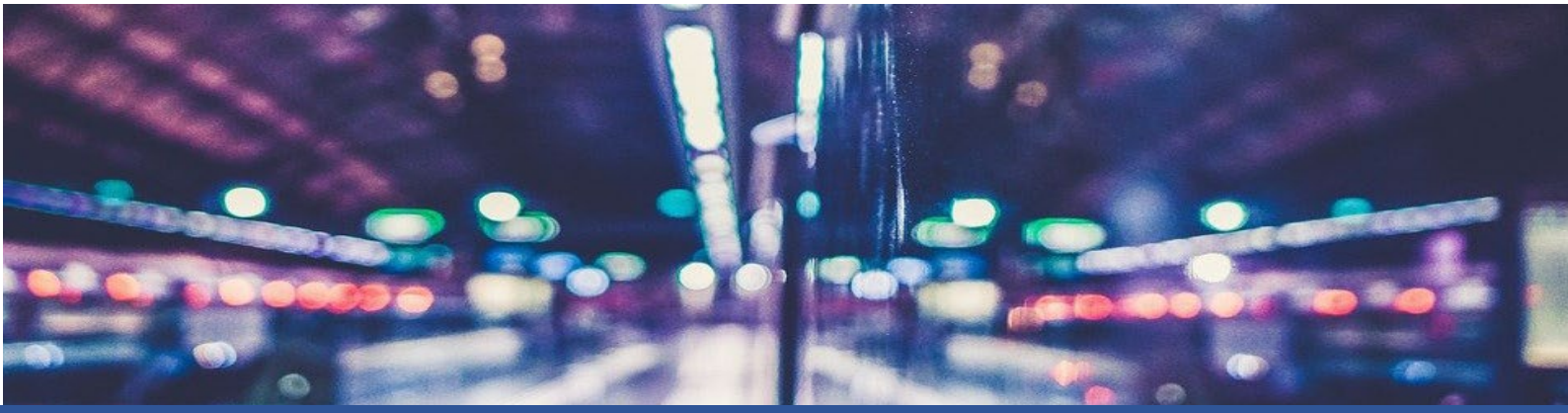
Urban Public Administration and ServiceS innovation for Innovative Urban Mobility Management and Policy



Deliverable 1
Regulatory framework and regulatory challenges raised by new mobility services

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Regulatory framework and regulatory challenges raised by new mobility services

This report forms UPASS Deliverable 1, documentation of regulatory issues associated with the five mobility services, and Milestone 1 which is the draft regulatory framework.

Primary authors: Caroline Mullen and Gillian Harrison and informed by collaborations with Meng Xu, Simon Shepherd, Qiuju Xue, Xintong Meng, Yacan Wang

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WP1 Objectives

This WP will develop and assess new regulatory approaches which support development and implementation of the five* identified service/innovation areas in keeping with principles of good governance and public administration. The objectives are to:

- Identify and analyse key regulatory challenges in governance of new and emerging mobility innovations in both the UK/Netherlands and China and develop appropriately adaptive regulatory frameworks and relevant KPIs in collaboration with key stakeholders
- Assess modelling and experimental work and revise the framework accounting for potential combination of service innovations.
- Promote best practice and assess transferability of approaches

Five identified service/innovations:

- Tradable credits scheme
- Automated vehicles
- Electric driving
- Ride sharing/Car sharing
- Shared bikes

Approach to developing a regulatory framework for sustainable mobility services

New mobility services are held, by many, to have potential to tackle some of the pressing challenges for sustainable mobility in countries and cities across the world. There are hopes that these services can help reduce use of fossil fuels, and therefore reduce outdoor ambient pollution and greenhouse gas emissions, and that they might provide inclusive, affordable mobility and so improve social and environmental sustainability. Increasingly however, concerns are raised that even if some new mobility services have potential to improve sustainability, that potential is by no means guaranteed and that there are reasons to think that they could exacerbate sustainability challenges, including transport decarbonisation which is already acute and urgent.[1]

It is in this context that we investigate governance and regulation of new mobility services.
To this end, we consider major procedural and substantive regulatory challenges in Europe and China which face the five mobility services with which UPASS is concerned.

At one end, we might question whether some services are desirable at all and so whether regulation should enable their implementation. Beyond this are more nuanced questions of how services,

[1] In relation to hopes, and concerns about new mobility services see for instance, Docherty et al (2018); Fonzone et al. (2018); Gebresselassie and Sanchez (2018) Wadud et al. (2016) Department for Transport (2019) Docherty (2021, forthcoming).

implemented and regulated in different ways, might have different sustainability implications. These questions are set out below and form the core questions for WP1.

