Wheels of change

Empowering cyclists today. From A to B.

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1. Introduction

Modern urban landscapes are rapidly evolving as cities worldwide face a growing array of challenges, from population growth and environmental concerns to congestion and the need for sustainable mobility solutions. The city of Munich is no exception to this global trend. In the course of the "Digitainability Project Week: Sustainable Smart Cities 2023" organized by TUM, we addressed a key challenge faced by the many cities – that of sustainable and smart urban mobility. In the project week, we collaborated with the national academy of science and engineering "Achatech" that operated as our challenge-givers. Acatech provided us inputs from their project "Mobility Data Space" (MDS)[1]. The MDS is a data-platform that functions as a marketplace for data sharing between more than 150 players from the automotive and mobility sectors. During the project week, we developed use cases that could build upon the data provided in the MDS. To define suitable use cases, we undertook a comprehensive case study. Resulting from our problem analysis, we specifically focused on the enhancement of conditions for cyclists, with the overarching goal of steering Munich away from a car-oriented city to one that is cyclist-centric.

Our collaborative project, affectionately titled "Wheels of Change," encapsulates the spirit of our collective effort to create a more cyclist-friendly Munich. In the Digitainability project week, we were guided from a research process, we set out to identify the status quo of cycling conditions in Munich, discerning the gaps in the existing infrastructure and services, and crafting visionary solutions to bridge these disparities. Our report outlines our research approach and the resulting two use cases, aiming towards better conditions for cyclists in Munich: First, a "Green-Wave" for cyclist-oriented traffic lights and second, a navigator for need-based route planning for cyclists. The experiences and lessons learned from defining use cases for the city of Munich can inspire similar urban centers globally, providing a blueprint for sustainable mobility, simultaneously enhancing quality of life for its citizens and visitors.

2. The challenge - background

During these two project weeks as part of the Digitainability project, we have operated as a team of three individuals, coming together to tackle this challenge. The challenge itself can be divided into two primary components, each crucial to our overall goal.

First and foremost, our initial task involved gaining a comprehensive understanding of the concept of sustainable smart cities and identifying best practices within this domain. This

[1] https://www.acatech.de/projekt/mobility-data-space/

entailed delving deep into the core principles of sustainability and exploring how they can be effectively integrated into the development of smart cities.

The second pivotal aspect of our project was centered around evaluating the position of the city of Munich within the Digitainability framework. Munich, as the capital city of Bavaria, is a city of immense significance in terms of its economic and digital development. It is essential to comprehend where Munich stands in the context of Digitainability, considering the numerous studies and analyses that have been conducted to rank Munich among other cities worldwide in terms of sustainability.

As we embarked on this project, it became evident that these two interrelated aspects were the cornerstones of our journey towards comprehending and advancing the concept of Digitainability, with a particular focus on Munich's role in this emerging field.

After we had great insights from five different challengers, the one that we will elaborate on will be the challenge from MDS, an acatech foundation. The main goal of the challenge and this organization is to build Sustainable & data Driven Smart Cities in the context of transportation, logistics, and mobility sectors. This challenge consisted of two main parts: The first part is to understand sustainable smart cities, and the second part was to design two to two "quick-win use cases" that overcome obstacles in terms of mobility and achieve the short-term goals that have been identified. These use cases should involve parties that are already part of the MDS.

3. The process

After receiving the topic, we had to take a step back and think out of the box. This led us to a long session of brainstorming that forced us to develop several ideas that were related to the problems that our group has, as citizens and residents of Munich. The ideas were a range of the common day to day problems until more complex problems. In our point of view it felt like this brainstorming was not enough to have a broader view about the mobility problems in the city of Munich, therefore we interviewed people of different ages in the streets to get a full picture of the issues.

Insights from interviews

The interviews gave us great insights about the issues and the difficulties that are present in Munich. We had insights about mainly the issue of public transport, and the delay that citizens face especially with trains and S-Bahn. This issue caused irritation to the people and led them to the solution of using their private car as the most convenient solution in terms of security and punctuality. In addition, citizens considered the use of a bicycle very difficult in the city because of the infrastructure and the traffic lights. In their opinion this made it very difficult using the bicycles in the city. That’s where our idea was born to focus on two use cases that made life easier for cyclists.

