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RESEARCH ARTICLE

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If you measure, they will come – investigating planners' views on the potential for floating bike data in cycling promotion

Felix Henriksson, Helena Strömberg and Pontus Wallgren

Department of Mechanical Engineering, Chalmers University of Technology, Gothenburg, Sweden

ABSTRACT

Interest in intelligent transport systems (ITS) has recently grown in cycling promotion due to technological developments and smartphone proliferation. This study presents interviews with planners deploying ITS and floating bike data (FBD) solutions within seven European local governments with a strong focus on increasing cycling. The aim was to increase the understanding of planners' motivations and challenges in deploying these solutions. The interviews revealed that interest in ITS is particularly focused on FBD, due to its potential to mitigate obstacles in cycling promotion. We identify two main uses: first, to optimise decision-making in planners' day-to-day work; second, to use insights from FBD to convince and collaborate with citizens and politicians. While FBD shows promise in supporting decision-making, its implementation involves significant practical and organisational challenges. Regarding the second use, FBD should be understood as one component within broader strategies for developing support for cycling. While its direct contribution depends on organisational and institutional conditions, FBD may also hold longer-term strategic value by ensuring that cycling is represented within increasingly data-driven planning and policymaking. To advance the understanding of FBD's future role, it is necessary to follow up on initiatives that utilise FBD to plan for cycling.

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Cycling; intelligent transport systems; floating bike data; data-driven decision-making; urban planning

1. Introduction

The EU's action plan for ITS describes how it should be used for the 'greening of transport' (European Commission: Directorate-General for Mobility & Transport, 2011). Active mobility, and especially cycling, is a crucial part of green, sustainable mobility, because replacing car trips with cycling leads to reduced CO_2-emissions (Buehler & Pucher, 2011). In addition, cycling can reduce congestion (Hamilton & Wichman, 2018), improve public health (De Hartog et al., 2010; Fraser & Lock, 2011) and costs society six times less compared to cars (Gössling & Choi, 2015). Therefore, it is interesting to investigate how ITS could be used to promote cycling and how it could make cycling more efficient and safer.

New technological developments, such as 5G, IoT and AI (cf. Elassy et al., 2024), along with the proliferation of smartphones and tracking apps, are creating new and improved preconditions for the implementation of ITS in cycling. One emerging ITS application relevant to cycling is floating bike data (FBD). This method involves timestamped cyclist location data, commonly tracked using GPS and similar to the more established concept of floating car data (Gillis et al., 2020). Researchers have begun exploring the potential of FBD to understand and improve cycling. They use such things as smartphone GPS data to calculate delays at intersections (Gillis et al., 2020) or bike-sharing system data to determine cyclist exposure to poor air quality (Smith et al., 2021). They also use fitness application data for a variety of purposes, including analysis of travel demand and route choice, plus infrastructure evaluation (Lee & Sener, 2021).

FBD is considered very useful in informing the decision-making of urban and transport planners to design bicycle-friendly cities and transportation networks (Lee & Sener, 2021; Romanillos et al., 2016).

CONTACT Felix Henriksson felix.henriksson@chalmers.se Department of Mechanical Engineering, Chalmers University of Technology, Gothenburg, Sweden

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Owing to better spatial and temporal coverage than is found in data gathered via more traditional methods (such as travel surveys and counting stations), FBD has the potential to ensure that infrastructure changes are placed where cyclists need them (McArthur & Hong, 2019). Compared to other types of ITS, the use of FBD also represents a type of implementation that does not rely on building intelligent solutions into the infrastructure.

Although urban and transport planners are expected to be capable of using ITS in general, and FBD in particular, to promote cycling, little is known about their capacity to do so. Most research into FBD thus far has focused on exploring its technological capacity to provide insights (see e.g. Bhowmick et al., 2025; Gillis et al., 2020; Heesch & Langdon, 2016; Strauss et al., 2017; Wang et al., 2024). To the best of the authors' knowledge, the only exception involving planners' perspectives in exploring FBD is Huber et al. (2019), who did so by exploring the experiences of German planners. Meanwhile, previous research into planners has shown that their attitude to cycling affects policy and investment, while scepticism results in merely symbolic interventions for cycling and upholds the marginalisation of cycling in cities with a low modal share (Bicalho et al., 2019). However, the research also shows that planners with a strong drive to improve cycling lack the capacity to do so. This is primarily due to budgetary constraints and political considerations, including strong car norms (Alm & Koglin, 2022). Consequently, planners play a decisive role in cycling promotion but have thus far received limited attention in FBD research. Therefore, to advance our knowledge of the potential of ITS and FBD in promoting cycling, this paper aims to investigate the motivations and challenges of planners from seven European local governments seeking to incorporate FBD into their cycling promotion work.