1. Core questions

i. Is the service legal in a given jurisdiction, or what needs to happen for the service to be legal?
ii. What statutory or common laws indirectly affect the way in which a service can operate, all should affect the way in which your service can operate.
iii. Under what conditions would the service contribute to or hinder sustainability?
    a. What evidence do we have about the sustainability implications of the service?
    - What forms of knowledge exist e.g. models, theories of travel behaviour, case studies?
    - What uncertainties are there in the evidence?
    b. How does substantive and procedural legal and regulatory context influence sustainability implications?
    - This includes multi-level governance and collaboration as well as substantive content of regulation
    - Includes practices of regulation (e.g. practices around assessment, or around service delivery)
    - How does the governance approach respond to unexpected or new sustainability challenges?
iv. How can governance and regulatory approaches be used to enable new mobility services to contribute to sustainability?
    a. What, if any, commonalities exist in governance approaches for sustainable mobility in different countries?
    b. What, if any, differences exist governance approaches for sustainable mobility in different countries?

2. Structure of this report

The report begins with explanatory notes covering the scope of questions we are considering. These explanatory notes outline the relation of new mobility services to the challenge of creating more sustainable mobility systems. They also outline the inter-relations between the core questions. Finally, the explanatory notes provide a brief account of the methods used in developing the report and the reasoning underpinning this methodological approach.

The report separates investigation of tradeable credits from the investigation of the four other mobility services. The reason for this is that a tradeable credits raises some quite different regulatory challenges than the other services. The report describes key regulatory issues raised by each of the new mobility services. As the discussion shows, there are multiple relevant interactions between the services, especially between electric driving, ride and car sharing, and autonomous vehicles. For electric driving, ride and car sharing, autonomous vehicles and shared bikes, the report argues that there are commonalities as well as differences in regulatory challenges faced in different jurisdictions, and potentially at different times. Informed by theories of adaptive and collaborative governance, the report considers the implications of these commonalities and differences. This is used to develop recommendations for governance and regulatory approaches which are informed by and respond to the major challenges we have identified. We argue that the nature of these challenges has implications for processes of government and regulation, especially in relation to collaborative and reflexive or adaptive governance. This part of the report concludes with specific recommendations for that collaborative and adaptive regulation and governance. This part of the report is then followed by discussion of the regulatory issues and governance implications for tradeable credits.

Explanatory notes

1. Sustainability and new mobility services

1.1 The regulatory framework is concerned with how new mobility services support sustainable mobility understood in its broad sense of including environmental, social and economic sustainability.

1.2 Many sustainability implications associated with mobility are well-known. A non-definitive list is given below. However for three broad reasons, it can be misleading to treat social, economic and environmental sustainability implications as *simply* a list of known implications:

(a) One reason is that some issues cannot be reduced either to a social, or an environmental, or an economic matter; but the way in which they matter can depend on what aspect of sustainability we are focusing on. For instance, decarbonisation matters for economy, social equity/ equality and environment. But the approach to tackling decarbonisation might be different is we were focused on economy rather than economy and social equity/equality.

(b) Another reason is that our understanding or knowledge of sustainability can change or develop over time. For instance, understanding of risk of cancer from diesel pollution has developed over last decade;[2] or there are understandings of social inclusion related to car dependent societies have been developing over recent years.[3]

(c) New mobility services may raise sustainability concerns which have not previously been identified.

So rather than attempting a comprehensive list of sustainability issues, it can be more useful to begin with the questions of '*how does transport/a mobility service/ measure matter for sustainability?' and 'how can we take account of the possibility of new sustainability issues emerging or becoming identified?'*

Non-definitive and non-ordered lists of sustainability implications of new mobility services		
Social sustainability	Environmental sustainability	Economic sustainability
Safety – passengers	Energy use/CO2 emissions at tailpipe	Congestion
Safety- vulnerable road users	Energy use/CO2 emissions - lifecycle	Affordability
Physical accessibility (i.e. in relation to mobility difficulties)	Air quality	Availability of services
Car dependence (ease of mobility without access to private vehicle)	Ground and water pollution	Competition
Availability of services	Land use	Accessibility
Data protection and sharing	Flora and fauna	
Participation in planning		

[2] IARC (2015)
[3] Mullen et al. (2020)

2. Cross-cutting considerations involved in addressing the core questions:

2.1 For each jurisdiction potentially relevant law and regulations need to be identified. We need to consider whether or how those potentially relevant laws or regulations could affect the operation of a mobility services.

