CycleOn:
Shared Mobility Solutions

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1 Background and Motivation

The study background for this data lake and warehousing project that focuses on data extraction through APIs pertains to an e-scooter user consulting company while analyzing climate changes, electric scooter and bikes availability, and time/money related saving solutions. The scope of this study can be framed as follows:

- **Background Study: Leveraging Data Insights for Sustainable and Efficient E-Scooter and Bikes Mobility**

In recent years, the global landscape of urban transportation has witnessed a remarkable transformation with the emergence and rapid growth of shared mobility services, particularly electric E-scooter rentals. These services have not only offered commuters a convenient alternative for short but fast-distance travel but have also contributed to reducing traffic congestion and greenhouse gas emissions.

In this evolving context, data-driven decision-making has emerged as a crucial driver for enhancing the efficiency, sustainability, and profitability of E-scooter sharing services in Zurich. The subject of this study lies at the intersection of data technology and sustainable urban mobility, focusing on the establishment of a data lake and data warehousing solution for a e-scooter and bikes user consulting company: **CycleOn**. This company is operating in the dynamic and competitive shared mobility market, but still recognizes the immense potential of data-driven insights in three key areas:

Climate Changes as a Variable for E-Scooter/Bike Sharing Services: The impact of climate change is undeniable, and its effects on urban environments, including temperature variations and extreme weather events, can significantly affect the operations and user behaviour of scooter sharing services. Understanding how climate patterns influence demand and rider preferences is essential for optimizing service availability, maintenance schedules, and fleet management.

Electric Scooter Availability as Shared Mobility Markets Grow: The shared mobility sector, with e-scooters and bikes as a pivotal player, is experiencing substantial growth worldwide. The availability of e-scooters and bikes, perhaps their charging infrastructure, and their alignment with eco-friendly transportation trends and city special events present unique opportunities and challenges. Analysing data related to shared mobility utilization and availability while regarding special demands in times and quantities can provide valuable insights for strategic business decisions, expansion, and sustainability initiatives [e] .

Analyzing Data in relation to Time Saving Using Different Solutions: The efficient operation of mobility sharing services relies on innovative solutions for charging and maintenance. Traditional time-consuming charging services in Zurich can be complemented or replaced by more efficient strategies, such as battery swapping. By quantifying the unavailable e-scooters/bikes and time efficiencies associated with these solutions, this study seeks to inform decisions regarding technology adoption and operational practices that promote availability and efficiency, especially in rush hours [1].

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[1] Source : Evjoints Battery Swapping Revolution, link, (08.10.2023)

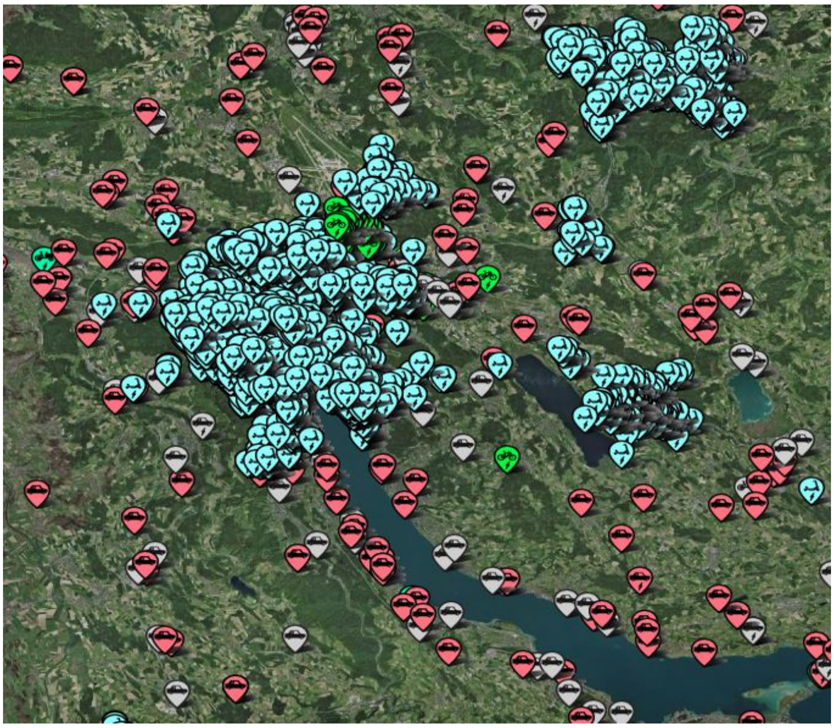

Figure 1 Map.geo.admin - Shared Mobility Offers in Zurich

- **Objectives and Output: A CycleOn**

This research project will draw data from diverse sources, including dynamic APIs (such as the Swiss Open Transport Data) to populate a data lake and support a data warehousing infrastructure. By integrating, processing, and analysing this multi-faceted dataset, the **CycleOn** mobility consulting company aims to achieve the following objectives:

Improved Decision-Making: Data-driven insights will empower ES companies to make informed decisions related to service expansion, pricing strategies, and maintenance operations, new charging strategies, …

Location Availability and Seasonal Consultation: By considering climate factors and ES availability, the company can contribute to sustainable yet informed urban transportation to prepare ES suppliers for higher demands according to locations and events.
Efficiency and Cost Reduction: Analysing time-saving solutions will enable the company to optimize charging for efficient benefits and enhance user experiences.

