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Analysis of use of shared data for smart parking services in Sweden

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**Paper submitted to
31st European Regional ITS Conference, Gothenburg, Sweden, June 2022**

**Title:
Analysis of use of shared data for smart parking services in Sweden**

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Abstract

The use of open and shared data in smart cities and public organizations have gained a lot of attention the last years. In Sweden, there are a number of projects looking into the use of open and shared data in the public sector. One application area of shared data is municipality driven information services on areas or streets with available parking spots. The input for this type of services are ticket machines, parking houses and spaces, and smart phone applications.

Besides different types of data and formats, the input data is usually provided by a multitude of different type of actors. Looking back, we can see that mobile phone based solutions for parking services have been used for a decade. These solutions were originally a complement to ticket machines where you did pay with cash or credit cards. Today not only the payment is digital but also the ticket handling is fully digital, the paper ticket is replaced by data records in data bases and receipts are send by be-mails or SMS. This development with digital tickets and parking sessions have enabled an emerging type of information services where car drivers can get information on the availability of free parking spaces in specific zones or streets.

However, in Sweden it turns out that these parking information services do not take off on a large scale based on a common framework and exchange of shared data. There are some examples where the municipality manages to provide a reasonably good overall picture, but currently most of these information services provide an “incomplete” map and there is no established way of cooperation between actors in the parking industry.

In this paper, we present a set of mechanisms, drivers and problems to share parking information among actors. The main research contribution is to identify patterns of cooperation among different actors and to identify main obstacles for sharing data. The analysis is based on interviews with different types of actors; mobile public and private parking operators and providers of mobile parking apps.

This work is performed within the City as a platform project financed by the Strategic innovation program “Viable cities”, a joint effort by the Swedish Innovation Agency (Vinnova), Formas and the Swedish Energy Agency

1. Introduction and background

The use of open and shared data in smart cities and public organizations have gained a lot of attention the last years. In Sweden there are a number of projects looking into the use of open and shared data in the public sector¹². Some research papers look into specific application areas like air quality measurements (Mak & Lam, 2021), data sets providing information about purchases and expenditures of the governmental sector (Apanasevic, 2021), and use of open data for innovation in Swedish municipalities (Taherifard, 2021).

Another application area where open or shared data is used is municipality driven information services on areas or streets with available parking spots. The input for this type of services are ticket machines, parking houses, parking lots, and smart phone applications (Markendahl, 2021). Besides different types of data models and formats, the data about parking services is usually provided by a multitude of different types of actors. Looking back, we can see that mobile phone based solutions for parking services have been in use for more than a decade (Markendahl & Laya, 2013). However, these solutions were originally a complement to ticket machines where you did pay with cash or credit cards. Today not only the payment is digital, also the ticket handling is fully digital. Data records are stored in databases, and parking ticket receipts sent by e-mails or SMS are replacing the paper ticket. This development with digital tickets and parking sessions have enabled new types of information services where car drivers can get information on the availability of free parking spaces in specific zones or streets.

However, in Sweden it turns out that these parking information services do not take off on a large scale based on a common framework and exchange of shared data. There are some interesting examples where the municipality manages to provide a reasonably good overall picture, but currently most of these information services provide an “incomplete” map and there is no established way of cooperation between actors in the parking industry. In this paper the mechanisms, drivers and problems to share parking information among actors is investigated. The main research contribution is to identify patterns of cooperation among different actors and to identify main obstacles for sharing data. The main research questions is:

- What main values, drivers and obstacles for sharing parking information between market actors can be identified?

In order to provide good coverage of the parking space situation in an area you need get access to data from a multitude of actors managing different types of parking spaces including; street parking and both private and public parking lots and parking houses. It may be that you technically can share parking data but there are two related questions that will be discussed:

- Will you share your data?
- Why should we share our data?

The paper is organised as follows; Section 2 contains notes on methodology and data collection and section 3 is about related work. Section 4 describes digital development and trends for parking services. Section 5 describes results and findings and section 6 includes discussion and conclusions.

