  $P(t)$  in Figure 11.  $P$ , referring to the respective land price, decreases with increasing distance from the city centre. This is due to the fact that commuting costs decrease for locations which are closer to the CBD, making these locations more attractive compared to areas further

out. This in turn leads to a land price differential from the CBD to surrounding areas and thus to an inverse relation between land price and distance. Research by KIM (2004, 26) suggests that a reduction of commuting cost and an increase of income over time results in an expansion of the urban area and hence to a reduction of the land price differential. This change is illustrated by the dashed curve in Figure 11.

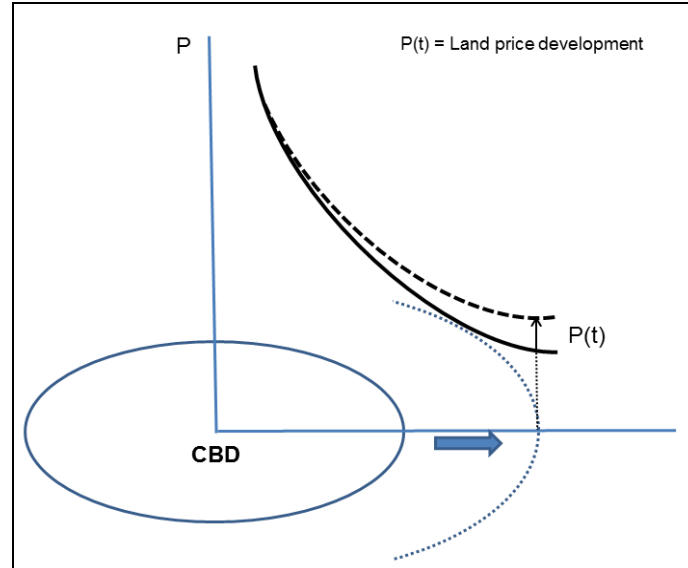
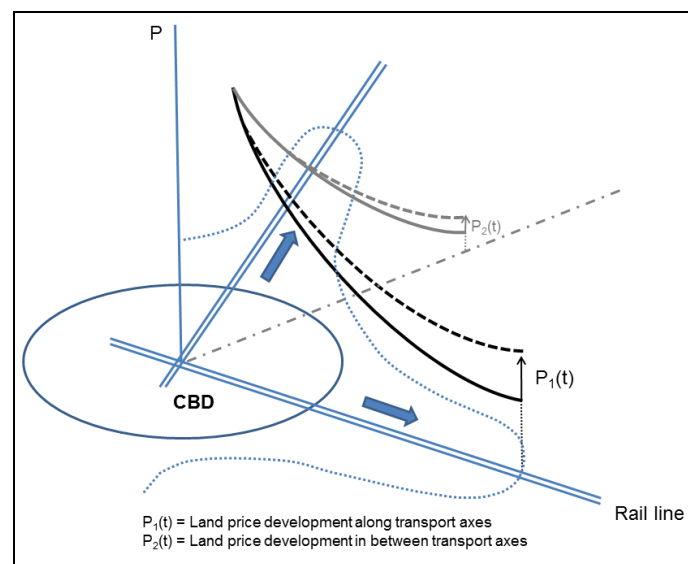


Figure 11: Expansion of the urban area and land price development (author's design, based on KIM 2004, 26).

With the development of railway lines, a further expansion of the urban area is primarily happening along these transport axes. This is due to the decreased commuting costs in these areas. As KIM (2004, 26) argues, the urban expansion along the railway lines leads to an increase of land prices in these areas and again to a decreased land price differential. This process is shown in Figure 12 (top). Thereby land prices tend to increase most in the immediate surrounding of stations (Figure 12, bottom). Thus, public transport comes along with an increasing value of the land, both in residential and commercial areas (KIM 2004, 27). In areas that are located in between transport axes, the reduction of land price differential is significantly lower - land prices increase less.



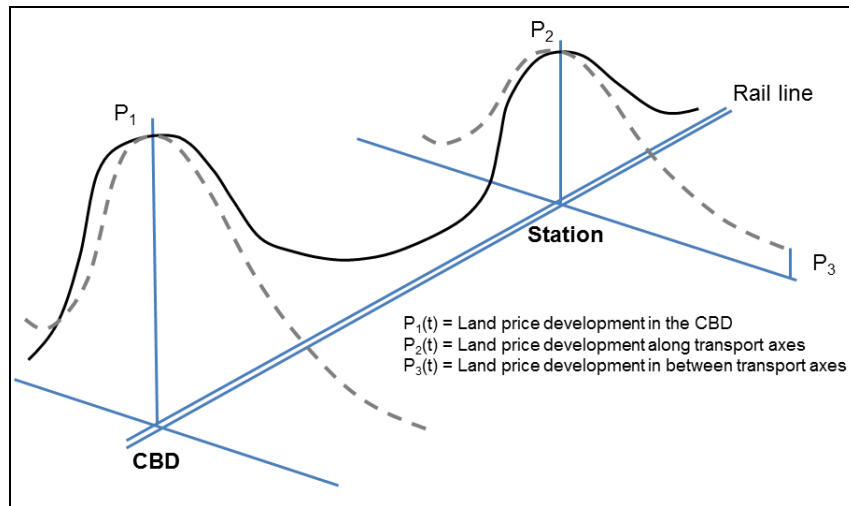


Figure 12: The influence of public transport lines on land prices (author's design, based on KIM 2004, 26/28).

Based on the investigations through ALONSO's land use model, it must be recognised that the infrastructural development and access of a location directly impacts on its attractiveness. This in turn influences the ratio of demand and supply and hence the development of land prices. Thus, the closer a site is located to the CBD and the better the transport connections are, the higher the land prices. Studies from Germany (BSI 2011, 11) support this finding. As Figure 13 displays, monthly rental prices in different municipalities in the metropolitan area of Munich are highest in the city centre of Munich. Apart from some exceptions it can be found that with increasing distance from the centre, prices decrease. However, they remain higher along public rail lines, compared to areas in between these axes (Figure 13). Also the work of KIM (2004, 118) supports this pattern, revealing a similar result for the region of Hamburg.

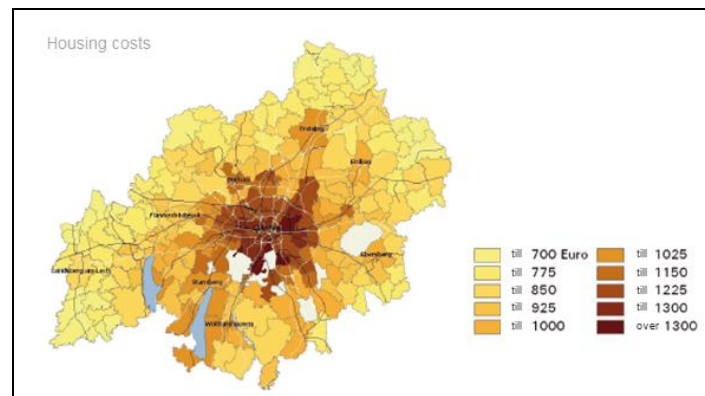


Figure 13: Average housing costs for different municipalities in Munich (adopted from BSI 2011, 11).

### Cost patterns of mobility

An empirical study of ALBRECHT ET AL. (2008, 95) on an income and expenditure survey in Germany in 2003 indicates some interesting results concerning car ownership and spendings on mobility, depending on residential location: While in city centres about one third of the households did not own a car, this only applied to 6.8% in rural municipalities and to 15.8% in suburban areas. Further, households owning more than one car comprised 12% in urban, 23% in suburban and 40% in rural areas. Thus, the

more isolated and the worse equipped a residential location is, the more cars are needed. In consequence, as illustrated in Figure 14, this leads to distinct differences regarding the portion of fixed costs for mobility at different locations: Expenses for car purchase, car taxes and other fixed costs are significantly higher in suburban and rural areas, compared to the overall average or the respective shares in core city areas. Further, locational differences exist regarding variable mobility costs. According to ALBRECHT ET AL. (2008, 95), households living in peripheral locations spend almost twice as much on running costs for their cars as compared to households in the cities (Figure 14). This is also influenced by the fact that most trips of private households start and end at home (BÜTTNER ET AL. 2012, 507). Thus, the further a house is located in the countryside, the longer the respective travels are to get to the next service facilities or working place. In contrast, daily travels are shorter for locations that are close to the city centre. Hence the longer the trips, the higher mobility costs for mobility. With respect to the costs for public transport, the cost structure changes into the opposite: Expenses are highest in urban areas. However, these costs only comprise a very small share on the overall mobility expenditures (Figure 14). Thus, referring to HAUTZINGER ET AL. (2004, 199), it can be agreed that car owners are also users of their cars. Once the threshold of buying a car is crossed, the vehicle is also used in everyday life. In conclusion, this means that mobility costs are lowest in central locations with good local supply and efficient public transport services. A lack of public transport supply is generally compensated by higher car use and therefore increased mobility costs (KIM 2004, 98).

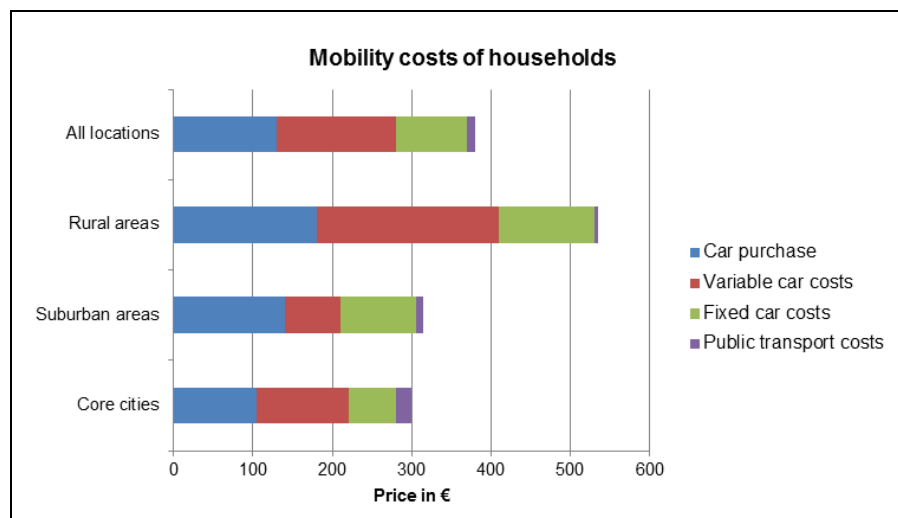


Figure 14: Share of different mobility costs depending on residential locations (author's design, based on ALBRECHT ET AL. 2008, 96).

Referencing back to the study that was undertaken in Munich (BSI 2011, 11), these findings are confirmed. As Figure 15 portrays, mobility costs are lowest in the core city of Munich. Besides, municipalities which are connected to rail traffic show cheaper mobility prices as compared to rural areas, which are located away from transport axes.

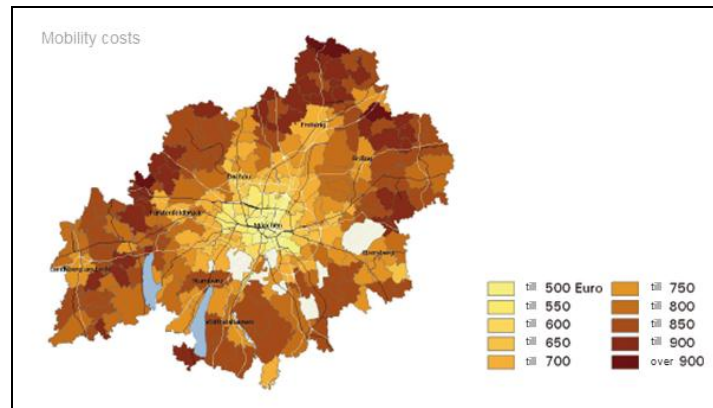


Figure 15: Average mobility costs for different municipalities in Munich (adopted from BSI 2011, 11).

### Relation of land and mobility prices

It was depicted earlier that residential locations which are placed in the close vicinity of rail stations come along with higher land prices on the one hand and lower mobility costs on the other hand. Both cost components weigh on the household's budget. Therefore the question arises, which relation these costs have to each other. A schematic illustration of this relationship is presented in Figure 16. Turning to KIM (2004, 32), one finds that the difference in land/housing prices at a location nearby rail transport ( $H_1$ ) and a rural location, away from transport axes ( $H_2$ ), may be expressed as  $H_{12}$ . This difference may be contrasted with the savings of mobility costs ( $S_1$  and  $S_2$ ) at the respective location, also referred to as *Location Efficient Value (LEV)* (KIM 2004, 32). The sum of *LEV* and other value effects ( $O$ ) at  $H_1$  is comparable to the difference in housing costs ( $H_{12}$ ). Thus, depending on how high the difference of the respective housing costs is and how much mobility costs may be saved at a more central location in the long-run, the overall costs may be less at more central locations.

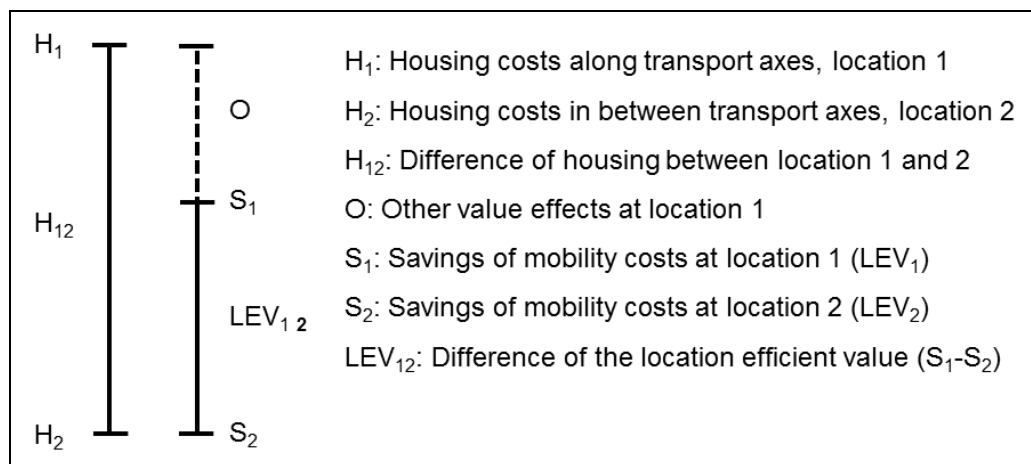


Figure 16: Housing costs and mobility savings at two locations (author's design, based on KIM 2004, 32).

In this context, a study of housing and mobility costs at various locations in the metropolitan region of Hamburg in 2003 demonstrates some interesting results (Figure 17). Annual housing and mobility costs are summed up for residential sites ranging from very central to very peripheral locations. Following the direction from central to peripheral, the described trend of decreasing housing prices on the one hand

and increasing mobility costs on the other hand, clearly stands out. However, most notable is the fact that the sum of both cost components does not decrease towards peripheral regions. Rather, with approx. 19,000€ compared to 18,900€ per year, very peripheral locations are even slightly more expensive than very central sites. The cheapest overall costs were identified in locations close to the city centre with about 17,600€. Here, the advantages of good public transport access (leading to reduced mobility costs) and cheaper land prices (compared to the core city) are combined.

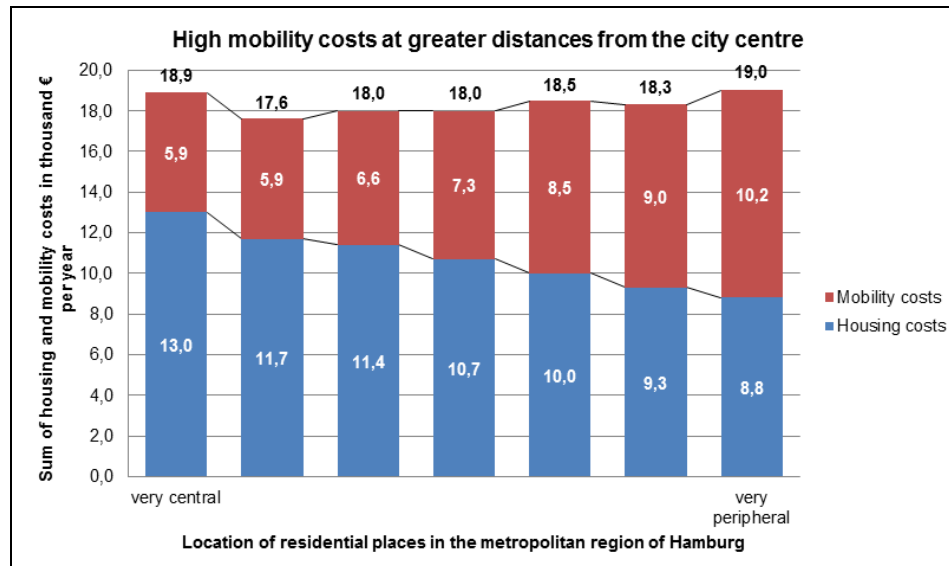


Figure 17: Housing and mobility costs depending on centrality (author's design, based on VCÖ 2010b, 18).

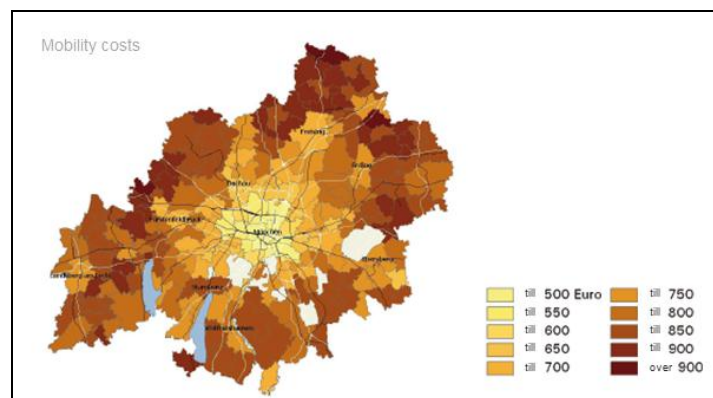


Figure 18: Sum of housing and mobility costs in Munich (adopted from BSI 2011, 11).

These findings partly go in line with the results found in the region of Munich. As shown in Figure 18, the overall costs of housing and mobility are highest in the surroundings of the core city area and in touristy regions (e. g. around the Starnberger See). The core city itself is not indicated as the most expensive place to live at. In contrast to the findings in Hamburg, lowest overall expenses can be found in rather rural areas. However, as it was found by the BSI (2011, 14), on the one hand, this is due to the fact that land prices (i. e. housing costs) in the core city of Munich are exceptionally high, causing higher land price differences between the city and suburban areas. Hence, mobility costs have a lower share on the overall costs. On the other hand, it must be emphasised that taking into account the described problem of peak oil and raising

energy costs, significant increases of mobility costs are to be expected. Thus, the situation of cheapest overall costs in rural areas is likely to change in future. This is due to the fact that areas with no or little mobility alternatives will be mostly affected by mobility price increases.

### Long-term development of real estate and car values

Apart from the monthly or annual costs for housing and transport, also the long-term value development of both real estate and cars needs to be considered. HOLZ-RAU ET AL. (2010, 51) correctly argue that especially for households who buy real estate, the long-term value development of the property is relevant. Already today, an automatic increase of property value is not self-evident and the risk of value stagnation or even reduction increases, looking at a stagnating or shrinking population numbers. Thus, as HOLZ-RAU ET AL. (2010, 51) point out, the crucial aspect in this context is the location of the property. More precisely, this means that value increases may be expected in regions with a strong economic sector and positive population development. At the macroscopic level, this requires suitable transport connections, as well as convenient infrastructure facilities nearby (e. g. local supply, schools, kindergartens, park areas, etc.). These conditions are usually to be found in urban areas with moderate to high social standards (HOLZ-RAU ET AL. 2010, 51).

In his study, KIM (2004, 111) differentiated between two types of households: On the one hand there are households investing less money into estate property (e. g. house purchase in more rural areas) and therefore more into transportation means (e. g. additional car purchase). On the other hand there are those who spend more on real estate (e. g. property in a central location) and respectively less on mobility (e. g. public transport usage). According to KIM (2004, 111), the latter group encounters advantages in the long-run. As a reason, KIM refers to the long-term expenditures and the respective equities of both real estate and car ownership. This relation is illustrated in Figure 19, where respective developments in the US are estimated over a period of 10 years. Depending on the conditions of the credit and the location of the property, the exact development may variate. However, the general trend is that the equity of a car is characterised by a significant decrease, whereas real estate property being placed in a good location generally grows in value.

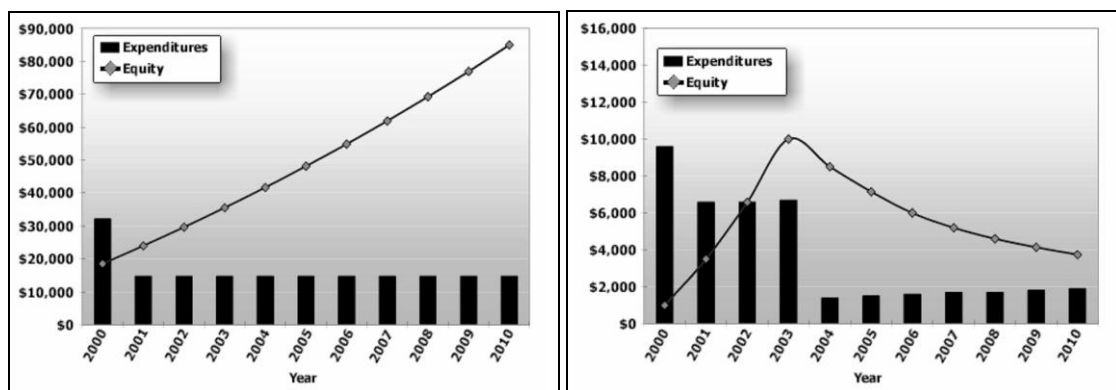


Figure 19: Long-term expenditures and equity development of real estate and car ownership (KIM 2004, 112).



### 4.3. Different Levels of Influence on Mobility

The mobility of households, i. e. the potential changes of household members in location in order to satisfy specific purposes or needs, depends on several factors and decisions. As FRANZ (2010, 20) found, these factors/decisions exist/take place on three major levels of mobility, namely the macro, meso, and micro level. An overview on these stages, as well as on the respective decisions, factors, and actors is presented in Figure 20. As it is shown, the macro level of mobility is influenced by the realm of spatial planning and the laws, plans and programs that are established in this context. Therefore this level of mobility concerns first and foremost spatial planners and decision makers. By determining the development of settlements, as well as spatial structures and transport systems, this level defines the overall spatial and functional scope for the meso level of mobility. This second level concerns households and is defined by various socio-economic and socio-demographic factors of the respective household, as well as by long- and medium-term decisions which are made concerning mobility. At last, the micro level refers to the everyday mobility of single persons. The individual scope of this level is determined by the meso level. Besides, this level of mobility is affected by short-term decisions, activities, needs, and partialities of individual persons. Thus, the structural conditions at a location together with specific destinations define the individual spatial scope of households. This scope in turn represents the long-term frame for short-term decisions concerning everyday mobility.

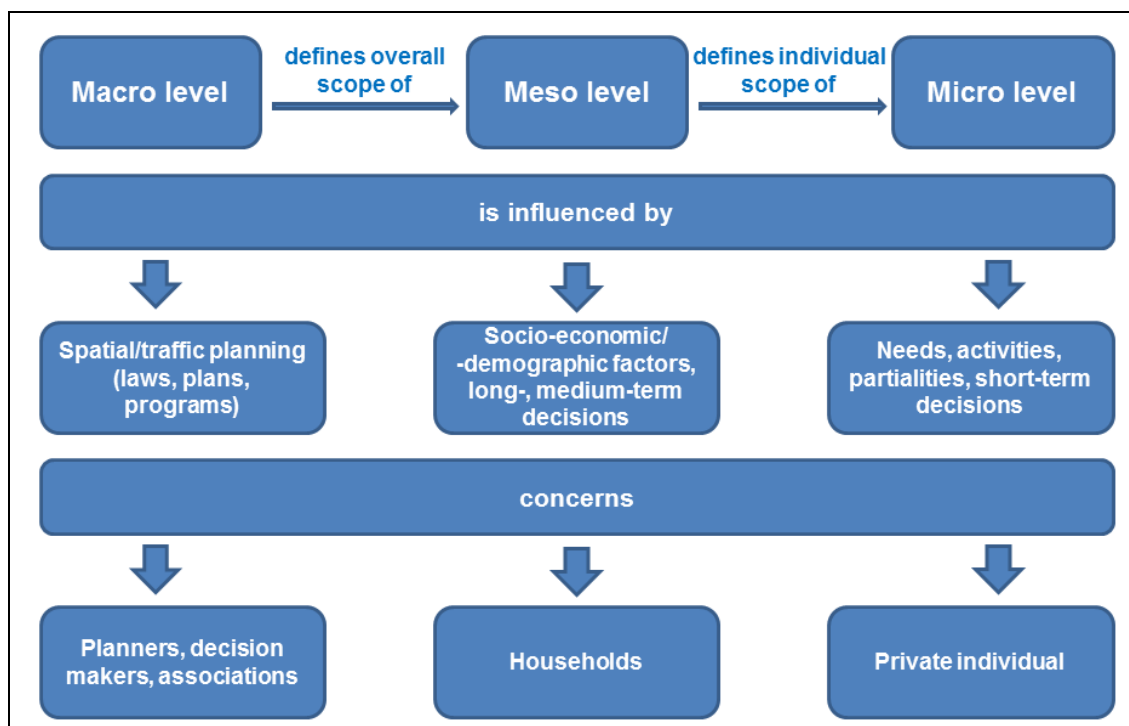


Figure 20: Different levels and influencing factors on mobility (author's design, based on FRANZ 2010, 21).

### 4.3.1. Spatial Planning and the Macro Level of Mobility

The following two sections investigate the macro level of mobility. Therefore an overview on the spatial planning system in Austria/Salzburg is provided, covering the different hierarchical planning levels as well as major instruments that exist. Furthermore, planning parameters and the impact of settlement structures on the mobility in urban and rural areas are outlined.