As this project unfolds, it will delve into various research questions, data modeling, and analytics to unlock the untapped potential of data in enhancing the efficiency of E-Scooter mobility services. Through the integration of technology, environmental considerations, and business acumen, this study endeavors to pave the way for a future where urban transportation is both eco-conscious and economically viable.

2 Problem Statement and Research Questions

Our main goal is to analyze the use of shared mobility services for bikes and scooters in the city of Zurich. We want to know what factors have an influence the use of these services. To this end, we want to collect data over the period of one month. Future research could collect data over a longer period to get insight into seasonal usage patterns.

Research Question 1: Does weather have an influence on the use of shared mobility services for scooters and bikes in Zurich? Does the influence vary depending on the type of transport vehicle?

Hypotheses: Usage is higher when the weather is good. The weather is better the higher the temperatures are and if it is sunny as opposed to cloudy or rainy.

How will it be answered: To communicate our results to interested companies we want to focus on clear and easily understandable graphs. For this research question we want to use bar plots that show the difference in use depending on the weather and for different types of vehicles (scooters vs. bikes). Additionally, we want check if the results are significant by using regression analysis. The dependent variable is the percentage of vehicles that are in use and the independent variables are weather measurements like temperature, wind, and rain and the type of vehicle.

Why is it relevant: For logistical purposes it is good to know the possible demand for a service. Therefore, it is important to know if the weather has an influence on the demand.

Research question 2: Does the weekday have an influence on the use of shared mobility services for e-scooters and bikes in Zurich? Does the influence vary depending on the type of transport vehicle?

Hypotheses: There is a variation in usage pattern based on the day of the week.

How will it be answered: To answer our research question, we can use mix of data analysis techniques like descriptive analysis, statistical testing, and comparative analysis. With descriptive analysis, we can understand the general usage patterns of shared mobility services on different weekdays. We can use line graphs and bar plots to visualize the variations in usage throughout the week for both e-bikes and e-scooters. Also, we can compare the patterns of scooter usage with bike usage on different weekdays to identify any significant disparities.

Why is it relevant: To understand the influence of weekdays on the use of the shared mobility services. It is crucial for both service providers and policy makers.

Research question 3: Does the usage of E-Scooters and bikes increase during rush hours?
Hypotheses: Higher usage during rush hours, such as travel from or to work, school, or other daily commitments. **How will it be answered**: To investigate the third hypothesis, testing the hourly usage e-scooter and bikes can be employed through data collection; mainly through tracking availability of e-scooters and bikes. We can implement time series analyses that would involve segmentation of hourly periods. A further step can include geospacial analysis to examine congestion hotspots in Zürich, differences in hourly patterns, and how busy the transportation means are. **Why is it relevant**: To analyze the availability of shared mobility and traffic management to aid and plan the transport with the efficient shared mobility options.

3 Methodology

3.1 Data Sources

Dynamic Datasets

Locations and availability of shared mobility services in real time[2]: The first API used to collect data gives information in real time on the location and availability of shared mobility services. It includes additional information like the provider or the vehicle type. The REST API allows the user to query for specific attributes (e.g. based on location or type of vehicle)[3]. Below is an example of how the JSON-file looks, that is returned from the API.


```
[
  {
    "geometry": {
      "x": 8.883597,
      "y": 47.564304,
      "spatialReference": {
        "wkid": 4326
      }
    },
    "attributes": {
      "provider.id": "voiscooters.com",
      "provider.name": "Voi",
      "provider.timezone": "UTC",
      "provider.apps.ios.store_uri": "https://apps.apple.com/ch/app/voi-scooters-get-magic-wheels/id1395921017",
      "provider.apps.android.store_uri": "https://play.google.com/store/apps/details?id=io.voiapp.voi",
      "id": "voiscooters.com:6d6d73d2-c985-4454-82ad-027f8b464b2e",
      "available": true,
      "pickup_type": "free_floating",
      "vehicle_type": "E-Scooter",
      "vehicle.status.disabled": false,
      "vehicle.status.reserved": false
    },
    "featureId": "voiscooters.com:6d6d73d2-c985-4454-82ad-027f8b464b2e",
    "id": "voiscooters.com:6d6d73d2-c985-4454-82ad-027f8b464b2e",
    "layerBodId": "ch.bfe.sharedmobility",
    "layerName": "Shared Mobility Angebote"
```


