DAVeMoS Newsletter

University of Natural Resources and Life Sciences, Vienna
Department of Landscape, Spatial and Infrastructure Sciences
Institute for Transport Studies – DAVeMoS research group

Newsletter Vol. 01/2021

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DAVeMoS is an Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (*Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie*, BMK)'s Endowed Research Group with a mission to strengthen the competitiveness and knowledge building in the field of digitalisation and automation in the transport and mobility system at local, regional, national, and the EU levels.

Read more about DAVeMoS at:
www.davemos.online

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Hosted by BOKU Institute for Transport Studies:
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1. A short reflection on 'work-from-home' impacts so far

About one year ago, we entered a lockdown period, due to the outbreak of the SARS COV 2 virus. Restriction on movement has been in place in many countries, resulting in significant changes in mobility patterns. In Austria for example, according to Google data, as per 5th March 2021, compared to the same time last year, people are travelling 45% less for retail and recreation, 3% less for supermarkets and pharmacy and 30% less for work (Google, 2021).

During this period, working-from-home has been resorted as a solution to sustain workers' activities and has been hailed as the great leap to the digitalisation age, and appreciated due to the reduction of daily global CO_2. Le Quere et al. (2020), for example, reported that, in total, daily global CO_2 emissions decreased by 17% by early April 2020 compared with the mean 2019 levels, just under half from changes in surface transport.

Based on a large scale survey which was conducted by TU Wien across 100 countries, Shibayama et al. (2021) reported that, during lockdown period, work-from-home alternative was used by 40% to 60% of working respondents, and among people with workplaces with possibility for home office, the percentage is between 60% and 80%.

Despite of such positive results, working-from-home is not without problems. Many studies have highlighted the challenges to work from home, and many recent analyses indicate that a greener new-normal may be much less significant than what was originally expected. Based on data in Sweden, Italy and India, Bin et al. (2021) found that the acceptance and long-term adoption of using technology alternatives are strongly related to the personality and socio-demographic group of the given person, which highlights the importance of promoting alternatives as a part of longer-term behavioural and lifestyle changes.

(to be continued)

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Furthermore, one of the most obvious negative impacts due to the lockdown is its impact on people's well-being (e.g. anxieties due to insecurity, confusion, emotional isolation and stigma) which can lead to insomnia, self-harming and suicidal behaviours. Pfefferbaum and North (2020) explain that particular groups of the society are more likely to be vulnerable than others to the psychosocial effects of pandemics. In particular, people who contract the disease, those at heightened risk for it (including older people, people with compromised immune function, and those living or receiving care in congregate settings), and people with pre-existing medical, psychiatric, or substance use problems are at increased risk for adverse psychosocial outcomes. Based on more than 1000 respondents in Austria, Pieh et al. (2020) found that depressive symptoms (21%) and anxiety symptoms (19%) are higher during COVID-19 compared to previous epidemiological data. Furthermore, they also found that the COVID-19 pandemic and lockdown seems particularly stressful for younger adults (<35 years), women, unemployed people, and low income. People, who do not have access to mobility, are more likely to be isolated and lonely, and some evidence suggests immobility is linked to poorer physical and mental health and even mortality.

Overall, as argued in Musselwhite et al. (2021), as we move towards vaccination programmes across the world, some may suggest that we will have an opportunity to make the world a better place, to have something positive to come out of this international disaster. There has never been a better time to encourage a more sustainable and healthier transport system across the world. There is no need to go completely backwards to the unhealthy high polluting hypermobility we had in the past. Enabling appropriate working at home, coupled with more public space for walking and cycling, allowing people to reduce their mental stress, while using policy measures and techniques to encourage people back to public transport are necessary.

Yusak Susilo

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2. We are growing!

After some delays due to COVID-19 and other issues, in the beginning 2021, a number of researchers joined DAVeMoS team.

Dr. **Anugrah Ilahi** is a postdoctoral researcher, who will be working on building agent-based simulation MATSim for Vienna and investigate the impacts of micro-mobility in Vienna and surrounding. Mr. Ilahi received his PhD from Institute of Transport Planning and Systems (IVT) at ETH Zurich on the topic of activity-based model approaches for sustainable cities. He got his masters from University of Gajah Mada and was working for 3 years as consultant at GIZ SUTIP. His research expertise includes transport planning, agent-based models, and discrete choice modelling.