2. Floating bike data

There is current interest among urban planners in using FBD to facilitate bicycle planning. This is driven by the potential benefits it could bring to their work. A study by Huber et al. (2019) found that 83% of planners who had used FBD in their work deemed it important, while 66% who had not used such data also considered it important. Three significant reasons for this are: (1) the ability of FBD to provide detailed insights into cyclist route choice behaviour, (2) the technological enablement of large-scale FBD collection and (3) the substantial reduction in data collection costs compared with earlier revealed-preference approaches (Hood et al., 2011). Potential insights to be gained from FBD generally include information on distance, duration and frequency (Bhowmick et al., 2025). From a network perspective, there are also insights into route utilisation rates, speeds along transport corridors, the origins and destinations of trips (Huber et al., 2019), breaking hotspots (Strauss et al., 2017) and waiting times (Gillis et al., 2020; Huber et al., 2019). Moreover, by applying certain strategies, further insights may be gained by comparing results over time. This may be intentional, by evaluating implementations (Heesch & Langdon, 2016), or unintentional, when unexpected changes are detected (Gillis et al., 2020). Another strategy for FBD is enrichment, such as combining it with other data sources. This has the potential to deepen understanding of cyclists' behaviour and the surrounding environment (Wang et al., 2024). Furthermore, FBD can be used in modelling software to simulate cyclists' actions (Chen et al., 2018). Finally, FBD can be exploited for more than mere insights. FBD data collected in real-time can be used in traffic management systems to facilitate the flow of road users (D'Andrea & Marcelloni, 2017).

Not all GPS data is suitable for use in urban planning, and some things must be considered in order to properly collect it. One such consideration is representativity, or how well a dataset corresponds to a given sample of the population (Lißner et al., 2020). Thus, depending on the cyclists who collect FBD, their data may correspond well or not well to a given group. This can influence decisions. Representativity, while being necessary, is a challenge in the context of FBD because FBD is commonly crowdsourced (Romanillos et al., 2016). Thus, as opposed to traditional travel studies where the sample of participants is deliberately chosen to represent a population, crowdsourcing involves a self-selection step (Lißner et al., 2020). This implies that it may not be representative while also being beyond the control of the researchers conducting the study.

During the last decade, FBD has become increasingly available, and the tools to process it have become more sophisticated (Zare et al., 2022). As a result, automated tools are playing a bigger role in decision-making, and the potential to exploit data-driven methods in planning has improved. From this point, the

endeavour of using big data in policymaking is (according to Giest, 2017) a matter of *how* it can be incorporated as opposed to *whether* it can. One factor enticing the involvement of big data is achieving data-driven decision-making. This allegedly has the potential to optimise decision-making (Van Der Voort et al., 2019). However, even though data is here to stay, Giest (2017) claims that it might complicate policymaking before improving it.

In summary, there is interest among urban planners in using this data, and there are limitations and challenges to it. However, it is supposedly becoming a permanent part of the landscape. Consequently, there is an urge to increase the understanding of its use. To achieve this understanding, answers to the following questions will firstly be sought: What motivates the participating planners to start using FBD in their work? What insights are these planners interested in achieving through FBD? And what would they like to use the insights from FBD for? The answers to these questions will, secondly, be discussed upon with established sources of knowledge, to try and outline a way forward for urban planners keen on using FBD in their work.

3. Method

An interview study was conducted with municipal and provincial planners of European countries involved in a project to deploy ITS solutions to increase cycling. The first and second authors were involved in this project.

The recruitment was conducted in two rounds. First, eight participants were selected in a purposive sample based on their involvement with ITS for cycling. Seven of these agreed to be interviewed. In the second round, five more participants were selected from a snowball sample, as previously selected participants had suggested including their colleagues. The recruitment was conducted via mail by informing participants about the interview study and its purpose and asking for their participation.

The preliminary information given to participants was that the interview would focus on their projects to implement ITS for cycling. Three of the interviews were held in pairs, while seven were conducted individually. Of these, one participant was interviewed both individually and in pairs. Twelve participants were interviewed in all, encompassing diverse roles (see Table 1). They were employed by the following organisations: the province of Antwerp, the province of Overijssel, Le Havre metropole, Copenhagen municipality, Enschede municipality, Hamburg municipality and Zwolle municipality.

The interviews were semi-structured and followed an interview guide partly inspired by Alm and Koglin (2022). The questions covered participants' backgrounds, how the work was conducted within their organisations, the influence of stakeholders and plans for and expectations of working with ITS in cycling. Additionally, open-ended questions and follow-up prompts were used to encourage participants to elaborate on both positive and negative experiences.

All interviews were conducted via Teams, and all included a recording of audio and video, except for one participant who participated by audio only. The recordings were automatically transcribed in real time by Teams' built-in transcription tool and then manually corrected.

In accordance with applicable Swedish regulations, formal ethical approval was not required for this study. The participants provided verbal informed consent at the start of each meeting after being informed

Table 1. Overview of participating planners.

Participant	Role	Department
1	Project manager	Space and mobility: Team mobility
2	Project manager	Project management bureau
3	Traffic advisor	Cycling team
4	GIS analyst	Mobility
5	Team leader	Team mobility policy
6	Project leader	Team mobility policy
7	Policy advisor	Strategy and Policy: Team mobility
8	Team leader, active mobility and data	Roads, bridges and waterways
9	Team coordinator	Traffic unit: Model and data
10	Project manager	Traffic unit: Traffic signals, traffic information & ITS
11	Project manager	Urban community
12	Project manager	Urban community

about the purpose of the study, the recording procedures, the data handling, and anonymisation. Audio and video recordings were stored securely and were accessible only to the research team.

