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Mobility Data Justice

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Abstract: Mobility experiences are becoming intrinsically linked with digital and data experiences. Being mobile increasingly involves the production, storage and sharing of data (consciously or not), from car sensor data for diagnostics and insurance apps for driving, to ticketing apps for public transport, urban micromobility share schemes, Google maps, fitness and wellbeing apps, Internet of Things sensors, or air pollution data. The 'datafication' of mobility raises new questions with regards to justice. What kinds of inequalities emerge at the intersection of mobilities and datafication? Whose mobility gets included and excluded through data collection and sharing, why and how? How are mobilities enabled and restricted through data? How are access and ownership to mobility and data changing? What about the mobility of data in relation to justice? This article links scholarship on mobility justice and data justice to develop a mobility data justice framework. It closes with a discussion of critical issues for mobility data justice and develops an agenda for future research in this area. The lens of social justice helps to understand the multiple ways power and (in) equalities are transformed or amplified at the intersection of mobility and data.

Keywords: Mobility, data, social justice, smart mobility, transport, mobility justice, digital society

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1. Introduction

Within the broader context of mobility studies, and its long-standing concern with the digital, the materiality of the virtual, and the making of networked space (Adey 2004; Amoore 2006; de Souza e Silva and Frith 2012; Elliot and Urry 2010; Kitchin and Dodge 2011; Graham, 2005), this paper aims to develop a novel framework that considers the entanglement of mobility and data with a social justice perspective. While mobility justice has considered data to some extent, and data justice has taken account of some mobility issues, there has not been a systematic approach to synthesising the literature on data justice and mobility justice. This paper signals how these apparently separate but related fields are increasingly becoming enmeshed and interpenetrated, requiring new hybrid approaches. The new framework proposed here contributes to the literature on the increasing intertwining of data and mobility by demonstrating their complex co-production of power relations and inequities, and thus adds a new social justice perspective to it. This article develops an argument about how power and injustices are both amplified and transformed at the intersection of data and mobility justice, in the context of growing importance of datafication and algorithmic culture across diverse (im)mobilities.

Datafication concerns 'how people's bodies and practices are rendered into digitized information' through quantification (Lupton et al. 2018, 3165), but also how 'different kinds of value' are generated from this data, to the benefit mainly of 'corporations, but also states and sometimes civil society organisations and communities' (Mejias and Couldry 2019, 2, 3). Algorithmic culture focusses on what happens with and around this data, 'the ways in which computational processes of sorting, classifying and hierarchizing of people, places, objects and ideas' takes place, and also how this has 'profoundly altered the way "culture", as a category of

experience, is now practised, experienced and understood' (Andrejevic, Hearn, and Kennedy 2015, 385; see also Striphas 2015), including implications for inequalities (Noble 2018; Eubanks 2017). In addition to privacy concerns around the mobilities of data capture, processing, and sharing, the datafication of mobilities has other profound consequences that have not yet been adequately conceptualized, and which we will consider here from multiple theoretical and empirical perspectives.

This work unfolds in this context of the increasing datafication of society and the associated rise of algorithmic culture, explored, amongst many other fields by Critical Data Studies (e.g. Iliadis and Russo 2016), alongside critiques of engaging with this ever increasing amount of data through algorithms which have become associated with inequalities (e.g. Mittelstadt et al. 2016; Algorithmic Justice League n.d.). Ragnedda differentiates between 'traditional digital inequalities', or digital divide - access, usage, outcome - and 'new digital inequalities' (knowledge, database, treatment) that are forming an 'algorithmic divide' (Ragnedda 2020, 93–94) and both types are highly relevant to mobility/data justice. Shapiro (2020) likewise crucially focuses on logistical governance and how algorithmic decision-making and artificial intelligence reconfigure urban geographies and inequalities. This context also extends to Artificial Intelligence (AI), especially Machine Learning (ML) where the role of training data sets has been critically interrogated (e.g. Crawford and Paglen 2019), for example. '[E]vermore aspects of everyday life', as Kitchen et al aptly summarise, 'are being captured and stored as data, made sense of through new data analytics, mediated through data-driven technologies, normalized through data-driven infrastructures, and shared through data infrastructures and data brokers' (Kitchin, R, McArdle, G. and Lauriault 2018, 1). What happens when the algorithmic divide collides with the injustices of inequitable mobility regimes and how do both together reshape the mobile

and networked terrain of struggles for justice? How are bodies, infrastructures, cities and mobility regimes caught up in and produced via these algorithmic inequities?

This article shows how multiple arenas of datafication can entangle each other and reverberate into mobility systems and practices, and how this can deepen existing injustices and create new ones. Being mobile, nowadays, more often than not involves the production, storage and sharing of data (consciously or not), from car sensor data for diagnostics and car insurance apps, to ticketing apps for public transport, geofencing of urban bike or scooter share schemes, use of Google maps, step counting or running fitness and wellbeing app, Internet of Things (IoT) data from traffic lights or car parks, air pollution data from airports. "The Right to the Smart City" (Kitchin, Cardullo, and Feliciantonio 2019) provides a long list of mobility-relevant examples of such smart city data, and also points to how 'co-proximity and co-movement with others might be used to infer political, social, and/or religious affiliation, potentially revealing membership of particular groups'(Kitchin, Cardullo, and Feliciantonio 2019, p. 8; based on Leszczynski 2017). Data capture and algorithmic processes may then have deterministic impacts on predictive analytics that are used in everything from policing and advertising, to crowd control and traffic management. Mobility data collection and analysis have also permeated the social sciences. With the rise of 'big data', analytics have been embraced by purveyors of smart cities to measure the metabolism of cities, celebrated in social sciences using data science to map large-scale spatial processes, and captured by epidemiologists studying the spread of Covid-19 and its impacts on mobility. The alleged promise of each of these data analytic applications has implications not only for mobility regimes and the deepening of existing mobility inequities, but also for how we measure, understand, and produce knowledge about (im)mobilities, for whom, when, where, and for what purposes.

