The City of Stockholm and Geofencing

City’s´ role as data provider to enable geofencing applications: innovation and digital transformation

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INTRODUCTION

Stockholm aims to be a sustainable city with a high quality of life for all. To accomplish this goal with limited resources, the city must adopt smarter practices and leverage the opportunities presented by innovation and new technology. In the Stockholm Sustainable Urban Mobility Plan[1] (SUMP) it is stated:

"Innovations and new technological solutions offer opportunities. The city will become smarter by leveraging digitisation and new technological solutions to make life easier and better for residents, visitors, and businesses. There is great potential in both electrification and digitalisation of the vehicle fleet, as well as in the new mobility services."

Further on:

"Geofencing can provide cities with new tools to control the desired traffic in order to achieve goals for climate, environment, mobility, safety, and traffic safety. Already today, the technology is used, for example, to partially control the parking of free-floating electric scooters."

Several geofencing trials have already been conducted in Stockholm. For instance, a concrete truck was granted an exemption to carry a heavier load than is normally permitted. With heavier loads, fewer trips to and from construction sites are required, reducing the overall number of heavy goods transports within the city. The condition of the exemption was that the vehicle maintained a low speed, which was ensured through automatic vehicle speed regulation using geofencing within the areas covered by the exemption. The tests have been successful but have not been scaled.

Stockholm's participation in the GeoSence project focused on getting a deeper understanding of the necessary actions the city must undertake to harness opportunities presented by innovation and new technological solutions, using geofencing as a case study.

The main research question in Stockholm has been: How can cities transition based on a use case where geofencing is used for speed limitation in a specific demarcated area? Underlying questions: How can geofences be used as an enabler in urban transformation and what is required for the geofence to be an enabler in urban transformation?

Focusing on data as a strategic resource, Stockholm has explored how digital transformation can be developed to implement geofencing and other connected solutions in its daily traffic planning and. This has been done by mapping relevant existing processes, including issuing, local traffic rule updates, road network editing, as well as creating new routines and processes for data management.

By mapping relevant processes and identifying gaps and other related initiatives, Stockholm's ambition was to get a picture of the current situation as well as the envisioned changes to scale up and implement geofencing and other tools as part of traffic planning and operations.

[1] https://start.stockholm/globalassets/start/om-stockholms-stad/politik-och-demokrati/styrdokument/stockholms-stads-framkomlighetsstrategi.pdf

CASE STUDY STOCKHOLM – CITY BACKGROUND

Stockholm is Sweden's and Scandinavia's largest city, with a population of 990 390 inhabitants in 2023. The city has over 40 000 employees (2021) where of Trakfikkontoret (The Transport Department[2]) in isolation has more than 400 employees. This means that a large number of employees must be mobilised in each change activity, hence, change activities such as the use of geofencing used to solve traffic and mobility challenges can easily disappear in the larger mass of other intentions and activities. Mobilising actors to prioritise tasks as geofencing, requires that the individual, organisation and ecosystem perceives the goal and the task as meaningful.

In GeoSence, the project group experienced challenges in finding a coherent common understanding around how the application of geofencing technology becomes a natural part of solving transport and

mobility issues. In order to find a common understanding of geofencing, GeoSence researchers contacted key actors in the Transport Department asking about how the work with speeds is done and how business-, organisation- and process development takes place. Moreover, these questions guided the researchers in the direction of additional interviewees.

The Transport Department in Stockholm, which is responsible for the operation and maintenance of the city's public streets, squares and parks, has the ambition to be a trusted data provider enable geofencing application and other location-based services. The related activities included investigating the need for organisational changes and process development to fully integrate geofencing as a way of working in the city organisation and make geofencing based on the city's policy and regulatory data possibilities. With previous experiences, from the Swedish national Geofencing program and ongoing related projects, Stockholm continuous to be a forerunner in this field.