The analysis was initiated in accordance with Erlingsson and Brysiewicz (2017) description of content analysis by working bottom up, extracting quotes, condensing quotes, generating code, creating categories and creating themes. The first author conducted the initial stages of the analysis, including coding, in the browser version of Atlas.ti. As the analysis progressed and moved towards higher levels of abstraction, it was continued in Figma's digital whiteboard software, where the other authors joined to review and discuss the developing analysis. All the authors continuously discussed interpretations, categories and emerging themes, allowing alternative explanations and interpretations to be considered and challenged. Where differing interpretations emerged, the authors revisited the original interview material and discussed the evidence supporting each interpretation until a shared understanding was reached. The analytical process was iterative, involving repeated movements between interview transcripts, codes, categories and emerging themes. Throughout the analysis, interpretations were continuously revisited and refined through re-examination of the original data and discussions among the authors.

After collecting and analysing the data, preliminary findings were presented in person to seven of the interviewed participants as a form of respondent validation (cf. Lindheim, 2022). The purpose was to provide participants with an opportunity to reflect on and comment on the researchers' interpretations, thereby strengthening the credibility of the analysis. Following the presentation, the participants were invited to freely discuss the findings and provide feedback. Their discussions provided an extended view of the state of their stakeholder influence. After this discussion, the analysis was amended to include participant feedback.

3.1. Reflexivity statement

The first and second authors were involved in the ITS project through which participants were recruited. As a result, the first author, who conducted all interviews, had established professional relationships with the participants prior to the study. While this facilitated access to knowledgeable informants, it also created a risk of social-desirability bias in participants' responses and confirmation bias in data interpretation. To mitigate these risks, participants were informed that the study aimed to understand experiences and perspectives rather than evaluate individual or organisational performance, and that all reported results would be anonymised. During the interviews, the interviewer used open-ended questions and follow-up prompts to encourage participants to elaborate on both positive and negative experiences. In the analysis phase, interpretations and emerging themes were continuously discussed among all authors, allowing alternative explanations and interpretations to be considered and challenged. During this process, the third author, who was not involved in the ITS project, provided an external perspective by reviewing emerging categories and themes and challenging interpretations where alternative explanations could be supported by the data. This helped reduce the risk of project-related assumptions influencing the interpretation of the findings.

4. Findings

The interviews were initially conducted by considering ITS as a broad concept. However, during the study, it became increasingly clear that FBD was the ITS solution of most interest to participants. Because of this strong mutual interest, together with the flexibility afforded by the semi-structured interview design, the interviews and subsequent analysis came to focus on FBD. All the participants showed an equally strong interest in discussing FBD in particular. To make sure that ITS was covered in full, the core interview guide remained unchanged throughout the study, ensuring comparability across interviews, while allowing follow-up questions on FBD when participants raised the topic. The participants explored other ITS solutions, such as smart traffic lights, smart lighting and smart parking solutions, but they had more pronounced expectations as to how beneficial FBD would be in their work. One participant explained: '*We really hope that the floating bike data will succeed, so we can start using that. It's something that my colleagues have been wanting for the last 15 years or so, because it will make so many things easier*' (P10) and another confirmed: '*We strongly believe that data is the way forward and therefore we are really*

interested in how we can use data' (P5). However, participants also acknowledged that although FBD solutions have high potential, they require a lot of effort to implement.

Based on how participants spoke of FBD, we see two main desired uses for FBD in their work: *internally* and *externally*. When used *internally* for planning, insights gained from FBD would be used to support day-to-day decision-making. When used externally, participants sought to use FBD to affect stakeholders outside their organisations and to combine it with collaborative efforts. The following sections detail these two main uses and describe the practical challenges planners face in implementing FBD.

4.1. FBD as an internal tool for planning insights

Focusing on the planning insights that participants expect to generate from FBD, the most common expectation was that it would enhance their understanding of cyclists' behaviour. They anticipated that they could use such insights to optimise decision-making about which actions or improvements to make. This was driven by the need to prioritise '*the greatest impact for the next kilometres of bike network since we're limited in the number of kilometres per year*' (P8) and to increase the chances that their limited budget was used for investments that had the greatest value to cyclists: '*Our budget will be lower in the coming years and if you're doing a bike path that won't be used, it will be dramatic.*' (P12).

The participants anticipated using detailed information about individual cyclists to provide insights into, say, a cyclist's speed, acceleration and route choice, plus FBD aggregated data from multiple cyclists to provide insights into the common use of the network. This would include the use of specific roads, breaking hotspots and travel times along different routes. Using these aggregated datasets, participants were expected to understand the use of the network in terms of where people are moving to and from and what time of day these movements take place. Such data is currently perceived as lacking: '*We have basically no data on how people bike around [the city], we know the counts in certain places but we have basically no knowledge as to how they go around in [the city].*'(P10).

On a more detailed scale, participants were expected to use FBD to understand route choice, focusing on cyclists' decisions to choose one route over another. They were especially interested in knowing which requirements go into cyclists' decision-making when travelling, to better understand the effects of interventions. Participant 10 explains: '*In [the city] there's been this implementation […] we have no idea if it works. Because we don't know where people are coming to and from and how many.*' Furthermore, both the use of the network and route choice were seen as key factors in understanding and solving congestion. If these factors can be understood, there is potential to redirect cyclists and relieve congested routes.