Public space is one of the key sites of mobilities and of data gathering. Therefore, 'the way public space is "translated" into "code", and how "code" is seen to "reshape" the public sphere' has to be an important element of a data/mobility justice approach (Graaf 2018, 154). There are many urban space approaches to data and mobility, and these have evolved over time as technologies have changed [see, e.g. Graham, 2005; Kitchin and Dodge 2011; Sheller and Urry 2006]. Beyond questions of justice relating to data in and of itself or relating to mobility in and of itself, our effort to cross-fertilize these two domains emphasizes emerging concerns around "technology sovereignty", mobility sovereignty, the public sphere, and the commons (Kitchin, Cardullo, and Feliciantonio 2019; Marcuse 2012). While cities are key contexts of mobility and often feature a higher density of smart and surveillance technologies, data/mobility justice goes beyond an urban infrastructure focus to also address broader questions of uneven citizenship, including access to rights of privacy, publicity, mobility and dwelling. We can interpret public space very broadly to include not just physical space, but also online space, virtual space, infrastructure space, and other sites where publics emerge to voice common concerns, including global publics that have mobilized around the climate emergency. Mobility data justice is crucial to all forms of public formation and communication, political organizing and protest, physical movement and mobility, while it also concerns the mobility of data itself.

Mobility and data have both recently been discussed with a social justice perspective (Sheller 2018a, 2018b; e.g. Cook and Butz 2020; Dencik et al. 2019; Taylor 2017). We posit that this focus on justice is crucial to understanding and analysing the implications of emerging entanglements of mobility and data in people's everyday lives, in the making of new urban infrastructures, in the crossing of international borders, and more widely in the constitution of political subjecthood and the right to have rights. The

multifaceted concept of justice developed within these bodies of literature offer a range of analytical tools to examine epistemic, procedural, and distributive dimensions of the datafication of mobility at a time when it is proliferating. It is relevant and urgent to take a social justice perspective when data access, collection, cross-referencing, and algorithmic processing increasingly determines who, what, when and where various (im)mobilities can and cannot take place. Whether entering a building, ordering a delivery, crossing a border, paying for goods, finding our friends, setting up a meeting, or sending a monetary transfer, various acts of mobility require access to data systems, leave traces in data systems, and *only can take place* through hybrid physical and data mobilities. This implies that crucial dimensions of (in)justice are embedded in these actions and our subjectivities, sovereignties, and agencies are deeply affected by what Keller Easterling (2015) calls the 'dispositions' of such infrastructure spaces.

While justice-related themes are also often discussed as issues of inclusion and exclusion or (in)equalities and (in)equities within the literature on data/digital (e.g. Henwood and Wyatt 2019) and on mobility/transport (Martens 2016; Jeekel 2018; Banister 2018), this paper will focus on data and mobility justice theories. The broader context for social justice-informed debates also includes spatial justice (Soja 2010), urban justice (Fainstein 2014; Peter Marcuse, James Connolly, Johannes Novy, Ingrid Olivo, Cuz Potter 2009), environmental justice (Agyeman, Bullard, and Evans 2010) and racial justice (Brown 2015; Benjamin 2019a) lenses, amongst others. Because cities are a key site of mobility and data activities, we will focus here on urban public spaces in particular. Within urban policy arenas, for example, both mobility data and data mobilities are key elements within climate change debates, questions around policing and racism, and public debates over the roll out of smart cities, such that the remaking of urban space and public policy are central to both mobility and data justice.

Existing efforts to bring together mobility justice and data justice include Sourbati et al's exploration of mobility justice in relation to data and older age (Sourbati, M, Behrendt 2020) and Moran's recently published work on the relationship between US public transit (rider activism) and open transit data. His research explores 'how such mobility services and transportation infrastructure operating in the public sphere as enclosures of the mobile-digital commons are experienced, politicized, mediated, augmented and interfaced in solidarity with data and software applications of GTFS [General Transit Feed Specification]' (Moran 2021, 43). As part of this, they develop the first steps of a mobility data justice framework. While the work is very much focused on and applied to Orlando's public transit, some elements are also relevant more broadly as Moran states: 'The scope of Mobility Data Justice (MDJ) can easily apply to so many material and immaterial mobility-related justice concerns considering the multi-scalar and dynamic frameworks that have been outlined by both mobility justice and data justice scholars' (Moran 2021, 43). The broad scope of Mobility Data Justice is envisioned as 'open to the context of the moment ranging from bodily movements to data mobilities and planetary ecologies' (Moran 2021, 114).

We pick up and expand on these existing threads in the literature. In the broad context sketched out in this introduction, urgent questions emerge: What kinds of inequalities emerge at the intersection of mobilities and datafication? In terms of their mobilities, who gets included and excluded through data collection and sharing and why and how? How are mobilities enabled and restricted through data? How are access to and ownership of mobility and data changing? How does the access to and control of data relevant to mobilities contribute to enhanced 'motility' and accumulation of 'mobility capital'? How is the mobility of data implicated in (in)justices related to race,

coloniality, sexuality, gender, or disability? What new forms of cross-cutting political commons are emerging at the intersection of data and mobility justice?

Some examples that highlight the importance of data mobility justice include: how 'mobile phone location data have become tied to understandings of and responses to the COVID-19 pandemic' (Frith and Saker 2020); how 'face-recognition technologies routinely fail to identify nonwhite faces—which is a problem when that influences your ability to travel or to access government services' (Redden 2018), see also (Crawford 2016); a proposal to track and 'monitor the movements of migrants moving towards the EU's southern borders' that would include 'machine learning performed on satellite images […], social media output and local online reporting' (Taylor 2017, 5); and the carbon emissions of data constantly moving between "cloud" data centres and mobile phones (Lucivero 2020; Pasek 2019). Each of these empirical problem fields raise new questions for theories of social justice at the intersection of data and mobilities, and demand that we reflect more deeply on their entanglements.

The research questions guiding this paper are: How is data considered in the literature on mobility justice? How is mobility considered in the literature on data justice? What could a mobility data justice perspective on the entanglement of mobility and data look like?