Ms. **Roxani Gkavra** is a researcher and PhD student, who is currently working on the analysis of demand responsive transport (DRT) services in suburban, rural and touristic areas in Austria, and in particular in the region of Salzburg. She has recently graduated from the Transport & Planning MSc at Delft University of Technology, the Netherlands. She also holds an integrated Master Diploma in Civil Engineering from Aristotle University of Thessaloniki, Greece. Her research interests are travel behaviour, active mobility and the integration of emerging data collection methods in capturing the travel choice behaviour and travel experience.

Mr. **Shun Su**, is a researcher and PhD student, who is currently planning to examine e-scooter users' behaviours in different traffic and urban settings via Virtual Reality environments. Mr. Su has a master of science in Transportation Systems from TU München and a master of engineering in Transportation Engineering from Beijing Jiaotong University. Prior joining the DAVeMoS team he worked as research assistant at Kassel University, Germany. His research interest lies in the travel behaviour analysis by utilizing alternative data sources and the optimization modelling for new mobility modes.

Ms. **Yusfita Chrisnawati** and Ms. **Shahnaz Nabila Fuady** are full scholarship PhD students, funded by Indonesian government in cooperation with OeAD GmbH (the Austria's Agency for Education and Internationalisation).
Ms. Chrisnawati is planning to examine the impacts of Transit Oriented Development (TOD) and mobility hubs' design and locations to the travel demand. Ms. Chrisnawati has a master degree from Transport System and Enginnering, Universitas Gadjah Mada, Indonesia. Currently she is also a lecturer at Dept. of Civil Engineering, Faculty of Engineering, Universitas Tidar, Indonesia.
Ms. Fuady is planning to examine the equity issues and sustainable impacts of digitalisation in transport and mobility systems. Ms. Fuady has a master degree of transportation from School of Architecture, Planning, and Public Policy, Institut Teknologi Bandung. Currently she is also a lecturer at Urban and Regional Planning, Institute Teknologi Sumatera.
As in any bilateral collaboration activities, in these two PhD projects, the students are expected to address case studies from both Austria and Indonesia.

In addition to these new full-time members, DAVeMoS is also pleased to inform that we also have one new visiting scholar and one new external PhD student.

Dr. **Gunnar Flötteröd**, our visiting scholar, has about 15 years of experience in transport modeling and simulation. His primary interests are mathematical model formulations and the development of methods that improve the performance and quality of detailed transport simulators. He has doctoral degree from TU Berlin, Germany, and currently he is affiliated with Linköping university and the Swedish National Road and Transport Research Institute in Sweden. In DAVeMoS, he will be involved in the development of MATSim system in Vienna and surrounding areas.

Ms. **Julia Schilder**, our external PhD student, is currently part of ÖBB, and she is planning to examine the adoption of ÖBB 360° services such as e-scooters and e-bikes in smaller city context in Lower Austria province. She has a diploma degree in industrial engineering from University Erlangen-Nuremberg, Germany, as well as a master degree in environmental resource management from BOKU. Her research interests are mobility behaviour analysis and decision making processes focusing on users' learning and adaptation characteristics.

Further information on DAVeMoS team, can be seen at: https://www.davemos.online/team

3. Mobility hubs as a game changer in transport

Important research areas for DAVeMoS are intermodality and mobility as a service (MaaS). The initiatives of the DAVeMoS research group in this area show first results through a successful project proposal within the ERA-NET Urban Accessibility and Connectivity (ENUAC) programme - project acronym: SmartHubs. Besides this, through an external PhD student's project (in collaboration with ÖBB) we aims to analyse the demand of Mobility as a Service (MaaS) in smaller and rural city setting, like in Korneuburg town.

