The Mobility Pass for Real Estate – A holistic tool for the Transparency of Mid- and Long-Term Environmental Effects and Mobility Costs

1. Research Background

In Austria, about 10 % of the population changes their home every year, in 2009 that was about 875,000 people. Nearly 80 % (680,000 people) residence changes occur within one or between neighbouring municipalities in Austria. Austria is a country greatly affected by urban sprawl; land purchase is much cheaper in not urbanised areas but infrastructure, from the school bus to the waste disposal, is paid by the public sector.
As illustrated in figure 1, the population in Austria has increasingly moved outside the main municipalities.

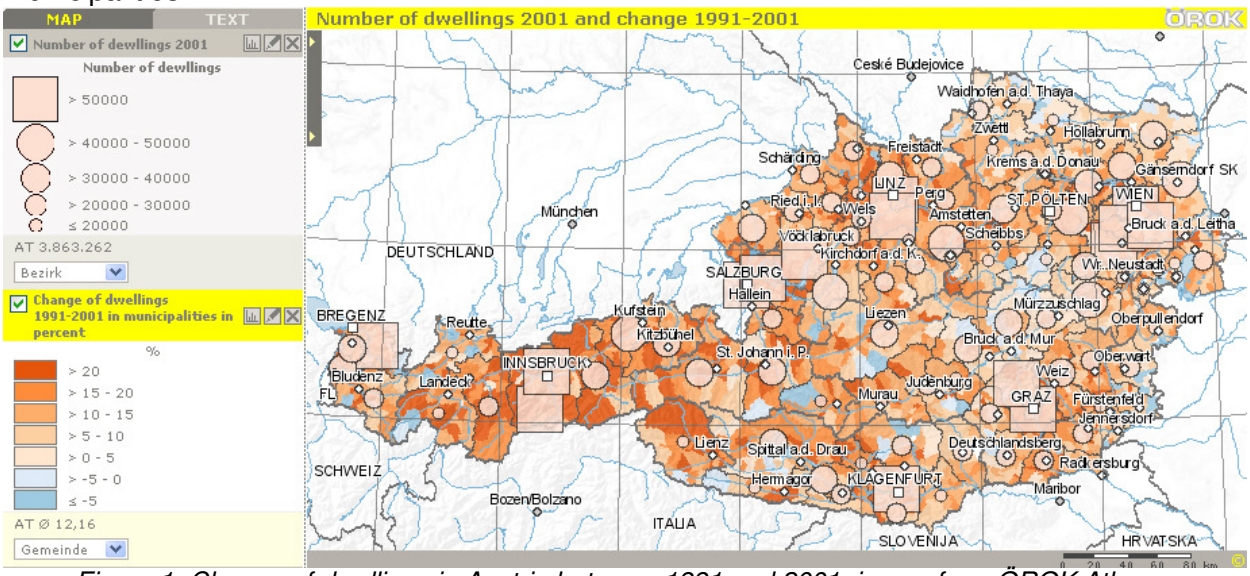

Figure 1: Change of dwellings in Austria between 1991 and 2001, image from ÖROK Atlas (www.oerok-atlas.at)

Located beside of the city centre most people move around by car and the commuting flows are increasing. It has been stated by the VCÖ (Verkehrsclub Österreich/Association for Transportation and Sustainable Mobility in Austria) that in all Austrian provinces transport is one of the main concerns as the emissions from traffic have increased since 1990 from 33 % to 71 %. The impacts of transport are also reflected in high economic costs, as in Austria every year more than 7.6 billion euro is spent in accident costs and infrastructure.
Transport infrastructure consumes about 25-30 % of land in urban areas and almost 10 % in rural areas within OECD countries (*Organisation de coopération et de développement économiques*), and in the EU15, of this transport infrastructure surface, 93 % is used by roads, whilst railways are responsible for 4 % of land take and airports for less than 1 % (EEA, 2004, p.26).

Looking at the individual scale, the location of the residence has a direct impact on the overall transport behaviour. Already in the 1970s, Torsten Hägerstrand dealt with an analysis of spatio-temporal behaviour of individuals and the depiction of human action in "time paths" (Hägerstrand 1975). The constraints identified by him through the spatial structure result in a manoeuvre, which are crucial to the design of the mobility possibilities and therefore to the possible needs. The "Mobility Pass for Real Estate" shares the same theoretical approach and creates a more transparent and comparable free online tool for those looking for a new house and for the real estate business.

