Pilot Evaluation Report

Pilot 3B: An efficient and automated process for intelligent access

Authors: Edwin Mein, Technolution; Daniel Moback, CLOSER; Sebastiaan Oremus, Scania; Andreas Säfström, City of Stockholm, Anna Vadeby, VTI

Deliverable: D6.1.2 and D6.3.3

Published: February 2025

This report is part of the Smart Urban Traffic Zones project that seeks to develop intelligent solutions within the city to enhance flexibility in urban space utilisation, optimise transportation efficiency, and enhance traffic safety. This involves testing and evaluation of digital tools like geofencing, sensors, and digital signage within the city. The project is conducted in three steps, with the ongoing third step initiated in February 2023. It involves the participation of 24 project partners, including public entities such as cities, technology providers, OEMs, transport companies, and academia. The project is partially funded by the Swedish Innovation Agency, Vinnova.

VINNOVA
Sweden's Innovation Agency

Document elaborated with the support of the Smart Urban Traffic Zones project, 2022-02805, has received funding from Vinnova

Table of content

Sammanfattning

Denna rapport är en del av projektet Smarta Urbana Trafikzoner, som har fått finansiering av Vinnova. Här presenteras resultaten från Pilot 3B, där ett system för hantering av trafikdispenser har utvecklats och testats. Inom piloten har en teknisk lösning tagits fram som gör det möjligt för kommuner att kommunicera dispenser, inklusive tillhörande villkor, digitalt och direkt till transportörer och deras fordon via digitala plattformar. Dispenserna kan avse att tillåtas trafikera med högre last än normalt inom specifika områden eller på specifika vägar. Vidare att tillåtas leverera varor utanför normalt angivna tidsfönster (så kallade off-peak-leveranser).

Det huvudsakliga målet med pilotstudien var att utveckla ett system som innebär förenklad hantering för alla inblandade och påverkade aktörer. Vidare att den tekniska lösningen skulle möjliggöra att dispenser och dess tillhörande villkor presenteras för transportören tydligt och i realtid. Ambitionen är att detta ska minska stressen för förare, bidra till bättre efterlevnad av villkoren och ge kommunerna bättre verktyg för att hantera dispenser och trafikflöden mer effektivt.

Rapporten redogör för den tekniska utvecklingen inom piloten, inklusive hur systemet integrerats med befintliga processer och plattformar samt hur användargränssnitt har utformats för att möta förarnas behov. Vidare beskrivs viktiga erfarenheter, exempelvis vikten av samverkan mellan olika aktörer och de utmaningar som finns kopplade till dataintegration och standardisering. Pilot 3B visar att det är möjligt att övergå till en digitaliserad hantering av dispenser, med stora fördelar för kommuner, transportföretag och förare. Sammanfattningsvis lyfter rapporten fram hur digital teknik kan bidra till smartare, säkrare och mer hållbara transporter i stadsmiljöer.

Summary

This report is part of the Smart Urban Traffic Zones project, which has received funding from Vinnova. In this report, the results from Pilot 3B are described. Within the pilot, a digital solution for managing traffic exemptions has been developed. This involved creating a system where permits, including their specific conditions, are communicated digitally and directly to vehicles through digital platforms.

The pilot specifically aimed to create a solution where exemption conditions are presented in a clear, accessible, and real-time manner. This approach is expected to reduce driver stress, improve adherence to exemption terms, and provide municipalities with greater flexibility. Secondary goals included increasing knowledge among stakeholders – such as municipalities, transport operators, and OEMs – regarding the technical and operational requirements of digital permit systems.

This report provides a detailed account of the pilot’s technical development, including system architecture, integration processes, and user interface design. It also highlights lessons learned, such as the importance of stakeholder collaboration and the challenges of data integration and standardization. Pilot 3B demonstrates the feasibility of transitioning to a digitalized permit management process, with significant benefits for municipalities, transport operators, and drivers. In summary, this report

showcases how digital innovation can lead to smarter, safer, and more sustainable urban traffic systems.

Introduction

The municipality enforces various traffic regulations to maintain order and safety on the roads. These include restrictions such as bans on heavy vehicles operating during certain hours, designations of pedestrian and cycle paths, and specific rules for parking spaces. Regulations also address vehicle weight, length, and load-bearing limitations on specific routes. In addition to local rules, there are broader restrictions outlined in national traffic regulations.

In certain cases, vehicles may need to operate on roads where movement is generally prohibited. For such instances, operators must apply for exemptions through the municipal or national road authority. According to Chapter 13, Section 4 of the Traffic Ordinance, exemptions can be granted if there are special circumstances and if the activity can proceed without compromising traffic safety, causing road damage, or creating other significant inconveniences. "Special circumstances," as defined by the Swedish Transport Agency, refer to situations that deviate from the norm and are uncommon. Applicants must present compelling reasons for the exemption. This applies to a small, clearly defined group.

The authority assessing these applications evaluates potential risks to traffic safety, infrastructure, and accessibility. For example, conditions are often attached to exemptions to ensure compliance with safety and durability standards. These conditions can include speed limits, specific vehicle positioning on the road, or additional signage to inform other road users. All exemptions include time restrictions, such as specific validity periods or operational hours.

Traditionally, the application and approval process for these permits has been manual, involving emails and the issuance of PDF permits. These permits, which detail the conditions of the exemption, must be available in the vehicle in either digital or paper form for inspections by law enforcement. The manual nature of this process often results in inefficiencies and challenges in compliance, especially for drivers navigating complex exemption conditions.

Digital Innovation in Pilot 3B

Pilot 3B of the Smart Urban Traffic Zones (SUTZ) project introduces a transformative approach to managing traffic exemptions. This pilot enables municipalities, as road authorities, to communicate exemption conditions digitally and directly to vehicles. By leveraging geofencing and digital communication tools, the project aims to simplify the permit process for all stakeholders, improve compliance with exemption conditions, and enhance overall traffic safety and efficiency.

The primary innovation lies in delivering tailored, real-time information to drivers. Instead of relying on static PDF/paper documents, drivers can receive dynamic updates through integrated vehicle systems or external devices like tablets. These updates ensure that drivers can easily access relevant conditions, such as speed limits or route restrictions, at the appropriate time and location. By enhancing the accessibility and usability of permit conditions, the pilot promotes better adherence to traffic regulations, reducing the risk of non-compliance and its associated consequences.

This digitalization initiative aligns with the broader goals of the SUTZ project, which seeks to harness technology to create more flexible, efficient, and safer urban traffic systems. The insights gained from Pilot 3B will not only inform the development of scalable solutions but also pave the way for more dynamic and responsive traffic management practices in urban areas.

Stakeholders and Systems in Pilot 3B

The success of Pilot 3B relies on collaboration between multiple stakeholders, each contributing their expertise and systems to enable a digital permit management solution. Below is an overview of the key stakeholders and their respective systems within the pilot:

City of Stockholm

The City of Stockholm serves as the municipal authority responsible for managing traffic regulations and issuing permits. Its digital permit handling system integrates:

- ***Utfärdaren*:** A diary system used to register applications, issue permits, and document decisions.
- ***Utforskaren*:** A geospatial database that provides detailed information, including local traffic regulations, road restrictions, and infrastructure data.
- **Digital Integration:** The city's system communicates permit conditions via a machine-readable format to Technolution's conversion module, enabling real-time updates through the EU DATEX II standard.

