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Finding Suitable Measures for Mobility Behaviour Change

Johanna Schmitt, Anna Butzhammer, Dagmar Lahnsteiner, Thomas Prinz

(Johanna Schmitt MSc., RSA FG Research Studio iSPACE, Salzburg, johanna.schmitt@researchstudio.at)
(Anna Butzhammer MSc., RSA FG Research Studio iSPACE, Salzburg, anna.butzhammer@researchstudio.at)
(Dagmar Lahnsteiner MSc., RSA FG Research Studio iSPACE, Salzburg, dagmar.lahnsteiner@reserachstudio.at)
(Dr. Thomas Prinz, RSA FG Research Studio iSPACE/Universität Salzburg – IDA Lab, Salzburg, thomas.prinz@researchstudio.at)

1 ABSTRACT

This paper presents a decision support tool for public authorities and planning experts developed within the scope of the transnational project SaMBA, which focuses on reward and pricing policies to induce changes in the mobility behaviour of citizens. The tool presents incentive-based measures to promote low carbon mobility and raise awareness of the value of behaviour change policies as a foundation of strategic planning. Based on a user-defined goal and characteristics of the target area with influence on mobility or mobility behaviour, a list of recommended measures including details regarding implementation and impacts derived from best practices is provided. The tool is implemented with Microsoft Excel, which allows access for a wide audience, and ArcGIS, which provides additional analysis and visualisation options for users with GIS experience. The goal was to develop an extendable planning tool, which can be used as a foundation of the identification of potential measures and action areas.

Keywords: Sustainability, Incentives, Decision support, Behaviour change, Mobility

2 INTRODUCTION

An important topic and enormous challenge in the field of urban growth is the future of mobility. Urgent problems in this regard still are the high modal split and the energy demand of the private car, which are related to several issues including congestion, pollution or noise. Although motors have become more energy-efficient, the energy demand has increased due to the higher weight and the higher motor power of modern cars. Furthermore, the occupancy rate has decreased. In Austria, the number of cars has increased by 26% between the years 2000 and 2016. The number of kilometres travelled by car has increased by 28% at the same time (VCÖ 2018). In addition, citizens in some areas are still strongly car-dependent in their everyday mobility. The transport sector is the second largest producer of greenhouse gas emissions in Austria. In 2019, it was responsible for 30% of all emissions (Umweltbundesamt 2021). Many cities and regions already address these challenges by an improvement of public transport networks, an extension of walking and cycling infrastructures or testing innovative and smart mobility solutions to promote sustainable mobility and increase the quality of life. These measures certainly create a necessary and adequate basis, but for optimal use, they require additional awareness-raising approaches including incentive and reward systems to motivate people to use these new offers and change their mobility behaviour in favour of sustainable solutions. This is the context of the project SaMBA (Sustainable Mobility Behaviours in the [1]Alpine Region), which is implemented in the years 2018-2021 and promotes mobility behaviour change by reward and pricing policies. One output of this project is a tool presenting incentive-based measures to promote low carbon mobility and raise awareness of the value of behaviour change policies. The tool supports decision-making processes and the choice of appropriate measures and incentives addressing the mobility behaviour of residents. Based on a user-defined goal and the characteristics of the target area, the tool provides a set of suitable measures and their impacts. It contains two components implemented with Microsoft Excel and ArcGIS to combine the advantages of both approaches. The functionalities of the tool have been tested in the Salzburg Region, Austria and other SaMBA pilot regions.

3 STATE OF THE ART

3.1 Incentive theories

In the last years, governments have started to consider behavioural science to gain a better understanding of human actions as a foundation of the development of policies promoting sustainable behaviour (Mont et al. 2014). The SaMBA project aims at the support of this development by promoting mobility behaviour change as an important current topic. For implementing mobility behaviour change policies, it is necessary to

[1] https://www.alpine-space.eu/projects/samba/en/home

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understand the basics of human behaviour. According to the Fogg Behaviour Model, behaviour consists of the factors motivation, ability and triggers, which have to come together at once for an action to be performed. To promote behaviour change, a person needs sufficient motivation, the ability to perform a certain action and a trigger for the target behaviour. Motivators can e.g. be hope, social acceptance or pleasure, but also pain or fear. Elements of ability are e.g. time, money or physical effort. Different types of triggers can e.g. help to motivate people to perform a behaviour or make a behaviour easier (Fogg 2009). In the case of the SaMBA approach, incentives are considered as motivating as they encourage people to perform certain actions. The SaMBA tool is based on the fact that people are pulled towards a behaviour that leads to a reward and pushed away from a behaviour that leads to negative consequences. This is also referred to as incentive theory, which is one of the major theories of motivation. It suggests that people are more motivated by outside incentives rather than by internal drives. According to incentive theory, incentives cannot only be used to promote certain actions, but they can also help to stop certain behaviours. However, incentives are only effective if the offered reward is obtainable and people consider it as important for themselves (Cherry 2020).

