

Research article

E-scooter regulation: The micro-politics of market-making for micro-mobility in Bergen

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ARTICLE INFO

Keywords:

Micro-mobility
 Micro-politics
 Market-making
 Mobility transition
 Mobility justice
 Commoning

ABSTRACT

Micro-mobility market-making represents an under-studied but important aspect of urban transport sustainability transitions. Micro-mobility roll-out combines several critical elements: decarbonisation, digitalisation and public space interventions. We theorise the emergence of a micro-mobility market, drawing on innovation studies, micro-politics scholarship and commoning mobility literature, and critically discuss the relationship between innovation and regulation in this emerging market. We examine e-scooter roll-out in Bergen, Norway, using a structured analysis that interrogates knowledge, authority and power. Our empirical analysis employs expert interviews and focus group discussions with key transport sector stakeholders, including policymakers, practitioners and urban residents. We discuss insights in terms of implications for how micro-mobility markets are made and in turn make urban transport sustainability transitions. We argue that while micro-mobility can enable just low-carbon mobility transitions, market forces drive outcomes that may undermine urban sustainability agendas. We identify scope for dynamic regulation to engender low-carbon mobility in wider public interest.

1. Introduction: regulating smart micro-mobility

Decarbonising transport is a challenging piece of the puzzle for sustainability transitions (Tsoi et al., 2021; Canzler and Knie, 2016). The urban scale is a key battleground for decarbonisation (Voytenko et al., 2016; Bouteligier, 2015). Urban transitions foreground multiple conflicts such as competition over space, and constitute contexts where accelerated politics of transition are most likely to play out, as social movements and policy lobbying by interest groups tend to take place in and around cities (Sheller, 2011). These aspects make the urban scale an apt one to study market-making in sustainability transitions (Moradi and Vagnoni, 2018). We understand transitions after Sheller (2011) as twin transitions to sustainability and mobility justice, i.e., as entailing both ecological low-carbon shifts and social shifts to equitable transport systems.

Urban authorities often have significant regulatory influence over local and regional transport. While national regulations set overarching frameworks, municipalities typically have responsibility for implementing the regulations, conducting land use planning, coordinating public transport and providing infrastructure. Urban transport policies have increasingly taken decarbonisation on board, as municipalities preempt or respond to ambitious national government commitments to decarbonisation and aim to take the lead themselves through trans-national networks such as C40 Cities and the Covenant of Mayors (Van der Heijden, 2019).

Consequently, changes in the transport sector are also more susceptible to politicisation amongst local publics with competing

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<https://doi.org/10.1016/j.eist.2021.10.009>

Received 14 May 2021; Received in revised form 4 October 2021; Accepted 12 October 2021

Available online 21 October 2021

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interests. This is particularly the case with collective and public modes of transport, which are premised on a shared sense of public space and services aimed at creating urban commons that make transport possible for everyone (Sheller and Urry, 2006; Adey et al., 2021). Stimulating a shift towards collective modes of transport is often in conflict with the model of private automobility, premised on a market model that targets individual ownership and preferences shaped in line with a socio-technical imaginary of transport as an individual need to be served through the production and consumption of cars (Axsen and Sovacool, 2019).

Yet decarbonisation of urban transport does not simply play out as a binary logic of transitioning from private automobility to collective and low-carbon transport modes. There are other logics at play, including electrification and digitalisation. Electrification of the hegemonic practices of transport that dominate urban transport planning legacies is evident in the prominent rise of electric cars to displace fossil fuel cars. This logic of electrification increasingly extends to buses, and other modes of electrically powered public transport such as subways and light rails are already in place and continue to expand within and across cities.

Electrification has also begun to penetrate bicycling and walking practices, or what is often referred to as ‘micro-mobility’ (Sunio et al., 2020). Stimulated by digitalisation, electric bicycles are becoming widely available for both private ownership and public sharing schemes, and e-scooter companies have proliferated with sensor-equipped electric, upgraded versions of foot push scooters in many cities worldwide (Abduljabbar et al., 2021). These trends are accelerating in parallel with a dramatic cost reduction in high-capacity batteries that make more compact, longer-range electric vehicles feasible in unprecedented ways (Zeng et al., 2019). Especially in cities, electric micro-mobility is an object of rapid market formation that discursively interpellates energy and transport policy ambitions of decarbonisation.

In this paper, we broach this emerging concern for sustainability transitions research: *how is an urban micro-mobility market made, and with what consequences for urban transport sustainability transitions?* There are experiences in cities across the world of new mobility solutions creating new markets, for example e-bikes and Uber taxis on digital platforms typically accessed as smartphone applications, that share some of the same conflicts and regulation issues (see for example Petzer et al., 2020a). Yet there is scarcity of literature on urban market formation of micro-mobility and in particular e-scooters. Indeed, a recent systematic literature review shows that the top terms used across 328 articles on micro-mobility and sustainability during 2000–2020 do not feature the word market (Abduljabbar et al., 2021). We see this as a gap to be urgently addressed, because the nature of market formation for micro-mobility has potentially significant and far-reaching effects, both for social inclusion and rapid decarbonisation of urban transport in line with ambitious 2030 targets. Birtchnell et al. (2018) show the value of considering socio-material particularities of similar yet distinct micro-mobility modes in attending to ‘maverick’ users. Therefore, we focus on the micro-politics of micro-mobility (Vigar, 2002; Hajer, 1995), using a particularly well-suited empirical case to address these concerns.

The medium-sized Norwegian city of Bergen, with a population of nearly 300,000 quite common to many European cities, has a mountainous and rainy physical geography that makes micro-mobility especially challenging and important for a low-carbon urban transport transition, as well as a compact historical city centre and suburban sprawl (Engebretsen et al., 2017). It is served by renewably sourced electricity (primarily from hydropower) with a fully digitalised electric grid, and is increasingly expanding an electrified transport system and phasing out fossil fuel vehicles, in line with ambitious low-carbon targets (Wanvik and Haarstad, 2021). In this context, we focus on the recent controversial roll-out of e-scooters – which began before any preemptive regulations to govern such a rollout had been established – from its emergence in summer 2020 up to the institutionalisation of e-scooter regulations by spring 2021. This roll-out constitutes a case of micro-mobility market formation, within an ambitious and complex urban transport sustainability transition context. Even though the experience with e-scooters differs between contexts, our analysis is likely to yield transferable insights for the governance of micro-mobility in other medium-sized cities, and to advance a scholarly understanding of how markets form and with what consequences for urban transport sustainability transitions.

We proceed as follows. Section 2 provides an overview of market formation in urban mobility transitions, and theorises the role of micro-mobility within this. We draw on research on innovation, micro-politics and commoning by scholars of mobility to draw out implications for market formation. Section 3 draws on Zuboff (2019) to foreground three questions about knowledge (who knows?), authority (who decides?) and power (who decides who decides?). It also summarises our methods and materials, namely expert interviews and focus group discussions with stakeholders in Bergen’s transport transition. From these, we draw on a subset that concerns micro-mobility, complemented by desk study of sectoral policies and media coverage. Section 4 features our empirical analysis of the emergence and institutionalisation of a micro-mobility market in Bergen, which we understand as market-making in micro-mobility through performative practices. In Section 5, we discuss this market in terms of its impact on low-carbon urban transport transitions in Bergen and elsewhere, by explicating the implications of our argument for scholarship on innovation, micro-mobility and commoning in relation to market-making. Finally, Section 6 concludes with reflections for future thematic research.