¹ [Open and shared data - Smart och uppkopplad stad \(smartstad.stockholm\)](https://smartstad.stockholm.se/)

² [Datadriven Innovation Sweden | RISE](https://datadriveninnovation.se/)

2. Methodology

This research was conducted as a part of the Swedish project “City as a Platform” (CaaP) on data driven IoT solutions. The CaaP project did run 2019 to 2021 with participation of 18 Swedish municipalities and cities. Several of the project participants have launched or proposed parking information services. The basic requirements and challenges were identified during the project.

Interviewed actors

Interviews have been conducted with different types of actors in the parking industry; private and public parking operators, the municipality itself and smartphone parking application providers. Interviews were done with municipalities both within and outside the CaaP project, see table 1. In Sweden all municipalities independently procure and operate different public services. There are 290 municipalities; most of them are quite small where 160 have less than 20 000 inhabitants. Most of the municipalities interviewed have between 100 000 and 1 million inhabitants, i.e. they are quite large to be in Sweden

The municipality itself, e.g. the traffic department	Local parking companies owned by the municipality	Private parking operators and parking app providers	Other actors
Eskilstuna Karlskrona Stockholm Strömstad Sundsvall	Borås Linköping Göteborg Lund Karlstad Uppsala	AimoPark EasyPark ParkMan	SvePark (Swedish Parking Ass.)

Table 1. Interviewed actors

Interview questions and aspects discussed

The questions were about the management of parking data and various related services.

General questions to all actors:

- What services do you have and are you planning?
 - o Payments? Information about vacant/occupied places? Guidance? Booking?
- What is your view on sharing parking data? Are there any barriers?

Questions to the private actors:

- Is parking data management uniform among municipalities or not?
- Are there differences between municipal and private Parking companies?
- Do you share your parking data?

Analysis

Looking into business relations, resources and activities of the parking operators and the municipalities it was possible to identify values networks and patterns of cooperation between actors. Here the business model description by Chesbrough and Rosenbloom (2002) is used, where the value proposition supports the analysis and understanding of values and drivers for sharing of parking data.

3. Related work

In this section related work is presented in two areas; use of open data (mainly in the public sector) and parking services in an IoT and smart city context.

3.1 Open data

Open Data Ecosystems (ODE) is an emerging concept for data sharing under public licenses in software ecosystems, which is investigated in (Runesson et al, 2021). ODE has some similarities to Open Government Data (OGD), where public agencies share data for innovation and transparency. Open data ecosystems were explored involving commercial actors, a main outcome is a conceptual model of ODEs' including aspects of value and governance.

Other recent papers try to identify trends for use of open data (Sołtysik-Piorunkiewicz & Zdonek, 2021) and deal with users' engagement with open datasets (Begany & Gil-Garcia, 2021).

Socio-economic effects and the value of open data for the public sector is investigated in (Apanasevic, 2021). The paper includes a very broad literature review including grouping of both effects of open data (e.g. operational efficiency and effectiveness), as well as potential risks related to open data publishing. Here different types of risks are listed; economic, legal, technical, organizational and risk related barriers. The analysis in the paper covers; Potential efficiency gains and time savings, current cost related to work, values related to operation efficiency or to economic impact. The paper also contributes by discussing the risks, challenges, and barriers related to open data. The author concludes that the motivation of municipalities depends on: *“(i) the level of their maturity in the area of open data and (ii) existing long tradition of Swedish municipalities, which have used to a passive role in their work with public records”*.

Value creation and innovation in the public sector in Sweden is analyzed in (Taherifard, 2021).

One question is: *“Why has the Swedish municipality sector been slow to adopt open data?”*

The analysis included interviews and some seminars with discussion of previous success stories relating to open data projects in municipalities. The author argues that:

“the mechanisms behind value capture is yet unexplored and has potentially a negative impact on incentives to publicize data”.

3.2 Parking services in an IoT smart city context.

Application of IoT, AI and data mining are described in a number of research papers about parking services in smart cities. A survey paper (Aljohani, 2021) contains both a useful overview of parking services and related supporting mechanisms as well as market related solutions for shaping traffic and influencing driver behavior when looking for parking spots. A system for fully automatic data acquisition and storage of parking information is presented in (Zhao et al, 2018), a key contribution is a new traffic model that can forecast the status of urban traffic.

Another proposed smart parking system is presented in (Gupta et al, 2021) combining IoT, low-cost sensor technology, mobile payments and real-time data analytics. The collected information can be on billboards and other smart boards at junctions of the city and thereby guiding traffic. The option to present data on-line or in mobile phones is not mentioned.

