Infrastructural Participation in Digital Societies: Challenges and Alternatives

Noortje Marres

University of Warwick, United Kingdom/ N.Marres@warwick.ac.uk

Brit Ross Winthereik

Technical University of Denmark, Denmark

Tanja Schneider

Technical University of Denmark, Denmark

Gloria González Fuster

Vrije Universiteit Brussel, Belgium

Sascha Dickel

University of Mainz, Germany

Abstract

User and citizen participation in the form of micro-actions scripted by digital systems has become indispensable to the functioning of government and society**.** In this article, we introduce the concept of 'infrastructural participation' to evaluate this phenomenon and investigate empirical instances of it in four topical areas: automated vehicles, digital education, citizen science and data protection. We formulate four societal challenges arising from infrastructural participation: 1) the resourcification of engagement, whereby digital participation becomes a mechanism for extracting people's data, work and attention to serve as resources for value generation by industry and state, 2) growing infrastructural dependency of the public sector on the private sector, 3) the 'infra-structuring' of persons - i.e. asymmetric, interactive categorisation - by digital technology, and 4) knowledge deficits and power asymmetries. We also identify an alternative form of infrastructural participation that has potential to empower social actors and strengthen relations between innovation and society, namely 'epistemic participation' by non-experts in governance, innovation and research. To conclude, we call for the development of society-centric approaches to digital participation to address the above challenges and realise potential benefits.

Keywords: Participation, Infrastructuralisation, Digital Society, Politics of Innovation

Introduction

"No phone!!", someone had written on the now defunct parking payment machine on a residential street in North London (Figure 1). For this particular user, or rather non-user (Wyatt, 2003), paying for parking had become practically impossible after the local council had decided to switch to an app-based system. Finding out where to pay with cash, it turned out, "still needs a phone." In

Figure 1. "No Phone," Haringey (2021, photo by N. Marres)

many countries, such more or less accidental, cascading forms of digital exclusion have become an everyday reality: you will probably remember similar situations. At the Winter Wonderland Christmas Fair, also in London, the only way to report lost property, include lost phones, was via a QR code, which required a... phone. To be sure, the "no phone" situation has analogies in bureaucratic situations from pre-digital times - as when the opening of a bank account required a form from a different institution that required you to provide... a bank account. But this type of recursive exclusion engendered by technologies of bureaucracy has gained special relevance in today's digital societies, where "no phone," "no bank account" and "no address" are joined by "no Internet," "no electronic ID," and "no computer" as vectors of social and political exclusion. The digitalisation of citizen services currently prevents people in various European countries from accessing such services, and, in some countries, it prevents them from accessing public benefits, as Singh and Jackson (2021) show in their study of Aadhaar, the biometric identification project of the government of India.

Situations of digital exclusion present an important social and political phenomenon in their own right, but they are also indicative of a broader transformation of the conditions for participation in digital societies. The time is long gone when people's participation in digital infrastructures was optional: digital participation has become indispensable to the provision of essential services in contemporary societies. Today it is not only exceedingly difficult to go about everyday life without using digital technology, government and industry also require citizens to participate in the delivery of essential services in the form of digital actions such as filling online forms and clicking buttons ("I agree," "I approve"). Plantin and colleagues (2018) describes the rendering of the internet as infrastructure for basically 'everything' as the 'infrastructuralisation' of the Internet in society. Others have described how today's near ubiquitous reliance on digital technology has an array of consequences for the relations between state, economy and society, including the delegation of public responsibilities to private companies, ever more demanding requirements on everyday people to acquire forms of 'digital literacy' tailored to specific technologies and platforms, and growing inequalities between the haves and have nots (Robinson et al., 2015).

In this article, we want to foreground one specific transformation that sits at the base of many of the political and societal consequences of the infrastructuralisation of digital technologies in society: the infrastructuralisation of participation. This development has profound implications for the relations between technology, society and democracy, not all of which have been sufficiently appreciated to date in our view: digital participation is today scripted into the provision of essential services to such an extent that it transforms the conditions and forms of participation in society. Infrastructural participation both affects the very status of participation in digital societies (what participation is) and the credibility of efforts to establish the public legitimacy of the economy and the state through increased participation (what participation may become).

Offering a stark example of infrastructural participation, recent debates about generative Artificial Intelligence (AI) have highlighted how the development of this powerful new technology depends on the appropriation of user-generated online data. Large language models like ChatGPT are trained on massive amounts of data scraped from the Web, making all creators of online content de facto participants in AI "innovation" whether they want to or not (Sloane, 2024). As we will discuss below, such forms of free digital labour have a long pre-history in digital culture, but with generative AI these effects are increasingly legitimised as a default condition for the functioning of the economy and the state (Kempeneer and Wolswinkel, 2023). To see how this could be otherwise, we therefore would do well to adopt a wider perspective and examine how infrastructural participation in AI is enabled by developments that have been on-going for several decades.

In what follows, we will investigate how participation has become infrastructuralised in digital societies in order to clarify some of its consequences for the relations between society, technology, and democracy. We will do this by examining four empirical cases of infrastructural participation in different topical areas: automated vehicles, education technology, citizen science and data protection. These instances emerged from the authors' research and thematise infrastructural participation on different scales: that of an everyday environment in society (the street), a public institution (primary schools), a strategic initiative (citizen science), and on the level of a regulatory mechanism (data protection law). Each of our cases highlights key features of infrastructural participation in different European countries through attention to a variety of social, technological and legal dynamics: the modification of public space, datafication, informal work, and the transformation of privacy.

In adopting a case-based approach to understanding infrastructural participation in digital societies, we have three principal aims: first, we seek to identify some of the features and consequences of infrastructural participation in digital societies. Second, we want to offer a conceptual handle on a phenomenon that is hard to grasp: infrastructural participation - like digitalisation itself - is a transversal development that cuts across societal domains, from education to government to science, and as such may easily slip below the surface of empirical studies of everyday life in digital societies. Third, we would like to show that comparative evaluation provides a way of understanding and addressing key challenges of infrastructural participation. Before taking on these tasks, however, we will first offer a general definition of infrastructural participation in digital societies**.** In the final sections we will reflect on defining challenges and alternative forms of infrastructural participation identified in this paper, and outline what we believe is needed to ensure that infrastructural participation serves the ends of society and not only those of industry and state.

Transformations of participation in digital societies

The notion of citizen participation as a pre-condition for the good functioning of society reverberates throughout the decades of the 20th and 21st centuries. John F. Kennedy, in his inauguration speech on 20 January 1961, famously pledged American citizens to ask not what their country could do for them, but what they can do for their country.[1] A similar ideal was invoked when Dutch prime minister Mark Rutte celebrated the "participation society," encouraging the delegation of social responsibilities previously assumed by the state, such as care for the elderly and disabled, to private citizens.[2] However, in today's digital societies, participation in the delivery of essential services is not only invoked as a moral duty or an ideological programme, but equally constitutes **a socio-technical reality**. Everyday transactions with institutions commonly involve myriads of minor acts of digital participation, in which citizens actively press buttons, fill in forms, provide their data, and activate sensors. Whether submitting a gas meter reading to an energy company, registering to vote, or applying for a travel card, we find ourselves providing information, adopting the role of participants in the management of societal systems, whether purposefully or not. Participation has become an infrastructural reality in digital societies.

