Curbside Management

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Shared Micro-Mobility
– Safe and Sustainable in Cities

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List of Abbreviations

CO_2	Carbon dioxide
GDPR	General Data Protection Regulation (German: DSGVO)
eKFV	Small electric vehicles regulation
GBFS	General Bikeshare Feed Specification
LCA	Life Cycle Assessment
MDS	Mobility Data Specification
MaaS	Mobility as a Service
SLA	Service Level Agreement
UN	United Nations
SDGs	Sustainable Development

Introduction

Rental bikes, e-scooters or mopeds are popping up in many, often smaller, cities. Using them is simple: just download the app and book the vehicle. Increasingly, these services are being integrated into Mobility as a Service (MaaS) platforms. For example, many offers can already be found in multimodal booking platforms such as the Mobility Stuttgart app or the Jelbi app in Berlin.

In this way, sharing offers in the field of micro-mobility (rental bike, e-scooter, moped) complement existing classic public transport modes and ensure connecting mobility from/to the station for many users.

According to an October 2020 study by the German Institute of Urban Affairs, 45 cities in Germany are already equipped with e-scooter rental systems - and more are being added every month.

When selecting, introducing, and managing a micro-mobility service, there are a number of issues to consider from the different stakeholder perspectives. We would like to highlight some of these issues - from the perspective of the municipality and with a focus on the rental offers - and take a closer look at them.

The challenges that arise when integrating micro-mobility offers from the perspective of city representatives can be divided into two different levels: the first one is the level that addresses cities or municipalities directly – dealing with infrastructure, availability, regulations or parking. The second level concerns the mobility provider and affects the cities indirectly. These may include, among others: cyber or data security, technical design, maintenance, usability or deployment.

It is generally advisable to roll out new sharing services step by step and to continuously improve them together with the providers according to a classic "Plan-Do-Check-Act" cycle and to consistently align them with the needs of the citizens. In order to improve the work of cities and municipalities as well as mobility providers and to support data-based decision-making, digital support is essential for monitoring, planning and controlling all sharing services in a city.

We have already addressed the challenges related to urban and mobility planning and the availability of mobility space in our last white paper „Micro Mobility & Geozonen“ (in German).

In this white paper, we would like to focus on the aspects of safety, security, data protection and sustainability.

From a terminological point of view, safety is defined as accident avoidance. It refers to the state of being protected against non-intentional failure inside a system. Security, on the other hand, means manipulation prevention from externals. It is the state of being protected from harm caused by intentional human actions.

With DEKRA DIGITAL, we have an expert who can demonstrate comprehensive and long-standing expertise in the areas of safety, security, and data protection.

Which areas and what kind of infrastructure do we as a Municipality ideally provide to serve the safety aspect?

The first decisive factor here is an overview of the distribution of sharing vehicles in the city. In the next step, this information can be used to address the management of parking and drop-off areas for micro-mobility vehicles. The objective must be to avoid disturbances and obstructions of public space caused by parked bicycles, e-scooters, or mopeds.

By designating dedicated areas as parking spaces for vehicles, corresponding safety is created for the users of the sidewalks. In some cities, such as Berlin, parking areas for private cars are being converted into parking areas for micro-mobility.

Agora Verkehrswende recommends that sharing offers should be considered at an early stage in mobility and land use planning. Especially wheelchair users or families with strollers often face some challenges when new micro-mobility offers additionally use the roadside or sidewalk as parking or drop-off area. Even though many of the offerings are station-less, establishing dedicated parking areas can often make a lot of sense for the city and providers. Especially at highly frequented locations, such as public transport hubs or marketplaces, these parking zones are helpful and act as "magnets" for station-less sharing vehicles. If necessary, the use of such parking areas can be further supported with tariff reductions. As a result, the vehicles are no longer in the way and the providers benefit from a clear visible communication of their offer.

Lisbon has had very good experience with this measure - even without separate communication, rules and benefits. The number of citizen complaints dropped dramatically after just some weeks of introduction. Based on the good overview of how the vehicles are distributed throughout the day, targeted areas were made available that were readily accepted by the users. This contributes enormously to safety in the road space.

E-Scooter parking space in Lisbon

E-Scooter parking without determined space nearby

In any case, these areas should also be designated digitally and communicated to all mobility providers via MDS interface (Mobility Data Specification), so that they can store the zones in their system and inform their customers accordingly.

Sign for E-Scooter parking space at Frankfurt main train station

E-Scooter parking space at Frankfurt main station

In addition to restricted zones that apply permanently, many zones with restrictions are only necessary temporarily to ensure safety in the street space. Whether it is a city festival, a major construction site or a large-scale demonstration - the responsible city departments define the space and time and the information can reach all providers - also via a direct interface.