An overview of different Cloud-based IoT applications and their roles in smart cities is presented in (Alam, 2021), an interesting contribution is an overview of what different actors can offer in in different verticals.

Many papers mention open data and parking in the paper title but still mostly focus on different types of methods, mechanisms or part of the intelligence in the system, e.g. predicting parking demand (Shuster & Volz, 2019) and predicting available parking slots (Badii et al, 2018), (Gao et al, 2019). The latter paper describes the use of New York City parking tickets open data, points of interest (POI) data and human mobility data.

There are several papers on Parking Guidance System (PGS) that support car drivers by recommending the most promising parking locations and routes (Liu et al 2018). (DiMartino et al, 2019), (Levin & Boyles, 2020) and (E. Dianawati and S. H. Supangkat, 2020)

To summarize, the papers mentioned above discuss general aspects and potential benefits for use of open data. Papers on parking services to a large extent present possible solutions and algorithms for estimating demand or available parking places or methods for guiding car drivers. It seems like the access to open parking data is taken for granted.

No paper is (so far) found where the motivation to share or not share parking data is discussed. Hence, this identifies a potential gap of research in the area of open data for parking services.

3.3 A note on FIWARE data models

Together with its members and partners, FIWARE Foundation drives the definition and the open source implementation of key open standards that enable the development of portable and interoperable smart solutions. The initiative supports the adoption of a reference architecture and compatible **common data models** that underpin a digital market of interoperable and replicable smart solutions.

Some of the domains are Smart cities, Smart Energy, Smart environment and Smart water. Within the Smart city domain you can find “smart data models” in areas like; Parks and Gardens, Street Lighting, Transportation, Waste Management, and Parking. Examples of data models for parking are; “On StreetParking”³, “OffStreetParking”⁴ and “Parking spot”⁵.

³ <https://fiware-datamodels.readthedocs.io/en/latest/Parking/OnStreetParking/doc/spec/index.html>

⁴ <https://fiware-datamodels.readthedocs.io/en/latest/Parking/OffStreetParking/doc/spec/index.html>

⁵ [ParkingSpot - DEPRECATED Old FIWARE DataModels \(fiware-datamodels.readthedocs.io\)](https://fiware-datamodels.readthedocs.io/en/latest/Parking/ParkingSpot/doc/spec/index.html)

4. Development and trends for parking services

4.1 From paper tickets to digital and mobile solutions

Year 2010 ticket machines and paper tickets was the main parking solution in Sweden, payments were made with cash or cards. Mobile payment solutions started to emerge, see Figure 1. One type was mobile parking subscriptions, where the end-user did make a phone call or send a sms to start and end parking sessions. The parking subscription provider registered ongoing parking sessions in a database. Users got a monthly bill for all parking sessions during the period. Another type of solution was based on SMS where parking sessions were started and ended by sending an SMS, the mobile phone bill was used for payments.