Defined user personae

Having this great insight from the citizens of Munich we defined 2 user personae that could fit into the problem of mobility in Munich (based also on data from the MiD report for the region Munich[2]):

1) The first one is Thomas, a 45 years old married man that has two kids and works for a finance consulting company. Thomas is living in Günding and he uses his own car to go to work and for every other commute that he does. He owns his own car, and he is very critical to public transport. The main goal for this user personae is to make him a regular user of public transport for commuting. For this reason, our very first idea was to offer an on demand bus that will be available for citizens of Munich and they can use it to fulfill their needs throughout the day. Thomas will take the bus to work, to the gym and to meet his friends as well, without the need of taking the car and make use of this time that he could have spent driving or in traffic working or with his kids.
2) The other user personae that we could think about is Maria, a 30 year old woman that has a 2 year old boy. Maria is living in Feldmoching and considering that the public transport in this area is not suitable she is driving her own car to accomplish the daily tasks that she and her family have. For this user personae we have come up with the solution of a sharing vehicle in her neighborhood. This way she can take the car whenever she needs it, but the difference is that this way she will contribute a lot in making the city of Munich more sustainable, with less traffic and eventually a better city for everyone to live in. Moreover, she is contributing to giving a great example for everyone how they can use less of their personal cars and instead use a sharing car and still be very efficient in their daily tasks.

Overall we conclude that making transportation and commuting easier via bicycle can serve and improve the life of both of our user personae keeping in mind that different solutions are needed.

Discussion with challenge givers

Traffic flow data becomes more and more important for cities. Acatech gave us not only insights about new data collection methods concerning car traffic that is currently tested, implemented and expanded to new cities. We also discussed the data gap of bike traffic flow data, e.g. Munich. The current way of collecting bike traffic data is inefficient, incomplete and static. This view was also supported by the challenge giver city of Munich who could tell us that the Mobilitätsreferat does not have a possibility to collect the data. Therefore we decided to focus on use cases for cyclists, the data collection, the pain points and the outcomes for cities and their citizens.

[2] Follmer, R., & Belz, J. (2018). *Mobilität in Deutschland-MiD Regionalbericht Stadt München, Münchener Umland und MVV-Verbundraum*. Technical report, infas Institut für angewandte Sozialwissenschaft GmbH and Deutsches Zentrum für Luft-und Raumfahrt ev, Bonn and Berlin, 2018. URL https://www. muenchen-transparent. de/dokumente/5499206/datei.

A new form of data collection

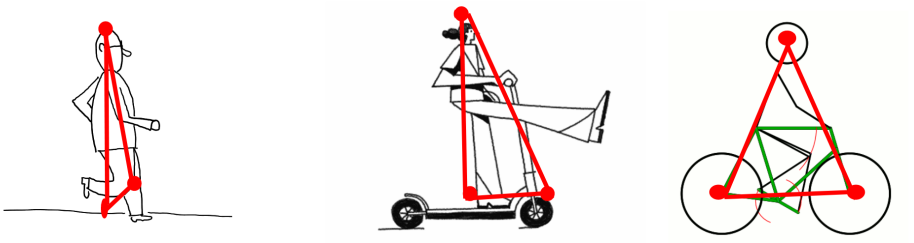

Figure 1: Moving points of interest

The already installed sensors all around the city will be programmed so that they recognize only three moving points of interest. This can be done similar to data collection at the Munich airport that recognize the three moving points at the head and shoulders. Only if these moving points are a triangle, it will be recognized as a person. This ensures the data privacy of individuals as no face recognition is required. In the case of a cyclist or a pedestrian the searched triangle is slightly bigger. The sensor recognizes the head and feet of or the head and wheels of a cyclist. These two cases create very different triangles which makes extracting bikes out of the data collection a lot easier.
Alternative ways of data collection could be using the Vision Zero data of car manufacturers[3] combined with data of telecommunication services to figure out the realistic paths of cyclists in big cities.