Technolution

Technolution developed two elements in Pilot 3B:

- The **Digital Integration** solution with the city of Stockholm, that converts the city's permit into a standardized, DATEX II-based message – as described above.
- The central **Data Exchange Node**, which serves as a data broker for sharing digital permits between stakeholders. This system ensures:
    - Standardized data formats for interoperability across platforms and stakeholders.
    - Secure transmission of digital permits and associated geospatial data to transport operators.

Scania

Scania contributes through its fleet management platform, which enables:

- Real-time reception of digital permit conditions from the central data exchange.
- Display of conditions to drivers via an integrated dashboard or mobile devices.
- Simulation tools for testing system functionality during development.

Drivers and Transport Operators

The primary users of the system, drivers and transport operators, interact with:

- **Digital Interfaces:** Devices displaying exemption conditions in real time, such as speed limits and route-specific instructions.
- **Compliance Tools:** Features that guide drivers to follow conditions, reducing errors and ensuring safety.

Law Enforcement and Oversight Agencies

Though not directly integrated into the pilot, law enforcement agencies benefit from improved compliance monitoring. Digital permits simplify inspections by ensuring that all required conditions are easily accessible and verifiable. Especially in a future where the police can digitally validate a digital dispensation with the municipality.

Purpose and Goals

The main objective of Pilot 3B is to improve the efficiency of communicating requirements and conditions for traffic exemptions. By adopting a digital solution, the project aims to enable clearer communication between municipal authorities, transport operators, and drivers. This approach simplifies compliance and enhances the overall permit handling process.

The pilot focuses on creating a system where exemption conditions are presented in a clear, accessible, and real-time manner. This is expected to reduce driver stress, improve adherence to exemption terms, and provide municipalities with greater flexibility to manage urban traffic dynamically.

Secondary goals:

- Enhance drivers' understanding of permit requirements through better communication and assistance.
- Reduce emissions and road wear by enabling optimized transport routes and schedules.
- Increase knowledge among stakeholders, including municipalities, transport operators, and OEMs, regarding the technical and operational requirements of digital permit systems.
- Foster improved enforcement and dialogue between municipalities and law enforcement agencies.

This pilot contributes to the broader vision of the SUTZ project, supporting the adoption of dynamic and digital traffic management practices that can scale to meet the challenges of modern urban environments.

Method

General evaluation methodology

The evaluation methodology used in Smarta Urbana Trafikzoner was created based on the FESTA methodology (Barnard et al. 2016) for field operational testing (FOT) of connected and autonomous vehicles. It was adapted to the needs of the pilot studies that are proposed in this project. The general structure of the evaluation plan is presented in figure 1.

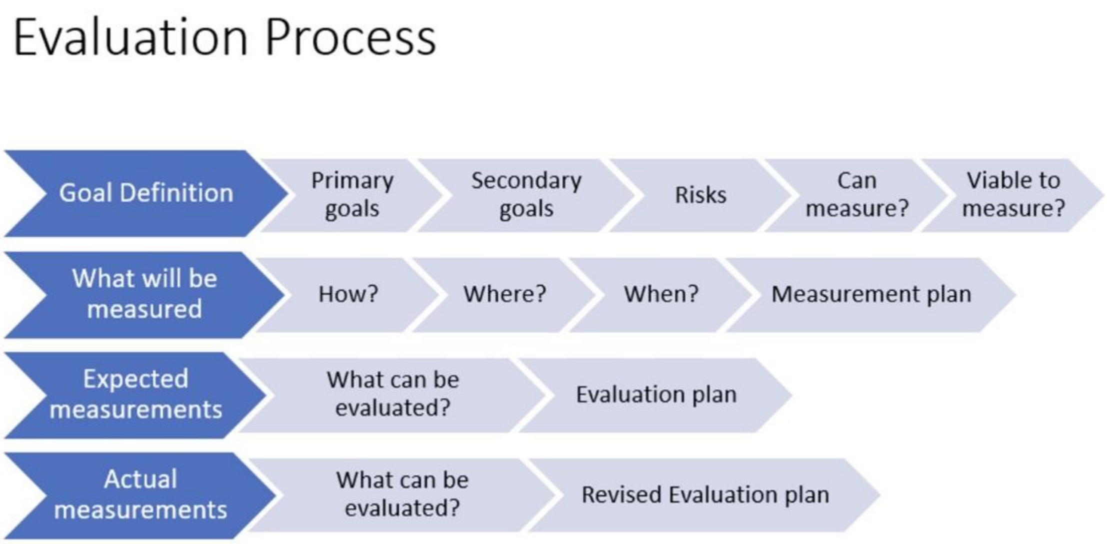


Figure 1, General evaluation methodology

The flow of activities starts at the top left and flows to the right and down, row by row. Each pilot has first explicitly defined the goals, split in primary goals and secondary goals that the pilot aims to achieve, as well as risks and potential negative effects. Then for each of the defined goals, the pilots have defined if these can be measured, estimated or otherwise assessed. In the third step, for each pilot the viability of these measurements (due to budget, equipment, other factors) is assessed.

This leads to a set of measurements (in the broadest sense, it includes interviews etc as well), that will be measured. For these measurements each pilot creates a measurement plan that defines how, where and when these will measured, which partner is responsible and identifies operational risks and mitigations.
In the third phase (third row) the evaluating partners will define what can be evaluated based on the measurement plan, resulting in an initial evaluation plan.

Finally, based on which measurements were actually collected (due to external factors this may be a subset of what was planned), a revised evaluation plan is produced. Each pilot adapted this general methodology to their specific needs.

The methodology for Pilot 3B was designed to systematically develop and evaluate a digital permit management system. The approach involved structured steps to address the challenges of existing manual processes and demonstrate the benefits of digital solutions. These steps are outlined below.

Pilot Description and Measurement Plan

The pilot was conducted to test and evaluate the effectiveness of a digital solution for managing traffic exemptions. A detailed Measurement Plan was developed to define the goals, key questions, and evaluation metrics. This plan connected the objectives of the pilot to measurable outcomes, ensuring that the results could be effectively analyzed.

Measurement Plan

Primary goal:

- More efficient communication of requirements and terms when granting permits. I.e., the city's ability (such as increased knowledge) to enable digital permits has increased.

Secondary goals:

- Better control of the entire permit process for different stakeholders:
    - The information about the permit becomes clearer for the driver. Less stress for the driver due to more assistance (both automatic control and information).
    - Increased knowledge in the process of applying for permits for transport companies.
    - Increased knowledge in the requirements for this type of system architecture and data sharing protocols.
    - Increased knowledge for OEMs and fleet management providers in what is required in terms of technical development.
- Better usage of existing road network:
    - Fewer kilometers are driven by concrete trucks due to increased load in their tanks.
    - Decreased emission rates due to fewer kilometers driven (if scaled up).
    - Cost savings for the city due to fewer vehicles and better compliance which leads to less wear and tear of the road infrastructure (if scaled up).
- More efficient enforcement and dialogue with the police.