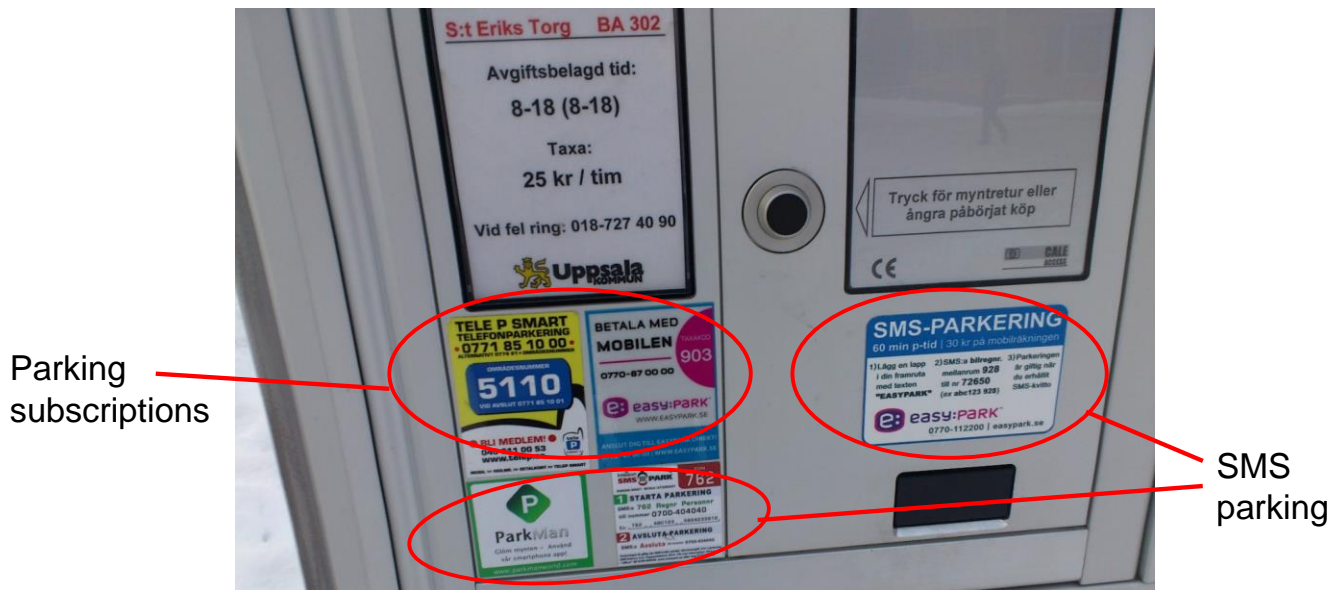


Figure 1. Ticket machine with mobile parking payment solutions, example from Uppsala 2012

For both the parking subscription and the SMS based solution the paper ticket was replaced by the “virtual” parking ticket stored in a database and linked to the registration number of the car. Hence, the parking staff could check in one or more databases if there is an ongoing parking session initiated by any parking operator or mobile app provider, see Figure 2 (left hand part).

SMS parking became more and more popular, both for end-users and for the parking operators. SMS payments offered the parking operators the opportunity to remove cash payments in the ticket machines or even to replace ticket machines with a sign with one or more SMS payment providers. In many cities you could find a multitude of co-existing SMS ticket providers, see Figure 2 (right hand part).

Ticket machines now make use of digital ticket in the sense that the paper ticket is replaced by a data record is stored in a database. When you buy a parking ticket in a ticket machine you need to input the registration number of the car. You can get a receipt of the payment by SMS or mail. In Sweden there are multiple providers for managing the data bases of ongoing parking sessions, examples are ParkRight and Octavius. Hence, mobile parking app providers and parking operators have agreements with these data base providers.

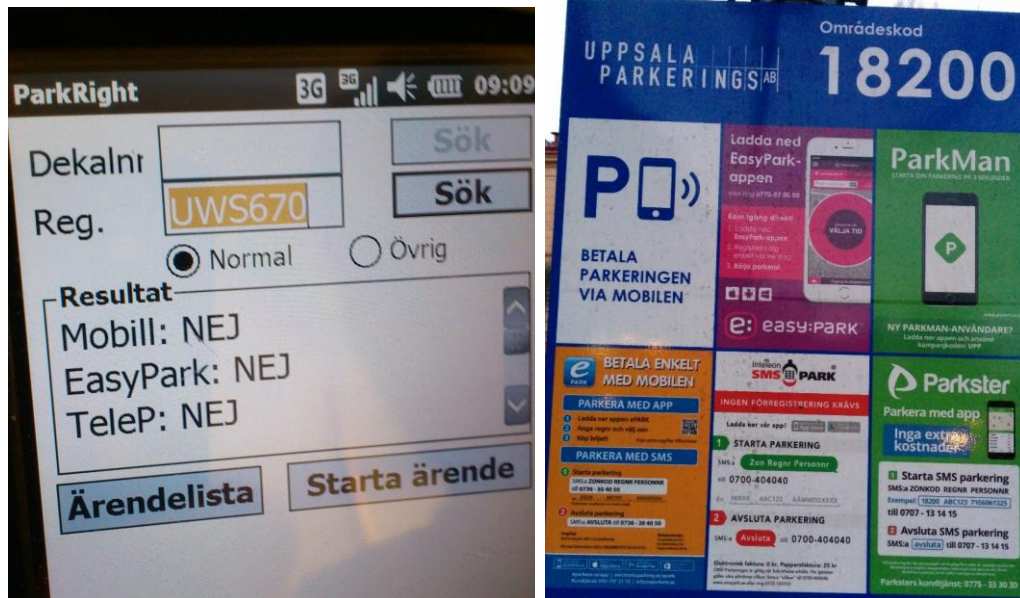


Figure 2. Mobile phone parking ticket solutions. User interface for parking control staff checking parking ticket in a database, example from Linköping 2013 (to the left). A multitude of different SMS based solutions, example from Uppsala 2017 (to the right)

