Actualizing sustainable transport: the interplay between public policy instruments and shared mobility providers' business models

Kriukelyte *et al.*
European Transport Research Review (2024) 16:11
https://doi.org/10.1186/s12544-024-00634-4

European Transport Research Review

ORIGINAL PAPER

Open Access

Actualizing sustainable transport: the interplay between public policy instruments and shared mobility providers' business models

Erika Kriukelyte[1*], Jana Sochor[2] and Anna Kramers[1]

Abstract

Cities around the world are trying to understand if and how to regulate urban mobility in a way that stimulates innovation and supports business while also promoting public values and accelerating a sustainability transition. Service providers are also attempting to understand how to grow and thrive as a business as they challenge existing urban mobility structures and practices via new mobility services, new uses of public space, etc. Thus, this article seeks to understand the interplay between business models and public policies and, ultimately, the implications policy instruments have on shaping conditions for sustainable urban mobility. To address these questions, a qualitative approach is utilized, comprising case studies of two 'new mobility' service providers (Bolt and Tier) operating in three Northern European cities (Oslo, Stockholm, and Berlin) including interviews with these companies and local public actors. Findings show that the business models are influenced by legitimization on the national level, the local authorities' and service providers' approaches, and policy instruments related to the right to operate, including caps, geographic coverage, parking, geofencing, and data sharing. Utilizing business models and multi-level perspectives, the findings are discussed in relation to actualizing sustainable transport, e.g. interdependencies, goal alignment, and temporal and spatial considerations. The authors emphasize the importance of learning by doing, policy mixes (versus instruments), and purpose-driven collaboration among stakeholders.

Keywords Sustainable transport, Business model, Policy instrument, City, Mobility service, Micro-mobility, Ride-hailing, Interview

1 Introduction

The advancement of digital technologies has enabled an influx of new mobility services such as ride-hailing, car-sharing, and micro-mobility, disrupting both the automobile industry and mobility travel patterns in urban areas [1, 17]. It has been argued that these new businesses can be viewed as private actors responding to market failures, such as urban congestion and a lack of sufficient access to quality services and affordable alternatives [17]. Some hope that these new businesses represent a 'window of opportunities' (cf. [43]) and a panacea that moves society from ownership to usership and accelerates the transition to a sustainable transport system [16], particularly in light of the climate crisis and the transport sector's contributions to it (e.g. around a quarter of greenhouse gas emissions [21, 66]). Others warn that they are not living up to expectations regarding e.g., sustainability, and are instead shifting business motives towards profit, as well as shifting users towards the hyper-consumption of cheaper, more easily accessible, and less sustainable options [16, 37].

*Correspondence:
Erika Kriukelyte
erikakri@kth.se
[1] SEED, Strategic Sustainability Studies, KTH Royal Institute of Technology, Stockholm, Sweden
[2] IMS, Design and Human Factors, Chalmers University of Technology, Gothenburg, Sweden

At the same time, public authorities work to define future visions, targets, and strategies to address the climate crisis and other sustainability-related transport issues. In the European Commission´s "The New EU Urban Mobility Framework" [22], the critical role of mobility is discussed vis-à-vis social inclusion and human well-being but also the need for a fair transition towards climate neutrality with safe, accessible, inclusive, smart, resilient and zero-emission urban mobility. This transition "is to be achieved by strengthening existing tools and complementing them with new ones" [22, p.3], of which public policy is arguably one. However, the impacts and implications of new or modified policies are often unclear, particularly in the case of new, innovative technologies and services with which there is little practical experience. Therefore, in this case, policymaking serves a dual purpose as "an exercise in solving problems" but also as "an attempt to make sense of a partially comprehensible world" (Zahariadis, 2014:27 in [36, p. 246]. And while the "capacity of systems and structures of governance" [20, p. 114] may be pressed to keep pace with rapid change, the public sector must work to accelerate a sustainability transition within urban mobility. According to the EU, "A multi-level, integrated governance approach to manage urban mobility, along with other relevant sectors such as energy, is needed as part of the drive towards climate neutrality" [22, p. 17]. Supranational, national, regional, and local goals and priorities regarding urban mobility and sustainability need to be coordinated, consistent, clarified and communicated (cf. [20]), both internally for themselves and externally for other stakeholders. Furthermore, closer, purpose-driven stakeholder collaboration will be vital for finding solutions and contributing to public value through market co-creation (cf. [38]).

The study upon which this article is based has sought to explore the interplay between business models (BMs) and public policies, i.e., how the mobility service companies' BMs adapt to diverse and evolving policy conditions in different regulatory contexts, and how the public authorities' policies adapt to the fast-paced developments in the (urban) mobility service sector. It has done so in order to understand the impacts and implications policies have on creating conditions for a sustainable transport system. To address these questions, a qualitative comparative case study was conducted consisting of two companies working with digitally enabled mobility services—Bolt as a provider of ride-hailing and micro-mobility services and Tier as a micro-mobility services provider—within three policy contexts—Oslo, Stockholm, and Berlin, i.e., large Northern European cities with diverse mobility services. As both private and public actors involved in the transport sector have been affected by rapid development and changing market conditions [20], interviews with representatives from both the companies and public authorities enable the exploration of both stakeholders' perspectives on the impacts and implications of policy for business, society, and sustainability.

The aim of this article is to offer a better understanding of the interdependencies between public policies and mobility service providers' BMs and the implications for actualizing sustainable urban mobility by exploring how providers adapt their business models to evolving local policy contexts. Specifically, this study makes two contributions: (1) through empirical data, it investigates the links between firm-level actions and the wider socio-technical system approach; and (2) by providing a comparison and analysis of the different policy interventions and their impacts on BMs, it responds to a timely and urgent need for knowledge on the governance of new mobility services.

This article consists of six sections, of which this is the first. The next, second section outlines the theoretical perspectives utilized, and section three details the material and methods. Section four presents the findings by theme, while section five offers an analysis and discussion. The final section includes concluding remarks and future research needs.

2 Theoretical perspectives

The 'business model' is commonly defined as "the rationale of how an organization creates, delivers, and captures value" [4, 42, 69]. Researchers generally consider the fundamental building blocks of a business to be: (1) the value proposition, representing the key activity of the business, (2) the value creation, explaining the process of developing and delivering value, and (3) the value capture, or the revenue-cost model in use (e.g., [42, 58, 72].

In the last decade, research has attempted to combine commercial and sustainability logics through the development of the 'sustainable business model' (SBM) [33, 51, 57]. This is based on the argument that the traditional approach to BMs has led to companies acting in silos and focusing only on their economic logics, thus ignoring their interdependencies and their relationships to ecology and society [33, 35]. As Schaltegger et al. [, p. 99] claim: "51*A business case for sustainability has to be created and managed—it does not just happen*"; a position reinforced by Curtis and Mont's research [19] within the context of the sharing economy. In other words, BMs require an upfront, intentional, and deliberative design to contribute to desired impacts such as sustainability and sustainable performance [5, 19]. Furthermore, companies need to actively seek to include a wider network of stakeholders in their value creation, delivery, and capture activities with the goal of optimizing value for the whole system [5, 57], as no sustainable value can be created without the

inclusion of a broader range of stakeholders (Schaltegger et al., [50]). In this spirit, a SBM can be defined through three characteristics: (1) pro-active multi-stakeholder management, (2) monetary and beyond value creation and capture for a wide range of stakeholders, and, finally, (3) long-term perspective (Geissdoerfer et al., [29]).

Business models can play a prominent role in accelerating sustainable transitions; for example, changing production and consumption systems [13], disrupting entire industries [4, 47], or creating new industries [58]. It has been argued that active contributions from an organization can create opportunities for sustainability. However, it is also important to remember that the BM does not act in a vacuum, and the systemic context in which a BM is developed also plays a crucial role in (un)sustainability. In other words, it is necessary but not sufficient for organizations to be(come) sustainable, as the system itself can create lock-in effects that promote specific behaviors and business activities which act as barriers to achieving a sustainable transition [6]. Thus, the whole system in which organizations interact must *also* move in a sustainable direction [57] and external environments such as regulations need to be developed in a way that would hinder the functioning and thriving of unsustainable BM, for example, making them economically unsustainable (e.g., [6, 51]).

To understand this interplay between BMs and their systemic contexts, increased efforts have been placed within sustainability and transition studies to integrate research on BMs with the multi-level perspective (MLP). The MLP approaches socio-technological transitions as non-linear interactions among three analytical levels: niche, regime, and landscape [28]. The approach has been applied in, e.g., energy transitions (e.g., [4, 12, 31]) and transportation (e.g., [47, 68, 71]). Other, related efforts to understand this interplay between BMs and their systemic contexts include the pioneering work proposing the concept of the Business Model Design Space (BMDS, which argues that businesses are delimited in their choices and opportunities existing within the socio-technical regime in which the businesses are positioned [4, 31]. This means that the so-called regime elements directly include the choices businesses can make in developing their BMs and, therefore, directly influence the possible sustainability outcomes [4, 31]. These regime elements typically comprise cultural practices, markets/user preferences, policy, industry, science, technology, and even infrastructure [27]. However, different regime elements can be easier or harder to address through BM-related choices [71]. For example, some elements such as industry, market, and culture can be considered "soft-edged", which means that BMs can more easily shape, overcome, and influence these elements compared to elements such as policy, science, and technology, which are considered "hard-edged", to which companies tend to conform or adapt rather than attempt to radically transform [71]. Thus, the policy or regulatory regime as an element that shapes the BMDS becomes a relevant point of departure in a study of BM development within the mobility sector.