Risks:

- More wear and tear of the road infrastructure due to heavier transports.
- Drivers lose their sense of freedom (feel controlled).
- A prerequisite for the possibility of allowing higher gross weights, i.e., higher payloads than currently permitted through digital permits, is that the applicable legislation is amended to make this possible.

Work Steps

1. **Data Sensitivity Analysis:** Ensured compliance with GDPR and established data-sharing agreements between stakeholders.
2. **Requirements Definition:** Identified the needs of municipal authorities, transport operators, and drivers to guide system design. This process also included interviews (conducted by VTI, see Appendix 3) with drivers and city authority.
3. **System Development:** Technical development of the digital systems, including integration of the digital permit management system with existing municipal processes and fleet management platforms.
4. **Testing and Validation:** Conducted iterative tests to refine the system and ensure functionality across different use cases.
5. **Simulated Full-Loop Testing:** Simulated full-loop scenarios to evaluate the interaction between system components, including the permit management system, the fleet management integration, and the driver interface.
6. **Evaluation:** Evaluation of pilot outcomes using metrics outlined in the Measurement Plan, focusing on system performance, user experience, and feasibility for scaling the solution.

Implementation Details (Key Questions Explored)

The development and implementation process also addressed several critical questions:

- **Standardized Formats:** Which data formats should be used to ensure compatibility? DATEX II emerged as a likely standard, but further investigation and validation were necessary.
- **Feedback Mechanism:** Could a feedback loop be established to allow transporters to share valuable data with the city? Such data could enable the road authority to support law enforcement in acting as an enforcement authority for transport permits, provided legal requirements are met.
- **Driver-Centric Requirements:** What information should be displayed to drivers, and when? For instance, should permit details be provided during vehicle loading or in real time during transit?

Technical Description

The technical implementation of Pilot 3B focused on creating an integrated digital solution for managing traffic exemptions. This chapter describes the system architecture, key technical components, and how these elements interact to enable seamless communication between stakeholders. More information about the system architecture as well as the development process in general can be found in Appendix 1.

System Architecture

The digital system is built on a centralized data exchange hub developed by Technolution. This hub enables:

- The conversion of traditional permit documents into machine-readable formats compliant with the EU DATEX II standard.
- Real-time data exchange between the City of Stockholm, transport operators, and vehicle systems.

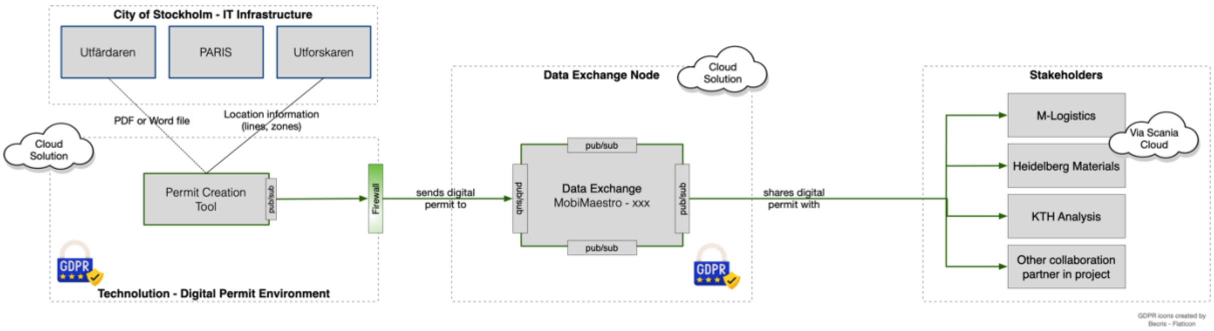


Figure 1: System architecture diagram illustrating the integration of digital permit management between the City of Stockholm, the data exchange hub, and fleet management system.

Key Features

1. **Digital Permit Creation:** The City of Stockholm generates input for digital permits using its *Utfärdaren* system, with geospatial data extracted from *LV-Utforskaren*. Technolution's Permit Creation Tool creates the DATEX II message including the geospatial information.
2. **Geofencing Integration:** Geofencing technology communicates permit conditions, such as speed restrictions and route requirements, to vehicles within designated areas.
3. **Driver Interface:** Permit conditions are displayed to drivers via Scania's fleet management interface or external mobile devices, ensuring clear communication of requirements.

Figure 2: Example of a driver's interface displaying permit details, including speed limits and route-specific instructions.

4. **Dynamic Updates:** Real-time updates enable immediate communication of changes to permits, enhancing compliance and reducing manual intervention.

Analysis

The analysis examines how the pilot's results align with the objectives outlined in the measurement plan and evaluates the system's overall impact on stakeholders and urban traffic management.

The results of Pilot 3B demonstrate that the transition from manual to digital permit management can address several key challenges, including inefficient communication of permit conditions, difficulties in compliance, and limited data sharing among stakeholders. The analysis focuses on the measurable outcomes of the pilot and their implications for future implementation.

Benefits for Stakeholders

The pilot produced a range of benefits for governmental and other stakeholders, as observed during implementation:

- **Municipal Authorities:** An increased digitalization leads to a more efficient approach to permit management. By integrating the diary system with important road input data into a system for the investigator, a more efficient overview and safer handling of dispensation is provided. If you also get an automated process from the completed application form to the diary system, the administrative work can be reduced, and the investigator can focus more on the investigation. The system could also provide municipalities with valuable insights into exemption-traffic flow and compliance trends.

- **Transport Operators:** Operators and drivers benefit from real-time access to clear and accurate permit conditions. This reduces delays and errors in operations and improves compliance with traffic regulations and conditions in the exemption. Feedback indicated that a user-friendly system design makes it easier for drivers to adapt to changing conditions. The real-time updates provided by the system ensure that drivers receive accurate and context-sensitive information. This minimizes confusion and supports better compliance with permit conditions.
- **Law Enforcement:** Although not directly integrated during the pilot, law enforcement agencies recognized the potential of digital permits for simplifying roadside inspections. The ability to access machine-readable permits could streamline enforcement processes and enhance compliance monitoring.
- **Citizens and Urban Environments:** Indirectly, citizens benefit from safer roads and reduced traffic disruptions due to improved adherence to permit conditions. The potential for reduced infrastructure wear was also noted as a long-term advantage of optimized routing and compliance.

This comprehensive set of benefits highlights the broad applicability of the digital system across various stakeholders, underlining its scalability and potential for long-term adoption.

Primary and Secondary Goals in Relation to the Measurement Plan

The following sections detail the impact of the pilot on primary and secondary goals, as outlined in the measurement plan.