After the methodology, section 3 reviews literature on mobility justice with a focus on elements that are relevant in relation to data. Section 4 reviews literature on data justice with a focus on mobilities. Drawing on sections 3 and 4, section 5 develops a broad framework for mobility data justice.

2. Methodology

This paper conducts a narrative literature review and draws on the insights from existing

research to develop a novel conceptual framework. In narrative literature reviews 'the findings (…) of relevant studies are outlined and discussed with a view to presenting an argument about the conclusions that can be drawn from the current state of knowledge in a field' (Lewis-Beck, Bryman, and Liao 2003, 579). For our narrative literature review, we draw on two bodies of literature that have had some intersections but have so far not been in much dialogue with each other. The first body of literature we review is on mobility justice, and our review focusses on those elements of mobility justice that are particularly relevant to concerns around data. Literature concerned with data justice is the second body of literature we review, this time with a focus on mobility-relevant elements. Both reviews do not give a systematic overview of mobility justice or data justice respectively but analyse existing material with a cross-cutting focus on data and mobility. Furthermore, we discuss other selected mobility and data-related literature that is relevant for the intersection of mobility and data justice. Building on these bodies of literature, we conclude by developing a broad framework for future social justice-informed analysis of mobility and data entanglements.

3. Mobility Justice though a Data Lens

This section reviews literature on mobility justice, focusing on elements that are particularly relevant for data elements of mobility, and identifies key elements for the new framework on mobility data justice (see section 5). In the initial thinking around what was called the mobility turn in the early-2000s there was a strong interest in the intersection of mobility and data, and the emergence of hybrid spaces that involved their necessary co-dependence. It quickly became clear that inequities would be built into such infrastructures for mobility and data, bringing attention to questions of justice.

For example, Sheller and Urry argued in their introduction to *Mobile Technologies of the City* (2006) that the mobility systems that constitute urbanism 'include ticketing and licensing [of drivers], oil and petroleum supply, electricity and water supply, addresses and postal systems, road safety and public safety protocols, station interchanges, web sites, money transfer, luggage storage, air traffic control, barcodes, bridges, time-tables, CCTV surveillance and so on' (Sheller & Urry, 2006: 5–6). Our point at the time was that the mobility of data and the use of information systems more generally were increasingly becoming entwined with the mobility of people, vehicles, and objects. We argued that these physical and informational mobility systems are tightly coupled into complex new configurations, such that mobility systems are increasingly more complicated, interdependent and dependent on computers and software; while media and communication systems are deeply embedded into specific physical and material contexts and infrastructures of circulation. However, the access to, effects of, and uses of such interdependencies of mobilities and data are not evenly distributed or equally determined. It was clear that there were unequal degrees of access, software sorting and remote control, as well as design inequities, built into the emerging materialities of data circulation, sorting and surveillance (Wood & Graham, 2006), producing what Kitchin and Dodge (2011) referred to as 'code/space' and what Sheller described more broadly as 'mobile mediality' (Sheller, 2013).

Elliott and Urry (2010) theorized various 'mobile lives' as dependent on 'network capital,' referring to the possession of capacities and potentials for self-determining movement (understood as "motility" [Kaufmann & Montulet, 2008] – the capacity to appropriate mobility potentials). These capacities to be mobile include appropriate documents, money, and qualifications; access to networks at a distance; physical capacities for movement; location-free information and contact points; access

to communication devices and secure meeting places; access to vehicles and infrastructures and time and other resources for coordination (Elliott & Urry, 2010: 10–11). Uneven access to and control over data emerge as crucial features of the uneven distribution of motility in relation to the surrounding physical, socio-political, imaginative, communicative and *informational* affordances for movement.

Uneven or differential mobility may take the form of uneven *qualities* of experience, uneven access to *infrastructure*, uneven *materialities*, uneven *subjects* of mobility, and uneven *events* or temporalities of stopping, going, passing, pausing, and waiting (Adey et al. 2014). The process of datafication has important implications for each of these. Geographical data such as maps afford capacities for navigating such terrains. Data for passenger management systems afford greater or lesser degree of ease, comfort, flexibility, and safety in travel. Data is often a dimension used to enhance, bypass, or mitigate friction, noise, speed, or turbulence of mobilities. Data is also central to the infrastructures and control systems such as passport control that govern (im)mobilities, speed and slowness, comfort and discomfort. Thus the datafication of mobilities reverberates through many layers and scales of dominant mobility regimes, with deep implications for the differentiation of mobility practices and experiences of differently positioned individuals – often in ways that *purposely become invisible* for those with the most privileged modes of access and convenience.

These uneven terrains of differentiated mobility regimes and splintered infrastructures bring data infrastructures to the social and political foreground in the production of (im)mobilities. Uneven mobilities depend not only on the design of the built environment but also on informational designs in which delay, exclusion, turbulence, blockage, and disruption produce unequal mobile subjects. As Sheller suggests, then, ‘Mobility justice is an overarching concept for thinking about how

power and inequality inform the governance and control of movement, shaping the patterns of unequal mobility and immobility in the circulation of people, resources, and information.' (Sheller in Cook and Butz, 2020, p. 23). Datafication is now central to the governance and control of movement, and hence to 'the entanglements of power and social exclusion in the mobilities of humans, things, and ideas, as well as to differential and unequal access to movement, and the ability to move.' (Cook and Butz 2020). *Distributive justice* in this view becomes not just a matter of accessing transport systems, but also accessing the data systems that control mobilities.

Mobility justice also is concerned with *procedural* justice. 'By recognising the different forms in which mobility injustice is produced and re-produced,' there emerges a demand for 'procedurally just approaches to how different groups are approached and participate in policymaking and research.' (Verlinghieri and Schwanen 2020, p.5). Whether in the realm of public access to wireless communication, the practice of 'on-demand' delivery logistics, or the impacts of predictive policing, for example, Shapiro shows how 'smart cities' are inherently political projects (Shapiro 2020). Within multi-scalar human and non-human environments, data systems determine the skeins of power and social exclusion that shape and control most transport-related mobilities, from the payment cards for accessing public transit, to the mobile apps for hiring scooters, bikes, or car-shares, to the ability to order online deliveries. While *distributive* justice might expand access to such services, *procedural justice* asks who has participated in the design of such systems. How, moreover, is labour controlled and compensated in mobility and delivery services, and who is at the table in policy making and research concerned with mobility as a service? What kinds of hidden algorithms are used to control ride-hailing apps, or to track customers through shops, or to predict where police should patrol, and what kinds of biases have been built into these (Shapiro 2020)?