4.2 The ecosystem, involved actors and data exchange

The ecosystem for the parking business now include a number of different types of actors, which have agreements with each other. The actors collaborate in order to support three main areas of activities; ticket issue and handling, payments and control of parking tickets/payments. Note that for mobile apps the end-user needs to have agreements with a payment and app provider, but not with the parking operator itself.

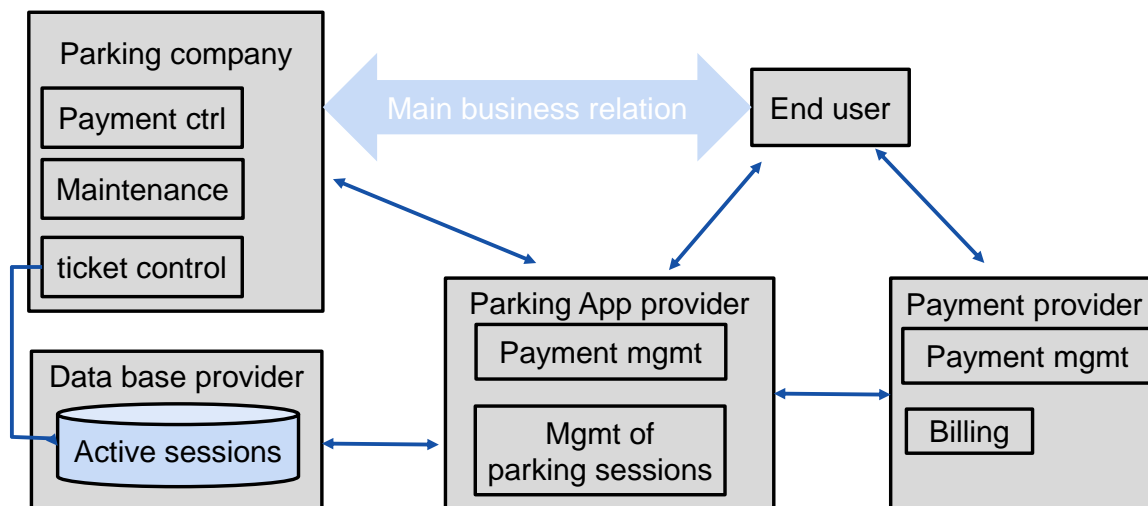


Figure 3. Business relations and data exchange between different types of parking actors.

5. Results and findings

In this section, the results and findings are summarised. The main finding is that there currently in Sweden does not exist any standardized and commonly agreed solution for sharing of parking data. The first subsection includes results from the interviews illustrating different reasons for sharing - and not. In the second subsection, observations are grouped into different typical cases.

5.1 Statements from the interviews

Here are some quotes from representatives of private parking companies and operators:

- We do not see any end user value with parking information services, as car driver you can always find a parking spot
- If the municipality/public parking operator require shared data then we will agree
- Some of our customers (parking houses) do not want us to share data, in some cases they do not want to reveal the status of their parking areas
- Some of customers are shopping malls, they do not see any point in providing information, “our customers come here in order to shop, not to park”

Public parking companies have provided these comments or answers

- Some of the private parking companies in our town do not want to share data
- Some of the private parking companies does not see any need or value of providing parking information and “to market” their offer
- Some providers of mobile apps claim that they cannot or do not want to share parking data
- Mobile app provider X told us that sharing of parking data is not included in the current agreement
- For us it was no problem to get parking data from the mobile app providers, we just did include it as a condition in the procurement
- We get parking data from the mobile app providers in “almost” real time,
- In Stockholm we have an own parking app called BetalaP
- Visitors in Stockholm can use their EasyPark app, Easpark so to say “buys” a parking ticket from Betala P
- Data from different source and technical systems with different data formats is not seen as a problem, when need we introduce data translators
- The municipality can offer city wide find park services because we have access to all parking data from all app providers
- We do not ourselves offer “find and park” services but the app provider Y can offer this in our city
- “Find and park” can be offered by app providers in the areas of our city where they are active and can use their own data