Primary Goal: Improved Communication

One of the primary objectives of the pilot was to improve the communication of permit conditions to transport operators and drivers. The introduction of digital permits, accessible in real-time through geofencing and fleet management systems, significantly enhances clarity. Drivers highlighted a potential for fewer misunderstandings and a greater ability to comply with conditions, particularly in complex urban environments.

Secondary Goals:

1. **Enhancing Driver Understanding:** The system reinforces the driver’s understanding of the various conditions in a dispensation and the importance of following them.
2. **Reduction in Road Wear:** Quantitative data on infrastructure impact has not been collected as part of this pilot study. However, it is possible that route optimization facilitated by digital permits could contribute to reduced road wear over time. This potential outcome aligns with the expected benefits outlined in the measurement plan, though further research would be required to validate this assumption.
3. **Knowledge Transfer:** The pilot fostered collaboration and knowledge sharing among stakeholders, including municipalities, transport operators, and

technology providers. Workshops and feedback sessions during the pilot facilitated a better understanding of the technical and operational requirements for scaling digital permit systems.

Information Classification

Each municipality is responsible for assessing the need for information classification. The City of Stockholm reviewed the implementation of the pilot, including the scope of information and personal data involved. Based on this review, it was determined that information classification is not required at this stage. However, if a permanent solution is developed in the future, conducting an information classification will be essential.

The review considered the types of information involved in the pilot project and whether any personal data is processed. The information includes:

- Diary number
- Validity date, including time of day
- Registration number (applicable to both individuals and businesses)
- A description of the exemption details, such as permitted driving conditions, speed limits, routes, weight, axle load, and other specific restrictions (e.g., conditions allowing the operation of an overweight vehicle under specified limitations).

Since the pilot involves only 1-2 vehicles, no issues related to registration numbers or personal data have been identified. The potential need for the traffic office to collect information was also examined. As the traffic office does not function as a regulatory authority, there is no requirement for such data collection. Furthermore, the current solution does not enable retrospective verification of compliance by applicants granted exemptions.

The absence of personal data within the pilot is the primary reason for concluding that information classification is unnecessary at this stage.

Scaling and Policy

Scaling the Digital Solution

The results of Pilot 3B indicate that the digital permit management system is scalable across multiple jurisdictions and use cases. Key enablers for scaling include the use of standardized data formats, such as the EU DATEX II standard, and the modular design of the system architecture. There are many opportunities to spread experiences from the new policy and changed conditions for digital communication conditions in an exemption between the municipality and the vehicle. There are good opportunities to spread the IT solution around communication of regulations and exemptions, etc., to use on local traffic regulations. Both to maintain compliance with local traffic regulations and to ensure more effective communication of exemptions to local traffic regulations, such as exemptions to environmental zones and night bans for heavy vehicles. Businesses within and outside the city, as well as to other interested municipalities, industry organizations and the police can gain from more user-friendly exemption handling, which can lead to better rule compliance and the possibility to work with more dynamic exceptions and local traffic rules in the future.

Lessons learned from the pilot highlight the importance of stakeholder engagement in scaling efforts. Early involvement of transport operators, law enforcement, and municipalities ensures that the system meets diverse user needs while addressing potential challenges.

Policy Recommendations

1. **Regulatory Alignment:** Regulatory frameworks must evolve to support the use of digital permits and geofencing technologies. This includes clarifying legal responsibilities for data sharing and compliance monitoring.
2. **Data Protection and Privacy:** Data protection remains a critical concern for stakeholders. Future implementations must prioritize compliance with GDPR and establish clear guidelines for data storage, sharing, and use.
3. **Infrastructure Investment:** Scaling the system requires investments in IT infrastructure, particularly at the municipal level. Funding mechanisms should be explored to support these upgrades.
4. **Enforcement Enhancements:** Automated enforcement tools, integrated with digital permit systems, can further improve compliance rates and reduce manual oversight requirements, assuming legislation is changed to allow this.

Conclusions and Future Outlook

Pilot 3B demonstrates the feasibility and potential of digital solutions to address long-standing challenges in urban traffic management. The pilot's success underscores the transformative impact of transitioning from manual to digital systems, with measurable benefits for all stakeholders.

Key Takeaways

1. **Digital Transformation:** Digital permit systems improve efficiency, compliance, and safety by providing real-time, context-sensitive information to users.
2. **Scalability:** The system's reliance on standardized data formats and modular design makes it adaptable to diverse urban and regional contexts.
3. **Future Development:** Enhancements such as integrating monitoring of adherence of local traffic regulations and communication of a desired behavior. (For instance, reminding the driver that they are entering a quit zone, or that the driver is aware that only vehicles of a certain emission class are allowed to enter a specific zone.) Expanding geofencing capabilities and developing automated enforcement mechanisms represent key areas for future growth.
4. **Stakeholder Collaboration:** Continued collaboration among municipalities, transport operators, and technology providers is essential to address challenges and optimize system performance.

Appendix 1: Further Details on Technical Description

DATEX II Standard for Urban Vehicle Access Regulations (UVAR)

DATEX II is the reference data standard in Europe for road traffic and travel information. With Version 3, DATEX II is now at the heart of connectivity, supporting the digitalization and exchange of road traffic and travel information. Next to important updates implemented for national road operators and service providers, DATEX II has broadened its focus to the domains of urban mobility, electromobility charging infrastructure, logistics, electronic traffic regulations and cooperative, connected and automated mobility. (https://datex2.eu/specifications/)

A new extension of the DATEX II standard is the support of Urban Vehicle Access Regulations (UVAR). These standards have been developed in the UVAR Box Project (https://uvarbox.eu/). Following this project and the classifications established in it, a common machine-readable format has been developed, as well as a method to implement its use. Further research could be conducted on standardized enforcement of UVARs in the EU. This report is not exhaustive and knowledge from the emerging UVAR community is welcome to enrich future work both within the UVAR Box Project and beyond.

In Pilot 3B, the technology from DATEX II and UVAR for the exchange of digital permits were combined. The information about road classes, closures, speed limits, etc. was already part of the standard. However, the pilot's needs for textual advice to drivers (e.g., "drive in the middle of the bridge") were missing and therefore was added to the DATEX II message.

The figure below shows the complete DATEX II definition of all possibilities that traffic regulation messages can contain. The specific elements can be part of the limitations a city exchanges with the driver and in the project a small set of the possibilities shown above were used.