Plantin et al. (2018) put forward the term, 'infrastructuralisation of the internet', to capture this changed reality. They pointed out how - well before AI was embraced as the guiding framework for the automation of public and social services - digital networked technologies were being integrated into the delivery of public services like health care and education, which rendered digital systems essential to the functioning of society in ways similar to energy and transport systems. This 'becoming infrastructure' of digital technology can be understood as the most recent configuration in the historical process of the digitalisation of society. Whereas, during the 1990s and early 2000s, the digital was primarily associated with participatory culture and the platform economy, during the last decade or so, the delivery of critical services by state and economy has emerged as a primary object and site of digitalisation. We can discern three periods of the digital society, three phases of the integration - or, rather, insertion, insofar as 'integration' suggests that the operation was successful - of digital technologies into society. It began with a first phase of the **culturalisation** of the Internet during the 1990s, when digital media became associated with cultural experimentation and online participatory culture, taking the form of virtual communities, blogging and so on (Kelty, 2012; Stevenson, 2018). From the 2000s onwards, this process was overtaken by a second phase of **platformisation** (Van Dijck et al., 2018) of social life, as an ever-widening range of everyday activities from shopping to travel and hanging out with friends was transposed onto online settings, 'walled gardens' on the Web managed by tech companies. In this phase, economy and society became infused not only with participatory culture but also with the logics of commodification of social and cultural activity specific to social media culture (Kennedy and Moss, 2015). A third phase is marked by the **infrastructuralisation** of the digital. Here, finally, it is not just mundane activities like shopping or travel, but critical services that are central to the functioning of state, public institutions and society, which are transposed into online settings. Examples of this can be found in the digitalisation of the evaluation of asylum applications (Perret and Aradau, 2023), the proctoring of exams (Williamson, 2017) and GP consultations, which in many European countries have become partially or largely transposed into networked computational systems. At the current juncture, vital functions from border control to education and public health would cease to operate without such systems.

The 'infrastructuralisation' of the digital, or 'tech,' in society fundamentally affects social, economic, cultural and public life in several dimensions at once. It is associated with the growing importance of private tech companies in the delivery of essential services in society, economy and by the state. Bunz (2021; drawing on Huysmans, 2016) has used the concept of **extitution** - as opposed to institution - to highlight the dispersal of responsibilities resulting from the delegation of public service provision to privately-owned digital systems. The consequences of this are still unfolding, but it is becoming clear that it has specific implications for the role of participation in digital societies. The shift to tech-based arrangements for the delivery of critical services entails a growing reliance on the activities of everyday publics to deliver those services. Within tech infrastructures, the optimisation of service delivery involves an increased delegation of tasks from organisations to citizens, users and consumers: the functioning of digital services depends on users installing and updating apps, filling online forms, generating by-product data through transactions, as they go about their daily lives. Importantly, even as human subjects must comply with platform designs in order to receive their services, these designs are often lacking in accessibility and usability. An important feature of the process of infrastructuralisation, then, is that mundane acts of participation are increasingly scripted - but *not* necessarily designed - into the provision of and access to essential services, and through these, into the coordination of social and public life.

The recent uptake of new generative AI technologies, in the form of powerful machine-learning systems, in societal domains as diverse as law enforcement, media, education, health and culture, is strongly marked by this dynamic of infrastructural participation. New machine-learning-based generative AI systems have been widely criticised for their reliance on 'extractive participa-

tion', most notably through the capture of user-generated content and its re-use as training data (Sloane, 2024). In extractive participation, the use of digital technology is structured to facilitate the extraction of people's data, work and attention, turning these into resources for value generation by tech industries without recognition, renumeration or, indeed, overt participation in these outcomes. This problematic of de facto, exploitative participation in tech development, however, predates the massive uptake of AI across society today (Roberge and Castelle, 2021), and is similar to what Chris Kelty (2012) called the resourcification of participation. It has notable precursors in the 'economy of contribution' of the platform age (Couldry and Powell, 2014) and in 'e-government' initiatives, the long-standing process of the transposition of bureaucratic processes onto computational systems (Pelizza, 2016). The infrastructuralisation of participation in contemporary societies then came before generative AI, and is equally operative in more basic computational architectures that do not involve its use.

Minimally defined, infrastructural participation refers to the structured activities that people must engage in on an everyday basis to facilitate the functioning, maintenance of improvement of digital infrastructures in society. In some respects, infrastructural participation is utterly ordinary. As anthropologists and historians of technology have shown, many different types of non-digital systems have historically relied on a type of infrastructural participation to function, from the maintenance of roads (Harvey and Knox, 2015) to the intentional flooding of agricultural fields by farmers to prevent damaging floods elsewhere (Edwards, 2003). However, in the context of digitalisation, infrastructural participation has gained a distinctive *strategic* importance through its close association with the 'innovation economy', the digital transformation of European welfare societies and the particular activation of citizenship within the context of neo-liberalism. That is, it has gained special importance within the context of a wider, structural development, in which the transfer of responsibilities for the public good away from the state - towards citizens and other actors in society - goes hand in hand with the re-allocation of the management and ownership of public infrastructures to private companies (Dalakoglou, 2016).

Within this socio-political context, infrastructural participation presents a many-edged phenomenon. On the one hand, the infrastructuralisation of digital participation - whereby the delegation of societal functions to tech infrastructures by state and industry results in the creation of systems and services that critically depend on digital participation for their functioning - intersects with the withdrawal of the state from the delivery of public and social services. On the other hand, alongside such top-down processes of infrastructuralisation, we can observe the rise of societal movements that undertake an infrastructuring of participation from below. Scholars across Science & Technology Studies (STS), media studies and related fields have documented the rise of 'infrastructural communities,' whereby citizens mobilise to reclaim key infrastructures - from disaster response to community-based renewable energy systems like district heating at the local level. Relatedly, they have described forms of 'infrastructural contestation' - as socio-technical systems like road, rail and renewable energy systems become the focus of political mobilization by affected groups and concerned citizens (Kallianos et al, 2023; also see Barry, 1999). The concept of 'infra-structuring publics' has been proposed to capture what is distinctive about such initiatives. It proposes that we move from the noun ('infrastructure') to the verb ('infrastructur*ing*'), and shift analytic attention away from infrastructures as accomplished objects towards the complex and consequential processes by which infrastructures are achieved, maintained, and adapted over time (Korn et al, 2019; see also Dantec and DiSalvo, 2013 and Winthereik and Wahlberg, 2021). Infrastructural participation, then, is a profoundly ambivalent phenomenon: it is associated with the delegation by state and industry of the labour and cost of infrastructure maintenance to everyday publics, even as they transform these infrastructures into a source of profit for private entities. But it is equally connected with the grassroots agency of civic actors as everyday publics actively take care of shared infrastructures under conditions of the withdrawal of the state from society.

One way to make this ambivalence explicit is to make a distinction between the '**infrastructuralisation of participation** from above and the **infrastructuring of participation** from below. Within such a schema, two different forms of infrastructural participation are opposed to, and vie with, one another, in contemporary societies. In the top-down processes of the infrastructuralisation of participation, participation mechanisms - such as carrying out basic tasks like filling templates, initiating campaigns, buying a train ticket or generating budgets and other types of structured digital data - are deployed as a *resource* to realise purposes defined by government, industry and science, a way of optimising socio-technical arrangements for the implementation of organisational objectives (Kelty, 2020; Powell, 2021). By contrast, in the bottom-up work of infra-structuring publics, everyday people claim agency in the creation and maintenance of society's infrastructures - often using digital means - even as they mobilise to advocate for infrastructural investment by the state to serve society. We find this distinction helpful insofar as it makes it clear that there is a range of different possible configurations of infrastructural participation, with different possible effects. For instance, top-down processes of infrastructuralisation may open up new ways of valorising citizen generated data, as in the case of online platforms for personalised medicine (Kallinikos and Tempini, 2014), but also of 'assetising' participation, as populations of active users become key to the valorisation of services, and traded as sources of innovation (Birch and Muniesa, 2020; Marres, 2025). Practices of infra-structuring participation, by contrast, may involve the development of new distributed forms of data-based monitoring of the state by citizens, as in the mapping of (the lack of) recycling facilities, or the asymmetric distribution of CCTV cameras in New York City (McPherson et al, 2020; Gray and Marres, 2020).