Direct and indirect costs follow the mobility trends, but so do time, CO_2 emissions and accident risk, all strictly related to the distances travelled. The medium and long-term consequences of most people's travelling patterns are still hard to estimate. Most times decisions are made on the basis of short-term decisions such as the price of the rent or for the purchase, the quality of the living according to the available facilities and so on, without taking into account the costs associated to forced mobility related to going to work or to leisure activities.

But not only the financial situation of private households has an influence on the awareness on mobility. In the survey "population-delphi" of 2011 it was identified that arguments on sustainability will play an important role in making decisions. The inclusion of mobility costs or the expected long-term value development is considered when comparing central and peripheral property locations" (Schroder, Huck, de Haan, 2011, S.119). Nevertheless, the question arises to what extent the attitude influences the development of cities and rural areas. The housing market is closely tied to the land market and thus restrictions arise for planners, real estate companies and buyers or renters, as the building areas will be offered by the municipality at their own discretion. However, planners and local administrations can use "Mobility Pass for Real Estate" to have an effective tool when thinking about where to further develop cities, whether in a compact or dispersed way. These aspects can affect choices in land use, in density indicators, in public transport planning and related infrastructures.

While the prices of the rents or purchase and energy costs can be calculated rather easily, the costs and the CO_2 emissions related to the mobility are quite hard to estimate for most people, but often count up for a large part of the household's budget. It was estimated that in 2010 a household in Austria spends EUR 5,240 on average on mobility. A recent study by the VCÖ shows that compared to year 2005, that Austrian households spend EUR 330 more on mobility. The VCÖ indicates that people living in Vienna are paying the least on mobility (VCÖ, 2011). On the other hand, commuters who use public transport to work spend on average EUR 1,800 per year less on travel costs than those who travel by car.

Moreover, it can be assumed that many mobility patterns will change over time, such as in the case of households with children where these will go from kindergarten to primary and then secondary school; or depending on a job, as this might change.
This is why the "Mobility to Pass for Real Estate", with the calculation of mobility cost, mobility time and risk of accidents and giving a transparent view of the environmental impact by indicating the CO_2 emissions will help users rethink their habits in a more economic, safe and environmentally friendly way.

2. Objective of research and development of a "Mobility Pass for Real Estate"

2.1. Objectives and principles

The focus of this research study is the relationship between the home and the residents. The starting point is the location of the residence and the fixed points of its mobility (such as the job, the sports location, the shopping areas, the recreational locations, etc.). To refine the results, a series of personal information can be inserted in the online tool producing detailed data on the mobility costs for the entire household; or an average can be taken according to socio-demographic characteristics and statistical data. Mobility structures greatly depend on the household structure (singles, family with children, …), income, social status, age, sex.
For the "object component" (apartment or house), the situation is analysed on the basis of the transport and the mobility options. The probable medium- and long-term mobility costs will be calculated according to the different locations. The aim is to provide residents with useful information on the advantages and disadvantages of a specific location according to their own personal mobility style.