Due to the value and the effectiveness of incentives, incentive-based approaches regarding mobility behaviour change are already used in policy planning in some cases. They address different target groups, e.g. commuters, pupils, tourists or the general public, and topics like the promotion of public transport, active modes or sharing systems. These measures cover different spatial levels including urban, suburban and rural target areas. However, most of the examples collected during the SaMBA project focus on urban and suburban areas. Incentives come in a variety of forms, but a major group of them is based on rewards like money or vouchers for shops and restaurants. Others are e.g. raffles, activities like bicycle tours or practical rewards, e.g. cycling gear.

A major group of measures is based on technical approaches. Many of them use mobile applications that can also contain a gamification component. An example is TrafficO2[2], a mobile app that provides challenges and information to promote sustainable transport. The users can collect points for using sustainable modes to win prizes and discounts.

Gamification in general is also a common approach, especially when designing measures for children. An example is the Traffic Snake Game[3], where children can collect stickers for their class every time they walk, cycle, use public transport or a shared ride on their way to school. The goal is to collect as many stickers as possible to win prizes.

Another approach used in a variety of best practice examples is promoting a certain transport system with the help of discounts on the user fee. An example is CAMPUSbike[4], which is a programme that offers students in different German cities free bike rental for the first 30 min of the rental term.

Besides policies with an incentive or a reward, pricing approaches can also be used. They mostly include congestion charges like an example from London[5], where a daily charge for driving a vehicle within the charging zone needs to be paid. Some pricing approaches are included in the tool, however, the focus is on measures including a positive incentive.

3.2 Existing tools on sustainable transport

Another important foundation of the development of the SaMBA tool was the analysis of already existing tools to simulate the impacts of policies in the field of sustainable transport. These tools can be split up into different categories depending on their type. It can be distinguished between applications, Excel tools, models and other forms.

Most tools fall in the category of applications, which include web or software applications. As examples, “IMPACT”[6], which analyses changes in transport systems, the “Multi-Actor Multi-Criteria Analysis” tool[7],

[2] http://www.traffico2.com/en/
[3] https://www.trafficsnakegame.eu/
[4] https://www.nextbike.de/de/campusbike/
[5] https://tfl.gov.uk/modes/driving/congestion-charge
[6] https://www.ait.ac.at/en/solutions/impact-assessment-for-transformative-mobility-systems/
[7] http://www.mamca.be/en/

which measures the impact of policies on different stakeholders, or the "HIGH" tool[8] for analysing different impacts of transportation policies can be named.

Another way of analysing the impacts of policies is the development of Excel-based models. Examples are the "FLOW" tool[9], which concentrates on changes in the transport infrastructure and the "VMT reduction: Phase One – Scenario Assessment Tool"[10], which considers the impacts of CO_2 emissions and travelled miles.

Some other tools appear in form of a model, which can for example be mathematical, like the "Integrated Transport and Health Impact Modelling Tool"[11] or agent-based like the "Mobility Transition Model"[12].

4 STRUCTURE OF THE SAMBA TOOL

4.1 Framework

Although some tools regarding mobility and sustainable transport solutions already exist, only a few include a GIS component and are linked to the promotion of mobility behaviour change with the help of incentives. This is a gap that the SaMBA tool addresses by utilising Microsoft Excel, which provides a comprehensive but easy to use database with recommendable measures, and an additional ArcGIS component with more analysis options for users with experience in this field.

The primary target group of this tool includes policymakers, public authorities and planning experts, but also sectoral agencies, education and research and infrastructure or service providers. Therefore, the tool needs to be easy to use and to be open to a wide audience without any restrictions. It also is designed for transnational applicability. The main functions of the tool can be exploited by using the Microsoft Excel component on its own, which does not require expert knowledge and provides an environment most users are familiar with. Furthermore, it does not require constant maintenance after the end of the project and allows an easy extension. However, presenting results is limited to diagrams and tables. Since the tool has a spatial context, an optional GIS component has been developed to provide more detailed analysis and visualisation options. The main purposes of the GIS component are to improve the required user input by pre-processed spatial statistics or data and to identify and visualise mobility demands and potential action areas in a spatial context as an element of decision support. However, it addresses a smaller target group and is limited by the availability of standardised geodata on a transnational level. For maximum benefit and to circumvent the specific disadvantages, both approaches were implemented. The final tool does not require expert knowledge in the field of GIS, but it is helpful for more in-depth analysis and the visualisation of the results.