3 Material and methods

The following section introduces the case selection and methods used for data collection and analysis. Section 3.1 provides an overview and a short introduction to the companies and cities, while Sect. 3.2 provides an account of the research design.

3.1 Case selection

To explore the similarities and differences of BMs vis-à-vis policy instruments, and to investigate implications for sustainable urban mobility, a deliberative approach was taken to the selection of both companies and cities. The companies needed to (1) work with shared mobility with low- and zero-emission solutions (à la "The New EU Urban Mobility Framework" [22]), (2) simultaneously operate in multiple cities by (3) replicating their BM in their active markets and (4) represent different segments within shared mobility. Furthermore, the cities needed to (1) be located in different countries (as policy instruments affecting mobility originate on both local and national levels), but (2) preferably have arguably similar socio-technological regime elements regarding culture, user preferences, industry, and technology. Various companies working within both personal- and goods-related transport services, from ride-hailing to last-mile delivery, and cities within Northern and Western Europe were mapped against each other to identify eligible candidates. While there are a number of companies considered to have global outreach, most are limited to specific regions and cities; thus, identifying businesses that are active in multiple cities simultaneously was key. After an initial screening of publicly available company information and willingness to collaborate, some were excluded due to not fulfilling the screening requirements. For example, the services connected to delivery boxes were excluded as the market is still developing without clear policy interventions and companies did not fulfil all mentioned requirements. The city selection was closely linked to the services but also connected to where the researchers are placed (Stockholm), which then guided the process to include one more city each from the Nordic and non-Nordic contexts. The final list of two companies and three cities were as follows: Tier, a provider of shared micro-mobility services, and Bolt, a provider of a range of mobility services including ride-hailing

and micro-mobility, both of which operate in Stockholm (Sweden), Oslo (Norway), and Berlin (Germany).

3.1.1 Bolt—from taxify to super-app

According to Bolt´s official website [7], the company's founder created ride-hailing software services in 2013 as a reaction to the low-quality and high-priced taxi services in Estonia. A decade later, the company has 100 million customers in 45 countries across Europe and Africa and has raised a total of two billion USD in funding. Over time, Bolt has also changed their overall mission to challenge personal car ownership through different offerings—ride-hailing, micro-mobility rentals (e-scooters and e-bikes), Bolt Food, Bolt Market, and Bolt Drive. Note, however, that Bolt's ride-hailing service accounted for up to 70% of their turnover in 2021 [23], so it remains a significant part of its business. Bolt refers to itself as a super-app [7] representing one of the fastest-growing technology start-ups in Europe [24].

In the selected cities—Oslo, Stockholm, and Berlin—Bolt offers ride-hailing options and e-scooters (see Table 1). Bolt launched its ride-hailing service in Sweden in 2019 and subsequently in Norway and in Germany in 2021; and launched shared e-scooters in Stockholm and Oslo in 2020 and in Berlin in 2021. Bolt´s front-end service offer is very similar in all three cities; from the user perspective, one could argue that there are only incremental differences (although for specific, individual users, these incremental differences may be highly significant). In all three cities, a Bolt user can book ride-hailing services in different classes: premium (premium cars only), economy (most affordable alternative), and XL (6-seats available or more luggage space) (see Table 1). In Oslo, Bolt also offers comfort class (more spacious and comfortable car), pets on board, and fully electric vehicles; in Stockholm, comfort class is not offered but pets on board and electric vehicles are offered; and in Berlin, comfort class is offered, and users can also book taxis with approximate price information.

Table 1 Bolt and Tier services (ride-hailing and micro-mobility) in Oslo, Stockholm and Berlin as of September 2022

Service Provider–*Service Type*	Oslo	Stockholm	Berlin
Bolt–*Ride-hailing**	Premium	Premium	Premium
	Economy	Economy	Economy
	Comfort	–	Comfort
	–	Child	–
	XL	XL	XL
	Pets	Pets	–
	–	–	Taxi
	Electric	Electric	–
Bolt–*Micro-mobility***	E-scooter	E-scooter	E-scooter
Tier–*Micro-mobility****	E-scooter	E-scooter	E-scooter
	E-bikes	E-bikes	E-bikes
	–	–	E-mopeds

*Source: Bolt [8–10]

** Source: Bolt [8–10]

*** Source: Interviewee Tier SWE NO, Interviewee Tier GER, Tier app

3.1.2 Tier—leading micro-mobility

Tier Mobility is a Berlin-based micro-mobility company with an ambition to "change mobility for good" [59]. The startup was founded in 2018 and launched its first e-scooter sharing services in Vienna. Since then, Tier has raised more than 600 million USD in funding and expanded its services through acquisitions to 520 cities in 21 countries with a fleet of 300,000 vehicles [60].

Currently, Tier has five services under its umbrella: e-scooters, e-bikes, regular bikes, cargo bikes, and mopeds. Tier started its e-scooter service in Stockholm and Oslo in 2019 and then in Berlin in 2020. In these cities, Tier's offering consists of e-scooters and e-bikes with mopeds being offered only in Berlin (see Table 1).

3.1.3 City contexts

The three cities—Stockholm (Sweden), Oslo (Norway), and Berlin (Germany)—were selected due to their similarities in multiple domains (see below,), differences in how they approach shared mobility services, and their being service areas for the same companies (see more in 3.1). All three cities are located in Northern Europe, each having a population exceeding 1 million inhabitants and having similar socio-technological regime elements regarding culture, user preferences, industry, and technology. For example, all three countries represented belong to the top ten countries regarding digital readiness [39], and all three cities have transport-related climate targets. Stockholm's goal is to be fossil fuel-free by 2040 [14]. Oslo is to reduce climate emissions by 95% by 2030 compared to 2009 [32] and has introduced a car-free zone prioritizing pedestrians, bicycles and public transport. The Berlin Mobility Act aims to support the target of climate neutrality by 2045 via e.g. new mobility services [3]. Furthermore, all three cities have well-developed public transport including a metro system, and plan to continually improve pedestrian and bicycle infrastructure. Oslo has become a rising star in the 2019 Copenhagenize Index for bicycle lanes, while Berlin has fallen in the ranking and Stockholm is no longer part of the top 20 cities [18]. See Table 2 for a summary of characteristics.

Table 2 Characteristics of Berlin, Oslo and Stockholm

City	Population 2022*	Main public transport modes**	Bicycle friendliness index (city)***	Digital readiness (country)****
Berlin	3,755,251	commuter train, subway, tram, buses and ferries	15 in 2019 (10 in 2017)	76.11
Oslo	707,548	commuter train, subway, tram, buses and ferries	7 in 2019 (19 in 2017)	75.68
Stockholm	984,748	commuter train, subway, tram, buses and ferries	below the top 20 (14 in 2011)	78.91

*Source: SCB [49], SSB [53], Statistik Berlin Brandenburg [55]

**Source: UITP [63], UITP [64], UITP [65]

***Source: Copenhagenize index [18]

****Source: NRI [39]

3.2 Methods

For the empirical data collection, semi-structured in-depth interviews were conducted with representatives from the selected companies and cities (see Table 3). The Zoom platform was used to perform and record the interviews during the summer and autumn of 2022. The resulting seven interviews (with the eight interviewees) each lasted 50–80 min and were conducted in Swedish or English providing rich data representing each city and company. The interviews were later transcribed and manually coded using thematic analysis. Note that the company interviews were conducted with policy managers who were typically responsible for regions rather than countries, which enabled the simultaneous gathering of data on both Stockholm and Oslo.

The interviews had a dual purpose: (i) to gain an understanding of the companies' business models and identify incremental changes in their offerings between different cities and countries; and (ii) to explore how these public and private actors make sense of ongoing developments within their mobility markets, including policy evolution and effects on tangible practices. Therefore, the company representatives were asked to reflect on their company's BM with a focus on the core building blocks of their businesses and how these are affected by evolving policy instruments. On the other hand, public authorities' representatives were encouraged to reflect on the city's position regarding these mobility services and the measures and tools they use to govern them. While all interviews used the same interview protocol of semi-structured interviews, there was flexibility for the interviewees to introduce themes and topics that they found relevant to the discussion.

A thematic analysis was used to organize and analyze the primary data in the interview transcriptions. The first round of coding was guided by pre-determined codes according to the BM building blocks—value creation, value delivery, and value capture—which facilitated a better understanding of the companies' BM logics and the identification of relevant elements. The second round of coding focused on identifying more specific policy interventions and linking them to the distinct aspects/elements of the mobility service providers' BMs, such as vehicle fleet, geographic coverage, and data sharing. The reliability of the codes was assessed via an ongoing discussion and reflection between the authors of this article based on their expertise in the field.