The distinction between top-down and bottom-up forms of infrastructural participation has, however, an important limitation. It risks narrowing our exploration of infrastructural participation by identifying two opposing archetypes and prematurely pre-distributing some of the features and dynamics of infrastructural participation to such arche-types. Thus, the distinction between top-down and bottom-up sets up an opposition between **instrumental** and **substantive participation**, making it the key question whether the infrastructuralisation of participation results in the deployment of participation as a (mere) resource for the realisation of objectives defined by government and industry, or whether it enables the involvement of citizens and publics in the shared realisation of a social, cultural or public good, i.e. whether it mainly serves state and economic interests, or collective interests. Secondly, the opposition between infrastructuralisation from above and from below suggests a distinction between **inadvertent** and **deliberate participation**. Here the key issue becomes whether everyday actors are enrolled as participants in infrastructure by generating data or performing labour (such as tagging images) without their knowledge, or whether their participation is deliberate, as in the case of national 'switch off' events, where participants record their experience of living off grid for 24 hours in public media. It might seem that top down infrastructuralisation is first and foremost associated with instrumental and inadvertent participation, while the infrastructuring of publics enables substantive and deliberate participation. But is that really the case? Should these archetypes guide our analysis of infrastructural participation? To examine this, we have undertaken an empirical review of exemplary recent cases of infrastructural participation in digital societies in Europe.

Methodology

To guide our empirical investigation of infrastructural participation, we will only assume a minimal definition at this stage: the infrastructuring of participation involves the scripting of various forms of engagement by users, citizens and everyday publics into the provision of societal services by socio-technical means. Such a minimal definition covers all four types of infrastructural participation identified above and potentially others too. To develop this minimal definition further, we will examine features of infrastructural participation through a discussion of four instances of it. We have derived these instances from field

research that the authors have carried out in different domains: automated vehicles, educational technology, citizen science and data protection law. Our choice of cases follows two logics: one, pragmatic, as these are the areas in which we are currently researching digital transformations of society, and second, diagnostic, as we have identified initiatives, events and phenomena in these domains that can demonstrate specific challenges and potentials of infrastructural participation at different scales. Our selected instances help to clarify processes, features and problematics of infrastructural participation in digital societies on the level of a) an everyday environment (UK streets), b) a public institution (primary schools in Denmark), c) a strategic initiative (citizen science), and d) a regulatory mechanism (EU data protection law).

As to our analytic framework, our aim here is not to investigate how digital innovation *caused* the infrastructuralisation of participation in our societies. Rather, we approach digital innovation as 'a critical site' (Procter, 2004) in which dynamics of the infrastructuralisation ('from above') and infra-structuring of participation ('from below') may intersect and become empirically explorable: the creation of digital arrangements, in the form of apps, devices and systems like automated vehicles, play a key role in both the inscription of everyday participation into societal infrastructures ('infrastructuralisation from above') as well as in the creation of new forms of community-based mobilisation ('infra-structuring from below'). We then understand the digitalisation of society and the infrastructuralisation of participation as intersecting developments. At the same time that participation in society is increasingly mediated by digital infrastructures - from social media to smart energy meters -, the infrastructures of society - from mobility to education - are rendered dependent on participation through government and industry interventions. Digitisation projects then present one dimension of a wider process of the reconfiguration of relations between society, state and industry alongside others, such as the privatisation of public services.

The next section presents our four instances of infrastructural participation. We introduce the cases and clarify why each presents an instance of infrastructural participation in our view. To do this, we will rely on our own research as well as media reports, scientific and professional literature. Next, we discuss what types of participation each instance brings into relief. This will make it clear that infrastructural participation complicates the relations between government, industry and civil society actors. While participation is often conceptualised as a relationship between citizen and state, or between the individual and the collective, infrastructural participation multiplies the actors and relations involved in the enactment of participation. In the case of infrastructural participation, the relations between state and citizen, and between individual and collective are always *mediated*, for example, by a tech company. As a consequence, the relations that come about through infrastructural participation are also potentially complex: for example, the non-users of a service, say passers-by in a street where automated vehicles are tested, might become inadvertent participants in the delivery of a computational service. Each case description, finally, concludes by identifying the challenges and potential benefits it brings into view regarding the ability of infrastructural participation to serve societal objectives.

Our empirical descriptions, we believe, can inform the development of a typology of infrastructural participation. As we discuss in a concluding section on the evaluation of infrastructural participation, such a typology enables us to move towards a statement of formative problems with infrastructural participation, and of its potential benefits might be for society.

Four instances of infrastructural participation

Automated vehicles: infrastructural participation in the street and the coming crisis of accountability

Since around 2016, tech companies and automotive industries have trialled connected and automated vehicles on public roads in the UK and elsewhere, which involves intensive and extensive forms of data capture in the streets. Automated vehicles are equipped with sensing technologies of various kinds that record the car's perfor-

mance, the road environment, weather and other road users, in the form of on-board cameras, light detection and ranging (LIDAR) devices (Hind, 2022). Autonomous vehicle companies operating in the UK like Waymo and WayveAI use data captured in the street to train a variety of models to develop navigational capacities including in situ behaviour prediction, so that automated cars can effectively anticipate "the behaviour of dynamic agents in the scene."[3] Automated vehicles, then, do not only model material environments (passing vehicles, fencing), but also the social environment. The London-based start-up WayveAI claims its data makes it possible to detect "human biases from drivers, which often have complex non-linear interactions between them too." [4] Oddly, this widespread capture of street-based data by automated vehicles has not attracted much public attention in the UK, and at present this data appears not to be classified as personal data. A recent UK government report stated that "with a few notable exceptions, data-driven systems in th[e] [transport] sector tend not to involve the processing of large volumes of personal data, so privacy risks manifest differently."[5]

It is not clear why the data captured by automated vehicles is not classified as personal data as it includes camera data featuring human road users, and the data are analysed for psychological and social attributes, as in the example of bias detection mentioned above. This relative lack of concern with data protection is also evident in the regulatory frameworks that govern automated vehicle testing in the UK: at the time of writing it is still the case that automated vehicles can be tested on UK roads without the need to request permission from public authorities in the UK,[6] and without requirements for informed consent, although trials conducted in partnership with local authorities do tend to include some data protection provisions such as privacy assessments.

It is still relatively common practice in the automotive sector to place publicity embargoes on on-the-road automated vehicle testing, meaning that in many cases the test is not publicised at all before or during testing. This is another reason why in many cases it is simply not possible for road users to consciously opt in or out of participation in data capture in the street. Automated vehicles in the street, then, present a clear case not only of inadvertent participation but also of continuous participation, as automated vehicle trials configure the street into a test environment in which road users may at any time participate in securing the performance of automated mobility systems via interaction and data capture without their knowledge (Cohen et al., 2020).