2.2 In some cases identifying relevant legislation is straightforward and can be done in isolation. For instance, for AVs to be legal on roads in the UK it would be necessary (though not sufficient) that they are operated in accordance with relevant laws on road safety and responsibility for safety (including that set out in UK Automated and Electric Vehicles Act 2018[4]).

2.3 In many cases there are inter-relations between the core questions which mean they cannot be considered independently. For instance, we can expect there to be many cases where identification and assessment of implications of relevant law and regulation will depend on how the mobility services might work. One example of this could be that legality of the operation of AV ride sharing services could be subject to legal commitments to decarbonisation (e.g. Climate Change Act[5]). The reason for this is AV ride sharing services could have implications for levels of vehicular traffic. If the provision of services led to increases in vehicular traffic which is not zero-emission, then it could be an obstacle to achieving legally binding commitments on decarbonisation.[6] In such a case, Qu. 3 would involve investigating how regulation can steer operation of AV ride sharing so that it does not increase transport carbon emissions. That could mean regulating services, or regulating vehicle efficiency and emissions, or both. This in turn would involve investigation of what formal and practical ability planners in a given jurisdiction have to regulate services.[7]

2.4 As is apparent that the tasks outlined in s2.3 also involve assessment of how new mobility services will work, and what their impacts might be for elements of sustainable mobility such as traffic levels, land use, social inclusion, emissions, and so on.[8] This is the reason for including the core question iii (a). Put simply: appropriate governance and regulation may depend on what we expect the service to do. One challenge in assessing impacts is that we have limited evidence of how new mobility services operate, and what their implications and impacts may be. Evidence we have may need to be extrapolated from evidence of existing services (review) and taken from modelling (WP3) and experiments.

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[4] HM Government, Automated and Electric Vehicles Act 2018 http://www.legislation.gov.uk/ukpga/2018/18/contents/enacted

[5] Climate Change Act 2008, amended in 2019 The Climate Change Act 2008 (2050 Target Amendment) Order 2019 http://www.legislation.gov.uk/ukpga/2008/27/contents

[6] An analogy might be the legal case against the British Government (and others) decision on Heathrow's Third Runway. The court ruled that the decision to build the runway had not properly considered environmental commitments as required by law. See https://www.judiciary.uk/wp-content/uploads/2020/02/Heathrow-judgment-on-planning-issues-27-February-2020.pdf

[7] Note that power to regulate might exist, but be too complicated or expensive or contentious to exercise – see e.g. Docherty at al. (2018)

[8] For some legal commitments on environmental and social sustainability, there is debate about whether they should be understood as procedural or substantive. In other words, do they require a process to be followed to assess impacts (recognising that assessment contains uncertainty), or are they concerned just with the impacts - Finck et al. (2020)

2.5 Addressing the core questions will involve consideration of multi-level governance and relations between actors in the places where mobility services are implemented. For instance, what sort of autonomy does local government have in regulating or planning mobility services?

2.6 Addressing the core questions will also involve consideration of how regulations are implemented and what practices are adopted. For instance, regulation might allow mobility services to be run privately or as public services, but practices may mean that they are actually only operated as (e.g.) private services. This could be relevant in turn to understanding how they may affect sustainability implications

3. Note on method and epistemology

3.1 This described might best be as socio-legal research, adopting a pragmatic epistemology

Very briefly, of pragmatic epistemology is one which focuses on problem solving, and investigates how our knowledge can contribute to this. It emphasises is the way in which knowledge results from out interactions with the world, and so draws attention to the prospect that our knowledge and understanding will need to develop as new challenges arise.

3.2 The components of the investigation are:

a. Identification and analysis of legislation, case law, policy and guidance and practices. This is done by review, and documentary analysis and expert interviews. Documentary analysis treats documents as data and also takes account of the purpose and context in which a given document is produced.

b. Review of evidence about potential sustainability implications of new services in differing contexts. This includes pragmatic assessment of the evidence, and pragmatic assessment of how we use assessment tools.

c. Expert interviews which serve two purposes:
   i. To contribute to evidence and assessment of implications of governance and regulatory context. This information from interviews needs to be critically assessed (as would any evidence).
   ii. To understand the discourses, perceptions and logics of actors working in the field. This is about understanding how actors think about the subject, and is not directly concerned with assessing those views. It is relevant because it could help in understanding decision-making affecting new mobility services.