2. Theory: innovation, micro-politics and commoning

We understand market-making after Araujo (2007) as the process whereby calculative practices (the combination of calculation and qualitative judgement) by multiple agents performatively produce the market as an institution. We make conscious use of the term market-making rather than market formation, to emphasise our relational approach which focuses on the roles of actors in making this market, rather than a structuralist understanding of market formation that may be more familiar to some transition studies scholars. There is, however, close coherence between both terms, and indeed, there is emergent recognition of the value of an emphasis on processual aspects of market formation (see e.g. Anfinson, 2021). Notably, Boon et al. (2020, p.346) emphasise the need to attend to “legitimized perceptions of market boundaries, the roles of actors, the interplay between markets, and the process character of market formation.”

To understand market-making in micro-mobility, we draw on literature from innovation studies, micro-politics and commoning

mobility. Together, these perspectives provide a multi-pronged approach to understanding market-making in micro-mobility, as they coalesce views on how new technologies and practices emerge and are shaped by interest groups, which condition possibilities for micro-mobility to provide common, public goods. Innovation studies feature a focus on the dynamics through which new technologies emerge and become embedded within socio-technical practices (Geels, 2005a; Deuten et al., 1997). Micro-politics research addresses the informal and often rapidly evolving reconfiguration that takes place at the local level as contestation arises and is resolved or escalates due to interventions such as new technologies (Lennon and Moore, 2019; Burns, 1961). These aspects are often not recognised or captured in formal analyses premised on existing institutional structures (Yates, 2015). Scholarship on commoning mobility introduces an explicitly normative aspect that is germane to our focus on sustainability transitions: mobility sector changes must create urban transport solutions that are in public interest, while pursuing low-carbon pathways that are themselves commoning at a planetary scale by lowering atmospheric burdening due to carbon emissions (Henderson, 2020; Sheller, 2011). Thus, these three fields focus on socio-technical change, sectoral reconfiguration and normative socio-spatial effects.

2.1. Innovation studies

Innovation scholars theorise that technological innovation drives the emergence of socio-technical solutions like micro-mobility by creating incentive structures within a market-based economy where supply is responsive to demand (Manso, 2017; Nemet, 2009). Further, they note that this relationship is recursive, so that supply in turn acts upon and shapes demand, i.e., a technology can serve a need that is only recognised as existing once the technology becomes available and embedded within socio-technical practices (O'Connor and Rice, 2013; Dewald and Truffer, 2011). A notable example is video streaming, which many people worldwide routinely rely on today for many everyday activities in diverse ways that were far less widespread just a decade ago (Gimpel, 2015), and a general shift to cloud-based streaming services that transformed the music industry in the early 21st century, away from reliance on physically owned copies of copyrighted music content (Wikström, 2020). A core premise of how scholars understand these developments is that as technological possibilities emerge, market actors channel these possibilities into particular value chains, and if successful this reconstitutes the very nature of those value chains (Frenken et al., 2020). In the case of electric mobility, innovation scholars identify the compactness and affordability of battery technologies as a game-changer (Zhang et al., 2017), with continuity from the smartphone revolution that relied heavily on innovation in lithium ion batteries. This development changes the political economy of the transport sector, opening up scope for new entrants and partnerships, and in instances such as the electric car market, enticing incumbent actors to adapt for optimal positioning during sectoral evolution (Sovacool et al., 2019).

In the transport sector's micro-mobility segment, technologies that can be displaced by electric solutions have been around for more than two centuries: the bicycle was invented in 1817, and walking is as old as humankind itself (Geels, 2005b; Martin, 2019). Other technologies such as skateboards and push scooters have played a relatively marginal role, but a notable aspect in recent decades is an increasing trend in urban planning to privilege these ways of moving in many cities, through infrastructural interventions like bicycle lanes, wider pavements, and car-free zones (Zipori and Cohen, 2015). The advent of electric bicycles, cycling as a service (CaaS), cargo bikes and e-scooters in the late 2010s thus arises at a time when transport policy is generally favourable to improving the built environment's ability to accommodate micro-mobility solutions (but see Glaser et al., 2020 on the persistence of automobility frames). Another important trend is strong policy traction for 'smart city' solutions, where lofty rhetoric and lobbying for digital solutions as crucial to sustainability and high life quality during the 2010s have led to a broadly positive disposition towards high-tech, electric interventions in most urban landscapes and leading, influential urban policy circles (Tompson, 2017; Mora et al., 2021; Petzer et al., 2020b).

Thus, innovation scholarship suggests that electric micro-mobility actors may be able to expand quite smoothly and rapidly – albeit with variation in strategies across socio-political contexts (van Waes et al., 2020) – by leaning on two virtuous trends: economic competitiveness and compactness of electric batteries, and popular perceptions of as well as growing policy support for such solutions as integral to building better, more sustainable urban transport systems. This presents challenges for governance, since innovation and market-making often occur faster than governance actors are able to keep up with them.

2.2. Research on micro-politics

The literature on micro-politics identifies several factors that may guide such a shift in technological solutions as they are embedded into existing socio-technical practices and consequently reshape these practices. Burns (1961) conceptualises micro-politics as the dynamic interaction between self-interested personal conduct and mechanisms to translate changes in the conditions of social systems into adaptive changes of these systems, which unfolds through human and material resources. Micro-politics scholars point out that multiple and often conflicting incentives are at play and that these are context-specific (Lennon and Moore, 2019). For instance, bicycle infrastructure may be the result of demands made by an articulate political constituency over time, to secure better mobility geared towards users who may not be similarly well-served by electric bicycles, which tend to be more costly and can operate at higher speeds (Lubitow and Miller, 2013). By the same token, electric bicycles may be promoted by overlapping yet distinct supporters, such as those who wish to use them for a mid- to long-range commute, e.g. between outer suburbs and the city centre, or those who lack adequate time or fitness for physically powered daily bicycle commutes (Golub et al., 2016). This distinction amongst which publics support or oppose a technology becomes more contrasting when scholars consider e-scooters. Unlike bicycles, these represent a relatively new mobility solution, and raise questions such as what parking rules are applicable, safety issues, and what existing uses of public space they are displacing when they are left idle on a pavement or in a square (Bai and Jiao, 2020; Lavoie-Gagne et al., 2021).