5.2 Different cases on how to share and use parking data

The main finding from the collected data is there is no common and agreed solution on how to share parking data in Sweden year 2020. However, we can find a large number of examples of how different actors share data on busy and available parking spots. In this sub section, the different cases of sharing of data on available parking spaces are presented. The Input from ten different cities/towns is grouped into five typical cases. Illustrations of cases, maps and presentation of mobile phone interfaces are found in appendix A.

Type Alpha

In some towns, the municipality and/or the local parking company tries to collect and present information on available and/or busy parking spaces to car drivers. Parking data from the resources that the municipality control itself; e.g. ticket machines, own parking houses and parking lots or own smartphone parking applications are not a problem. However, some providers of mobile parking ticket solution do not agree to share their data on street data. The reasons can be that “it is not possible”, “we can do it, but it is difficult and/or costly” or “it is not included in the agreement with the parking company”.

Type Beta

In one town the availability of free parking spaces for almost all public and private parking houses are shown in one single map. Private parking operators initially had some concerns on costs for collecting and presentation of the parking data. However, when the municipality agreed to cover the investments then there was no longer any problem. In this town only information on parking houses is available, no information of street parking is available. Compared to case A the issue of street parking and sharing of mobile application data is not considered.

Type Delta.

In other cities/towns there is a large variation in what kind of parking data that can be found for car drivers. Information for most public parking houses and some private parking houses are available. Some private parking operators are positive about sharing data and see the benefits in terms of marketing, but still some private parking operators hesitate to share their data. For some streets the parking data is collected and presented.

Type Gamma.

In these cases data from all(most) possible data sources can be aggregated and presented in order to show a picture of available parking lots in all or most of the areas of the municipality. Data is collected and combined from ticket machines, mobile parking app providers, private and public parking houses. The high “coverage” of data is usually achieved by putting requirements on different providers during the procurement process. Successful examples of this strategy are the parking companies in Borås and Linköping.

Type Epsilon.

In this case, the municipality is in control of the parking services, but one or more mobile application providers are involved. The coverage of the mobile app can high/good or “spotty”, all depending on in what areas the app provider is allowed to act. Reasons for allowing one or more mobile app providers can be that the providers are “national”, i.e. it may be that the car driver already is a customer of a specific mobile provider.

In Stockholm there is a local public parking app called BetalaP (“pay_your_parking”). In the case that the car driver has the app “EasyPark” you can make use of this app in Stockholm. Using EasyPark you can “buy” a parking ticket from the local app BetalaP.

For information on available parking spaces at streets, Easypark offers a service at the locations and in the zones where they have an agreement with the local parking operator. In many cases this information can be quite spotty, e.g. see illustration in appendix A for the case of Uppsala.

The multitude of cases on how parking actors can share parking data is summarized in table 2 below. The main reasons for the different solutions in different municipalities seem to be:

- Different willingness of private companies to share data
- Differences in conditions in the agreements between the municipality and private actors

Case	Data from streets	Data from public parking areas	Data from private Parking areas
Type Alpha	No	Yes	Some
Type Beta	No	Yes	Yes
Type Delta	Yes	Yes	Some
Type Gamma	Yes	Yes	Yes
Type Epsilon	Some	No	No

Table 2. Different typical cases of sharing of parking data in Swedish cities and municipalities.

6 Discussion and conclusions

The main issues discussed in this paper is about values, drivers and obstacles for sharing parking information. From the results in the previous section, we can summarize drivers and obstacles:

- If the terms and conditions state that a company need to share their data with the municipality (i.e. the customer), the company needs to agree in order to make business in this municipality. If there is a cooperation without this type of condition, the municipality has no bargaining power.
- The absence of a common standard or framework would be a hurdle, each municipality has to create and apply an own strategy
- From the interviews we can conclude that some private actors find it risky to share data, one motivation is that they do not want to reveal parking status due to business reasons

One conclusion is that there are no technical obstacles to share data, there is a fully developed ecosystem (see fig 3) and there are a number of good examples where providers of parking services share their data with the customer.