A mobility hub at Seestadt Aspern, Vienna

The SmartHubs project, which will kick off in May 2021, examines mobility hubs, dedicated on-street locations where citizens can choose from different shared and sustainable mobility options. The main objective is to assess if a co-designed, user-centric development can enable mobility hubs to act as a game changer towards inclusive sustainable urban mobility and accessibility. SmartHubs will examine, develop and apply research methods and tools in five Living Labs across Europe, i.e. in Brussels, Rotterdam - the Hague metropolitan region, Munich, Vienna and Istanbul. SmartHubs will develop and apply novel participatory and impact assessment tools like (i) an open accessibility tool involving inputs from individual citizens to examine the local accessibility impacts of mobility hubs, (ii) an accessibility network analysis and resilience tool to examine the impacts of mobility hubs on transport network resilience, (iii) a multi-actor multi-criteria analysis method to involve individual citizens and (iv) tangible augmented reality technologies and gamification and user experience (UX) approaches to facilitate co-creation processes of mobility hub design. Finally, SmartHubs goes beyond the current state of the art conducting rigorous research on a broad range of mobility, accessibility, vulnerability, resilience and societal impacts of mobility hubs, including vulnerable to exclusion population segments such as low-income, digitally under-skilled, female citizens and refugees.

The Austrian core partners, led by the DAVeMoS team within the Institute for Transport Studies at BOKU, consists of 2 institutes of the Technical University of Vienna (Transport System Planning, Multidisciplinary Design and User Research) and MO.POINT, a developer of mobility solutions for city quarters and real estates. Six other Austrian institutions are supporting the project as associates such as Aspern and Graz mobility labs, ITS Vienna Region, Wien 3420, Stadt-Umland-Management Wien Niederösterreich and the Province of Lower Austria. Furthermore, the Viennese transport operator Wiener Linien has also agreed to act as external expert and stakeholder in the course of this project.

Another type of mobility hub at Nordbahnviertel, Vienna

The DAVeMoS team is looking forward to build on and expand the knowledge base in this area, which is able to be a game changer towards sustainable mobility.

Roman Klementschitz and Yusak Susilo

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4. Brief overview of the state of the art on the use of VR in transport planning and analysis

Virtual environment is defined as an interface that creates an effect of a three-dimensional world, in which the user directly interacts with virtual objects, has been around for more than two decades (Bryson, 1996). However, only recent technological advancements, which reduced the costs and computational requirements of the displays while maintaining, or frequently increasing, the visual quality of the environments resulted in their wider adaptation for research purposes (Slater & Sanchez-Vives, 2016). Henceforth, it is not surprising that VR has become an increasingly popular tool for travel behaviour and mobility research. This is because in the transport domain, it is often inherently difficult to collect real-life data in hazardous road circumstances. VR provides a high degree of experimental control, safety and easiness of data collection, while at the same time allowing to collect data in a dynamic setting. Furthermore, VR makes it possible to collect data in hypothetical future scenarios allowing to pre-test behavioural responses in the context of new modes and novel urban designs.

Consequently, VR has been widely used in previous studies in the transport context such as pedestrian behaviour research. For instance, Lin et al. (2020) investigated how prior spatial knowledge affects passenger's wayfinding behaviour during emergency evacuation in underground environments, while Birenboim et al. (2020) used a walking simulator together with biosensors and eye-tracking to evaluate the impact of different urban designs on walking behaviour. Moreover, researchers from Austrian Institute of Technology employed virtual reality to investigate pedestrian navigation behaviour in public infrastructure. In particular, Bauer et al. (2017) used immersive CAVE to assess pedestrian interaction with guiding systems, whereas Schrom-Feiertag et al. (2017) combined eye-tracking and immersive environments to construct attention maps of public spaces to better understand the impact of signage on wayfinding behaviour.

Moreover, VR has also been previously employed to study behaviour of cyclists. For example, Nazemi et al. (2021) applied VR together with cycling simulator to investigate cyclists' safety perception. Similarly, Bogacz et al. (2020) used VR jointly with neuroimaging device to explore the differences in neural risk processing between 2D and 3D cycling scenarios. Furthermore, Bialkova et al. (2018) looked at the impact of different urban environments on cycling experience in the Dutch context.

Furthermore, VR has been also used to investigate behavior of drivers in both, existing as well as future (hypothetical) scenarios. For example, Moussa et al. (2012) applied the Augmented Reality Vehicle system to study left-turn manoeuvre at two-way stop-controlled intersection. Whereas Farooq et al. (2018) elicited preferences over Connected and Autonomous Vehicles comparing three methods: an immersive reality technology, a conventional visual presentation and text-only descriptions.