It was also thought that FBD could generate insights through more advanced analysis. Participant 4 had positive experiences using other data and an analysis technique focused on unexpected patterns. This explored correlations in large quantities of different data or by layering datasets: '*You can see maps of [the region] with the main cycling infrastructure and all the information that's attached to it. Quality, material, colour, priority rules, crossings, anything. The accidents that we get from the police, the counts.*' Others dreamed of more far-reaching AI tools that could support their work and improve the attractiveness of cycling. However, no participants had experienced such a tool for cycling, and their ideas about it remained largely conceptual. They spoke loosely of a network for sharing tools or '*a data lake, or data space or whatever, that's big enough for us to create tools for whoever's using something.*' (P8).

4.2. FBD as an external communication and impact tool

A strong theme among all participants was a wish to do more to promote cycling but feeling hindered in that ambition by the circumstances of their work. The participants spoke of multiple interrelated obstacles affecting their ability to promote cycling. These issues are related to the work circumstances set by decision-makers at different levels of government and their prioritisation of cycling. In part, the high expectations of the participants were because they hoped to use FBD to overcome these obstacles. The following section gives an overview of the obstacles, while the one after it presents how FBD could potentially overcome them.

4.2.1. Obstacles to cycling promotion

All participants worked in municipalities or provinces with goals to increase cycling set by the local government. Notably, all but two participants were situated in areas with some of the highest modal shares of cycling in Europe. Despite this, the participants expressed discontent regarding the cycling goals. For some, the goal was not considered ambitious enough, with participant 4 stating, '*We've reached the goal already but I think—this is a personal opinion—I think the ambition should be greater.*' Participant 5 from the same municipality explained, '*The goal is to have a 50/50 modal shift, which means 50% cars and 50% alternative modes, meaning cyclists, pedestrians or public transport. That's the goal for 2030. So I think it's not… it's not that ambitious*'. For other participants, the dissatisfaction stemmed from the goals being insufficiently defined. Participant 3 said of their goal, '*Get 20% more cycling in 2030, that's the goal. That's actually specific but also fake […] you can interpret it in many different ways.*' They cited examples of either measuring cyclists crossing a point or the distance travelled, neither of which guaranteed more cycling. By contrast, another participant lacked deadlines to reach the goal, thus negating any obligation to fulfil it: '*Having an increase in cycling by about 20% to 30% in the coming years. It's not linked to any given year […], so it's quite an open policy aim for now.*' (P1).

The critique of existing cycling goals was linked to perceptions that, despite paying lip service, local governments did not truly commit to or prioritise cycling promotion actions. Their commitment to cycling was hampered by a reluctance to negatively impact the use of cars. In relation to the construction of a bike path that had risked narrowing the car lane, participant 7 explained, '*In local politics, everyone's in favour of bicycles right up till the moment you say, 'now we're against cars'. Then some of the parties say 'OK, no, we're in favour of [bi-]cycles but people should also have the freedom to choose the car*'. Some participants attributed this to the fact that decades of car-centric planning had led to cities in which citizens have difficulty imagining life without cars. And because politicians depend on votes from citizens who rely on cars, they didn't want to jeopardise their re-election by limiting cars: '*The whole mindset of the population is that cars are normal and we should drive them everywhere. It's changing now but [local government] is still unwilling to cut down on it because the politicians who made this possible still want to be reelected*' (P6). Problematically, to make cycling safer and better, participants considered it necessary to put limits on cars: '*First, the number of cars and second the speed that they're driving; these are the main risk factors and the main obstacles to convincing people to go and cycle more.*' (P4). They needed their local politicians to get on board with this, comparing their situation to cities like Amsterdam, Rotterdam and Utrecht, which they thought had made the crucial political choice to prioritise cycling, saying '*[our city] is trying to make that decision but not yet fully committed […] that's a big step.*' (P2). For others, their level of government had made the decision but still felt hindered by '*the other levels of government, the [regional], the [national], the local ones, are still very much focused mainly on cars.*' (P4).

The perceived car-centric mindset among politicians also manifested in the limited budget for investing in cycling. Participant 4 explains: '*There has to be a political willingness and, I mean, we have a certain [regional] budget for cycling infrastructure which is still much, much less than the one for cars and much less than compared to similar regions in the [country].*' All participants considered their budgets to be a limiting factor in their work: '*Our main obstacle, you have our budget, basically.*' (P1). Limited budgets hindered their work, as building physical infrastructure was considered expensive and thus limited the number, size and speed of projects. These limited budgets also increased pressure for projects to succeed and, if the top priority actions were perceived to be too expensive, caused decision-makers to view planners' lists of prioritised actions as merely suggestions.

Beyond the willingness to commit to cycling and finance it through budgets, participants also described politicians' ad hoc decision-making and its negative effect on their work. The participants remarked that politicians tend to be subjective in their decision-making and easily swayed by public opinion: '*If people living close to a project complain loudly, local politicians don't support your project anymore.' (P5).* They also described how much easier it is to get approval for reactive measures rather than proactive ones, such as after a fatal accident involving a child: '*Then, all of a sudden, there were all kinds of safety measures possible. Before [the accident], everyone said 'no, this is a thoroughfare, it's really important that we have a 50 km/h speed limit here' and now [after the accident] they're saying 'OK, there are so many schoolchildren here, maybe we should lower the speed limit'.*' (P7). These subjective and reactive tendencies negatively affected participants' plans and priorities, impairing their ability to work long-

term. Even though participants would like to counteract ad-hoc decision making, they acknowledge that complete objectivity is probably unattainable: '*A lot of decisions in the past were made based on gut feeling. And that's something I really don't think will ever totally disappear.*' (P5).