While the empirical data provided rich and extensive insights into the research questions, additional secondary data was needed to complement and cross-validate the identified themes. For the companies, the information from the companies' websites, blogs, and social media accounts provided a more detailed image of how they represent themselves to a wider audience, including the values they identify with and how this relates to their business activities. Newspaper articles and posts from all three selected cities allowed us to track how services were perceived in the public realm and which

Table 3 List of Interviewees

Interviewee	Organization	Role
PA SWE	City of Stockholm	Project manager
PA NO	City of Oslo	Mobility planner
PA GER	Berlin Senate department of customer protection, mobility, and climate action	Urban planner
Bolt SWE NO 1	Bolt	Lead on Global policy team; responsible for the Nordic and Baltic regions
Bolt SWE NO 2	Bolt	Policy manager Sweden
Bolt GER	Bolt	Policy manager DACH (Germany, Austria, Switzerland)
Tier SWE NO	Tier	Head of public policy Nordics
Tier GER	Tier	Public Policy manager DACH

issues received the most attention or caused a public outcry. This also allowed for a better understanding of the general developments within the three selected markets, e.g., the implications of a new vehicle classification and insurance requirements for e-scooter services. For the public authorities, secondary data were mostly based on the official laws, regulations and press releases and used to validate and confirm the chronological order of the events and clarify interview statements about the existing laws and regulations. Simultaneously, some relevant themes, such as the legitimation of the services, were identified as valuable for the purpose of this article but the empirical data lacked a clear narrative and details, in which case supplementary data were utilized.

Finally, the alignment of BM building blocks, organizational and systems aspects, together with policy instruments provided a thematic structure for the findings, analysis, and discussion. This resulted in three main themes that were deemed to have the most significance for the research aim: (i) legislation at the national level; (ii) the cities' approaches to their local mobility market (e.g. the role of various mobility services) and transport system; (iii) and, finally, how these approaches translated into regulation and governance in relation to following sub-themes: civil contracts, geographical coverage, parking, data sharing and digital solutions, such as speed geofencing.

4 Findings

Legislation affecting ride-hailing and micro-mobility can be found on the national, regional/federal, and local levels. Based on the interview findings, the legitimization of new mobility services (such as ride-hailing and e-scooters) and technologies (such as e-scooters) is largely dealt with on the national level, while regulating actual operational practices is often determined on the local level, with some exceptions. This insight guided the following structure of the findings, which starts with the legitimization of the services on the national/federal level and then moves to the 'local' (city/state) level with a more specific focus on how the services and related legislations are being perceived by authorities and companies and how this translates into the right to operate according to the following themes: civil contracts, geographic coverage, parking, data sharing and, finally geofencing and speed limitations.

4.1 Legitimization on the national level

Ride-hailing and micro-mobility represent two novel types of shared mobility services with distinctly different legal bases. Thus, the legislation and regulations associated with each service are presented here.

4.1.1 Ride-hailing regulations by country

In *Sweden*, taxis were deregulated in 1990 and this created a liberalized market in which anyone fulfilling professional requirements can establish services without pre-decided quotas or price regulations [40]. As a reaction to the disruption of ride-hailing services, a new bill—creating a new category of taxis—was passed in April 2018 and came into effect in September 2020 that: (i) allowed these 'new taxis' to utilize different mechanisms than the taximeter to calculate the total price, (ii) restricted their use of taxi ranks; and (iii) required advanced booking to use them [41]. From Bolt's perspective, this created favorable conditions for their business—"We can see that in Sweden, there is an understanding that this kind of transformation cannot be stopped"—and they consider their dialogue with the Swedish Taxi Association (*Taxiförbundet*) to be productive (Interviewee Bolt SWE NO 1).

In *Norway*, the discussion to deregulate the taxi market began in 2017 in relation to the sharing economy [41]. There was also pressure from the European Free Trade Association (EFTA) Surveillance Authority to not violate the freedom of establishment described in the European Economic Area (EEA) Agreement [41]. In 2018, the Norwegian government initiated a public dialogue process regarding new taxi regulations that would increase competition, facilitate new business models, and accelerate the implementation of new technologies. The main changes introduced by Amendments to the Professional Transport Act related to the flexibility to exchange a taximeter with an app solution, the removal of the maximum number of taxi licenses, and the lifting of requirements to be connected to a dispatch center.[1] Thus, as in Sweden, ride-hailing was then considered a new type of taxi. Although these new regulations are in effect today, a new discussion has recently arisen regarding withdrawing the deregulation [44] and re-regulating to return to the former system: "In Norway, there is serious discussion about introducing again regulations to safeguard the traditional taxi monopolies" (Interview Bolt SWE NO 1).[2]

In *Germany*, ride-hailing services are not considered to be some form of taxi, but rather 'a rental car with a driver' (*mietwagen*). In 2021, an Amendment to the Passenger Transport Act was passed by the German parliament (Bundestag). According to this legislation, ride-hailing drivers are: (i) not allowed to spontaneously pick up

[1] Innst. 300 L (2018–2019) Innstilling fra transport-og kommunikasjonskomiteen om Endringer i yrkestransportlova (oppheving av behovsprøvingen for drosje mv.) [56].

[2] In December 2022 (i.e. after the interviews were conducted), the Norwegian government decided upon new stricter regulations on the taxi industry that came into force on January 1, 2023.

passengers (i.e. the rides need to be booked in advance); (ii) not allowed to wait on the streets for new rides; and perhaps most significantly (iii) required to return back to the company's official 'rental location(s)' with an empty car at the end of each trip [25]. Although German cities are permitted to allow multiple locations to be used as '*mietwagen* ranks' those locations need to be identified by each individual city and, according to the interviewee, none of the cities that Bolt operates in provides multiple locations (Interviewee Bolt GER).

4.1.2 Micro-mobility regulations by country

Turning to micro-mobility, one of the challenges that Bolt and Tier need to address in developing their business models relates to the way e-scooters are legally classified in different local contexts, which is connected to both national legislation as well as local rules and regulations regarding e-scooter use, particularly in relation to other transport modes.

In *Sweden*, e-scooters with speed limit under 20 km/h and motor power of max 250 watts[3] currently fall into the same category (and under the same rules) as bicycles; thus, parking and riding e-scooters should be addressed in a manner comparable to bicycles [62]. However, some wish that the Swedish Transport Agency (*Transportstyrelse*) would introduce a division between bicycles and e-scooters, as this would allow for more specific regulations targeting only e-scooters (Interview PA SE).

Unlike Sweden, in Norway and Germany, e-scooters are now a new, separate small electric vehicle class, although for different reasons. In *Norway* before June 2021, e-scooters operated under the same rules as bicycles, and the government (on all levels) had less power to regulate them. For example, questions related to driving under the influence and high numbers of injuries were perceived as difficult to deal with [45]. The national government did not want to lower alcohol limits on bicycle users, so they reclassified e-scooters as a type of light electric vehicle with an alcohol limit of 0.2 mg per mille (Interviewee PA NO). Among other things, the e-scooter law also requires: e-scooter operators to be at least 12 years old, helmet use while under the age of 15; mandatory liability insurance for shared and private e-scooters [54]. As a result of the reclassification, the City of Oslo is reevaluating the ban on riding at night, which was put into place to try to minimize driving under the influence (Interviewee PA NO). Furthermore, in response to the insurance requirements, the companies' plans generally entail price increases of around 15–20% (if insurance was not already included before) [67]. Additional implications of this June 2021 law change are discussed below.

[3] E-scooters that do *not* fulfill the requirements to be categorized as bicycles are considered as mopeds [62].

In *Germany*, e-scooters were not allowed to be used until they became legally classified, which officially occurred on June 15, 2019, when they became a new type of 'light electric vehicle' (along with Segways). As the Berlin interviewee recalled: "after they were allowed, the next day they popped out" (Interviewee PA GER). The German e-scooter law entails regulations regarding technical requirements, road use rules such as a ban on using pedestrian infrastructure, requirements for license plates and insurance, limited use under the age of 14, and alcohol limits [34]. Tier's perspective was that the e-scooter regulations combine parts from car regulations and parts from bicycle regulations (Interviewee Tier GER). Tier considers this as "a barrier to using" e-scooters as it makes it more complicated for users to understand what is expected of them, which leads to problems (e.g. drunk driving, incorrect parking, misuse of street space) and even pure mistakes (particularly for tourists), which creates a negative public outcry. "People have known the rules for cars for decades, they have known the rules for bicycles for decades, and the rules for e-scooters are only four years old". This places extra pressure on the companies but also public authorities to educate the e-scooter users on the rules.

4.2 The local authorities' and service providers' approaches to shared micro-mobility

As mentioned previously, while national legislations play an important role in legitimizing services, the real negotiations, communication, and governing of practices are taking place on the regional and especially local levels in direct dialogue between public authorities and service providers. The approaches are illustrated in the interviews with the company and city representatives.

Public authorities

First, in the Oslo interview, the discussion was strongly tied to the sharing economy and its possible effects—"Is the sharing replacing something unsustainable, or does it just increase your consumption of something?"—although's/he also reflected that similar questions are not posed regarding traditional modes as they are considered part of the norm (Interviewee PA NO). At the same time, the public authority is assessing its role in planning and governing these new modes. Second, in the Stockholm interview, questions were raised regarding improving efficiency, e.g., the use of vehicles and different strategies for how to increase their utilization rates (Interviewee PA SWE). The City of Stockholm interviewee pointed out the low utilization rate of e-scooters that varies from 20 to 40 min per day, as well as reflected on the impact of the introduced cap on the number of e-scooters—"the

utilization rate increased with a lower cap, but they still stand still for 23 h and 20 min every day"—although's/he also perceived a correlation between companies with fewer problems (e.g. incorrect parking, broken vehicles) and higher utilization rates (Interviewee PA SWE). Third, in Berlin, shared mobility services have a relatively longer history,[4] and thus these services are perceived as part of the City's mobility and included in the Berlin Mobility Act [48]. The Berlin public actor interviewee explained that in their work with these services, they currently identify a gap between the companies' business models and the public authorities' needs, but that they try to convince companies to align with their strategies: "the city is for everyone, mobility is for everyone, and we want to make it safer for everyone and bring a higher [modal share] of biking, walking, and public transportation" (Interviewee PA GER).