Interestingly, a new trend emerges also among local and national governments which more often resort to innovative approaches such as virtual reality to better tackle local transportation issues and complement traditional research activities. For example, so-called Austrian Mobility labs were brought to life across Austria, where inter alia VR technology is used to demonstrate the work of cooperative intelligent transport systems, and to measure and evaluate individuals' perceptions to proposed, future solutions (Austrian Mobility Labs, 2021; C-Roads Austria - AustriaTech, 2021).

Taken together, the results of these studies suggest that VR technology allows for constructing experimental scenarios that give the researcher more control over factors that affect the respondents' choices and can be successfully applied to a wide range of transport topics. Beyond, they allow for integrative use with different types of biometrics and eye-tracking devices. Nonetheless, the validity of VR experiments is one of its main issues and given that VR is still an innovative and relatively new research tool, the best practices are yet to be established.

Together, current state of art virtual reality opens exciting opportunities for mobility behaviour research, while showing the need for more studies in this direction to provide evidence and validate existing findings. For this reason, we aim at addressing these gaps within DAVeMoS project by novel virtual research studies where we will adopt an interdisciplinary

approach to investigate the behaviour, perceptions and interaction between different road agents. In particular, we will explore drivers' hazard acquisition in the present era of automated cars and digitalised road infrastructure. Moreover, we will look at the dynamic choices on the road of micro-mobility users and factors that influence them in order to gain better understanding of the underlying drivers of behaviour.

Martyna Bogacz

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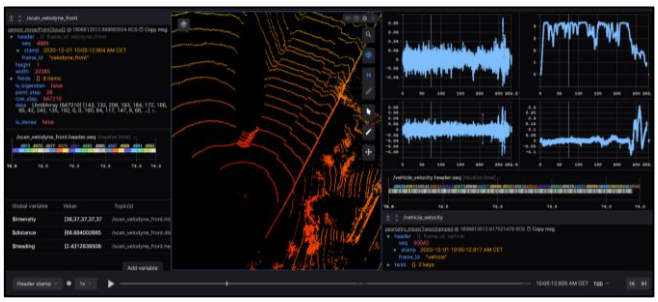
5. Analysis of interactions between autonomous shuttle and other road users

The analysis of interactions between autonomous vehicles (AVs) and other participants in the road traffic system is increasingly important for enhancing the capacity of AVs' prediction functionality and will provide valuable references for traffic management, regulation and policy development, as well as infrastructure design. DAVeMoS team has been fortunate to be able to receive LiDAR data from Salzburg Research which was collected during the real life demonstration activities of the Digibus® Austria project in Koppl, Salzburg. From this dataset, the team can visualize the Point Cloud data (PCD) from LiDAR and interpret a series of indicators such as direction, speed and location. Furthermore, making use of Point Cloud Library (PCL) with segmentation and clustering algorithms, surrounding objects were detected and distinguished as involved participants of interest (vehicles, pedestrians, bicycles, etc.). From our data vehicle overtaking can be extracted 11 times in 12 minutes operation. The feasibility of the analysis could be proved, however to provide more comprehensive analyses, a larger size of data is needed.

Shun Su



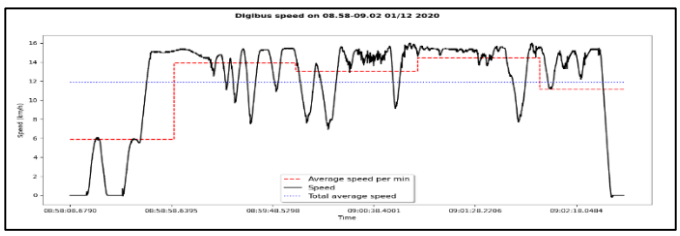


Figure : Visualization (left) and velocity profile (right) of the automated bus

6. Time-use and travel behaviour changes due to COVID-19

Everything we do, we do in a specific time and place and in a specific order. The perceived utility of the trips and activities that we carry out every single day depends on the given order, duration and situational contexts that we experience at the given times. In order to get a better understanding about people's multidimensional decisions across temporal, spatial and monetary dimensions and the resulting mobility needs, time use diaries have been considered as a valuable information source in addition to regular travel diaries, as they can give us information of not only what happens outside our home, but also inside our home. This information is becoming more critical in the age of COVID-19 pandemic and with increasing digitalization of our activities, as now we are 'travelling', working, and engaging with our society digitally.