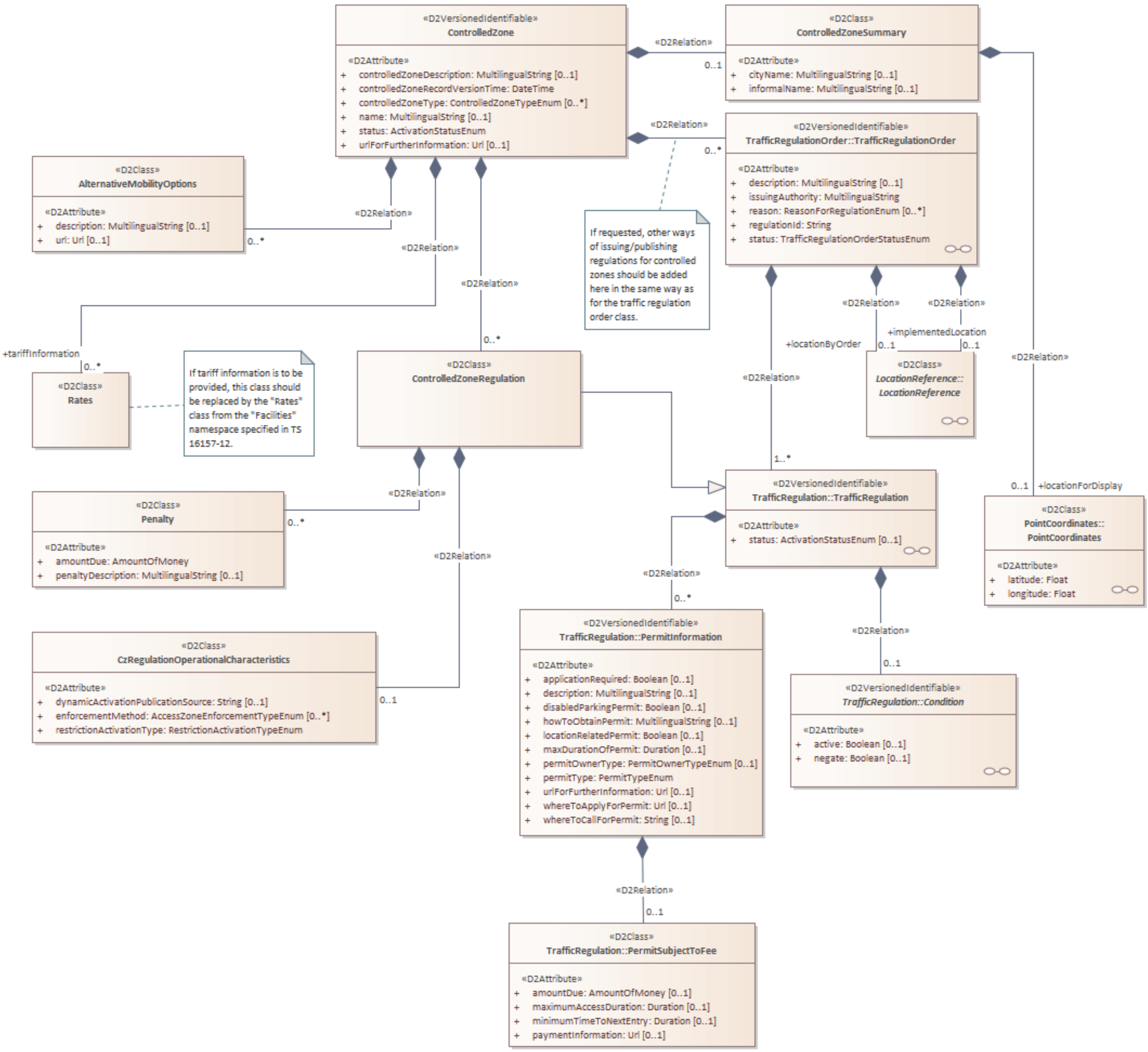


Figure 3: Standardized traffic regulation structure from EU DATEX II.

Data Exchange Process

The data exchange process between the city, the central data exchange node and Scania's fleet management system is visualized in the illustration below.

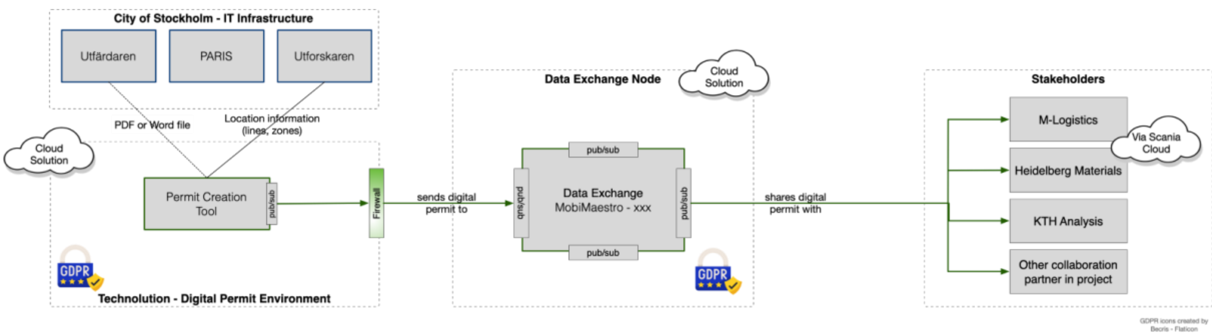


Figure 4: System Architecture.

On the left-hand side, the figure shows the city's systems where permits are created with a combination of tools, i.e., *Utfärdaren, LV-Utforskaren* and Technolution's

Permit Creator Tool. *Utfärdaren* is a diary system where applications are registered and filed. The decision document is also created there. The *LV Utforskaren* is a database that gathers, among other things, local traffic regulations as well as other infrastructure. From the *LV Utforskaren*, geodata for the various routes that a permitted transport will travel can be extracted.

Normally this process results in a formal PDF file. However, in Pilot 3B, the *Permit Creator Tool* was added, where the digital information was embodied into a machine-readable version using the EU DATEX II standard. This process encompasses the geographical information, geofences, driver advice messages, and permit restrictions.

In the middle (see the illustration above), the *Data Exchange Node* enables sharing the machine-readable version of the permit with the other stakeholders, i.e. Scania as receiving user of the digital permit. This central *Data Exchange Node* ensures that more users can join without creating additional connections to the city.

On Scania's side, the permits are fetched from Technolution's *Data Exchange Node* via a standard, secure MQTT (Message Queuing Telemetry Transport) call, an upgrade from the method used in Smart Urban Traffic Zones 2. In the previous project, the main attention was given to how a permit automatically could adapt to the speed limit in the vehicle. Therefore, in Pilot 3B, this was considered to have been evaluated enough. Instead, the main focus for Scania was to evaluate different types of permits and see how that information could be displayed to the driver.

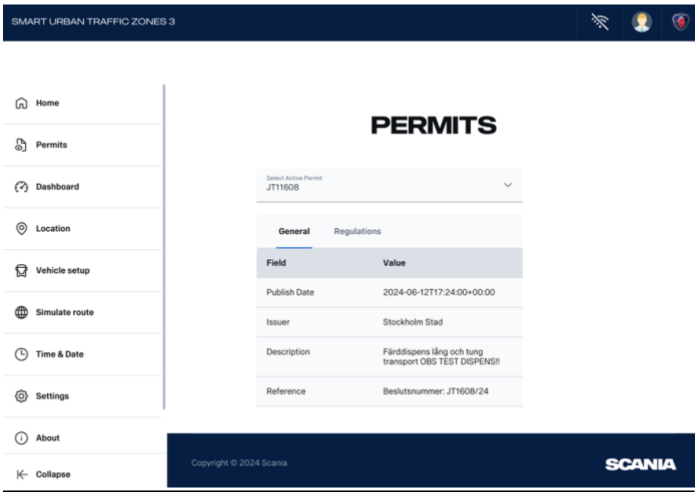
Instead of a full-scale vehicle, a dashboard logic was implemented on a website, allowing it to be used in any mobile device with Internet connectivity and positioning. This allows for easier and faster prototyping, as fewer systems with different programming languages are involved. It also makes it possible to switch between using the positioning from the device, or a simulated route. As a result, functionality can be tested from the desk, as well as demonstrated live during a presentation. This simplicity of not using a full integration in the vehicle does not remove the integration points that are important for a digital permit process on Scania's side.