   It is worth noting that (i) and (ii) involve different analysis. So (ii) does not seek to challenge the discourses of actors, whereas (i) would assess what he said using triangulation from other sources such as publications. With respect to (i) it is important to recognise that interviewees are providing evidence which needs to be tested and are not expected to have infallible insight into how the world works.

d. Application of different governance and regulatory context (law, policy, guidance) to evidence about how new mobility services might work. This will inform recommendations for governance and regulation.

Regulatory and governance issues for the five UPASS mobility services and measures

In this section we describe major considerations for regulation and governance of the five mobility services if they are to contribute to, or at least not hinder sustainability. We see in what follows that many of the questions are inter-related, and it can be impossible to appreciate issues facing one service without an understanding of other services. It should be noted that the first section, on electric vehicles, does much of the groundwork for the sections of other mobility services. As such the descriptions should be read in conjunction with each other. In the next section we investigate approaches to governance which may address the issues raised in relation to each of the services.

1. Electric driving

Electrification of passenger cars and public transport has been for a number of years, and remains, the dominant measure in efforts to tackle carbon and other transport pollutants transport systems across countries.[9] There is little, if any, question about the case for attention to transport electrification. Climate change and poor air quality have huge implications for environmental, economic and social sustainability, and the urgency of tackling this pollution is underlined by the rate of decarbonisation required and increasing understanding of the scale of mortality and morbidity associated with poor outdoor air quality. [10]

There are questions about how electrification can effectively support development of sustainable mobility. These are questions for governance, regulation and policy. The section will first outline some of the practical challenges for governance arising from electrification as something involving multiple actors with varying interests. It will then consider factors influencing how, or the extent to which policy and regulation on electrification can be expected to support sustainability. In doing this it will indicate how regulation and governance of other mobility services, including those considered by UPASS may interact with electrification in ways which affect sustainability.

Developing the electricity infrastructure to support vehicle electrification creates challenges on multiple levels. At the users' end, there are questions about where charging points are placed, who pays and who has access. The nature of this challenge varies in different places; so private charging is less feasible in areas with high density housing and little private parking than in places where houses have driveways.[11] Where charging is made available to the public, a slightly different set of questions arise concerning the relative roles of public and private sector providers. This reflects issues between public and private sector interests which are played out across many of the new mobility services. There are limitations in capacity of the public sector to provide services, especially in countries such as Britain where public sector has been 'hollowed out' over recent decades.[12] Further there are potential differences between the service provision which would best meet the interests of private providers, and the sorts of provision which would best support sustainable urban mobility planning.[13] In the case of charging points, one dilemma can be between provision which offers people across a geographical location access to charging and which hence could support equity in uptake of electric vehicles, and provision concentrated in locations of high demand where income could maximised.[14] As with other issues in sustainable mobility, we should note that this matter is complicated by other

[9] See e.g. Hao et al. (2014); Mullen and Marsden (2016).
[10] IPCC (2018); WHO (2016); IARC (2015)
[11] See for instance Hall and Lutsey (2020).
[12] See Doherty et al. 2018
[13] See for instance Flemming (2018).
[14] For instance Zoepf and Riggs (2018); Vithanage (2020);

factors. Here, those factors include relative costs of electric vehicles which may be a stronger factor in reduced demand in some areas, and by the consideration that electric vehicles (arguably) bring societal benefits and not just benefits to users.

Further challenges concern the capacity of electricity infrastructure from local to national level, given the burden placed on that by transport electrification. There are questions about who has responsibility for upgrades, and questions about how development of infrastructure should be organised. Both are practical questions with implications for governance. The matter of responsibility could appear simply one of determining who has contractual or statutory responsibility. However, any apparent simplicity here may simply be masking the question of contract or statutory responsibility *should* be revisited in light of what is a relatively recent policy commitment to electrification intended to bring wider societal benefits. In other words, electrification of transport and its motivation part of a landscape which may have altered since regulations underpinning responsibility for electricity infrastructure were developed. An altered landscape may provide a reason for altering regulation.