Mandate

The city plays an important role as a traffic regulator for motor vehicles. It is through local traffic regulation that the city legally has the ability to influence traffic. For example, traffic safety can be improved by lowering speed limits, noise can be reduced by implementing bans on heavy vehicles at night, and air quality can be affected by introducing environmental zones or banning studded tires.

[2] https://start.stockholm/en/about-the-city-of-stockholm/organisation/specialist-departments/transport-department/

With today's increase in connected vehicles, there are opportunities for improved compliance by informing (or alternatively controlling) vehicles based on the rules applicable to the location of the vehicle (geofencing). Therefore, the city also plays an important role as a producer of traffic regulation data, ensuring that traffic rule data is created and made available in a machine-readable format. Enabling vehicles (not just humans) to understand applicable traffic regulations.

Conditions

In 2023, the City of Stockholm Transport Department issued a total of 1,605 permanent traffic regulations, including parking regulations. There are organisational structures, dedicated resources, IT support systems and templates in place to digitise traffic regulations. The regulations are standardised in accordance with the Swedish Transport Agency's rules, to a large extent.

The Transport Department manages the traffic regulation until the decision and publication on STFS (Transport Agency webpage and database). Stockholm uses an IT system to create local traffic regulations and to transfer it from the decision-making authority, the city, to the Transport Agency. The regulation is provided with processable data, and it is also linked to the digital road network (machine readable).

The process starts with the City of Stockholm Transport Department creating a local traffic regulation using an IT system and sending it to the Swedish Transport Agency's website and database STFS, where the regulation is then stored (as a PDF and, if applicable, with accompanying machine-readable data).

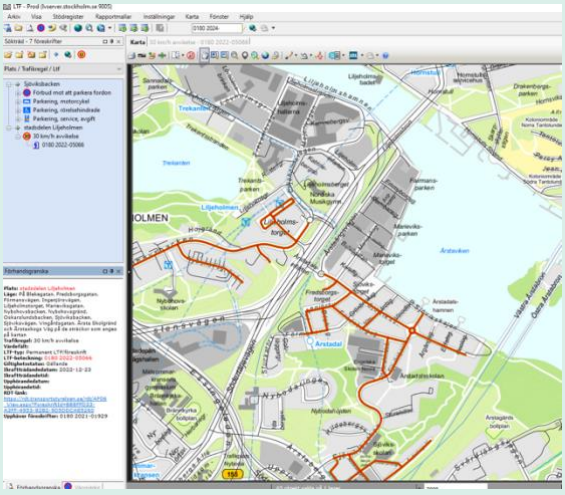
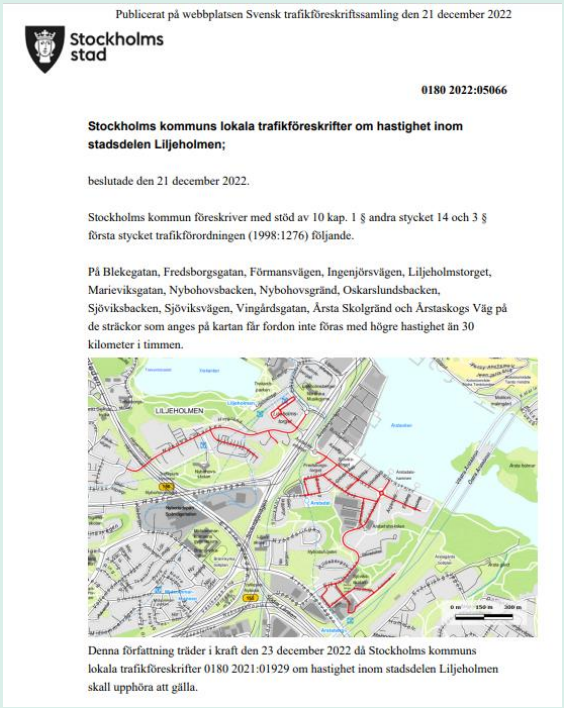


Figure 1. ITS system creating local traffic regulations in Stockholm, Sweden.