Research on existing projects on sustainable mobility in Munich

The subgroup „MunichWays“ from the regular's table of the mobility department of the organization Green City[4] collects data manually on cycle lanes in Munich. The lanes are characterized as

- cosy and comfortable
- average
- stressful
- very stressful
- Plan/gap data[5]

Combined with the data of the MVV Radroutenplaner[6] which calculates the "greenest, safest and fastest route" for a cyclist it is possible to create a comprehensive and coherent mobility tool for cyclists that should be included to already existing apps like public transport apps or private MDS partners (FREENOW etc.))
The most important part of our research was defining where we want to focus and which

[3] https://www.bmdv.bund.de/SharedDocs/DE/Artikel/StV/Verkehrssicherheit/verkehrssicherheitsprogramm-2021-bis-2030.html
https://www.bmw.de/de/more-bmw/concept-cars/bmw-neue-klasse-ueberblick.html
[4] https://www.greencity.de/projekt/stammtisch-verkehrswende-und-mobilitaet/
[5] https://munichways.carto.com/builder/6a281201-8c34-4753-9234-bf0b9c01beb8/embed , https://www.komoot.de/user/munichways/collections
[6] https://www.mvv-muenchen.de/fahrplanauskunft/mobile-auskunft-app/mvv-radroutenplaner/index.html

problems we want to give a solution to. As Munich is a car oriented city we decided to improve the general condition of bike lanes in Munich. To start with, by collecting the data using the new way of detecting bikes, the city of Munich will be able to identify the pain points of bike drivers. This way they can invest in the most needy areas and as well in the risky areas.

4. Resulting use cases

As a result of our research process, we identified two use cases that target improved conditions for cyclists to move within the city. These are outlined below.

a. "Green-Wave" for cyclists

The first use case centers around the implementation of a "Green-Wave" for cyclists, a concept aimed at optimizing traffic lights to create a seamless and efficient cycling experience throughout the city. The "Green-Wave" not only promotes a smooth flow of traffic but also encourages a healthier and more eco-friendly mode of commuting. A new data collection can help with the optimization.

Data Fit Gap Analysis

Data	Owner	Provider	in Mobility Space?	suggestion
traffic lights	Stadt München	Mobilitätsreferat	no	Stadt München
bike traffic flow			no	IBM
average bike speed			no	IBM
existing bike lanes	Stadt München	Mobilitätsreferat	no	Stadt München
accidents	Stadt München	Mobilitätsreferat	no	Stadt München
accidents	ADAC	ADAC	yes	ADAC
car traffic	OEM	OEM	yes	e.g. BMW

Partner Fit Gap Analysis

Partners	Missing Partners
IBM	Stadt München-Mobilitätsreferat
BMW, ADAC	
Reply TD	
swarm analytics	
ströer	
Trafficon - Traffic Consultants GmbH	

b. Navigator for cyclists “BEcoWay”

In the second use case, we present a specialized route planner tailored to the unique needs of cyclists. This navigator, called “BEcoWay”, is designed to facilitate quick and safe journeys from point A to point B. It takes into account factors such as bike-friendly paths, real-time traffic conditions (including weather data as already implemented by FreeNow in Hamburg), and personalized preferences, ensuring that cyclists can effortlessly chart their course through Munich's ever-evolving urban landscape. Figure 2 illustrates the prototype of the navigator.

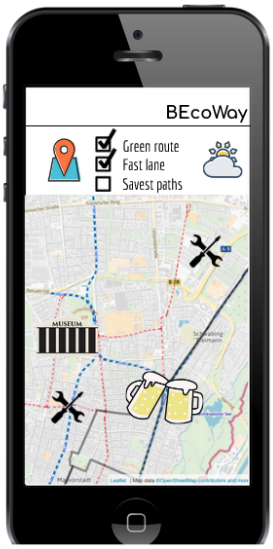

Figure 2: Prototype of the navigator “BEcoWay”

Data Fit Gap Analysis

Data	**Owner**	**Provider**	**in Mobility Space?**	**suggestion**
routes	MVV	MVV Radplaner	no	
car traffic			yes	see above
bike traffic			yes	see above
weather forecast			yes	Free Now, TomTom
accidents	Stadt München	Mobilitätsreferat	no	Stadt München
accidents	ADAC	ADAC	yes	ADAC
car traffic	OEM	OEM	yes	e.g. BMW

Partner Fit Gap Analysis

Partners	**Missing Partners**
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Trafficon - Traffic Consultants GmbH	
swarm analytics	
Free Now	
Tom Tom	

5. Key learnings from the challenge

This challenge was a great learning experience due to various aspects. First, the format itself brought several learnings. During the challenge, we were required to think and to improvise out of our comfort zone. We had to come up with our own strategy to solve a given challenge from an external institution, to develop a use case for an implementation in practice. The tasks thus were nothing alike compared to previous theoretical lectures or seminars. Additionally, the short time frame of four days we had to come up with a solution was challenging but made us develop a clear strategy to conduct our teamwork at the same time.