4.2.2. How FBD is perceived to overcome the obstacles

Some participating planners believed that they could use insights from FBD to address the above-mentioned obstacles of lack of commitment, limited budgets and ad-hoc decision-making and thus affect matters beyond their immediate decision-making authority. Planners expected to use FBD externally to impact stakeholders and establish stronger support for their cycling promotion. In other words, they used FBD to support their argument and convince stakeholders such as other traffic or city planners, politicians, or the public. They saw the potential for data to be used as a means to increase their say in negotiations regarding which projects to undertake: '*We can use this to convince politicians, to say, "look, here we have this potential, here we have that potential".*' (P4). Participant 5 described the power of data as follows: '*You can make it more objective and more tangible for politicians to say, "OK, it's based on data."*' (P5).

Participants had previous experience of using data to convince politicians, which strengthened their expectations of FBD: '*sometimes politicians can overrule our priority list. […] What we're seeing is that if we have good data, we always have a good story to sell to our politicians; that we really have to follow the priority list.*' (P5). The participants also brought up the potential of FBD to support the shift from cars to bikes in more general and long-term ways by having '*…a better dataset that we can feed into these strategic approaches and the political sphere. In the end, the political decisions would be based on the better dataset.*' (P10).

Another way of conducting cycling promotion externally was brought up by participants from two different organisations. This involved collaboration with citizens. The participants from one of the organisations mentioned the possibility of enabling collaboration through a digital platform, such as a phone app, as most bicycle FBD solutions rely on apps to collect their data anyway. An interesting benefit of collaboration through an app is that it can make in-person meetings redundant. Participant 4 described how they had previously collaborated with stakeholders through face-to-face events called information evenings, in which inhabitants, politicians and planners would meet. However, there was interest in exploring other collaborative formats, as the information evenings had issues: '*People who object very strongly turn up and start shouting. Politicians are very sensitive to that and only listen to the shouters. So we said no, we have to reach more of the population and there has to be, you know, a more anonymous approach or even a multi-anonymous one.*' (P4). Furthermore, participant 3 from another organisation talked about how cyclist data, including FBD, could be used in digital twins to collaborate with citizens: '*We want to collect more data and share more of it with our cyclists. […] A way to communicate with visitors by bike. […] We want to make data visible in a digital twin.*'

4.3. Challenges in the practical implementation of FBD

Amid the high expectations placed on FBD, it is important to note that only participant 7 had access to FBD at the time of the study. Their municipality had a mobile app for cyclists, with 2,000 users tracking their journeys. However, this data was not currently being used: '*We get a lot of data from this app. This can be really helpful but, at the same time, we're not using it. So if we're not using it, why are we collecting it?*' (P7). This is somewhat surprising, considering the expectations of FBD that were voiced by all participants. One explanation for this non-use was that it was difficult to access and work with the collected data. To remedy this issue, participant 7's organisation was implementing a dashboard, an analysis tool to use the collected data. This points to the conclusion that it is not only necessary to collect data but also to make it accessible to those who would use it. On the other hand, participant 7 also acknowledged the possibility of FBD turning out to be irrelevant: '*If the dashboard shows that we still aren't using the data, then maybe that's also an indicator that maybe we shouldn't value this data as highly, because we don't actually use it.*' (P7).

For other participants, who did not even have access to FBD, the challenge of finding out how it might be obtained and used in practice was even greater. The participants without current access to FBD were

looking to obtain it, either by buying it from other actors or by developing tools to gather it themselves. The way in which participants wanted to approach the use of FBD was through learning-by-doing: '*The floating bike data is an experiment we're trying. We know there's a lot of interesting stuff in there, really valuable information in there. Once we know how to use it—and that's something we need to learn—then we can apply it everywhere.*' (P4).

However, to gain that valuable information, they first needed cyclists to collect the data. The participants understood that most FBD solutions require cyclists to at least consent to share their data and, in some instances, to also choose to run an app whilst biking to collect the data. This requires effort by cyclists. Furthermore, even though the participants regarded all cycling trips to be of interest, the trips considered most important were the commutes. This category comprises a large share of daily trips, which implies major potential for positive change. However, participants expected it to be challenging to reach commuters since they do not have any evident needs which an app could satisfy: '*I think the most impact we have in bike-related policies are the commuters and in the end, the floating bike data from commuters is the hardest to get because when you commute, you don't need a routing app, which would be the easiest way to collect your data.*' (P8). Additionally, there was little guidance from existing cycling applications; participants did not know of any successful examples of commuters being reached.

Nevertheless, the participants had some plans to motivate cyclists to use apps. A common assumption was that users would be motivated by analyses of their rides, inspired by existing GPS-tracking applications designed for exercising: '*People will like to have their own statistics and know how much CO_2 they've saved and how many kilometres they've cycled in a week, or anything like that.*' (P1). Another potential motivator was to show the contribution made by cyclists' data in planning processes: '*The main thing is really convincing people, getting their data and also giving it back to them. I say "look, because of your impact there's fewer accidents now, we've improved things there, there's more bicycles now, we've improved the situation".*' (P4).