4.2 Building blocks

To be able to recommend suitable measures, the tool requires a dimension, a goal and a set of parameters for the characteriation of the target area. Based on these user inputs, a list of suitable measures is presented. Furthermore, the impacts of a measure are described based on best practice examples (cf. Fig. 1).

Based on the objective to introduce incentive-based measures that promote low carbon mobility and climate and environmental protection, four important dimensions for mobility behaviour change have been defined for the SaMBA tool. They include public transport, active modes, multimodality/access and sharing systems. Each goal embedded in the tool is assigned to the appropriate dimension for better clarity and structuring (cf. Fig. 2). Dimensions and goals have been defined with the help of pilot activities carried out during the project and regional, national or international strategic documents. One of the most important regional documents in this regard is the Mobility Concept of the Federal State Salzburg, which describes future strategies for sustainable mobility and transport policies. It defines goals including the promotion of eco-friendly and multimodal transport, the promotion of alternative and innovative approaches like sharing systems and the provision of equal mobility options for all residents (Land Salzburg 2016). Similar objectives are presented in the Austrian Traffic Master Plan, which introduces Austrian-wide transport political goals for all modes (BMVIT 2012). The European Commission has published a strategy on low

[8] http://www.high-tool.eu/index.php?id=home
[9] http://h2020-flow.eu/
[10] https://www.wsdot.wa.gov/research/reports/fullreports/765.1.pdf
[11] https://ithim.ghi.wisc.edu/
[12] https://www.top-ix.org/it/2018/06/04/disegnare-mobilita-sostenibile-con-motmo/

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emission mobility, focusing on improving the efficiency of the transport system, promoting low emission alternative energy and zero-emission vehicles (European Commission 2016). The Transport Protocol of the Alpine Convention describes characteristics of a sustainable transport policy, which include e.g. reduction of negative effects on the environment, improved accessibility, optimisation of the use of existing infrastructures and measures against noise or emissions (EU 2007).