Further questions raised by the need to plan planning for potentially major changes and upgrades to infrastructure to support transport decarbonisation. Electrification of transport requires robust infrastructure for electricity, but the location and forms of investment in infrastructure should be shaped by speed of electrification and buy levels of demand in different places. This presents difficult questions for the boundaries of decision-making regarding short medium and long term plans for electricity infrastructure. A criticism levelled at the UK government is that it is separated its strategy to decarbonize vehicles from its strategy to improve infrastructure, and so runs the risk but the two strategies will not align.[15]

Another regulatory challenge associated with electrification of transport also concerns the roles, responsibilities, and potential influence of different levels of government and of private actors, in this case manufacturers and arguably consumers. The approach taken within the European Union for a number of years now has been to set binding targets on manufacturers for vehicle efficiency as a means of reducing carbon and other pollutants. This approach follows the unsuccessful efforts at voluntary targets.[16] This regulatory approach rewards manufacturers for efforts to promote electric vehicles, allowing them to double count the reduction in emissions brought by zero emission at tailpipe vehicles within the average carbon emissions per kilometre which they are required to meet. Despite this overall regulatory approach and the favouring of electric vehicles within that, there is increasing concern that the efficiency of vehicles as not only failed to improve as much as hoped, in some years had actually increased. A reason for this is that while the attention of those concerned with decarbonisation was on efficiency and electric vehicles there was simultaneously an increase in sales of heavy and therefore less efficient vehicles particularly SUVs. [17] This indicates that sustainable

[15] For instance see one local authority's (Tameside) response to the UK Government 2020 consultation on Transport Decarbonisation

[16] The voluntary agreement was 1999/125/EC: Regulation (EC) no 443/2009 of the European Parliament and of the Council of 23 April 2009 (https://goo.gl/AoUpXW). This voluntary approach was considered ineffective and in 2007 the European Commission proposed a regulation to set binding targets (Proposal for a Regulation of the European Parliament and of the Council setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO2 emissions from light-duty vehicles COM/2007/0856 final - COD 2007/0297 (https://goo.gl/xFwVvE)). In 2009 a Regulation was adopted Regulation (EC) no 443/2009 of the European Parliament and of the Council of 23 April 2009 (https://goo.gl/AoUpXW). This has since been superseded by Regulations in 2014 (setting targets to 2020-21) and then 2019 which set targets to 2030 (Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R0631)

[17] See Anable et al. 2019

mobility requires more than consideration of what is being done to support it and that it also requires attention to what actions are actively undermining it. The difficulties of improving vehicle efficiency in this way also prompt a question of which governance level would be most effective in supporting sustainable mobility. Efforts to encourage manufacturers to create and sell more efficient vehicles have been operating at a multi-national level in Europe, and if this approach is not sufficiently effective it may be that city and regional governments would have more success through measures such as low pollution zones.[18]

Beyond the considerations of how to plan and organize electrification of transport effectively, are a set of questions about what a policy focused on electric cars might mean for the sustainability of the mobility system in different places. To begin it is worth noting that even the most optimistic assessments of progress in development and sales of electric vehicles, fuelled by low carbon electricity generation, is not expected to achieve what is needed unless distance travelled by vehicles also reduces.[19] Further, electric vehicles still create particulate pollution associated with poor health and early deaths.[20] These points indicate a case for thinking about whether, how or where vehicular traffic should be reduced. This case is greatly strengthened when we consider the implications that vehicular traffic has for other aspects of sustainability.

There is a large, and longstanding literature on the complex relationship between passenger cars and environmental, social and economic sustainability beyond carbon and other air pollution. Many of these issues are well-known, but it is worth giving a brief (and inevitability incomplete21) outline in order to keep the range of relevant issues in the fore of the discussion, and to indicate how sustainability concerns can emerge and change over time and in different circumstances. Mobility systems, which in most places involve high levels of travel by passenger car, support economic, social, health, education and other systems. A dominant approach in transport planning is that there is a value of travel for individuals, and so people will travel if they consider the benefits of doing so outweigh the costs and time involved. This view is widely criticised for a number of reasons including the argument that it privileges planning decisions which facilitate more and faster travel by car.[22] While this dominant view of the value of time might be open to criticism, it is less controversial to argue that there is a cost associated with travel time. For instance research is concerned with transport related social exclusion argue that in locations where public transport is limited, and distances are significant, those without access to a private car may need to spend a significant amount of time making every day journeys and this can reduce time available for other activities including time with family or time spent on education.[23] The value of cars for the functioning of other systems, and for individuals' opportunity and welfare, may depend to a significant extent on whether the mobility system is such that there is car dependence. In other words, it could be perfectly feasible to support systems and individuals through very different mobility systems in which cars have far less significance. Nevertheless, it may be worth reflecting that there would be limits to such change. One consideration is that passenger cars provide mobility for people who would otherwise find it physically difficult to travel, and they can provide safe mobility for travellers especially women in places where they would not otherwise feel safe. It may also be that aspects other systems rely on a highly motorized mobility system. This may be true of some aspects of health care, where centralization of