#### 4.3.1.1. The Spatial Planning System in Austria/Salzburg

In Austria, the development of 'space' i. e. the designation of areas for living, working, shopping, leisure, infrastructure, and transportation is the task of spatial planning. Thereby spatial planning as defined by the traditional Austrian word *Raumordnung* relates to the comprehensive and foresighted planning of land use as well as respective spatial-related measures (VCÖ 2007, 13). Spatial planning in terms of the Austrian *Raumplanung* in turn is concerned with the activities of a target-oriented development of towns, municipalities and regions. It controls land use in the interest of the public and comes into action in case spatial development contradicts any socio-political objectives or raises conflicts with other land uses (VCÖ 2007, 13). Consequently, *Raumplanung* is supposed to prevent undesired development in unsuitable places and to facilitate desired intentions at appropriate locations. This shall establish the frame for urban and regional development. In general, the planning system is characterised by a complex dispersion and various interconnections of different competences. Different planning levels and instruments exist, being ordered in a hierarchical structure. On (supra-)national, regional and municipal level, there are plans, programs, concepts and proposals. An overview on the different levels of planning, as well as on the respective instruments is given in Figure 21.

#### Federal government level (*Bundesplanung*)

The legal foundations for spatial planning are defined in the Austrian constitution. As a basic principle, the constitution separates spatial planning into local and supra-local (=regional) land-use planning (Figure 21). With respect to the former level, the federal government of Austria and the nine Austrian states have responsibility for respective legislation and implementation (MAIR 2011, 18). This means that spatial planning is based on a federalist political structure. However, although numerous spatially relevant realms belong to the federal government, it lacks in a comprehensive competence on regional planning. Thus, MARKSTEIN (2003, 34) perceptively states that planning in the literal sense is under provincial jurisdiction. In order to still coordinate the different competences, the *Austrian Conference on Spatial Planning* (*Österreichische Raumordnungskonferenz - ÖROK*) was founded in 1971. The ÖROK is a permanent institution of the federal government, states members and representatives of the municipalities. In addition to the creation of a planning report (*Raumordnungsbericht*) every three years and the coordination of the interests of the federal government and state levels in the EU regional policy, the ÖROK determines the Austrian concept for integrated spatial development (*Österreichisches Raumentwicklungskonzept-ÖREK*)

(MAIR 2011, 19). However, as the ÖROK operates outside the scope of the law, this concept is not to be seen as a formal planning tool (MARKSTEIN 2003, 173).

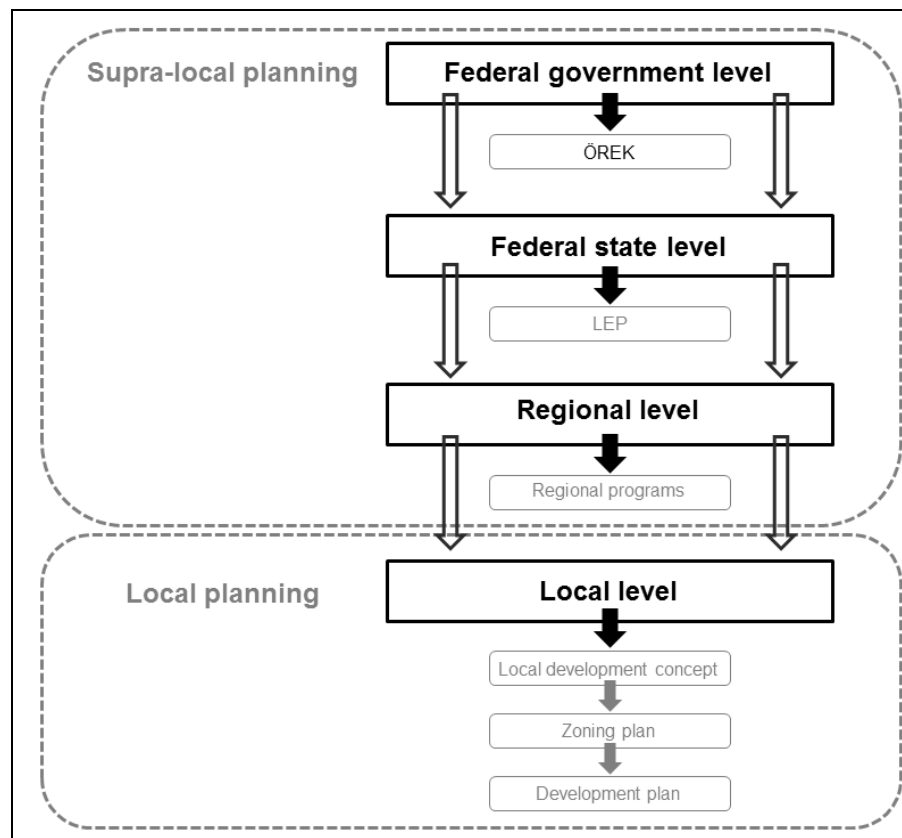


Figure 21: The spatial planning system in Austria/Salzburg (author's design, based on MARKSTEIN 2003, 36).

### Federal state level (*Landesplanung*)

As mentioned before, the federal states are responsible for regional planning in Austria. Their laws (*Raumordnungsgesetze* - *ROG*) and programs (*Landesentwicklungsprogramme* - *LEP*) establish the basic provisions for the organisation and planning of urban development in the respective towns and municipalities. As MARKSTEIN (2003, 34) points out, they determine both general principles about regional and local planning (*Bauleitplanung*) and declarations on the regulatory law of the federal state regarding the planning of municipalities. With respect to regional planning, the laws determine the provision of regional planning plans/programs (*Raumpläne/Raumprogramme*) by the federal state government. These plans/programs in turn are necessary for the implementation of respective projects on local level and have to be followed by the municipalities (VCÖ 2007, 13).

### Regional level (*Regionalplanung*)

In between the level of the federal states and the municipalities, a regional level (*Regionalentwicklung*) exists in some states (e. g. in the province of Salzburg - Figure 21) (MARKSTEIN 2003, 173). This kind of planning overlaps municipal borders and deals with problems that municipalities cannot solve on their own. Control and regulation is achieved through regional policy and respective regional programs. Usually, economic measures are applied at this level, such as the allocation of

subsidies or the construction of high-level infrastructure. In contrast to spatial planning, regional development is primarily a financial incentive system (VCÖ 2007, 13).

### **Local level (*Örtliche Raumplanung*)**

Local planning is subject to the municipalities, which realise spatial planning within their territory. Thus, as MARKSTEIN (2003, 34) found, the municipalities act as a self-governing body. However, they are bounded by the laws and regulations of federal government and states and subject to their supervision. This means that the municipalities are empowered to take responsibility regarding their structural and spatial development, taking into account regional plans and programs. Important instruments of the municipalities encompass the local development concept (*örtliches Entwicklungskonzept - REK*), the zoning plan (*Flächenwidmungsplan*) and the development plan (*Bebauungsplan*). These three instruments are briefly described in the following:

- The local development concept/program is a spatial instrument, determining spatially-relevant policy decisions of the municipality development (MARKSTEIN 2003, 35). Thus, forming a general guiding principle, it presents the spatial-functional development of a municipality for 10 to 15 years. As basic planning tool it precedes both the zoning and the development plan (MARKSTEIN 2003, 76).
- The zoning plan plays a central role in the context of local land-use planning. It structures the entire area of the municipality according to the intended goals and the spatial-functional requirements (MARKSTEIN 2003, 35). Thereby it defines binding land use categories for the respective areas, separating building land from non-building land. Thus, in combination with the infrastructural development, the zoning plan is the fundamental prerequisite for the transformation of grassland into building land.
- The development plan determines the formation of the building land, based on individual parcels. It defines the type, arrangement, and extent of specific building use within the building zones, as well as other regulations regarding structural usability (MARKSTEIN 2003, 77). The development plan requires the existence of a zoning plan for the respective site since its content is derived from the determinations made in the zoning plan.

Thus, with respect to the process of land development, three major steps can be identified (MARKSTEIN 2003, 76): First, grassland becomes designated building land through the respective determination of the municipality in the zoning plan. Second, through the design of a development plan and the creation of building lots by the land owner, non-developed building land is generated. Thereby land owners transfer a part of the land to the municipality to be used as traffic area. Third, building land ready for construction is developed through the provision of services (electricity, water, traffic). To conclude it can be said that in the Austrian spatial planning system only the federal states and the municipalities are bound as planning authorities. Neither the regional level (which according to MARKSTEIN (2003, 35) has to be understood as small-scale federal planning) nor the federal government have accurate competences in the realm of spatial planning.

#### 4.3.1.2. Planning Parameters and Settlement Structures

As it was found in the introduction of this chapter, spatial planning and more precisely the federal states and the municipalities set the conditions on the macro level of mobility in a region. On the one hand, this is due to the determination of mobility concepts, which decide on aims and strategies of mobility in a state, measures to be taken with respect to traffic quality, mobility management, and traffic infrastructure (SCHNÜRER 2006, 5). Hence these concepts impact directly on the mobility behaviour of citizens, i. e. car purchase, bike usage or public transport use. On the other hand, GERTZ&ALTENBURG (2009, 791) make clear that settlement structures influence the way households organise their mobility and therefore these structures define the frame for various possibilities and decisions regarding mobility. WEGENER&FÜRST (1999, 6) have expressed a similar view. In their work the authors present the interactions between urban land use and transportation in urban areas as a 'feedback cycle' (Figure 22). Thereby the theory deals with the locational and mobility reaction of private actors (e. g. households) to changes that occur in land use and the transport system at an urban/regional level. As it is commonly known, the spatial distribution of land uses (e. g. residential, commercial, and industrial) causes spatial activities (such as working, living or leisure). This in turn creates the need for overcoming space between different activities and therefore leads to interactions with the transport system (WEGENER&FÜRST 1999, 6). Thus, given the fact that suburbanisation processes are linked to an increasing spatial division of activities, this leads to raised traffic. However, the reverse effect, i. e. the impact of transport systems on land use is less obvious: The arrangement of traffic infrastructure and services shapes locations, facilitates spatial interaction, and in consequence determines their accessibility (Figure 22). Thereby accessibility characteristics of locations may be described by travel times, distances, and costs. These parameters in turn impact together with other attractiveness characteristics on the preference of a location and hence on the location decision of investors as well as on the location decision of households and businesses (BMVBS 2012, 24f.). This again provokes respective changes in the land use system and consequently closes the circle. Therefore land use (i. e. locations of activities) along with traffic services influence the mobility behaviour of inhabitants and hence the demand for transport (in particular transport mode and trip lengths).

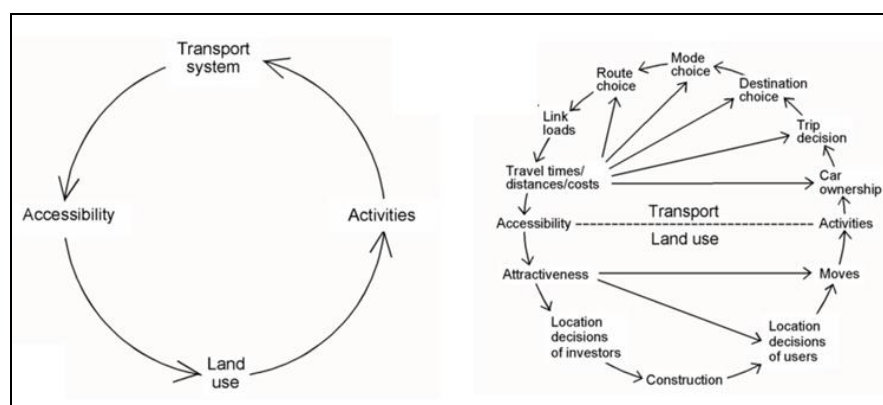


Figure 22: The 'land use transport feedback cycle' (adopted from WEGENER&FÜRST 1999, 7).

Studies by the ARL (2011, 6f.) suggest that based on the action-space theory of HÄGERSTRAND (1970), money and time budgets are the main constraints of everyday mobility of people. This means that individuals do not – as assumed in traffic behaviour theory – minimize their effort to overcome space, but rather maximise the number of facilities that can be reached within the available time and money budget. According to ARL (2011, 6f.), that is the reason why traffic accelerations in the past did not lead to time savings, but to more and longer trips. Furthermore, it explains why reduced petrol prices in the past did not result in less traffic spendings, but instead to locations in suburban areas. Thus, reduced transport prices cause decentralisation on an urban/regional scale, rather than to large scale developments. Apart from these finding, the theory allows predictions on what would happen if travel velocity and costs were changed by spatial planning: While acceleration and decreased costs would come along with faster and longer trips, the opposite would foster slower and shorter travels. This mutual reaction also affects the settlement structure, where longer trips allow dispersed locations together with further division of labour; shorter travels in turn foster spatial concentration (ARL 2011, 6f.). Conversely it can be inferred that the targeted support of dense and mixed quarters in combination with low transport prices would have relatively weak effects on traffic. Also, the citizens in these quarters are likely to continue making use of their respective time and money budgets due to the demands of the labour market and the attractiveness of remote shopping and recreational opportunities.

This brief overview on theoretical approaches, explaining some of the interdependencies between traffic and settlement structure, illustrates that decreasing transport costs result in spatial polarisation (on the large-scale level) and to decentralisation (on the urban level). Moreover, it demonstrates that measures for settlement development have little impact in terms of less and more sustainable traffic, if they are not accompanied by supporting actions in terms of traffic policy (especially financial incentives). All in all it becomes clear that settlement planning may be seen as an important starting point and crucial control parameter for the development of mobility. As GERTZ&ALTENBURG (2009, 791) emphasise, transport-efficient settlements are needed in order to reduce traffic and car dependency. Therefore settlements need to be characterised by compact structures, short distances, mix of uses, a development along public transport axes, high design quality, attractive residential areas, and nearby opportunities for daily needs. A brief description of several of these characteristics and respective interdependencies is given in the following.

### **Compact settlement structures**

The guiding principle of compact structures takes several starting points. In its core, high densities lead to a reduction of daily distances and travel times between different activities (Figure 23, top). This is mainly due to the nearby distribution of facilities (MEGA 2013, 175). Thereby research by the SE&ARE (2006, 3) suggest that substantial differences may be found between settlements of different densities: Based on similar socio-economic characteristics, daily distances of citizens in loosely build quarters may be at least 40% higher compared to the distances of citizens from dense areas. Apart from that, higher populations come along with a higher number of clients and consequently foster supply structures (GERTZ&ALTENBURG 2009, 791). This in turn facilitates the growth of further supply utilities as well as a better efficiency of public transport services. Furthermore, MITTER (2011, 148) perceptively states that

compactness and reachability positively affect the modal split (i. e. the use of different transportation modes) at a location. While in compact structures motorised traffic declines and alternative transport modes (especially bike and foot traffic) are fostered (INFAS&DLR 2010, 2), loose structures heavily rely on cars (BMVBS 2010, 12f.). This matter of fact can also be seen in Figure 23 (bottom). Not only the share of households without a car is about twice as high in compact areas compared to loosely built areas; also the portion of households having two or more cars is significantly higher in areas with fewer inhabitants per km<sup>2</sup>. Thus, strategies that support the principle of compact settlements encompass the conservation of dense structures, mix of uses, as well as the densification of loosely built areas. Therefore urban wastelands and existing building gaps need to be closed. At the same time however, further urban sprawl and land use have to be prevented.

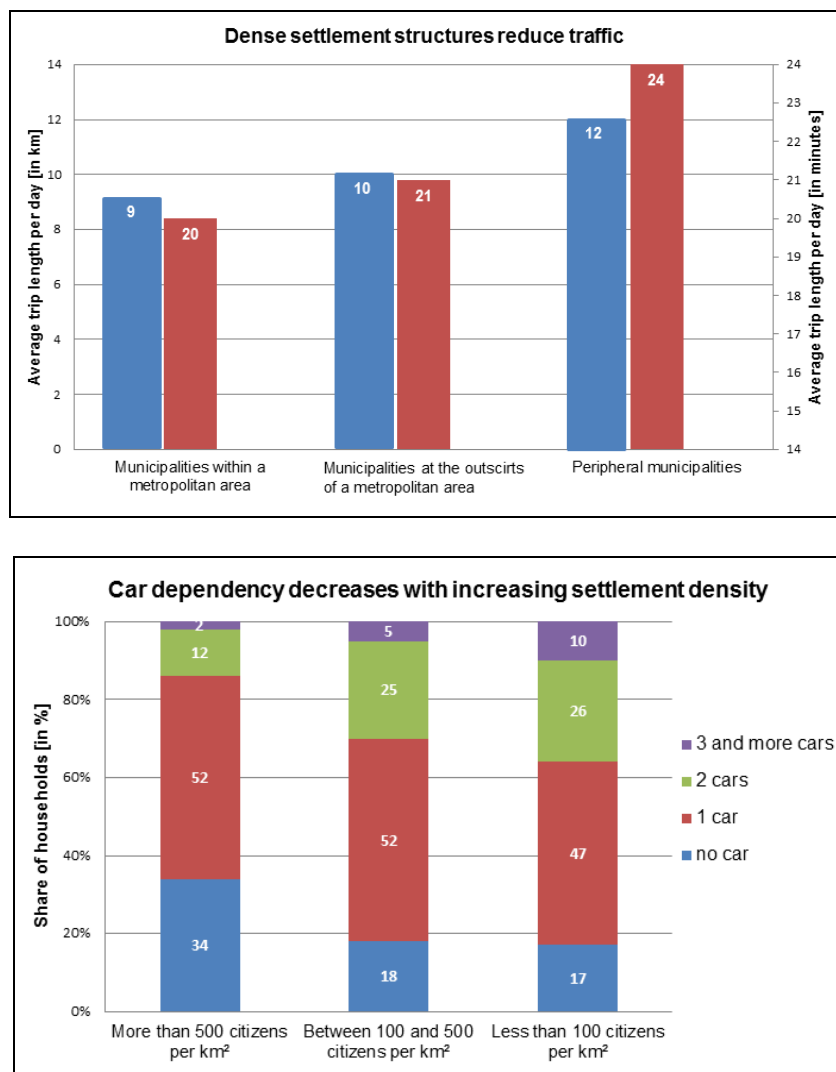


Figure 23: Daily distances, travel times, and car ownership depending on settlement density (author's design, based on VCÖ 2010b, 27/12).

### Mix of uses

A high mixture of land use within a neighbourhood aims at the provision of variegated facilities within short distances. Transport volumes are reduced since citizens do not have to leave their neighbourhood as often in order to complete different activities. This

in turn makes travels on foot and by bike more attractive (VCÖ 2010b, 24). As the work of GERTZ&ALTENBURG (2009, 791) indicates, significant potentials may be expected from the enrichment of neighbourhoods through additional supply infrastructure. However, it is also necessary to foster utilities beyond the neighbourhood level, along the routes between workplaces and residential areas. FRANK ET AL. (2008, 40) found that the decision to combine multiple trips depends among other factors on the availability of facilities and services close to home and work. This has several reasons: Given the highly specialized labour market, the goal of combining workplaces and homes within the same neighbourhood for a high number of citizens is not realistic (GERTZ&ALTENBURG 2009, 791). Besides, many types of commerce and industry face disadvantages in housing areas, either because of conflict potentials or missing attractiveness of these locations. Thus, people will still be forced to leave their neighbourhood to execute certain activities. Therefore not only at the neighbourhood level, but also on a city-wide and regional level, the mix of uses is important in order to reduce commuting flows and number of trips.

### **Local supply**

The conservation and development of comprehensive local supply which can be reached by non-motorised transport is a key strategy for mixed land uses (GERTZ&ALTENBURG 2009, 792). A major goal in this context has to be the ensuring of infrastructure consisting of periodic goods and services that may be reached with minimal traffic. Especially against the background of the demographic development in many areas, being characterised by an increasing number of older people with restricted mobility, well functioning local supply gains importance. Research by FRANK ET AL. (2008, 39) suggests that the likelihood of a person to walk increases by 20% for each additional facility within a 1km distance around the place of residence. Also, a higher number of shops and services in the neighbourhood of homes and workplaces reduces the overall number of trips as different trip purposes may be combined (NAESS 2003, 158f.).

### **Integrated settlement and public transport planning**

Settlement structures have a decisive influence on the transport demand as well as on the sustainability of different means of transportation (INFAS&DLR 2010, 33). Today, large settlement areas exist, highly depending on motorised individual traffic, since an appropriate accessibility with public or other transport is hardly possible. Thereby reference to GERTZ&ALTENBURG (2009, 792) reveals that a retrieving development with public transport in these areas is rather difficult. This is mainly due to the fact that new public transport services have to compete with the existing individual transport behaviour of the residents and hence are unlikely to be economically sustainable (especially at the beginning). This indicates that it is of high importance to follow an integrated planning of settlement and public transport development at an early stage: Settlement development has to take place along available public transport axes. However, RITTER (2005, 736) argues that even if public transport services exist in an area, their preferential usage is only assured if a good service quality is offered and at the same time the use of cars is made unattractive (e. g. through higher parking prices). Further, FRANK ET AL. (2008, 48f.) discovered that time is considered as a crucial predictor of transit use. Therefore high service intervals and fast connections need to be provided.



### **Creation of attractive residential areas in central places**

GERTZ&ALTENBURG (2009, 792) report that 'urban housing' and 'compact settlements' are often-times perceived as negatively afflicted terms. Therefore it is even more important to create attractive urban quarters, which apart from good accessibility offer a high quality of life for different kinds of households and life styles. In addition to high design quality of housing types and public space, the specific strengths of inner-city areas need to be enhanced. Furthermore, it is crucial to establish adequate housing for the demands and needs of larger households/families. GERTZ&ALTENBURG (2009, 793) observed that especially households with children are often crowd out of city areas because of insufficient living space and high costs; a clear preference of families for suburban areas is rarely found. The question to which extent certain population groups prefer urban housing is rather difficult to answer. However, the creation of additional, attractive residential areas within cities is in any case a reasonable measure both to prevent emigration of households to the periphery and to facilitate immigration into the cities.

### **4.3.2. Private Households and the Meso/Micro Level of Mobility**

In the upcoming three sections the relation of households and mobility is analysed. This comprises several influencing characteristics of a household regarding the macro and micro level of mobility as well as mobility-related decisions which may be of different maturity. As it is demonstrated in this context, the decision on housing may be seen as the most influential long-term decision of households, determining far-ranging consequences regarding the mobility behaviour and mobility expenses of households. In other words, it defines the scope of the household's individual mobility. With reference to the second hypothesis of this work – the difficulty for households to assess housing and mobility costs in the long run, provoking short-term considerations – an overview on the decision-making process on housing is provided, focusing on common decision criteria. Thereby different surveys are looked into in order to inspect the importance of different housing criteria. This in turn highlights short- and long-term considerations that are made. Last, relating to the problems described in the introduction of this work, possible reactions of households on rising travel costs are inspected. In sum these investigations indicate potential starting points for influencing mobility decisions and mobility behaviour.

#### **4.3.2.1. Influencing Factors and Decisions of Households**

As it was outlined in the overview, spatial structures (comprising among other parameters public transport services, mix of uses, and settlement density) are just one influencing factor on mobility, taking effect on the macro level. Other factors determining mobility requirements at this stage include several structural parameters (such as the societal and economic conditions) (HUNECKE&SCHWEER 2006, 148). Within this predefined scope, the actual use of space by households and single

persons is dependent on a range of individual, mutually influencing factors at the meso and micro level (Figure 25). With respect to the meso level of mobility, these include socio-economic and socio-demographic characteristics of households, such as the household structure and income (BMVBS 2012, 30f.), as well as the education level, sex, age, and health impairments of individual household members (FRANZ 2010, 20). Thus, the mobility behaviour of a household changes according to the life cycle (e. g. starting a family) or certain alterations in the situation of life (e. g. variance of income that can be spent on mobility). To exemplify the influence of income with respect to mobility behaviour, Figure 24 indicates the share of different means of transportation depending on five distinct household-income categories. The portion of non-motorised transport (i. e. public transport, bike and foot traffic) is highest in households with very low/low income. The higher the income level, the less the share of these transportation modes and the higher the portion of car-use become.

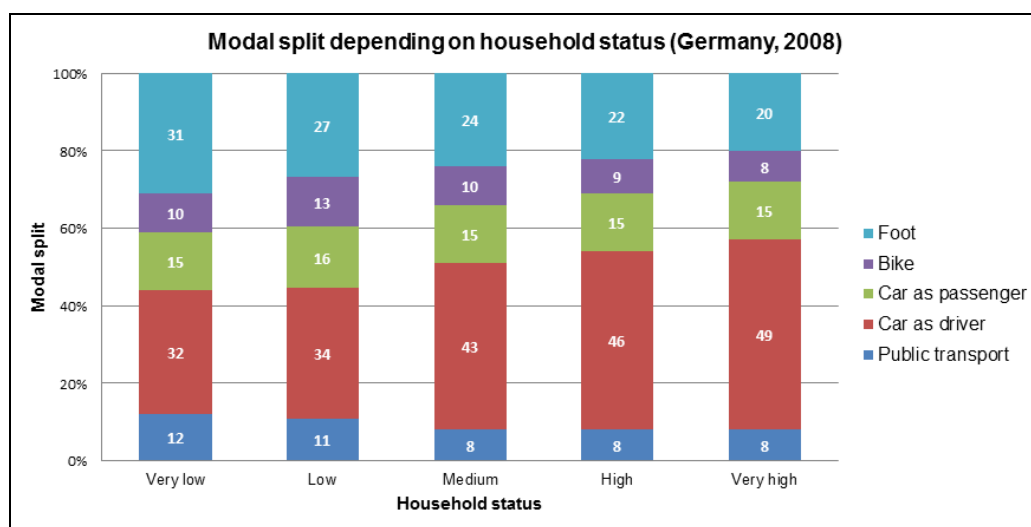


Figure 24: Influence of income on the use of transportation modes (author's design, based on INFAS 2009, 30).

Apart from that, various decisions of different maturity impact on the mobility behaviour i. e. the length of trips, transport modes, destinations and motorisation (Figure 25). Thereby long-term decisions generally influence short-term ones, but also vice versa (BAUER ET AL. 2006, 64). Most important long-term decisions encompass the decisions on housing, inflexible destinations (e. g. workplace), and car purchase (BAUER ET AL. 2006, 80). However, due to the fact that approx. 80% of all daily trips in Austria start or end at home (VCÖ 2010b, 9), the decision on housing plays a key role, influencing most other mobility decisions (NAESS 2003, 173f.). Thus, by determining both the structural conditions of the living environment and the distances to different activities (work, leisure, shopping), the residential location creates the 'individual mobility scope' of a household (BMVBS 2012, 29f.). FUCHTE (2006, 33) has supports this view: According to his research, it was proven by a number of empirical studies that the environment of a housing location is closely correlated with the amount of traffic and the choice of transportation modes. Thereby both the quality of local facilities (i. e. the proximity and density of local supply) and the availability and quality of transport services are crucial parameters influencing car ownership, modal split, travel distances and in consequence mobility costs. As an example, a choice between different modes of transport only exist in case public transport and other supply services are offered within close reach of a housing location (BAUER ET AL. 2006, 64f.). Also, in an article by

the SE&ARE (2006, 6) it was found that the closer a household is located to a bus station the more likely it is that households are subscribed to season tickets. SCOTT&AXHAUSEN (2006, 311) on the other hand investigated that significant substitution effects exist among the amount of season tickets and the number of cars. Therefore KREITZ ET AL. (2002, 156) correctly argue that decisions on the place of residence either fosters or restrict certain forms of mobility behaviour.