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Stockholms stad

0180 2022:05066

Stockholms kommuns lokala trafikföreskrifter om hastighet inom stadsdelen Liljeholmen;

beslutade den 21 december 2022.

Stockholms kommun föreskriver med stöd av 10 kap. 1 § andra stycket 14 och 3 § första stycket trafikförordningen (1998:1276) följande.

På Blekegatan, Fredsborgsgatan, Förmansvägen, Ingenjörsvägen, Liljeholmstorget, Marieviksgatan, Nybohovsbacken, Nybohovsgränd, Oskarslundsbacken, Sjöviksbacken, Sjöviksvägen, Vingårdsgatan, Årsta Skolgränd och Årstaskogs Väg på de sträckor som anges på kartan får fordon inte föras med högre hastighet än 30 kilometer i timmen.

Denna författning träder i kraft den 23 december 2022 då Stockholms kommuns lokala trafikföreskrifter 0180 2021:01929 om hastighet inom stadsdelen Liljeholmen skall upphöra att gälla.

Figure 2. A Swedish example of a local traffic regulation submitted as a PDF, and available online on STFS website.

Following that, the Swedish Transport Administration proceeds to retrieve the regulation (including any data) and update NVDB (National road database). From NVDB, data is then retrieved for use by, for example, the navigation industry, ISA systems etc. The flow of data from

the city to the NVDB is not automated at the moment.

These conditions for the city of Stockholm lay the foundation as the traffic regulation data from NVDB enables geofencing applications.

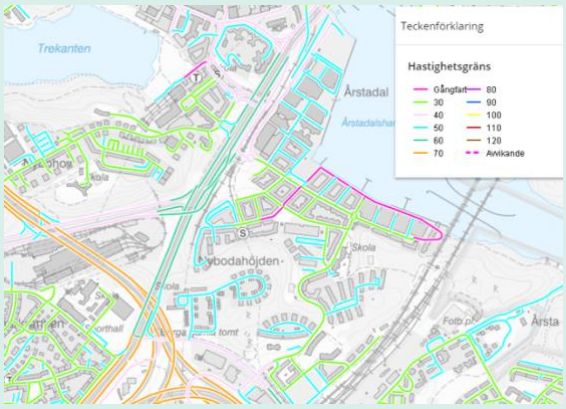

Figure 3. Speed limits as shown in the Swedish National Road Database (NVDB).

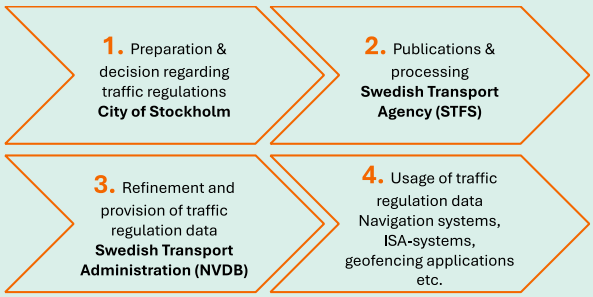

Figure 4. The traffic regulation process, and publication of traffic regulation data in Sweden.

USE CASE: DATA, DATA PRODUCTION AND DATA PROVISION

Whereas the use cases in Gothenburg and Munich focused on applying geofencing on concrete transport modes; special transport and e-scooters, the use case in Stockholm focused on data management associated with geofencing. This approach was based on a hypothesis suggesting that inadequate quality of traffic regulation data is impeding the broader implementation of geofencing applications. Therefore, the focus was on addressing this issue. While significant progress has been made in geofencing free floating fleets of e-scooters, applying geofencing to motorised vehicles presents an entirely different challenge.

Data management becomes most effective and relevant when all levels (the individual, the organisation and the ecosystem) see data as a valuable strategic resource. Data management is often talked about from two perspectives:

- The application of data, e.g., for analyses, and data-driven decisions.
- The hard and soft digital infrastructure that enables data to be used as a strategic resource in the organisation, e.g. for interoperability, dataspaces, and instruments such as SUMPs (Sustainable Urban Mobility Plans).