IVe (the Institute of Transport Studies) in co-operation with the Vienna University of Economics and Business and in combination with the consumer survey by Statistik Austria have been collecting a multi-wave combined time-use and travel diary. The first wave was collected between 09/2019 – 03/2020 and the second wave between 03/2020 – 08/2020, which coincided with the first lockdown phase during the COVID-19 pandemic.

The survey consists of a general household questionnaire as well as a 7-day combined travel and time use diary for each member of the household. We plan to merge this information with the information from the households' consumer survey after the processing of both data sets has been completed. In total, we received valid responses by 441 persons in the first and 467 persons in the second wave. The distribution of socio-demographic characteristics in the sample represents the overall distribution in Austria quite well, with a slight over-representation of women. Also, the spatial distribution of participants between region types represents the Austrian situation well with 27 % in urban, 32 % in intermediary and 41 % in rural areas. Regarding the regions ("Bundesländer"), Lower Austria is overrepresented, while Salzburg shows a significant and Vienna a slight underrepresentation.

Travel behavior

The survey showed, as expected, a massive reduction of travel between the first (pre-COVID) and second (during and after 1st lockdown) survey wave. The average weekly distance travelled by participants before the lockdown was around 260 km/week, while in March 2020 it dropped to around 30 km/week to then gradually increase again to ca. 210 km/week by end of June, still about 20 % less than before the lockdown (see Figure 1). It might be due to a general travel reduction in summer time as well. Accordingly, time spent on travelling reduced from 1.2 h/day in the first survey wave to 0.7 h/day in the second wave on average. In the 2nd wave, the number of trips per person reduced by about a third (see Figure 2). The only mode with higher absolute trip numbers during and after the lockdown was cycling, which almost doubled its modal share (6 to 11 %). A particularly strong decrease in modal share was registered for public transport (13 to 7 %). Walking and car showed slight increases in modal share.

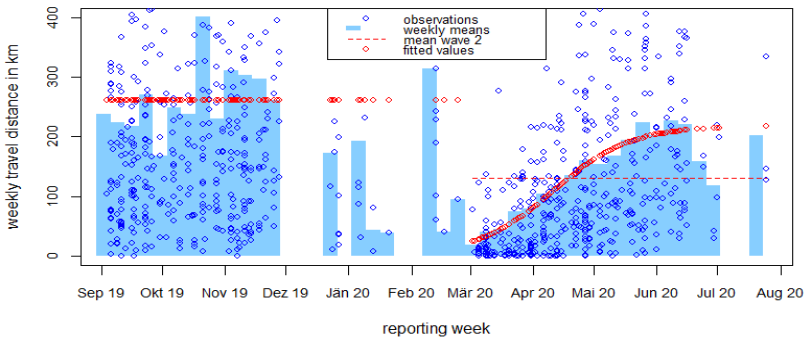


Figure 1: Travel distance per week

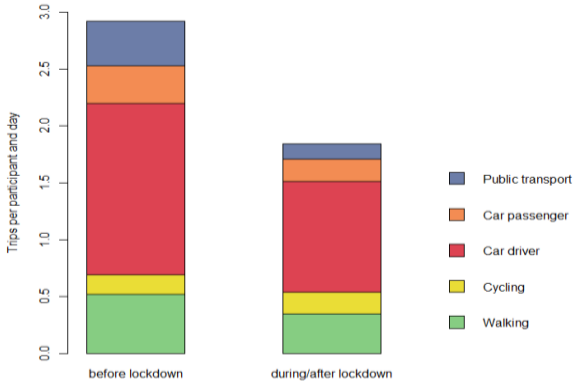


Figure 2: Modal split by lockdown period

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Time use

In parallel to the reduction in travelling, time for work decreased by 0.75 h per day (considering only working participants). The highest increases in time use show the activities leisure (+0.8 h), eating (+0.3 h) and household (+0.2 h), as can be seen in Figure 3. Rather surprisingly, also time spent for personal care dropped considerably from 1.6 to 1.2 h per day. However, there we observe considerable differences between groups, e.g. time spent on cycling increased by about 80 % (0.03 h/day) for men, but did not change significantly for women.