Micro-politics research offers several insights in this regard. One is that the sequentiality of intervention matters; initial reactions in

the public domain can be quite consequential - indeed prefigurative - for further regulatory evolution, which is contingent on legitimisation in multiple domains, such as the legislative, the administrative, and the political domain (Yates, 2015). Whereas discussion in the political domain develops quickly, e.g. through statements by private sector actors rolling out technologies, by city council representatives and media coverage including the views of urban residents and various interest groups, identifying an administrative stance typically takes longer as it can often require building up new capacities and conducting evaluation based on expertise that may be limited with regard to a new intervention (González and Healey, 2005). Change in the legislative domain is usually slowest, as it must clear democratic checks and balances that are important to ensure accountable decision-making and maintain the stability of socio-technical systems like transport even during sectoral transition (Dilley, 2017).

Thus, the micro-politics literature directs attention to interactions across different domains as a new technology is embedded into socio-technical practices, emphasising the multiple rates at which institutionalisation occurs in and across domains, and the opportunities and trade-offs that this gives rise to for differently interested actors in a changing sector. It is focused on dynamics at the urban and sub-urban local scales (Willner, 2011); these are often overlooked as informal elements in higher-level analyses. For instance, in their study of e-scooter usage in Munich, Hardt and Bogenberger (2019) find high levels of leisure usage, indicating that their advent may give rise to new forms of and reasons for mobility practices.

2.3. Commoning mobility scholarship

Finally, scholars in the mobilities field add a normative thrust away from consumerist and individualistic systems grounded in a continuation of automobility (Kester et al., 2020; Sheller and Urry, 2006) and towards commoning mobility (Sheller, 2011). Broadly, this range of approaches directs attention to what sort of solution a particular technology provides for micro-mobility: whether it enables remote forms of ownership and profit extraction through corporate billing models that hollow out revenue flows to public transport, or makes cities more accessible for diverse types of users without penalising its non-users (Uteng and Lucas, 2017). An emphasis on commoning asks whether an intervention combines elements of mono-cultures or one-size-fits-all solutions (design the same as in many other cities, based on economies of scale and a technological learning curve) with some context-specific adaptation (where to position e-scooters, how to add to rather than abuse urban public space, how to complement rather than undermine existing public schemes such as bicycles, and locally situated branding). This subset of commoning mobility literature is particularly interested in the effects of a given intervention on creating or reducing urban commons for mobility (Nikolaeva et al., 2019). Notably, Glover (2016) sees scope for communal ownership to constitute a basis for personal mobility, challenging the public/private binary often assumed in mobility analyses.

More generally, a close connection between transport and related sectors like housing is foregrounded by commoning scholars who consider the equity impacts of interventions in debates like the 'right to the city' (Arcidiacono and Duggan, 2019). Micro-mobility can be understood as part of a policy mix to enable greater housing availability within a wider radius from hubs (such as light rail stops) with the last-mile served by e-scooters, but this perpetrates a continuity of automobility down to the level of the individual, where many user types are liable to be excluded from this sort of housing (Bodirsky, 2017).

Commoning mobility scholars hold that transport options determine people's choice of where to reside and are closely intertwined with housing prices (Trimikliniotis et al., 2015); e.g., lower-density and far-flung areas are hardest to service with high quality frequency, and last-mile issues are particularly severe as suburban sprawl increases with more widely interspersed bus stops. This field of research points to intersecting inequalities and the need to adopt an intersectional approach that commons in broadly inclusive ways, away from enclosure in various transport policy guises (Nikolaeva et al., 2019).

Thus, research on commoning and specifically the commoning mobility literature consider socio-spatial effects of an intervention in terms of its impact on access and equity. Attention to commoning makes us mindful of differences between diverse user types, as well as implications across sectors. Interpreted further in relation to digitalisation, it could also equip us to approach questions such as commoning data on micro-mobility, with emphasis on questions such as user control and privacy, as well as what purpose the usage of data systematically collected by micro-mobility companies is serving (Feng et al., 2020; Mouratidis et al., 2021).

3. Methodological approach

Informed by the conceptual underpinning above, we structure our case study analysis of Bergen's micro-mobility transition by employing three questions to guide a structured understanding of socio-technical transition. The questions are drawn from influential scholarship on surveillance capitalism that unpacks the roll-out of platforms that extract data, condition users and financialise user behaviour (Zuboff, 2019). We borrow Zuboff's questions about knowledge, authority and power to understand the dynamics of market-making in our case. After linking these questions to our study below, we provide a summary overview of our methods and materials, then elaborate the empirical analysis in Section 4.

3.1. Knowledge, authority and power

The three questions that structure the analysis, drawn from Zuboff (2019), are: (i) who knows - this concerns which actors hold and are seen to hold relevant knowledge regarding micro-mobility; (ii) who decides - this concerns who holds the authority to make decisions on the nature of micro-mobility; and (iii) who influences - this concerns power to determine the conduct of conduct (Foucault, 1982), i.e., who is able to influence the institutionalisation of decision-making on micro-mobility during roll-out.

First, considering knowledge and who knows necessitates a focus on epistemic politics. This focus makes us mindful of the multiple

bases of expertise, and the contingent nature of knowledge in a circumstance of uncertainty, such as a transitioning sector (transport) or segment (micro-mobility). Hence asking ‘who knows’ is a way to problematise overly simplistic claims or assumptions about the actors who are ‘experts’, in line with the insight from innovation studies that where expertise is situated is in flux during transitions as the nature of sectors evolves (Jalas et al., 2017). The differential experiences of diverse users are important to account for (Whittle et al., 2019), as also the situated nature of expert actors and their embodied biases in perception and self-interest (Meadowcroft, 2011). We therefore consider the basis for expertise and diverse kinds of expertise linked with various actors in our empirical analysis. This is linked to a key concern in market-making research: how the constitution of expertise conditions market orientation (Skjølsvold et al., 2013; van Waes et al., 2020), in a given sector like transport.

Second, examining authority and who decides ensures a focus on the governance of micro-mobility by institutional actors who have social legitimacy to formulate and implement regulations on micro-mobility roll-out. This focus is in keeping with insights from micro-politics on the context-specificity and contested exercise of power (Lennon and Moore, 2019). Examining who decides reminds us that the nature of authority is itself uncertain during a sectoral transition, as multiple actors vie for legitimacy of viewpoints that support their interests, and this contestation is reflected in multiple domains including potential institutional reconfiguration (Ghosh and Schot, 2019). Particularly at the urban scale, the role of particular individuals in positions of authority, e.g. within local government, becomes significant (Vagnoni and Moradi, 2018). The scope and mandate of existing institutions is subject to change (Barnes et al., 2018), and attention to who decides provides insight into the actual constitution of authority. This focus on authority pertains to how rules emerge and become institutionalised in market-making, a concern mirrored in micro-politics research (Burns, 1961; Giamporcaro and Gond, 2016).