Inefficient data management has major implications for digitisation at all levels.

Digitisation has long been considered one of the most important enablers for transformation to achieve European, national, regional and local missions. As an example, the Swedish government expresses a clear ambition that Sweden will be the best in the world in making use of the possibilities of digitisation. Another example is the City of Stockholm, which describes that the city takes advantage of the possibilities of digitisation and develops internal processes to become more efficient. Managed correctly, digitisation contributes to more efficient and better welfare. Lead to that the city's

employees are able to devote their working time to resident-related, value-creating and qualified issues to a greater extent.

Pilots/use case

The use case examines several aspects of geofencing with a starting point from data management. While the focus is on data management, other aspects of geofencing and traffic planning, such as user experience or sustainability issues, may not be addressed to the same extent.

Depending on the use case's strategic hypothesis linked to data availability and data quality, tests and mapping were focused around**: Data from Swedish public actors NVDB, provision of data and traffic rules.**

Method

Two series of workshops were carried out during the project. One where participants from different parts of the data chain were present and one Stockholm conducted a workshop based on location-based mission-driven development, around speed limits in Sjöviksbacken, Stockholm. The test of the retrofitted system is also part of the method to reach the goal of envisioned changes needed to scale up and implement geofencing and other tools as part of traffic planning and daily operations.

"Data chain" workshops

In this workshop series, focus was on the data chain and the strengths, weaknesses, opportunities and threats in that data chain were discussed and identified. The data chain under consideration spans from the decision to implement a new speed limit, all the way to its delivery to the end user of an ISA system, for example.

The starting point was to understand the current situation and identify obstacles preventing us from taking advantage of the opportunities and potential that comes with data. The workshops included people involved directly and practically with the creation of the local traffic regulations, but also people that previously have worked with geofencing pilots within the city.

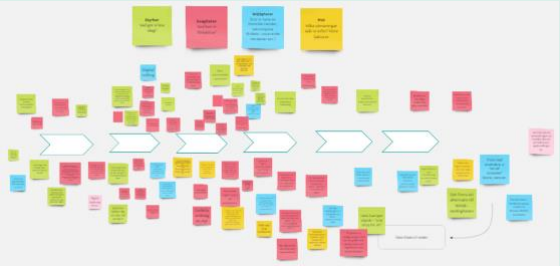

Figure 5. Post-It exercise in one of the workshops conducted in the City of Stockholm use case.

Test of retrofitted speed limiter system

During the summer of 2023, the city conducted a reality test of a geofence application installing a retrofitted ISA system in one of the city's own cars and driving that vehicle in an urban environment. The test was carried out by the city together with the supplier Loh Electronics AB[3]. The purpose of the test was to gain more practical knowledge about the technology itself, but also to gain a better understanding of the data used to limit speed. The system being tested utilised speed limit data provided by HERE Technologies[4].

The conclusions from the test were that overall, the system worked well – most often it was not possible to drive faster than what is regulated on the route.

[3] https://www.lohelectronics.se/en-gb/

[4] https://www.here.com/

Mostly positive reactions from those who have test driven but there were also challenges mainly when the system thinks there is a lower speed than what is signposted. The positive experience was most evident on stretches of 30 km/h or low-speed areas. Challenges with the system could be due to various things, e.g. that the data was not updated, that regulations are not written for private roads and more technical reasons such as positioning. NVDB was not used directly but third-party map provider data was used. Third party map provider uses NVDB to update their data. Provided and required data was available and usable.