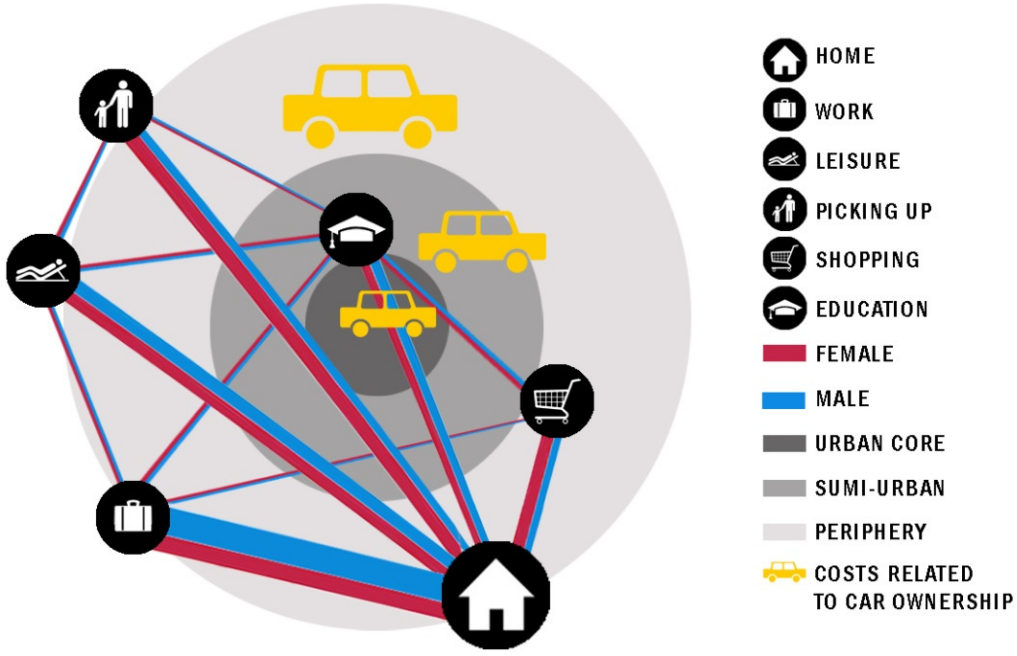

Figure 2: Main Focus of the "Mobility Pass for Real Estate" (Own illustration)

Figure 2 illustrates the various components of the "Mobility Pass for Real Estate". Social and spatial components form the basis for the Mobility Pass. As the individual travel behaviour of people is subjected to various factors, such as family size or net income, these factors must be considered in the evaluation of the mobility behaviour. Based on this data, the mobility behaviour will be influenced by the existing and/or the envisioned residential location, the number of trips to work or to the study place, the utilities and the leisure destinations. The location-related variables have a big influence on the transport mode and on car ownership. "Mobility Pass for Real Estate" wants to include CO_2 emissions, time costs and accident risk as benchmarks mobility costs to ensure transparency and have a positive influence in the decision-making process.

The users of the online tool will be able to understand the costs of their residence related to their mobility and lifestyle. The "Mobility Pass for Real Estate" will therefore further develop an environmental awareness concerning the chosen transportation mode.
Another long-term goal is to integrate the topic of "mobility and traffic development" in the real estate and property evaluation, and therefore the "Mobility Pass for Real Estate" would be a useful tool for the housing and real estate industry. The online tool is designed with GIS components and should be further developed after an intensive research and testing phase, into a structured tool with specific algorithms so to be used for broader applications by the real estate industry. In a further stage, there is the intention to develop the "Mobility Pass for Real Estate" for the decision-making concerning land use, transportation planning and subsidized housing.

2.2 State of the Art

There are already some basic approaches which calculate mobility costs (in term of money). These tools are a good basis for developing a "Mobility Pass for Real Estate". This will contain some of the basic approaches, but extend the state of art of the research through the use of a much more holistic point of view – and by including all exact address locations (in the first step for all of Austria).
One good example for an existing calculator of residential and mobility costs is the "WoMo" (Wohn- und Mobilitätskostenrechner) calculator in Hamburg – and there is also a similar instrument for Munich. The "WoMo" is a free online tool. Transparency and information of the residential and mobility costs are the main objectives of this tool. The consequences of the long-term individual mobility patterns and the environmental awareness are neglected in the "WoMo", but will instead be shown by this research study "Mobility Pass for Real Estate".

	"WoMo" calculator Hamburg/ (Munich)	Mobility Pass for Real Estate
Database	Based on location and household types	Based on lifestyle types and data on accident risk and CO_2 emissions
Area	Refers only to the district or municipality	For each location site through entering the exact current or future address
Spatial limits	Refers only to the district of Hamburg and the municipalities on its border	At the moment for entire Austria, but Mobility Pass is structured in modules and expandable (potentially to a Europe-wide dimension)
Determination of the costs	Estimation of the housing and mobility costs (CO_2 emissions through car and household)	Estimation of the mobility costs, time, CO_2 emissions, accident risk, and additionally a medium- and long-term forecast to these 4 components
Output	Identifies the financial consequences of the location decision	Additional to the financial consequences, as well the accident risk, time and environmental consequences

Table 1: Differences between "WoMo" and the "Mobility Pass for Real Estate"

Table 1 shows the significant differences between the "WoMo" calculator and the "Mobility Pass for Real Estate". One major new function of the "Mobility Pass for Real Estate" is the routing option based on Open Street Map data (see chapter 4.2.) which allows to calculate the real distance for example between a selected home and a selected working place.