Elsewhere in Europe, the transformation of streets into surveillance theatres by means of the car *has* begun to attract critical attention. In 2022, Tesla cars were found to be taking photographs of passers-by in the streets of Copenhagen. When a citizen filed a complaint about this with the Danish Data Protection Agency, they were told the photography was already being examined by European partners as part of a research project focusing on privacy by design.[7] Which is also to say, it is not just automotive companies but transport authorities who act as partners in the infrastructuralisation of digital participation in the street. Street deployments of automated vehicles, however, do not just threaten privacy through increased surveillance, they also play a role in transforming the infrastructural conditions of participation in a more fundamental way (Lindgren et al., 2021). The automation of mobility - not only through automated vehicles, but through smart infrastructure like networked traffic lights and automatic speed limiting - is part of wider developments that are turning the street into an intensely monitored environment: ubiquitous data capture in everyday environments like the street transforms the conditions for participation in public life in this setting, which is now continuously monitored, recorded and observed by computational means. As automated mobility initiatives align with the expansion of surveillance in the lived environment of the public street, they reduce the scope of more unstructured forms of participation in street life. As a respondent to the Ada Lovelace Institute's consultation on biometrics explained: "If there is a CCTV camera you are less likely to act outside of what's acceptable, because you're under observation. So, you modify your own behaviour, stop being as wild, or as wonderful, or as kinky, or as strange, as you could possibly be. And no one has asked us if we want to live in that society."[8]

The infrastructuralisation of data- and compute-intensive technologies into street environments in the UK is part of a wider drive to hand over public responsibilities to private industries. The government is actively committed to outsourcing street-based data services to third party service providers. As part of an envisioned shift to 'vehicle-centric' digital communication, responsibility for systems like traffic guidance and road signage is transferred to private actors. On the automated road, participation in traffic is increasingly organised through private communication, in the form of navigation apps and camera- and sensor-systems built into cars and in some cases, the road environment (Marres, 2024). This affects participation in the street in a variety of ways, including on the level of accountability: if an app tells a driver the wrong traffic speed, who is at fault? It is not an exaggeration to say that the infrastructuralisation of computational technology into road environments threatens to render traffic participation unaccountable, in the classic sociological sense of the capacity of social actors to orient their actions in situ to the perceptions of others that are co-present in the situation. The embrace of 'vehicle-centric' modes of communications as part of automated mobility initiatives also creates significant information asymmetries: while some 'smart' vehicles will be able to access real-time traffic information alongside digital road signs, 'older' vehicles may not be able to do so. As a consequence, some road users will be informed of the rules and some won't be, which is also likely to impact accountability relations with external authorities, such as the transport police, as well as among road users. Intra-situational account-ability - the mutual coordination between road users that are co-present in the street - is put at risk. Automated mobility infrastructure may dismantle situated practices of traffic participation: social processes of mutual coordination on which the running of traffic has long relied, and which are now being undermined by the on-going privatisation of public infrastructure through the automation of mobility systems.

Chromebookgate: Infrastructural participation in public education in Denmark

In describing Denmark's infrastructural dependency on big technology corporations in the US, Cone and Lai (2024) identify five different lock-ins based on their examination of a case of technology for education – the Google Chromebook. Cone and Lai argue that to understand how the datafied welfare state operates, we must pay attention to infrastructural power (Flensburg and Lai, 2020) and its frontend (political, discursive) and backend (technical) perspectives. For our purposes here, their focus on lock-ins helps understand the issue of infrastructural participation, as they ask the question of why it is so hard to imagine the future of the public sector without the involvement of large, commercial technology corporations.

In the early 2020s, Google Suite for Education was in use in primary schools in around half of all municipalities in Denmark. It was considered an affordable solution by public authorities under financial strain. The software is used on cloud-based computers – Chromebooks – and was offered cheaply to the municipalities as a favourable deal. Municipal schools would be able to live up to their ambition to deliver 21st century skills – e.g. innovation skills, digital literacy and life skills such as flexibility and adaptability – to Danish school children. Google would gain access to long-term contracts through which to sell cloud storage, platform services, software maintenance, and new products.

The use of Chromebooks in primary schools became a matter of public concern when, in the summer of 2022, the Data Protection Authority of Denmark, the Datatilsynet, reacted to a complaint that a parent had filed two years previously. This complaint brought to public attention that information about school children, such as their full name and location, was being made available to Google to use for unclear purposes along with additional information that was associated with these potential personal identifiers.[9] In addition, with the implementation of Chromebooks at school, children were automatically signed up for YouTube and Gmail without their consent,[10] and children could not opt out of the provision of

their personal data, because the use of Chromebooks for their learning activities was mandatory. A 'smoking gun' was presented to the public when it was discovered that personal data about schoolchildren had been leaving Europe.[11] This was not just a potential risk. The municipalities had used a standard configuration when setting up the system, and no counter-evidence could be provided that data had not been passed on to Google's data servers outside the EU. It was therefore likely that the data had been passed on to third actors across borders. Therefore, in 2022, the Data Protection Authority banned the use of Chromebooks in the municipality where the father had filed the case, and later in all municipalities. The Data Protection Agency decided that the municipalities had to find a solution that would not include Google Workspace for schools.

This decision, however, was soon called into question by the Association of Municipalities, whose Director said: "Denmark cannot run without big tech" and argued that improving "some systems using data about user behavior" is not surveillance.[12] On the face of it, Chromebookgate, as it was later dubbed, offers a clear example of infrastructuralisation of digital participation into public institutions through the introduction of privately-owned systems and services. In 2025, Danish school children are still required to use Google services. As most of the schools in Denmark are run by the municipalities it is fair to say that – through their acts of entering data and creating content – Danish school children have inadvertently become participants in the creation of a privately-owned digital backbone of public education without a realistic chance to opt out. This has consequences for participation in public education as such, as participating in education now means contributing to the creation of privately-owned, commercial data and infrastructure. However, we should note that according to our analysis of news articles and 838 tweets about Chromebooks for schools (in Danish) between June 2022 and 2024, what was mostly discussed was not these wider political, moral and cultural implications but the narrower issue of (non-) legality of passing on children's data to third parties.

Of course, it is tempting to speculate about the (lack of) good intentions of public managers in a tech-optimist country such as Denmark, where national digitalisation strategies argue for making public data available to companies. Digging deeper to consider how the case elucidates infrastructural participation 'from below', i.e. if we do not only consider this case as a traditional money and power game, but as a more deep-seated transformation of a public institution (education), we find an ever closer relation of dependency between the tech industry and the public sector, and indeed the state, as what is especially significant. This relation is what required the Association of Municipalities to demand from the Government that it makes changes of the School Act and obtains a clear legal basis for allowing the transfer of personal data to Google for specific purposes.[13]

Requesting a change of law indicates that there is more at stake for the municipalities than the particular case of the use of Google in primary schools. Instead, we observe that Danish public schools are being transformed into an inventory for data and participation through data (Salling and Winthereik, 2025). Long-term service contracts with Google - as well as with Microsoft for other parts of the public sector - which state authorities and public sector institutions cannot break free of mean that children's education is now also part of an 'assetisation' of their participation in public institutions (Birch and Muniesa, 2020). Children generate data that are a source of value to a company, and they also participate in strengthening the mutual entanglement of the public authorities with big tech. Participation in education today is likely to involve the de facto extension of the obligation to participate in a privately owned digital infrastructure, Google Education. School children themselves have not been asked and are therefore only implicated, and spoken about by spokespersons such as 'the Chromebook Father', an activist, who has been demonstrating against the authorities for several years now (Clarke and Star, 2008: 119). However, recent events in the US seem to be changing the grounds of the discussion and reframe the issue of inadvertent participation. Whereas it used to be the school children who were in a position where their privacy could not be safeguarded, additional

'victims' will be the local authorities and government, who find themselves in a **participatory lock-in** as they are bound to expensive license agreements with US based companies for years to come while the EU is figuring out how to establish its digital independence.