In addition, zones with speed limits can also be defined, e.g. along riverbanks, in narrow inner-city areas or where there is heavy mixed-use with pedestrians. This also contributes to safety in the road space.

What regulations regarding security and safety are useful for a City?

Sensible regulation from a safety perspective ensures that the acceptance of sharing services among citizens increases and, at the same time, supports the transport policy goals of the cities. The sustainability and efficiency of the new mobility are thus continuously increased.

Furthermore, the regulatory framework should be simple and clear. This prevents excessive and inefficient bureaucratization. In addition, a simple and comprehensible set of rules promotes understanding and the likelihood of compliance.

To make regulations as practical as possible, it is advisable to develop certain measures together with the mobility providers. For example, to better serve certain mobility hubs or outlying areas, users could be provided with certain benefits, such as price reductions, extended rental periods, integration with other public transport services, access to battery replacement stations, etc.

Geofencing with geo zones are enormously helpful in communicating regulations to mobility providers. Geofences are geographic areas or spaces defined on an urban map where special rules apply. In this way, regulations for the maximum speed allowed (e.g., in pedestrian zones) or for access or parking can be defined for specific geo zones to reduce the risk of injury to pedestrians from micro-mobility vehicles.

Since these geo zones are created digitally, these "machine-readable rules" can be read directly by the mobility providers' IT systems via open interfaces. Especially in situations where geo zones change (e.g., during temporary events such as city festivals, large-scale demonstrations, construction sites, etc.), the advantages of digital geo zones can be fully exploited.

Digital communication ensures that all operators are confronted with the same requirements and implement them in the same way and that there is no patchwork of different implementation interpretations. At the same time, given a large number of processes, automated communication saves a lot of time on both sides. However, several authorities or departments are usually involved in the administration as well, and they should all have the same view of the rules and regulations.

The agreements between the city and the mobility provider typically contain the following points:

- Definition of a service level agreement (SLA) and thus determination of demand, fleet size and the business territory
- Establishment of parking and no-driving zones
- Determination of set-up points and rules during set-up
- Data availability and reporting requirements
- Standards for data sharing, common privacy policy
- Define complaint management and processes
- Integration with existing mobility services, mobility hubs, relationship with public transport.
- Standards for distribution, maintenance and vehicle disposal are defined
- Contact persons and communication protocols
- Channels for citizen communication

DEKRA, together with the German Road Safety Council, published additional recommendations, like:

- Mandatory equipment with direction indicators ("turn signals")
- Increased visibility through retroreflective foils
- Adjust minimum age for use of e-scooters to 15 years and introduce a test certificate
- Anchor change of perspective more firmly in driver training courses
- Automated speed limits for novice drivers, in certain weather conditions, late at night, on weekends and on the occasion of major events
- Charge rental rates by distance instead of time
- Clear contact person for authorities and the police

(see also the Agora Verkehrswende recommendations and "Deutscher Verkehrsrat" for action)

What digital support do Municipalities need and how can the data be processed securely?

To enable cities to have an overall view of the sharing services and their orchestration in their city, it is essential to connect the systems of all mobility providers via interfaces and to establish a bidirectional data exchange for location and telemetry data on one hand and regulatory and geofencing data on the other.

Above all, the operation of such an IT system requires the appropriate attention and must meet the legal and industry-typical quality standards.

The legal basis for data processing is the DSGVO / GDPR. Even if the need for protection of telemetry data is not excessive, the required principle of data economy should be taken into account from the outset and only that data should be processed which is actually needed for the urban tasks of traffic planning - and regulation.

The data on trips are particularly sensitive in this context, as the addition of other external data sources may allow conclusions to be drawn about specific individuals and their movements in the city (so-called "trip reconstruction attacks").

For the monitoring of stationary traffic, however, one does not need information on the mobility profiles that the vehicles actually travel. It is sufficient to know the location and status information of the vehicle. This alone provides a multitude of possible applications and insights for the city without running the risk of inadvertently getting into the processing of personal data.

We currently observe that the MDS (Mobility Data Specification) data exchange standard is gaining acceptance for communication between cities and mobility providers. Currently, more than 80 cities around the world are already using MDS and Lisbon (Portugal) is one of the first European cities to mandate the use of the MDS standard for shared mobility providers.

MDS evolved from an earlier standard GBFS, which was developed specifically for bikesharing (GBFS) applications. Many other cities use GBFS or the GBFS component of MDS to exchange data with micro-mobility providers.

It should be noted that the entire sharing mobility industry continues to be extremely dynamic and even a standard such as MDS is subject to regular changes and updates. In this situation, cities should rely on IT systems that can be easily adapted to changing framework conditions and new interface versions without compromising on data sovereignty, stability, scalability and security of the overall system.