Mobility service providers

Moving to the selected companies, both Bolt and Tier acknowledge public authorities as important partners for their businesses and, at the same time, they as service providers perceive themselves to have agency to address transportation challenges in the cities. Bolt, as a company, considers themselves to be one of two building blocks needed to solve urban transportation challenges (the other building block being public transportation). Thus, they view their role in the wider system to "be close and alongside public transport to serve society's mobility needs" (Interviewee Bolt SWE NO 1). Though, when asked about their business model, Bolt responded: "We are a platform, and we are the platform that connects demand and supply" (Interviewee Bolt SWE NO 1). As such, digital intermediation between drivers and users together with fleet management can be considered their main value proposition. Bolt claims the advantages of their platform are fast and effective rollout as their resources do not require extended infrastructure and they can tweak their platform to fulfill many different functions (Interviewee Bolt SWE NO 1). According to Tier, they are now "the largest multimodal micro-mobility operator globally" (Ibid.). They do not view themselves as an operator of e-scooters or e-bikes, but rather that they work with unbundling cities and reshaping urban mobility vis-à-vis (1) decreasing car dependency by changing the way people move, e.g. through public transport and micro-mobility, and (2) transforming cities through a redistribution of urban space, e.g. how streets and overall public space are being used (Interviewees Tier SWE NO & Tier GER). Moreover, Tier perceives public transport authorities as the most important stakeholder for their business and partner in collaboration. In Berlin, Tier has been integrated with the Jelbi MaaS app, and in Stockholm with the Travis app. Tier also works with companies like Cabonline, a taxi company in Sweden, to nudge users to use other services when using e-scooters may not be appropriate (Interviewee Tier SWE NO).

4.3 The right to operate

E-scooter operations are usually regulated at the local level (e.g., the city), which creates a variety of adaptations depending on local conditions. The heterogeneous nature of local contexts (in general) was acknowledged in interview responses from both the micro-mobility companies and the city representatives: "It is difficult for the e-scooter company to work as every city works with [e-scooter regulations] differently. There is no suggestion from the national level, and we [the cities] are left on our own." (Interviewee PA GER). Although this may create difficulties for the cities, it creates a fertile landscape for the researcher; in this case, enabling comparisons across aspects (identified through the interviews) related to the numbers of vehicles and operators, geographic coverage and parking, and data sharing and digitally enabled use limitations (discussed below).

4.3.1 Civil contracts

The selected cases showcased two different policy tools used to govern mobility services: special use permits and tenders. The decision to use one or another has direct implications for the companies, especially the relationship to the number of vehicles and operators.

Tender in Oslo

In Oslo, the June 2021 national law change (referred to above) created greater opportunities for governments to regulate e-scooters. Oslo first tried implementing a total cap on the number of vehicles, which resulted in a situation of 8000 e-scooters (and e-bikes) evenly distributed over 12 providers. This was economically unsustainable for the providers (to operate so few scooters each), thus making it difficult or impossible for some companies to have their own business strategy. According to the Oslo public actor interviewee, this resulted in some inappropriate collaborations among some providers (e.g., sourcing e-scooters from one of the other providers, including directing their users to the other provider's app for bookings, but reporting those e-scooters [to the city] as one's own), which was not good for competition. As a result, Oslo decided to combine the vehicle cap (8000) with

[4] Car-sharing has existed in Berlin for three decades; the first free-floating bike-sharing service started in 2017; and now the recent wave of e-scooters as of 2019.

a cap on the number of providers (3). On April 1, 2022, three companies (Bolt, Tier and Voi) won the exclusive right to operate. Based on the tendered contract, they also needed to distribute the vehicles in a way that would provide wide coverage of the zones specified by the City. The Oslo public actor interviewee explained the tender process, in which the City first described the purpose of and specific goals and requirements tied to shared e-scooters, and then the providers offered proposals to address the goals in compliance with all requirements (Interviewee PA NO). Rights are granted on an annual basis, which the City perceives to provide the flexibility to learn from experience as well as apply those learnings in a timely fashion; for example, the City can relatively quickly introduce adjusted requirements as needed. Tier advocate for a tender process (versus special use permits) as they believe that: it creates stability in the market; encourages experimentation so that companies can suggest and trial solutions for the local context; and, at the same time, it provides cities with the tools to introduce stricter or adjusted requirements (Interviewee Tier SWE NO). Moreover, they approach this as a way for cities to find reliable partners that can fulfill the vision and goals of the public authorities (Interviewee Tier GER). On the other hand, the tender process entails a commitment from both the company/ies and the cities, so the requirements and process need to be well thought through and well executed. For example, in reflecting on their experience with bike-sharing tenders, the representative from Oslo explained that the city bikes have entailed a high monetary cost for the City and have been losing market share due to e-scooters and e-bike sharing, but the City has a tendered commitment with the contracted provider until 2030 (Interviewee PA NO).

Special use permit in Stockholm and Berlin

In both Stockholm and Berlin, the companies need to apply for a special use permit to operate (discussed below). In Stockholm, permits are issued every six months, and in Berlin, every 12 months. In Stockholm, permits are issued by the Stockholm region Police department in accordance with the municipalities, while in Berlin, permits are issued via Berlin's Senate Department for the environment, urban mobility, consumer protection, and climate action, which encompasses the entire federal state of Berlin—"these permits were connected to the specific [and static] land use and now [the vehicles] move around…so we need to do this [as the vehicles move across municipal boundaries]" (Interviewee PA GER). In Berlin, e-scooter companies are also required to maintain a hotline with information on vehicles that citizens can use to complain about inappropriate behavior (Ibid.). In both cities, providers should now share data with the public authorities as well (although this is technically non-legally binding due to the use of special permits; the implication of not cooperating is likely not getting one's permit renewed). In Stockholm, it is 12,000 vehicles divided by the total number of eligible providers, due to freedom of establishment (as of the summer of 2022, there were eight providers with a maximum of 1,500 vehicles each) and in Berlin, there is no vehicle cap (as of autumn 2022 there were 5 providers and 55,000 e-scooters). Since the vehicle cap came into effect in Stockholm, some e-scooter providers have or are pulling out, so it remains to be seen if the number of providers will stabilize in relation to the current vehicle cap (if Stockholm does not follow Oslo and find a legal way to move to a tender process and introduce a cap on the number of providers). According to the Stockholm public actor interviewee, at least one e-scooter provider has shown interest in coming to Stockholm, but *not* if Stockholm is utilizing special use permits instead of a tender. In Berlin, there is talk of also introducing a vehicle cap but as they are still setting up their data storage and analysis systems, they prefer to wait with this decision until they can take a more data-driven approach to make it.

Advantages and disadvantages of policy tools

The special use permit utilized in Stockholm and Berlin is the same type of permission that local businesses need to apply for annually to conduct business activities on public land (for example, outdoor serving at restaurants). In other words, while some conditions vary between these two cities, they still utilize the same basic tools with the same strengths and weaknesses. Tier's perspective on cities choosing to use permits is that "they [local authorities] know it [special use permits] and they have been using it for decades" (Interviewee Tier GER), thus cities feel comfortable with it. The permit is supplemented by the additional rules and requirements that operators need to follow to get an extension: "If you behave, you will get the new one" (Interviewee PA SWE). This means that the companies sign under the set of rules that they need to follow, for example, data sharing. However, use permits have their own disadvantages. As merely a *use* permit, there are no limitations on how many companies can apply for one, and permits can only regulate what falls under special road laws (such as the use of public space, traffic, and pedestrian safety). In other words, use permits are limited in regulating anything more specific to internal organizational activities, such as logistics, the sustainability of the services, the energy source for loading, etc. (Interviewee Tier GER). This corresponds to the information from the City of Stockholm—that they can

regulate the number of vehicles and their placement, but not pricing or geographic coverage of services (Interviewee PA SE) Therefore, special use permits are often supplemented with a memorandum of understanding (MOU) between the cities and mobility service providers. While non-legally binding, the MOU is used as a tool to decrease tensions and informally govern services (Interviewee Tier GER) in questions related to e.g., identifying parking and non-parking areas or lower-speed areas with the help of geofencing.

4.3.2 Geographic coverage

The geographic coverage of both Bolt's and Tier's services depends on the allowed number of vehicles and other requirements from public authorities. "Part of our business model is connected to the dense distribution of vehicles [that is necessary to create an attractive service]" (Interviewee Tier SE).

In Oslo, Tier and Bolt are obliged to distribute their e-scooters among the zones specified by the local government. In Stockholm, the introduced cap on total vehicles (with no mandatory distribution over specified areas) has led to a shrinking of the operation zone to only the inner city according to both Tier and the City of Stockholm (Interviewees Tier SE and PA SE). According to Tier, "the lower number of vehicles they [the e-scooter companies] have, the smaller the services area could be covered, and this is the one [service area] that is most profitable for us" (Interviewee Tier SE). This same interviewee reflected that this creates a negative impact both for the company and the city. In Berlin, an uncapped number of vehicles provides Tier and Bolt flexibility to quickly adjust to new needs and experiment with different variations of vehicle distribution; for example, Bolt's pilot in the business park area of Neukölln [11].