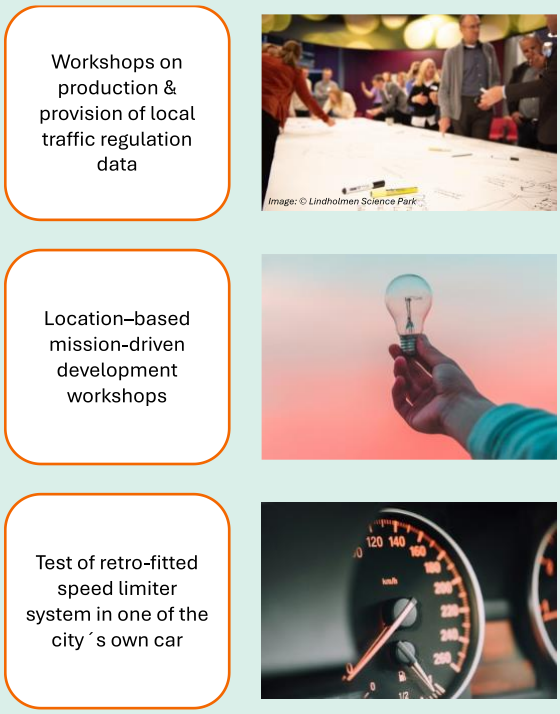

Figure 6. Method summary used in the City of Stockholm use case.

Figure. 7 Example of the challenge of positioning from Nynäsvägen, Stockholm.

In Figure 7, the vehicle is on a road where it is 70km/h, but the system picks up 30km/h from the parallel road on the other side of the fence Felt very uncomfortable to have to accelerate through it to reach the appropriate speed (due to heavy traffic, etc.). This needs to be improved for the system to be useful and feel safe for traffic.

Location based mission driven development workshops

Representatives from different areas in the Transport Department: innovation, digitisation and data management participated in the workshop. The overall mission was to enhance representatives' understanding of the different responsibility areas in the Transport Department and explore how new innovative ways of working can be developed to implement geofencing and other connected solutions in its daily

traffic planning and management operations.

The participants were asked three questions:

1) What are your area's strengths within the function (utility models, governance, organisation, process, evaluation, and strategic learning)?

2) What does your area see as an area of development within the function?

3) What activity do you propose to create improvements in the area you propose to be developed?

The responses were categorised by what the participants considered as strengths, needs to be developed and activities. An example was the answers of representatives from digitalisation area concerning utility models.

Utility models Digitalisation

- Strength: Impact relationship within traffic safety.
- To be developed: Methodical approach to create business models that make it possible to take advantage of digitalisation's opportunities and evaluation of whether current utility/business models are adapted to the needs and that make it possible to take advantage of digitalisation's opportunities.
- Activity: Develop simple templates and working methods for (simplified) cost-benefit calculations.

Recommended next step for workshop tool

In order for the workshop tool to function fully, the tool needs to be developed in several ways.

- The time required for the exercise itself was too short. The exercise would have to be at least 6 hours instead of 3 hours.
- The tool needs to be improved so that the results and clarifications can be produced "real-time" while the exercise is still in progress.
- The process needs to be completed with another session where the group can revisit the results, modify and add.
- The process needs to be supplemented with another session where the working group immerses itself in each area in order to make decisions about which areas should land in the joint action plan for the assignment (mission).

LESSONS LEARNED

Results from the workshops and the tests conducted on the retrofitted speed limiter system, clearly show that the quality of traffic regulation data is not the primary issue hindering the scalability of geofencing applications. This is further validated by a quality test conducted on speed limit data in the NVDB (2021), which shows that approximately 96 % of the data is accurate on a national level.

The experiment around place-based, mission-driven development yielded only certain results. If transformation work linked to speed limitation with geofencing application is to be done, a

much clearer mission is needed, the place needs to be personally meaningful for the actors who participate. The very application of a feature such as geofencing cannot be the purpose of location-based mission-driven development. Location-based mission development is therefore a particularly bad fit for the use case that would be processed in this context.

The use case in Stockholm focused on how geofences can be used as an enabler in urban transformation as well as what is required for the Geofence to be an enabler in urban transformation.

Results show that the issues are highlighted around three interconnected and overlapping perspectives.