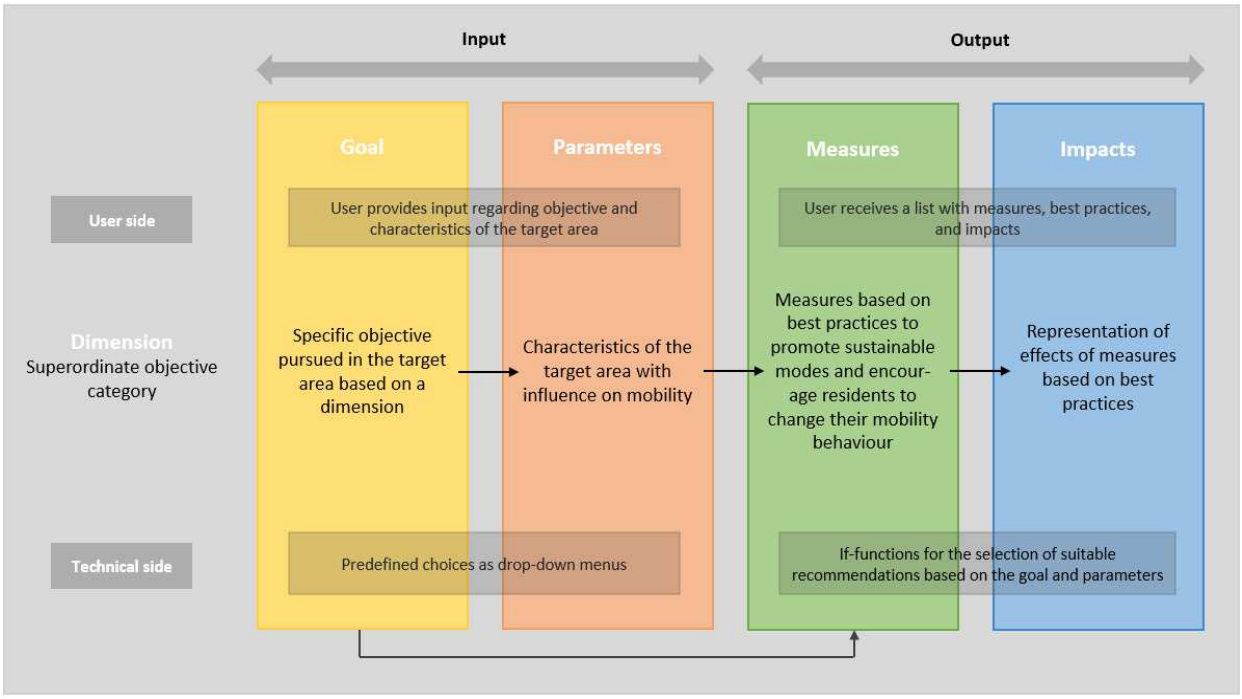

Fig. 1: Central building blocks of the SaMBA tool

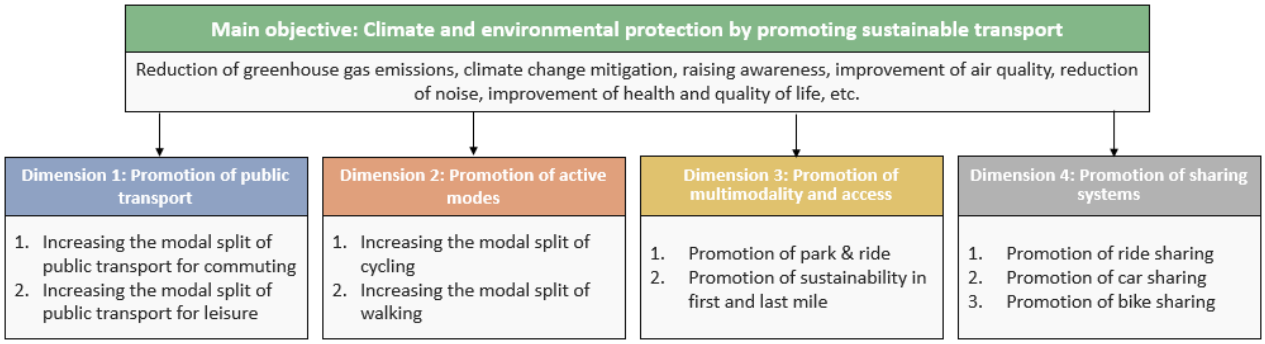

Fig. 2: Dimensions and goals

In the next step, the characteristics of the target area in terms of mobility and mobility behaviour are defined with the help of a parameter set. This set includes e.g. transport infrastructure and services, demography, topography and settlement (cf. Fig. 3). All parameters are embedded in Microsoft Excel, but some of them currently are not part of the GIS component due to data availability issues.

Based on the selected goal and the parameters, the SaMBA tool recommends measures that are suitable for the target area. In the context of the presented project, measures are defined as policies including an incentive to motivate citizens to change their mobility behaviour in favour of eco-friendly modes. Measures are presented along with their impacts, which are defined as effects based on an indicator. Mostly, they are quantitative and include e.g. changes in the modal split or the amount of CO2 emissions saved. However, also qualitative impacts like health benefits from active modes are described since in some cases no specific studies on the impact and no quantitative data exist. Measures will not have the same effects in different target areas since they depend on many factors and details that are beyond the scope of the project. Therefore, the tool provides results and impacts derived from best practice examples.

Parameter name	Categories	Excel	GIS
Type of the target area	Urban, suburban, rural	✓	✓
Topography	Flat, hilly, steep	✓	✓
Quality of footpaths and sidewalks (density of footpaths, presence of sidewalks, street lighting etc.)	High, medium, low	✓	✓
Quality of cycling infrastructure (density of bicycle lanes, presence of adequate bicycle parking facilities, street lighting, pavement quality etc.)	High, medium, low	✓	✓
Quality of public transport (frequency, vehicle type, persons living in walking distance to a public transport stop etc.)	High, medium, low	✓	✓
Presence of high commuter flows (in and out)	Yes, no	✓	✓
Presence of a university or a university catchment area	Yes, no	✓	✓
Presence of a primary school	Yes, no	✓	✓
Presence of a secondary school	Yes, no	✓	✓
Presence of a bike sharing system	Yes, no	✓	✗
Presence of a car sharing system	Yes, no	✓	✗
Presence of a park & ride system	Yes, no	✓	✓