Digitalization aspects

Due to the lockdown measures, the use of electronic tools for travelling increased steeply. Electronic ticketing was used for 2.5 % of trips before, but for 10 % of trips during/after lockdown. For electronic routing, the effect is similar (2 % to 8 % of public transport trips). A major driver ought to be the fact that personal ticketing at ticket offices or directly at the bus driver was strictly limited. Hygienic aspects might have led people to avoid using ticketing machines. However, it has to be noted again that the absolute numbers of trips by public transport has decreased by about 2/3. It might be the case that people who were still using public transport had a higher affinity to electronic tools in the first place.
Working-from-home was broadly implemented together with the lockdown measures. Before, only 0.23 h per day of working activity was done at home, which increased to 0.96 h afterwards. Educational activities shifted almost completely to the home location (see Figure 4).

The 3rd survey wave in preparation

Due to its importance, in particular for understanding the impacts of digitalization on mobility needs and behaviour, DAVeMoS is contributing to a 3rd wave of this time-use survey which is expected to be conducted in 2021 (given it is permitted by the COVID-19 related condition at the given time).

Further information of the 1st and 2nd wave datasets can be seen at: http://ive.boku.ac.at/covid/

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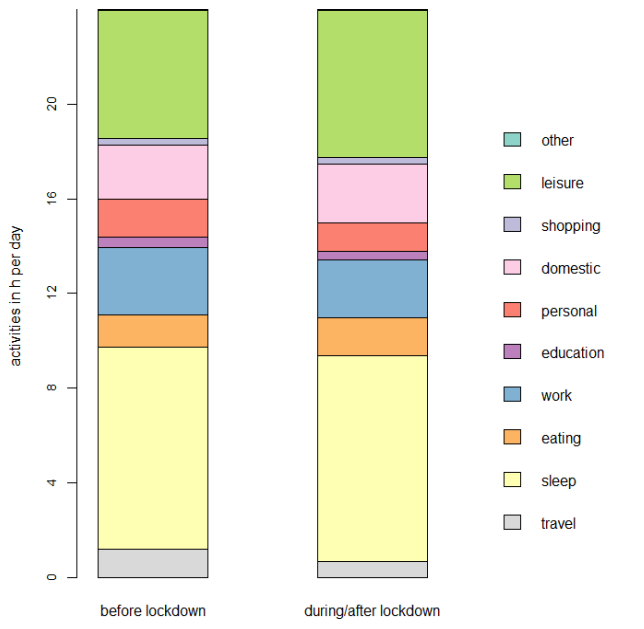

Figure 3: Activities by lockdown

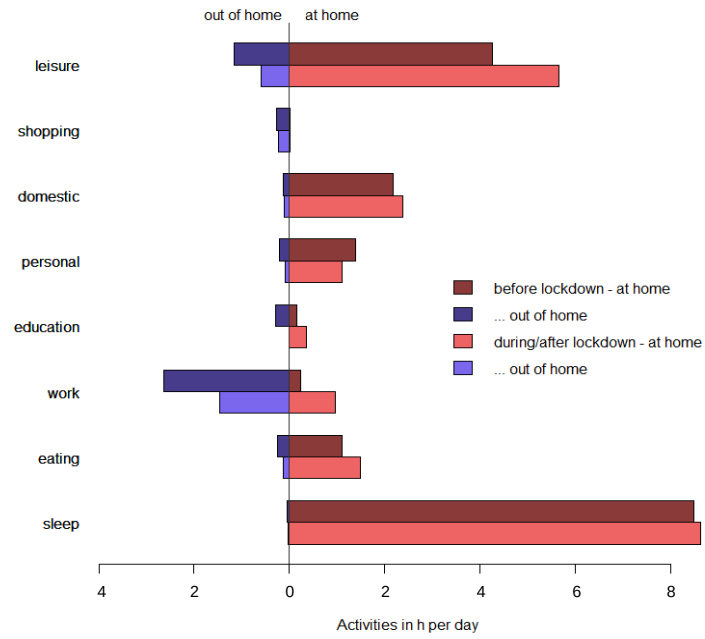

Figure 4: Location of activities

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7. List of DAVeMoS activities (10/20 - 03/21)