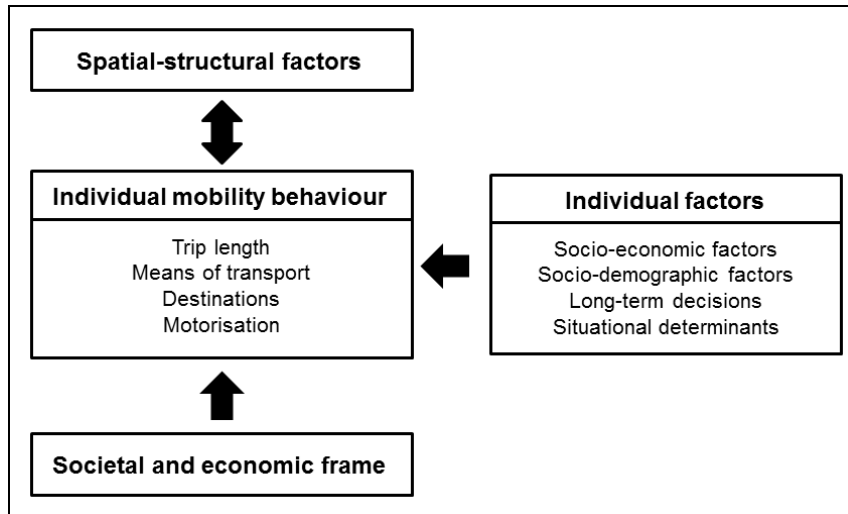


Figure 25: Impact factors on the individual mobility behaviour of households (author's design, based on GERTZ&ALTENBURG 2009, 786).

In the context of these findings, the work of FUCHTE (2006, 33) reveals interesting complements: Theories in the 1990s were based on the assumption that first and foremost the type of space would impact on traffic behaviour. Thus, towns with high settlement densities, mixture of uses and various kinds of local supply would automatically lead to shorter trips and a higher share of travels on foot, bike and public transit. Therefore this approach would only compare the behaviour of citizens according to the regions they live. However, more current studies question this narrow view. Because of increased mobility, present mobility behaviour is more independent of the actual settlement structures. Hence migration of citizens between different residential locations and more precisely between distinct types of space is added as an important criterion. As FUCHTE (2006, 34) remarks, every change of residence provokes changes of behaviour routines, which need to be adopted to the new location. Due to the fact that this adoption happens slowly and with a certain time lag, the mobility behaviour of migrants differs from the respective behaviour of the inhabitants of the area. As an example, covered distances of citizens moving to suburban areas raise dramatically because of various relations to the city area which are maintained. Besides, increasing car use of these households often comes along with additional car purchase (i. e. a second or third car), while households moving to urban areas show higher public transport use, foot and bike traffic (FUCHTE 2006, 34).

At the micro level of mobility, situational determinants can be found which influence mobility behaviour. As FRANZ (2010, 20) points out, these factors comprise individual preferences and traffic patterns (Figure 25). Other studies suggest that also the individual value system, orientation, and lifestyle are of relevance with respect to mobility choices (ALBRECHT ET AL. 2008, 94; HUNECKE&SCHWEER 2006, 148). KREITZ ET

AL. (2002, 156) conclude that these factors determine both short-term restrictions and possibilities of a household. Thus, depending on the attitude of a person and how active this person is (during work or leisure time), certain personal mobility patterns are determined. In this context a study by the BMVBS (2012, 30f.) shows that attitudes with respect to mobility influence the choice of transportation, whereas lifestyles rather impact on the destination of trips. Further, BAUER ET AL. (2006, 80) notes that there are also important short-term decisions which affect mobility behaviour on the micro level. These decisions encompass the choice of transportation mode for single trips, as well as decisions on flexible destinations (e. g. for shopping). These in turn depend on the individual views that were mentioned, as well as on previously made long-term decisions. A central question in this context is, to which extent the difference in traffic demand arises from the fact that households with certain preferences (e. g. with respect to transportation means) move to areas where these preferences are fostered (or at least not contradicted). This approach – also described as ‘residential self-selection’ (BMVBS 2012, 30f.) – means that differences in traffic behaviour also result from voluntary concentration of individuals with common preferences and attitudes in certain types of space (e. g. urban, suburban, rural, etc.).

To sum up, it can be concluded that processes on all three mobility levels impact on the mobility potential of a household at a certain location. Thereby both possibilities and restrictions regarding the availability of different traffic infrastructure are determined. On this basis it may be inferred that penetrating and understanding all of these interrelations and dependencies regarding mobility behaviour may be seen as a great challenge. In order to further elaborate on this difficulty from a household’s perspective, the decision-making process on housing, as well as various decision criteria are inspected in the following.

#### **4.3.2.2. Decisions on the Place of Residence**

It must be emphasized at the beginning of this section that the decision to relocate/migrate and subsequently the decision on housing is a complex process, being strongly influenced by each individual household. Thus, FUCHTE (2006, 22) correctly points out that these decisions cannot be explained by one (most decisive) factor or a few decision criteria. Rather, there is a number of overlapping reasons and preferences, which again are influenced by individual circumstances and social conditions. Therefore a model which illuminates the entire complex of residential location choice does not exist (FUCHTE 2006, 22). However, on a general level, the work of ADAM ET AL. (2008, 403) reveals that the decision-making process on the place of residence may be phased into distinct sections. An extended schematic illustration is presented in Figure 26. Thus, at the beginning there is usually a trigger causing the decision to relocate. In this context, BAUER ET AL. (2006, 81f.) found that shortcomings of the previous location or the residential surrounding as well as personal and compassionate grounds often lead to regional/nearby movements. In contrast, nationwide migrations are usually caused by a new job, a changing apprenticeship training position or the starting of a family (e. g. marriage, moving in together). The second phase in the decision process comprises the development of respective demands on a new location (Figure 26). Thereby various criteria may be considered,

including location, leisure and recreation opportunities, access to certain activities and public transport, energy consumption or security, to name a few (VCÖ 2010b, 14). KREITZ ET AL. (2002, 156) also mention experiences and restrictions encountered in everyday behaviour at the previous location which may be incorporated. Research by FRANZ (2010, 11) suggests that costs often play the most important role in this regard. Thus, in combination with preferences for either urban or rural locations, a wider or smaller scope of alternatives is created. This conclusion is also found by several other studies: Empirical investigations of the (BMVBS 2012, 94) on location criteria indicate financial aspects as most important and partly dominating criteria. Further, turning to a study by the BVK (2010, 62f.) on residential location motives in the Taunus region (Germany), one finds that aspects of costs, living space and living environment are considered even more important than accessibility. Also, DITTRICH-WEUBER ET AL. (2011, 93) looked into requirements of migrants in Western Germany; in accordance with the previous results, it was found that housing costs are of great significance, being assessed as 'very important' by 60% of their respondents.



Figure 26: Schematic illustration of the decision-making process on housing (author's own design).

Subsequent to the identification of housing criteria, the third phase of the decision-making process is concerned with the search of appropriate locations (Figure 26). Thereby households try to optimise their residential location according to their demands. In this context SCHEINER ET AL. (2010, 95) observed that certain trade-offs are made: While on the one hand satisfaction with a certain criterion is increased (and respectively dissatisfaction is reduced), satisfaction with another criterion is reduced on the other hand. Finally, by the time suitable locations are found, the assessment of location alternatives begins (Figure 26). This phase is characterised by complex appreciation and decision processes (BAUER ET AL. 2006, 81f.): Individual interests and preferences of the household members, the stage of life of the household (e. g. creation, expansion, shrinkage), the financial budget and the satisfaction with the existing housing situation are in constant interaction with the objective conditions of the housing and labour market, accessibility, costs, as well as fiscal control instruments. At this stage, MCFADDEN (1977, 1) makes clear that the economically rational consumer will weigh up all the attributes of each alternative, such as accessibility of the workplace, shopping opportunities, neighbourhood quality, availability of public services, costs (including housing price, taxes, and mobility costs), dwelling characteristics (e. g. age, number of rooms, type of appliances), and other properties, choosing the alternative with the maximum utility. However, as KREITZ ET AL. (2002, 156) correctly point out, it can be assumed that most citizens never think about all these attributes and their mutual interactions. Rather, due to the fact that complete information is rarely available, an incomplete view and lack of knowledge exists. Therefore most decisions are made on the basis of assumptions and intuitive knowledge. This is also the opinion held by FRANZ. According to her research, it is often the subjective impression on the basis of which the tenant or buyer decides;

medium- and long-term costs can hardly be estimated and especially mobility costs only play a minor role in such considerations (FRANZ 2010, 11). Turning back to the study of the BVK (2010, 64f.), a similar result is found: about 60% of the households did not account for mobility costs in their decision-making process. Besides, it was figured that households who claimed to consider respective costs, made only rudimentary calculations, factoring in just a few cost components. Thus the evidence seems to be strong that resulting mobility costs are often-times not included or at least underestimated in location decisions. In this respect BAUER ET AL. (2006, 81f.) have drawn attention to the fact that two stable trends in the past fostered the neglect of mobility costs in favour of housing costs, although a trend reversal has occurred in recent years:

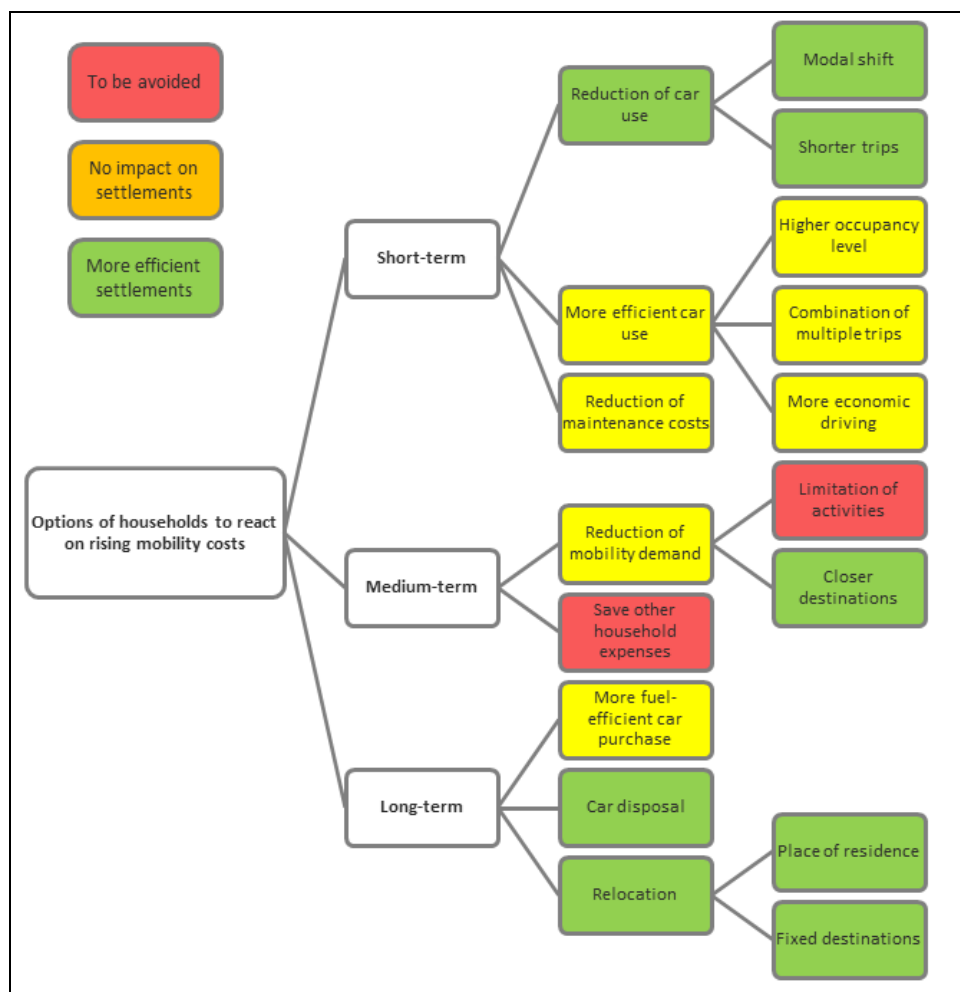
- In relation to the disposable income, mobility costs have declined over a long time, despite larger vehicles and increasing distances. Only in recent years, these costs have significantly increased.
- In contrast, housing costs have grown continuously with increasing living space per person. However, over the last few years, these costs have stabilised and even decreased in certain areas.

BAUER ET AL. (2006, 81f.) assume that purchasers and tenants on the real estate market expect this gap between mobility and housing costs to persist in the future. In consequence, decreasing housing prices from urban towards suburban areas (as described in chapter 4.2.) remain an important factor in the location decision of private households: In the trade-off between different residential areas there is an expectation to be able to save money when realising a higher standard of living in peripheral areas, accepting a higher mobility effort. Thus, based on respective assumptions and thoughts, the actual decision on the place of residence is made (Figure 26).

#### **4.3.2.3. Possible Reactions of Households on Rising Travel Costs**

Referencing back to the problem description in the second chapter of this work, it was found that both economic and political developments will cause raising fuel prices in the future, resulting in long-term increases of mobility costs. Based on these upcoming conditions, there are numerous theoretical options for private households to react, providing that the high price volatility is recognised as a warning (ARL 2011, 4). As illustrated in Figure 27, possible reactions range from short-term changes in mobility or consumer behaviour to medium- and long-term alterations. Short-term adoptions may comprise the shortening of average trip lengths or the reduction of motorised individual transport use (ARL 2011, 7). The latter target may be accomplished through a shift from car usage to more affordable modes of transportation such as walking, cycling or public transport (Figure 27). Further, individual motorised traffic may be used more efficient through a higher occupancy level of cars (i. e. the substitution of solo car use by rides with others), the combination of multiple trips or the reduction of fuel consumption through more economic driving (ARL 2011, 7). Besides, HAUZINGER ET AL. (2004, 6) note that also a reduction of distance-independent maintenance costs is possible by cutting back repairing, insurance, and other additional charges. Regarding

medium-term measures, money may be saved by a reduced overall demand for motorised mobility, e. g. through the limitation of certain activities (HAUTZINGER ET AL. 2004, 6). Further, closer destinations may be chosen to execute certain activities (GERTZ&ALTENBURG 2009, 787). In case previous car usage is not to be changed, there is also the option to save on other household expenses, reallocating the disposable budget (Figure 27). Finally, long-term measures may encompass the purchase of a new, more fuel-efficient car as a replacement of the former one. Apart from that, it may be thought about the disposal of the (second/third) car, or even the relocation of either the place of residence or fixed destinations such as the workplace in order to reduce daily distances and car dependence (HAUTZINGER ET AL. 2004, 6f.).



**Figure 27: Possible reactions of households on raising mobility costs (author's design, based on GERTZ&ALTENBURG 2009, 787).**

Thus, there is a wide range of theoretical responses of households on rising mobility costs. Which of the measures or which combinations of these are eventually chosen by the individual household, depends on several factors. To exemplify this, HAUTZINGER ET AL. (2004, 6) observed that it is a matter of personal preferences, to decide which steps to take. Further, the authors argue that looking at the possibilities of both short-term and long-term adoptions, it is important, whether alteration in mobility costs are perceived as episodic fluctuations around a constant mean or rather as long-term changes in the fuel price level (HAUTZINGER ET AL. 2004, 6). Moreover,

GERTZ&ALTENBURG (2009, 786) make clear that the availability of alternative transportation services at specific locations as well as socio-economic aspects of the respective household impact on the actual possibilities. Then again, research by HAUTZINGER ET AL. (2004, 199) shows that 'mobility' is seen as too valuable in as much as associated lifestyle factors would be changed immediately. In addition, the authors point out that significant reductions in vehicle mileage (and hence a decline of mobility costs) can in most cases only be achieved through a permanent change in the sources and destinations of regular trips (e. g. residential locations and workplaces). However, due to the long-term consequences of such decisions, these actions are hardly taken, especially against the background of moderately rising petrol prices. Thus, indications are therefore that in reality, possible reactions of households are significantly reduced. On this basis, GERTZ&ALTENBURG (2009, 787) identified two main trends of reaction which according to the authors will gain importance in the context of raising petrol prices.

- **Compensation:** Numerous households will try to maintain their mobility behaviour as before. However, while households with high income levels are able to cope with the changing conditions, there will be a substantial number of households without such financial flexibility. Hence these will try to hold up their mobility habits at the expense of other parts of the household budget. Due to the fact that raising energy prices will come along with increasing expenses in other budgets as well, the remaining possibilities of these households will be severely restricted. (GERTZ&ALTENBURG 2009, 787)
- **Relinquishment:** In low-income households, raising mobility costs can be expected to come along with either a reduction of activities or even their full omission. Relinquishing behaviour in this respect is to be equated with a decreased participation in activities and other areas of cultural and social life. This in turn may lead to exclusion, declining quality of life, and growing dissatisfaction. Thus, in case certain activity and participation standards are burst (at least) a partial exclusion exists. (GERTZ&ALTENBURG 2009, 787)

It must therefore be recognised that the different ways of reacting on rising mobility costs can be categorised, depending on their overall positive or negative long-term effects on both spatial structures and society. Reactions through compensation and relinquishment are rather problematic, as they may cause loss of living quality/welfare for households while at the same time preserving unsuitable spatial structures (BÜTTNER 2011). Therefore these options should be avoided (Figure 27, illustrated in red colour). Apart from this first category, a second group can be identified, comprising options with respect to a more efficient use of motorised individual transport (marked in yellow in Figure 27). Although these measures prevent the loss of household's mobility and in deed come along with certain positive environmental effects, such as the reduction of fuel consumption and emissions, less air pollution, and traffic noise (ARL 2011, 16), no long-term contributions to significant settlement improvements are made (BÜTTNER 2011). In contrast, the third group of measures (indicated with green colour in Figure 27) may lead to more efficient settlements, while facilitating a more sustainable mobility behaviour (BÜTTNER 2011). Thus, spatial re-organisations and a modal shift towards a higher share of travels on foot, bike, and public transport and consequently the growth of inter-/multi-modality (ARL 2011, 7) has to be fostered.



#### 4.4. Contextualisation and Starting Point of the *Cost Calculator*

Referring back to the hypotheses formulated in the introductory chapter of this work, it was claimed that there are particular patterns in space for housing and mobility costs. Thereby, it was argued that particularly mobility costs are difficult to assess in a comprehensive way, resulting often-times in a neglect of respective expenses and short-term considerations when making location decisions. Further, it was hypothesised that location as well as mobility decisions of households may be positively influenced by the provision of objective and individual information, being communicated through systematic communication strategies. This in turn would contribute to a more effective settlement development and less individual traffic. With respect to the first hypothesis, it was found in chapter 4.2. that certain cost structures exist in space; their rough distribution and general spatial trends were demonstrated. Based on these explorations, it was outlined in chapter 4.3.2. that households face great difficulties when trying to estimate mobility costs, especially in the context of a new place of residence. The section at hand picks up these findings, elaborating on the communication strategy to influence housing and mobility decisions of households. Thereby the *Housing and Mobility Cost Calculator* that was developed in the scope of this work is put into the context of spatial planning processes and the respective tools that are available in this field. In addition, the starting point of the tool is determined, arranging it in the decision-making process on housing as presented in chapter 4.3.2.

A major difficulty when tackling the problems described in the introduction of this work (such as persistent land use and landscape fragmentation, growing motorisation, longer distances, and increasing traffic) is the mediation of the advantages for private households that come along with a decline of land use and traffic. In this regard, EIZENHÖFER&SINNING (2009, 141) perceptively state that the challenge to overcome this difficulty is to make the topic aware at the right point of time, to the right actors, with appropriate means. Needless to say, information which aims at the strengthening of integrated settlement structures and space-saving locations is not free of value; rather, it is based on normative principles and on the idea of a sustainable regional development (HOLZ-RAU ET AL. 2010, 92). BAUER ET AL. (2009, 122) therefore correctly argue that from a household's point of view, the reduction of land use, sustainability and environmental protection are not on explicit focus, as these undertakings aim for the reduction of societal, rather than individual costs. In some cases, these intentions may even be perceived as a certain restriction (of space). Thus, in order to successfully communicate the advantages of such reductions, it is important to point out relevant arguments and specific benefits for individuals. EIZENHÖFER&SINNING (2009, 141) suggest that costs are well suited for this purpose: Their quantification facilitates the illustration of individual advantages (e. g. time or money savings), while at the same time ensuring an emotional appeal.

As it was found in chapter 4.3., a number of spatial-related decisions preceded the citizens' everyday decisions on their destinations, routes, and transportation modes. In particular, this includes the decision on housing, but also decisions on the location and accessibility of certain destinations (e. g. workplace, educational institutions, shopping or residential locations of friends and relatives). While the former decision is more or less subject to the individual arbitration, the latter can hardly be influenced. As outlined

in chapter 4.3.1.1., these spatially significant decisions fall within the jurisdiction of urban, regional and spatial planners. The distribution of land uses in space and respective developments are subject to their planning considerations (KUTTER 2006, 48). Thereby not only law-based instruments exist, such as those described in the context of the planning system in Austria/Salzburg (chapter 4.3.1.1.), but also various kinds of Web-based information material and tools that may be used to control spatial development in terms of an overarching concept. A schematic overview on some of the tools/resources that currently exist is provided by Figure 28.

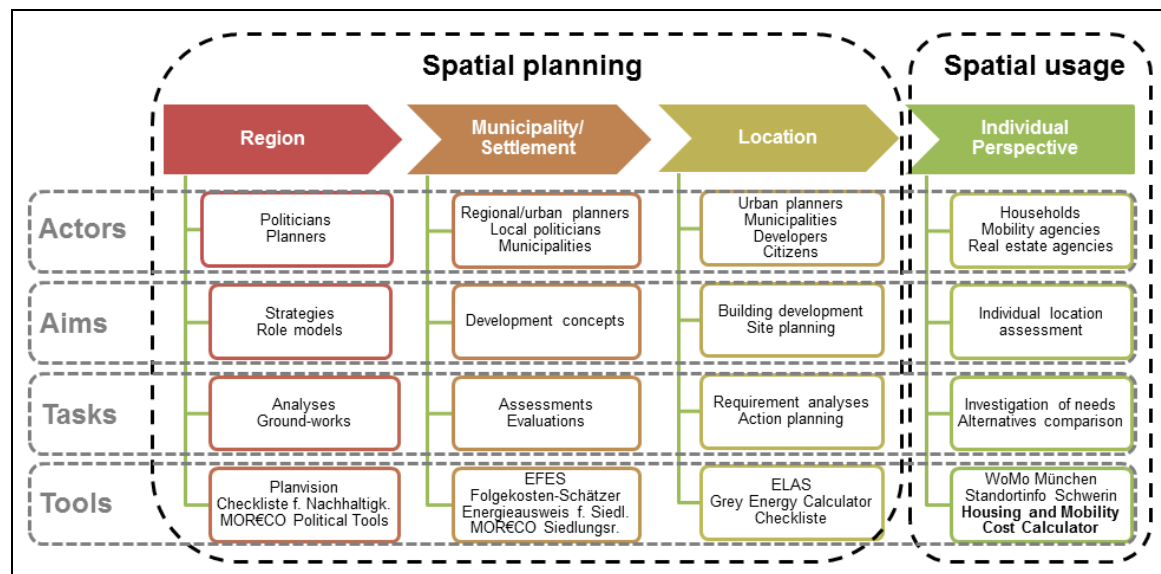


Figure 28: Contextualisation of the *Cost Calculator* into the planning process (author's own design).

On a coarse regional level, where politicians (i. e. decision-makers) and planners are in charge of designing general strategies and role models for subordinate planning levels, information materials and check-lists are available to be used for analyses and ground-works (Figure 28). These encompass instruments such as *Planvision*, which allows users both to identify energy-related aspects of spatial planning and to investigate the effectiveness of planning with regard to energy goals (UNIVERSITY OF VIENNA 2011b). Besides, the *Checkliste für Nachhaltigkeit* of the province of Salzburg facilitates the examination of sustainable effects of a project or planning intention before it may be approved and implemented (GLAESER n d., 2). At this stage, also the planning information that was collected and elaborated in the scope of the *MORECO* project (including a slide pool, regional analyses, and settlement assessments) provides assistant support (BISCHOF 2013; ISPACE 2013).

On the municipality/settlement level (Figure 28), regional and urban planners, as well as municipalities, and local politicians are concerned with the design of regional and local development plans and concepts (such as the *REK*, as described in chapter 4.3.1.1.). Thereby these actors need to assess and evaluate different planning proposals for municipalities or settlements. In this context different appliances give assistance. To exemplify this, the tool *Energieeffiziente Siedlungen (EFES)* makes it possible to assess existing and planned settlements with respect to their energy efficiency. Thus, users are given the opportunity to register a settlement and to optimise it in terms of energy usage (ÖIR 2009). Similarly, the *Energieausweis für Siedlungen* helps to calculate the overall energy efficiency of settlements: Based on

defined parameters, different buildings types can be compared with each other, using pre-defined categorisations (ARL 2010). The *Folgekosten Schätzer – Was kostet mein Baugebiet?* in turn is a calculator which shows how quickly follow-up costs of technical infrastructure and green space develop, depending on different planning strategies (GERTZ ET AL. n. d.). Last, the *MORECO Siedlungsrechner* supports decisions at this stage. By facilitating a comparison of potential settlement areas, an objective and transparent overview can be gained on mobility expenditures and environmental impact (ISPACE 2013).

Finally, on the level of individual locations/objects, not only local planning and municipalities, but also developers and even citizens are able to perform requirement analyses and action planning (Figure 28). This is done in the context of building development and site planning. These tasks are supported by instruments such as the calculator for *Energetic Long-term Analysis of Settlement Structures (ELAS)*. By means of *ELAS*, single houses may be analysed with respect to the energy situation. Both the current state and planning intentions may be tested (UNIVERSITY OF VIENNA 2011a). Besides, the *Grey Energy Calculator of Residential Buildings* allows for the assessment of 'grey energy' consumption which is caused by the construction/maintenance of buildings and technical infrastructure; additional expenses which are often neglected (NIEDERL&BUßWALD n. d.). Apart from that, the *Checkliste-Wohnbau* of the city of Salzburg emphasises ecological and sustainable ways for the development of residential projects. Thereby clear and comprehensible sustainability criteria for each location may be investigated (MAGISTRAT SALZBURG 2013).