Epistemic justice would go even further to address the ways in which value, work, equity and inclusion are determined in the first place. And asks why more cities do not have free public transit, communal kitchens, or shared mobilities and greater commoning of mobilities (Sheller 2018b). Sheller follows advocacy groups such as The Untokening who have called into question Eurocentric approaches and exclusions of racialized minorities from decision making around transportation investments and urban planning, and argues for the inclusion of communicative planning or collaborative planning approaches to broaden the epistemic field of decision-making. Advocates for mobility justice thus call into question the quantification of mobility data collection and epistemologies, and seek our greater richness of qualitative data. Alternative epistemic approaches to mobilities have also emerged in Critical Indigenous Studies, in ways that are applicable to both mobility and data justice concerns, where parallels can be drawn between critical concepts of mobility sovereignty and data sovereignty. 'Mobility sovereignty' is an interdisciplinary analytic that refers to 'the ability to choose when, where, how, and for what purposes to engage in movement', and data sovereignty is a form of epistemic justice that is crucial to such capabilities (Carpio et al 2022: 5).

From a historical perspective, Docherty et al argue that the current transition to 'smart mobility' is of equal importance as the transition towards automobility and urge for a more proactive governance (and public good) approach for the current transition, which is also highly relevant for mobility/data justice. They are concerned about a 'data and information asymmetry' between the public sector and the private sector, where, for example, cities and governments give away transport data for free (e.g. open data) with industry building mobility products and services that monetize the data. They conclude that 'very clear approaches to data sharing which protect public interest and ensure the state can use the data to support public value creation' are needed. This is closely

related to concerns around ‘an appropriate degree of equity and non-discrimination in access to “Smart Mobility” services’, and extends to service inequalities between rural, urban and per-urban areas (Docherty, Marsden, and Anable 2018, 121). The authors also consider ‘what kinds of digital discrimination will emerge’, such as prioritizing services for whiter neighborhoods, ‘Gender-segregated shared taxis, [] no services for areas deemed undesirable (or unprofitable) by mobility firms themselves, [] premium costs to travel on a Saturday night for young people aged under 25’ (Docherty, Marsden, and Anable 2018, 122).

As some of these examples already indicate, this broader concern with smart mobility and logistical governance also extends to the quickly growing debates on shared mobility. A mobility/data justice perspective is thus also relevant for Mobility as a Service’s (MaaS) ‘technological gentrification’ of transport that ‘does not address the needs of those experiencing transport poverty’ and ‘might further exclude social groups experiencing difficulties in handling new technologies or having access to banking’ (Pangbourne et al. 2020, 43, 47). As data is central to MaaS, this comes with ‘the threat of potential enclosure of our mobility systems by allowing private entities to control the products that enable people access to transport through integrated platforms as well as through data monetization’ (Pangbourne et al. 2020, 47). This also extends to critical work on the data and mobility politics of micromobility such as shared bicycle schemes (Spinney and Lin 2018) and e-scooters (Petersen 2019), as well as ride-hailing and delivery services (Shapiro 2020). Data-driven AI emerges as powerful non-human actor in governance processes, also with regards to mobilities and sustainability (Servou, Behrendt, and Horst 2022). It is therefore important to pay close attention to the ways that the datafication of mobility can further entrench existing injustices – or create new ones – for example around the provision of mobility in certain geographic areas (cities,

countries, etc.), access to mobility (gender, race, sexuality, etc), policing of mobility that employs discriminatory algorithms (Benjamin 2019a).

Public transport data is another key area of mobility data equity discussions. Here, conflicts over open transit data have emerged as one of the first important arenas for mobility data justice. One of the first studies to suggest a 'Mobility Data Justice' framework is a dissertation by David Moran on 'Extending Open Mobility to Mobility Data Justice' (University of Central Florida, 2021). Moran focuses on the use of General Transit Feed Specification [GTFS] by transit activists to show 'how the GTFS open data ecosystem can be operationalized via justice ontologies to support active knowledge creation and collaborative, Mobility Data Justice tactics between transit riders, activists and software developers' (Moran 2021, abstract). Open data is one important dimension of Mobility Data Justice, but not the only one, thus we hope to articulate a broader overview of the topic.

As the study of mobility justice has gathered pace, the intersectionality of race, gender, sex, and disability in structuring differential mobilities becomes clear, while we also find a role of datafication in each of these dimensions. The study of racialized uneven mobilities, for example, shows how modern data systems were first built on the indexical ledgers, physical marking, and accounting systems of the slave trade. Simone Browne (2010, 2015) shows how 'digital epidermalization' is central to the governing of databased bodies, in which racial difference is key to biometric algorithmic processes. Surveillance technologies serve to informationalize 'suspect' bodies whose data is then warehoused in interconnected databases, a practice that draws on the history of branding enslaved bodies, and using such markings to track runaways. Further bridging science and technology studies and critical race studies, and prioritizing justice and equity, Ruha Benjamin asks: 'Who and what are fixed in place to enable innovation

in science and technology? What social groups are classified, corralled, coerced, and capitalized upon so others are free to tinker, experiment, design, and engineer the future?' (2019, p. 3). To this we might add: who and what are *datafied* to allow, control, or coerce various (im)mobilities, including those involved in smart cities and new technologies for managing mobilities that claim to be innovative? Simpson and Sheller (2022) point out that new cryptocurrency 'startup societies' purposely 'create digitally bordered interstitial spaces that undermine sovereign territories and currencies, empower cyber-kinetic elites, and exclude and marginalize' others in ways that leverage existing sites of colonization and racialized capitalism.