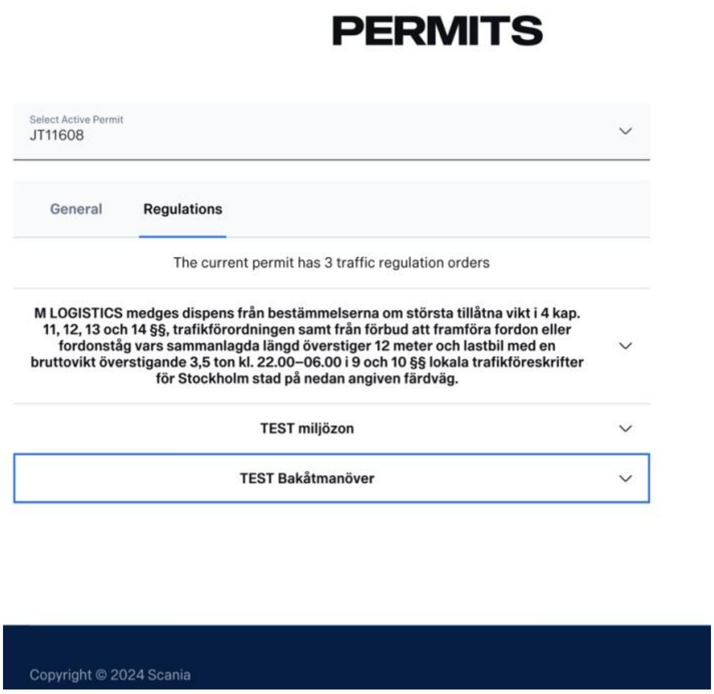
User Interface

As a first step the permit document is displayed in its entirety. This gives all the details of the permit as if it had been printed on paper. The idea is that a complete view of the permit could be useful for the driver when planning the trip. Another usage for this would be to show the control agency on the road.

The permit document's information is divided into different sections to make it more readable and user-friendly. In the project, rules for which terms and information that wanted to be provided to the vehicle at specific geolocations and times were set. When the information is split to make it readable for the system, it is necessary to determine when and where the different conditions should be displayed on the dashboard.

Below are static images with information extracted from the permit document but divided into sections. The driver can see this in their vehicle. Both the diary number and the issuer of the permit are visible, which is useful for reference when contacting the police or road authority. It is also possible to display which regulation the permit applies to, as shown in image 2. Image 3 displays a map with detailed information that the driver can plan according to.





TEST miljözon

Subject	Info	Extra
Overall validity	2024-05-03T00:00:00+00:00	2024-08-31T23:59:00+00:00
Daily	Not active between	• 06:00 - 22:00
Speed Limit	20	km/h

TEST Bakåtmanöver

Subject	Info	Extra

Appendix 2: Lessons Learned from Development

Creating the digital permits gave the following insights:

The entire exemption document contains a lot of information. An important part of the work of effectively communicating the various exemption conditions is to filter out the information considered important for the driver and that the driver should be made aware of at specific locations and times. Some of the information can be presented as pre-trip information, such as a map of the route that can be reviewed before the journey, as well as a full version of the exemption in the dashboard to show to supervisory authorities during inspections. To achieve the full potential of digital exemptions, a solution with other control mechanisms than a document should be in place, e.g., a QR code that the control instance can scan that immediately brings up all the information.

Conditions have varying quality/automation possibilities:

- It is possible to make the vehicle automatically comply to speed limits. E.g., as demonstrated in *Smarta Urbana Trafikzoner Phase 2*.
- Weight and access rights are difficult to enforce. They can basically only generate red warnings.
- Free text variants, like "Drive in the middle of the road", "Don't drive on drain covers", are difficult to interpret and present to the driver, while driving in traffic, text is difficult to read by the driver, so a kind of visual representation is often a better option. A recommendation here is to add the possibility to either

embed an icon definition or point to a web address where the pictogram could be downloaded.
- A full integration between road authorities and vehicles requires collaboration among many stakeholders, both within the municipality and with external parties. Information classification, system solutions at both the road authority and the vehicle manufacturer, as well as the transporter, need to be in place. This often requires investment in data systems

Timing:
- Times are commonly defined in UTC time.
  - This works quite good here, in defining overall start and end times.
  - For recurring periods, like between 0800 and 1800, it is difficult to use UTC. Especially due to standard time vs daylight saving time, which make the offset variable.
- Recurring periods are challenging since it is difficult to know/determine what traffic regulations are valid outside of the permit period, so nothing can be shown to the driver outside of the permit period.
  - If 50 tons is only allowed 00-06 and 19-00, what is then allowed between 06-19? <50, <40, <30?
  - For speed the problem is similar.
  - Access rights are easier as they are binary – allowed or not allowed.

Geospatial data:
- Describing roads easily creates areas that are not fully accurate to map data, as shown in the example below. Here, the orange area misses a small part of the road, just in the part where it makes a turn. This is difficult to avoid completely, because the map data used by the different participants will not always be the same. One way to improve it is by creating a slightly larger zone around the road. This does, however, create inaccuracy with other roads that are close to or cross the zone. Furthermore, tunnels are difficult to handle because vehicles today mainly use GPS data for their localization and thereby can’t really distinguish well between being in the tunnel or above.