Challenging and rewarding cyclists through gamification was mentioned as a third way to potentially increase the motivation for cyclists to use data-gathering apps. It was assumed that cyclists could be willing to use an application if they were incentivised: '*if we can do some kind of gamification, if you collect 100 kilometres of data, let's say with a tracker, yeah, you get a free coffee.*' (P4). A version of this approach had been tested on a small scale in another city: '*We made this challenge, cycle a lot and if you cycle so many kilometres, you get a free pie. And that time we had 20 people and there were four who actually got rewarded with a pie.*' (P7).

The fourth strategy mentioned was to add additional services to the app, such as a service to inform about new cycling infrastructure and let people discover improvements faster. The application could also communicate with other ITS solutions to provide better trips for cyclists who use the app. Participant 3 explained how one such solution could motivate cyclists: '*We can also add the implementation of 'faster green' [at traffic lights]. So by putting more things in the app, you get faster green and then some sort of exchange. They give us their data.*'

The last challenge of FBD mentioned by the participants refers back to the overarching goal of increased cycling. One way the participants wanted to increase cycling was by making more people cycle to facilitate non-cyclists in becoming cyclists. However, as FBD can only indicate how cyclists who are tracking their journeys are using the network, and provides no data on non-cyclists, the data in the context of making more people cycle are biased. Therefore, participant 8 raised the question of FBD's abilities: '*The biggest problem is, I want to improve the bike networks for those not using the bike network at the moment […] for these by definition I don't have any data.*'

5. Discussion

This article seeks to increase the understanding of planners' motivations and the challenges of using FBD to facilitate cycling. The study noted a great interest, amongst all its participants, in pursuing some form of FBD implementation in their daily operations, despite having little previous experience. This interest appears to be driven by FBD's perceived potential to overcome obstacles to cycling promotion, both by aiding planners *internally* to facilitate day-to-day decision-making and by allowing them to *externally* impact stakeholders and establish stronger support for cycling-friendly infrastructure and initiatives. As

mentioned in the introduction, previous research has shown similar high expectations of the use of data in planning work. Huber and colleagues (2019) found that, even though less than a quarter of their respondents had used GPS data, the majority of planners considered them important for planning (83% of planners with experience of data, 66% of those without any experience). The interest in FBD is also in line with trends identified by Zare et al. (2022), towards big data and other emerging data-driven technologies in bicycle planning, and by Giest (2017) of bigger movements towards data-driven decision-making, with big data increasingly used to support policymaking.

In this study, the high expectations on FBD appear to be connected to constraints in planners' work. Planners desire data, as they perceive that it can help them optimise their decisions and investments to benefit as many cyclists as possible, thus making the most of their limited budgets. Moreover, planners desire strong justifications for their decisions and perceive data as producing stronger arguments than their planning experience and competence. Given the car-centrism that participants perceived in their cities, this appears especially crucial in convincing politicians and gaining support for investment in infrastructure that benefits cyclists. For several of the participants, the desire to justify decisions is even stronger than the need for optimisation. Alm and Koglin (2022) found that planners often knew which action would increase cycling, but that there was a lack of political will to invest. Indeed, strong political support is essential if cycling is facilitated to the detriment of cars (Wang, 2018). It therefore stands to reason that strong arguments are necessary to gain such support.

However, despite participants' expectations of FBD, there is reason to temper this view by considering the surrounding context of cycling promotion. Initially, it is advisable to approach the process of starting FBD with caution. Accordingly, this paper notes that planners seeking to begin using FBD in cycling promotion have encountered the following challenges.

Getting cyclists to collect data: Several potential ways to entice cyclists to generate FBD have been brought up by participants in this paper. However, it is not known which ones will lead to useful FBD being generated. This is a crucial challenge, because for FBD to be useful in planning, it needs to be representative, meaning that a sufficient number of cyclists with a broad spread in terms of cycling behaviours need to have generated the FBD (Lißner et al., 2020). Meanwhile, FBD may also be bought from other actors who have already tracked it. While there are several actors offering FBD, finding an appropriate one for urban planning remains an open challenge. Since most available FBD data have been collected for purposes other than urban planning, this may complicate its application in planning practice. Repurposing data requires awareness of how the original purposes affect the new one, in terms of potential and limitations (Sielemann et al., 2020). While there are multiple ways of obtaining FBD, the method through which it is generated influences its potential applications and limitations, underscoring the importance of carefully considering how it is obtained.

Increasing the number of cyclists with FBD: At this point, it remains unclear to what extent the use of FBD can contribute to increasing cycling uptake. On the one hand, there are uncertainties regarding how insights derived from FBD may affect different population groups. A particularly important group in this context is non-cyclists. Since increasing cycling uptake is a central objective of many cycling promotion efforts, it is problematic that FBD only captures information from existing cyclists and provides no direct insights into potential cyclists. While improving cycling conditions based on the preferences of current cyclists may also benefit non-cyclists, there are clear limitations to assuming that the needs of these groups are identical. In support of this concern, 2024, Pearson et al. (2023) found that the preferences of potential cyclists differ from those of existing cyclists. In this regard, there is a mismatch between the population represented in FBD and a key population that cycling interventions aim to influence.