4.3.3 Parking

The cities are testing different e-scooter parking solutions and trying to move away from the free-floating nature of e-scooters to more structured, allocated parking. In responding to the issue of parking, a Bolt representative said: "This is a realization of the cities that regulation in itself would not change anything in the cities. They need to give space to this new kind of mobility. You cannot just expect everything to work out without changing anything" (Interviewee Bolt GER). However, the way this'space' is being created is different in different cities. In Sweden, a new national law that came into effect on September 1, 2022, forbids e-scooters from parking on bicycle paths, walking paths and sidewalks (and from driving on walking paths and sidewalks) [61]. Stockholm City's website instructs users to now park e-scooters in specially dedicated e-scooter parking areas or ordinary bike racks [15]. According to the Stockholm public actor interviewee, the City adds 2000 new bike racks annually, thus, if all the 12,000 existing e-scooters would park in bike racks, this would use up all the bike infrastructure development planned for the upcoming six years (Interviewee PA SE. In other words, a new 'problem' potentially emerges if e-scooters and bicycles need to compete for the same parking infrastructure. The micro-mobility companies are divided on how to navigate this new law as some of them govern parking through service apps, while others increased parking personnel to keep the e-scooters in order (Interviewee PA SE. In Berlin, local authorities also perceive parking as a high-priority issue and hope to introduce a system that would allow parking only in dedicated areas. This would entail installing additional parking within the public transport company Jelbi mobility stations/points and repurposing car parking spots into e-scooter parking in the highest-use zones (Interviewee PA GER.

4.3.4 Data sharing

Data sharing is not only an important element to achieve connectivity within the system and the integration of services—supporting e.g., multi/intermodal trips and Mobility-as-a-Service—it is also important for both private and public actors to make informed decisions. In the case of public actors, shared data is vital for strategic planning and impact analysis. The stakeholders interviewed for this study did not share any specific, ongoing problems related to data sharing; as such, one can hope that the status quo is and remains positive and collaborative in nature. However, data sharing between companies and public authorities does not always go smoothly [52]. In this study, the companies are sharing their data with public authorities (as legally required by the tender contract or according to the non-legally binding terms of the special use permit). The cities are then able to use this data for following up on sustainability impacts and for making strategic decisions. Oslo, for example, follows up on the movement patterns of the e-scooters and e-bikes. In Berlin, the public authorities plan to use the data to make a strategic decision regarding a potential vehicle cap.

Bolt and Tier have similar standpoints regarding data sharing. With tender contracts in Oslo and with use permits in Stockholm and Berlin, both companies share data with local authorities. This entails data related to vehicle position and patterns, trip origin and destination, etc. but it does not include any personal, user data (the collection and use of which is regulated at the European level through the General Data Protection Regulation (GDPR)). Before transferring data, Tier requires public authorities to sign a data-sharing agreement with

requirements on data handling, storage, etc. The "data sharing agreement is something that is very important for us, that they [the public authority] would understand why we do this and would follow [the agreement]" (Interviewee Tier SE). When it comes to personal data, Bolt expresses a strong stance: "we [as a company] were trusted with this data, and we must be very careful how we use it, and with whom we are sharing it, and who can look at it" (Interviewee Bolt SWE NO 1).

4.3.5 Geofencing and speed limitations

In using digital technology to create limitations on e-scooter use, geofencing is a commonly used option for identifying use zones, parking or non-parking areas, as well as for introducing areas with reduced speed limits. In Oslo, Bolt and Tier are required (according to the tendered contract) to use geofencing for these purposes, while in Stockholm they have an MOU. In Berlin, Bolt do not, and cannot, use geofencing to create speed restrictions, as using geofencing to restrict speed is considered an active intervention in the riding process (Interviewee Bolt GER), which is not allowed in Germany (although public authorities are hoping that this might change (Interviewee PA GER)). Implementing geofencing to limit speed has not always been smooth to implement in practice, particularly in terms of its effects on users' driving. In Stockholm, the introduction of speed restrictions via geofencing almost caused traffic incidents when users suddenly moved from normal- to lower-speed areas as the lower speed affected how e-scooter users could maneuver among the other vehicles on the street (Interviewee PA SWE), which required reconfiguring these lower-speed zones and being more deliberate in the process of setting limits. In relation to this, the City of Oslo interviewee raises a question of ethics: "How much responsibility does the local government need to have in steering vehicles digitally? I am not sure about the answer, but a lot of people are very eager to use this on users because we can, but should we?" (Interviewee PA NO).

4.4 Summary of the findings

The findings from the interviews demarcate clear boundaries between national legislation and local regulations and policies, where the former is perceived as a more stable element with clear structure and low flexibility, and the latter provides guidance and governs the services on a day-to-day basis. This necessitates those local policies be more fluid and adaptable to experimentation and learning from mistakes. In Table 4, the main takeaways from the findings are summarized with a focus on matching the policy instruments in use with the implications as identified by the interviewees. This is further discussed in the "Analysis and Discussion" section below.

5 Analysis and discussion

This study investigated how mobility service providers adapt their BMs to the local policy regime. In this section, the empirical findings are discussed in a broader perspective by linking firm-level actions to the wider socio-technical regime, exploring interdependencies between public authorities' actions and service providers' BMs in relation to sustainable transport. The contribution includes: (i) a reflection on different types of transformations, (ii) a discussion about time perspectives, (iii) the identification of the need for an alignment between short-term needs and long-term goals (both within and among stakeholders), and (iv) the proposal to focus on the policy mix versus specific policy instruments.

Different types of transformations

While both ride-hailing and micro-mobility can be considered new and disruptive services within the wider (urban) transportation system, *different mobility services entail different types of transformations* (across different combinations of regime elements) with implications for public authorities, companies, transport users, and society in general.

The findings suggest that the legalization of ride-hailing services as taxis has been a cornerstone for the sector. As stated by the ride-hailing operator, their BM is embedded within a platform that allows for an 'efficient' distribution of supply and demand. While the service exchange is analogue, all the processes behind it are managed digitally. This means that the company plays an intermediary role between the drivers (and their vehicles) and riders, all of whom are already within the transportation system. As such, the new value created via the ride-hailing platform materializes in the form of the utilization of existing resources without needing to add something new to the physical realm. Simultaneously, the digitalization of traditional practices, such as taxi services, disrupted the taxi industry by competing within the established market and exposing changing users' preferences and needs. However, *how* ride-hailing has been legalized has other implications, such as in Berlin with ride-hailing's mietwagen status. While it does not affect the fundamental service offering, it entails greater inefficiencies in terms of lost time, fuel cost, and negative environmental impacts and is claimed to limit innovation and promote unfair competition in the taxi market, as expressed by other ride-hailing providers Uber and FreeNow [25].

For micro-mobility services and especially shared e-scooters, the national-level categorization of the technology to a specific transportation mode was only a starting point and the local cities are still finding their way in terms of governance and legislation. Currently, both

Table 4 Summary of the findings (based on the implications identified by the interviewees)

	Stockholm	Oslo	Berlin
Legitimization on the national level			
Ride-hailing	A new type of taxi in April 2018 (in effect in Sep. 2020)	A new type of taxi in 2019	"A rental car with a driver" (*mietwagen*) in 2021
Implications	Not identified	Not identified	BM: Extra km-traveled—the requirement to come back to the company's official "rental locations(s)"
Micro-mobility	Same category as a bicycle	New category—a light electric vehicle	New category—a light electric vehicle
	Use rules – similar to bicycles with the exception of parking	New use rules, e.g.: Alcohol limit Age limit of 12 and above; Helmet requirement for under 15 years old; Mandatory liability insurance	New rules, e.g.: Technical requirements; Ban on using pedestrian infrastructure; License plates and insurance; Minimum age limit of 14 years old; Alcohol limit
Implications	Not identified	BM: Increased prices due to insurance requirements; BM and PA: reconsideration of night-ride ban	BM: "A barrier to use"; extra pressure on companies to educate users
Local authorities' approach to shared mobility			
	On increasing efficiency and utilization rates	The governance of the sharing economy and assessing their role in planning and regulating	Services as part of the City´s mobility offering; how to align BM and public authorities' needs
Right to operate			
Civil contract	Special use permit issued by the Stockholm region Police department in accordance with the municipality; granted every 6 months; vehicle cap of 12,000 e-scooters divided by the total number of eligible providers (12 providers in autumn 2022); no cap on providers	After issuing special use permits, moved to tenders; a limited number of vehicles; a limited number of providers; granted on an annual basis	Special use permit issued by Berlin´s Senate Department for the environment, urban mobility, consumer protection, and climate action; granted every 12 months; companies' hotline for users; no vehicle or providers cap—total number of vehicles 55,000 e-scooters shared among 5 providers (autumn 2022)
Implications	PA: Requires supplementing rules and agreements; competitive market; providers pulling out; cannot regulate internal organizational activities, pricing, or coverage area	PA: Three companies operating in the city; tying specific goals and requirements to e-scooters; commitment from both city and providers; flexibility to adjust requirements if needed	PA: Require supplementing rules and agreements; cannot regulate internal organizational activities, pricing, or coverage area
Coverage area	Cannot be regulated; relates to the number of vehicles	Use zones specified by local authorities	Cannot be regulated; relates to the number of vehicles
Implications	BM and PA: Shrinking coverage area due to low number of vehicles	BM and PA: More equal distribution in the city	Not identified
Parking	A law from 1 Sep. 2022 forbids parking on bicycle, walking paths, and sidewalks; parking allowed in special areas and bike racks	Regulated by the tender	Working on introducing a system with dedicated spaces by extending Jelbi mobility stations/points and repurposing car parking spots
Implications	BM and PA: Bikes and e-scooters compete for the same infrastructure	Not identified	Not identified
Data sharing	The vehicle position and movement patterns shared; non-legally binding terms	The vehicle position and movement patterns shared according to the tender	The vehicle position and movement patterns shared; non-legally binding terms
Implications	BM and PA: can make informed decisions; important element in achieving a multimodal transport system		
Geofencing and speed limitations	Use of geofencing and speed limits according to MOU	Use of geofencing and speed limits according to tender	Use of geofencing according to MOU; speed limits not allowed as considered an active intervention
Implications	BM and PA: Provides the possibility to restrict and steer use; can cause problems when implemented incorrectly; ethical considerations		