Infrastructural participation in digital citizen science: the resourcification of research activity or epistemic participation?

Citizen science projects are defined by the inclusion of volunteers in the research process, enabling the participation of non-experts in knowledge production (Hecker et al., 2018; Haklay, 2012). This endeavour has historical antecedents in amateur research dating back to the early 19th century – for example in historical research or ornithology – in which laypersons contributed to the production of scientific knowledge. Today, the ubiquitous use of digital infrastructures has made it much easier for lay actors to engage in widely distributed collaborative projects including citizen science. This also means that participation in citizen science is today often mediated by digital infrastructures.

Citizen Science projects encompass a wide range of participatory practices, ranging from people offering the processing power of their computers for large-scale distributed computational analysis projects to the collection of observational data (e.g., to map air pollution in urban areas) or the donation of personal digital data (e.g., loyalty card data), the classification of images of artworks, or the sharing of health-related observations, symptoms and experiences. The specific forms of involvement vary from project to project. In most cases, participants are involved in data collection, data donation and data analysis. Digital devices, such as smartphones, notebooks, cameras, sensors, and dedicated apps enable the massive generation and evaluation of data, and, in this regard, digital citizen science can be understood as crowdsourcing and crowdworking (Franzoni and Sauermann, 2014).

One of the largest web portals for citizen science is the Zooniverse. This platform grew out of Galaxy Zoo, a popular citizen science project launched in 2007 to classify galaxies through digital mass participation (Kasperowski and Hillman, 2018). Today, the Zooniverse hosts more than 100 projects and has 1,6 million registered users. It is run by the Citizen Science Alliance (CSA), an organisation of scientists, software developers and educators governed by a board of seven institutions in the United Kingdom and the United States (including Oxford University and Johns Hopkins University). The infrastructure of the Zooniverse platform makes it possible to process very large data sets. According to the Zooniverse website 2.696.236 volunteers have performed 786.908.360 classifications of data so far.[14] This classification work by volunteers can then be used to train algorithms that perform such classifications automatically (Franzen et al., 2021). Citizen participation in scientific data classification here becomes a resource for the development of AI systems.

Another example of digital citizen science is the FoodCoach research project. The aim of this project is to facilitate healthy shopping and eating practices by developing a consumer-oriented mobile phone application (app) based on donated shopping data. Swiss consumer volunteers donate their individual customer loyalty programme data as collected by two major Swiss supermarkets (Coop and Migros, which together have a market share of approximately 70 per cent (Statista, 2021)). The legal procedure for the sharing of customer data by individual customers lies in European data protection law, concretely in the General Data Protection Regulation (GDPR), which we discuss in the next section.[15] Using this donated shopping data, the FoodCoach interdisciplinary research team, spanning computer science, information studies and STS, is compiling a comprehensive database and developing an automated approach to analyse digital food shopping data and making it available to individual users in an easily understandable form via a mobile phone app. The app provides an assessment of nutritional consumption patterns using the Nutri-Score and alternative product recommendations that support a nutritionally healthier diet. Simultaneous to the technical development, the FoodCoach project explores people's lived experience of this type of digital receipt-based dietary tracking through ethnographic go-along interviews (Kusenbach, 2003) and focus group

discussions. This gives users - but also non-users[16]- a chance to voice their views on the app and thereby to co-shape the design of the interface as well as the kinds of information and hence interventions provided.

Digital citizen science does not just *extend* public participation in science, but also *(re-)defines* the conditions and the meaning of participation, compelling a shift "from deliberation to production" (Strasser et al., 2019: 65). This involves the 'resourcification of participation' (Kelty, 2020): through citizen science, the structured activities undertaken by project participants – such as data collection, donation, classification and voicing views – generate data which subsequently serve as infrastructure for knowledge production and technology development as forms of value generation. While the science policy discourse on citizen science emphasises the potentials of democratizing scientific research, scholars like Mirowski (2017) have defined the new modes of crowd participation as a form of 'extractive participation'. Similarly, volunteer and user participation in the development of (commercial) ethical consumption apps often involve invisible digital labour (Schneider and Eli, 2023). Citizens become participants in data-and-value generation within the infrastructures of digital societies in under-acknowledged ways. Citizen involvement in science then takes the form of the provision of resources by non-scientists to science, rather than that of epistemic participation in the process of inquiry as knowing subjects (co-inquirers, co-authors). Citizen science itself turns into an infrastructure that enables new types of large-scale projects.

In considering how digital citizen science involves infrastructural participation, we do well to consider how science as a whole has become heavily infrastructuralised in all its practices – from informal exchanges with colleagues (via email or video chat) to the publication in digital journals or publicly accessible repositories, from data collection to data processing and analysis. Many aspects of academic life nowadays need to conform to the rules and affordances of digital infrastructures. Within this context, digital citizen science may be understood as a vector of the infrastructuralisation of tech in science: it is part of a wider set of initiatives which render scientific research increasingly dependent on digital infrastructures, in other words - digital participation is a vector of the growing infrastructural dependency of science on the tech industry. At the same time, citizen science opens new possibilities for bottom-up infra-structuring. Individual projects as well as community initiatives, organisations, platforms, and networks dedicated to the establishment and expansion of citizen science actively experiment with infrastructures that can enable distributed, community-based modes of research.

Bottom-up infra-structuring of citizen science involves finding new ways to address knowledge and information asymmetries between experts and non-experts, as well as between commercial and public institutions. Citizen science can serve as a semi-independent knowledge infrastructure for both intra- and extra-academic purposes (Ottinger, 2022). Designing citizen science as a participatory infrastructure remains a crucial challenge for the field's development. One way to meet the expectations of broadening participation in science and empowering the public to be not just resource contributors but also epistemic participants, is to address the challenge of structuring participation in a participatory manner. This can be achieved through the co-design of science projects from the outset and ongoing collaborations with citizens. Such an approach must also implement mechanisms to ensure that citizen science benefits citizens, it must show how project results will be used to their benefit and how citizens can participate in future applications of the knowledge, algorithms, and prototypes produced.

The GDPR as instrument of infrastructural participation or the case of gender attribution by Twitter

Our fourth case is the General Data Protection Regulation (GDPR), which was adopted by the European Parliament in 2016, and incorporated into UK law in 2018. This regulation presents a cross-cutting phenomenon, as it is applicable in all of the sectors discussed sofar. However, we include it as a separate instance of infrastructural participation for two reasons: 1. this regulation forms a key attempt by European governments to

address the negative consequences of infrastructural participation for society. 2. Its adoption has altered the conditions for participation in digital infrastructures in Europe, not least by mainstreaming – or generalising - the transformation of users into data subjects. Under data protection law, individuals become 'data subjects' as soon as personal data related to them are processed. Data subjects are automatically entitled to a series of 'data subject rights', which includes the right of access to personal data, also known as data access right (DAR), alongside the right to rectification, the right to object, the right to erasure, and the right to data portability, among others. These rights aim to equip individuals to better protect the personal data about them held by others, and thus their rights and freedoms (González Fuster, 2014).