It must therefore be recognised that different instruments exist, each of them taking effect at specific points of time in the planning process, focusing on particular tasks and actors. The problem which arises in this regard is that the development of compact settlement structures with well-integrated locations cannot assure their efficient use (Figure 29). Thus, even within well-organised traffic structures households and companies may act in a very traffic-intensive way (BAUER ET AL. 2006, 67). GERTZ&GUTSCHE (2002, 4) have expressed a similar view:

*“Land use planning can only provide options, but there is no guarantee for a more environmental friendly travel behaviour of the people “moving in”. As much as land use planning decisions are a necessary prerequisite for modal shifts down the line, in the end the traffic effects are always caused by the people’s way of „living a land-use pattern“.”*

In consequence, a regional strategy which is supposed to impact on traffic-related decisions of actors has to be based on two pillars: On the one hand, the strategy must influence decisions regarding spatial development, fostering traffic-efficient structures; on the other hand, it has to advertise and encourage the respective traffic-efficient use of these structures in everyday-mobility. As demonstrated in chapter 4.3.1.2., spatial structures and the usage of space are interdependent and mutually reinforcing in their effects. Effective spatial structures can only have an influence if their potential is reflected in the behaviour of the citizens. Conversely, attractive destinations (e. g. workplaces, shopping locations, and leisure opportunities) need to be within close reach and accordingly accessible by public transport to allow residents to move efficiently, i. e. with reduced car traffic. BAUER ET AL. (2006, 67) correctly point out that information provision and consulting services play a pivotal role in this context,

facilitating a linkage between the structurally oriented spatial strategies and transport-relevant decision of actors. As GERTZ&GUTSCHE (2002, 4) add, these concepts need to

*“(...) “sell” the advantages of mixed-use locations close to public transportation to the people by making visible the individual benefits of these locations (...).”*

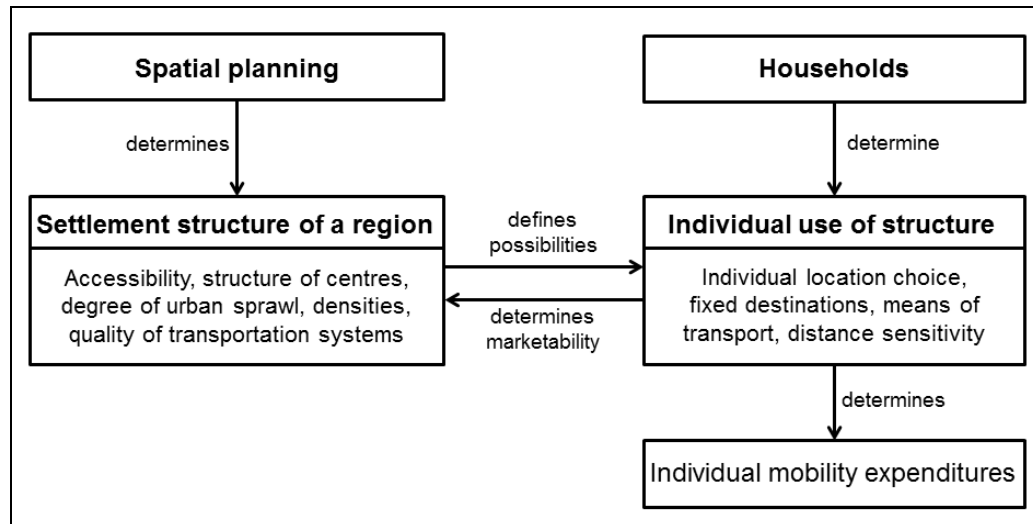


Figure 29: Interplay between settlement structure and use by households (author's design, based on GUTSCHE&KUTTER 2006, 67).

This is where applications such as the *MORECO Housing and Mobility Cost Calculator* set in. Thus, in contrast to the tools described, these concepts take the actual use of spatial structures as a starting point, being based on the individual perspectives of households on particular locations (Figure 28). Allowing for the investigation of individual needs and facilitating comparisons between different options, personal assessments can be made. While earlier research by ADAM ET AL. (2008, 409) suggests that a couple of years ago, the provision of respective information on location qualities and financial consequences of increased mobility efforts was not very common in local-authority practice, this has changed over the last couple of years: Today, a number of mobility cost calculators exist in the Web. Some of these encompass the *Wohn- und Mobilitätsrechner des Münchner Verkehrs- und Tarifverbundes* (MVV 2013), the *Wohnstandortinfo Schwerin* (LANDESHAUPTSTADT SCHWERIN 2011), and the *Mobilitätsausweis für Immobilien* (CEIT n. d.), to name just a few. Further calculators as well as a more detailed description and analysis of these is given in chapter 5.2. As it is outlined in Figure 28, these tools address in particular households looking for residential locations (both buyers and tenants). However, also mobility and real estate agencies (including estate businesses and property developers) may profit by offering better services (SCHRENK 2011, 11).

Similarly to the calculators mentioned, the *MORECO Housing and Mobility Cost Calculator* pursues the approach to illustrate the consequences that accompany mobility and (in particular) housing decisions. Thus, due to the various interdependencies that exist between housing and traffic (chapter 4.3.2.), the possibility to determinate mobility expenditures (both time and monetary costs) for different locations and means of transport becomes very important. This is all the more true against the background of increasing mobility costs in the future (chapter 3.1.),

demanding higher portions of a household's budget. However, in this context the tool has to be understood as a complement to existing information sources: Neither a direct assistance in finding a suitable location, nor a full consultation with all necessary information for a site selection (e. g. land prices, additional housing costs, information on surrounding qualities and funding possibilities) is provided. Rather, the basic purpose is to make individual follow-up expenditures more transparent, providing a better basis for decisions. KRÜGER (2008, 269) perceptively states that in case follow-up costs of a decision are recognised and taken into account, it may be expected that seeming benefits of certain locations are critically reviewed and qualified. Thus, households are motivated to examine alternative locations, but also different means of transport (e. g. at the same location). The latter approach aims at the promotion of environmentally friendly modes of transport at the expense of car use: Previous mobility patterns and behaviour routines shall be questioned and reflected. In sum, it is expected that based on the findings, the demand for new residential areas and in consequence the provision of new development areas in structurally unsuitable locations is reduced. As a result, households shall - in their own interest - contribute to a more efficient and sustainable settlement development in the future.

With respect to the decision-making on housing, it was demonstrated in chapter 4.3.2.2. that it is a multi-stage process. Thereby it was found by several studies (GERTZ&GUTSCHE 2002; ADAM ET AL. 2008; HOLZ-RAU ET AL. 2010) that a number of current concepts which are concerned with the consultation of households on their location/mobility decisions, do not reach households at the 'right' time. To exemplify this, numerous consultation services start after the movement to a new location, e. g. by providing households with information on public transport. These approaches primarily aim at the choice of transportation, trying to achieve a modal shift under the given circumstances such as spatial conditions, action spaces, and everyday distances (HOLZ-RAU ET AL. 2010, 61). GERTZ&GUTSCHE (2002, 2f.) correctly point out that the problem in this context is that many households do not have any options apart from car use as they live in places with poor public transport and long distances to be covered. Thus, in this regard even the best mobility approach will have little impact on a household's mobility behaviour and no effect at all on settlement development and land use. In contrast, the *MORECO Housing and Mobility Cost Calculator* intends to approach households in the earliest possible stage of the decision process, i. e. in the stage of assessing alternative locations. Apart from that, it may even work as a trigger for relocation or may be used to determine the demands on a new location (Figure 26).

## 5. Application Development

This chapter represents the practical part of the thesis and is concerned with the conceptualisation and implementation of the *Housing and Mobility Cost Calculator* in the pilot site. Therefore a brief overview on the province of Salzburg is given, including background information on the development of the population, motorisation, changing travel distances/times, and other housing and mobility aspects. Next, a state of the art review of a selection of six cost calculators is undertaken. This includes a brief description of each, highlighting the respective goals, functionalities and methods. Subsequent to this, a strength-weakness-analysis is performed, covering different features regarding user input, outputs of the tool, and different implementation criteria. Based on this analysis, respective demands for the *MORECO Housing Calculator* are derived and specified in a next step. These requirements in turn are used to develop the functional concept of the calculator. Thus, input parameters, functional relations, and calculation outputs are defined. Finally, in the last section, the actual implementation is outlined, i. e. the way different technologies are used and structure of the tool architecture. Also, important extracts from the programming code are highlighted and their respective function is explained.

### 5.1. Investigation of the Pilot Site

The region for which the *MORECO Housing and Mobility Cost Calculator* is implemented comprises for the main part the province of Salzburg (Appendix I); the specific area of application follows the coverage of the *Salzburger Verkehrsverbund* (SVV), as described in the approach of this work (chapter 2.4.). Therefore also parts of neighbouring provinces such as Upper Austria, Tyrol, Styria, Carinthia, and the German administrative district of Berchtesgaden are included (SVV 2012). This spatial restriction of the calculator results from the *SVV API* that was used. Thus, information on public transport ticket prices is only provided for the SVV-area. Other features of the calculator, such as the address search and all routing services are available for the whole of Austria (public transport - *VAO API*) and even for whole Europe (individual transport - *Google API*).

Covering an area of 7,154km<sup>2</sup> (MAIR 2011, 16), the province of Salzburg (SBG) consists of six political districts, namely Salzburg City, Hallein, Salzburg-Umgebung, Sankt Johann im Pongau, Tamsweg, and Zell am See (Appendix I). As HASLAUER ET AL. (2013a) note, these are commonly referred to as Flachgau (Salzburg-Umgebung), Tennengau (Hallein), Pongau (Sankt Johann), Pinzgau (Zell am See), and Lungau (Tamsweg). All together, these districts encompasses 119 municipalities, including the city of Salzburg (holding its own statute), 10 urban municipalities, and 24 market towns (MAIR 2011, 16). Salzburg City is the biggest municipality comprising 148,078 inhabitants (HASLAUER ET AL. 2013a); the province as a whole has currently a population of approx. 530,000 (FASCHINGER&RAOS 2008, 1). Looking at the past population development, the Flachgau exhibited by far the highest population increase (Figure 30): Between 1971 and 2010 it grew by 66% (MAIR 2011, 104). In the same

period, the Tennengau, Pongau, and Pinzgau grew at the average rate of the province; the city of Salzburg and Tamsweg in turn grew considerably less. To exemplify this, between 2001 and 2010, the SBG City increased by only 2.8%, compared to the province's average of 4.3%. Thus, as SCHNÜRER (2006, 12) and HASLAUER ET AL. (2013b, 185) conclude, the core area of population growth in the past has been in the northern part of the province, in the surrounding municipalities of the state capital; dynamics in the southern area have been rather low (Figure 30). With respect to future projections, FASCHINGER&RAOS (2008, 1) identified two major trends, namely a significant demographic ageing as well as a considerably reduced population growth for the whole province. Therefore population is expected to grow from approx. 530,000 inhabitants to 560,000 by 2032 and respectively 580,000 until 2050. This corresponds to an increase by 5.6% (resp. 9.4%) or 0.2% per year (compared to 0.7% per year between 1981 and 2007). Thus, evidence seems to indicate that the former pole of growth will develop towards a province growing below the Austrian average. However, as MAIR (2011, 119) notes, the development will variate between the districts, with the Flachgau holding an exceptional position as a continuously growing district (Figure 30). Apart from that, demographic and societal trends in the province will lead to decreasing household-sizes as well as to a disproportionate increase in the number of households, relative to population development. As an example, an increase by 77% of single-households is expected for the Flachgau district between 2001 and 2031 (MAIR 2011, 127). Regarding settlement density, the Salzburg province is with an average of 72 inhabitants per square kilometre (Austrian average: 100 inhabitants per km<sup>2</sup>) rather sparsely populated. Thereby values differ considerably between the districts, especially due to the high share of mountainous areas in the southern districts (MAIR 2011, 110).

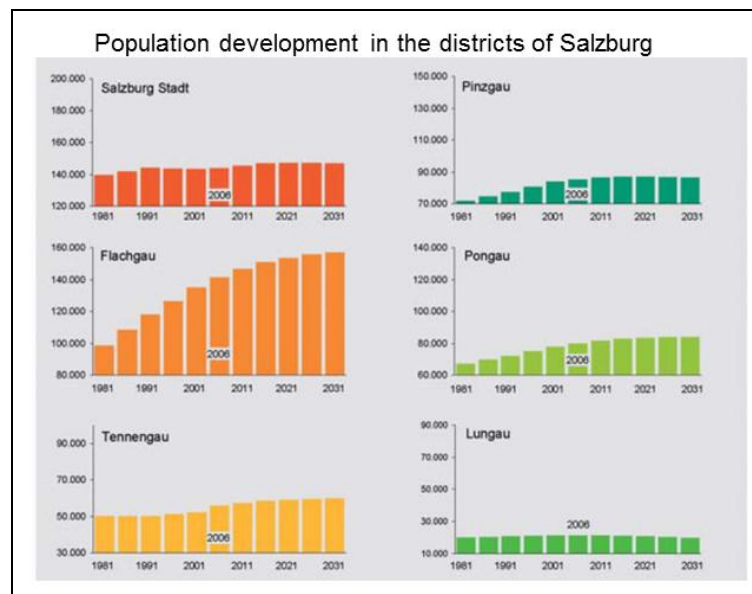


Figure 30: Past and future population development in the province of SBG (adopted from SCHNÜRER 2006, 13).

With respect to car ownership, the degree of motorisation in the province of Salzburg in 2004 added up to 480 cars per 1,000 inhabitants (HERRY 2005, 10). This was less than the Austrian average of 505 cars. However, as illustrated in Figure 31, there were great differences between the districts: While the Flachgau was characterised by an above-average motorisation of 519 cars per 1,000 inhabitants, the rate of 473 cars per 1,000 inhabitants in the city of Salzburg was below the average. In relation to the

number of households, this means that approx. 90% of the households in the province had at least one car and consequently only every tenth household had none. Again, there are discrepancies: In Salzburg City at least every fourth households stayed without a car (SCHNÜRER 2006, 22). Further, with respect to recent motorisation development, it can be found that the increase of cars is significantly less in the city as compared to more rural areas such as the Flachgau (Figure 31). Yet, in terms of the resulting traffic, the overall amount has risen seriously over the last 20 years, especially on highways. Research by SCHNÜRER (2006, 24) suggests that within the last 10 years, the traffic amount has risen by over 30%. This is equal to an increase of 2.5% per year.

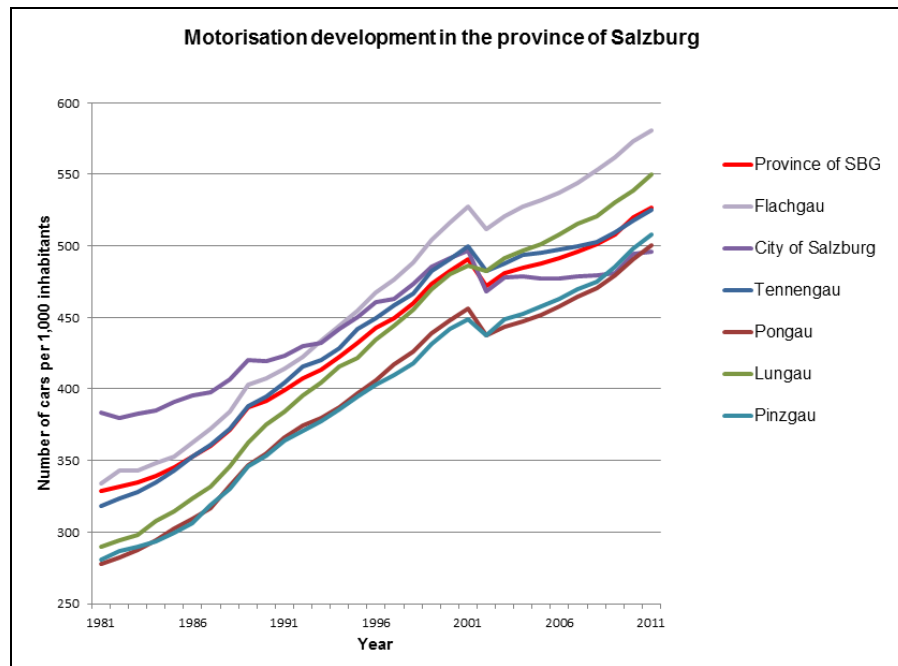


Figure 31: Motorisation in the province of Salzburg (author's design, based on HASLAUER ET AL. 2013a, 14).

Investigating on the actual trips, SCHNÜRER (2006, 17) found that the average distance travelled per day in the central region of the province (comprising the city, as well as the Flachgau and Tennengau) in 2004 summed up to 31.1km per person. More recent analyses from 2012, undertaken by SCHNÖTZLINGER (2013, 7) indicate 34km in this area; in 1983, daily distances amounted to just 18.5km (SCHNÜRER 2006, 17). Therefore trip lengths have increased significantly and still do so today. However, as SCHNÖTZLINGER (2013, 7) points out, again substantial differences exist, depending on location: While in 2012, the average overall travel distance in the Salzburg City covered 25.1km per day, people from the Flachgau and Tennengau travelled almost 40km on average. HASLAUER ET AL. (2013b, 185) found even higher discrepancies for the city centre and surrounding rural municipalities. In this context HERRY (2005, 11) argues that average distances increased the most for commuting travels to work as well as for leisure time activities. Thus, in order to get or keep a job, increasing distances are accepted by employees. Similarly, the growing interest in an increasing number of recreational facilities is realised at the expense of longer travels. These activities are expected to further increase in the future (SCHNÜRER 2006, 17). With regard to the modal split, i. e. the share of different means of transportation (chapter 4.1.), Figure 32 shows that in 2012 almost two third (62.9%) of all trips were undertaken by means of motorised individual transport. Travels on foot accounted for almost 20% and the



remaining 20% were almost equally distributed among public transport and bike use. Comparing Salzburg City with the other districts, it stands out that public transport and bike use were highest, car usage was lowest in the city: More than 50% of all trips in the city were travelled by eco-mobility (foot, bike, public transport). In the other districts, the share of eco-mobility added up to just 32% (Flachgau, Pinzgau, and Lungau) and approx. 35% (Tennengau, Pongau). Hence, as it was found in the theoretical investigation (chapter 4.3.1.), the centrality of a location directly impacts on the choice of transportation. Exploring further on the modal split in the region and the distances being covered by car, HERRY (2005, 10) notes that in 2004 every tenth travel by car was shorter than 1km. This is equal to the average distance being travelled on foot. Apart from that, SCHNÜRER (2006, 17) found that 44% of all car trips were less than 5km – a distance which may easily be covered by bike. Thus, indications are that immense potentials exist to reduce car traffic in the region. However, looking at the past development of the modal split in the province, the work of HERRY (2005, 10) reveals trends of decreasing travels on foot and (in some areas a strong) decline of public transport use. Moreover, individual car traffic rose together with a slight increase of bike traffic.

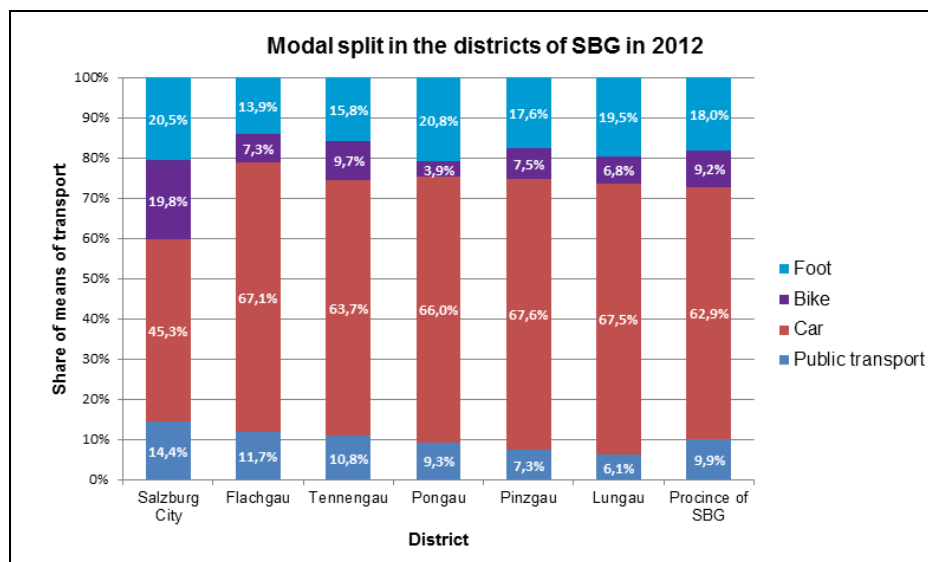


Figure 32: Modal split in the districts of Salzburg (author's design, based on SCHNÖTZLINGER 2013, 9).

Turning over to the topic of land action and land use, 10,091hectare of land in the province of Salzburg were allocated to residential housing in 2010 (MAIR 2011, 157). Thus, compared to 2006, this area increased by 198hectare i. e. by 2%. The highest share of this additional building land was designated in the Flachgau region (84hectare). MAIR (2011, 157) sees this as an indication for an expansion of the central region towards the north. Relating residential land to inhabitants, it can be found that the cities (such as Salzburg, St. Johann, and Hallein) show both the lowest share of allocated land per inhabitant and the lowest increase of additional building land. Nevertheless, it can be expected that increasing demand on land use (especially for settlement and infrastructure development as well as tourism expansion) keeps pressure on the remaining free space. MAIR (2011, 170f.) correctly states that the reasons for increasing land use in the province of Salzburg are to be found in societal and economic changes, as well as in the spatial planning practice:

- A continuing trend of land-intensive forms of development, especially in suburban areas (one- and two-family houses)
- A decoupling of population and settlement development due to socio-economic changes (smaller household sizes, larger living space per person)
- Economic and structural changes, increasing the mass appeal of central areas and regional centres; a shift from land-intensive services and manufacturing in suburban locations increases land use in these areas
- An increasing competition between municipalities (for inhabitants and businesses) causing building land allocation according to short-term and consumer-based demands; in consequence, unsuitable land development provokes high external costs for traffic, environment, and free space
- Neglecting interdependences between settlement structure and traffic (chapter 4.3.1.), in which increasing mobility fosters urban sprawl, which again causes forced mobility.

Finally, looking at real-estate prices in the province of Salzburg, it strikes out that values vary a lot between the different districts and especially between single municipalities. A map illustrating average square metre prices for each municipality in the pilot site is provided in Appendix I. The data being used in the map originates from the *Gewinn* land price list from 2012, being updated in an annual rhythm. The prices are estimated based on both direct requests to the respective municipalities and statistical calculations of the *Department of Urban and Regional Research at the University of Vienna* (WAILAND&WALDSTEIN 2012). Thereby square metre prices of single-family building lots are investigated, excluding development costs for infrastructure (WAILAND&WALDSTEIN 2012). As it can be seen in the map, top level prices were found in the city of Salzburg (although even within the city land prices differ a lot between the urban districts), as well as in surrounding municipalities in the Flachgau (Seeham, Mattsee, Anif, Koppl, Hallwang). Besides, scattered central municipalities and touristy areas in the province, such as Saalbach-Hinterglemm, Zell am See (Pinzgau), Flachau, Untertauern (Pongau), and Hallein (Tennengau) stand out. In all these municipalities, average land prices amounted to 400€ per square metre and more. In some quarters in the city of Salzburg (Parsch, Aigen), even average land prices of more than 1,000€ were found (WAILAND&WALDSTEIN 2012). Further, numerous municipalities from the Flachgau fall into the range of 300 to 400€, including St. Gilgen, Bergheim, Fuschl am See, Elixhausen, Mattsee, Wals-Siezenheim, and Eugendorf. Communes with lowest average land prices (less than 100€ per square metre building land) were primarily identified in the district of Tamsweg: Lessach, Murh, Zederhaus, and Ramingstein, to name just a few. As HASLAUER ET AL. (2013a, 34) note, prices for building land rose heavily between 2011 and 2012, especially in Salzburg City, where average increases by 224€ were registered. Also, surrounding municipalities were rather heavily affected (HASLAUER ET AL. 2013b, 185). MAIR (2011, 160) reports that a major problem that comes along with high land and rent prices (coupled with building shortage), is the provision of affordable housing. Thus, in central areas, where housing prices are too expensive, population decreases and consequently settlement density is reduced. This happens at the expense of suburbanisation and urban sprawl. Especially younger people and families are forced

(for cost or space reasons) to suburban migration (MAIR 2011, 160f.). Thus, as it was outlined in the theoretical part of this work (chapter 4.3.), this process leads to higher expenses on infrastructure as well as to a further spatial separation of activities, which in turn causes increased traffic (chapter 2.1.: Self-induced dynamic of regional traffic).

## 5.2. State of the Art Review

In the following sections, the practical implementation (process) of the *MOR€CO Housing and Mobility Cost Calculator* is presented. The procedure being followed for this purpose is illustrated in Figure 33. Thus, as a first step, existing calculators being related to the calculation of housing and mobility costs are researched. In this context it can be found that to date, numerous freely available tools exist, pursuing the goal of making people more aware of housing and mobility costs. Thereby a wide range of approaches and strategies are followed to communicate the information to households. Also, there are various kinds of overall concepts, which these calculators belong to. Based on innovative features, prominence, and user-friendliness, a selection of six calculators is chosen for a further examination of their applicability. These tools encompass:

- the *Wohn- und Mobilitätskostenrechner Hamburg (WoMo Hamburg)*, Germany
- the *Wohn- und Mobilitätsrechner des Münchner Verkehrs- und Tarifverbundes (WoMo München)*, Germany
- the *Mobilitätsausweis für Immobilien (MA++I)*, Austria
- the *Mobilitätskostenberechnung Schwerin*, Germany
- the *Entscheidungshilfe Gotha*, Germany
- the *VAG Mobirechner*, Germany

A brief description of each is given in the following section. Further, as shown in Figure 33, the functionality and usability of these tools is assessed by means of a strength-weakness-analysis. Therefore different properties and characteristics, such as user input, data basis, usability, and maintenance expenditure are inspected and opposed in a summary table. The resulting findings from this analysis are used to define the functionalities and demands on the *MOR€CO Housing and Mobility Cost Calculator*. From these requirements in turn, a respective concept for the functional, technical, and graphical realisation is derived, determining the technologies and services to be used. Finally, the actual implementation is done, covering the programming and debugging process.