3. Implementation of the online tool "Mobility Pass for Real Estate"

The "Mobility Pass for Real Estate" is designed as a free online tool with the components of the database, data from Open Street Map, the data from the evaluation about the lifestyle types and the accident risk. Another important component is the user interface where the interaction between the user and the collected data and algorithm takes place.

3.1. Object-relational database

The implementation of the online tool is with PostgreSQL (SQL stands for "structured query language"). SQL allows running complex queries on an object-relational database. It also provides a means of creating databases. It is an implemented standard, so many database products support SQL, and an update with actual data is very easy. These features are useful for the "Mobility Pass for Real Estate". That way, for example, real estate agents could update the prices of residential real estate on their own. PostgreSQL is a freely available open source relational database management system (RDBMS) that uses SQL and it can be extended through language extensions with object-oriented methods and data types for handling complex structured data. This allows the software developer to integrate own types and methods in the object-relational database management structure. PostgreSQL is an essential part of almost every open source PHP application. Good examples for SQL-based applications are phpBB, osCommerce, and Joomla.

3.2. Preparation of the OSM data model

Open Street Map (OSM) is used for the calculation of the routing. OSM is a public project that aims to create a free editable map of the world and puts all collected data under a public domain license. OSM can be seen as a typical web 2.0 application to which everyone can contribute and collect data using a GPS device. The coverage for Austria is already quite good and it meets sufficiently the criteria to be used for the online tool. The design of the OSM data makes it suitable for the routing und and thus for the calculation of the time and CO_2 emissions in the online tool. The first open routing application based on OSM was created for Germany and it shows that OSM data is applicable for routing and can be also implemented in the "Mobility Pass for Real Estate".

The challenges are in the road graphs which must meet the requirements of the "Mobility Pass for Real Estate". For example, a highway with the key-value pair is marked highway = motorway. In the community of Open Street Map there is no tag that identifies roads in urban areas.

For this purpose, with the help of Corine Land Cover 2006 data set (CLC), there is an attempt to have a delineation of inner-city and non-urban roads. The Corine Land Cover data set consists of 44 classes (28 of which occur in Austria). The delineation from the city streets, the main class of "built-up area" and its subclasses are used. Here, the OSM road data should been intersected with the built-up area of CLC. The results are all the road data, which exist within the built-up area. In addition, for the road graph (shortest path between two points on any polyline layer) of OSM in the project, further information concerning the travel speed is needed. For the OSM graph top speeds can be defined on a road segment within the various road classes.

This is possible with the attribute (tag) "maxspeed". For a temporal calculation of the different road classes in Open Street Maps it is not possible to reach constantly the maximum speed along the entire distance. For example, the maximum speed will not be reached if there are traffic lights at the crossroads in the town. Therefore, an average travel speed for different road classifications with respect to the Open Street Map properties (tags) and the used classes of Corine Land Cover combined data set (built-up area) has to be determined in a travel time matrix.

3.3. Data Evaluation

3.3.1. The lifestyle types

For the calculation within the online tool the evaluation of the type of lifestyle is essential. The mobility behaviour varies greatly according to the particular type of lifestyle. The specific mobility per household is mainly due to the household size which means that the number of trips per household is proportional to this, but also affected by other factors like age and sex.

Based on the lifestyle matrix developed out of the micro-census gathering made by Statistics Austria, 7 different lifestyle-types could be identified for Austria. In relation to the residential

location (urban, semi-urban, peripheral), 21 lifestyle groups have been established and a certain mobility behaviour can be classified.