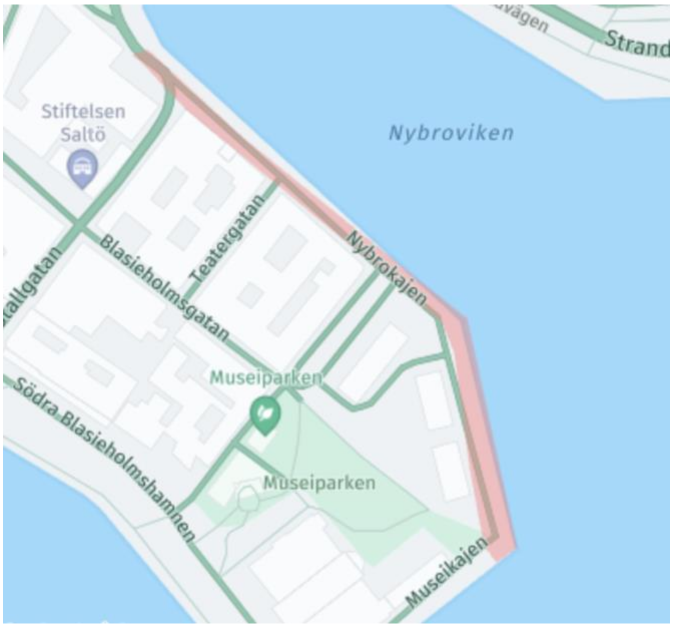


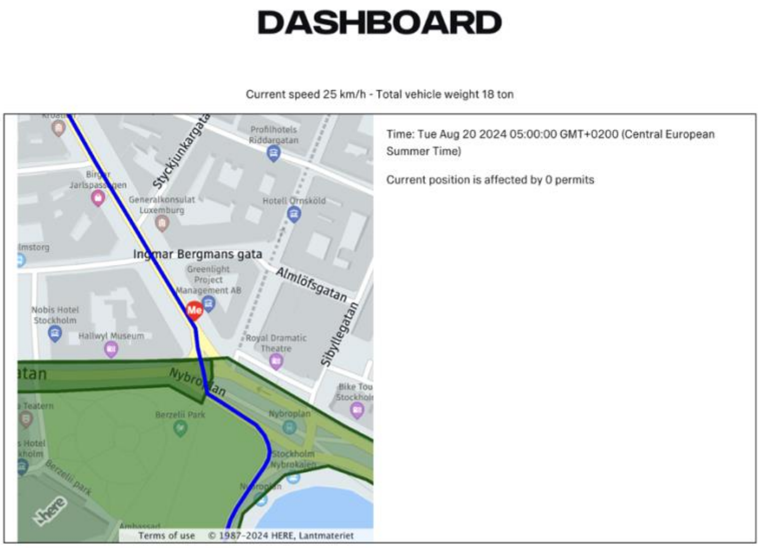
Figure 5: Inaccuracy in road representation.

User Interface

All permit information is connected to a geozone. Therefore, a map is shown with all the zones in the active permit plotted, to give the driver an overview even before entering the zone. A major advantage here is that the driver can plan their journey by viewing a pre-marked route on the map, before starting the trip. With no permit active, it will just show the current location and the route. It is often not the case that the vehicle system knows the route that the vehicle will drive.

Sometimes external applications like Google Maps or a 3rd party logistics system are used. Another case can be that the driver is aware of the route and does not need a navigation system to be active.

The figure below shows the dashboard (in the vehicle) when no permit is active.



In case permit conditions are active and fulfilled, they are shown but in black colors:

In case permit conditions are not fulfilled, the values are shown as red. With a 68-ton vehicle in the example below, the 54-ton limit is exceeded for the first permit condition, as well as the 20 km/h speed limit for the second condition. Permit condition 2 also contains free text that was difficult to convert to an icon, and therefore just printed (In English: “Drive backwards to the destination”).

Several conditions could overlap, and, in that case, it would be easier for the driver if only the most relevant value was shown, normally the lowest one. For testing purposes, it was chosen to clearly show both values. As in the example above, both 50 km/h as well as 20 km/h, both from different conditions, and in a finalized version probably only 20 km/h would have been shown to the driver.

Appendix 3: Interviews with Drivers and Permit Administrators

In Pilot 3B, the possibilities of improving construction transport through digital automated permit management are explored. The purpose of the interviews, the results of which are presented below, is to capture the views of drivers and permit administrators on how the permit process and driving with permits work today. The purpose is also to capture their opinions on increased digitalization and automation in the future.

Method

The permit administrator and five drivers with varying experience in permit transports were invited to a semi-structured group interview. Two of the drivers were unable to attend on the interview day, and therefore supplementary individual phone interviews were conducted with these two persons afterward.

The group interview, consisting of the permit administrator and the three drivers who were able to participate, was conducted in May 2024 in Stockholm and lasted approximately 90 minutes. Immediately after the group interview, an individual interview with the permit administrator was also conducted, lasting about 30 minutes. All interviews (including the two supplementary phone interviews) followed a semi-structured format where an interview guide with overarching questions and sub-questions was used as a guiding document. Two people conducted the group interview – an interviewer who led the conversation and asked the overarching questions with the sub-questions as support, and a main person responsible for taking notes of the respondents' answers. During the interview, the leader also took brief notes, and the person responsible for notes also asked some clarifying questions. The interview was also recorded with the respondents' approval.

The two supplementary individual phone interviews were conducted by the interviewer approximately two weeks after the group interview using the same interview guide as for the group interview.

Both individuals who conducted the interviews have jointly analyzed and compared notes, as well as listened to the recording to provide as accurate a representation of the respondents' opinions as possible. In the compilation of the results, the respondents' answers have been grouped into several thematic areas. These are: *experience with permit transports, biggest difficulties, work environment, current information, and future technical solutions*.

Results

Experience with Permit Transports

The four drivers have varying experience with permit transports. Two of the drivers usually handle long and wide transports (e.g., of mobile cranes) with escort vehicles where traffic may need to be stopped at specific locations such as exits. These transports require specific permits that are issued for shorter periods (e.g., two months) and apply to a specific route or construction site. One driver also drives daily, but usually with lighter vehicles (up to 32 tons) and a general permit that applies to a larger area and for a longer period (the example given is “all of Stockholm for one year”). The fourth driver states that they have only driven with a permit a few times with a concrete truck. It is either the permit administrator or the customer (the construction site) who is responsible for applying for the permits for the drivers.

Biggest Difficulties

The respondents' answers show that there are quite significant differences between general and specific permits. One problem with general permits is considered to be the large amount of information to keep track of. In contrast, a specific permit does not contain as much information, but the problem with these can instead be that you have many different permits at the same time. One driver state that they currently have eight permits and that it can sometimes be difficult to keep track of them. The permit administrator agrees that it can sometimes be difficult to manage many different permits and that it took time to find a good routine for this.

The permits are viewed as clear and easy to understand but having them in the truck in PDF format is not considered helpful during the actual driving. Rather it is seen as a security measure in case of a police check. One of the drivers expresses it like this:

> *I mean, having to stop, find somewhere to stop at all, and start flipping through those, and start searching, it becomes too cumbersome.*

Time restrictions are described as a problem. Since heavier vehicles are only allowed to drive before 9:00 AM and after 6:00 PM, vehicles and construction sites can be left idle if these times are missed. The drivers and the permit administrator also agree that a difficulty with permit transports is finding alternative routes if something unforeseen happens (external circumstances such as roadwork or an accident). Since concrete gets ruined if the truck is stationary for too long, according to one driver, there are cases where the rules are broken, and an unauthorized route is taken if the authorized route is blocked. Here, greater flexibility is desired both regarding the possibility of choosing alternative routes when needed and regarding the load-bearing classification of roads (BK). One driver believes that the road system should be improved:

> *You could say almost all areas, all suburbs around Stockholm are BK2, and then it becomes like this: why have they done that? It's something that should perhaps be reviewed to have transport routes out/.../especially for environmental reasons.*

Work Environment

The drivers largely agree that permit transports can be both more and less stressful compared to regular transports. They say that as long as they have the permit in the vehicle and are aware of all the details permit transports are usually not stressful. Two of the drivers mention that there are certain situations when they experience greater stress. For example, if they have to drive in the middle lane on a bridge and they feel they are irritating other motorists. The same applies if they are driving with a wide or long transport as it can be difficult for other motorists to pass, and they are perceived as a "road nuisance." All drivers agree that interactions with cyclists are a problem as they are difficult to spot.