The differences in willingness to share data may be explained if you look into the different roles that different actors take. The municipalities and public parking operators usually have an overall perspective on the car traffic and situation in the entire municipality, hence it seen as a value to have an overall picture with good coverage of parking status. On the other hand, private operators may focus more on the local parking business and parking situation in a specific local area. Hence, the value proposition of different actors may be different, i.e. public actors largely may want to include parking information in service offer.

It may be that municipalities are more interested to identify and test opportunities with new technology in the form of information services. Private parking companies may be more focused on the existing parts of the parking business; ticket handling, payment and monitoring of parking areas, see figure 4. One suggestion for the future is to look more into motivation for and obstacles for sharing data and not only develop the technical aspects of sharing data.

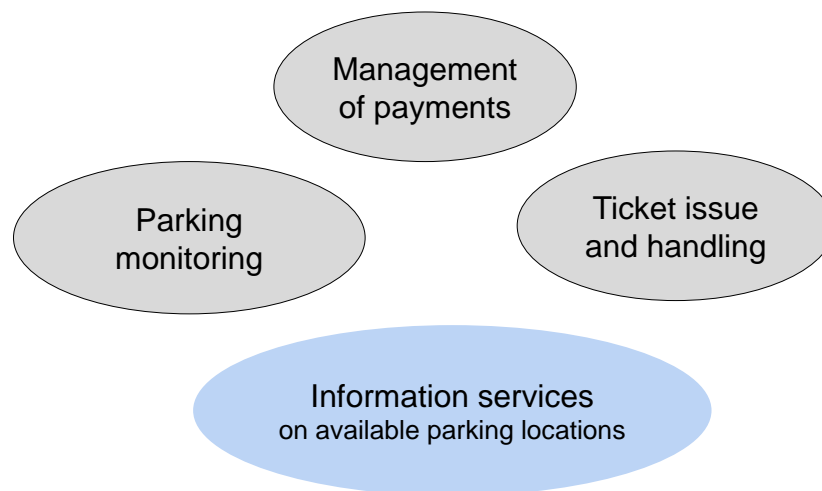


Figure 4. Different types of activities in the parking business

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Appendix A, Examples of presentation of parking data

Nu **736** lediga P-platser i centrum

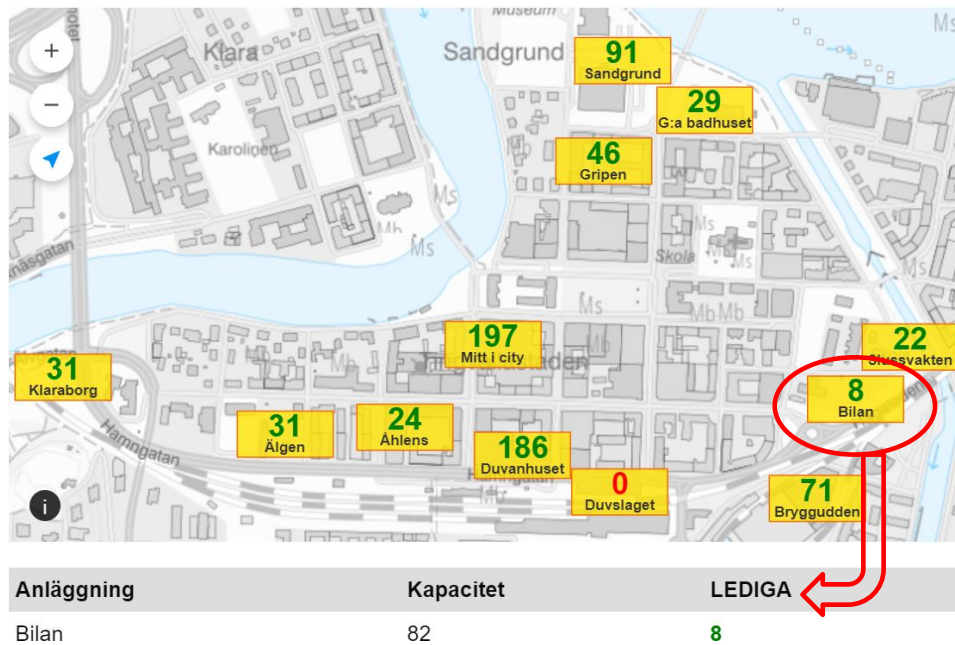


Figure 5. Example from Karlstad 2020, Information on availability in parking houses