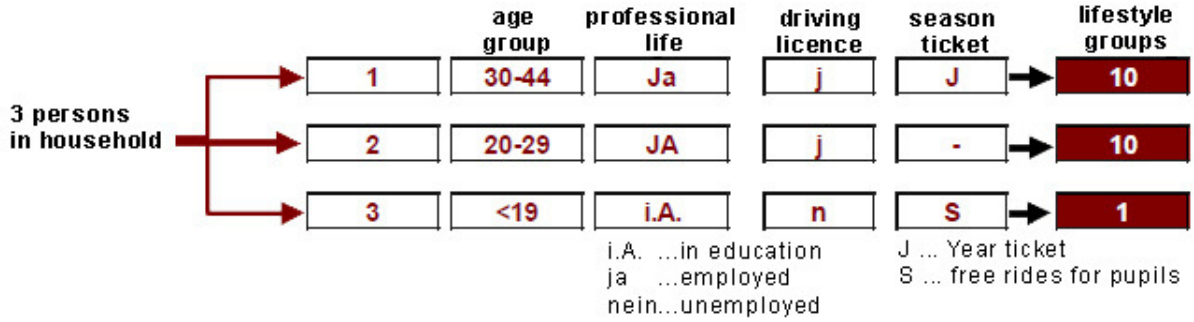

Figure 3: Lifestyle group classification

Based on the user data (Figure 3), the online tool chooses the correct lifestyle group and enables the calculation of the mobility costs.

3.3.2. The accident risk

The accident risk describes the calculation of the probability of accidents of certain groups (stratified by age, gender, and transport mode) and the determination of a risk score with the help of the economic costs of accidents. The variables are not considered isolated but take into account their mutual interaction.

3.3.3. The CO_2 emission calculator

The "Mobility Pass for Real Estate" will calculate the CO_2 emissions produced by personal mobility between the residence and the main destinations such as work, shopping, leisure, etc. In combination with the calculation of distance and time, the estimation of the CO_2 emissions will be calculated on the base of the transport modality and in the case of the use of cars.

Already many internet sites calculate the CO_2 emissions, greenhouse gases and the ecological footprint. This implies that the total quantity of greenhouse gas emissions caused directly and indirectly by an individual, event, organization or product, is expressed mainly as CO_2 emissions. Carbon footprints and their calculations have recently drawn attention as they can limit CO_2 emissions considerably. Most carbon footprint calculators available online estimate the CO_2 emissions of individuals and households based on house, car, and other consumption-related measures. When considering the CO_2 emission related to mobility a very important factor to be considered is the residence location.

The important added value of "Mobility Pass for Real Estate" is that it is a combination of a footprint calculator and the calculation on costs, time and accident risk based on mobility.

3.4. The user interface

The user interface is the space where interaction between the user and the online tool occurs and where the output of mobility cost, accident risk, CO_2 emissions and time will appear. Usability is mainly a characteristic of the user interface and makes the process of using the system effective, efficient and satisfying.

Based on the user guide and the data on mobility balance, a user interface could be built. For this jQuery was used. It is a free, extensive JavaScript class library, which provides comfortable features for Document Object Model (DOM) manipulation and navigation. Figure 4 shows the current user interface and the input options. The residence can be selected by clicking into the map and will automatically be assigned to the current area category (urban, semi-urban, periphery). This interface would correspond to the first of two planned modules which contains the minimum information necessary to be filled in by the user.