Third and last, analysing who decides who decides turns focus to questions of power, also beyond formal relations of accountability and in informal arenas of contestation. This enables analytical identification of vital aspects of sectoral change, such as which actors hold capacity to exercise change (Bowman, 2008). It also explains the salience accorded to justice aspects in mobility studies, as power expressed without accountability in an essential service sector like transport can enact deep injustices and exclusions (Petzer et al., 2020a; Henderson, 2020). In micro-mobility, decision-making may rest with operators, regulators, and others. The question of who conducts conduct also draws attention to who determines the basis that is available to inform decision-making through the selection of key standards and metrics as well as the socio-technical measurement of particular aspects of sectoral functioning that are thus rendered selectively visible and governable (Sareen et al., 2020). The exercise of power is thus approached as a function of the interaction of actors with each other and with the political ecology of a changing sectoral segment such as micro-mobility. Power analysis is useful for unpacking market-making dynamics (Jaehrling, 2015), and in the terminology of commoning mobility research, can characterise changes in terms of shifts towards greater enclosure or commoning depending on whether power advances narrowly private or broadly public interests respectively (Nikolaeva et al., 2019).

3.2. Methods and materials

To inform this empirical analysis, we conducted fieldwork from July 2020 to May 2021, using a variety of methods for data collection on the roll-out of a particular micro-mobility solution, namely e-scooters. The analysis is informed by several sources of data, collected as part of a larger research program on sustainable urban mobility. These data sources include (1) secondary information provided by local media, (2) expert and stakeholder interviews, and (3) focus group discussion with selected residents. Of these sources, the first and second provide the primary input to the analysis, while the third was useful in scoping and exploration of the theme.

First, desk study of Norwegian language media coverage, particularly the local newspaper *Bergens Tidende*, and social media sources such as the ‘urban development in Bergen’ Facebook group, were important sources of data. E-scooters proved controversial from the outset, starting in July 2020 when a company called Ryde placed the first e-scooters in the streets of Bergen without informing authorities. So the roll-out received significant media attention throughout the study period of initial roll-out, contestation and emergent regulation. Central politicians, such as the Commissioner for Urban Development, were regularly interviewed by local media.

Second, we conducted 20 expert interviews, with municipal officials including transport and urban planners, political party representatives engaged in transport debates, a developer with close involvement in the municipality’s platform for regulating micro-mobility, architects and housing agency representatives to capture cross-sectoral issues, a journalist with thematic expertise, and a representative of the Norwegian Data Protection Authority. Interviews lasted from 30 to 120 min and covered a broad range of issues within the theme of just mobility transitions. We also approached the micro-mobility company Ryde, who refused our request for an interview (although we have consulted interviews they have given to the local newspaper).

Third, during autumn 2020, our team conducted three focus group discussions with a total of 17 residents of Bergen, selected by posting public invitations through local networks (strategic and convenience sampling). Since participants volunteered their time, selection leaned towards those with some interest in urban transport transition, which ensured well-informed discussion. During each hour-long discussion, one team member posed several questions about micro-mobility, including a word association prompt for which we report results. These discussions captured a range of ordinary, interested users’ perspectives on Bergen’s larger low-carbon mobility transition as well as the roll-out of e-scooters specifically, within two months of their appearance. There are some limitations in the focus group data, for example selection bias and representiveness. But we used the data primarily for scoping and exploration, and in this paper we show some of the data to illustrate some perceptions of local residents towards the e-scooters.

In addition, to complement these approaches, we undertook participant observation, including the lived experience of navigating the city and observing e-scooters being used, parked, battery-swapped and placed at strategic locations by company staff, and

proliferate in the urban landscape, especially Bergen's city centre, during the study period. We also held a three-hour public seminar on a just low-carbon mobility transition for Bergen, which featured transport planners, transport researchers, digital mobility experts and a diverse audience of 50 people who engaged with the speakers.

Throughout the research process we ensured rigour by having multiple authors undertake iterative analyses of the written notes (of interviews) and transcripts (of focus group discussions) during the study period, as well as rewatching a video recording of the public seminar, and maintaining an ongoing dialogue with several engaged urban planners about our analysis, to actively solicit clarification and feedback on the emerging insights. The empirical analysis draws most directly from the first and second data source, while the other sources provide informative contextualisation.

4. Empirical analysis: from controversy and contestation to a public-private partnership

E-scooters appeared in Bergen's urban landscape several months after being introduced in Norway's other major cities, Oslo, Trondheim and Stavanger, where they had proved controversial. At the end of June 2020, one e-scooter company, Ryde, that had pulled out of Oslo faced by many competitors and been taken to court by Trondheim municipality, placed 500 e-scooters on Bergen's streets overnight without permission from Bergen municipality or police. E-scooters have been considered similar to shared bicycles in the existing regulations. But arguably, as opposed to bicycles there are no established norms for how users on e-scooters should behave