Data protection law enables and sustains multiple forms of infrastructural participation. Personal data are often shared and made available for processing on a voluntary basis, with individuals freely consenting to the processing. When data processing is technically not based on the individuals' consent but on a 'legitimate interest' of the controller or a third party, individuals could exercise their right to object, but often refrain from doing so. Consent to personal data processing is often misused, and it is highly debatable that all online processing of data allegedly based on 'consent' is actually based on legally-sound, fully free and informed, and thus actually technically valid consent. In a way or another, nevertheless, a certain endorsement by individuals is typically activated to turn them into implicated actors, and thus participants in a minimal sense in the processing of data about them. Such endorsement – more or less lawful, but certainly connected to the law - is integral to the functioning of numerous online platforms.

Another significant form of infrastructural participation enabled by data protection law concerns specifically the use of data subject rights. Using their right of access to personal data, users can request all the data processed by, for example, X (formerly Twitter) that relates to them. Doing so, they might be able to download a multiplicity of folders and files, among which there is one that can take them to an html document which appears to have been designed for a human reader. Here, the individual can visualise what X designates as "interests", which might consist of notions such as "Electronic music" or "Feminism". They will also see, presented by X as personal data linked to them, brands they only vaguely know or persons they have never heard about. The data subject can also explore all ads that have been displayed by X to them, including ads they maybe do not remember having seen. Interestingly, by clicking on the information about these ads, it will be possible for the data subject to see some of the criteria used for targeting them, thus learning about how companies and organisations operate in order to target audiences – opening a window into how their participation has been infra-structured. The accessible data might include some rather straightforward criteria, such as country of location, but also more intriguing factors such as being a "follower look-alike" of the followers of another X account. This triggers the question of which kind of structuring is taking place: what does it mean to be a "follower look-alike" of the @MileyCyrus profile, for instance, and, more generally who decides about these (data) matters, and how they do they end up being personal data?

From the standpoint of participation in digital infrastructure, what is striking about the data revealed through data access requests, is that they are at the same time personal and institutional, as well as technical. The data relate to the individual, they are linked to them, but they may also provide information about digital infrastructures used by the organisation in question, about what type of information is being collected, in what categories, and for which purposes. From this, two points follow: firstly, that data access rights afford a form of 'epistemic participation' in digital infrastructures. When 'given back' to the data subject, the data have gone through a further re-configuration or translation, deliberately re-arranged to comply with a legal obligation. What the data subject eventually sees is thus, in a way, a very specific choreography of a multitude of traces of their activities, as well as of the digital platform in question. This data can be used by data subjects and others to gain knowledge about the platform, allowing for further interaction, for instance by

exercising the right of erasure or the right to rectification.

Secondly, the use of data access rights is itself an instance of the 'infrastructuring' of the participation. It constitutes a structured activity that data subjects are invited to engage in, if they wish to protect their rights and freedoms in a digital environment. To participate better, one is invited to participate more. On a more general level, data access rights thus engender further data-intensive forms of infrastructural participation.

Data access rights can be used to make infrastructural participation visible to wider publics, as demonstrated by some data access request campaigns made by citizens and activists. Here, digital participation is approached not merely as an individual act, but as a data practice that brings individuals into a series of relations with and through digital infrastructures. Sometimes the right of access is envisioned as an open door to knowing what others know *about us*, which assumes others would have both an interest in and the possibility of knowing *us*, and that this is what personal data processing is about (González Fuster, 2018). However, researchers have also used the right of access to gain an understanding not of what organisations know about individuals, but how they use the capture of personal data to serve organisational ends. Understanding access rights as a form of infrastructural participation helps to draw a more accurate picture of contemporary data practices.

While data access rights belong to individual data subjects, the knowledge created through data access requests transcends individuals (Mahieu and Ausloos, 2020): it empowers subjects to explore heterogeneous relations between individuals, digital platforms, other subjects, processes of categorisation, and regulations as well as their mutual transformations, as mediated by data processing. Personal data are not merely data related to persons but also to data practices, and the persons involved in digital participation are to a degree infra-structured persons.

In digital platforms it is especially clear that the infrastructuring of persons arises out of participation (Day et al., 2023): it emerges from recorded interactions between user and platform.[17] Take the example of gender attribution in X. When users do not self-assign a gender as part of their account settings, the platform may automatically attribute gender, based on the processing of other data related to a user account, such as their profile and activity (Fosch-Villaronga et al., 2021). Users can then eventually discover which gender has been attributed to them, based thus on their actions and provided profile information, by accessing the "privacy settings" of their account, where they will find, in addition to the mentions associated with their account, the following message: "If you haven't already specified a gender, this is the one associated with your account based on your profile and activity. This information won't be displayed publicly". By merely being active online and contributing to the social media platform, thus, users are made to work for their own structuring in gender terms.[18]

Data access requests may enable an empowering, epistemic form of infrastructural participation, in which knowledge can be used to create public awareness about the resourcification of participation in digital societies. The fact that individuals may eventually request access to their personal data already by itself exercises a certain power on the controller, who might as a consequence refrain from labelling them in inappropriate ways. The GDPR after all requires that all organisations should in principle be ready to explain on which basis it concluded that was an appropriate statement. Furthermore, as the GDPR empowers data subjects to challenge how they are classified (the right to rectification), using the right to access may also confer a degree of agency to data subjects in rejecting how they are classified, and/or publicly revealing the patent inauthenticity of some of the classifications in use.

Evaluating infrastructural participation: from tech-centric to society-centric models of participation

Our brief overview of instances of the infrastructuralisation of participation in digital societies highlights a range of negative consequences of this development, alongside some upsides and potential benefits. These negative consequences are 1) the resourcification of participation, as mun-

dane acts of participation by everyday people increasingly serve as resources for value generation by industry and state 2) growing infrastructural dependency of the public sector on the private sector 3) the infra-structuring of persons, as tech industries and governments hold or have access to large volumes of personal data and rely on automated processes of social categorisation, which, in some countries, undermine or risk to undermine conditions for accountability. 4) information deficits and knowledge asymmetries, as part of wider dynamics of the inclusion and exclusion of persons, as familiarity, expertise and access to digital technology and digital literacy widely diverge across populations. Alongside these risks and harms, however, we have identified a set of empowering features of infrastructural participation, most notably the invention of potentially new forms of epistemic participation.

Our review suggests that some sectors are more vulnerable and some less vulnerable to the negative consequences of the infrastructuralisation of participation, and some are well-positioned to enable the development of more empowering forms of infrastructural participation. Our examples from the domains of citizen science and data protection law showcase structured opportunities for the use of arrangements of infrastructural participation for the enactment of epistemic participation. In these cases, the infrastructural mediation of acts of participation in knowledge production and digital governance enable insight in, collective mobilisation around, and public contestation of the digital infrastructuralisation of society. Our instances also indicate that the distinction between infrastructuralisation from above and the infrastructuring of participation from below holds empirical water: where industry leads in the infrastructuralisation of participation, as in the instances from the domain of education and mobility, participation is more likely to figure as a resource and is performed without the subjects knowledge or active or chosen involvement, while in citizen science and data protection we observed opportunities for the development of deliberate and substantive forms of infrastructural participation.