On the other hand, the extent to which this limitation affects the usefulness of FBD may depend on the representativeness of the available datasets. So far, characteristics such as gender, age, and trip purpose have been identified as important dimensions of representativeness (Lißner et al., 2020). Ensuring adequate representation across such characteristics may therefore improve the extent to which FBD captures preferences that are relevant beyond current cyclists. However, as the research on representativeness is still evolving, the current understanding of which characteristics matter most remains incomplete (Lißner and Huber, 2025; Lißner et al., 2020). As a result, it remains uncertain which dimensions of representativeness are most important for addressing the challenge identified by Pearson et al. To fill this gap, further research is needed to determine whether representativeness in terms of currently identified

characteristics is sufficient, or whether additional factors are required to ensure that FBD-derived insights remain relevant for potential cyclists.

Providing planners with the right tools to process FBD: Having FBD is not the same as using it. This was exemplified by participant 7, whose organisation had access to FBD without working with it. The participants attributed the non-use of FBD to its being in a format in which their planners had neither the competence nor the tools to work with. This is seemingly a common issue, as Huber et al. (2019) concluded in surveying bicycle planners. They found tools and competence to be among the major challenges to using FBD. Notably, the participants also acknowledged that, even if made accessible, FBD could turn out to be of limited practical value. There is reason to consider this a valid concern. Drawing from the broader field of data-driven decision-making, Bilkštytė-Skanė and Akstinaite (2024) claim that the effectiveness of data depends on the organisational adoption of data-driven decision-making. While competencies and tools are parts of their prerequisites for adoption, they also urge the need for culture and mindset changes, as well as process and workflow improvements. However, these are prerequisites for the most effective use of data: a higher bar than merely getting started. Meanwhile, what is required to get started is not made explicit. Consequently, equipping planners with tools and competence is important, but whether it is enough to start using FBD is not entirely clear, as the matter may be influenced by the broader organisational context.

Learning by doing: The approach to using FBD: The approach to starting to use FBD, as described by participants, is learning by doing. The fact that an explorative approach has been named indicates that there is limited accessible knowledge on how local governments should start working with FBD. That being said, this does not mean that their approach is flawed. On the contrary, according to Hertzum and Simonsen (2011), explorative approaches are preferable in the context of IT developments. However, one should be aware that these are iterative processes. These can be unpredictable in terms of knowing beforehand the number of iterations and when they will be finished.

Consequently, there are considerable challenges facing planners looking to start applying FBD for cycling promotion. For internal application, this implies that FBD needs to generate insights justifying its costs by increasing planners' ability to promote cycling within their sphere of decision-making. Otherwise, if FBD ends up costing more than it provides, it would actually limit the ability to promote cycling. This is a risk that should not be taken lightly, as there are significant budgetary constraints both on cycling promotion (Alm & Koglin, 2022) and on buying FBD (Huber et al., 2019). In addition, the fact that the only participant with access to FBD was not actively using it suggests that effective application of FBD depends on more than merely having access to the data. In this case, difficulties in accessing and working with the collected data were identified as one explanation for its non-use. Although it remains unclear whether the planned dashboard will address this issue, the case points to the potential importance of aligning analytical tools with organisational capabilities and planning practices when implementing FBD, a challenge also highlighted by Nelson et al. (2021). Nevertheless, this application of FBD holds potential. Previous studies have shown that FBD can provide insights into cycling and, as found in this paper and that of Huber et al. (2019), some planners see the utility of applying these insights for cycling promotion. However, given the challenges above, there is reason to recommend that, as an approach, getting started working with FBD should be viewed as a long-term investment.

Reassessing the role of the external use of FBD: Through its external application, FBD may strengthen planners' ability to promote cycling by providing evidence that can be used in interactions with decision makers and other stakeholders outside the planning organisation. As reported in the findings, several participants had experience of using other forms of data for this purpose, suggesting that FBD may also hold potential in such contexts. However, the usefulness of FBD in building support for cycling should not be overstated. Establishing support for cycling is a collaborative process that depends on a wider system of organisational, political, and social factors (Ingeborgrud et al., 2024; Tuominen et al., 2022). Based on this, it is likely that participants who had successfully used data to influence decision makers also benefited from favourable conditions beyond the data itself. The value of FBD should therefore be understood in relation to the broader strategies and conditions within which it is applied, rather than as a stand-alone driver of change.

Participants also saw the potential to use FBD externally by interacting with citizens in digital participation platforms (DPP). This approach is increasingly practiced but its effects are still being

explored within academic research (Musiatowicz-Podbial, 2024). However, as claimed by Kleinhans and Falco (2022), the discourse on digital participation tends to focus on technology, while technology should rather be considered an element within a larger 'non-technological' process. Therefore, when applying FBD to citizen engagement, it is important to acknowledge that its role is primarily supportive, as successful citizen engagement depends on careful social craftsmanship and governance practices. Otherwise, there is a risk that technology is afforded disproportionate importance, obscuring the broader processes that ultimately shape meaningful citizen participation.