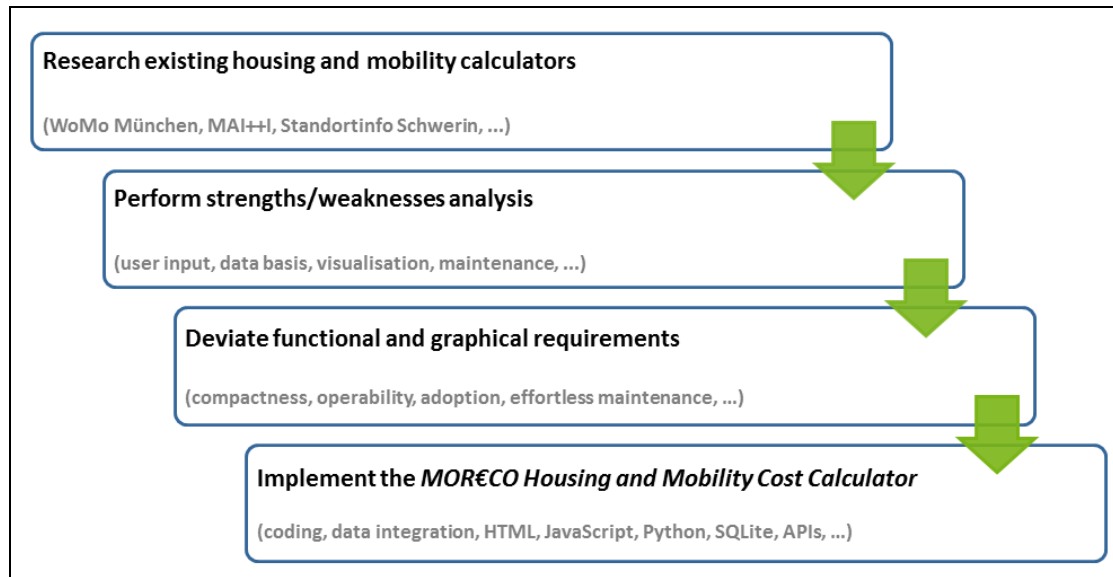


Figure 33: The approach being followed to develop the *Cost Calculator* (author's own design).

### 5.2.1. Current Cost Calculators

#### ***Wohn- und Mobilitätskostenrechner Hamburg***

As one of the first housing and mobility cost calculators, the *Wohn- und Mobilitätskostenrechner Hamburg* (<http://www.womo-rechner.de>) was developed between 2006 and 2008 at the HafenCity University Hamburg (HCU n. d.). Project partners encompassed the planning office *Gertz Gütsche Rümenapp* as well as the consulting company *F+B Forschung und Beratung*; funding was granted by the *German Federal Ministry of Education and Research (BMBF)*. The goal of the tool is to increase cost transparency for private households by estimating both housing and mobility costs for a residential location in the city of Hamburg as well as in neighbouring municipalities. In order to get these estimates, the user needs to choose his/her place of residence (based on a district level) and give details about the housing situation, including the type of housing (apartment, house), ownership (rent, purchase), and living area. Further, information on both the household structure (number of members, age) and the total net income is required. After this specification, a first result is obtained, comprising the total amount of monetary residential and mobility costs as well as the respective cost components. These results are also visualised in a bar chart. The method being applied to calculate the costs is based on statistical data on energy, mobility and housing structure: Average values for typical household types in different city districts were derived from a survey (HCU n. d.). Therefore common expenses for the purchase and usage of living space, the ownership and usage of cars as well as public transport use are determined, depending on both district and household structure. In a further step, the user has the possibility to individualise this data in order to adopt it to his/her situation. As a special feature, the calculator allows for the investigation of an alternative location as well, taking over all input made at the first location and adopting it to the new one.

### ***Wohn- und Mobilitätsrechner des Münchner Verkehrs- und Tarifverbundes***

Being based on a former research project of the *Bavarian Ministry of the Interior*, the *Wohn- und Mobilitätsrechner (WoMo)* of the Munich transport association (<http://womo.mvv-muenchen.de/>) was completed in 2011 by the *Gertz Gutsche Rümenapp* office in Hamburg, together with the *SpaceNet AG* and the *Phase 4 Communications GmbH* (MVV 2013). It follows a very similar concept as the *Mobilitätskostenrechner Hamburg* but on an even more sophisticated level. As a basic aim, the *WoMo* intends to inform households planning to relocate in the region of Munich on expenditures (both financial and travel distance/time) as well as on environmental effects (CO<sub>2</sub> emissions) that are to be expected at different locations. Therefore the user has to determine the number of household members as well as the working location of each employed family member (exact address, to be defined through a map or address field) and the number of travels to the respective workplace. Next, the place of residence has to be defined (again as an exact address) together with the housing situation (ownership, housing type, and living area). Regarding mobility, the user is provided with expectable travel durations for four different travel modes (covering public transport, car, park&ride, bike/foot) for each connection. Thus, for every trip to work, a means of transport needs to be chosen as well as the total number of cars and public transport tickets available in the household. In this context, the share of households in the neighbourhood owning no, one, two or more cars, is illustrated for a comparison. As a result, the user receives a table (including a graphical representation) which lists all of the monetary housing and mobility costs as well as respective components. Besides, the corresponding CO<sub>2</sub> balance, differentiated between housing and mobility is presented. The underlying approach for the calculation consists of both the input made by the user and general average values that were derived from various statistical analyses and institutions, calculated for specific types of households at particular locations (MVV 2013). Thereby most price quotations refer back to 2009/2010; public transport costs are current. All of these pre-defined entries may be adjusted by the user to his/her individual situation (as indicated by a magnifier symbol). Exclusive features in this context are that on the one hand, the consequences of both different locations and distinct choices on the means of transportation may be directly opposed to each other. On the other hand, the individual result may be compared to an average household at the respective location.

### ***Mobilitätsausweis für Immobilien***

The *Mobilitätsausweis für Immobilien* (<http://www.mobilitaetsausweis.at>) was published in 2012 by *CEIT ALANOVA*, *HERRY Consult*, the *Kuratorium für Verkehrssicherheit*, and the *Vienna University of applied Sciences for Management&Communication* (SCHRENK n. d.). Also, in the scope of the *ways2go*-programme, it was supported by the *Austrian Ministry for Transport, Innovation and Technology*. Similarly to the previous calculators, the *MA++I* estimates individual mobility and housing costs for two different locations (including rent, energy, maintenance, and running costs). In addition to that, follow-up costs such as CO<sub>2</sub> emissions, accident risk, and travel time are guessed, each on a yearly base. This shall assist citizens in the decision-making on housing. Thereby the user may choose between two different versions of the tool, namely a starting edition (providing a rough cost estimation, based on little and simple input) and an enhanced version (yielding more detailed results, based on more comprehensive user information and routing calculations). The particularity of the

former approach is the use of lifestyle clusters which were developed from the micro-census survey 2009 (*Statistik Austria*), comprising data on age, gender, income, respectively related to family types (SCHRENK n. d.). Based on the identification of seven lifestyle groups, every cluster was subdivided into four possible housing locations (cities with special infrastructure, urban, rural character, and rural community), resulting in 28 clusters, each being characterised by specific mobility behaviour. Thus, depending on the input of the user, he/she is assigned to a specific lifestyle class. In the enhanced tool version, the user needs to specify a location for both housing and (at least one) workplace. This can be done through a map. Further, different kinds of monthly costs for housing and a range of personal details are necessary: For each family member, age, gender, workplace, car usage, and (optional) weekly activities have to be defined and located. As a result, mobility costs for each person of the household are illustrated as well as overall housing costs. Besides, it is possible to display the respective travel routes for each person and weekday.

### ***Mobilitätskostenberechnung Schwerin***

The *Mobilitätskostenberechnung Schwerin* belongs to the research project *Integrierte Wohnstandortberatung – Wohnstandortinfo* (<http://www.schwerin.wohnstandort.info/>), which run from 2006 until 2010 and was funded by the *BMBF* (LANDESHAUPTSTADT SCHWERIN 2011). Just as the *Wohn- und Mobilitätskostenrechner Hamburg*, the project was part of the *REFINA* program, aiming at the reduction of land use and the promotion of sustainable land use management. Stakeholders of the *Wohnstandortinfo* project involved the *Technical University of Dortmund*, the planning offices *Büro für integrierte Planung* and *planwerkStadt* as well as the municipalities Schwerin and Wilhelmshaven. The goal of the *Wohnstandortinfo* project is to support house-hunting citizens in finding a suitable residential location. In this concept, the *Mobilitätskostenberechnung* is just one tool being offered apart from other services and instruments such as the *Gezielte Wohnstandortsuche* (which helps to identify residential locations based on individual preferences and demands), information collections on the different city districts, and personal consulting, to name just a few (LANDESHAUPTSTADT SCHWERIN 2011). This may also be the reason why (in contrast to other cost calculators), the *Mobilitätskostenberechnung* provides exclusively information on mobility costs, taking no account of any housing costs. At this stage, a rough estimation of commuting costs is performed: First, the user has to select a district, which may either be in Schwerin or within a 10km radius around the city. Besides, the number of persons in the household has to be defined. For each person, a line for regular trips to work/education is created in a mobility table. Further, the number of available public transport tickets and cars (including respective car types: small, medium, large) have to be determined. Based on this input, the user may choose for each family member the location of his/her place of work/education and the means of transportation that is generally used. Thereby options range from car (as driver), car (as passenger), motorbike, public transport, bike, to foot travel. Last, the number of trips per weeks has to be specified for each connection. As a result, the total amount of yearly commuting costs is presented, differentiated between the chosen means of transport. These costs are illustrated in a bar graph as well.

### ***Entscheidungshilfe Gotha***

Analogous to the consultation strategies in Schwerin and Wilhelmshafen, the German cities Gotha and Erfurt developed a Web portal collecting various information regarding housing and mobility (<http://www.fh-erfurt.de/vt/komkowo/entscheidungshilfe/>). This was done in cooperation with the *University of Applied Sciences* in Erfurt (FH Erfurt). Also, as a part of the *REFINA* program, the work was funded by the *BMBF* in the scope of the research project *Kommunikation zur Kostenwahrheit bei der Wohnstandortwahl (KomKoWo)* (EIZENHÖFER&SINNING 2009, 134). As a major result, the interactive tool *Entscheidungshilfe* for housing was developed, which shall support private households in their individual housing decision in Gotha (FH ERFURT n. d.). Being designed in the form of a survey, the tool rests on two pillars, namely cost and benefit: While cost aspects are assessed on a credit basis, a qualitative rating of different locations is performed by different (distance-based) criteria (EIZENHÖFER&SINNING 2009, 136). The overall intention of the tool is to both make costs more transparent and to illustrate advantages of certain locations. This in turn shall facilitate housing decisions. Input requirements of the tool encompass the structure of the household (number of persons, age, and occupation) and the preferred distance to the workplace/education institution for each family member. Further, maximum distances to different leisure time and supply services need to be determined, including shops for daily needs, general practitioners, cultural/catering facilities, public green space, and the car park; also, regarding public transport, the desired quality needs to be defined. In terms of monetary costs, the maximum price for a house (without the estate) and the number of cars are to be chosen as well as the frequency of travels to work/education/bulk purchase (including the respective means of transport). Based on this input, the user is proposed three locations in different districts which match the preferences most. For each of them, a result sheet, housing, and mobility costs are presented and respectively opposed to each other (FH ERFURT n. d.). Thereby housing costs encompass the financing need for all three locations, based on a calculation example. Mobility expenditures in turn comprise monetary and time costs both on a monthly and yearly basis: Travels to work, general leisure travels, shopping, and total travels as well as fixed costs for cars and public transport prices are respected.

### ***VAG Mobirechner***

An example which is rather distinct from the other cost calculator concerns the *VAG Mobirechner* of the *Freiburger Verkehrs AG* (<http://www.mobirechner.de>). Conception, layout, and implementation was undertaken by *m-bient MEDIAdesign* (FREIBURGER VERKEHRS AG 2013). In a very simple and straight forward way, it allows citizens to compare mobility cost savings of either car or public transport use. Although no further information regarding the calculator development and the calculation method was found, the tool was included in the selection due to its particular usability and visualisation technique: Based on very few sliders and one button (switching between a monthly and a yearly representation), respective cost saving are presented. The adjustments that can be made by the user encompass the price for petrol, the petrol consumption per 100km, kilometres being travelled per day, and costs for insurance and tax per year. Depending on how these screws are set, either car or public transport use is cheaper in the long-run. When using common settings, this is usually the case for the latter means of transportation. Thus, the respective amount of money saved per month/year is illustrated to the user.

### 5.2.2. Strengths- Weaknesses-Analysis

When exploring these six cost calculators in more detail and examining them for specific criteria, it stands out that each has particular strengths, but also certain constraints. An overview on the investigated criteria (comprising aspects on user input, output, and implementation) as well as the respective assessments is presented in Appendix II. In terms of user input, the criteria encompass the consideration of different travel purposes for the calculation of mobility costs (e. g. work, leisure, shopping, etc.), individual adoption possibilities by the user (such as financing, costs, calculations), the spatial accurateness for the calculation of mobility costs (municipality level, address-based), and the overall amount of necessary input by the user. Further, regarding the output, calculated costs (e. g. monetary, travel time, emissions, etc.), the possibility of alternative comparisons and scenario simulations as well as graphical illustrations of the result are looked into. Last, implementation aspects encompass the overall usability, spatial restriction of the calculator's coverage (cities, regions, and countries), the incorporation of a map/routing function, the possibility to immediately see the effect/result of a certain input change, references to any data sources, special features, and an estimation of the required technical and maintenance effort.

Looking at the *Wohn- und Mobilitätskostenrechner Hamburg* (Appendix II), it can be found that its major strengths encompass the possibility for users to adopt any pre-determined assumptions for the cost calculations, a low amount of required input data, the possibility to compare two locations with each other, and a bar chart visualising the result. Also, public transport ticket prices for any connections are calculated automatically. In terms of its usability, explanations on the different input fields are provided, a lot of input fields are pre-filled, and everything is ordered in a clear structure. However, turning to its limitations, it can be noted that apart from working travels, no other trip purposes are accounted for. The calculator lacks of a scenario simulation and the effect of changes performed by the user are not immediately visible. Moreover, the effort for the technical development as well as for maintenance seems to rather high.

The *Wohn- und Mobilitätsrechner München* in turn has strong capabilities with respect to the range of costs that can be calculated, including monetary housing and mobility costs, respective CO<sub>2</sub> emissions, and travel time expenditure. All relevant calculation parameters are described in detail and can be adjusted to the individual situation. The spatial resolution on the basis of which the housing and mobility costs are calculated is very fine, allowing for address-based location search and accurate investigations. As a special feature, the *WoMo München* provides travel time information for every trip to work and respectively for every means of transport. Besides, comparisons with the neighbourhood and an average household are possible. The restrictions of the calculator are very similar to those of the *WoMo Hamburg*. However, due to additional features and a broader data base being implemented, both the technical effort and long-term maintenance expenditures may be estimated even higher.

Following a different approach compared to the two previous calculators, it strikes out that the *Mobilitätsausweis für Immobilien* is not spatially restricted to a certain city or region, but rather facilitates calculations for almost any location within Austria (Appendix II). Yet at the same time investigations at particular addresses can be made



and variants may be compared. At this stage, even the route of individual trips on different days including different leisure activities may be displayed on a map. The effort that was necessary to implement the tool is assessed substantially less (in comparison to the other two calculators) and even maintenance may be easier to handle. However, despite these advantages, the calculator has some shortcomings. First of all, hardly any adoptions of the calculation parameters are possible. Further, a lot of user input is necessary before any calculation is done. Thereby the order in which different information is queried is not always comprehensible. This is further worsened by a rather noisy and unattractive layout.

The *Mobilitätskostenberechnung Schwerin* in turn has the advantage of being a clearly structured, easy-to-use application, demanding little input from the user. Thus, as part of an overall consultation concept for citizens in Schwerin, it may be used in a straight forward way. In terms of the technical development it may be assumed that manageable effort was necessary. Besides, requiring only a small amount of background data, maintenance expenditure may be considered as moderate. Looking at the limitations on the other hand, the user can exclusively inspect his/her mobility costs; housing costs are neglected completely. Also, as a further restriction in this context, solely travels to work can be analysed and few adoptions in terms of car costs can be made (no options for maintenance, fuel consumption, etc.). Moreover, when comparing locations with each other, the user can only see financial differences, without any information on how this difference comes about. Last, the calculator is spatially restricted to the city of Schwerin (including a radius of 10km).

When inspecting the *Entscheidungshilfe Gotha*, it can be found that the user may determine different criteria for his/her new location. Based on these, three locations in the city of Gotha are proposed which match the preferences the most. Apart from that, the result lists both monetary mobility/housing costs and time expenditures for all three locations. Thereby mobility costs, include expenditures for three kinds of trip purposes, namely for work, leisure, and shopping. However, the weaknesses of the tool include both the extensive amount of input that is required and the lack of individual adoption possibilities of the costs: Apart from the number of cars and the frequency of travels to work (including the respective means of transport), no changes can be made. Thus, the incorporation of other travel purposes is done exclusively on an average base; no routing function is used. In terms of the technical implementation and maintenance, rather high effort is expected.

Last, the *VAG Mobirechner* proves itself with very few input data by the user as well as with a direct illustration of the effect of the changes made. To exemplify this, an increase of petrol prices or reduced petrol consumption immediately leads to another result that is presented. The structure of the tool is very clear and implemented in a modern and attractive design; also, the comfortable handling through sliders facilitates an intuitive usage. At the same time, development expenditures as well as maintenance effort may be assessed as low, since few functions and data are necessary. On the other hand, this high usability comes at the expense of a lack of many features: The *Mobirechner* does not account for any trips made and consequently does not make use of any routing. It is restricted to the coverage of the *Freiburger Verkehrs AG* and does not account for any housing costs or time expenditures. Also, a description of the calculation process in the background, a comparison of alternatives, and a graphical illustration are missing.

It must therefore be recognised that different priorities exist for the investigated tools. On the one hand, there are calculators that account for both housing and mobility costs, indicating the dependencies of both cost components; on the other hand, several applications focus exclusively on mobility costs, illustrating the effect of different mobility behaviour. Furthermore, there are substantial differences regarding the amount of detail that is taken into account in terms of housing and mobility costs: Calculators that are spatially restricted to a certain area often incorporate very detailed information on costs. However, these calculators can only be used by a limited number of people. Other tools, being designed for larger areas are based on more general assumptions which sometimes are quite vague or lack of transparency.

### **5.2.3. Derivation of Requirements for the Calculator**

Based on the review of current state of the art cost calculators and the elaboration of both proven technical possibilities and aspects that are to be avoided, the methodological, technical, and graphical demands on the *MORECO Housing and Mobility Cost Calculator* are defined. As highlighted in the list in Appendix II, this comprises a range of different aspects. A selection of the most important features and characteristics is presented in the following, including a brief description of each.

#### **Usability and adaptability**

In order to be used by a broad range of people, the calculator needs to be quickly available and easily operated. Analyses and evaluations by SINNING ET AL. (2009, 14) suggest that users of on-line applications expect these to be compact and understandable. Therefore, a quick access to the final information has to be a major goal of the development. As found in the previous chapter, this can be achieved by different means, including a small overall amount of user input, the distinction between mandatory and optional input attributes (KREITZ ET AL. 2002, 159), and pre-filled input fields which may be modified by the user if it is desired. As another way of assuring a comfortable usage, brief descriptions of input fields may be given, where necessary. Apart from that, attention has to be drawn to the fact that there is a limited willingness of people to provide personal information (ALBRECHT ET AL. 2009, 150). Thus, although it was found earlier, that a variety of personal factors and individual variables impact on mobility behaviour and on costs, not all of this information may be obtained.

#### **Seriousness**

Aiming at the provision of independent and objective information, private households and house-hunting families shall perceive the calculator as a reliable and serious source of information. It has to become clear that it is not the intention of the tool to flog anything or to tempt citizens in the interest of the public. In this context ALBRECHT ET AL. (2009, 151) correctly argue that the design and textual explanations of the application have to be factual and neutral. Any technical, political or cultural message should be avoided. However, at the same time it is important to verify and qualify any assumptions made or information being used for the calculation. Therefore references to any incorporated sources or studies have to be provided.

### **Different trip purposes**

Given the fact that an increasing amount of traffic in the province of Salzburg is caused by leisure time activities (chapter 5.1.), it is important to account for these travels when calculating mobility costs. LOHR (2013) has expressed a similar view. According to his research, it would be too short-sighted to only think of trips to work or education; private trips play an important role with regard to traffic generation. In consequence, the calculator shall facilitate the investigation of various trip purposes, including work, leisure, shopping, and others.

### **Immediate representation of changed input**

As it was found when studying current cost calculators, none of them included the feature of an immediate representation of the effect that certain selections or input changes have on the result (Appendix II). This is true, except for the *VAG Mobirechner*, which does include the technique. However, as it was outlined, this tool is not to be understood as a comprehensive housing and mobility cost calculator (chapter 5.2.2.). Thus, it has been common practice so far to first let users provide all input and to present the result at the end. This makes it difficult for users to assess where respective costs come from and how much certain criteria impact. Therefore, following the general concept of the *VAG Mobirechner*, the *Housing and Mobility Cost Calculator* should integrate a function which directly illustrates respective changes made.

### **Comparison of alternatives**

Similar to some of the cost calculators explored, the calculator to be developed shall allow the user a direct comparison of two variants. SINNING ET AL. (2009, 47) perceptively state that it is important to be able to compare alternatives with each other in order to facilitate a respective assessment. These alternatives shall comprise both the investigation of two different locations (assuming the same mobility behaviour) and the testing of the same location (based on changed mobility behaviour). Thereby the user shall be able to change both variants independently from each other.

### **Easy maintenance**

Turning to HOLZ-RAU ET AL. (2010, 84), one finds that it is of high importance for the acceptance of a service that the information being provided is correct and current. Thus, in order to keep the calculator up-to-date, it is necessary to follow an approach which allows for easy and effortless maintenance of the information. As BAUER&WOHLTMANN (2010, 10) note, this may be achieved by making use of interfaces to respective external services, rather than saving all data locally. To exemplify this, by applying an *Application Programming Interface (API)* to the *Salzburger Verkehrsverbund*, in order to retrieve information on ticket prices, changing charges are directly accounted for in the application. This offers an efficient way to guarantee the up-to-dateness of the tool. Hence, wherever possible, *APIs* and Web services are to be used.

### 5.3. Calculator Conceptualisation

As it was outlined in chapter 2.3., the *MORECO Cost Calculator* shall estimate individual expenses of a household, including monetary housing costs (consisting of rent, loan financing, and associated charges), monetary mobility costs (comprising fixed and variable car expenses as well as monthly public transport ticket costs), and travel expenditures (namely distances being covered with different means of transportation and the overall travel time). In addition, the annual mileage covered by car(s) and also the total travel time for trips shall be listed. The concept that is followed to calculate all these expenses is illustrated in Figure 34.

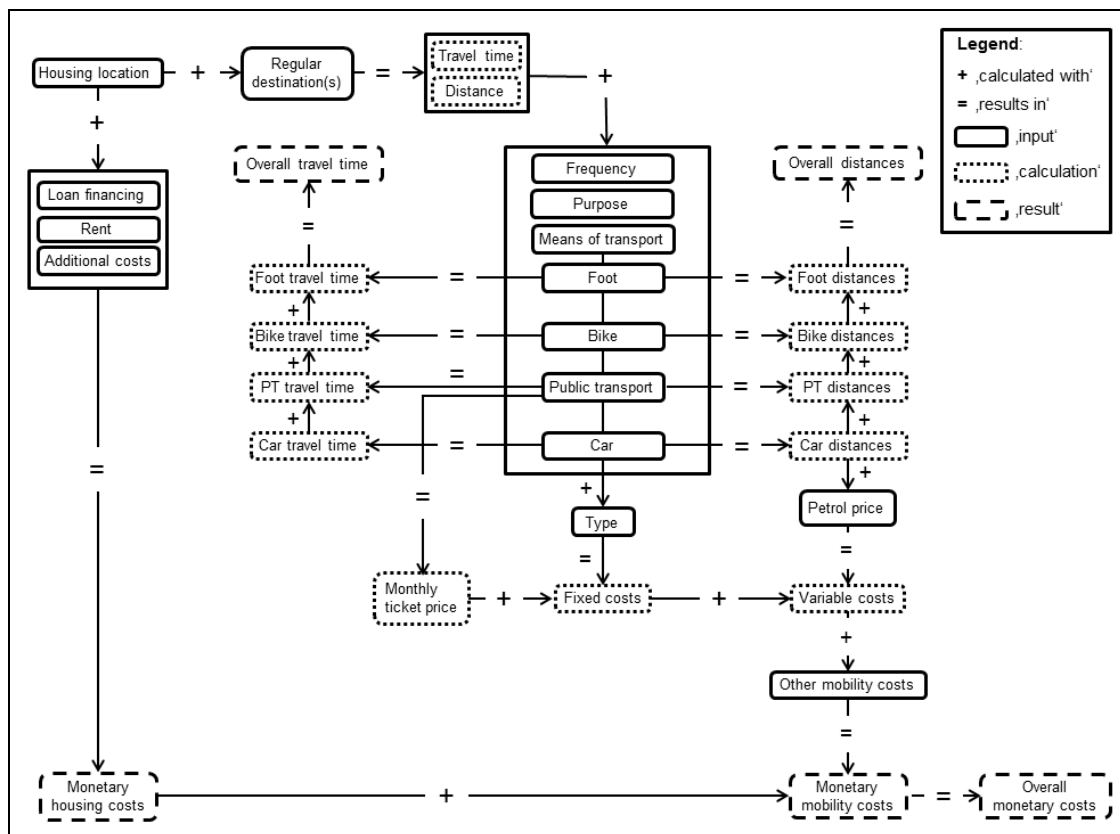


Figure 34: Functional concept of the *Housing and Mobility Cost Calculator* (author's own design).