Mobility justice also connects directly to the climate crisis through the questions of procedural and epistemic justice that consider how 'collective decisions about which activities involving mobility are valued and accommodated' (Mullen & Marsden, 2016). Henderson's analysis of electric vehicles is a recent example of a multi-scalar mobility justice approach (Henderson 2020) and together with his other work on 'tech mobility' (Henderson 2018) resonates well with mobility data justice concerns. The mobility justice perspective ultimately demands that we pay attention to multiple scales and dimensions of (in)justice, including environmental justice, social justice, racial justice, and climate justice, all understood through a combination of distributive, procedural and epistemic approaches (Sheller 2018b). To this list we now wish to add data justice.

4. Data Justice through a Mobility Lens

This section reviews publications on data justice with a focus on elements that are relevant for mobility. It also identifies key elements for the new framework on mobility data justice (see section 5).

The concept of data justice has emerged in the late 2010s. This included scholars from media and communication studies and those with a critical data studies perspective becoming interested in social justice perspectives informing their analysis of the datafication of society (e.g. Dencik et al. 2019). It also involved scholars already interested in social justice issues who became more interested in the increasing role data plays in this realm (e.g. Taylor 2017). Taylor defines data justice as 'fairness in the way people are made visible, represented and treated as a result of their production of digital data' and highlights the associated importance of 'ethical paths through a datafying world' (Taylor 2017, 1). The way mobility data is used around representation, visibility and actions clearly matter for ethical approaches to studying or designing mobilities. According to Dencik et al, data justice 'position[s] data in a way that engages more explicitly with questions of power, politics, inclusion and interests, as well as established notions of ethics, autonomy, trust, accountability, governance and citizenship' (Dencik et al 2019: 874). Kitchin states that "a fairer data future can only be secured by locating the source of unequal and uneven data power in wider structuring relations and working to transform these into more just arrangements" (2021a). Data Justice thus takes into account how 'our understanding of social justice is changing in the context of datafication' (Dencik et al 2019: 873) and extends the 'ongoing historical struggles against inequality, oppression and domination' (Dencik et al 2019: 876).

While concerns over surveillance and privacy of data are one dimension of historical struggles for data justice, they are by no means the only one. The struggle against racialized surveillance has also been an important dimension of data and mobility justice movements, which have highlighted the racial bias within 'stop and frisk' policies in the U.S. and the violence perpetrated by police against Black motorists in particular. Urban planners such as Tamika Butler, Destiny Thomas, and Charles T.

Brown identify ‘arrested mobility’ as the discriminatory policing of Black and Brown mobilities, including through the use of inequitable data collection and algorithmic policing (UCLA Lake Arrowhead Symposium 2021). However, work by Browne (2015), Benjamin (2019b) and others also highlights other forms of algorithmic bias, invisibilization, hypervisibility, and exclusionary manipulation that shape racialized injustices of data. The “Data for Black Lives” movement aims for ‘data science to create concrete and measurable change in the lives of Black people’ and considers data’s ‘tremendous potential to empower communities of color’ at the same time as investigating how ‘data is too often wielded as an instrument of oppression, reinforcing inequality and perpetuating injustice’ (Data for Black Lives n.d.).

Debates on race and mobility justice mentioned above (see section 3) thus link closely to data justice considerations and highlight the importance of non-western (e.g. Milan and Treré 2019; Cinnamon 2020) perspectives on data, critiques of data-colonialism (Ricaurte 2019), alongside feminist (e.g. D”Ignazio and Klein 2020) perspectives around data. This also extends to work on “Indigenous Data Sovereignty” (Walter et al. 2021) and Kidd’s work on Indigenous ‘counter-mapping as data justice’ projects that challenge ‘European imperialist and then capitalist extraction of natural resources’ (Kidd 2019, 954), amongst others. Akbari’s “Spatial|Data Justice: Mapping and Digitised Strolling against Moral Police in Iran” analyses ‘the way traffic camera footage is used against female drivers with improper veiling’ as well as phone-app- and social-media based resistance to this, also contributing to the intersection of data and mobility with a justice perspective (Akbari 2019). Sexual orientation and gender identity has also been considered from a data justice perspective. Andreassen’s work (Andreassen 2021) is one such example that is also clearly relevant from a mobility perspective as it engages with how LGBTQ refugees’ asylum claims are processed in

Europe and ‘how their credibility — and thus their ability to obtain asylum — is determined, in part, by their social media profile’. The paper shows also how ‘current use of biometric digital data traces to identify refugees, govern borders and manage migration has been intensified by the application of social media content in asylum proceedings’ – an issue clearly at the intersection of mobility, data and justice (Andreassen 2021).

All of this shows, how, ever more, the way mobilities of all kinds are shaped and organized, and decisions are taken, is intrinsically bound up with data, algorithms, and, increasingly AI. Data practices therefore become central to ‘shap[ing] the terms and conditions for our participation in society’, including ‘how we come to understand the world, what services we are able to access, *where we are able to go*, what we are able to do, and the way we are governed’ (Dencik et al 2019: 873 – highlight by us: ‘where we are able to go’ in italics). This increasing normalisation of datafication, within mobility, but also beyond illustrates ‘the growing assumption that being visible [or, we would add, invisible or hypervisible] through the data we emit is part of the contemporary social contract’ (Taylor 2017, 1). Taylor also identifies an interesting tension between ‘the need to be seen and represented appropriately’ through data on one hand and ‘the needs for autonomy and integrity’ on the other hand (Taylor 2017, 10). An example is the use of Strava metro data that simultaneously makes (largely white, male, leisure and commuter) cycling more visible in transport planning, while rendering those who do not use the app more invisible in data-driven policy processes around mobility infrastructure (Williams 2021).

Many mobile media art projects bridge the space between data mobilities, exploring public space, hybrid realities, play and games, co-design and space and urban interventions that raise questions of justice (Hjorth, de Souza e Silva and Lanson 2020).