They reiterate that time restrictions and limited route options are a problem and the biggest source of stress. The permit administrator mentions that from their perspective, the most stressful aspect is ensuring that all necessary permits and escort vehicles are in place on time.

Current Information

When asked if any information is currently missing in connection with permit transports, one driver highlights a problem where the permit is sometimes missing in the truck if the customer/construction site is responsible for the permit. The permit administrator agrees that this can be a problem. A clearer routine is desired to prevent this issue from happening.

Furthermore, it is emphasized that all information in the permit is considered important and that the information in the permit needs to be easy to understand. The permit administrator thinks that the Swedish Transport Administration's system for permit management, Trix, should be more user-friendly and contain clearer information. The permit administrator describes that there are "many steps and button presses" for each application, and it is easy to make mistakes. The map in Trix is also described as difficult to understand, which forces the permit administrator to use Google Maps in parallel. However, they also point out that the people at the Swedish Transport Administration are helpful when something goes wrong. One driver believes that customers sometimes refrain from applying for permits because it is perceived as complicated.

One driver also mentions that if the permit application process becomes easier, more people might apply for permits. This, in turn, could lead to being able to carry more load and reduce the number of transports, which is seen as positive for the environment:

> *If the permit application process was simplified, I also think that, from an environmental perspective, it would be beneficial.*

Positive environmental effects of fewer, but heavier, vehicles are highlighted by several drivers as an important consequence of using permits.

Future Technological Solutions

The drivers wish for a future permit system to be integrated with the vehicle's navigation. They want to see their "permit route" – allowed routes and alternative routes – on the vehicle's screen. The permit administrator agrees with this and wants to see a similar dynamic route system when planning permit applications. At the same time, there is an understanding that developing this type of system can be complicated and take time. Therefore, the drivers are positive towards the system with additional information proposed in the project pilot, which they see as a step in the right direction. They think reminders are good as it can be difficult to remember all the details in some permits. One driver says:

> *Anything that gives us more information is good.*

In general, they have a positive attitude towards more information and automation, including ISA and geofencing systems that can, among other things, limit the vehicle's speed. One driver emphasizes:

> *It should be easy to do the right thing.*

However, they also stress the importance of the driver being able to bypass these systems in certain situations. They also highlight that additional information is good so that the driver can focus on other things (e.g., surrounding traffic) rather than thinking too much about upcoming requirements along the route. At the same time, they understand it is fundamentally the driver's responsibility to comply with the permit.

Conclusions

The results above can be summarized in the following conclusions. Regarding the purpose of Pilot 3B, to explore the possibilities of improving construction transport through digital automated permit management, the respondents are positive:

- Everyone expresses a positive view of digital additional information as proposed in the Pilot. It is seen as a first step towards more complex systems that can simplify their work.
- Everyone expresses a positive view of more information and automated systems, if the systems can be bypassed in certain situations.

There is also hope that digitalization and automation can improve some of the problems experienced today. According to the results, these problems are:

- With general permits, it can be difficult to keep track of all the information.
- With specific permits, it can be difficult to manage several different permits at the same time.
- The current system with PDF/paper permits in the truck is not considered helpful during the actual driving but more as a security measure in case of a police check. Route planning must be done before driving.
- Time restrictions for certain transports are perceived as a difficulty and a source of stress because the construction site cannot start on time if the truck is stationary.
- Permits from construction sites are sometimes missing in the trucks, making it difficult to know what applies.

In the future, greater possibilities to choose alternative routes in case of unforeseen events in traffic are desired. This is believed to improve the work environment by reducing stress. They would like the permits to be integrated with the vehicle's navigation system, but there is also an awareness that this can be complex to implement. Finally, it is emphasized that a more digitalized permit process could lead to more people applying for permits. This, in turn, could have positive environmental effects as it would allow the same load to be transported using fewer vehicles.

Appendix 4: Tips for Getting Started – Implementing a Digital Permit System in Your Municipality

For municipalities looking to introduce a digital system for managing traffic exemptions and permits, it can be challenging to know where to start. Based on our experience in the Smart Urban Traffic Zones project, we have identified several key steps that can help streamline the transition from traditional permit management to a digital, integrated system.

1. Digitalize the Entire Process – From Application to Decision

A major efficiency gain comes from eliminating manual, paper-based processes and creating a fully digital workflow for permit applications, decisions, and enforcement. This includes:

- Developing an online application system where transport operators can apply for permits and track their status.
- Implementing a structured data format (such as DATEX II) for permits to enable seamless communication across platforms.
- Ensuring that permits and their conditions are available in machine-readable format, allowing integration with vehicle systems and navigation tools.

2. Strengthen Collaboration with the Supervisory Authority

For a digital permit system to be effective, it must be recognized by law enforcement and regulatory bodies. Early collaboration with the police and other oversight authorities is crucial to ensure:

- That the digital permit format is accepted by officers conducting roadside inspections.
- That there is a clear and practical way for drivers to present permits (e.g., via mobile devices, vehicle dashboards, or QR codes).
- That law enforcement has direct or indirect access to permit data for verification.

3. Address Information Classification and GDPR Compliance

Since digital permit management involves handling sensitive data, municipalities must establish clear guidelines for data storage, transmission, and access rights. Key questions to address include:

- What data can be stored, and for how long? (e.g., permit details, vehicle information, exemption conditions)
- Who has access to the data? (e.g., municipal authorities, transport operators, law enforcement)
- How is data securely transmitted between systems? (ensuring compliance with GDPR and national regulations)

Early engagement with legal experts and IT security professionals can help mitigate risks and ensure compliance before scaling the solution.

4. Enable Data Integration with Multiple Vehicle Manufacturers

For maximum impact, the digital permit system should be compatible with a range of vehicle manufacturers and fleet management platforms. This ensures that all heavy transport operators – regardless of their choice of technology – can benefit from the system. Steps to achieve this include:

- Using standardized formats for permit data (e.g., DATEX II) to facilitate broad compatibility.
- Engaging with OEMs (Original Equipment Manufacturers) early to discuss technical feasibility and integration options.
- Allowing for both direct vehicle integration and external device compatibility (e.g., tablets, mobile apps).

Final Thoughts: Start Small, Scale Up

Implementing a digital permit system does not have to be an overwhelming process. Begin with a small-scale pilot, focusing on a specific permit type or geographic area, before expanding citywide. Learn from early adopters, refine the system based on real-world feedback, and gradually build toward full digitalization.

By taking these steps, municipalities can create a more efficient, transparent, and flexible system for managing traffic exemptions – leading to smoother operations for transporters, better enforcement capabilities, and improved urban mobility.