In surfacing both negative and positive consequences, our cases also enable us to further specify the transformations of participation engendered by the infrastructuralisation of technology in digital societies. Most importantly, these insights take us beyond the two binary distinctions between instrumental and substantive and between deliberate and inadvertent participation. Firstly, our instances indicate that we need to move beyond the notion of inadvertent participation. In virtually all of the instances we reviewed infrastructural participation either is or has strong potential to be extractive. Furthermore, in the case of automated vehicle testing, infrastructural participation in everyday mobility environments like the street is not just inadvertent but ubiquitous, as here road users may become implicated *at any time and in any street* in the functioning of automated systems through data capture and interaction (see also Cardon et a.l, 2023). The case of the use of Chromebooks in Danish primary schools demonstrates that digital participation is not just unfree and unchosen because it is implemented 'without consent' or without proper consent mechanisms having been put in place, but because infrastructural participation is locked-in, whereby the growing dependency of public institutions on the tech industry arises from the strategic objectives of the innovation state (Pfotenhauer and Juhl, 2017).

To a degree, the difference between instrumental or exploitative and substantive forms of infrastructural participation seems to map onto the distinction between industry-driven versus public institution-led initiatives and arrangements of infrastructural participation. But our indicative exploration of different cases also raises a more general question: how do we define forms of infrastructural participation that serve not merely the interests of the infrastructuralisation of digital technology in society, but the public or collective interests? Identifying when the public interest is clearly not served by digital participation is something social researchers are getting better at including by following the pioneering work of digital rights activists and experts (Binns et al., 2018). But what about the positive cases? The challenge of identifying benefits of infrastructural participation for society and democracy here is partly empirical (the research methods of Science and Technology Studies are better suited

for tracing frictions and harms as opposed to improvements and benefits (Ruckenstein, 2025)). But the issue is also conceptual: to evaluate infrastructural participation, we need to be able to define it, beyond the minimal definition, as involving the socio-technical scripting of engagement by everyday people into the provision of societal services.

Part of the challenge here is that the conceptual framings of democratic participation that are influential in science and innovation policy, such as the framework of public deliberation, invite us to define participation in abstract terms, as an ideal, procedure or right (Binder et al, 2021). This tradition is informed by the Habermasian concept of the ideal speech situation, which encourages us to conceptualise democratic participation as disembedded from its socio-material environment: as involving actors (subjects, citizens, publics) and ideals (self-determination, public use of reason, the pursuit of collective interests). As the French political philosopher Charbonnier (2021) has highlighted, the liberal traditions in democratic theory that start with Locke state explicitly that the environments of participation should not actively influence the enactment of participation. The material and technical architecture of democracy is supposed to be informed by theoretical ideals of participation, and not the other way around, as in the circular design of parliaments (Dányi, 2021), or indeed, the egalitarian discussion forums of the early Internet (Dahlberg, 2007). The formatting of participation through technical and media-based infrastructures has recently received more scholarly attention (Krämer, 2022). This work has drawn attention to the ways in which the formatting of participation often serves the objective of abstraction (the representation of the public as population, for example). However, when considering infrastructural participation, there is no way around it: in this case, we can only conceive of participation as socio-materially and indeed infrastructurally constituted.

Feminists have long called for more recognition of the fact that participation is an embodied, materially situated activity (Pateman, 1989; Young, 2002), in order to demonstrate that women participate in society far more (not least through care work) than restrictive definitions of political participation acknowledge. But it is also a way of rejecting the bifurcation of the public, the idea that there are two publics: the general public represented by professionals in parliament, and the mundane publics that consists of everyday people going about their lives. Work on material participation (Marres, 2012; Knox, 2017), too, has challenged this splitting of the public in modern democratic theory, by proposing that in today's technological societies, citizens contribute to the public good through socio-material practices: using renewable energy, for instance, can be defined as a way of participating in an environmental public. However, work on material publics has to date not primarily been evaluative in orientation, while addressing this challenge is increasingly important: how can we determine when and how different forms of infrastructural participation serve public interests? We then conclude from our discussion that a revised typology of infrastructural particiation should be designed as an evaluative device.

Whatever the form of this device,[19] it is clear that some of the assumptions that underpin existing evaluative frameworks of participation will need to be revised. Activists and researchers have pointed at the phenomenon of 'participation fatigue,' where a combination of factors from lack of time to growing awareness of the extractive purposes of participation leads everyday publics to decline the invitation to engage (Hinchliffe quoted in DEFRA Social Science Expert Group (2022)). It seems all too likely that the rise in participation fatigue is connected with the growing resourcification of participation. Why participate, if the point is to make things better or easier for the organisation in question, while creating more work for the participant? The rule of thumb that more participation is better than less participation clearly does not always hold under conditions of the resourcification of participation, and critical investigations of the conditions in which it does are therefore called for. Such investigations, we believe, should meet infrastructural participation where it is currently being configured: as an actually existing socio-technical arrangement being implemented in different sectors and diverse settings such as streets, classrooms, scientific fieldsites and advertising platforms.

Our schematic exploration of infrastructural participation in this paper can inform the guiding distinctions for a more comprehensive evaluation of infrastructural participation in digital societies. As already noted, it is not enough to consider whether participation is inadvertent and deliberate - whether it is done with our without consent - if the aim is to evaluate the exploitative effects and/or possible benefits of infrastructural participation on everyday publics. The question is also whether digital participation is optional or not, and when it is not, whether it is regulative: whether it is effectively "restricted according to rules or principles."[20] We feel that the second binary distinction we introduced earlier in this paper, that between instrumental and substantive participation, does open up a helpful perspective on our empirical cases, insofar as it directs attention to the objectives and interests that participation serves. However, within a context in which participation is increasingly extractive, we would like to add a further distinction to this: that between **technology-centric and society-centric forms of infrastructural participation**.[21]

In many of the instances of extractive participation described in this article, participation is organised to optimise technological functioning and to maximise value generation by industry and state at the expense of civil society. One relatively crude but useful way to evaluate a given case of infrastructural participation is therefore to ask whether participation is designed to serve the interests of the tech industry or to realise societal objectives. Of course, this is rarely a simple case of "either-or", but a distinction between tech-centric participation and society-centric participation can help us to focus critical attention on the type of objectives and interests that infrastructural participation is designed to serve: is infrastructural participation optimised for sector-specific, individualising and privatising ends - as in the case of the valorisation of data capture by big tech - or does it facilitate heterogeneous objectives of a range of actors who are differently positioned in society? When it works well, participation tends to serve multiple ends and interests all at once, which in itself can help to generate shared social goods.

Conclusion

A defining problem of participation in digital societies can be summed up as follows: everyday forms of engagement in the form of micro-actions scripted by computational systems have become indispensable to the functioning of government and society in ways that in many cases do not serve the interests of citizens and publics and does not benefit the democratic atmosphere of these societies overall. Even as participation is today actively promoted as an instrument for making tech industries responsible for their operations, through the regulatory mechanisms of data protection and digital service acts, digital participation has been re-structured by these same tech industries as an exploitative arrangement. As participation is 'extracted' in the form of data, labour and attention, digitalisation threatens to erode conditions for societal participation as it has historically been understood, as serving the collective interest and/or the public good. While in many sectors the infrastructuralisation of participation in digital societies continues to develop in ways that prioritise technological requirements and innovation industry interests over the needs of society, a different infrastructural participation must be made possible. How to get there?