Artists have critically interrogated the tensions between data collection, physical in/visibility, and im/mobilities by intervening in and playing with 'hybrid spaces' of digital and physical interaction (de Souza e Silva and Sutko 2009; Sheller 2014). Hildebrand and Sheller, for example, consider the mobility justice implications in the work "*Where the City Can't See,*" a piece that questions the uses of LIDAR (Light Detection and Ranging) technology along with Google Street View in the now normalized use of autonomous-vehicles with mobile cameras to scan, account, and plot urban spaces using a 'machinic LIDAR gaze.' In response, denizens of the over-surveilled city use 'digital camouflage' to generate 'blank spots and furtive movements, that escape its surveillance' as they seek to hack, manipulate and subvert the mobile-medial logics of the smart city (Hildebrand and Sheller 2020, 476).

Mobility infrastructures are also shaped by inequitable investments by major technology corporations. What Henderson calls 'tech mobility' focusses on the role of large tech/data companies such as Google or Uber in the re-shaping of urban mobility, providing a justice-relevant analysis of developments such as Google buses (Henderson 2018). They ask: '[c]an tech mobility be harnessed in ways that, instead of propping up the car system and metropolitan inequity, [can] be targeted at redoubling the efforts of expanding bicycle and transit spaces, densifying suburbs and overlaying that with a social housing strategy that ensures an equitable urban future?' (Henderson 2018, 449). Thus mobility data justice also intersects with spatial justice within urban planning. Another example concerns equity issues of sensor placement in cities (Robinson et al. 2022). This is also highly relevant for mobility, as the sensors in question include those capturing mobility, e.g. footfall, or mobility-associated issues such as air pollution. Robinson et al's (2022) analysis of how monitoring (rather than surveillance) data can

help in understanding how injustices can be evidenced and remediated could usefully be extended to mobility issues.

Existing work on the intersection of "data justice" with other types of justice includes environmental justice (Vera et al. 2019) and international development (McNutt, n.d.; Heeks and Shekhar 2019). Heeks and Shekhar [2019] develop an applied data justice framework that they use in the context of international development, but that is useful more broadly. This considers five dimensions of data justice: procedural refers to 'fairness in the way in which data is handled'; instrumental to 'fairness in the results of data being used'; rights-based to 'adherence to basic data rights such as representation, privacy, access and ownership'; structural to 'the degree to which the interests and power in wider society support fair out- comes in other forms of data justice'; and distributive to 'an overarching dimension relating to the (in)equality of data-related out- comes that can be applied to each of the other dimensions of data justice'. We will return to some of these dimensions in section 5.

As communications scholar Hildebrand (2021) has highlighted, another "data" element that is relevant for mobility data justice considerations is the mobility of data iself, and how it is discussed and conceptualised in critical approaches to data. For describing the mobility of data, the word "flow" is often used, while others have suggested that the terms such as 'data journey […] better locate[s] data in physical space' (Bates et al. 2016: 4; cited in Kitchin et al's book). Other metaphors used are data fumes (Thatcher, 2014), data trails (Behrendt 2016, 2019; Sourbati & Behrendt, 2020), and "data threads" (Merrick White, 2018). They highlight 'the more abstracted and relational movement of data; the way in which they are incorporated into material-discursive practices which take place' (Merrick White, 2018, 93). This also relates to the issue of data portability 'in which the data subject shall have the right to receive the

personal data concerning him or her', and which, as Benjamin reminds us, 'like other forms of movement, is already delimited by race as a technology that constricts one's ability to move freely' (Benjamin 2019b, 188). Critically discussing the intersection of mobility studies and security studies, Guittet interestingly observes 'that mobility of data is privileged ahead of the mobility of persons, or, more accurately, certain categories of people' (Guittet 2017, 214). Overall, while the "mobility of data" has been acknowledged occasionally in mobility studies, there seems to be ample opportunity for research that specifically focusses on it. This sensibility to considering how the mobility of data unfolds sits alongside the considerations of data justice in informing the mobility justice framework.

Considerations around the mobility of data also link to debates on data ownership and access, as these are key to the way data is stored and transported. Important work has emerged around the idea of 'data commons' (see Kitchin 2021b for a concise summary) that could be brought into conversation with recent discussions of 'mobility commons' (Nikolaeva et al. 2019), which we suggest could be bolstered by a broader framework of mobility data justice. Birkinbine and Kidd, for example, contribute a 'reexamination of […] the communications commons, especially given the major changes in geopolitics and global communications economies, ecologies and cultures' with a special issue that 'investigate[s] sites of commons struggle by examining the history, as well as the contemporary applicability and relevance, of the communication commons' (2020, 153, 154). This certainly chimes with mobility concerns. Critical and justice-informed approaches to data commons include those by Prainsack who calls for a 'more systematic attention to the issue of exclusion from digital data and information commons' and 'whether commons can change power asymmetries or whether they are more likely to perpetuate them' (Prainsack 2019, 1).

This echoes Sheller's concerns of how the 'communicative commons which is materialised in all human efforts to communicate with each other […] have been colonised by tech companies, who have commercialised and monetized human communication by gathering data' (Sheller 2018b: 167-8).

Monahan (Monahan 2020) is another example of mobility-relevant work on data commons, researching 'conflicts over data sharing between city transportation departments and ride-hailing companies such as Uber and Lyft' (Monahan 2020, 1). They discuss these companies' strategic extraction-logic driven resistance to sharing data with public bodies and 'explore[s] the notion of a "data commons" approach to transportation management' (Monahan 2020, 1). They call for 'a reassertion of cities as shared spaces and lived environments for the public good' to extend to data (commons) debates, for example around micromobility or lift sharing. Monahan warns that '[o]therwise, the public will continue to be colonized and depleted for private gain, and the politics of these moves will be obscured by the elusive technological platforms that govern our lives' (Monahan 2020, 7), resonating with debates on smart mobility mentioned in section 3.