Figure 2: Extract from the JSON that is returned from the API (filtered request for free floating vehicles: https://api.sharedmobility.ch/v1/sharedmobility/find?filters=ch.bfe.sharedmobility.pickup_type=free_floating)

All the information that is in the REST API described above is also available here: https://sharedmobility.ch/gbfs.json. In case the REST API doesn't work[4], we could also get all the information needed from this alternative source. This would need some additional merging of different tables since information on providers and availability is made available under different APIs.

Weather API (current weather data)[5]: The second API gives information on the current weather for a specified location. It includes different information like temperature, cloudiness, or wind speed. Below there is an example of how the data looks. By default, it comes in JSON format, but other formats (HTML or XML) would be possible. To use it for free the limit is on 60 requests per minute or 1'000'000 per month, which is sufficient for the scope of this project.

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[2] Source: Open Transport Data, link, (30.09.2023)

[3] Source: github - API Access SharedMobility, link, (30.09.2023)

[4] First attempts at querying the REST API only returned 50 items per request. If we can not get more than that, this approach will not yield all the necessary data.

[5] Source: Openweathermap.org, link, (30.09.2023)

```json
{
    "coord": {
        "lon": 8.55,
        "lat": 47.3667
    },
    "weather": [
        {
            "id": 801,
            "main": "Clouds",
            "description": "few clouds",
            "icon": "02n"
        }
    ],
    "base": "stations",
    "main": {
        "temp": 19.14,
        "feels_like": 18.99,
        "temp_min": 17.14,
        "temp_max": 20.12,
        "pressure": 1026,
        "humidity": 72
    },
    "visibility": 10000,
    "wind": {
        "speed": 1.54,
        "deg": 60
    },
    "clouds": {
        "all": 20
    },
    "dt": 1696094234,
    "sys": {
        "type": 2,
        "id": 2019255,
        "country": "CH",
        "sunrise": 1696051354,
        "sunset": 1696093751
    },
    "timezone": 7200,
    "id": 2657896,
    "name": "Zurich",
    "cod": 200
}
```


Figure 3: Print screen from the JSON that is returned from the weather API (request for Zurich: https://api.openweathermap.org/data/2.5/weather?q=zurich&units=metric&appid={API-Key})

Additional Datasets

To answer the research questions no additional datasets are needed. However, a consulting company like **CycleOn** could in the future enrich their data warehouses with other sources to help their partners make even more informed decisions. One such data source could be the locations of the urban bicycle pumping stations [6].

3.2 Addressee

The results of our work could be helpful for following entities:

E-Bike Business Industry: The results of our work would be invaluable to e-bike business, particularly those who would like to invest in shared mobility services in Switzerland. By analysing demand patterns and availability across different regions, these businesses can make informed decisions to allocate their resources. For example, it may reveal specific areas with a high demand but limited availability, presenting attractive investment opportunities. Conversely, it could highlight areas with a saturated market, suggesting a need for

[6] Source : Opendataswiss, link, (6.10.2023)

differentiation or focusing efforts elsewhere. Additionally, insights into how weather impacts demand on help businesses optimize their operations and marketing strategies.

Policy Makers and Regulators: The project findings will be of great interest to policy makers and regulators at various levels of government. By identifying areas with high demand and low availability of e-bikes, it can help policy makers to make decisions related to infrastructure development and regulations. For example, it may lead to recommendations for increasing the availability of charging stations or implementing incentives for e-bike adoption in underserved regions. Understanding the impact of weather changes on e-bike demand can also guide policies related to sustainable transportation during adverse weather conditions.

Urban Planners and City Officials: It can also benefit urban planners and city officials to support sustainable and efficient urban mobility. The data on e-bike demand and availability can inform city planning efforts, such as the placement of bike-sharing station or the creation of e-bike lanes in high demand areas. This information can contribute to reduce traffic congestion and improve air quality, along with creating more liveable and eco-friendly cities.

Environmental Organizations: Environmental organization can promote sustainable transportation options through e-bikes and e-scooters. Our insights can show the benefits of e-bikes in reducing carbon emissions and traffic congestion, a valuable data for Environmental organizations. This can support their efforts to raise awareness and lobby for policies that encourage the use of e-bikes as green alternative to conventional transportation methods.