Secondly, we enriched our knowledge on the topic of urban mobility in smart cities. We investigated existing projects and business cases and learned about the obstacles that the city of Munich and its citizens are facing on the path towards sustainable modes of transport. It became clear that the infrastructure for mobility in Munich is highly car-oriented and thus poses several technical lock-ins for a transformation. However, there is already a progress of innovative solutions that might shape the urban environment .

6. Next steps and future outlook

This challenge gave us a lot of insights that could help us understand in a broader view the issues, the improvements, and the opportunities that the city of Munich has. The capital city of Bavaria has plenty of initiatives that are ongoing as part of the process of making Munich a smart and sustainable city. The city of Munich sees itself as a pioneer in this respect and has previously set itself the goal of reducing the city's energy-related greenhouse gas emissions to 0.3 tons of CO2 per inhabitant per year by 2050. Now the state capital has set a new goal and wants to become climate neutral by 2035[7]. This final goal can be achieved if only some very important parts of the mobility in the city of Munich get better. To start with, the reduction of

[7] https://stadt.muenchen.de/dam/jcr:ea585d01-a676-4ee2-889b-5345f480d44b/PM_Magazin_en_web.pdf

the number of cars is the primary setup, but this seems very challenging since every second person in Munich has a car.

Therefore, it is a must to have more bike lanes, better public transportation, so in general better mobility and more sustainable. The efforts to make Munich a smart and sustainable city are part of a broader trend across Europe, where many cities are implementing innovative practices to address environmental and urban challenges. To elaborate on practices from other European cities in terms of sustainability and smart cities, we can draw parallels and highlight different approaches.

Amsterdam, the capital city Netherlands, leads the way with its extensive network of bike lanes[8], promoting cycling as the primary mode of transportation, providing inspiration for Munich's bike lane expansion efforts. Meanwhile, Copenhagen, Denmark excels in sustainable urban planning, emphasizing walkability, public transit, and green spaces to create eco-friendly neighborhoods[9]. In Stockholm, Sweden, green initiatives, including clean energy and green spaces[10], have been pivotal in reducing carbon emissions, offering Munich valuable insights on its journey to climate neutrality. Barcelona, Spain stands out with its smart city solutions, using technology to enhance public services, optimize energy usage, and enhance urban mobility, a model Munich could explore for greater efficiency and sustainability[11]. Lastly, Copenhagen's efficient public transportation system encourages citizens to leave cars behind, aligning with Munich's goals to enhance public transit[12].

These cities provide valuable insights into how Munich can further its journey towards becoming a smart and sustainable city. By examining successful practices in other European cities, Munich can adapt and implement strategies that align with its specific goals and challenges while contributing to a more sustainable and livable urban environment.

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[8] de Lange, Marjolein, and Fred Feddes. *Bike city Amsterdam: how Amsterdam became the cycling capital of the world*. Nieuw Amsterdam, 2019.

[9] Madsen, Stine Hach Juul. "Changing Energy Supply Through Urban Sustainability Experiments: A comparative case study of Sonderborg and Copenhagen, Denmark." (2016).

[10] Sandstro¨ m, Ulf G. "Green infrastructure planning in urban Sweden." *Planning practice and research* 17, no. 4 (2002): 373-385.

[11] Pérez González, Daniel, and Raimundo Díaz Díaz. "Public services provided with ICT in the smart city environment: the case of spanish cities." (2015).

[12] Lee, Eugene Siong Aun. "Promoting sustainable transportation through the integration of cycling with public transit: lessons from Copenhagen and Munich for Singapore." PhD diss., Massachusetts Institute of Technology, 2010.