Fig. 3: Parameters

5 TOOL FUNCTIONALITIES

5.1 Workflow

Fig. 4 presents the workflow of the SaMBA tool. The starting point is the selection of a dimension and a goal with the help of dependent dropdown menus in Microsoft Excel. For higher user-friendliness, the tool only shows parameters that are relevant to a selection. Parameter inputs can also be selected as categories from dropdown menus. The user is not obligated to fill in all listed parameters, however, with a larger amount of input, the results will be more customised and adapted to the characteristics of a target area. After filling in the parameters, Microsoft Excel with the help of If-functions filters measures that are embedded in a database. As a result, the tool provides a list of recommended measures including a measure name, a best practice and indicators (e.g. modal split) the measure has impacts on. Further details regarding the implementation and the impacts are displayed when the user clicks on the name of a best practice example. Besides worksheet functions, the Microsoft Excel component also uses the programming language Visual Basic.

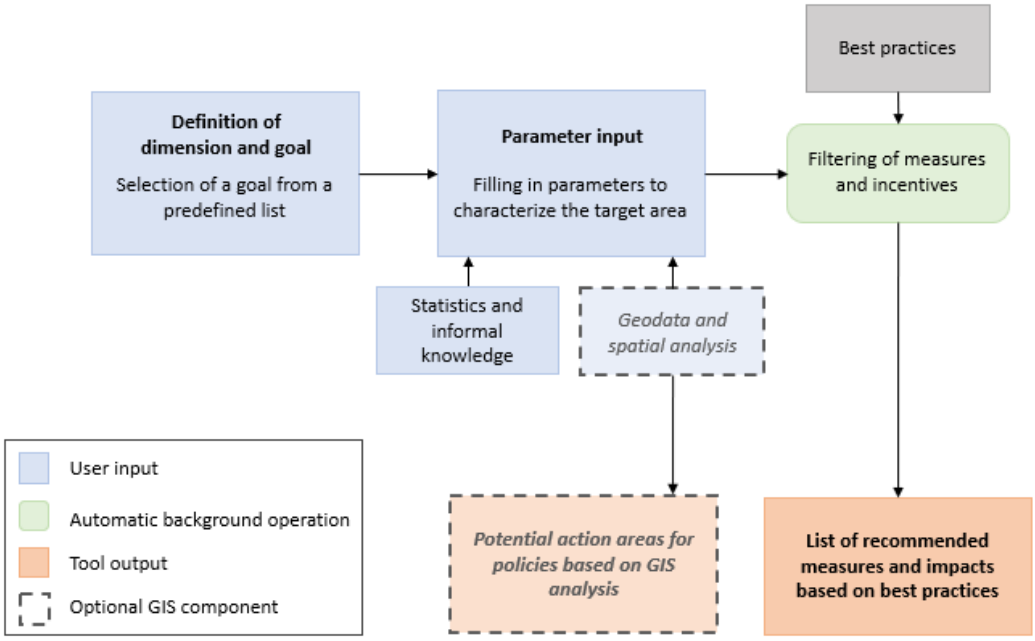

Fig. 4: Workflow of the SaMBA tool

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The additional GIS component can be used in two ways. Besides sources like municipal statistics and informal knowledge, parameter inputs can also be derived from a GIS analysis of the region. The latter will help to get more exact values, consider areas beyond predefined borders or focus on small areas that are not listed in official statistics. With the help of spatial data regarding demography, topography, settlement structure, commuter flows and transport infrastructure or services, the required input parameters can be modelled in ArcGIS. The GIS component also offers methods for the assessment and comparison of mobility demands or potential action areas for behaviour change policies. Framing conditions based on the settlement structure (e.g. urban-rural-typologies and topography) and infrastructure quality for walking, cycling, public transport and intermodal trips are used for the identification of potentials. The idea is to detect action areas with an adequate infrastructure quality and a high potential for mobility behaviour change measures.

5.2 Interface and output examples

The Microsoft Excel component consists of six different worksheets. The first one is an introduction describing background information and the purpose of the tool. The second sheet represents the main user interface including all inputs and outputs. It also provides an export function, which transfers the sheet to a PDF document. For users who want to gain further insight into the collection of all integrated measures, an additional overview table is provided in the third sheet, which also allows filtering the measures by a goal. The fourth sheet contains a glossary defining important terms. The databases containing the inputs for the dropdown menus and the If-queries for the identification of recommendable measures are included in the fifth and sixth sheets, which are only open for tool developers. Fig. 5 shows the main user interface demonstrating inputs and outputs for promoting the use of public transport among commuters based on exemplary user inputs from a municipality in the Salzburg Region.