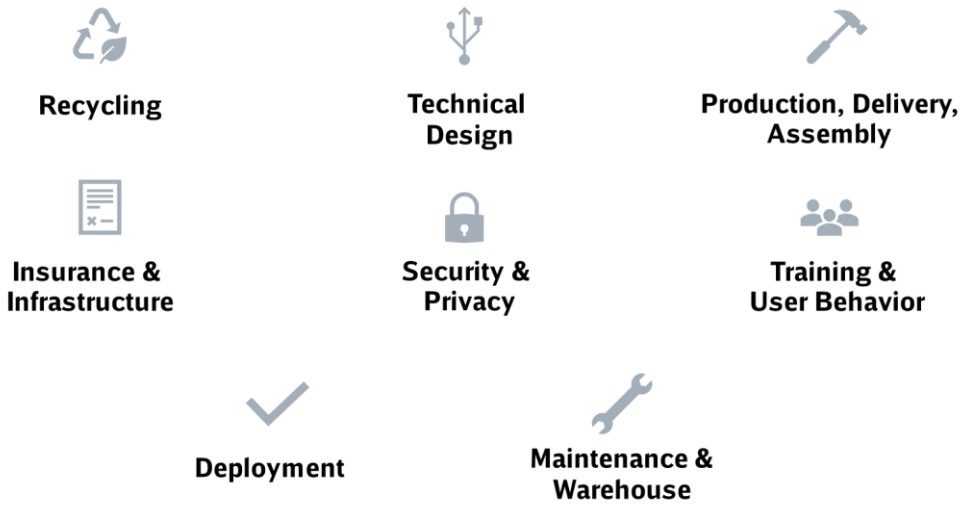
DEKRA crash tests with e-scooters

What factors do Cities need to consider before allowing e-scooters to operate in the City? Why are these factors necessary?

The Federal ministry of road transport authority developed a regulation in the form of eKFV to regulate the use of personal light electric vehicle. The regulation covers various aspects of the e-scooter such as the height, length, width etc. but as well the insurance requirements, guidelines to use an e-scooter on the road. An e-scooter sharing operator must fulfill a Kraftfahrt-Bundesamt certification in order to operate an e-

scooter sharing service in the market. However, cities need to consider aspects beyond eKFV, as problems pertaining to the e-scooter sharing services are not only restricted to the design of the e-scooter, but also regarding how mobility providers operate their service.

A neutral third-party organization can provide consulting in fulfilling the necessary safety as well as security factors - and provide certification to the operator once the requirements are fulfilled. Cities can rely on such certifications which ensure that the e-scooters used in the city's traffic cannot be manipulated by any externals and are safe to be deployed on the road. These requirements can include:



Maintaining a cyber secure infrastructure

E-Scooters used in a sharing model are integrated with software technology for the functioning of its hardware i.e. Software enables book-out - locking, book-in - unlocking and as well as the speed of e-scooter can be adjusted as per the regulations.

Manufacturer face the challenge of creating products with intelligent capabilities and fast, but secure connections. Because of the embedded software, e-scooters are susceptible to cyber security attacks where the device can be manipulated without the user's knowledge. A research conducted by Fraunhofer Institute proved how e-scooters can be manipulated through gaps in API's and Bluetooth connectivity. Researchers

were able to reverse engineer the locking and unlocking process and could stop a moving e-scooter on the road. Such gaps in the software need to be identified before the e-scooters are deployed on road.

Cities can rely on those operator's e-scooter systems on which Security evaluation is done. Mobility sharing systems are made of up of 3 different domains.

1. **The product** i.e. communication protocol (Hardware including wired and wireless protocols) + firmware (software embedded in hardware)
2. **App** on the smart phone, mobile application
3. **Cloud Management interfaces**

For the safety of the user on the road, the security of the devices needs to be evaluated across the above three domains. Cybersecurity experts will try to identify the potential entry points trying to simulate the same attacks that could be performed by a malicious attacker. One of the most cost-effective ways to check the security of any product is penetration testing. Penetration Testing, usually known as Pen Test or ethical hacking is a measure taken by organizations where various IT experts analyze the IT system (full ecosystem including mobile app and cloud services) and measure the strength of the system in a hypothetical scenario. The experts try to identify the entry points within the system through various tests and tools through which the attackers can try to enter.

Penetration testing is a testing methodology executed by high experienced experts focused on finding vulnerabilities by identifying potential attack vectors and scenarios covering the full product ecosystem (HW + Cloud + Mobile App).