PA = public authorities, BM = business model, 'Not identified' = no implication mentioned by the interviewees

national and local legislation (or the lack of it) have far-reaching implications for service providers. In Oslo and Berlin, the introduction of the new light electric vehicle category led to changing offers to users, such as increased prices, and additional responsibilities for the company to educate their customers about the new use rules. On the other hand, the categorization gave local authorities additional governance tools, including rules on drunk driving.

Another local governance issue is the use of public space. For example, micro-mobility services' claim to public space (to deploy vehicles) entails new competition for a share of operating space and transport infrastructure, e.g., on roads, bicycle and walking lanes, sidewalks, parking racks, etc. All this has a direct effect both on the general public (and other modes, services, and functions) that use public space and/or transport infrastructure, and on public authorities' governance of the use of public land and transport infrastructure. In discussions with public authorities (in these interviews and otherwise), they have flagged the pricing of public space as a missing or inadequately formed tool in their regulation toolbox, as well as the need for an official strategy regarding the use of public space (i.e., how to prioritize among functions and services) as ever more and varied services express an interest in using such space. Similarly, service providers flag a real or perceived lack of access to public space as a hindrance to innovation and business. As the original BM for shared e-scooters relied on unrestricted access to free public space, it is yet to be determined how the BM will adapt to the new, fluctuating policy conditions being tested by national and local public authorities regarding the use of public space and transport infrastructures such as parking.

Time perspective

It is important to remember that *transitions take time*. The new services and innovative business models acted as a spark and created urgency for change. Both interviewed companies have benefited from others' earlier efforts to provide sharing-type services, as these efforts helped shift cultural perceptions regarding ownership and sharing as well as influenced user behavior and public policy [26] and even created new opportunities for start-ups [71]. However, ride-hailing also emerged earlier than micro-mobility in the form of e-scooters (at any significant scale), and thus the market conditions for ride-hailing have had more time to find an equilibrium. Founded in 2009, Uber, as a 'first-mover' within ride-hailing, played a prominent role in disrupting (mainly) the taxi industry that suddenly needed to deal with a new market actor providing cheaper services for end-users. Since then, it has taken different policy contexts different amounts of time to find where ride-hailing, as a mode, fits within their national legislation—e.g., deregulating the taxi industry in Norway in 2018 and amending the passenger transport act in Germany in 2021—although the final word on this may not yet have been heard (see the above interview findings). Thus, when Bolt finally entered Norway and Germany in 2021 as a 'later entrant', the initial turmoil of disruption had settled and the markets were converging on specific solutions for ride-hailing, including legislation. (Legislation regarding employment is also central to the discussion of ride-hailing, although outside the scope of this study.)

In the case of micro-mobility, although Lime may be considered a 'first mover' in Europe, a wave of companies emerged around the same time (including those interviewed here), perhaps related to e-scooters being more of a technological solution and not needing to build up a supply side (of drivers) as in the case of ride-hailing. Furthermore, the time taken for the equivalent legislative process of finding where to place e-scooters, as a mode, in national legislation has generally been shorter, which is likely related to previous experiences with other, new modes such as ride-hailing. However, updating policies regarding the use of public space (and their implications for BMs) may take a while longer to work themselves out due to the more recent and different nature of this disruption (i.e., disrupting the use of public space in general versus disrupting a specific industry). In this respect, one might argue that the e-scooter markets are still in the initial disruption phase, at least in the case of public space if not generally.

Alignment of short-term needs and long-term goals

Achieving sustainability in transport requires *deliberative alignment balancing short- and long-term perspectives*. This applies to private companies and public authorities, both internally within their own organizations as well as collaboratively. In other words, both business practices and the regulatory regime must carry this responsibility and align their strategic direction to create momentum that contributes to sustainability (and hinders unsustainability) (cf. [20, 29, 38]). The interview findings exemplify how mobility service providers and public authorities can be reflective of both the process and each other's perspectives, which creates a good basis for collaboration as seen in Berlin's case with a clear acknowledgement of their role in governing mobility services. The public authorities are actively testing different conditions with the intention of improving ecological and social sustainability outcomes while also acknowledging economic implications for business, as represented in the iterative learning process

from Oslo. However, finding the balance between short- and long-term perspectives is an ongoing challenge in developing collaboration. A long-term business strategy is considered a precondition to achieving SBMs, so a lack of long-term commitments without a clear indication of future opportunities can become a barrier to companies' developing such strategies. And although public authorities also have long-term visions and targets, their role in governing mobility services is perceived (by themselves) as unclear and builds on the assumption that all involved stakeholders share the same interests, at least in the Swedish context [30]. Even more (in the Swedish context), in policy documents, public authorities are encouraged to take a market-supportive role passing the torch to shape future mobility by the private actors [30, 70]. In the case of new, innovative services, there is also a lack of historical data upon which to make decisions, i.e., the outcomes are also uncertain, increasing the risk. In this study, the involved stakeholders are trying to strike this balance by experimenting and learning by doing, part of the iterative nature of any design process.

Focus on the policy mix

Public authorities need to *focus on the policy mix* and its impacts on and implications for sustainability outcomes. This can be illustrated (as follows) by relating this study's findings to accessibility, for example (but similar discussions may be had regarding implications for safety, resilience, ecology, and more). As seen in Stockholm and Oslo, the cap on the total number of vehicles (which Berlin has not done, yet) is used as a policy instrument to control the vehicle fleet and clear space due to 'too many' e-scooters. While this may have a positive effect in terms of clearing streets for the benefit of other active modes such as walking and biking, the introduction of the vehicle cap (especially when not combined with a cap on the number of providers) limits both business possibilities and service accessibility. As discussed in the interviews, these companies built their BMs on a dense distribution of vehicles within an extended geographic area, which is something perceived as crucial to attracting users. Thus, the fewer vehicles allowed, the smaller an area can be covered at any relatively high density (i.e. maintaining the same level of service). As discussed above, this shrinking coverage effect has been evidenced in Stockholm since the introduction of the cap, which led to the removal of vehicles from peripheral areas, subsequently limiting residents' access to e-scooter services and leading to companies adjusting their BM to fit new conditions of higher competition for users in the city center. This represents a development contrary to those advocated for in "The new EU Urban Mobility Framework", e.g. that cities need to work to ensure better integration between public transport and shared and active mobility, especially for the areas with sparse public transport and lower public transport frequency [22], i.e. where micro-mobility can serve as first- and last-mile solution [46].

On the local level, the governance of micro-mobility services occurs via a special use permit or a tender. In these studied cases, the 'problem' partly stems from which policy instrument is utilized, and partly from which concurrent policies are (able to be) applied. The special use permit does not grant the right for public authorities to regulate the distribution of vehicles or the number of providers, while a tender does (*if* the city chooses to include such requirements). For companies, while partly limiting their original BM, the tender represents stability and exclusive operational rights. As demonstrated in Oslo, moving to a tender process *and* introducing requirements on the distribution of e-scooters across zones—an example of an equity policy [46]—led to increased availability and accessibility of e-scooters in the city periphery. Furthermore, introducing a cap on the number of providers (as Oslo has done) works as a gatekeeping practice while creating more stable conditions for the providers. This utilization of double caps for both vehicle fleets and providers is a fairly common practice in e.g. American cities [46].

'Too much' competition and the thresholds caused by digitization can also be disadvantageous for accessibility. When there exists a greater number of providers relative to the number of vehicles, accessibility will be lowered, as, in practice, users stick to relatively few apps and will not download the apps of all the mobility service providers in a city. In Oslo after the law change, using one provider's app meant ('on paper') having access to only one-twelfth of 8000 vehicles (12 providers and 8000 vehicles), while the next year it meant having access to one-third of 8000 vehicles (a cap of 3 providers for 8000 vehicles). From that perspective, e-scooters from a single provider suddenly became four times more accessible once the number of providers was capped, creating more favorable conditions for high utilization and value capture.

This discussion about accessibility illustrates how transport accessibility and development of BMs are affected by many factors such as the city's size and density, the fixed transport networks (e.g., road and rail), the number of vehicles and providers, the distribution of vehicles, as well as digitization and user practices. As such, this only emphasizes the need for cities to carefully consider the *policy mix* that they choose to implement as well as its implications. A narrow focus on a specific issue can result in a ripple effect with unexpected and unsustainable outcomes.