In Management:

1. In the beginning of 2021, DAVeMoS team is growing. We are privileged to have Mr. Ilahi who recently graduated from ETH Zurich as our postdoc, 2 new research assistants/PhD students, Mr. Su (a graduate from TU Munich) and Ms. Roxani (a graduate from TU Delft), 2 Indonesian/OeAD Scholarship Students, Ms. Chrisnawati and Ms. Fuady, Dr. Flötteröd (from VTI and Linköping University) as our visiting scholar and Ms. Schilder as our industrial/external PhD student who is also part of ÖBB.
2. DAVeMoS is a part of SmartHubs consortium which won the ERA-NET Cofund Urban Accessibility and Connectivity grant. The consortium involves 30 partners from 6 countries. In Austria, TU Wien, MOPOINT, The Fed. Gov. of Lower Austria, ITS Vienna, Wien 3420 AG, SUM, Aspern.mobil Lab and Mobility Lab Graz are also part of the consortium.
3. DAVeMoS continues to have regular meetings with different funders and relevant stakeholders in Austria to develop relevant collaboration and joint proposal biddings.

On the Research:

1. In the last six months, DAVeMoS team has been contributing to 5 journal publications, 1 editorial, 1 conference presentation, and 2 keynote and invited presentation at national and EU level conferences.
2. Recently DAVeMoS team members have been granted access to use the most powerful super computer in Austria (VSC, Vienna Scientific Cluster). DAVeMoS intends to use this facility to support its works in developing agent based simulation for Vienna Metropolitan Area.
3. From January 2021, a DAVeMoS member has been appointed as an Editorial Board member of Transport Reviews. Transport Review currently is the 2nd highest ranked among Transportation journals.
4. DAVeMoS team member has been listed among the Top 2% of Scientists Worldwide in 2019.

In Education:

1. DAVeMoS currently is preparing itself to open data driven course in urban planning at BOKU in Autumn 2021.
2. Currently DAVeMoS team are supervising six master theses on topics promoted/requested by our funders and stakeholders.

8. List of DAVeMoS publications (10/20 – 03/21)

Peer-reviewed journal:

1. Guo, J., Susilo, Y., Antoniou, C., Pernestål, A. (2021) When and Why do People Choose Automated Buses over Conventional Buses? Results of a Context-dependent Stated Choice Experiment, Sustainable Cities and Society, doi:10.1016/j.scs.2021.102842.
2. Irawan M.Z., Belgiawan P.F., Joewono T.B., Bastarianto F.F., Rizki M, Ilahi A. (2021) Exploring activity-travel behavior changes during the beginning of COVID-19 pandemic in Indonesia, Transportation, doi: 10.1007/s11116-021-10185-5.
3. Bin, E., Andruetto, C., Susilo, Y.O., and Pernestål, A. (2021) The trade-off behaviours between virtual and physical activities during COVID-19 pandemic period. European Transport Research Review, 13:14, doi:10.1186/s12544-021-00473-7.
4. Chee, E.P.N., Susilo, Y.O., Wong., Y.D. (2021) Longitudinal interactions between experienced users' service valuations and willingness-to-use a first-/last-mile automated bus service. Travel Behaviour and Society, 22, pp. 252-261, doi: 10.1016/j.tbs.2020.10.004.
5. Rubensson, I., Susilo, Y.O., and Cats, O. (2020) Fair accessibility – operationalizing the distributional effects of policy interventions. Journal of Transport Geography, 89, doi.org/10.1016/j.jtrangeo.2020.102890.

Editorial:

1. Musselwhite, C., Avineri, E., Susilo, Y. (2021) Restrictions on Mobility due to the Coronavirus Covid19: Threats and Opportunities for Transport and Health, Journal of Transport and Health, doi:10.1016/j.jth.2021.101042.

Conference Presentations:

1. Bin, E., Andruetto, C., Susilo, Y.O., and Pernestål, A. (2021) The trade-off behaviours between virtual and physical activities during COVID-19 pandemic period. The 100th US Transportation Research Board Annual Meeting, January 2021.