Thus, beginning with the selection of a housing location, the user defines the starting point for all regular travel activities. Further, by determining the monthly rent for this location or – in the event of property purchase – the monthly financing costs as well as any additional charges that exist, the total housing costs per month can be calculated. Monthly mobility expenses in turn are derived from regular trips which are undertaken by the user: Based on the housing location and the respective trip destination(s), both travel time(s) and distance(s) for the prevailing connection(s) can be determined, initially for all four modes (foot, bike, public transport, and car). In combination with further details on the respective trips(s), including trip frequency, purpose, and the means of transportation that is generally used, the actual travel time(s) as well as distance(s) can be calculated and stored (Figure 34). This is done separately for every means of transportation. Hence, by summing up both travel time(s) and distance(s) for every mode, the overall time and distance expenditures for the prevailing location can

be calculated. Thereby, it is distinguished between different trip purposes: Work/education trips are listed separately from other travels. Next, with respect to the monetary mobility expenses, public transport tickets, car costs, and additional mobility charges are taken into account. The former are derived from the *Salzburger Verkehrsverbund* for the prevailing trip, based on a monthly season ticket. Monetary costs for private car use on the other hand are composed of fixed costs (such as depreciation, insurance, maintenance) and variable running costs. Variable costs depend on both distances being covered and the petrol price (Figure 34) (KREITZ ET AL. 2002, 161). Besides, additional mobility costs may be included, comprising any other expenses the user wants to consider (e. g. bike maintenance costs, etc.). Finally, by adding up monetary housing and mobility costs, the overall monetary expenses may be derived. In this context time expenditure is not included as a monetary cost component.

As it was found by numerous studies (e. g. FRANZ 2010, 79; KREITZ ET AL. 2002, 162; SCHEINER 2008, 57) and as it is illustrated in Figure 34, it is important to differentiate between different car types when calculating monetary car costs. FRANZ (2010, 79) correctly argues that both fixed and variable car costs differ from each other, depending on the car model. In this regard, several auto-mobile associations such as the *Österreichischer Automobil-, Motorrad- und Touringclub* (ÖAMTC) collect various kinds of technical data for a range of car manufacturers and models and calculate resulting costs. Thereby both fixed and variable costs are investigated (ÖAMTC 2013). However, given the huge number of different car types, it would be too much to account for individual models. Therefore FRANZ (2010, 79) suggests a differentiation between car categories. Thus, three classes are defined (small, mid-range, and upper class car) and for each class, three representative cars are chosen in terms of size, features, and cubic capacity (Table 1). The respective fixed costs (list price, depreciation, liability insurance, insurance tax, maintenance, and additional costs) as well as information on variable costs (i. e. fuel consumption) are derived from the ÖAMTC. In this respect it needs to be highlighted that the expenses are calculated for new cars, being run for 6 years, with a mileage of 15,000km per year (ÖAMTC 2013). Based on the resulting figures, average values for each category are computed and stored in a database, from where they are included into the calculation process. However, in doing so, the user may examine and (if necessary) individually adopt the values.

**Table 1: Car data and monthly fixed costs for different vehicle types (author's design, based on ÖAMTC 2013).**

| Category        | Example                            | Fuel consumption | List price   | Monthly costs |                     |               |             |                  |
|-----------------|------------------------------------|------------------|--------------|---------------|---------------------|---------------|-------------|------------------|
|                 |                                    |                  |              | Depreciation  | Liability insurance | Insurance tax | Maintenance | Additional costs |
| Small car       | Panda 1,1 ECO Active               | 5,4              | 9460         | 107           | 59                  | 14            | 54          | 30               |
|                 | Renault Twingo Tce 100 Gordini     | 6,8              | 14430        | 154           | 73                  | 28            | 90          | 30               |
|                 | Citroen C1 1,0 Attraction          | 4,5              | 9250         | 103           | 59                  | 14            | 67          | 30               |
|                 | <b>Average (small car)</b>         | <b>5,6</b>       | <b>11047</b> | <b>121</b>    | <b>64</b>           | <b>19</b>     | <b>71</b>   | <b>30</b>        |
| Mid-range car   | VW Golf Plus Comfortline 1,4 TSI   | 6,9              | 25370        | 257           | 76                  | 36            | 97          | 39               |
|                 | Opel Astra ST 1,4 ecoFLEX Kombi    | 7,5              | 20720        | 217           | 73                  | 28            | 98          | 29               |
|                 | Audi A3 SB 1,2 TFSI ComfortEdition | 6,8              | 24800        | 255           | 73                  | 29            | 107         | 31               |
|                 | <b>Average (mid-range car)</b>     | <b>7,1</b>       | <b>23630</b> | <b>243</b>    | <b>74</b>           | <b>31</b>     | <b>101</b>  | <b>30</b>        |
| Upper class car | Mercedes-Benz E 200                | 9,8              | 45100        | 450           | 92                  | 61            | 151         | 28               |
|                 | Audi A6 2,0 TFSI                   | 9,4              | 43280        | 406           | 92                  | 59            | 137         | 26               |
|                 | BMW 520i                           | 9,5              | 43850        | 427           | 92                  | 61            | 134         | 27               |
|                 | <b>Average (upper class car)</b>   | <b>9,6</b>       | <b>44077</b> | <b>428</b>    | <b>92</b>           | <b>61</b>     | <b>141</b>  | <b>30</b>        |

## 5.4. Calculator Implementation

Based on the functional concept presented in the previous section and the technologies described in chapter 2.4., the implementation of the *Cost Calculator* is undertaken. Client-side, this encompasses the design of the user interface using *HTML* (.html file) and *Cascading Style Sheets* (.css file) as well as the development of the interactive behaviour of the tool interface by means of *JavaScript* (.js file), including the mentioned *JavaScript* libraries – *jQuery*, *jQuery UI*, and *Highcharts*. Server-side, the implementation comprises the set-up of the *SQLite* database (holding the data of the different car categories) and the creation of two *Common Gateway Interface (CGI)* scripts in *Python* (.cgi file); one of them being responsible for the calculation of the costs, the other one being used to access the *SQLite* database. Relevant code snippets of the different files are provided later on in this chapter. An overview on the techniques and the tool architecture is displayed in Figure 35. All technologies and development environments applied are open source, no proprietary software is used.

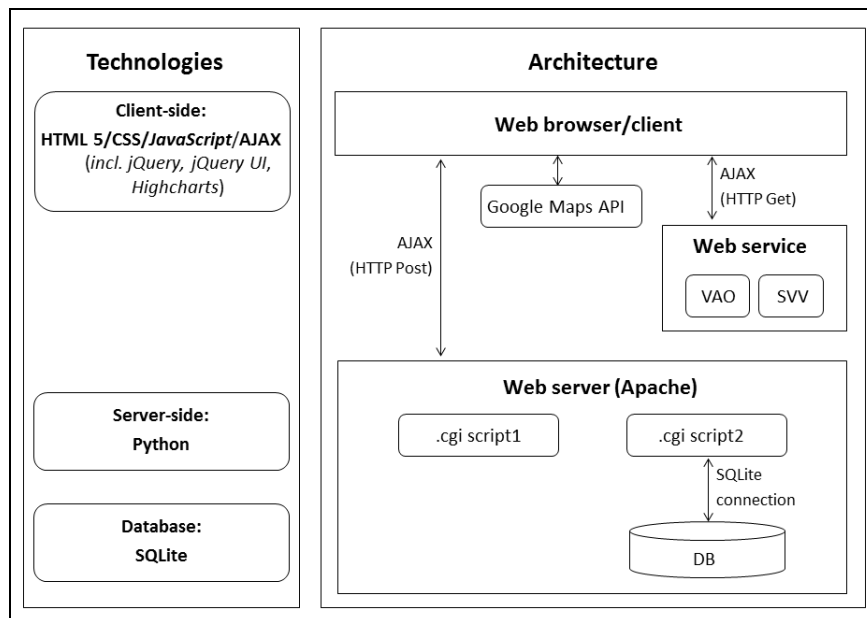


Figure 35: Architecture of the *Cost Calculator* (author's design, based on SCHRENK ET AL. 2012, 1302).

Based on the figure, the work-flow can be described as follows: The *Cost Calculator* may be accessed through any current Web browser such as *Firefox* (version 3.6 and higher), *Google Chrome* or *Internet Explorer* (version 9 and higher). Apart from the fact that JavaScript needs to be activated in the browser, no further plug-ins or additional software are needed. By filling the respective input fields in the user interface, the data provided by the user is sent to the *CGI* script, being stored on an *Apache* Web server. This is done by making use of *Asynchronous JavaScript and XML (AJAX)*, a technique which allows to perform asynchronous *HTTP* requests (JQUERY FOUNDATION 2013b). Thus, by means of *AJAX*, the user information is sent to the server and the resulting calculations are received, without the application/Web page being reloaded. This reduces waiting time, as the data exchange takes place in the background of the application, while the user may continue with the data input (asynchronously). Depending on the input of the user, requests are either sent to script1 or script2: While the former is exclusively used to calculate expenses (monetary costs, as well as

travel time and distance expenditures), the latter is addressed in case vehicle data is required (such as maintenance costs or fuel consumption of a certain car category). Thereby script2 accesses the *SQLite* database, querying vehicle information based on the determined user parameters. Apart from this client-server interaction, the *Google Maps API* and two Web services are incorporated in the *JavaScript* file (Figure 35). As it was mentioned in chapter 2.4., the *Google Maps API* is used for three main tasks, namely for *Places Autocomplete* (i. e. the suggestion of addresses, based on the beginning of a place name entered by the user), *Geocoding* (transforming strings of place names to coordinates and representing them on a map as well as the other way round: Retrieving coordinates and place name for a location selected on a map), and *Direction* services (that is routing between two places for foot, bike, and car travel, calculating respective distances and travel time expenditures). The two Web services in turn encompass the integration of information from the *Verkehrsauskunft Österreich (VAO)* and the *Salzburger Verkehrsverbund (SVV)*. While the VAO offers high-quality routing services for public transport (i. e. travel time, distances to the bus stop to be covered on foot, and transfer frequency), the SVV provides information on transport ticket prices for respective connections. Both the VAO and the SVV API are not directly accessed from the *JavaScript* file, but instead by means of a Web service, which was developed by *Traffic Consultants GmbH (TraffiCon)*. This separation between the *JavaScript* file and the services is necessary in order to avoid problems regarding the *cross-domain/same origin policy*, an important security concept for client-side programming. The policy allows scripts originating from the same site (origin) to interact and access each other's *Document Object Model (DOM)*. However, it restricts access in case the domains differ. This implies that the VAO/SVV services need to originate from the same domain as the *JavaScript* file/*HTML DOM* does, to facilitate information exchange with the *HTML DOM*. Hence in a first step, the VAO/SVV services are queried by a small application being stored under the same domain as the JS file/*DOM*; in a further step, the information is inserted into the *HTML DOM*.

A selection of important (simplified) extracts of the different code files is provided in the following. While the first five samples comprise program parts of the *HTML* document and the *JavaScript* code (including *jQuery*, *jQuery User Interface*, *AJAX*, the *Google Maps API*, and the VAO/SVV Web service access), the last two code blocks illustrate parts from the two *Python CGI* scripts. Each code extract is briefly contextualised and its respective function is explained. Apart from that, in-line documentation is provided to describe in more detail what is done in each step. Thus, Pseudo Code 1 presents the *head* section of the *HTML* document. This is where meta data on the document is provided and all *JavaScript* files, *Cascading Style Sheets*, and *APIs* are linked. More precisely, these encompass both external files (such as the *jQuery JS* and the *Google Maps API*) and files that are stored locally (including the *CSS* of the *HTML*, the main *JavaScript* document, a script to serialize information provided by the user through the input fields, the *jQuery UI JS* and *CSS* files, the *Highcharts* library, and a *JavaScript* program which is used for coordinate transformation). It is necessary to register all these files and services to allow for interaction and data exchange between them.

```

<head>
  <meta charset="utf-8" />
  <title>MORECO Haushaltsrechner</title>
  <meta name="author" content="Sebastian Cadus" />
  <!-- Date: 2013-09-09 -->
  <link type="text/css" rel="stylesheet" href="css/style.css" />
  <!-- JQuery JS -->
  <script src="http://code.jquery.com/jquery-1.9.1.js"></script>
  <!-- JQuery (UI) CSS -->
  <link type="text/css" rel="stylesheet" href="jquery-ui-1.10.3.custom/css/custom-theme/jquery-ui-1.10.3.custom.css" />
  <!-- JQuery (UI) JS -->
  <script type="text/javascript" src="jquery-ui-1.10.3.custom/js/jquery-ui-1.10.3.custom.js"></script>
  <!--Google Maps V3 JavaScript API + Places Library -->
  <script type="text/javascript" src="https://maps.googleapis.com/maps/api/js?v=3.exp&sensor=false&libraries=places"></script>
  <!-- Local scripts -->
  <!-- Main Script -->
  <script type="text/javascript" src="js/functions.js"></script>
  <!-- Script to serialize data to be send to a server -->
  <script type="text/javascript" src="js/serializeAnything.js"></script>
  <!-- Highcharts Library -->
  <script type="text/javascript" src="js/highcharts.js"></script>
  <!-- Script for coordinate transformation -->
  <script type="text/javascript" src="js/proj4js-compressed.js"></script>
  <!-- Hint to the user, if JavaScript is disabled -->
  <noscript>Sorry, your browser does not support JavaScript!</noscript>
</head>

```

Pseudo Code 1: Incorporation of the JavaScript files, CSS, and APIs into the HTML head.

Next, Pseudo Code 2 illustrates the implementation of the graphical user interface using *HTML* and *jQuery UI*. At this stage, both the *Tab* and the *Accordion* widget of *jQuery UI* are applied to structure the overall appearance of the application. In order to make use of the widgets, it is required to initialise them in the *JavaScript* file. As it is indicated in the code, this is done by referring to the respective element class name of the *HTML* document and calling the *.tabs()* (and resp. the *.accordion()*) function (JQUERY FOUNDATION 2013a). More detailed formatting may be done by adding parameters to the function call (as demonstrated for the *heightStyle* property of the *Accordion* call) and through the *HTML/CSS* document.

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HTML       | <pre> &lt;body id="htmlbody"&gt;   &lt;!-- Define form document and path to cgi script --&gt;   &lt;form id="mainform" name="mainform" action="/cgi-bin/index.cgi"&gt;     &lt;div id="div_container" style="width:1000px"&gt;       &lt;!-- Tab Structure --&gt;       &lt;div id="div_tabs"&gt;         &lt;ul&gt;           &lt;li&gt;&lt;a class="reiterlink" id="li_wohnen_T1" href="#div_tabs_T1"&gt;1. Wohnen&lt;/a&gt;&lt;/li&gt;           &lt;li&gt;&lt;a class="reiterlink" id="li_mobilitaet_T2" href="#div_tabs_T2"&gt;2. Mobilität&lt;/a&gt;&lt;/li&gt;           &lt;li&gt;&lt;a class="reiterlink" id="li_ergebnis_T3" href="#div_tabs_T3"&gt;3. Ergebnis&lt;/a&gt;&lt;/li&gt;           &lt;li&gt;&lt;a class="reiterlink" id="li_alternative_T4" href="#div_tabs_T4"&gt;4. Alternative&lt;/a&gt;&lt;/li&gt;           &lt;li&gt;&lt;a class="reiterlink" id="li_vergleich_T5" href="#div_tabs_T5"&gt;5. Vergleich&lt;/a&gt;&lt;/li&gt;         &lt;/ul&gt;         &lt;!-- Tab 1 --&gt;         &lt;div class="reiter" id="div_tabs_T1"&gt;           &lt;!-- (...) --&gt;           &lt;!-- Accordion Structure --&gt;           &lt;div class="div_accordion" id="div_accordion_T1"&gt;             &lt;h3 id="accordion1_1"&gt;Wohnprojekt 1&lt;/h3&gt;             &lt;!-- (...) --&gt;           &lt;/div&gt;         &lt;/div&gt;         &lt;!-- (...) --&gt;       &lt;/div&gt;     &lt;/form&gt;   &lt;/body&gt; </pre> |
| JavaScript | <pre> // Execute functions when document is loaded \$(document).ready(function(){    //Initialisation of the tabs   \$(function(){     \$("#div_tabs").tabs();   });    //Initialisation of the accordions   \$(function(){     \$(".div_accordion").accordion({       //determine accordion heights       heightStyle: "content"     });   });    // (...) } </pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

Pseudo Code 2: Set up of the interface structure in *HTML* by means of *jQuery UI*.



```

//Update calculations in HTML input fields
function updateBerechnungen () {
    //HTTP AJAX request
    $.ajax({
        //A string containing the URL to which the request is sent
        url: "/cgi-bin/index.cgi",
        //The type of request to make ("POST" or "GET")
        type: "post",
        //The type of data that is expected back from the server; "json": returns a JavaScript object
        datatype: "json",
        //Data to be sent to the server; in this case all input fields of the html body
        data: $("#htmlbody").serializeAnything(),
        success: function(cgiresponse){
            //write result to respective HTML input fields
            $("#jahreskilometerMIV1").val(cgiresponse.calculations.autoJahresKilometer1);
            $("#ergebnisGesamtkosten1, #ergebnisGesamtkosten1_1").val(cgiresponse.calculations.gesamtKosten1);
            $("#ergebnisDarstellung1").val(cgiresponse.calculations.ergebnisDarstellung);
            $("#ergebnisWohnkosten1, #ergebnisWohnkosten1_1").val(cgiresponse.calculations.gesamtKostenWohnen1);
            $("#ergebnisMietel, #ergebnisMietel_1").val(cgiresponse.calculations.mietFinanzierungsKosten1);
            //(...)
            //Call function to update Highchart
            updateChart();
        }
    });
};

```

Pseudo Code 3: Data exchange between the *HTML* document and the *CGI* script via *AJAX*.

```

//Parameters being handed over: number of location, pathnumber, starting position, destination
function route (wohnprojektnr, wegnr, start, ziel){
    try {
        //define request parameters for car routing
        var request = {
            origin:start,
            destination:ziel,
            travelMode: google.maps.TravelMode.DRIVING
        };
        //request route
        directionsService.route(request, function(result, status) {
            if (status == google.maps.DirectionsStatus.OK) {
                //if route found parse time and distance and write to html
                document.getElementById("miv_Strecke"+wohnprojektnr+"_"+wegnr).value = Math.round(parseFloat(result.routes[0].legs[0].distance.value)/1000);
                document.getElementById("miv_Zeit"+wohnprojektnr+"_"+wegnr).value = Math.round(parseFloat(result.routes[0].legs[0].duration.value)/60+10);
            }
            else alert ("error");
        });
        //(...)
    }
    catch (e) {
        //exception handling
        document.getElementById("miv_Strecke"+wohnprojektnr+"_"+wegnr).value = 0;
        document.getElementById("miv_Zeit"+wohnprojektnr+"_"+wegnr).value = 0;
        // (...)
    }
};

```

Pseudo Code 4: Car routing request for the *Google Maps API*.

```

//Parameters being handed over: number of location, pathnumber, coordinates for starting position and destination
function vao_route(wohnprojektnr, wegnr, startLat, startLng, zielLat, zielLng){
    //Google Maps LatLng class for start and destination coordinates
    var start = new google.maps.LatLng(startLat, startLng);
    var dest = new google.maps.LatLng(zielLat, zielLng);
    //HTTP AJAX request
    $.ajax({
        //The type of request to make ("POST" or "GET")
        type: "GET",
        //The type of data that is expected back from the server; jsonp loads in a JSON block using JSONP
        dataType: "jsonp",
        //A string containing the URL to which the request is sent.
        url: "http://ispace.v08.researchstudio.at/moreco-service/vao-route",
        //Requests are sent asynchronously
        async: true,
        //Data to be sent to the server.
        data: {origin: start.toUrlValue(6), destination: dest.toUrlValue(6) }, //appends Params
        //force a crossDomain request (such as JSONP)
        crossDomain: "true",
        //Functions to be called if the request succeeds.
        success: function (data) {
            var distance = 0;
            var distancePart;
            //Sum up sections of the route
            for (element in data.routeDetailsList) {
                distancePart = data.routeDetailsList[element].distance;
                distance = distance + distancePart;
            }
            //write result to respective HTML input fields
            document.getElementById("oew_Strecke"+wohnprojektnr+"_"+wegnr).value = "Fußweg: "+String(Math.round(parseFloat(distance)/100)/10).replace(".",",");
            document.getElementById("oew_Zeit"+wohnprojektnr+"_"+wegnr).value = Math.round(parseFloat(data.duration)/60);
            document.getElementById("oewUmsteigen"+wohnprojektnr+"_"+wegnr).value = (data.changes + "xUmst");
        },
        //error handling
        error : function(jqXHR, textStatus, errorThrown) {
            alert(textStatus);
        },
    });
};

```

Pseudo Code 5: Public transport routing request for the *VAO Web service*.

The block of Pseudo Code 3 shows the data exchange between the *HTML* document and the *CGI* script, i. e. the transmission of user input to the server and the reception of the calculated results. As it was mentioned before, this is done by means of an *HTTP* *AJAX* request. The *AJAX* call via *jQuery* (*\$.ajax()*) consists in this case of the *URL* address of the *CGI* script, the request type (*post*), the datatype that shall be returned (*json*), and the data that is to be sent (all input fields of the *HTML* document) (JQUERY FOUNDATION 2013a). Further, the call defines, what happens once the response is received (*success: function()*): The results are written in the *HTML* input fields.

Further, Pseudo Code 4 displays the use of the *Google Maps API* in order to receive routing information for car travel. Thus, as it is illustrated, the *route()* function is called, together with some parameters that are handed over. These include, amongst other information, the start and destination location. Within the *route()* function, the parameters for the request are defined (comprising start and end point as well as the means of transport). Subsequent to this, the routing is requested and – in case a route is found – distance and time expenditures are filled in the respective input field.

The program snippet presented in Pseudo Code 5 provides details on the routing request for the *VAO* Web service. Again, this is realised by means of an *AJAX* call. First, the coordinate pairs for the start/end location handed over to the function are transformed to a *LatLng* object through the *google.maps.LatLng* class. As a result, both coordinates are represented as geographic points. Second, these points are sent to the Web service, from where they are forwarded to the *VAO API*. In the *success* function, the received *routeDetailsList* is run through to calculate the overall distance. Last, the overall distance, travel time, and number of transfers are inserted into the *HTML*.

```
//Parameters being handed over: coordinates for starting position and destination, number of location, path number
function proj(originx, originy, destx, desty, standort, ticketNumber){
    //EPSG:31469 DHDN / 3-degree Gauss-Kruger zone 5
    Proj4js.defs["EPSG:31469"] = "+proj=utmcrs +lat_0=0 +lon_0=15 +k=1 +x_0=5500000 +y_0=0 +ellps=bessel +datum=potsdam +units=m +no_defs";
    //source coordinates will be in Longitude/Latitude WGS84
    var source = new Proj4js.Proj('EPSG:4326');
    //destination coordinates Gauss-Kruger zone 5
    var dest = new Proj4js.Proj('EPSG:31469');

    // transforming point coordinates
    //any object will do as long as it has 'x' and 'y' properties
    var p_origin = new Proj4js.Point(originy, originx);
    //any object will do as long as it has 'x' and 'y' properties
    var p_dest = new Proj4js.Point(desty, destx);
    //do the transformation. x and y are modified in place
    Proj4js.transform(source, dest, p_origin);
    //do the transformation. x and y are modified in place
    Proj4js.transform(source, dest, p_dest);
    //origin
    var nav5_origin = {x : "0", y : "0"};
    nav5_origin.x = p_origin.x;
    nav5_origin.y = 6160000 - p_origin.y;
    //destination
    var nav5_dest = {x : "0", y : "0"};
    nav5_dest.x = p_dest.x;
    nav5_dest.y = 6160000 - p_dest.y;
    //send HTTP-GET with JSONP request to Web service
    $.ajax({
        type: "GET",
        dataType: "jsonp",
        async: false,
        url: "http://ispacesrv008.researchstudio.at/moreco-service/tarif?",
        data: {origin: nav5_origin.x + "," + nav5_origin.y, dest: nav5_dest.x + "," + nav5_dest.y }, //appends Params
        crossDomain: "true",
        success: function (data) {
            try {
                var abfrage = data.ticketList;
                //Choose monthly adult ticket
                $("#sevTicketpreis"+standort+"_"+ticketNumber).val(Math.round(parseFloat(abfrage[abfrage.length-2].adult)));
            }
            catch (e) {
                //Error message
                alert ("Es konnten keine Tarife gefunden werden. Möglicherweise befindet sich der Start- oder Zielort außerhalb des SVV Gebietes.");
            }
        },
        error: function(jqXHR, textStatus, errorThrown) {
            //alert(textStatus);
        },
    });
}
```

Pseudo Code 6: Public transport ticket price request through the *SVV* Web service.

Moreover, in Pseudo Code 6, the request on the Web service for the public transport ticket prices is illustrated. Again, start and end coordinates are required to retrieve the information. The problem encountered in this context is the fact that the *Salzburger Verkehrsverbund* uses a coordinate system which differs from the *WGS84* (latitude/longitude), namely *Gauß-Krüger zone 5*. Therefore a coordinate transformation from the source system (*WGS84*) to the target system (*Gauß-Krüger zone 5*) is necessary, as presented in the code. Once the coordinates have been transformed, they are sent to the Web service via *AJAX*. Finally, from the resulting *ticketList*, the monthly season ticket for adults is chosen and written into the *HTML*.

The last two extracts represent *Python* code, dealing with the retrieval of data from the database and the calculation of expenditures, based on the details provided by the user. As portrayed in Pseudo Code 7 and 8, in a first step, the Web server is told, where the *Python* interpreter is found, to be able to read the code. Besides, several modules are imported, to be able to process all required tasks. With respect to the data retrieval (Pseudo Code 7), a connection to the database is established, using the *connect()* function of the *sqlite3* module. The return value of this function represents an object of the class *sqlite3.connection*, which can be used to access the database. Further, the *cursor()* method of the connection object is called to create a *data record cursor*. By means of this cursor, it is possible to query the database and to receive respective results later on. Apart from these steps, an object of the *FieldStorage* class (from the *cgi* module) is created, holding all elements of the *HTML* form sheet that were sent to the script as well as their prevailing input values, as defined by the user. The following *print()* statements represent the header of the program, defining the format of the document content (*JSON*), followed by a required empty line. Also, a result *dictionary* is created (consisting of key-value pairs), which is used to store the outcome of the query. Finally, in order to retrieve the data from the database, the form object is run through to search for the user-determined vehicle type. Based on the selection, an SQL statement is defined and sent to the database through the *execute()* function. The received data (being stored in the *cursor* object) in turn is saved to different variables. As an additional dictionary, they are added to the result *dictionary*. Last, the result *dictionary* is stored as a *JSON* object to be sent back to the *HTML* document and the connection to the database is closed.