6 Concluding remarks and future research

Mobility service offerings are tightly related to the interdependencies between the BM and the regulatory regime's conditions. While the findings did not indicate any drastic differences in BMs in selected cities (for either of the interviewed companies), the incremental adaptations based on each location's regulatory regime can influence how sustainable BMs and services are in particular contexts. These findings suggest that innovative BMs can bring more disruption to stable structures such as established industries (cf. [4, 47, 58]) or the traditional distribution of public space. However, the role public regulations play in shaping mobility providers' offerings needs to be more clearly acknowledged. As shown in this paper, targeting specific issues through policy tools without a broader system perspective can diminish the competitive advantage of sustainable business practices, create 'barriers to use' for users, increase km-travelled, or even result in a decrease in accessibility of parts of the transport system by shrinking coverage.

Ongoing service and policy developments in the urban mobility sector are amidst a trial-and-error phase. New services and providers emerge and test different variations of their BM to understand the conditions necessary to create a flourishing business case with attractive offerings. Policymakers attempt to find solutions that stimulate innovation and support business but at the same time, they act in precaution to represent and embody public values. However, as findings suggest, reactive solutions addressing negative externalities can lead to 'new problems' rather than fostering and promoting sustainable practices. Furthermore, the cities are struggling to understand their roles and desire both clarification and new regulatory tools from the national authorities, particularly in light of the evolving mobility landscape. Clearly defined and communicated goals would help the companies better understand the business model design space within which they operate and strategize.

Actualizing a sustainable transport system will require letting go of outdated preconceptions, discourses, and roles of both public and private actors, as well as actively engaging in aligning interests and needs. Furthermore, rigid established organizational structures within and among public and private actors are likely to hinder the potential progress toward a sustainable transport system and the development of sustainable business models. New collaboration practices are not only necessary between public and private actors but also among the various public authorities, as no sustainable value can be created without the inclusion of a broader stakeholder group (Schaltegger et al., [50]); an insight taken from the BM literature but relevant even in other domains. Regarding the organization and governance of future mobility: "Existing organizational cultures often have to be challenged to enable and accelerate transformation and continuous improvement. This involves breaking down legacy functional silos with a view to creating cross-functional collaboration with processes—such as new product and service development and experimentation—that flow seamlessly across departments, as well as setting up flexible structures to manage collaboration and open innovation with external stakeholders." [, p. 76].2

The cases presented in this article indicate various levels of movement towards stronger public engagement and collaboration efforts, where, *of the three cities*, Oslo may arguably be considered the front-runner in experimenting with adapting regulations to meet sustainability goals. Although Berlin is taking a very 'deliberative' approach, this may be related to their long history of embracing mobility services as a part of the urban transport system. Stockholm's efforts may be viewed as more hands-off than the other cities, although this may be changing as they gain more insight and experience. Thus, this study's findings argue for policy experimentation and closer engagement with mobility services through active follow-up as important elements in cities' sustainability strategies (e.g. accessibility), which is relevant for any city in the world. The challenges and strategies should be considered as moving targets constantly evolving and adapting.

Future research should include an expansion of this study to include more cities and mobility services, including last-mile delivery services, to confirm to what extent these findings and analyses are more generally applicable. The study's findings can also be expanded to other types of sustainability. And as such data becomes available, it would be relevant to match empirical, quantitative evidence of local sustainability impacts against the experience-based, qualitative evidence of public and private stakeholders, across regulatory contexts, to understand the importance of policy mixes more deeply.

Acknowledgements

The authors wish to thank the interviewees for their willingness to collaborate and contribute their valuable time to this study. The authors also wish to acknowledge the importance of current and future multi-institutional collaborations between the public, private, and academic sectors in order to collaboratively develop and accelerate transition to a sustainable transport system.

Authors' contribution

EK–conceptualization; data collection and analysis; writing and editing of the manuscript, writing and editing of the final version; JS–conceptualization; data collection and analysis; writing and editing of the manuscript, writing and editing of the final version; AK–conceptualization; writing and editing of the manuscript; editing of the final version.

Funding

Open access funding provided by Royal Institute of Technology. This work was supported by Mistra, (Grant No.: DIA 2014/25), Anna Kramers.

Availability of data and materials
The data is available on request.

Declarations

Competing interests
The authors declare that they have no competing interests.

Received: 9 May 2023 Accepted: 12 January 2024
Published online: 05 February 2024

References

1. Abduljabbar, R. L., Liyanage, S., & Dia, H. (2021). The role of micro-mobility in shaping sustainable cities: A systematic literature review. *Transportation Research Part D: Transport and Environment, 92*, 102734.
2. AD Little. (2018). *The Future of Urban Mobility: Towards networked, multimodal cities of 2050*, report. https://www.adlittle.com/en/insights/viewpoints/future-urban-mobility-0 (Accessed: 2023-9-15).
3. Berlin.de. (n.d.). *Berlin Mobility Act*. https://www.berlin.de/sen/uvk/en/mobility-and-transport/transport-policy/berlin-mobility-act/. (Accessed: 2023-9-15).
4. Bidmon, C. M., & Knab, S. F. (2018). The three roles of business models in societal transitions: New linkages between business model and transition research. *Journal of Cleaner Production, 178*, 903–916.
5. Bocken, N., Boons, F., & Baldassarre, B. (2019). Sustainable business model experimentation by understanding ecologies of business models. *Journal of Cleaner Production, 208*, 1498–1512.
6. Bocken, N. M. P., & Short, S. W. (2021). Unsustainable business models—Recognising and resolving institutionalised social and environmental harm. *Journal of Cleaner Production, 312*, 127828.
7. Bolt. (n.d.). *About Bolt*, https://bolt.eu/en/careers/about-bolt/ (Accessed: 2022-10-20).
8. Bolt. (n.d.). *Bolt i Stockholm* https://bolt.eu/sv-se/cities/stockholm/. (Accessed 2020-10-20).
9. Bolt. (n.d.). *Bolt i Oslo* https://bolt.eu/sv-se/cities/oslo/. (Accessed 2020-10-20).
10. Bolt. (n.d.). *Bolt i Berlin* https://bolt.eu/sv-se/cities/berlin/ (Accessed 2020-10-20).
11. Bolt. (2022). *Bolts micro-mobility services to improve connectivity in Neukölln,* https://blog.bolt.eu/en/bolts-micromobility-services-to-improve-connectivity-in-neukolln/ (Accessed: 2022-10-20).
12. Bolton, R., & Hannon, M. (2016). Governing sustainability transitions through business model innovation: Towards a systems understanding. *Research Policy, 45*(9), 1731–1742.
13. Boons, F., & Lüdeke-Freund, F. (2013). Business models for sustainable innovation: State-of-the-art and steps towards a research agenda. *Journal of Cleaner Production, 45*, 9–19.
14. City of Stockholm. (2020). *Even higher environmental goals*. https://international.stockholm.se/news/2020/06/environment/ (Accessed: 2023-9-15)
15. City of Stockholm. (2022). *Elsparkcyklar* https://cykla.stockholm/elsparkcyklar/ (Accessed 2022-11-07).
16. Ciulli, F., & Kolk, A. (2019). Incumbents and business model innovation for the sharing economy: Implications for sustainability. *Journal of Cleaner Production, 214*, 995–1010.
17. Cohen, B., & Kietzmann, J. (2014). Ride on! Mobility business models for the sharing economy. *Organization & Environment, 27*(3), 279–296.
18. Copenhanize index. (n.d.). The mots bicycle-friendly cities of 2019. https://copenhagenizeindex.eu/. (Accessed: 203-9-15).
19. Curtis, S. K., & Mont, O. (2020). Sharing economy business models for sustainability. *Journal of Cleaner Production, 266*, 121519.
20. Docherty, I., Marsden, G., & Anable, J. (2018). The governance of smart mobility. *Transportation Research Part A: Policy and Practice, 115*, 114–125.
21. EPA United States Environmental Protection Agency. (2022). Fast Facts on Transportation Greenhouse Gas Emissions (website). https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions (Accessed 2022-11-09).
22. EC European Commission. (2021). *The New EU Urban Mobility Framework*. Communication from the commission to the European parliament, the council, the European Economic and Social Committee and the committee of the regions, Brussels, 14.12.2021, COM(2021) 811 final. https://transport.ec.europa.eu/system/files/2021-12/com_2021_811_the-new-eu-urban-mobility.pdf (Accessed 2022-11-07).
23. ERR Estonian Public Broadcasting. (2022). *Bolt posts €547,2 million losses for 2021,* https://news.err.ee/1608651247/bolt-posts-547-2-million-losses-for-2021 (Accessed: 2022-9-28).
24. EU-startups. (n.d.). *Bolt*. https://www.eu-startups.com/directory/bolt/ (Accessed: 2022-9-28).
25. Eurofound (2021) *Amendment to passenger transport act in Germany*, https://www.eurofound.europa.eu/data/platform-economy/initiatives/amendment-to-passenger-transport-act-in-germany (Accessed: 2022-9-28).
26. Frenken, K., & Schor, J. (2019). *Putting the sharing economy into perspective*. Edward Elgar Publishing.
27. Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy, 31*(8–9), 1257–1274.
28. Geels, F. W. (2012). A socio-technical analysis of low-carbon transitions: Introducing the multi-level perspective into transport studies. *Journal of transport geography, 24*, 471–482.
29. Geissdoerfer, M., Vladimirova, D., & Evans, S. (2018). Sustainable business model innovation: A review. *Journal of cleaner production, 198*, 401–416.
30. Henriksson, M., Witzell, J., & Isaksson, K. (2019). All change or business as usual? The discursive framing of digitalized smart accessibility in Sweden. *Transportation Research Procedia, 41*, 625–636.
31. Huijben, J. C. C. M., Verbong, G. P. J., & Podoynitsyna, K. S. (2016). Mainstreaming solar: Stretching the regulatory regime through business model innovation. *Environmental Innovation and Societal Transitions, 20*, 1–15.
32. Klimaoslo. (2020). *Oslo´s new climate strategy*, https://www.klimaoslo.no/2020/06/10/oslos-new-climate-strategy/ (2023-9-15).
33. Laasch, O. (2018). Beyond the purely commercial business model: Organizational value logics and the heterogeneity of sustainability business models. *Long Range Planning, 51*(1), 158–183.
34. Library of congress. (2019). *Germany: regulation to allow use of e-scooters on public roads enacted,* https://www.loc.gov/item/global-legal-monitor/2019-06-25/germany-regulation-to-allow-use-of-e-scooters-on-public-roads-enacted/ (Accessed: 2022-10-10).
35. Lüdeke-Freund, F., Gold, S., & Bocken, N. M. (2019). A review and typology of circular economy business model patterns. *Journal of Industrial Ecology, 23*(1), 36–61.
36. Marsden, G., & Reardon, L. (2017). Questions of governance: Rethinking the study of transportation policy. *Transportation Research Part A: Policy and Practice, 101*, 238–251.
37. Martin, C. J. (2016). The sharing economy: A pathway to sustainability or a nightmarish form of neoliberal capitalism? *Ecological economics, 121*, 149–159.
38. Mazzucato, M. (2021). *Mission economy: A moonshot guide to changing capitalism*. Penguin UK.
39. NRI. (2022). *The Network Readiness Index 2022 – Stepping into the new digital era*, report. Ed. S. Dutta & B. Lanvin. https://networkreadinessindex.org/analysis/#preface (Accessed: 2023-09-15).
40. OECD. (2018). *Working party No. 2 on competition and regulation, Taxi, ride-sourcing and ride-sharing—notes from Sweden*. https://www.konkurrensverket.se/globalassets/dokument/om-oss/oecd/2018_taxi-ride-sourcing-and-ride-sharing-services_daf-comp-wp2-wd-2018-12.pdf (Accessed: 2022-9-10).
41. Oppegaard, S., Saari. T, & Saloniemi, A. (2020) Chapter 3. Uber´s trajectories in Nordic countries, *Platform work in the Nordic models: Issues, cases and responses* (pp. 25–46), Publisher: Nordic Council of Ministers. https://www.researchgate.net/publication/343944527_Chapter_3_Uber%27s_trajectories_in_the_Nordic_countries (Accessed: 2022-9-10).
42. Osterwalder, A. & Pigneur, Y. (2010). *Business model generation: a handbook for visionaries, game changers, and challengers* (Vol. 1). Wiley.