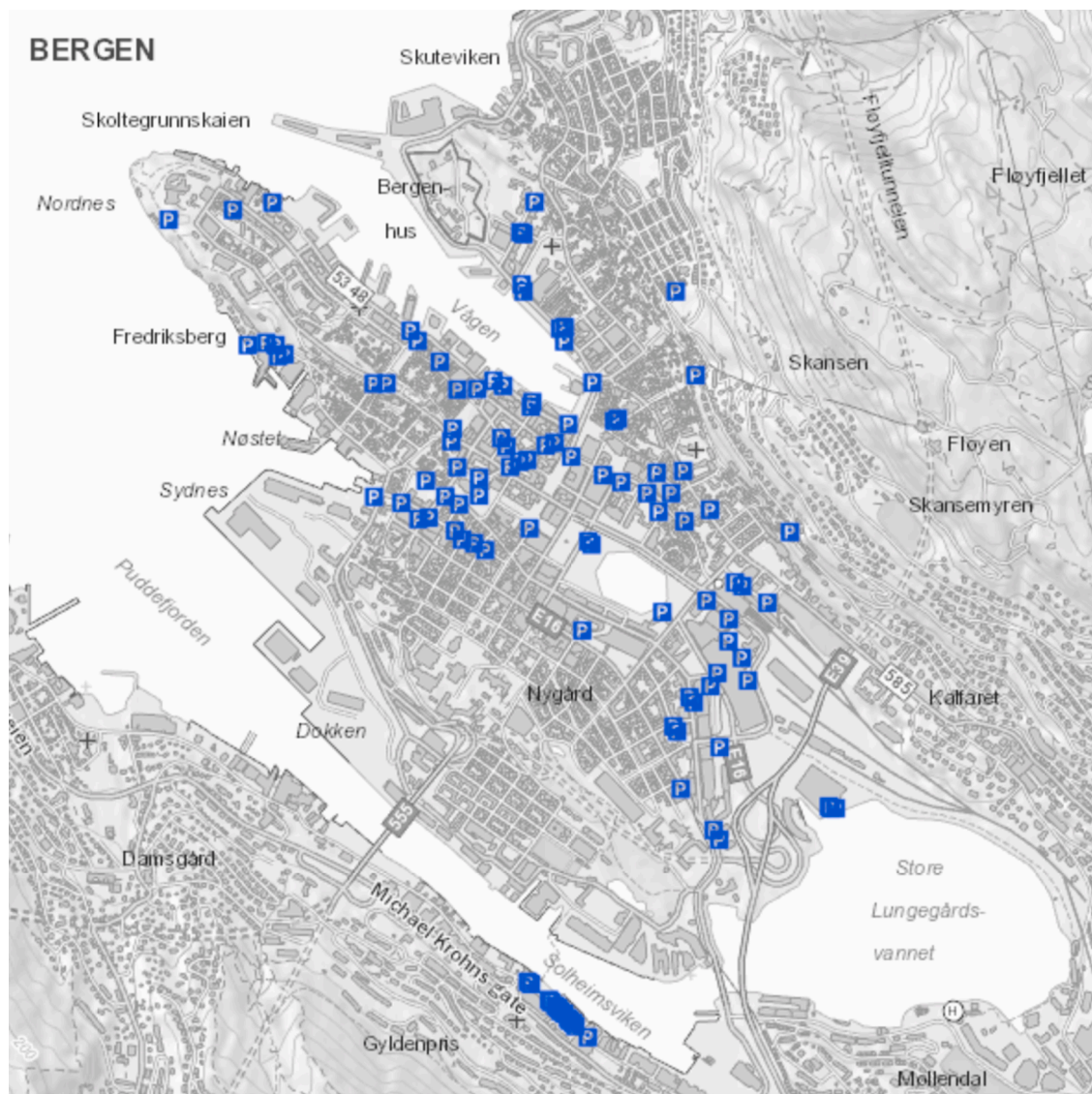


Fig. 1. Map of e-scooter parking zones (screenshot of Bergenskart tool with filters). Source: Bergen Municipality. Link: <https://www.bergen.kommune.no/innbyggerhjelpen/trafikk-reiser-vei/vei-transport-og-parkering/sykel/elsparkesykler-i-bergen> (accessed 13.5.2021).

in traffic, and no infrastructure for parking. Indeed, part of the initial business model was that the e-scooters could be left anywhere, whereas shared bikes typically have to be placed in a dock. So the rapid introduction of e-scooters in Norwegian cities proved controversial.

Bergen municipality's Urban Environment Agency initially responded by confiscating e-scooters that obstructed sidewalks and demanding a fine of 5000 kroner (approximately €500) per case, but Ryde countered by pointing out the municipality's slow approach to establishing an approval process since the company claimed to have first made its interest known in February 2019 (the municipality has denied knowledge of this initial expression of interest). Bergen municipality took Ryde to court for violating its ordinances. But the court ruled in late July that Ryde could continue its operation as it did not pose clear imminent danger. At the same time, it also ruled that the municipality is in a position to protect itself based on exercising property rights, i.e., its authority over urban public space. This outcome, similar to the one in Trondheim, underscored a lacuna in existing regulation which had not anticipated the rapid innovation that led to the roll-out of e-scooters as a new urban micro-mobility solution.

In late August 2020, the police approved Ryde's doubling of e-scooters in the city to 1000 for a limited period during September–November 2020. amongst calls for regulation, the Norwegian Association of the Blind notably emphasised its slogan from a campaign in Trondheim which led people to place stickers with its logo and the statement 'I have obstructed the weak-sighted and blind' (in Norwegian) on e-scooters that they found blocking pavements. Meanwhile, Bergen municipality proceeded with a formal process to establish regulations for the emerging e-scooter market, which as many as ten other companies expressed interest to operate in. After inputs from a large meeting on 26.8.2020 on micro-mobility regulation and 13 one-to-one meetings with interested companies, [Bergen Municipality \(2021\)](#) proposed this test period timeline:

- November 2020 – February 2021: pilot projects with up to four companies to test mechanisms including road tolls for e-scooters (to be calculated but not invoiced), and to evaluate and set revised parameters for the next test period.
- March–May 2021: potentially include additional companies, begin to invoice e-scooter road tolls, establish e-scooter parking zones and a potential common street patrol.
- June–October 2021: full-fledged operation, with a concluding evaluation and a potential additional test period before concluding the pilot projects.
- November 2021 – April 2022: Final adjustments before bringing new regulations into force, with prolongation or a shortened timeline, as necessary.

The Urban Environment Agency partnered with a Norway-based government technology company, Nivel, to develop and test a micro-mobility digital control tool. This included a digital regulator tool that “analyses real-time position data from the vehicles with dynamic algorithms, putting city administrations on top of micromobility and public space utilization”, and a parking report tool that “provides the last brick to control shared scooters ... for the general public and ... regulatory authorities ... assuring useful metadata and reliability” (from Nivel's website <https://www.nivel.no>, accessed 13.5.2021). By May 2021, Bergen had a competitive e-scooter market with six companies - Bolt, Tier, Voi, Wind, Bird and Ryde - of which all except the last had opted to enrol in the pilot project, and were sharing micro-mobility data with Bergen municipality. The municipality had also established e-scooter parking zones in and near the city centre, as [Fig. 1](#) shows. [Table 1](#) provides a summary timeline of key micro-mobility developments between July 2020 and May 2021.

We now analyse these developments, drawing on expert interviews and focus group discussions, following the same structure as the analytical framework, on knowledge, authority and power.

Table 1
Timeline of micro-mobility developments in Bergen (July 2020 - May 2021).

Month	Development	Indicative media coverage and public announcements
End-June 2020	500 e-scooters by Ryde appear in Bergen	https://www.dagbladet.no/nyheter/full-sparkeykkel-krangel-fjerner-syklene/72624999
End-July 2020	Mixed outcome in the e-scooter court case	https://www.aftenposten.no/norge/i/K3OXxo/bergen-kommune-tapte-foerste-runde-om-elsparkeyklene-naa-maa-de-betale
August 2020	Norwegian Association of the Blind issues a statement against unregulated e-scooters; Bergen police approve 1000 Ryde e-scooters for a limited period	https://www.blindeforbundet.no/om-blindeforbundet/nyhetsarkivet/el-sparkeykler-til-besvaer ; https://www.bt.no/nyheter/lokalt/i/LAVGeR/politiet-sier-ja-til-en-utvidelse-fra-500-til-1000-elsparkeykler-i-be
End-October 2020	Bergen municipality invites companies into a pilot project, in line with rules of the Norwegian Government Agency for Financial Management	https://www.bergen.kommune.no/hvaskjer/bymiljo/inviterer-til-pilotprosjekt-for-utleie-av-elsparkeykler ; details in the database for public procurement: https://www.doffin.no/Notice/Details/2020-367202
December 2020	Wind introduces 800 e-scooters with new economic models; seven companies are approved in the pilot in Åsane suburb	https://windmobility.blog/2020/12/04/wind-lanserer-delning-av-elsparkeykkel-i-bergen ; https://www.aasanetidende.no/nyheter/2020/11/20/naa-er-elsparkeykkel-aktoerer-valgt/
January 2021	Norwegian Competition Authority experts praise Bergen's emerging e-scooter regulatory approach	https://konkurransetilsynet.no/kronikk-bergen-ser-ut-til-a-handtere-sparkeyklene-bedre-enn-oslo/
March 2021	Institute of Transport Economics highlights a study of e-scooter risks in Denmark; Net magazine Bilduden ('The car dude') compares micro-mobility companies in Bergen	https://samferdsel.toi.no/forskning/elsparkeykkelen-fa-regelbruddmen-hoy-risiko-article34484-2205.html ; https://bilduden.no/leie-elsparkeykkel-bergen-trondheim-stavanger/