- Innovation and innovativeness (act effectively) - plan and act for transformation in complex systems.
- Digitisation (enabler) - one of the most important enablers for significant transition in complex systems.
- Data (the raw material): data is the basic raw material and a key prerequisite for individual, organisational or systemic transformation.

The three perspectives need to be integrated in strategies, action plans and activities when the geofence is to be applied in trial, pilot and implementation projects.

Challenges: The view on challenges varies between the actors. One of them sees challenges in getting a GPS-geofenced image of Stockholm and wants to stop checking properly parked cars. Another actor sees challenges in ensuring that the speeds are sufficiently error-free and quality assured. Several see challenges in ensuring that the input data is correct, especially when it comes to speeds around schools and during roadworks. A different actor sees challenges in getting the GPS data to be accurate enough and in setting up rules for geofencing.

” It is not the technology; it is not data – it is the 100 other things.”

Technologies applied in Geofencing has great potential. Nevertheless, the potential can easily be locked in if other effecting factors are not addressed. A city that wants to apply geofencing has to take a holistic approach on all the factors that are contributing to the underlying purpose of Geofencing application. A holistic approach means that the combination of finance/business models, regulation, competence and ability; needs to integrate towards the challenge to be solved. In addition the city need to integrate and adapt ways of working for enablers such as digitalisation, innovation and data management.

Taking a holistic and integrated approach will help individuals, cities and ecosystems to release the great potential that can be harvested from Geofencing.

Going forward

Some general conclusions were drawn within the Stockholm use case, based on the results from the GeoSence workshops and tests as well as from other experiences, projects and initiatives.

- Traffic regulation data can already now be used to geofence vehicles, but increased focus is needed on data management and the development of the city's role as a reliable data producer and data provider.
- A strategy is necessary to develop the city's digital infrastructure to enable increased communication and dissemination of data (beyond the open data strategy).
- The city should more actively use procurement as a means to impose requirements and promote new technology and innovation.
- The city should continue to be a role model and to drive technological development forward.

Traffic regulation data can already now be used to geofence vehicles, but increased focus is needed on data management and the development of the city's role as a reliable data producer and data provider.

Although traffic regulation data can currently be used to geofence vehicles, the processes involved present challenges. The city should regulate through local traffic regulations and ensure that data about these regulations is made available digitally (machine-readable) and quality assured. Achieving this requires higher prioritisation and investment in data management to maintain good data quality and develop new working methods to meet future needs and challenges.

It also requires collaboration with data consumers (users), other cities, other national authorities and at the EU level, regarding data management and data sharing.

A strategy is necessary to develop the city's digital infrastructure to enable increased communication and dissemination of data (beyond the open data strategy).

For example:

- Interoperability
- Portability
- Integration of the mission and the innovation and digitalisation process

The city should actively use procurement as a means to impose requirements and promote new technology and innovation.

The city cannot influence or control all vehicles, but can do its part by using procurement as a tool to influence certain fleets, for example. To achieve this, a new step in the procurement process is required, involving the right individuals who understand both procurement practices and the desired outcomes of the procurement (what we aim to achieve).

The city should continue to be a role model and test bed to drive technological development forward.

Becoming proficient as a reliable data producer won't automatically lead to significant changes. The city must take the lead, pave the way, create incentives, demonstrate feasibility, and cooperate with others to drive meaningful progress.

PLANS FOR THE FUTURE

The transition for a city, from a time when data was not considered important to recognising its crucial role in solving challenges, making better decisions, and more, has only just begun. For the city to keep being a trusted data provider frontrunner and to explore and learn the City has to continue to expand and strengthen its connection between the EU-level, National-level and EU-level. To harvest the potential and benefits from initiatives on all levels. Meaning that it is essential to engage in initiatives such as dataspaces. In this case the European Mobility dataspace.

REFERENCES/MORE INFORMATION

Further details on results and findings relating to the Stockholm Use case can be found in documents available at the project web site[5].

Image ©: CLOSER at Lindholmen Science Park

[5] https://closer.lindholmen.se/en/geosence