Looking at Pseudo Code 8, where the overall travel distance and time expenditure for public transport use is calculated, a very similar process to Pseudo Code 7 is passed through. Thus, subsequent to the localisation of the *Python* interpreter, the import of required modules, the creation of the *FieldStorage* object and a result *dictionary* as well as the declaration and initialisation of variables, the *FieldStorage* is run through, searching for regular trips that were defined by the user. For each trip that is found, the chosen means of transportation, the purpose, and the frequency per week are identified. Depending on which means of transport was chosen (in Pseudo Code 8, the use of public transport is examined), the respective trip distance and travel time is chosen and extrapolated for a one month period. Afterwards, the calculated details are stored as *dictionary* in the result *dictionary*, which in turn is transformed to a *JSON* object and sent back to the *HTML* document.

```

#!C:\Python31\python.exe
# Import required modules
import cgi, cgitb, sys, json, sqlite3

# Connect to database ("Fahrzeuge_new.sqlite")
connection = sqlite3.connect("Fahrzeuge_new.sqlite")
# Create data cursor
cursor = connection.cursor()
# Create object of the class FieldStorage
form = cgi.FieldStorage()

print("Content-Type: application/json;charset=utf-8")
print()

# Create dictionary for result
result = {}
# Store success message
result['success'] = True

# Run through FieldStorage object
for a in form.keys():
    feldname = str(a)
    # Search for 'fahrzeugtyp' in FieldStorage object
    if "fahrzeugtyp" in feldname:
        fahrzeugtyp = str(result["data"][feldname])
        # SQL statement
        sql = "SELECT * FROM Fahrzeugtypen WHERE ID =" + fahrzeugtyp
        # Execute SQL statement and store response in cursor object
        cursor.execute(sql)
        # Run through cursor object and save data from database in variables
        for dsatz in cursor:
            listenpreis = dsatz[2]
            haftpflicht = dsatz[3]
            steuer = dsatz[4]
            wartung = dsatz[5]
            nebenkosten = dsatz[6]
            verbrauch = dsatz[7]
            restwert = dsatz[8]
            nutzungsjahre = dsatz[9]
            jahreskilometer = 0
        # (...)

# Add dictionary with db results to result dictionary
result["calculations"] = {"listenPreis":listenpreis, "haftPflicht":haftpflicht,
                          "steuer":steuer, "wartung":wartung, "nebenKosten":nebenkosten,
                          "verbrauch":verbrauch, "restWert":restwert, "nutzungsJahre":nutzungsjahre,
                          "jahresKilometer":jahreskilometer}

# Save result dictionary as JSON object
print(json.dumps(result))
# Close database connection
connection.close()

```

Pseudo Code 7: Data retrieval from the SQLite database in Python.

```

#!C:\Python31\python.exe
# Import required modules
import cgi, cgitb, sys, json
# Create object of the class FieldStorage
form = cgi.FieldStorage()
print("Content-Type: application/json;charset=utf-8")
print()
# Create dictionary for result
result = {}
result['success'] = True
# Create dictionary and store data sent by AJAX request
d = {}
for k in form.keys():
    d[k] = form.getvalue(k)
result["data"] = d
# (...)
# Declaration of variables
streckegesamt1 = 0
streckefuegesamt1 = 0
streckeovgesamt1 = 0
streckeovgesamt1 = 0
streckemivgesamt1 = 0
# (...)
try:
    # Run through FieldStorage object
    for element in form.keys():
        feldname = str(element)
        # Search for 'verkehrsmitteli'
        if "verkehrsmitteli" in feldname:
            # If found, extract path number
            wegnummer = feldname.split("_")[1]
            # Create String to query means of transportation
            verkehrsmittelstring1 = "verkehrsmitteli_" + wegnummer
            # Store value (means of transportation)
            verkehrsmittel = result["data"][verkehrsmittelstring1]
            # Create String to query trip purpose
            wegweckstring1 = "wegweck_" + wegnummer
            # Store trip purpose
            wegweck1 = int(result["data"][wegweckstring1])
            # Create String to query number of trips
            anzahlwegestring1 = "anzahlWegel_" + wegnummer
            # Store number of trips
            anzahlwegel = float(result["data"][anzahlwegestring1])
            # (...)
            # Check whether public transport is chosen as means of transportation
            elif verkehrsmittel == "oew":
                try:
                    # Create String to query trip length
                    streckeovstring1 = "oew_Streckel_" + wegnummer
                    # Store trip length
                    streckeov1 = float(result["data"][streckeovstring1].split("_")[1].replace(".", ""))
                    # Calculate overall public transport trip length
                    streckeovgesamt1 = streckeovgesamt1 + streckeov1 * haeufigkeit1
                    # Calculate overall trip length
                    streckegesamt1 = streckegesamt1 + streckeov1 * haeufigkeit1
                    # (...)
                except:
                    # (...)
except:
    # (...)
# (...)
# Store dictionary with calculations in result dictionary
result["calculations"] = {"ovKosten1":ovticketsgesamtpreis1, "ovKosten2":ovticketsgesamtpreis2,
                          "gesamtKostenFzge1": gesamtkostenfzge1, "gesamtKostenFzge2": gesamtkostenfzge2,
                          # (...)
                          }
# Save result dictionary as JSON object
print(json.dumps(result))

```

Pseudo Code 8: Calculation of public transport travel expenditures in Python.

## 6. Result and Analysis

As a result of the development process, the *MORECO Housing and Mobility Cost Calculator* for the Province of Salzburg is available on-line and free of charge at <http://www.moreco.at/haushaltsrechner>. An overview on the user interface is presented in Appendix III. Thus, as it is illustrated, the layout structure of the application consists of five tabs, which are passed through one after the other. Some of the tabs comprise sub-sections, separated through accordions which may be hinged to inspect pre-defined settings or specify particular details. Question marks next to several input fields offer hints on the respective input being expected. Besides, a bar chart on the right hand side of the user interface illustrates housing and mobility costs, given the current input values and selections. It adapts dynamically to any input changes which refer to monetary costs. Buttons as well as underlined words open dialogue windows, where further details can be designated. Furthermore, red asterisks indicate input fields being mandatory for the calculation; for other fields pre-defined values may be assumed.

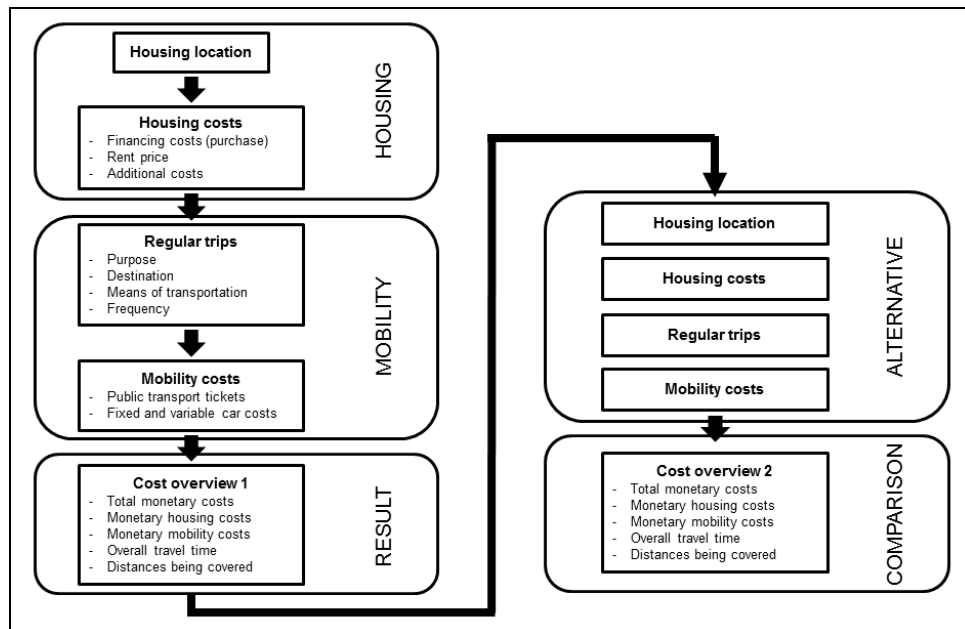


Figure 36: Data input and result structure of the *Cost Calculator* (author's own design).

A schematic illustration of the input and result sequence being followed by the calculator is presented in Figure 36. Thus, the first tab of the calculator encompasses information on housing. Here, the user has to define the address of a place of residence which shall be inspected. This can be done directly through the input field, where the user is suggested addresses (including street-names, municipalities, towns, and postal codes) based on the letters or numbers that are entered. Besides, it is possible to simply click on the map; the respective address is automatically inserted into the input field. In the second accordion of the first tab, details on housing costs are to be defined. These may either comprise monthly financing costs (in case of property purchase) or rent per month. For the calculation of loan financing (involving the house and real estate price, own capital, interest rate, and term), a separate calculator may be accessed through a dialogue window (Appendix III). Apart from that, additional costs (e. g. for heating, lighting, and services) may be listed as well.

Moving on to the second tab, details on mobility are to be provided. In the first section, this involves several aspects on regular trips, including the purpose (work/education, shopping, leisure, or other), the destination, the travel mode (public transport, car, bike or foot), and the frequency (Figure 36). Once a destination is chosen (again directly through the address field or on the map), travel times and distances for all four means of transportation are calculated and presented to the user. For public transport, also the number of transfers is illustrated. All suggested details may be changed and adapted by the user, if desired. Further, by selecting the preferred travel mode through a radio button, resulting costs (both monetary and in terms of expenditures) are calculated. For public transport use, this means that the respective monthly adult ticket price is queried from the *Salzburger Verkehrsverbund* and listed in the calculations. If the car is chosen, a pop-up box with four functors is displayed from which the user needs to select one. In consequence, a mid-range car is added to the calculation. This car may be specified (e. g. regarding its size, fuel consumption, etc.) in a following step. If the same car (functor) is chosen for two or more regular trips, fixed costs are only calculated once. Variable costs in turn are summed up, depending on the overall distances being covered with this car. Further, with respect to bike and foot travels, no monetary costs are considered. However, if the user wants to account e. g. for bike repair services, it is possible to add a lump sum in the result section. The second accordion of the mobility tab allows the user to adapt general assumptions made on public transport prices and car expenses. In terms of public transport, the monthly ticket price as well as the number of season tickets per year may be changed. Also, it is possible to delete existing tickets or to add additional ones, which are not linked to any particular trips. Regarding car costs, the user has several options for adoption: On the one hand he/she may choose between three different car categories (small, mid-range, and upper class car). For each category, average maintenance and running costs are loaded from a database and used for the calculation (as described in chapter 5.4.). On the other hand, the specific values (e. g. insurance, tax, etc.) may be changed individually through the respective dialogue window (Appendix III). Last, it is possible to add additional cars to the calculation, manually determining the annual mileage.

Next, turning over to the third tab, the result of the calculation is presented (Figure 36). As it was mentioned before, this covers total monetary costs (consisting of housing and mobility expenses) and travel expenditures (including overall distances and travel time). Respective cost components are listed as well. Also, the user may separately assess time expenditures for work/education travels with an hourly wage to receive a further indicator on commuting expenditures. All costs may be displayed for different periods of time, namely on a monthly basis, per year, for ten years, and in a petrol price shock scenario. The latter option calculates monthly monetary expenses, based on the assumption of a short-term 50% increase of petrol prices as well as a respective rise of 25% for public transport ticket prices. The reason why public transport prices are assumed to increase more moderately in this context is that these costs are less influenced by the market and more by political forces MERCIER ET AL. (2013, 5). Besides, the petrol price is just one component of the public transport ticket, apart from personnel costs, etc. If the user intends to inspect a second project, to be able to compare the result with an alternative (either in terms of location, or with respect to a different mobility behaviour), this can be done optionally in the last two tabs. Thus, by moving on to the fourth tab, a copy of all user entries from the first project is created as a start. This copy may be changed as desired. To exemplify this, by choosing a



different location for the place of residence, all respective distances, travel times, public transport tickets, and car expenses are recalculated and respectively adapted, while the determined destinations and means of transportation remain the same. Besides, it is also possible to stay with the same location and to choose different travel modes or frequencies for certain trips in order to find out about savings or additional costs. All input fields and adjustment possibilities for the second project are the same as for the first one, but compressed on one tab only. Finally, heading to the fifth tab, a comparison of both projects is presented. The layout, figures, and options are the same as for the first result sheet; the only difference is that both projects are listed. At this stage, it is possible to undertake further adjustments or to restart the application.

With respect to the analysis and evaluation of the *Housing and Mobility Cost Calculator*, several aspects may be addressed. On the one hand, these comprise functional limitations that exist, when comparing the tool to other state of the art applications. On the other hand, critical points regarding the development process may be mentioned and briefly discussed. Thus, in terms of the functionalities offered, it stands out that – although its name implies – the application does not actually calculate housing costs for a chosen address. Rather, respective cost components need to be entered by the user and are simply added up. The reason for this pragmatic solution is threefold. First, it was found that housing/land prices differ a lot within municipalities and even within certain districts (chapter 5.1.). Therefore respective average values may not coincide with the actual land price at a particular location and hence may lay the ground for wrong assumptions. Second, maintenance efforts for the calculator are significantly higher in case land prices for all municipalities need to be updated on a regular base. Yet, as stated in chapter 5.2.3., it was a major intention during the development process to keep these efforts on a low level. Third, housing costs in the context of the tool are first and foremost presented to support the assessment of mobility expenses by providing a comparison: While monthly rent and financing prices are generally known, the share of mobility costs is rather hard to estimate. Apart from this restriction, the calculator lacks of a depiction of inter-modal travels, such as *park and ride* or even *bike and ride* concepts. It takes the user quite some effort to represent these mobility patterns in the calculator, although they may be very common in particular areas. Furthermore, no information is provided on any environmental implications of the mobility behaviour, such as corresponding CO<sub>2</sub> emissions. Yet, these effects may also be seen as resulting costs and may even gain importance in the future (e. g. with respect to particular incentive systems).

Looking at the development process of the tool as described in chapter 5.3. and 5.4., it becomes obvious that on the one hand, a phase of in-depth testing is missing. Thus, in order to ensure an intuitive and straight-forward use of the tool by a broad range of people, it is necessary to let different groups of persons investigate and assess it. This way, potential misinterpretations, uncertainties regarding certain intentions, and other weaknesses may be identified and consequently removed. On the other hand, EIZENHÖFER&SINNING (2009, 142) perceptively state that the acceptance and use of such a service is highly dependent on the respective representation, form, and layout of the tool. Therefore the authors refer to common usability criteria which should be followed. Although the problematic nature and significance of both aspects were well known to the author, it needs to be emphasised that within the temporal scope of this work, it was not possible to fully account for these topics.

## 7. Test Case

In order to demonstrate the potential applicability and benefits of the *Housing and Mobility Cost Calculator*, this small test case is set up. It is based on research and assumptions suggested by STEINER ET AL. (2013), from the *Salzburger Institut für Raumordnung & Wohnen (SIR)*. In this context, the calculator was used to investigate the respective long-term consequences for a young couple, based on distinct types of housing and different locations in the province of Salzburg. The example at hand is slightly adapted and explores the possible future situation of a fictitious family in Salzburg, consisting of a husband, his wife and a child at the age of 12 years. Due to the lack of living space and high land prices in the city of Salzburg, the young family intends to move from the city to the surrounding region in order to built up their own single family house. The two municipalities Bürmoos and Dorfbeuern have been included in the final choice for this undertaking. Both municipalities belong to the Flachgau district (chapter 5.1.) and have encountered a positive population development over the last years (STEINER ET AL. 2013, 1). Bürmoos is a commune consisting of approximately 5,000 inhabitants and is settled 25km north-west of Salzburg (GEMEINDE BÜRMOOS 2013). It has a good public transport connection through the *Lokalbahn*, which is operated from 05:00 until 02:00 during the week and on Saturdays and therefore offers an attractive service for both commuters and leisure time activities (STEINER ET AL. 2013, 8). Moreover, Bürmoos has different facilities (such as shops, a library, and a post office), a primary and secondary school, as well as different societies (including a sports club and a youth centre) (GEMEINDE BÜRMOOS 2013). Dorfbeuern in turn is a small village, 30km in the north of Salzburg and comprises about 1,500 citizens (GEMEINDE DORFBEUERN 2013). The village is served by a regional bus service, which is operated on an irregular basis and hence is not suitable for commuting (STEINER ET AL. 2013, 8). However, there is a possibility to make use of *park and ride*, switching to the *Lokalbahn* from Lamprechtshausen or Bürmoos. Further, there are only few facilities and societies in the village; for a broader activity offer it is required to visit surrounding municipalities (STEINER ET AL. 2013, 8).

With respect to housing costs, STEINER ET AL. (2013, 6f.) researched on prices for single family houses offered by different prefabricated house manufacturers. Thus, based on a living area of 150m<sup>2</sup>, a total sum of 300,000€ may be assumed, independent of the location. Further, in terms of land prices, the respective expenses for a common size of 700m<sup>2</sup> were derived from a land price table, maintained by the *SIR* (STEINER ET AL. 2013, 6). According to this table, a price of 120€ per square metre in Bürmoos and 90€ in Dorfbeuern should be regarded as reasonable. This is slightly less, compared to the investigation of WAILAND&WALDSTEIN (2012), who calculated an average square metre price of 142€ for Bürmoos and 115€ for Dorfbeuern, as illustrated in Appendix II. Yet, based on the long-term records of the *SIR* land price table, overall expenses of 840,000€ for Bürmoos and 630,000€ for Dorfbeuern are determined. Further, with regard to additional costs, research by STEINER ET AL. (2013, 6) suggests that 7% of the land acquisition price are to be paid for purchase transaction. In Bürmoos, this amounts to 5,880€, in contrast to 4,410€ in Dorfbeuern. Finally, as a last component of housing cost, additional expenses/running costs of 3€/m<sup>2</sup> may be expected (STEINER ET AL. 2013, 6), which adds up to an extra 300€ per



month. Therefore, given a family's own capital of 100,000€ and a loan with a term of 25 years as well as an interest rate of 3.0%, total monthly costs of 1,669€ for Bürmoos and 1,562€ for Dorfbeuern can be calculated by means of the *Housing and Mobility Cost Calculator*.

In order to estimate the respective monthly mobility costs that are to be expected at both locations, it is necessary to provide details on the regular travels of the family members and to reproduce them in the *Cost Calculator*. Thus, with respect to work and education trips, the father works five times a week in Salzburg Itzling, close to the *Lokalbahn* station, while the mother has a full-time job in Hallwang, at a place which can hardly be reached by public transport. For this reason, the family has recently bought a small car. The child goes to school at the *Christian-Doppler-Gymnasium* in Salzburg. All three persons intent to keep their jobs and resp. the place of education after the movement. Further, in regard to leisure time activities, the man goes climbing twice a week. Due to the fact that the climbing hall is located nearby his work place, the activity can be combined with the trip to work during the week. On the weekend, an additional travel is necessary. The woman attends a fitness course twice a week and also meets up with some friends once a week in the city of Salzburg. In order to be more flexible, this distance is covered by car. The child in turn is part of an athletic team, practising twice a week and plays the piano at a music school once a week. In addition to these activities, the family undertakes several irregular trips. This includes grocery shopping, which is generally done twice a week either close to their home or nearby the mother's workplace, where flexibility is given through the car. Approximately every third weekend, the family takes the car to drive to a shopping centre in Salzburg for general purchases. These trips are often combined with some leisure time activities such as bowling or the cinema. Besides, the family undertakes hiking trips in the surrounding of Salzburg or visits its relatives in Bischofshofen once a month. After the movement, the family intends to continue with these activities and undertakings. Thereby the respective destinations shall remain the same as before, except for hobbies of the mother and her daughter, as well as the grocery shopping. For these activities, the family plans to make use of facilities close to their new location. In this context, reference to BÜTTNER&WULFHORST (2012, 17f.) as well as to GUTSCHE (2003, 3) reveals that this is a very common behaviour of families moving to a suburban community. Hence, due to the continuing orientation towards the former place (e. g. regarding work place, hobbies, friends, etc.), the overall distances being covered may be significantly higher compared to the average mobility pattern of the people living in these suburban areas (GUTSCHE 2003, 3).

For the calculation of the mobility expenditures at the two locations, ticket prices from the *Salzburger Verkehrsverbund* and data from the *ÖAMTC* are used (as described in chapter 5.3.). Petrol prices are accounted for with 1.50€ per litre. Thus, inspecting the situation in Bürmoos, the father as well as the daughter may use public transport to get to Salzburg for work and school. While the father may take a monthly season ticket for 77€, the daughter may use the *SVV-SUPER s'COOL-CARD* for 96€ per year. The mother in turn may use the car to get to work as well as to meet her friends in the city. Other leisure activities may be undertaken either by bike/foot or car (e. g. when visiting relatives, going hiking or shopping in Salzburg). Based on these conditions, Figure 37 indicates overall mobility costs of approx. 523€ per month: 79€ for the public transport tickets and 444€ for the small car. Thereby the annual mileage travelled by car would

amount to about 20,000km. However, it needs to be emphasised in this context that the calculations do not account for any repayments from the commuter tax allowance. Turning to the location in Dorfbeuern, the family would be forced to a different mobility behaviour: Due to the fact that no regular public transport is offered at this location, the father may require an additional small-sized car in order to get to work. Therefore he may waive the public transport ticket, covering also his other travels by car. Although he may take his daughter with him to Salzburg in the morning, the *SUPER s'COOL-CARD* would still be required for her to get back home in the afternoon. Apart from that, the location would come along with slightly longer travels to the surrounding sports and music activities. Hence, as illustrated in Figure 37, overall mobility costs of roughly 867€ per month may be expected. This would include 8€ for the daughters public transport ticket and about 860 for the use of the cars. The annual car mileage would rise to more than 35,000km. Also, when comparing the overall travel time per month, it would take the family 30 additional hours of travel. These would first and foremost be caused by longer trips to work/school (Figure 37).

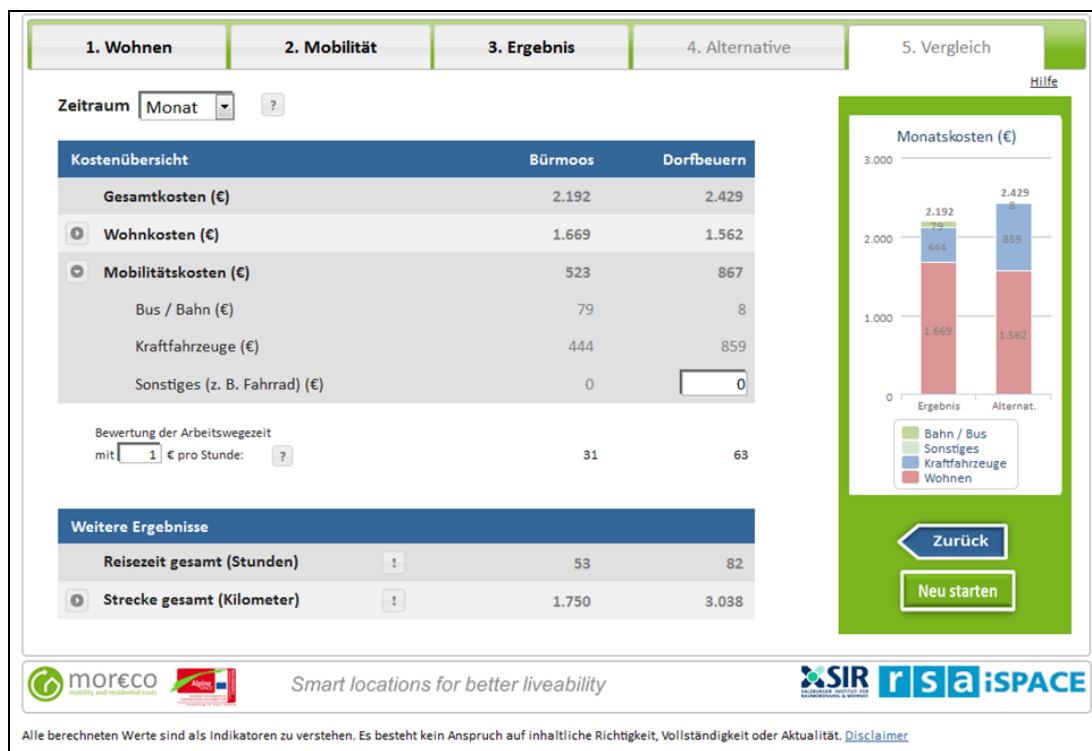


Figure 37: Resulting comparison of the calculator between Bürmoos and Dorfbeuern (author's own design).

Summing up the comparison in this test case, it may be deduced that high mobility costs (especially through car use) relativize possible cost advantages in remote areas. Also, time expenditures for commuting may significantly differ, depending on public transport connections. These findings support the assumption made in hypothesis 1. Thus, housing and mobility costs may in fact balance each other out and hence movements to areas with cheap land prices rarely lead to financial savings. In this respect HOLZ-RAU ET AL. (2010, 42) conclude that the question, whether housing costs at a location are completely, partially or even over compensated by mobility costs depends on regional market conditions. Besides, individual behaviour of the family members play a crucial role, e. g. with respect to the vehicle types being used (size, new/pre-owned car) as well as the size of living space.

## 8. Conclusion

This last chapter sums up the approach of the work and highlights relevant findings and outcomes. Reflecting on the problems that were taken as a starting point, the objective that was pursued, and the hypotheses that were investigated, an overall conclusion with respect to the *Housing and Mobility Cost Calculator* is drawn. Apart from that, the actual contribution of well chosen housing locations on energy saving and climate protection is questioned and discussed. Finally, a future perspective is given, covering necessary further steps and potential enhancements of the tool.

### 8.1. Summary

As it was outlined in the introduction of this work, the study at hand was concerned with issues related to the development of housing and transport over the last decades. Both realms have countervailed a sustainable progress, fostering persistent land use and land fragmentation, longer distances being covered every day, and increasing use of motorised individual transport, to name just a few tendencies. The investigation focused on the role of private households and their decisions relevant to land use and traffic generation. It was the intention to make households more aware of the far-ranging consequences that come along with particular location and mobility decisions. By elaborating major dependencies and interactions between these two aspects, existing relations should become more transparent. This in turn should motivate people to both make more conscious decisions regarding their place of residence and to reflect their respective mobility behaviour (e. g. in terms of travel mode, the number of trips, and distances). The approach that was followed to achieve this goal encompassed the investigation of three major hypotheses.