4.1. Who knows?

An urban mobility planner, interviewed 26.10.2020, estimated that 80% of e-scooter trips were replacing walking or public transport trips, and attributed this trend to the profit-maximising model of the first company to enter the market. When Ryde introduced 500 scooters in downtown Bergen overnight in late June, this came during an ongoing process where urban planners were already underway with co-designing a pilot project with partners to learn how shared micro-mobility solutions could enable modal shifts away from automobility. By October, these e-scooters had completed 600,000 trips, giving a single company an advantage in collecting data on micro-mobility usage patterns - and presumably in adjusting e-scooter locations to maximise revenue flow - that its competitors and the municipality did not have access to. A study in Oslo using an internet-based survey ($n = 549$) and in-depth interviews confirms similar usage trends, showing that only 8% of studied e-scooter trips there replaced car or taxi usage, whereas 60% replaced walking, 23% replaced public transport trips, 6% replaced shared or individual bicycle rides and 2% were gratuitous, with the majority of trips starting in the city centre during morning rush hours (Fearnley et al., 2020).

From a more embodied perspective, mobility users know the impact of this micro-mobility intervention. Our prompt to play word association in response to 'e-scooters' in three focus groups with a total of 17 users yielded 24 revealing phrases, listed in Table 2. The majority of these indicate grounds for concern with regard to safety, affordability, exclusion and the use of public space. A female focus group participant reflected:

"With my pram, they are in the middle of the road so I have to go out on the road to roll past them. And for people in wheelchairs, it is also very annoying ... Suddenly there are five scooters blocking your way. Or if you have poor eyesight or are blind, suddenly the pavement is blocked, you have to get out onto the road."

Upon requesting a clarification regarding who was responsible, she elaborated: "I feel, those who drive can put it to the side rather than in the middle of the road. Also, there is no place where you can put the scooters either. So I understand that people do not think, it's so easy to just throw it away, in a way."

In a literal sense, the algorithm underlying the software application for each company knows live locations. The Nivel platform that the municipality is piloting has the capability to track e-scooter locations across multiple providers. Moreover, any third parties the companies share anonymised user data with may know patterns over time and correlate them with other information on users (e.g. based on using the same credit card), an aspect where we lack adequate detail.

Thus, three kinds of knowledges matter: about the impact of e-scooters on public space and modal transport usage; about their utility or obstructive nature to different urban residents; and about what their linked cloud platforms know and who they make this knowledge available to. During the study period, emerging regulation enabled a public-private partnership and a common platform to generate data for micro-mobility companies and the municipality that would allow real-time knowledge on needs, provision of micro-mobility services, and the impact of e-scooters on public space, including an option to report any parking violations. Yet the largest operator, Ryde, remained outside this private-public partnership, consolidating its solo headstart. It simply decided to not participate in the regulatory efforts of the city, and the authorities have so far lacked the tools to force compliance.

4.2. Who decides?

By leading the roll-out before the municipal process was ready, Ryde tried to shape regulation through innovation, creating a de facto market. Local court rulings followed a legislative basis that was not written with the particular e-scooter technology in mind; they did not set the normative course so much as they acted as bureaucratic implementers of institutionalised norms. A male focus group participant opined:

"I kind of experience that city bikes are the good guys, you also have these e-scooters that are commercial, they are only concerned with making money. And it's a bit trendy, that city bikes have managed to market themselves as a green thing, something that we are all for. While these e-scooters are easy to make money on, more than caring for the environment or for these social things."

He elaborated on this comparison:

"City bikes have a completely different history, where parking racks have taken a long time. I happen to know because I have a son who works as a city bike operator, and there was a long process of being allowed to set up racks and rent land, and they collaborated with the municipality in a completely different way. So there is a reason why these two things are perceived as two different concepts."

A female participant explained:

"Ryde challenged, they just put them out. ... Bergen Municipality is very conservative in many ways. ... But then to not have a dialogue with the municipality, nor with the Bergen Chamber of Commerce, all these things that normally all processes should somehow be anchored in. ... So I think only the package here is a bit poorly thought out, they have thought it a bit too easy. That's not how it works. But maybe it would have worked in another city to do it that way. I do not know."

Thus, users saw reason to be critical. A representative of the transport service provider, Skys, interviewed 21.4.2021, emphasised the importance of the public sector playing a major role in an urban transport sustainability transition:

"Commercial companies are required to prioritise making a profit while the public sector doesn't need to make money, they must achieve something in society. They have other means than the private sector. ... If we let the commercial actors take over

Table 2
Word association responses to ‘e-scooters’ by focus group discussion participants.

Threatening	I get very tired of it	Exclusive
Chaotic	In the way	Hindrance
Destroys the cityscape	Flexible	Plague and ugly
Zigzag	Jerks	Excludes
Electric	Reckless	Double standards
Expensive	Greedy and expensive	Practical
Damage	Fun	Available, for some
Difficult to pass	Dangerous	Very Silicon Valley

the services will be more expensive and skewed. The public sector focuses on vulnerable groups, the elderly, children, groups that are weak in society.”

But the same representative was critical of the public sector’s actual performance, arguing that it must be challenged to innovate:

“The system is slow to change partly because there are a lot of things to consider, for example laws on privacy, the working environment, and road traffic ... Everything we do, we must ask the municipality, county, national authorities and private road owners, many actors have opinions. There is a well-established system around who is responsible for what, but it is resource-intensive and laborious to find out who must be involved. ... We need new constellations, and we need to do it faster because technologies are changing really fast.”

She concluded that while “bureaucratic structures make the changes safe and stable, they make it extremely hard to change focus, when we need to do something in a different way.”

The municipality’s official webpage on developing e-scooter regulation¹ shows an ability to act on this recognition of urgency, by partnering with Nível to develop a digital regulatory solution. When Ryde forced their hand, the municipality sped up and expanded its pilot project. An urban planner, interviewed 26.10.2020, elaborated: “They (e-scooter companies) have developed advanced systems and apps to optimise profits. We shall meet this with the same sophistication and benefit from their analytics.” An Urban Environment Agency representative explained that the digital platform was adaptive by design, with ongoing changes envisaged, and nominal street rental fees levied per e-scooter were meant to cover costs for marking parking zones rather than to generate revenue. Companies had to share data with and receive data from the municipality in a standard format to enable a dashboard with information on operating zones, e-scooter volumes, parking spaces and zonal speed limits.

4.3. Who decides who decides?

The approach to regulation was anchored in the ‘Green strategy for Bergen’, the inverted transport pyramid which accords walking the highest priority, principles of universal design, and consistent with drafts of the ‘Walking Strategy for Bergen 2020–2030’ and ‘Cycling Strategy for Bergen 2020–2030’. A female focus group participant captured the flux that e-scooters introduced in defining regulations:

“At intersections, they [e-scooter users] switch from being a bicycle to becoming a pedestrian, and they are so small that in a way they are, while a bicycle is like what we are used to and it has those rules to follow. So it may be that there is a lack of regulations, such as that there should not be two people on an e-scooter.”