The penetration testing evaluates:

The embedded hardware and software	**Communication protocols** between the product, the mobile device and cloud	**Mobile application** (frontend)	**The cloud services** (backend)

Operators through neutral third parties can test their systems for such vulnerabilities. As gaps are identified in the system, a neutral third-party organization can provide testing as well as information to the manufacturers to fulfill the gap. Added benefit of such tests enables municipalities to provide regulations for operators to adhere.

Ensuring safe warehouses and workplaces

In past various warehouse fire incidents are reported where multiple e-scooters are stored. E-scooters are collected by sharing operators during the non-operating hours in the night and charged over night to be deployed the next day during operational hours. In a recent warehouse fire incident, it is reported that a spark in one of the e-scooter batteries may have been the cause of the fire. Thus, such issues pertaining to warehouse charging and storing conditions highlights the need to verify the warehouse safety according to the industrial norms.

E-Scooter rider wearing a helmet

Building a safe riding culture

Unsafe riding behavior is another major source of concern for governments, insurance companies and as well as e-scooter sharing operators. Users are unaware of the road

rules, parking of e-scooters in safe zones. E-scooter sharing operators educate users through online training modules as well as during the registration process. However, problems such as drunk riding, riding on footpaths persist. To tackle this problem, cities need to conduct road safety training events in collaboration with e-scooter sharing operators and independent neutral 3rd party road safety organization.

Ideally, City authorities should consider deploying pilot programs to check the effectiveness of e-scooter sharing service in a city. Pilot programs can provide authorities with a clear understanding of the usage patterns of the e-scooters, last mile connectivity by integrating e-scooters in the public transport, educating the user about the safe usage of e-scooters. E-scooter pilot programs together with a cross-provider monitoring system also allow cities to monitor the number of active e-scooters in an e-scooter fleets in case if the e-scooters are dumped in the river by vandals.

Pilot programs are widely accepted in many European cities and as well as in the United States for example, the city of Portland is one of the pioneers of such a program which evaluates the e-scooter sharing service based on the usage patterns, user trainings, deployment guidelines, public engagement surveys to understand the perception of sharing service within the community.

How can the impact of E-Scooter sharing services on the environment be calculated?

The impact of e-scooter sharing services can be calculated through the life cycle assessment process. Life Cycle Assessment (LCA) is a systematic analysis of the potential environmental impacts of a product or service during its entire life cycle. It covers production, distribution, use and end of life cycles. This also includes processes such as the raw material extraction for the production, the energy generation and consumption, the waste management, etc. In other words, it is an environmental impact assessment from cradle to grave.

LCA is generally made up of ISO 14040 and ISO 14044 and consists of 6 steps: The overview of services, the target definition, the data collection, the calculation, the preparation of the study and optional the critical review of the study.

E-Scooter sharing services challenge the traditional use of cars in city centers and for short-distance travel. However, on many occasions, it is discussed whether the electric micro-mobility is more sustainable than conventional mobility in cities, arguing the emissions associated with the battery production or the scooters' end of life, for example. Using LCA, different impact categories such as carbon footprint, dust and aerosol emissions or acidification can be measured and even the life cycle phase which contributes the most to the impact. Some of the micro-mobility sharing operators have published the LCAs to demonstrate that their products have a low environmental impact in comparison to the rest.

For example, one of the big e-scooter operators did an LCA for its e-scooter sharing service in Paris. They determined that 35g of CO_2 eq. per person per kilometer were emitted, most of this during the production phase. However, the emissions were less than for diesel buses, electric cars, and petrol cars. Additionally, an electric car company, did a LCA to compare emissions between the petrol car and the electric car The results showed that CO_2 eq. emissions were lower for the electric car (considering different electricity mixes), and most of the CO_2 eq. was emitted during the materials production phase.

LCA is a remarkable tool to have transparency regarding the environmental impact of different mobility forms. Besides, it can be used to identify the life cycle phase which produces the most impact and act on it. Nevertheless, other impact categories such as resources depletion or acidification should be considered beyond CO_2 emissions to determine the most sustainable form of mobility.

The United Nations (UN) have developed an agenda for 2030 for sustainable development in 2015. At the core of the agenda, the UN calls out to all its member nations to fulfill the 17 Sustainable Development Goals (17 SDGs). Through collaborations with Neutral 3rd party organizations and mobility providers cities will be able to accelerate the fulfillment of the 11th goal, which is Sustainable Cities and Communities. Sustainable Cities and Communities focuses on making cities and human settlements inclusive, safe resilient and sustainable.

Effective collaboration between cities and mobility sharing providers can lead to sustainable transport by providing better intermodal connectivity, first and last-mile connection and transportation for all. The basics are safety and sustainability of mobility offerings, and good fact-based communication from cities to mobility providers with digital support to live the "Plan-Do-Check-Act" cycle.

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