First, this involved the analysis of cost patterns that may be identified in space. Thereby it was confirmed that housing and mobility costs are characterised by opposing trends. On the one hand, different studies indicated that housing prices tend to decrease from central places and locations being well connected to public transport towards surrounding areas. On the other hand, highest mobility costs were found in peripheral regions. Amongst other reasons, this is because of longer distances which need to be covered in order to fulfil daily activities as well as due to additional mobility investments caused by a lack of alternative transportation modes (e. g. public transport). In consequence, it was proven that there are in deed areas where high mobility costs compensate or even over compensate potential savings of housing. However, a particular zone where both cost components are even could not be defined on a general level. Rather, it depends on the individual mobility behaviour of a household and related decisions, how respective costs develop. Most important in this context is the number of cars which are required: This factor contributes most to mobility costs and hence significantly influences overall cost relations.

The second hypothesis focused on the lack of cost transparency that currently exists from a household point of view, provoking short-term considerations regarding location

decisions. Hence, in order to illustrate the complexity and interdependencies between housing, mobility, and resulting expenditures, different levels of mobility were inspected as well as respective influencing factors and players. In this regard, it was demonstrated that both public and private decisions (which affect each other) impact on mobility requirements. Public influence is mainly controlled by spatial and traffic planning, determining residential areas, spatial structures, and public transport quality. In consequence, the macro level of mobility is defined, providing the overall scope in which mobility patterns may take place. On the meso and micro level in turn households act as decision makers on their mobility behaviour. First and foremost this is done through the determination of the place of residence, which defines the individual frame of a household's everyday mobility. Apart from that, other long-term decisions (such as the purchase of a car or the place of work) as well as different socio-economic and socio-demographic factors impact on respective mobility patterns, such as the means of transportation and the length of trips. Based on these findings, the *Housing and Mobility Cost Calculator* was conceptualised, accounting for these relations and illustrating according connections.

As a third hypothesis it was argued that the decision of households on their place of residence as well as on their regular travel behaviour may be influenced through appropriate measures. More precisely it was hypothesised that the communication of individual and objective information on housing and mobility costs may prevail upon households to question peripheral locations and to examine places which are better structurally integrated. This in turn would contribute to a more effective settlement development and less individual traffic. In order to investigate this hypothesis, the *Housing and Mobility Cost Calculator* was developed for households living in the province of Salzburg. It allows people to oppose housing and mobility costs, as well as respective expenditures at different locations. In this context the conceptualisation and implementation of the tool was presented. Besides, the calculator was contextualised in regard to the spatial planning process, defining its temporal integration and its delineation from other existing tools and applications. Last, the potential usage and particular benefits of the calculator were pointed out by demonstrating a fictitious application example. On this basis it may be inferred that the potential influence of the instrument in regard to spatial determinations is considerable: Aiming at those decisions of households which directly impact on the generation of traffic, the mobility behaviour of people may be influenced in a sense that trips become shorter and the share of eco-mobility (public transport, bike, and foot) is increased. Thereby the calculator may not only be of interest for citizens planning a relocation, but also for those who intent to stay at their current location. To exemplify this, potential monetary savings by the use of different transportation modes may be investigated for a particular place. Thus, if this work/application succeeds in making the interdependencies between housing and mobility more aware to the general public, the transparency may contribute to a reduction of negative environmental effects and hence foster climate protection. Yet, at the end, it depends on the user of the tool to decide which conclusions are drawn from the information being provided. It is neither the purpose of the application to give instructions on what a household shall do, nor does the calculator pursue specific political intentions in terms of public cost savings, the disparaging of rural areas or the prevention of suburbanisation processes.

## 8.2. Discussion

As it was elaborated in connection with traffic reduction and a modal shift towards more environmentally sound modes of transport, settlement patterns play a key role: Short everyday distances were identified in districts characterised by compact structures, mixed use, and high density in contrast to peripheral areas with low densities and a lack of supply structures. This was taken as evidence that former structures are to be fostered in order to reduce distances being travelled and in consequence the overall amount of traffic. Yet, it may be noticed that the analyses are limited to everyday and mainly local traffic. Turning to HOLZ-RAU&SICKS (2013, 16) one finds that because of their overall lengths, long-distance travels have a substantial share on the total amount of transport. This is despite the small number of trips. Therefore long-distance travels contribute to a considerable extent to energy consumption, climate change, and other environmental effects. What strikes out in this context is the finding that the – to some extent - restricted quality of life in some urban areas, caused by high densities and environmental pollution (through noise, exhaust emissions, etc.) results in high shares of 'escape traffic', especially for leisure activities (HOLZ-RAU&SICKS 2013, 17). Hence it may be found that the 'city of short distances' is at the same time a place of long travels. This situation deteriorates when looking at the significant rise of long-distance travels over the last years. Thus, in the event of a continuing increase of the frequencies and distances of these travels, the spatial differences regarding long-distance trips may in future even over compensate the differences in local traffic (HOLZ-RAU&SICKS 2013, 28). As a consequence, inhabitants of urban areas may even cover longer distances compared to the citizens of smaller municipalities. The indications are therefore that the intention of this work, to foster structurally integrated and urban areas in order to reduce everyday distances, may in fact make only a small contribution to energy saving and environmental protection.

Notwithstanding, (independently from these findings), economic land use, compact structures, mixed uses and an orientation towards public transport axes are important concepts in order to secure reachability, facilitate participation of people without motorised individual transport, and to ensure the overall efficiency of urban and regional structures. However, in order to arrive at the post-fossil age, additional developments are required such as new energy, production, and traffic technologies. As WÜRDEMANN&HELD (2009, 763) point out, these will have to encompass energy efficient power networks, innovative building cultures as well as new forms of mobility: inter-modality and multi-modality instead of mono-modality, vehicle use rather than ownership, to name just a few aspects. GERTZ&ALTENBURG (2009, 795) make clear that the earlier this transformation process is initiated, the less trouble will be encountered during the actual implementation. For a successful mobility transformation, the cooperation and broad acceptance of both political and societal actors is required. This in turn can only be achieved through a profound rethinking of everyday behaviour. Rather than about restrictions, it is about a liveable and affordable mobility for all sections of society. A distinct mobility behaviour should not be associated with negative connotations or relinquishment but instead as a contribution to a higher quality of life (GERTZ&ALTENBURG 2009, 795). A broad consensus needs to be created on the fact that current mobility behaviour is not future-compliant since its

foundation will be removed. Therefore this post-fossil change is not pushed by preferences, but by necessity.

### 8.3. Future Work

Taking a look at potential future steps of this work, there are different aspects which might be investigated or further elaborated. Some of them are essential for a widespread application of the *Cost Calculator*, such as its publication and distribution. Other tasks in turn may encompass useful enhancements such as the development of additional tool functionalities or the additional use of a different scale to analyse current problems in the realm of housing and traffic. Regarding the publicizing of the tool, ALBRECHT&GUTSCHE (2010, 72) correctly point out that hardly any user may search for a housing and mobility cost calculator on the Web, without having a particular reason. Hence the question arises, how the service may be communicated to the public in order to reach its intention of more conscious housing and mobility decisions. At this stage, it is suggested that a specific date is determined at which the tool is presented to the public through distinct media channels, including different regional newspaper publishers. Subsequent to this, it is important to persistently inform citizens about improvements and additional functions of the calculator e. g. through brief newspaper reports. Furthermore, existing portals and Web pages may be used to integrate or refer to the *Cost Calculator*. These may comprise the public transport timetable information service of the *Salzburger Verkehrsverbund* or regional real estate portals. Besides, there are platforms being explicitly dedicated to the distribution of applications in the field of mobility, such as *mobilotse.at* (<http://www.mobilotse.at/was.html>), which may be of use.

With respect to further enhancements it should be emphasized that the current version of the tool is not to be seen as complete or finished. SIEDENTOP ET AL. (2013, 340) perceptively state that relevance for both private users and especially for planning practice can only be achieved if a continuation of such systems is guaranteed. This includes regular maintenance and updating of the information. In addition to that, FRANZ (2010, 91) rightly argues that new findings on the topic, upcoming technical developments as well as an increasing availability of useful data and Web services can be expected over the next years. These may propose further developed theoretical, methodological or technical approaches which in turn may be investigated and incorporated. In this context, two additional services may be seen as particularly useful. On the one hand this encompasses the provision of information on infrastructural facilities which are located in the close vicinity of an address being investigated. These may consist of local supply (e. g. grocery shops or supermarkets), social institutions or services (kindergartens, schools, doctors or pharmacies), public institutions (city halls, etc.), leisure time offers (such as playgrounds, sports facilities, swimming pools), and transportation facilities (public transport stops including respective service frequencies, cycle tracks or parking lots). This kind of information may not only further impact on mobility decisions but also allows the user to better assess mobility advantages at a particular place and in consequence influence housing decisions as well. SCHRENK ET AL. (2011a, 119) note that the increasing availability of Open Government Data (OGD), i. e. geographic data of national governments which is provided to the public for free

use, may be appropriate for this purpose. On the other hand, a second service which might indicate valuable information is the calculation of travel times for motorised individual traffic based on different times and traffic loads in an area. Thus, depending on the time of the day (e. g. during rush hour in the morning/afternoon) and the prevailing route that is chosen, different travel time expenditures may be calculated. As the BVK (2010, 70) pointed out, this approach does not only offer more realistic travel times (especially for car usage), but also provides a non-discriminatory representation: The different means of transportation are treated equally in regard to their actual expenditure.

Last, turning over to the scale that was chosen to inspect the problems outlined in the approach, such as increasing daily distances, car dependency, and raising fuel prices, a further perspective may be added: Apart from the situation of single households at a particular address, it may be useful to additionally consider the overall conditions that exist on a municipality level. Especially against the background of increasing mobility costs, it might be important to find out, how well a certain municipality is prepared for the future in order to account for this in the decision-making process on housing. A suitable approach that might be further examined in this context is the vulnerability assessment suggested by BÜTTNER ET AL. (2013). Thereby the authors explored the susceptibility of municipalities to dramatic increases of mobility costs, based on the general mobility behaviour as well as the socio-economic situation of the citizens that live in the respective municipality. The underlying concept originates from the vulnerability approach which was originally used to examine the susceptibility of an area to famine, food security, hazards, and climate change (BÜTTNER ET AL. 2013, 4). More precisely, it describes the ability (in this case of a municipality) to respond to, recover from or adapt to potential perturbations or stresses (BÜTTNER ET AL. 2013, 4). Three dimensions are therefore looked into, namely the exposure to stress, the sensitivity, i. e. the degree of affection, and the resilience, referring to the ability to absorb the perturbation. The indicators which BÜTTNER ET AL. determined to investigate municipalities encompass the average vehicle kilometres per capita (indicating which municipalities will be exposed the most to increasing fuel prices), the average net income level (identifying sensitive municipalities), and the accessibility of jobs by non-motorised and public transport (determining municipalities which are most resilient to raising fuel prices). On the basis of these indicators, it is possible to point out municipalities which are especially vulnerable to fuel price increases, namely those being highly exposed, very sensitive, and having a low resilience. Although these indicators represent the average situation in a municipality and hence conditions of individual households might be quite different, they may still be seen as a valuable means to make people aware of the future challenges in regard to housing and mobility.

## 9. References and Lists

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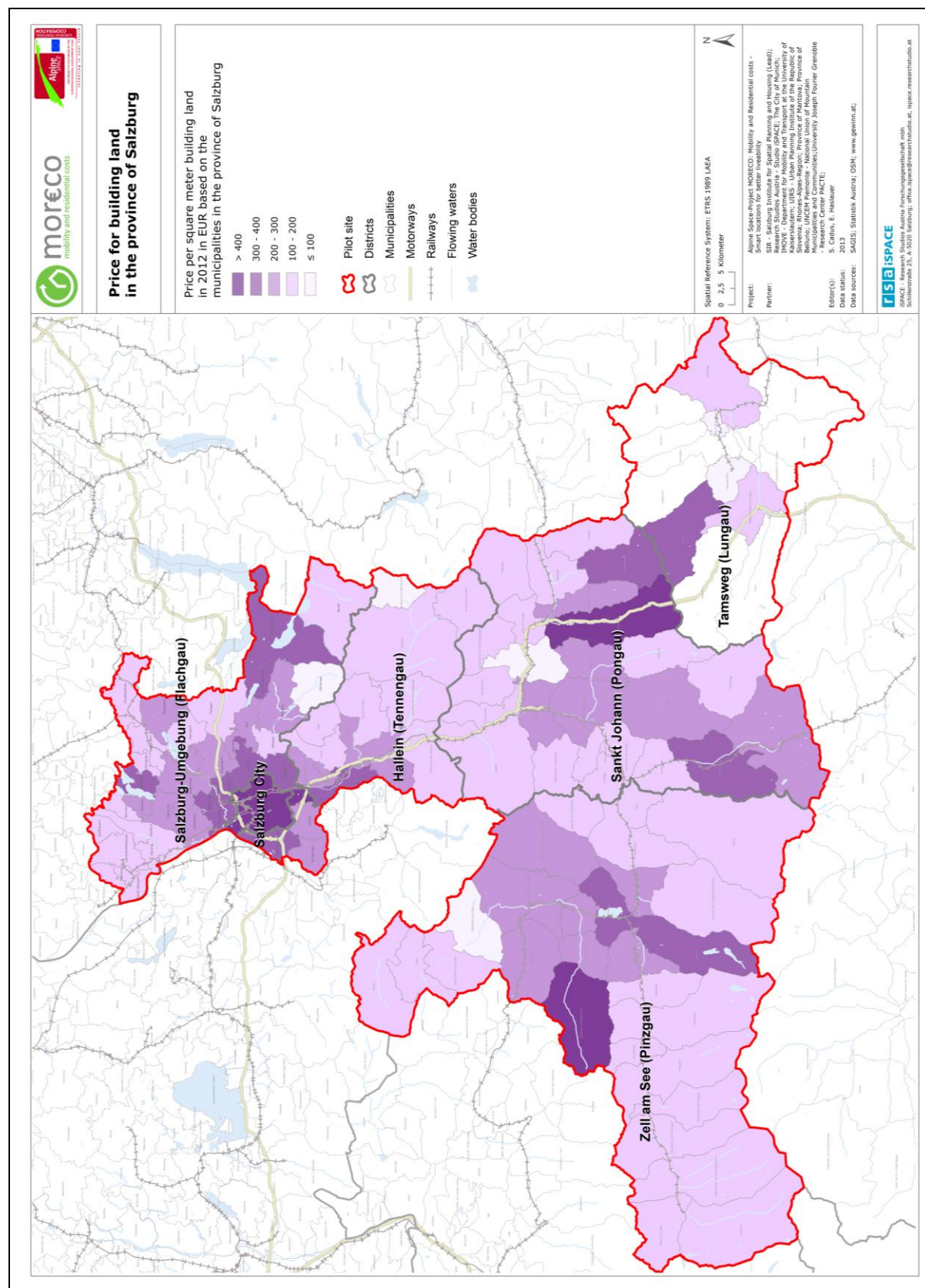
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## 10. Appendix

**Appendix I: Average prices for building land in the province of Salzburg (author's own design).**



Appendix II: Strength and weakness analysis of a selection of current cost calculators (author's own design).

| Name of Cost Calculator                                                                                                      | Criteria                       |                      |                                     |                      |                                                                                                        |                        |
|------------------------------------------------------------------------------------------------------------------------------|--------------------------------|----------------------|-------------------------------------|----------------------|--------------------------------------------------------------------------------------------------------|------------------------|
|                                                                                                                              | Input                          |                      |                                     | Output               |                                                                                                        |                        |
|                                                                                                                              | Trip purposes                  | Individual adoptions | Spatial resolution                  | Req. amount of input | Types of costs                                                                                         | Alternative comparison |
|                                                                                                                              |                                |                      |                                     |                      |                                                                                                        | Scenario simulation    |
|                                                                                                                              |                                |                      |                                     |                      |                                                                                                        | Graphical illustration |
| WoMo Hamburg                                                                                                                 | few [work]                     | many                 | low [municipality level]            | low [7]              | several [monetary housing and mobility costs]                                                          | available [bar chart]  |
| WoMo München                                                                                                                 | few [work]                     | many                 | high [address level]                | medium [12]          | many [monetary housing and mobility costs, CO <sub>2</sub> emissions, time expenditure]                | available [bar chart]  |
| MA++/                                                                                                                        | several [work, leisure]        | few                  | high [address level]                | high [≥20]           | many [monetary housing and mobility costs, CO <sub>2</sub> emissions, time expenditure, accident risk] | available [bar chart]  |
| Mobilitätskostenberechnung Schwerin                                                                                          | few [work]                     | few                  | low [municipality level]            | low [9]              | few [monetary mobility costs]                                                                          | available [bar chart]  |
| Entscheidungshilfe Gotha                                                                                                     | many [work, leisure, shopping] | few                  | medium [municipality/address level] | high [≥17]           | several [monetary housing and mobility costs, time expenditures]                                       | not available          |
| VAG Mobirechner                                                                                                              | none                           | several              | none                                | low [4]              | few [monetary mobility costs]                                                                          | not available          |
| Legend: high suitability medium suitability low suitability requirements for the MORéCO Housing and Mobility Cost Calculator |                                |                      |                                     |                      |                                                                                                        |                        |

| Name of Cost Calculator             | Criteria                                                         |                                         |                                       |                  |                                                     |                                                                                                                                                                 |                                         |                     |  |  |
|-------------------------------------|------------------------------------------------------------------|-----------------------------------------|---------------------------------------|------------------|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|---------------------|--|--|
|                                     | Implementation                                                   |                                         |                                       |                  |                                                     |                                                                                                                                                                 |                                         |                     |  |  |
|                                     | Usability                                                        | Spatial restriction                     | Map/routing function                  | Immediate result | Data references                                     | Special features                                                                                                                                                | Technical effort                        | Maintenance effort  |  |  |
| WoMo Hamburg                        | high [explanations, pre-filled input fields, clearly structured] | medium [metropolitan region of Hamburg] | available [map, routing function]     | not available    | available                                           | automated public transport ticket calculation, graphical result presentation                                                                                    | high [design, data basis]               | high [data basis]   |  |  |
| WoMo München                        | high [explanations, pre-filled input fields, clearly structured] | medium [metropolitan region of Munich]  | available [map, routing function]     | not available    | available                                           | automated public transport ticket calculation, graphical result presentation, address search, average/neighbourhood comparison, information on trip connections | high [design, calculations, data basis] | high [data basis]   |  |  |
| MA++/I                              | medium [structure, input, design, colour]                        | low [Austria]                           | available [map, routing function]     | not available    | available                                           | lifestyle clusters, person-based distances and travel routes                                                                                                    | low                                     | medium [data basis] |  |  |
| Mobilitätskostenberechnung Schwerin | high [clearly structured, intuitive usage]                       | high [city of Schwerin]                 | partly available [routing function]   | not available    | available                                           | part of overall consulting strategy                                                                                                                             | low                                     | low [data basis]    |  |  |
| Entscheidungshilfe Gotha            | medium [input]                                                   | high [city of Gotha]                    | not available [map, routing function] | not available    | available                                           | location suggestion including profile                                                                                                                           | high [calculations, data basis]         | high [data basis]   |  |  |
| VAG Mobirechner                     | high [clearly structured, intuitive/straightforward usage]       | high [city of Freiburg]                 | not available [map, routing function] | available        | not available                                       | modern design, comfortable handling                                                                                                                             | low                                     | low [data basis]    |  |  |
| Legend:                             | high suitability                                                 | medium suitability                      | low suitability                       | requirements     | for the MORECO Housing and Mobility Cost Calculator |                                                                                                                                                                 |                                         |                     |  |  |


Appendix III: User interface of the *Housing and Mobility Cost Calculator* (author's own design).

1. Wohnen 2. Mobilität 3. Ergebnis 4. Alternative 5. Vergleich [Hilfe](#)

\* Pflichtfelder

Wohnobjekt Nr. 1

Adresse\*   Bitte Wohnstandort angeben






Wohnkosten

Monatskosten (€)

0 0 0

Ergebnis Alternat.

☐ Bahn / Bus  
☐ Sonstiges  
☐ Kraftfahrzeuge  
☐ Wohnen

  Smart locations for better liveability 

Alle berechneten Werte sind als Indikatoren zu verstehen. Es besteht kein Anspruch auf inhaltliche Richtigkeit, Vollständigkeit oder Aktualität. [Disclaimer](#)

1. Wohnen 2. Mobilität 3. Ergebnis 4. Alternative 5. Vergleich [Hilfe](#)

\* Pflichtfelder

Wohnobjekt Nr. 1

Wohnkosten

Kauf (Kreditkosten) pro Monat(€)  0

oder Miete pro Monat(€)  0

Wohnnebenkosten pro Monat(€)  0

Finanzierung berechnen

Haus/Wohnung (€)  0

Grundstück (€)  0

Nebenkosten (€)  0

Sonstiges(€)  0

Summe Kaufkosten(€)  0

davon Eigenmittel(€)  0



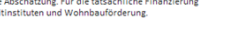
Summe Kreditkosten(€)  0

effektiver Zinssatz (%)  3,6

Jahre Laufzeit  20

monatliche Finanzierung(€)  0

Diese Tabelle bietet eine erste Abschätzung. Für die tatsächliche Finanzierung informieren Sie sich bei Kreditinstituten und Wohnbauförderung.

  Smart locations for better liveability 

Alle berechneten Werte sind als Indikatoren zu verstehen. Es besteht kein Anspruch auf inhaltliche Richtigkeit, Vollständigkeit oder Aktualität. [Disclaimer](#)

1. Wohnen 2. Mobilität 3. Ergebnis 4. Alternative 5. Vergleich [Hilfe](#)

\* Pflichtfelder

Regelmäßige Wege aller Personen im Haushalt

Wohin

Wohin    0  0  0  0 Min/Weg  5 pro  0 Km/Weg  Woche

Wohin    0  0  0  0 Min/Weg  5 pro  0 Km/Weg  Woche

Hochgerechnete Jahreskilometer im Auto basierend auf Ihren Eingaben [km]:




Kosten für Verkehrsmittel

Monatskosten (€)

0 0 0

Ergebnis Alternat.

☐ Bahn / Bus  
☐ Sonstiges  
☐ Kraftfahrzeuge  
☐ Wohnen

  Smart locations for better liveability 

Alle berechneten Werte sind als Indikatoren zu verstehen. Es besteht kein Anspruch auf inhaltliche Richtigkeit, Vollständigkeit oder Aktualität. [Disclaimer](#)

1. Wohnen 2. Mobilität 3. Ergebnis 4. Alternative 5. Vergleich

Hilfe

\* Pflichtfelder

Regelmäßige Wege aller Personen im Haushalt

Kosten für Verkehrsmittel

Bus / Bahn ?

| Wohn | Wohn | Monatskosten (€) | Anzahl pro Jahr |
|------|------|------------------|-----------------|
| X    |      | 100              | 11              |

Kraftfahrzeuge ?

| Fahrzeugtyp                                  | Gesamtkosten pro Monat (€) |
|----------------------------------------------|----------------------------|
| X [Name] [Mittelklasse] [Kilometer angeben!] | 479                        |

Individuelle Fahrzeugkosten berechnen

|                                                 |       |
|-------------------------------------------------|-------|
| Listenpreis (€)                                 | 23630 |
| Nutzungsjahre                                   | 6     |
| Restwert (€)                                    | 6150  |
| monatlicher Wertverlust (€)                     | 243   |
| Haftpflicht Versicherung/Jahr (€)               | 890   |
| Versicherungssteuer/Jahr (€)                    | 370   |
| Wartung (Service, Reifen, Reparaturen)/Jahr (€) | 1210  |
| Nebenkosten (Parken, Maut, Waschen)/Jahr (€)    | 360   |
| monatliche Unterhaltungskosten (€)              | 236   |
| Kraftstoffpreis (€/l)                           | 1,50  |
| Verbrauch (l/100km)                             | 7,1   |
| Kilometer/Jahr                                  | 0     |
| monatliche Kraftstoffkosten (€)                 | 0     |
| monatliche Gesamtkosten (€)                     | 479   |

Exakte Kosten für fest jeden Autotyp bietet u. a. die QAMTC Auto-Info

moreco Smart locations for better liveability

Alle berechneten Werte sind als Indikatoren zu verstehen. Es besteht kein Anspruch auf inhaltliche Richtigkeit, Vollständigkeit oder Aktualität. [Disclaimer](#)

Ok

1. Wohnen 2. Mobilität 3. Ergebnis 4. Alternative 5. Vergleich

Hilfe

Zeitraum Monat ?

Kostenübersicht Strubergass.

|                               | Strubergass. |
|-------------------------------|--------------|
| Gesamtkosten (€)              | 0            |
| Wohnkosten (€)                | 0            |
| Mobilitätskosten (€)          | 0            |
| Bus / Bahn (€)                | 0            |
| Kraftfahrzeuge (€)            | 0            |
| Sonstiges (z. B. Fahrrad) (€) | 0            |

Bewertung der Arbeitswegezeit mit 0 € pro Stunde: ?

Weitere Ergebnisse

| Reisezeit gesamt (Stunden) | 0 |
|----------------------------|---|
| Strecke gesamt (Kilometer) | 0 |

Monatskosten (€)

Ergebnis Alternat.

Bahn / Bus  
Sonstiges  
Kraftfahrzeuge  
Wohnen

Zurück Weiter

moreco Smart locations for better liveability

SIR r s a iSPACE

Alle berechneten Werte sind als Indikatoren zu verstehen. Es besteht kein Anspruch auf inhaltliche Richtigkeit, Vollständigkeit oder Aktualität. [Disclaimer](#)

1. Wohnen 2. Mobilität 3. Ergebnis 4. Alternative 5. Vergleich

Hilfe

Zeitraum Monat ?

Kostenübersicht Strubergass. Strubergass.

|                      | Strubergass. | Strubergass. |
|----------------------|--------------|--------------|
| Gesamtkosten (€)     | 0            | 0            |
| Wohnkosten (€)       | 0            | 0            |
| Mobilitätskosten (€) | 0            | 0            |

Bewertung der Arbeitswegezeit mit 0 € pro Stunde: ?

Weitere Ergebnisse

| Reisezeit gesamt (Stunden)   | 0 | 0 |
|------------------------------|---|---|
| Strecke gesamt (Kilometer)   | 0 | 0 |
| Bus / Bahn (nur Fußweg) (km) | 0 | 0 |
| Fahrzeuge (km)               | 0 | 0 |

Monatskosten (€)

Ergebnis Alternat.

Bahn / Bus  
Sonstiges  
Kraftfahrzeuge  
Wohnen

Zurück Neu starten

moreco Smart locations for better liveability

SIR r s a iSPACE

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