Interreg Alpine Space SaMBA

SaMBA Tool

for finding policies & estimating impacts in terms of mobility behavior change

For definitions of some important terms see glossary!

Please fill in the blue cells

Reset | Save as PDF

Select a dimension: Promotion of public transport

Select a goal: Increasing the modal split of public transport for commuting

Fill in the parameters to characterize your target area *The more parameter values are filled in, the more measures can be recommended!*

Type of the target area	Urban
Quality of public transport	High
Presence of high commuter flows (in and out)	Yes
Presence of a university or a university catchment area	Yes
Presence of a primary school	Yes

Click on a best practice to receive further information

Recommended measures

Measure name	*Best practice*	*Documented impacts*	*Further information*	*Link/contact*
Rewards for not using a parking space	Parking cash out program	Modal split	**In motion program** Description: This program was implemented in King County, Washington and provided residents with incentives to drive less and raised individual awareness on alternative travel options. Participants committed to change two trips per week from MIV to another mode for 12 weeks and for every successful week they received a voucher to purchase public transport tickets, biking and walking gear or gasoline for carpooling. Impacts: Participants reduced MIV trips by 24%. Most trips were converted from MIV to public transport (40%), but the program had also high positive effects on walking.	Click here
Incentives for residents to use less MIV	In motion program	Modal split		
Collecting points for sustainable mobility behavior	TrafficO2	CO2 emissions		
Rewards for avoiding peaks	MIMOSA, Spitsmijden	Modal split, traffic volume		
Charges for vehicles	London, Stockholm, Milan, Gothenburg, Singapore	Modal split, traffic volume		
Commuter challenges for reducing traffic during peaks	MOBI	Modal split		
Voucher programs	Transit voucher program	Modal split		

Fig. 5: Main user interface of the SaMBA tool

The impacts of measures are represented with the help of best practice examples. If no measure can be recommended for the target area, general suggestions (e.g. that it is required to improve the infrastructure before implementing behaviour change policies) are provided. Currently, the recommendation of measures and their impacts are only depicted in the Microsoft Excel component.

The ArcGIS component consists of 13 different models developed for parameter calculation and the estimation of potentials and demands. Fig. 6 shows the quality of public transport in a part of the Tennengau Region, which is located to the South of the city of Salzburg, based on a 250m raster. The results can also be transferred to other spatial levels like municipalities or settlement cores. The quality of the public transport system presented in the map is based on the "ÖV-Güteklassen" (classification scheme for public transport quality in Austria) and the walking distance to a public transport stop. The map shows that most municipality centres have very good public transport infrastructure, especially in the municipalities located in the

Northern part of the study area, which is nearer to the city of Salzburg. One reason for this is the existence of a train line.