An important element of a democratic response to this challenge is to make the case for new forms of procedural participation that give those who are forced to participate in digital infrastructures a chance to withdraw their participation. Following the credo by disability activists - Nothing about us without us - such forms of procedural participation, say the possibility to file a complaint, can give affected publics the opportunity to ensure their interests are taken into account. More important, perhaps, is the need to make a distinction between technologies and services in which participation is designed to serve private interests versus technologies and services that afford multiple interests, i.e. more pluralistic forms of digital participation. Only by securing the possibility of making deliberate choices about everyday participation in digital societies at a regulatory level can participation as a substantive good be safeguarded. Finally, our overview of empirical cases shows that the infrastructuralisation of participation plays out differently in different sectors and environments

and for this reasons a comparative approach to evaluating how the challenges of infrastructural participation can be addressed in these different settings will be key.

Public participation in technological societies has been valued for its distinctive affordances for the co-articulation of heterogenous interests and objectives across society (Callon et al., 2011). There is no inherent reason why infrastructural participation could not serve this purpose, too. We have argued that under conditions of the infrastructuralisation of participation, this requires the explicit articulation - and operationalisation - of the societal objectives of digital participation in different sectors and settings. In pushing for the development of such society-centric approaches to digital participation, we do not have to assume that society is either unitary or homogeneous but can focus on identifying and resourcing modes of participation by heterogeneous actors that are substantive and collective.

Historically, participation has been valued as a way of infra-structuring society – a way of creating structures in society that are collectively empowering (Kelty, 2020). The appropriation of mechanisms of public participation for the pursuit of private ends has a history that is almost as long. Within the current phase of the digitalisation of society, it is clear that the models for infrastructural participation that are advanced and implemented by the tech industry do not serve democratic ends. We need different models that can inform designed arrangements of infrastructural participation that can take the place of forms of digital participation that are often scripted to optimise technological functioning and serve industry ends. At the same time, a comparative evaluation of the infrastructuring of participation in different settings in digital societies is needed as there are many questions still unanswered. Not least: should all participation be deliberate and not inadvertent? Not necessarily so. To formulate principles that can guide the design and implementation of infrastructural participation, we must undertake empirically grounded, comparative explorations of infrastructural participation in specific contexts. These stand much to benefit from analytic co-labouring with affected publics.

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Notes

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2 Government should keep out of 'participation society", says Prime Minister, Dutch News, October 3, 2013. Available at: https://www.dutchnews.nl/2013/10/government_should_get_out_of_t/ (accessed 21.2.2024).

3 Available at: https://wayve.ai/thinking/predicting-the-future/ (accessed 21.2.2024).

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5 Centre for Data Ethics and Innovation, "AI Barometer Part 4 - Transport and logistics" 17 December 2021. Available at: https://www.gov.uk/government/publications/ai-barometer-2021/ai-barometer-part-4-transport-and-logistics (accessed 21.2.2024).

6 "Trialling any level of automated vehicle technology is possible on any UK road if carried out in line with UK law. Trialling organisations do not need to obtain permits or pay surety bonds when conducting trials in the UK." https://www.gov.uk/government/publications/trialling-automated-vehicle-technologies-in-public/code-of-practice-automated-vehicle-trialling (Accessed 4 February 2024)

7 While privacy may be a guiding design principle, in practice personal data transfers between Tesla and law enforcement seem to be a new normal. Dutch law enforcement recently established that Tesla cars records much more data than the company had to date communicated to law enforcement by directly hacking into a Tesla vehicle. Available at: https://dataethics.eu/smile-tesla-wants-your-photo/ (accessed 21.2.2024).

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9 Meaker M (2022) A Danish City Built Google Into Its Schools—Then Banned It. *WIRED Magazine*, published 23 September 2022. Available at: https://www.wired.co.uk/article/denmark-google-schools-data?fbclid=IwAR0teO4Iul-r0gNKypsxbCwZ25I9JQz3574jGX6Bl0i46tymoAX5-2noqO8 (accessed 20.2.2024)

10 Magnusen M 2022 Far politianmelder Helsingør Kommune i Chromebook-sag. *RADAR*, published 3 August 2022. Available at: https://radar.dk/artikel/far-politianmelder-helsingoer-kommune-i-chromebook-sag (accessed: 20.2.2024).

11 This is problematic in relation to the 'Schreems 2' decision from the European Court of Justice. The court decision says that companies with a base in the US cannot guarantee that European data is processed in compliance with European data legislation. There is currently no functioning data transfer agreement between the EU and the US – the last one, Privacy Shield – was repealed, partly because the US will not guarantee that data is not stored and analyzed by e.g. intelligence services and a new agreement is now being negotiated. Available at: https://www.kl.dk/okonomi-og-administration/digitalisering-og-teknologi/databeskyttelse-og-informationssikkerhed/schrems-ii-dommen/, and https://epic.org/foreign-intelligence-surveillance-court-fisc/

12 Available at: https://www.version2.dk/artikel/danmark-kan-ikke-koere-uden-big-tech-mener-kl-saa-skal-vi-have-en-meddelelsesbog-og-en-blyant-til (accessed 26.07.2024).

13 Available at: https://www.bleepingcomputer.com/news/google/denmark-orders-schools-to-stop-sending-student-data-to-google/ (accessed 26.07.2024).

14 Available at: https://www.zooniverse.org/ (accessed 22.10.2023).

15 Based on the GDPR's right to data portability European consumers are supposed to regain in a sense "sovereignty" over their customer data and may request an electronic, machine-readable copy of their data at any time.

16 The FoodCoach team recruited users and non-users of loyalty cards and tracking app/devices as participants and asked them to discuss their non-use and the kind of questions they have when presented with mock-ups of the FoodCoach app (during a focus group) or when volunteering to test a prototype of the app during their shopping (go alongs).

17 Sociologists have described how digital knowledge infrastructures are involved in making up people (Day et al., 2023); technologies of participation articulate the subject as socio-technical hybrid by imposing a processes of categorisation, and/or making participation conditional on categorisation.

18 Also important to note here is that individuals will typically be unaware of the fact that they are being attributed a gender (or gender-structured) based on their profile and activity unless they proactively access their privacy settings and search for gender information. Twitter's 'Privacy policy' does not say anything about users being automatically gendered. As such, online gender attribution illustrates well the phenomenon of inadvertent participation: one might know what one is doing online, but have no perception of the fact that by reading this or that they are determining the gender that they will be assigned. See Twitter Privacy Policy available at: https://twitter.com/en/privacy (accessed 1.3.2023).

19 One influential evaluative device in participation research is Arnstein's (1969) ladder of participation. However, it is not self-evident that a 'ladder' is the best form for diagramming different forms of infrastructural participation, given the social complexity of infrastructural arrangements in contemporary societies (Jensen et al., 2016). A more fluid format might be more suitable: a streamgraph of infrastructural participation? Arnstein's ladder is available at: https://www.citizenshandbook.org/arnsteinsladder.html (accessed 21.2.2024).

20 As per the definition offered online, see https://useful_english.en-academic.com/110892/regulative (accessed 10.4.2025).

21 The distinction between technology-centric and society-centric participation implies a move beyond the notion of socio-technical entanglement that is used and endorsed in much work in Science and Technology Studies. We believe such a move is necessary in order to speak critically about the use of digital innovation to disorganise society and to dismantle conditions for social engagement (for a discussion, see Marres, 2025). A notion that is closely related to that of the socio-technical in STS - which informs our conception of society-centric innovation - is that of the 'heterogeneity' of implicated actors and interests. While notions like the heterogeneous assemblage have been used by some to dismantle the idea of society, and along with it, the notion of collective interests grounded in solidarity, we think the project of securing conditions for the allignment of heterogeneous interest can be understood as a societal - or society-making - initiative. In this sense, the distinction between technology-centric and society-centric participation partly maps onto that between homogenising and heterogenising forms of innovation.