Public/Tourists: The public can benefit as increased awareness of e-bikes and e-scooter availability, especially in areas with high demand can encourage more people to consider e-bikes as convenient and eco-friendly mode of transportation. Besides if the area is touristic attraction, the travel agency can be collaborated with e-bikes agencies and show around the city. Lastly, it can also help individuals to make informed decisions when to use e-bikes based on weather conditions, contributing to a safer and enjoyable riding experience.

In conclusion, our results have broad implications for various stakeholders including businesses, policy makers, urban planners, environmental organizations and the public and tourists. By addressing question related to demand, availability and the impact of weather, our consulting can drive positive changes in the e-bike industry and sustainable transportation landscape in Switzerland.

3.3 Proceeding and Method

API Data and analysis: The data from weather and e-bikes, e-scooters API data will be collected over a period to capture daily variations accurately.

Exploratory Analysis:

Descriptive Statistics: We will use descriptive statistics to summarize and visualize e-bike usage patterns, availability, and weather conditions.
Spatial Analysis: Using geographic information systems we can check e-bike demand and availability across Zurich. This can help us to identify the hotspots and areas with potential for growth.

Cost-Benefit Analysis: We can also perform cost-benefit analysis to assess the economic feasibility of investing in e-bike infrastructure in different regions. This can include calculating the potential return on investment based on increased e-bike usage.

Scenario Analysis: We can also think of conducting some scenario analysis to explore the impact of different policy changes or investments in e-bike / e-scooter infrastructure. For instance, we can think of the effects of increasing the number of charging stations or offering subsidies for e-bike purchases.

These can be our possible research methods, but based on our data we might use other analysis than what we mention here. The research methods that we mention here can act as framework for us to answer our research questions.

3.4 Time Schedule

Milestone 1: Plan and prepare the project:
(October)
A successful project needs good planning which was partly achieved by writing this proposal. But there remain some important steps that need to be taken. Most importantly we need to familiarise ourselves with the data we want to collect and plan our data lake and data warehouse architecture. The goal of this milestone is to get a clear idea what data we want to collect (is all the information from the APIs needed or not), how we want to design the data pipelines (how and by whom is the data collected) and how we want to set up the data architecture. To achieve this, we still need some theoretical input from class. The results of this step shall be presented at the mid-term presentation.

Milestone 2: Set up the data pipelines and data lake/warehouse infrastructure:
(October-early November)
Once the preparatory stage is done, we can set up the data pipelines and our data warehousing infrastructure. Since we want to collect data hourly, we need to use scheduled lambda functions or Apache airflow. We don't have the required knowledge yet to choose one of the two options. Also, we need to clarify if we need additional infrastructure to run the scheduled tasks on (e.g. a virtual machine). The goal of the second milestone is getting working pipelines for both APIs and having the accompanying data lake/warehouse infrastructure to store the data.

Milestone 3: Collect and analyse the data:
(November-December)
With the data pipelines and data lake/warehouse infrastructure in place the third milestone is to successfully collect data from the APIs, bring it together in a data warehouse, connected this to a visualisation tool like tableau and analyse the data. The main goal of this milestone is it to answer our research questions. First results shall be presented at the final presentation.

Milestone 4: Project Report
(October-January)
The last milestone will be to document our learnings and findings from the previous steps in a written project report. As the project progresses, we can gradually add to the report.

4 References

Shared Mobility

a) Consumer acceptance of shared e-scooters for urban and short-distance mobility, *ScienceDirect*, link, (08.10.23)
b) Shared mobility services towards Mobility as a Service (MaaS): What, who and when?, *ScienceDirect*, link, (08.10.23)
c) An Overview of Shared Mobility, *MDPI*, link, (07.10.23)
d) Sustainability and Shared Mobility Models, *MDPI*, link, (07.10.23)
e) Who uses shared micro-mobility services? Empirical evidence from Zurich, Switzerland, *ScienceDirect*, link, (07.10.23)
f) Low prices and more vehicles in the shared mobility sector, *zhaw.ch*, link, (08.10.23)

Electric vehicles

g) Evjoints Battery Swapping Revolution, *Evmagz*, link, (08.10.2023)
h) How much charging infrastructure do electric vehicles need? A review of the evidence and international comparison, *ScienceDirect*, link , (07.10.23)
i) Infrastructure to Facilitate Usage of Electric Vehicles and its Impact, *ScienceDirect* , link , (08.10.23)
j) Daily electric vehicle charging load profiles considering demographics of vehicle users, *ScienceDirect*, link, (07.10.23)
k) Spatial and temporal patterns of electric vehicle charging station utilization: a nationwide case study of Switzerland, *IOPscience*, link , (08.10.23)
l) Touchpoints for electric mobility: Investigating the purchase process for promoting sales of electric vehicles in Switzerland, *ScienceDirect*, link , (07.10.23)