[18] This point was made by an interviewee from a Non-governmental organisation concerned with improving environmental sustainability of transport in Europe.
[19] Brand et al. (2020)
[20] Timmers, V.R. and Achten, P.A., (2016) Non-exhaust PM emissions from electric vehicles. Atmospheric Environment, 134, 10-17
21 Incomplete because there is not space to attempt a complete outline of all the issues currently recognised in literature, and further because current literature will likely not have recognised all relevant issues.
[22] See e.g. Banister 2008
[23] See e.g. Lucas (2012); Mullen et al (2020)

care can facilitate specialization which can save lives which would not otherwise be saved, but which rely on people traveling significant distances.

Vehicular traffic, especially where speeds are relatively high or where there is insufficient provision for other road users, can itself be a barrier to (non-vehicular) mobility, and so to the activities involving mobility and the welfare and wellbeing those activities support. In relation to social sustainability there is decades-old work on relationships between social interactions and traffic levels on residential streets.[24] Beyond this correlation there is slowly emerging understanding of some of the ways in which roads, especially those with fast traffic and without adequate provision for pedestrians, can affect the mental and physical wellbeing of residents particularly those with low incomes who rely on walking.[25] The implications for cycling of vehicular traffic behaviour and road design are also well researched. In England there is evidence that fear of motor traffic is a major barrier to cycling uptake, and that this fear is (arguably) well-founded given near misses[26] and relatively high deaths and serious injuries suffered by cyclists compared to car occupants measured by number of trips and distance travelled.[27] Famously, other European countries, especially the Netherlands began on a similar trajectory for cycling but through campaigning and a range of measures to improve conditions for cycling, are now held as an exemplar.[28] Social and economic sustainability is affected by dominance of vehicular traffic. In places where active travel is discouraged physically by risks or barriers imposed by traffic, or culturally by norms that vehicular travel is normal or expected,[29] there is lost opportunity for physical activity and the economic benefits associated with improved health.[30] Presence or absence of vehicular traffic is also held, by some, to affect the quality of urban areas and in turn to affect their capacity to attract residents and visitors and so improve economic prosperity. Beyond this, there is some evidence that simply removing or reducing traffic can improve residents' perceptions of the places in which they live.[31] Beyond direct effects for people, vehicular traffic and its supporting infrastructure has substantial impacts on flora and fauna especially through pollution and land-take, the latter of which not only leads to casualties but also to habitat severance which can reduce viability of animal populations and in some cases lead to local extinction.[32]

In summary, there is evidence of sustainability concerns associated with traffic volumes and land use given to traffic, and also evidence of that the way in which cars are used has impacts on residents and non-car users. Further, the extent to which people rely on cars, and hence the extent to which inhibiting car use damages social sustainability, depends in part on what alternative mobility or alternative to travel is possible. That alternative travel may include other new mobility services. Understanding how, or whether, changes in the mobility system will affect sustainability is further complicated by also evidence of how sustainability concerns are not fixed but develop and change over time as conditions change (such as changes in economic systems) and new knowledge emerges (for instance health impacts of poor air quality).

[24] Appleyard D. (1980)
[25] Bostock (2001)
[26] Aldred and Crosweller (2015).
[27] Mullen et al.(2014)
[28] Pucher and Buehler (2008).
[29] Pooley et al. (2014)
[30] Kahlmeier (2017)
[31] See e.g. Florida (2005); Lee and Anderson (2013); Mullen and Marsden (2015); Stehlin (2015).
[32] Karlson and Mörtberg (2015).

This recognition that electrification, while important, is not sufficient, is not especially contentious, for instance the UK Government current consultation of decarbonisation of transport includes plans for mode shift.[33] The challenge is in implementing regulation and policy which:

(i) Effectively supports rapid electrification; and
(ii) Reduces risks of increasing traffic and overall travel distances,
(iii)Avoids creating other sustainability problems.