Environmental concerns are not systematically integrated into data (justice) debates, something that needs urgent addressing. While papers such as Vera et al (Vera et al. 2019) have opened up the debate, there is space to develop this more fully, something a mobility perspective could be helpful for. This could draw on considerations of the environmental and ethical implications of big data (Lucivero 2020), on critical approaches to "Managing Carbon and Data Flows" (Pasek 2019), and Gabry's work on environmental sensor data (2016) and smart forests (Gabrys, Westerlaken, and Ritts 2022). Environmental Data justice 'generates ways to critically reflect on how all data practices – including our own – are embroiled in the very

extractive logics that we aim to critique and replace' (Vera et al. 2019, 1023). Vera et al highlight that those communities and individuals that are 'experiencing disproportionate environmental impacts' are also often 'disproportionately burdened with surveillance and data extraction without consent' and therefore the authors 'push for environmental data stewardship that takes into account accessibility and transparency while preserving anonymity and confidentiality' (Vera et al. 2019, 1024). This seems also true for the intersection of mobility and data justice, where those disproportionally affected by limitations on their (im)mobilities are also often those communities and individuals vulnerable to data injustices. Their (Vera et al. 2019) paper does not discuss the environmental (justice) implications of datafication. A connection with AI research that considers climate change implications (e.g. Dobbe and Whittaker 2019; Crawford 2021) would be a fruitful way to develop this debate.

Another feature of such technical inequities is the surveillance of refugees, migrants, and displaced people. Martin and Taylor provide a data justice analysis of digital identities for displaced populations – a topic highly relevant from a mobilities perspective, as forced (im)mobilities are key to the context and understanding of these communities and individuals. 'Refugees, like migrants and the poor, constitute a population that has both extraordinary needs and extraordinary vulnerabilities', and the paper considers how aid organizations, companies and governmental institutions use data approaches that 'create[] opportunities (e.g. more just distribution of aid), but also open[] up to function creep by governance and policing' (Martin and Taylor 2021, 51). The authors focus on 'the inclusion and exclusion effects of digital identification on refugee and displaced populations', of particular relevance also as these populations often become the test cases for systems rolled out to larger or all parts of countries" populations in the future (Martin and Taylor 2021, 53). Sheller (2016) additionally

identifies the use of mobile phones and the need for access to charging, sim cards, and other minds of data access by refugees as a crucial component of the experience of moving across highly technologized borders within refugee mobile practices.

Recent Covid-focused debates in the field of data justice are also highly relevant to mobility approaches; for example research on pandemic-related sharing of mobile phone provider's tracking data, changes of and limitations to personal and society wide mobility patterns and associated data collection, to name a few (e.g. Linnet Taylor, Gargi Sharma, Aaron Martin 2020).

This mobility-focused review of literature on data justice and related issues has identified key issues that are relevant for understanding the intersection of mobility and justice from a data perspective and also identified some areas where future research would be fruitful.

5. Mobility Data Justice

Drawing on the elements we have identified as crucial for a justice-informed approach to the intersection of mobility and data in the literature, this section develops a framework for analysing past, contemporary and future mobilities with regards to the intersection of data and mobility with a social justice perspective. This endeavour chimes with anti-racist, decolonial, and feminist work towards ending "practices of discrimination and a redistribution of power relations so that citizens have a much stronger say in how such systems work and receive fair treatment" (Kitchin, Cardullo, and Feliciantonio 2019). This is needed not just for smart cities, as referred to in this quote, but also for mobility data entanglements broadly understood. Rather than setting out a narrow framework, we aim to open broad debates and avenues for a wide range of work that has data, mobility and justice concerns at heart. Data justice and mobility

justice are wide-ranging areas of research in their own right, with broad scope and interdisciplinary approaches, making their intersection a complex terrain to navigate. We aim to provide some first thoughts and questions that could inform further work. We suggest that a mobility data justice perspective can contribute to new approaches in a number of areas at the intersection of mobility and data.

We envision that the framework could inform existing and emerging research on data, mobility and justice and encourage it to also consider the respective "other two" elements to some extent, without it being the key focus of the work. We posit that the intersection of justice, mobility and data are a key concern of, firstly, any research that engages with (im)mobility at various scales, as there is hardly any aspect of mobility that is not touched by data in some shape or form, and, secondly, any research that engages with data at various scales as there are not many aspects of datafication that do not have a mobility dimension (of data, bodies, things, finance, etc.) – while justice concerns pertain to all mobility and data issues. Thirdly, we hope to inspire new studies that specifically use the triple lens of mobility, data and social justice to shape new research.

In short, mobility data justice provides a multi-scalar, interdisciplinary approach for examining entanglements of mobility and data with a social justice perspective. Based on this definition and the broader considerations in this article, we propose a focus on distributive, procedural, and epistemic elements of mobility data justice, that also indicate initial thoughts on how the framework could be operationalized.

A *distributive* mobility data justice perspective considers (a) how mobility and data are accessed, accumulated and distributed in (un)equal ways, (b) how data and mobility infrastructures lead to (in)equitable risks and benefits distributions, and (c) how moral subjects are constituted with relation to mobility and data, i.e., who is

considered deserving or worthy of access to various mobility data or data mobilities, and who is targeted by such data collection, surveillance, and control. A focus on the outcomes of (in)equalities at the intersection of data and mobility are part of this research agenda, as is the question of how new data mobility systems reinforce inequities in distribution of access to the 'goods' that they purportedly offer. Distributive perspectives also explore how 'subaltern' groups appropriate data through practices such as counter-mapping to seize back control over their own territories and mobilities, and how commons approaches might further mobility data justice by opening up distributive justice in new ways (e.g. Rosa 2022).

A *procedural* perspective on mobility data justice explores who participates in the decision making and the design of infrastructure that is relevant for the intersection of mobility and data, as well as its use. This involves considering the wide range of infrastructures relevant to mobility data (in)justices, but also the design, economic and policy processes around them, and who get to participate – or not. Also, this extends to the roles of public institutions, private companies, and governance processes in (co)producing mobility data (in)justices. It is thus crucial to ask how the "who" and "how" and "why" of decision making around mobility is intrinsically bound up with data, algorithms, and, increasingly AI. AI is increasingly blackboxing how crucial decisions are reached, and leaving people out of the loop to a greater extent than ever before, undermining the very notion of procedural justice. Procedural perspectives also examine how data is gathered, organized and utilized in ways that shape social and spatial organization including mobilities. They also consider the function of public space, with its physical and virtual elements – and their hybrid entanglements – in producing, understanding, resisting and challenging mobility data (in)justices.