More broadly, FBD may also hold strategic value that extends beyond its immediate applications. There is reason to believe that ensuring that cycling is represented in datasets will become increasingly important as public planning and policymaking become more data-driven (Giest, 2017). As Behrendt and Sheller (2024) argue, data systems play a growing role in shaping which mobilities become visible and actionable within governance processes. From this perspective, representation in data may increasingly influence whose needs, practices, and forms of mobility are recognised and included in decision-making. Thus, the strategic value of FBD may lie not only in its immediate applications but also in ensuring that cycling remains visible within the data infrastructures that increasingly inform planning and policy.

Consequently, while FBD presents several promising opportunities for external engagement, persuasion, and strategic positioning, there is reason to be cautious about interpreting its potential in technologically deterministic terms. The findings suggest that the usefulness of FBD is contingent upon complementary structures, competencies, and institutional arrangements that enable data to be mobilised effectively. To this end, future advancements of FBD should recognise that its effectiveness will continue to depend on the broader systems and processes within which it is embedded.

As previously stated, there are strong trends towards data-driven decision-making. Accordingly, future research should, for one thing, follow up on public organisations' approaches to adopting FBD and answer the question of how this process should be carried out. Moreover, the external use of FBD should be followed up on to map the strategies and factors needed for FBD to increase urban planners' abilities to promote cycling.

Limitations of the study: Finally, it should be noted that all respondents were involved in a European project focusing on ITS, which suggests an inclination towards addressing cycling-related challenges through technological solutions, of which FBD is one example. This may have introduced a bias towards planners who were already interested in such approaches. Nevertheless, the participants' interest in FBD, despite the broader range of ITS solutions available, indicates that the technology is perceived as particularly relevant within this context. Given the previously discussed trend towards data-driven decision-making, these participants may be viewed as early adopters of a broader development in transport planning. As data-driven approaches become more widespread, it is reasonable to expect that similar considerations will become relevant to a wider range of cities, making the insights from this study potentially transferable beyond the specific contexts examined here. It is also worth noting that the municipalities and provinces represented in this study have some of the world's highest documented levels of cycling (see European Commission, 2023). If planners operating in these relatively mature cycling contexts are turning to FBD partly to overcome the barriers encountered when promoting cycling and implementing cycling infrastructure, this suggests that such barriers remain significant even in places with well-established cycling cultures. By extension, corresponding barriers in lower cycling contexts may be at least as significant, and potentially more pronounced. This may be particularly relevant given previous findings suggesting that planners in low-cycling cities may themselves need to be convinced of cycling's potential and legitimacy (Bicalho & Silva, 2019).

Another note concerning the transferability of these findings relates to the contexts in which FBD will realistically support cycling-related planning. While the participants in this study, all operating in high-cycling contexts, expected FBD to enhance their work, its applicability in cities with very low levels of cycling remains uncertain. On a basic level, lower cycling rates naturally result in less available cycling data, reducing the potential value that can be extracted from FBD. However, an even more important limitation may concern representativeness. In low-cycling contexts, cyclists are often concentrated within specific demographic groups, whereas cycling populations in high-cycling contexts tend to be more broadly representative of society (Goel et al., 2022). Meanwhile, preferences may also vary across demographic groups (Garrard et al., 2008), and as discussed previously, the preferences of non-cyclists

differ from those of active cyclists. Since assuring representativeness is important in crowdsourced data (Lißner et al., 2020), planners working with FBD must also consider issues of representativeness. Consequently, low-cycling contexts may not experience the same benefits from FBD, as the available data are more likely to reflect the preferences of a relatively narrow subset of the population, potentially leading to planning decisions that do not support cycling uptake across society as a whole.

6. Conclusion

Based on our study, we can conclude that the participating planners want to increase their capabilities to promote cycling and see FBD as a promising way to do so. If planners can measure cyclists and get the right data, they expect to gain the insights to know which investments to make and the right arguments to convince politicians to make the right decisions. Through these insights, the internal and external concepts of FBD application are introduced. However, there may be more challenges in achieving this dream scenario than they currently realise. These challenges concern the approach to starting to use FBD, such as reaching the right cyclists to get a representative sample, learning the implications of using FBD with the aim of increasing cyclists' numbers (as potential cyclists are not included in the data) and discovering the adaptations required to begin using FBD. As for applying the insights, they also need to find out how FBD could be used externally to engage stakeholders and establish support for cycling promotion.

Previous research has concluded that when up and running, FBD will be able to inform urban planners in a way that supports them in making decisions (Chen et al., 2018; Huber et al., 2019; Romanillos et al., 2016). However, reaching this point requires certain challenges to be overcome, some of which have been discussed in this paper. In the short term, planners may need to carefully consider whether the insights generated through FBD justify the investments required to acquire, manage, and use the data, particularly given the budgetary constraints surrounding cycling promotion. At the same time, the value of FBD should not be understood solely in terms of its immediate usefulness. As planning and policymaking become increasingly data-driven, ensuring that cycling is represented within relevant datasets may become strategically important for maintaining its visibility within governance processes. Consequently, the significance of FBD may lie both in its potential to support cycling promotion directly and in its longer-term contribution to ensuring that cycling remains represented within emerging data infrastructures.

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Author contributions

CRediT: **Felix Henriksson:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing; **Helena Strömberg:** Conceptualization, Funding acquisition, Methodology, Supervision, Validation, Writing – review & editing; **Pontus Wallgren:** Conceptualization, Funding acquisition, Methodology, Project administration, Supervision, Validation, Writing – review & editing.

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