There are aspects of existing approaches to electrification which might be expected to increase the difficulty of this challenge. If, as is the case in some countries, electric vehicles have lower running costs than conventional ones: in that case, even if upfront costs of purchase are higher.[34] It is also complicated by policies such as that in China which removes restrictions on vehicle registrations if they are for electric vehicles.[35] As noted above, this also requires care that attention to electrification does not distract from activities which are undermining efforts at decarbonisation (such as high sales of SUVs).

Recognising problems is only part of the matter, and solutions to these regulatory challenges are more complex, and likely to be context dependent. The discussion in this section indicates factors which may be at play in different places. Governance and design of regulation will need to consider how to take account of and align the roles of different stakeholders with differing interests, and to align measures taken across sectors. Isolating measures on electric driving increases risks of undermining efforts to improve sustainability. Evidence of the complexity of relationships between sustainability and passenger cars indicates that regulation on electric driving needs to be framed within wider governance for sustainable mobility. That governance for sustainability mobility needs itself to take account of how sustainability issues can change as conditions and knowledge changes.

2. Ride sharing and car sharing

Ride-sharing and car-sharing cover a range of services, which may be small scale community car-pooling or ride pooling, or services which are planned and possibly provided by the public sector, or privately run and managed services. Ride-sharing and car-sharing have been considered to have some potential to improve mobility for individuals, especially those who do not own or have access to a private car. To the extent that this is the case they may bring some benefits to social sustainability since, as noted in the previous section, lack of access to a car can exclude some people from economic, social and other activities. Ride-sharing and car-sharing have also been held to bring the prospect of reducing reliance on private cars and thus reducing traffic volumes. These two points provide reasons for national or city governments to at least consider facilitating or allowing such services. However, there are complex regulatory issues surrounding safety, conditions for drivers providing ride-sharing services, and questions about weather or under what conditions the services will contribute to sustainable mobility rather than increase traffic and therefore hamper sustainability. One side of the investigation of how such services should be regulated involves attempting to understand what conditions would support sustainability. The other side concerns the powers or capacity that national or city governments have in regulating the services.

While some regulatory issues vary according to whether a service is concerned with ridesharing or car sharing, the greater variation in regulatory issues depends on whether they are public or private or

[33] Department for Transport (March 2020)
[34] For discussion on relative costs of buying and running electric vehicles see Anable (2013), and for assessment of relationship between running costs and demand see Wadud et al. (2009).
[35] See for instance, He et al. (2018); Qian et al. (2019)

community services. So, this section is organized in a way that considers the services according whether they are public or community, or private.

2.1 Private planning and provision: Large private, platform-based ride-sharing services, dominates ride-and car-sharing services. Major regulatory issues associated with these services can be grouped into those concerning regulation for safety and for working conditions for drivers, and implications for travel behaviour and traffic-levels. However, as the discussion below will indicate, these three types of issues are mutually influential. As these services have been operating for some time there is some, albeit, empirical evidence of how these services work, and this along with evidence which can be drawn from theoretical understandings can help to inform regulatory considerations.

2.2. Regulation for safety and for working conditions for drivers: Companies such as Uber have claimed over years that drivers using their platform are self-employed rather than workers or employees with associated legal rights to minimum wages and other conditions and benefits. This is a highly disputed matter in Europe and the US, with drivers bringing legal cases against the platform companies, and at least one ongoing process of deciding whether legislation should be defined in a way which would treat the drivers as employees (California).[36] In France, the Cour de Cassation, has determined that drivers are employees;[37] in the UK the Supreme Court is set to make a judgment on whether to uphold a previous Court of Appeal decision which ruled that drivers are workers and not self-employed.[38]