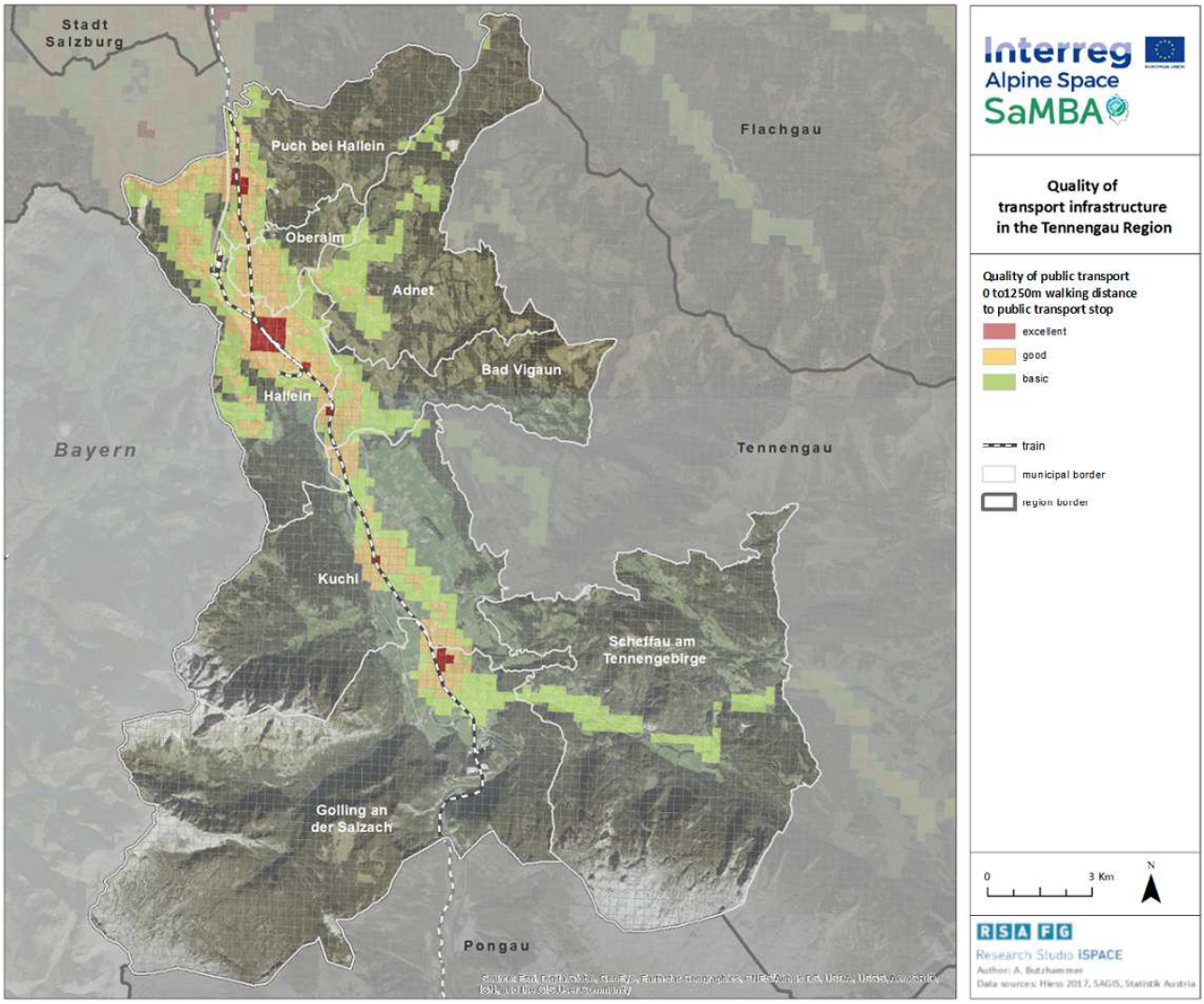

Fig. 6: Quality of public transport

Fig. 7 demonstrates the identification of potential action areas with the help of two maps covering the municipalities Hallein and Kuchl, which are located in the Tennengau Region. The first map represents the conditions for walking to public transport stops based on settlement structure, slope and the distance to the next public transport stop. Furthermore, the service interval and the vehicle type are considered, since for most persons the motivation to walk to a public transport stop with good service quality is higher. This output can e.g. be combined with potential modes for the first mile to public transport stops for commuters to determine action areas for measures that promote public transport and walking in the first mile. This is displayed in the second map, which shows the share of commuters with good first mile options for cycling, walking and the car. In this case, a potential action area for promoting public transport and walking in the first mile in the North of Hallein could be identified.

6 DISCUSSION AND OUTLOOK

The SaMBA tool provides decision support as a foundation for public authorities in strategic planning introducing recommendable measures that aim at a mobility behaviour change of citizens. The tool has the potential to be adapted in different ways. For an easy modification of the tool, the demonstration of possible extensions by additional goals, parameters or measures and further insight into the utilised spatial analysis methods, a guideline including detailed documentation of the tool workflow, the implementation process and all GIS models and Excel statements is provided.

The Microsoft Excel component provides an intuitive and uncomplex way to gain insight into different approaches. This component is considered a comprehensive database that easily presents existing solutions

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to allow an overview and a quick finding of measures for the user. Since its required inputs can be based on statistics and informal knowledge, it is of especially high importance in regions with limited geodata availability. Because the Microsoft Excel component does not require expert knowledge, it is open to a large user group, but it is limited regarding its outputs as it only allows diagrams and tables and no more comprehensive visualisation options.