A representative of Nível saw their role as providing a platform to enable meaningful e-scooter regulations. Interviewed 14.4.2021, he stated that “we are a government technology company that wants to help authorities get the same kind of tools the private actors have, so they can control the urban landscape and public space by putting their data to work.” He saw extensive data sharing as the main regulatory novelty in micro-mobility, and Nível correspondingly aimed to facilitate new business model development to enable public-private partnership. He explained:

“Proper data sharing provides benefits, like registering poor parkings. When there is poor parking from an actor outside the collaboration, we do not know if they have handled the problem or not. Then they have to pay more fees. If they collaborate, they pay a minor fee for poor parking. Data sharing operators can have subsidies to service peripheral areas.”

He construed the problem in terms of street rental fees, both positive (to generate revenue and as sanctions in over-served areas, e.g. >1500 e-scooters in one zone) and negative (to incentivise service provision), and posited real-time regulation, dynamic rules and automated control as the solution.

His experience with municipal public procurement suggested that “the contracts are so poor, the government cannot really push the suppliers in any direction, and it is hard to get out of the contracts if the suppliers do not provide.” He favoured more open-ended tenders that allowed innovators to pitch a range of solutions to a broadly-framed challenge. In the e-scooter case, the Nível representative argued, the public sector should “identify the missions challenges and problems, not specify the solution in detail. ... If you want to invoke innovation, you as a government person do not really know what is going on and what is possible, but you should know what is needed.”

¹ See [https://www.bergen.kommune.no/innbyggerhjelpen/trafikk-reiser-vei/vei-transport-og-parkering/sykkel/elsparkesykler-i-bergen](https://www.bergen.kommune.no/innbyggerhjelpen/trafikk-reiser-vei/vei-transport-og-parkering/sykkkel/elsparkesykler-i-bergen), accessed 13.5.2021.

This complements the Skyss representative's reflection, interviewed 21.4.2021, that "we talk a lot about public procurement competence. It is easy to say and hard to do. It is about the capacity for innovation in the public sector. The procurement system states that they must describe what they are ordering clearly, [while] competition and innovation require being open to creative solutions." She saw achieving this balance as key to solving the last-mile problem of public transport through feasible multi-modal solutions using micro-mobility, and saw the county's incumbent transport service provider itself transitioning from a traditional 'collective transport' focus into a 'mobility company' to enable a seamless mobility experience with digitally integrated multi-modality.

In terms of piloting the platform itself, the municipality used the test periods up to May 2021 to implement these weighted qualifying criteria for companies: quality of routines and tools to achieve good parking practices (30%), environmentally friendly operation (20%), quality of delivered data (20%), presence in the suburb of Åsane (20%) and quality of e-scooters (10%) (Bergen Municipality, 2021). Thus, the private sector led the creation of this market in terms of the actual modalities, even though the guiding intent in terms of who decides who decides was partly set by the municipality as the public authority in charge, and partly by a large operator that refused to fall in line with the municipal regulations. The municipality facilitated the enclosure of public space by e-scooter companies, as a trade-off it justified for socially equitable, centrally regulated provision of micro-mobility. As national rules develop, this dynamic will continue to evolve, potentially strengthening the role of the municipality to rein in defiant actors in their urban space.

5. Discussion: market formation at the tension between innovation and regulation

Micro-mobility technologies such as e-scooters have been assumed to present a possibility to advance an urban transport sustainability transition, since e-scooters offer users of mobility an electric and readily available mode of transport that can replace other more carbon-intensive modes. There is certainly a debate around this. The perspective of innovation studies would be that e-scooters represent a form of technological innovation that creates and fills a market demand (Geels, 2005a; Deuten et al., 1997). It has been found, however, that electric bicycles replace other 'benign' modes of transport such as walking, traditional cycling and taking the bus (Lin et al., 2017).

In our case, the introduction of e-scooters has revealed the contentious and asynchronous relationship between this innovation, sustainability and regulation, expressed through micro-politics (Vigar, 2002; Burns, 1961). As a relatively new mode of transport, e-scooters were not matched with appropriate regulatory categories. This is in stark contrast with public transport provision at urban and regional scales by the regional operator Skyss whose service offerings are bound by framework agreements in terms of frequency and reliability, an advantage of a territorial monopoly approach to provision of essential services. Also, the introduction of e-scooters revealed gaps in which actors were able to make decisions and how these decisions shaped the use of public space and micro-mobility services, highlighting questions of commoning mobility (Nikolaeva et al., 2019; Sheller, 2011). The first operator chose not to comply with the municipality's rules and the local courts upheld its ability to continue to do so, even as new regulations and a micro-mobility market began to take shape, with which other e-scooter operators opted to comply through pilots during the incipient stage of regulation. Below, we discuss these dynamics in relation to innovation studies, research on micro-politics, and commoning mobility research.

The pilot project enabled the municipality to initiate governance mechanisms for an emergent technology. The forces of innovation and regulation engaged recursively (O'Connor and Rice, 2013; Dewald and Truffer, 2011) as part of technological embedding in socio-technical practices of mobility. Whereas innovation initially led regulation, the digital platform which enrolled all but one micro-mobility company enabled the municipality to shape the roll-out by aligning incentive structures with broader societal commitments (Nemet, 2009; also see Frenken et al., 2020). The state thus tried to steer micro-mobility towards enhancing mobility justice through a 'mediated' or 'consensual' model of market-making, but was confronted by the first mover advantage gained by a company with trans-local experience, which learned from experiences in other cities ahead of Bergen, and was able to devote resources to timing and managing its roll-out in a strategic way attuned to maximising profit, with a clear vision (and calculation) of market-making. This aligns with insights on strategic behaviour of market actors by van Waes et al. (2020). This leading actor's market position enabled it to ignore the municipality's rules, which partly undermined the city's regulatory efforts. However, rather than unbridled economic competitiveness, market formation was also inflected by softer concerns, including multi-modal and digital integration as well as normative and practical considerations. This orientation of steadily implemented regulation paved the way to institutionalise fines, parking zones, operating zones and speed limits as aspects internal to market functioning, through the digital ontology of a digital public-private partnership platform. The digital platform allows for real-time regulation, and can enable flexibility during various times of day as well as to address diverse needs throughout the year, e.g. for large sporting events.

Our analysis reveals dynamic interaction between companies and regulators with context-specific concerns (Lennon and Moore, 2019) such as the need to provide micro-mobility services in suburbs like Åsane, to ensure inclusion across broad lines (Lubitow and Miller, 2013). The questions scholars elsewhere have raised regarding the impact on public space (Bai and Jiao, 2020; Lavoie-Gagne et al., 2021) express in wide-ranging ways in our case study, from associations that represent marginalised (e.g. blind) users, to reflections by supply-side actors on how to ensure inclusion with private sector participation in a traditionally largely public sector. This raises questions of governmental capacity and speed (González and Healey, 2005), operating under conditions of urgency while maintaining a functional system by managing conflict (Dilley, 2017), as the municipality did with Ryde while bringing other companies aboard its pilot platform by partnering with a company that bridged the public and private sectors.