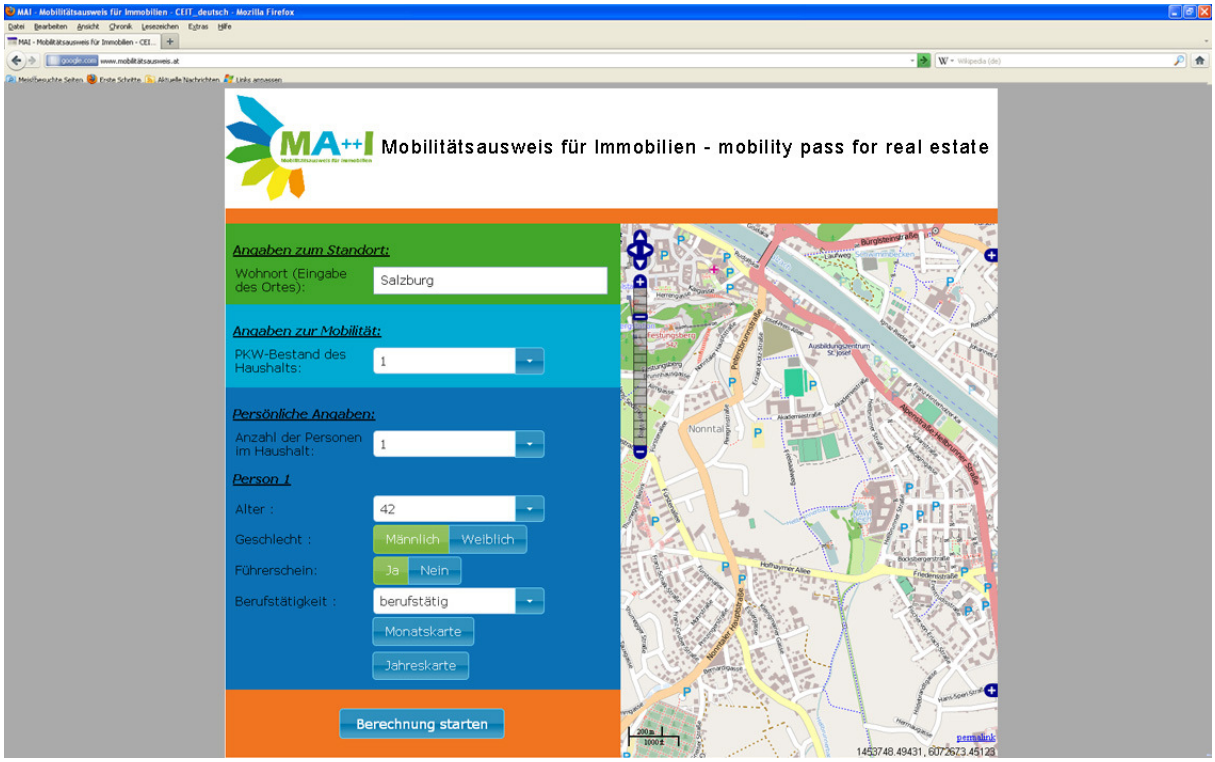

Figure 4: Mobility Pass for Real Estate user interface and the input options

In the second module, in a later stage, the minimum information will be integrated with more specification options for the end user. The more accurate the description of the personal mobility behaviour is the more accurate will the output of the online tool be.
If only a few specific features are entered, standard statistical values based on the calculated average data on mobility and accident risk will be applied which were compiled and calculated for all objects for the respective groups and mobility types.
The target group of the first module will be the general public while the second module is specially designed for real estate agents. As a result, they can offer a better service to their customers and, therefore, a professional version will be developed where real estate agents can update facts and data themselves.

4. Conclusion and Future Perspectives

Although only 42.9 % of the population in Austria considers the issue of climate change in a major concern (survey of the insurance company Allianz), foreseeing the mobility costs, CO_2 emissions and accident risk enables citizens to make their own choices when choosing housing or business locations. Reducing personal costs and consequently community ones would help citizens in becoming more active participants in the shaping of the city.
For this reason, it would be indicated if the same status were given to the Mobility Pass as it was for the "Energy Pass" because of the EU directive, which is compulsory since 2009 and shows on a scale from A to G how energy efficient the building or flat is. This view does not take into account the waste of energy related to mobility, as a low energy house with car has a higher total energy than a standard house without car. The energy certificate should therefore expand to the area of mobility. (VCÖ, Factsheet, 11.2010)
A future possibility to enlarge the offer within the "Mobility Pass for Real Estate", is the integration of Open Government Data (OGD). OGD is the idea that certain not personalized data should be freely available to everyone and can be republished as they wish, without restrictions from copyright, patents or other mechanisms of control.
Several national governments around the world have committed to making a large part of the data they collect available to the public, and have created a central project and website to act as a distribution point. In Austria, Vienna has started a good process in publishing the data –

especially the one related to geographical reference and it is obvious that this will be available for the whole of Austria. In the next years this data could be also used within the online tool of the "Mobility Pass for Real Estate" and help to enlarge the quality and service for the user and in the field of real estate consulting.
This online tool can also influence the personal life patterns and can be seen as a modern and holistic planning tool which can impact the mobility behaviour and further the spatial patterns in times of sprawling cities, the lack of resources and climate change.
The "Mobility Pass for Real Estate" is an online planning tool that considers the interests of all the actors involved and becomes a communication platform, a possible link between top-down and bottom-up approaches.

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