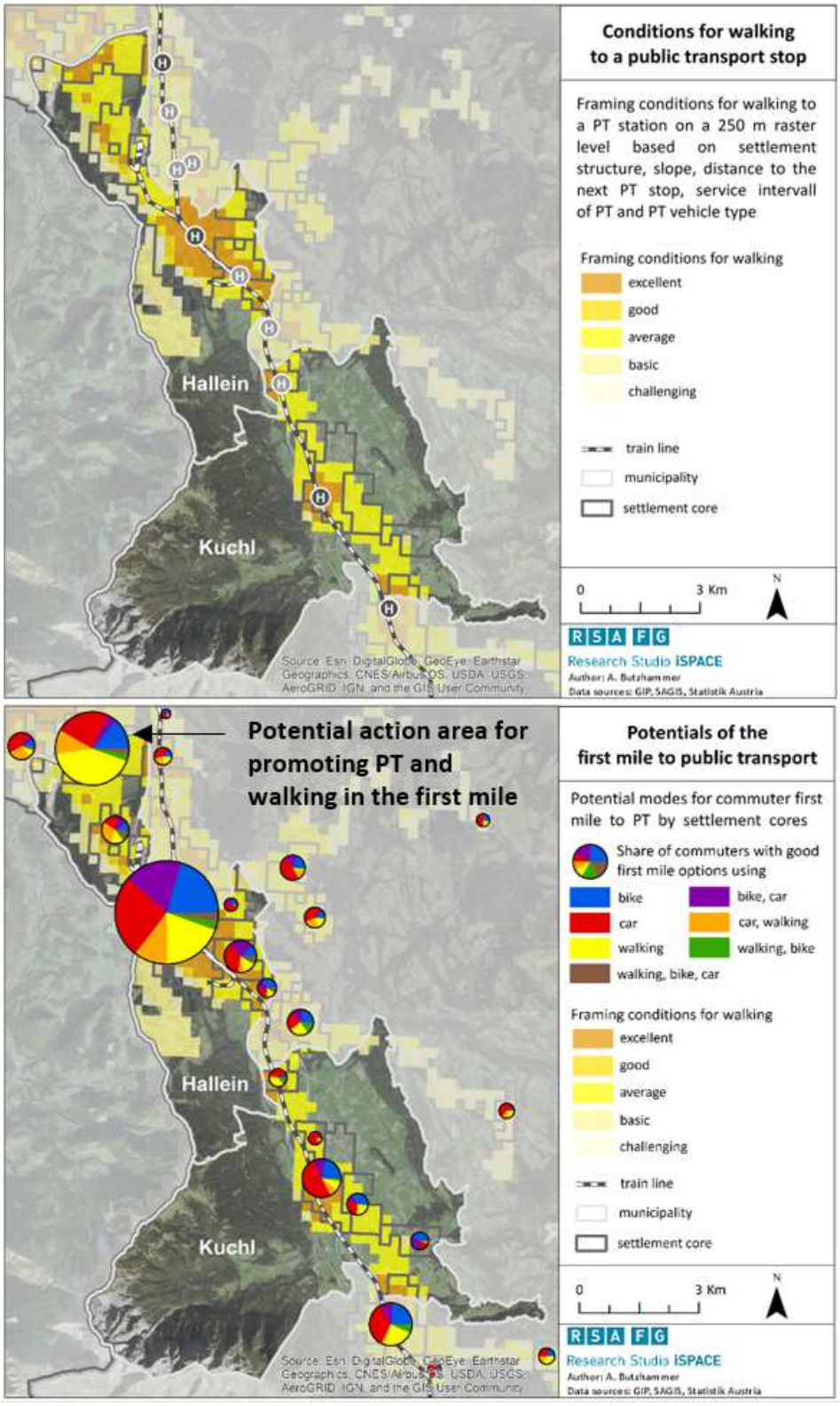

Fig. 7: Conditions for walking to the next public transport stop and potential action areas

The underlying concept of the tool is designed for transnational applicability, which means that the presented goals and parameters have no regional specification. The GIS component, however, is dependent on data

availability in the target area, but it contributes to improvements in the results of the tool. GIS supports the development of regional analyses to identify suitable measures and to compare different target areas.

At the moment, one weakness of the tool is the strong dependence on best practices, especially in the field of impacts of measures. Currently, the tool does not allow a direct transfer of impacts or their calculation in the target area of the user. To address this issue, appropriate adaptations in the long term can help to estimate regional impacts of measures based on an interconnection with traffic information, commuter flows and effects on modal split and CO2 emissions. The tool has the potential to be further developed to allow the construction of scenarios and to simulate potential effects on congestion, occupancy of public transport, pollution and necessities to improve existing infrastructure.

Currently, although GIS and Microsoft Excel are considered components of one tool, they are not strongly interlinked. ArcGIS can present possible action areas, but it does not recommend suitable measures for these areas. An improvement in this regard would lead to more comprehensive analysis and interpretation options. Furthermore, a combination with other tools is thinkable for the future.

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