43. Reardon, L., & Marsden, G. (2018). *Conclusion: A window of opportunity*. Emerald Publishing Limited.
44. Regjeringen. (2022). *Regjeringen stanser frislippet i drosjenæringen vill stille en rekke nye krav*, press release, https://www.regjeringen.no/no/aktuelt/regjeringen-stanser-frislippet-i-drosjenaringen-vil-stille-en-rekke-nye-krav/id2900936/ (Accessed: 2022-10-10).
45. Regjeringen. (2022). *Nå blir det strengere regler for bruk av elsparkesykler* https://www.regjeringen.no/no/aktuelt/na-blir-det-strengere-regler-for-bruk-av-elsparkesykler/id2914010/ (Accessed: 2023-03-08).
46. Riggs, W., Kawashima, M., & Batstone, D. (2021). Exploring best practice for municipal e-scooter policy in the United States. *Transportation research part A: Policy and practice, 151*, 18–27.
47. Sarasini, S., & Linder, M. (2018). Integrating a business model perspective into transition theory: The example of new mobility services. *Environmental Innovation and Societal Transitions, 27*, 16–31.
48. Senate Department for the Environment, Mobility, Consumer and Climate Protection. (n.d.). *Berliner Mobilitätsgesetz*, https://www.berlin.de/sen/uvk/verkehr/verkehrspolitik/mobilitaetsgesetz/ (Accessed: 2023-03-08).
49. SCB. (n.d.) *Statistikmyndigheten*. https://www.scb.se/ (Accessed: 2023-11-20).
50. Schaltegger, S., Hansen, E. G., & Lüdeke-Freund, F. (2016). Business models for sustainability: Origins, present research, and future avenues. *Organization & Environment, 29*(1), 3–10.
51. Schaltegger, S., Lüdeke-Freund, F., & Hansen, E. G. (2012). Business cases for sustainability: The role of business model innovation for corporate sustainability. *International Journal of Innovation and Sustainable Development, 6*(2), 95–119.
52. Sochor, J., Fenton, P., de Bode, A., Conill de Azpiazu, M., Lamas Borraz, R., & Gasparin, P. (2023). HALLO: Hubs for Last Mile Delivery Solutions in Barcelona and Stockholm. *Transportation Research Procedia, 72*, 3300–3307.
53. SSB. (n.d.). Statistisk Sentralbyrå, https://www.ssb.no/ (Accessed: 2023-11-20).
54. Statens vegvesen. (2022). *Regler for liten elektrisk motorvogn* https://www.vegvesen.no/trafikkinformasjon/trafikksikkerhet/sikker-pa-elsparkesykkel/ (Accessed: 2023-03-07).
55. Statistik Berlin Brandberburg. (n.d.). *Statistik Berlin Brandberburg*, https://www.statistik-berlin-brandenburg.de/ (Accessed: 2023-11-20).
56. Stortinget. (2019). *Innstilling fra transport- og kommunikasjonskomiteen om Endringer i yrkestransportlova (oppheving av behovsprøvingen for drosje mv.)* https://www.stortinget.no/no/Saker-og-publikasjoner/Publikasjoner/Innstillinger/Stortinget/2018-2019/inns-201819-300l/?all=true (Accessed: 2023-03-07).
57. Stubbs, W., & Cocklin, C. (2008). Conceptualizing a "sustainability business model." *Organization & Environment, 21*(2), 103–127.
58. Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning, 43*(2–3), 172–194.
59. Tier. (n.d.). https://www.tier.app/en/ (Accessed: 2022-10-15).
60. Tier. (n.d.). https://about.tier.app/tier-enters-north-america-by-acquiring-micromobility-operator-spin/ (Accessed: 2022-10-15).
61. Transportstyrelsen. (2022). *Nu gäller nya regler för elsparkcyklar* https://www.transportstyrelsen.se/sv/Nyhetsarkiv/2022/nu-galler-nya-regler-for-elsparkcyklar/ (Accessed: 2022-11-07).
62. Transportstyrelsen. (2022). *Elsparkcykel* https://www.transportstyrelsen.se/elsparkcykel (Accessed: 2023-03-07).
63. UITP. (n.d.). *Collective and shared mobility options* https://citytransit.uitp.org/stockholm/collective-shared-mobility-options (Accessed: 2023-11-20).
64. UITP. (n.d.). *Collective and shared mobility options* https://citytransit.uitp.org/berlin/collective-shared-mobility-options (Accessed: 2023-11-20).
65. UITP. (n.d.). *Collective and shared mobility options* https://citytransit.uitp.org/oslo/collective-shared-mobility-options (Accessed: 2023-11-20).
66. UN United Nations. (2021). *Sustainable Transport, Sustainable Development*. Interagency report for second Global Sustainable Transport Conference. https://sdgs.un.org/sites/default/files/2021-10/Transportation%20Report%202021_FullReport_Digital.pdf (Accessed 2022-11-09).
67. VR. (2022). *Pålagt forsikring for elsparkesykler neste uke: Kan gi prisøkning* https://www.vg.no/nyheter/innenriks/i/dngj2z/paalagt-forsikring-for-elsparkesykler-neste-uke-kan-gi-prisoekning (Accessed: 2022-10-15).
68. Waes, A. V., Farla, J., Frenken, K., de Jong, J. P. J., & Raven, R. (2018). Business model innovation and socio-technical transitions. A new prospective framework with an application to bike sharing. *Journal of Cleaner Production, 195*, 1300–1312. https://doi.org/10.1016/j.jclepro.2018.05.223
69. Wainstein, M. E., & Bumpus, A. G. (2016). Business models as drivers of the low carbon power system transition: A multi-level perspective. *Journal of Cleaner Production, 126*, 572–585.
70. Wallsten, A., Henriksson, M., & Isaksson, K. (2022). The role of local public authorities in steering toward smart and sustainable mobility: Findings from the Stockholm metropolitan area. *Planning Practice & Research, 37*(5), 532–546.
71. Wesseling, J. H., Bidmon, C., & Bohnsack, R. (2020). Business model design spaces in socio-technical transitions: The case of electric driving in the Netherlands. *Technological Forecasting and Social Change, 154*, 119950.
72. Zott, C., & Amit, R. (2010). Business model design: An activity system perspective. *Long Range Planning, 43*(2–3), 216–226.

Publisher's Note