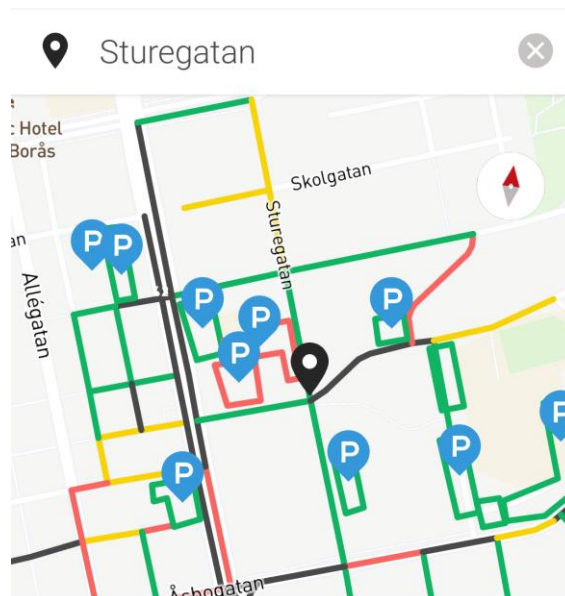
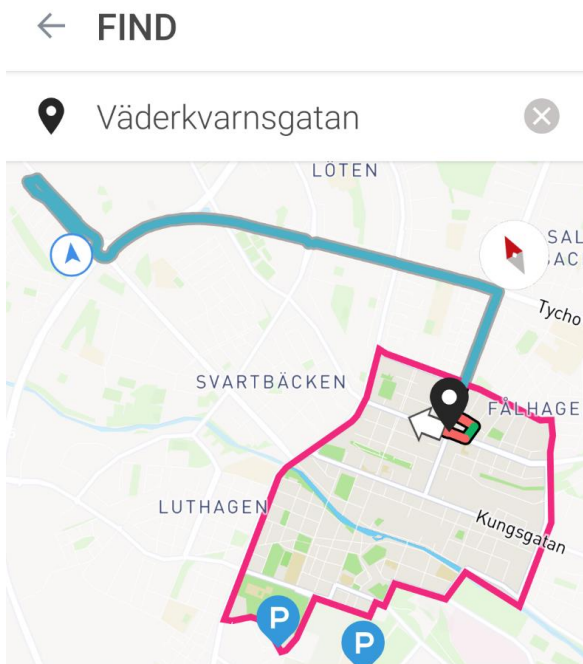


Figure 6. Example from Borås 2020, Information on street parking, colour coding



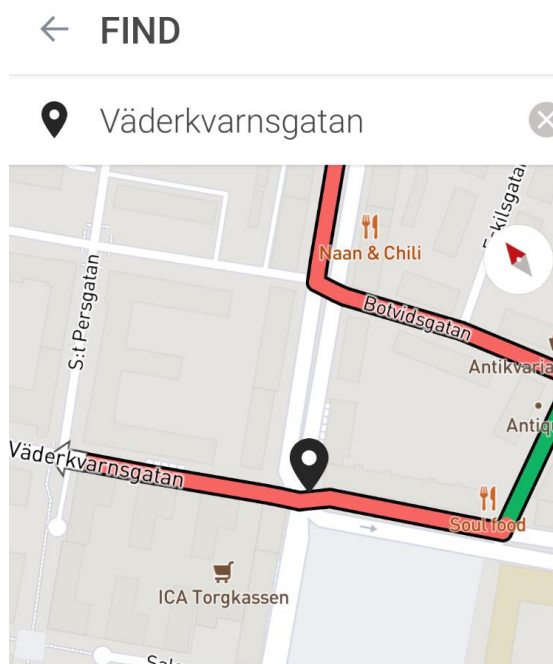
Rekommenderad rutt



Nå destinationen 9 min

Hitta parkering längs din rutt 5-8 min

Starta navigering



Rekommenderad rutt



Nå destinationen 9 min

Hitta parkering längs din rutt 5-8 min

Starta navigering

Figure 7. Example from Uppsala 2020, Information on location of streets with available parking space, and how to get there