An *epistemic* perspective of mobility data justice explores what counts as 'data' and knowledge in relation to mobility, and how it is applied to knowing the world. This includes considerations of the ways data systems are implicated in the production of intersectional (im)mobilities, including age, gender, race, sexuality, class, and disability. Epistemic perspectives also examine how capabilities for mobilities are supported or prevented by uses of data, and what other ways of knowing might be imaginable. For example, how justifications for the collection of data or applications of databases inadvertently, surreptitiously or consciously limit mobilities; and vice versa, how the limitation or control of mobilities produces particular kinds of data-subjects or objects within databases via sorting, tracking, and identifying anomalies. Much of this work will entail analysing existing injustices and the power relationships behind them, but it also extends to defining principles for fairer approaches to mobility and data, for example extending manifests on data justice from feminist (Cifor et al. 2019), development (Heeks 2017), and indigenous/post-colonial perspectives (Carpio et al. 2022).

This mobility data justice framework combines the insight of both data justice and mobility justice approaches to bring to light important new areas of research and activism around mobility data injustices. It is also important to integrate this academic work with concerns raised by various mobility justice and data justice movements, which contribute toward an emerging intersectional awareness of mobility data justice. On the mobilities side, this includes movements around transport equity, shared mobility, commoning mobility and open borders, to name a few (Sheller 2018b). On the data side, justice movements engage with open data, net neutrality, data commons and data sovereignty, but also with algorithmic bias, AI ethics, bridging the digital divide and the limits of smart cities. Privacy protection, tracking and non-commercial sharing

of mobile data are also key topics for social and justice movements. These movements should provide fertile ground for collaborations with academic research on mobility data justice.

Additionally, a mobility data justice perspective leads to new formulations of ideas of the commons and commoning. While mobility theorists have begun to call for mobile commons, and data justice theorists call for a data commons, Moran is one of the first to bring together both in the concept of the 'Mobile-Digital Commons.' This is a promising direction that calls for further development, especially in the face of emerging blockchain technologies and their associated claims of horizontal libertarian secession from existing forms of regulation, governance, and sovereignty (Simpson and Sheller 2022). We suggest there is a need to re-think the meaning of commons in a way that encompasses both its physical and its informational manifestations. The new mobile commons are hybrid spaces of informational mobilities as much as physical mobilities; and the enclosures of public space are achieved by data fencing and exclusionary algorithms or encrypted geographies as much as by physical fences and walls. Ultimately, the concept of the mobile-digital commons can contribute not just to academic research but also to activist movements seeking to build new kinds of relationality.

It is also urgent to place environmental (justice) concerns at the heart of mobility data justice, to take a global and intersectional perspective of multiple scales and complexity, and to embrace alternative ways of knowing that decenter Western perspectives on mobility and data. This might include the impacts of high energy usage associated with cloud computing, the processing of e-waste, and the ways in which greenhouse gases and polluting processes directly contribute to the displacement of communities who are subjected to environmental injustices and coloniality. These very

groups are then prevented from accessing free movement across borders via discriminatory technologies of bordering and racialized exclusion (Sheller 2018b). At this scale we can also think about planetary mobilities and the ways in which practices such as space exploration, geoengineering, GIS visualization, and remote sensing have all entangled data gathering functions with control of earth and extraterrestrial systems, in ways that raise numerous mobility data justice concerns in terms of how such technologies are distributed, who will make procedural decisions about their usage, and what kinds of epistemic systems they empower or disempower (Szerszynski 2016; and see Clark and Szerszynski 2021).

6. Conclusion

We have shown first how the mobilities turn already incorporated into it concerns with datafication in the production of uneven mobilities and differentiated mobile subjects. The perspective of mobility justice began to consider how data systems were implicated in the production of intersectional (im)mobilities and how the uneven accumulation of network capital contributed to dimensions of kinopolitical power that reinforced and reproduced mobility injustices.

We have secondly shown how the study of data justice contributes to critical perspectives on how data is gathered, organized and utilized in ways that shape social and spatial organization including mobilities. Data justice emphasizes that how decisions are taken is intrinsically bound up with data, algorithms, and, increasingly AI, with many inequitable results. We have also highlighted how the mobility of data should form part of these debates.

Both perspectives lead towards an investigation not only of *distributive* justice in terms of access, accumulation and distribution of/to mobility and data, but also of

procedural justice in terms of who is included in the taking of decisions and the design of mobility and data infrastructures. Together they also open compelling new questions around *epistemic* justice in terms of what counts as 'mobility, 'data' and knowledge, and how it is applied to knowing the world. Mobility data justice approaches work within the broader context of the climate emergency; take into account the intersectionality of gender, race, sex, and disability, and their dynamic shaping by both mobilities and datafication; and consider global complexity and non-Western perspectives. Together these approaches form the cornerstones of our mobility justice framework that aims to facilitate analysis of the past, present and future of entanglements of data, mobility and social justice.

This paper contributes a mobility data justice framework that could help analyse a broad range of topics at the intersecting of mobility data and justice. It thus extends debates on mobility justice and data justice but will also be relevant to researchers that are broadly interested in social justice, mobility, transport, datafication and digital society. Future research on mobility data justice could include further theorisation of mobility data justice approaches, additional work on operationalising the mobility data justice framework, and applications of the framework. This could be in research related to mobility, data or social justice, and in studies specifically focussing on the intersection of those three. This could include case studies, e.g. drawn from the Data Justice Lab's "Data Harm Record", 'a running log of problems with automated and algorithmic systems being reported from across the globe' (Redden 2018), and collaborations with relevant social/data/mobility justice movements (see e.g. section 5), amongst others.

The lens of social justice helps to understand the multiple ways power and (in) equalities are transformed or amplified at the intersection of mobility and data.

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