In relation to such pilot regulations, the Council of European Energy Regulators (2021, p.5) highlights 'dynamic regulation', defined as "adaptive regulation", stimulating regulators to be enablers of the adaptation of the energy regulatory framework, in connection with the society-wide digitalisation trend, smart technologies, decarbonisation policies and decentralisation of energy

generation.” This body explicates “a need to develop regulatory frameworks that balance the tension between achieving regulatory goals without discouraging innovation.” We discern a similar dynamic regulation trend in the mobility sector, also evident in e.g. the UK (Hirst, 2021). In our case, the municipality’s role in governing micro-mobility is to ensure that it serves a positive public purpose without negatively impacting existing rights such as the use of public space or equitable pavement access for diverse urban residents. Its main contribution to market-making is to push micro-mobility companies into adopting a system that can enable real-time responsiveness through an incentive and automated digital control model, e.g. to offer micro-mobility in suburbs. This has been addressed as the state acting as a ‘socially responsible customer’ in research on public procurement (Jaehrling, 2015), to embed particular practices within market-making.

We note earnest commitment to a shift away from automobility and towards commoning from the municipality, to make urban space more inclusive and accessible to diverse users (Nikolaeva et al., 2019; Sheller, 2011; Uteng and Lucas, 2017). But the e-scooter companies nonetheless largely decide who decides: they get the municipality to allocate them public space for a form of micro-mobility premised on automobility, and they can divert fines for wrongly-parked e-scooters to users. This can be regarded as a form of ‘pure’ or rather ‘forced’ creation of a market by companies using a position of power to their advantage due to regulation lagging behind innovation and being unable to prioritise the public interest. While they have created a viable framework to expand their business, the distribution of risk through blanket smartphone application terms of use may burden users and absolve companies of liability (Zuboff, 2019). Unregulated e-scooters represent the enclosure of public space for private gain, while the contribution of this innovation to making transport sustainable is unclear. Ryde’s conduct runs counter to principles that keep the urban commons accessible and safe for everyone. This unwillingness to take shared responsibility (paying street rental fees; cooperating with local rules) for how mobility impacts society opposes commoning mobility (Nikolaeva et al., 2019) and raises important local questions of how control over shaping the city has come to be wrested away from public authority and into the hands of a remote commercial operator. The struggle between this private actor and the municipality in the digitally-enabled emerging micro-mobility market exemplifies the exercise of power necessary to protect the viability of any commons, and the ongoing risk of exclusion - including cross-sectoral (Arcidiacono and Duggan, 2019) - linked to innovation processes.

By refusing to play by the rules, Ryde banks on their position in this emerging market to get their way counter to the municipality’s plans, and to the spirit of democratically agreed upon goals of inclusive, equitable urban development and the inverted transport planning pyramid. Their argument that demand for their service confirms its utility is undergirded by the prioritisation of individual self-interest over collective decision-making about the urban commons (also see Glover, 2016). The municipality, by contrast, has a formal responsibility as well as more informal expectation to manage multiple concerns and represent multiple, often split, publics. This places it at a disadvantage in terms of implementing a vision of market-making, where the unequal distribution of power affords other agents more short-term agility (Araujo, 2007). As the first and largest operator, Ryde takes a position where it can dictate terms. Other companies with a delayed start have greater certainty but a competitive disadvantage to the first-mover’s contextual learning, which gives the latter a better basis in data on e-scooter locations and what conditions to write into its smartphone application user agreement. A key element here is existing privacy regulation, and what data it allows companies to capture, retain, use and sell to third parties (Zuboff, 2019). While users directly decide to use an e-scooter or not, if using it they are left with no option but to accept the terms of use. For the lay user, there is little transparency about how companies use this data. For the city, there is a battle on its hands to avoid a dual market extending far into the future, which would undermine the legitimacy of the municipality as representing public interest by its inability to regulate the enclosure of public space by a defiant commercial actor that benefits over competitors who cooperate with local rules.

6. Conclusion: micro-mobility, market formation and sustainability transitions

We have examined the formation of a micro-mobility market and unpacked its consequences for urban transport sustainability transitions. We find that micro-mobility can be an enabler of low-carbon mobility in socially just ways, for instance ensuring adequate last-mile services in suburbs, but that market forces tend to drive outcomes that are profit-maximising, rather than public interest, and that risk excluding multiple publics. However, dynamic regulation can engender low-carbon micro-mobility markets and a broader just mobility transition.

Taking a relational approach to market formation by focusing attention on market-making processes and actors has surfaced some aspects that are relatively overlooked in transition studies, such as the diverse roles of multiple private actors in non-linear entanglement with public authorities themselves developing an understanding of regulatory possibilities in the wake of technological innovation and its social impact. Anfinssen (2021, p.16) points out the value of such approaches in unravelling “the outcome of networked processes between users, technologies, driving practices, cultures, weather and topography”, an outcome of scholarship that looks beyond structuralist understandings at “the processes of organization and legitimization of markets for transitions” (Boon et al., 2020, p.347). This is a key contribution of our study.

The Bergen case offers an emerging public-private partnership model for public interest regulation of micro-mobility innovation. This is the outcome of a process with deep contingencies, that required leadership by urban public authorities faced with market-making based on technological innovation and profit maximisation prerogatives by an aggressive private actor, as Bouteligier (2015) has reflected upon. The municipality’s manner of institutionalising this market, centred on a digital regulatory platform for shared micro-mobility with dynamic rules and automated control, has significant implications for the inclusivity and accessibility of micro-mobility, as part of multi-modal transport solutions. Our nuanced discussion of the challenges and promises involved in negotiating private and public interests - the micro-politics of micro-mobility - problematises mainstream depictions of emerging markets for smart mobility. Rather than a panacea of benefits related to efficiency, flexibility, seamless integration, data-driven

development and economic growth, we submit that micro-mobility is potentially burdened with risks of injustice, surveillance, commodification of urban space, and knowledge asymmetries in public-private partnerships and uncertainty around edge technologies such as algorithmic automation on centralised digital platforms to control micro-mobility flows.

In sum, regulatory lag and rapid innovation in micro-mobility imply a need for public-private partnership in market-making to charge companies rent for public space based on use, to institute adaptive policies for dynamic regulation at sub-urban scales, to enable a transparent data-sharing protocol, and to offer dynamic economic incentives. Judicial and regulatory challenges must be addressed in order to implement innovative solutions and re-make the market for shared micro-mobility in public interest. Only then can micro-mobility be an enabler of low-carbon mobility in socially just ways, and advance ambitious urban sustainability agendas.

Declaration of Competing Interest

The authors declare no conflict of interest.

Acknowledgement

The authors gratefully acknowledge generous support from JPI Climate through its SOLSTICE call and the Research Council of Norway for the ‘Responsive Organising for Low Emission Societies’ (ROLES) project (grant 321421). We also wish to thank our colleagues in Bergen Municipality as well as other experts and mobility users in Bergen who devoted time to engage with us and to inform and challenge our insights, and the editors and two reviewers for their constructive and insightful feedback.

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