The legal cases question whether existing employment laws require drivers to have the status of workers or employees given the way they are treated by the business models operated by the platforms. Questions of whether the law should be changed in order to ensure they are treated as employees are slightly different. Whether there is a case for clarification or change of law is a subject which is to a large extent beyond the scope of this report, and something which affects sectors beyond transport. However, it is interesting to note that at least some drivers are motivated to bring legal cases in an effort to be recognized as workers or employees, and this suggests discontentment with their current conditions. Further, the employment conditions of drivers matter for sustainable mobility for two reasons. First is that social sustainability is something that would be concerned with the conditions faced by people working in the transport sector. Second the working conditions for drivers providing rights sharing services may have wider societal implications. There are two aspects to this. First, if drivers have relatively low incomes from their work in ridesharing then they may find that they need to work long hours in order to provide an adequate income. The pressure to work long hours can be exacerbated in circumstances where there is relatively high unemployment or relatively few alternative opportunities. Working long hours as a driver has potential implications for safety, and for the supply of ridesharing services. Working long hours may also lead to an increased supply of ridesharing services, and this may have implications for levels of traffic, which as was discussed in relation to electric driving in turn has implications for sustainability. Ride-sharing services of this type are relatively new phenomenon, and it is difficult to determine causal links between drivers' conditions and safety or increases in supply leading to increases in traffic. However it should be noted that there is empirical evidence that in at least some places the introduction of these services has led to an increase in collisions, and to an increase in traffic. [39]

[36] Paul, K (15th Oct 2020) Prop 22 explained: how California voters could upend the gig economy, Guardian https://www.theguardian.com/us-news/2020/oct/15/proposition-22-california-ballot-measure-explained

[37] Cour de Cassation, Uber - Case n°374 - 4 march 2020https://www.courdecassation.fr/institution_1/in_6_2850/english_2851/n_374_9667/) and legislative action

[38] Supreme Court, Uber BV and others (Appellants) v Aslam and others (Respondents) https://www.supremecourt.uk/cases/uksc-2019-0029.html

[39] Barrios et al. (2018); Schaller (2018); Transport and Environment (2019).

One question for governments, at national or local level in relation to this is whether there are measures other than employment law which could mitigate concerns around conditions for drivers and related implications for safety and traffic levels. In relation to safety, drivers will be subject to the laws applicable in any given jurisdiction about fitness to drive. The concern however is that the effectiveness of those laws could be reduced by economic pressures on drivers to work longer hours than is safe. A further question would be whether there are other powers available to local or national governments, such as powers around licensing of services which could prevent drivers facing unsafe working conditions. This raises a question of the circumstances in which governments, and in particular city governments are able prevent services operating at all or two negotiate terms on which services operate. This may again be a matter of what is possible in law, and also a matter of what capacity local authorities have to negotiate.[40]

2.3 Traffic and travel behaviour: to recall, the hope for right sharing is that it can provide benefits to individuals who would not otherwise have access to the mobility that they need, and that it might reduce the pressure or desire for privately and vehicles, and thus reduce traffic levels.

In relation to the benefits to individuals, one question is whether privately run services provide mobility for people he lived in relatively inaccessible places and so may not be well served by public transport, and whether services are affordable. The concern here is that the interests of providers operating for profit (which is what private providers are expected to do) align with the needs of those who are at risk of transport related social exclusion. There is some empirical evidence that new mobility services operate in places that are already relatively well served by public transport, and where walking or cycling are also feasible forms of mobility, but where populations are relatively affluent.[41] There is also evidence from analogous cases in public transport, where privatisation has tended to mean a reduction in services where there is lower demand despite the social significance of those services for people that live in relatively in inaccessible areas. For instance experience from Britain has been that privatisation focuses services on areas of high demand, and this is light governments from different political positions to recognize a case for greater involvement by the public sector.[42]

Coupled with this is concern that private ride-sharing services may increase rather than decrease traffic levels. As noted above there is empirical evidence that this is occurring in some places. There are also theoretical accounts of travel behaviour which suggest that increased traffic could be expected, particularly if ride-sharing operate in a way intended to increase profitability by maximising demand. Economic approaches to understanding travel behaviour, suggest that if services are offered at a cost comparable with public transport they may leads to a transfer from public transport used to ridesharing, and that cost may also have an influence in increasing overall demand for travel. Social practice theory, which does not necessarily accept the assumptions of economic theory, will also suggest that availability of convenient and affordable ridesharing services could facilitate the development of practices involving vehicular travel and replacing practices which involve less travel. By analogy, we might consider some of the contemporary practice is made possible by availability of passenger cars which did not previously exist.[43] The question of the extent to which increases in traffic will have implications for sustainability depends impart on the efficiency and emissions of the vehicles used. It may be that measures designed to improve vehicle efficiency search as regulations on vehicle standards, or regulations creating economic incentives to use more efficient vehicles will influence the sustainability implications of ridesharing services. However as noted in the section on electric vehicles, more efficient or cleaner vehicles is not sufficient for sustainability and increases in traffic brings a

[40] Doherty et al. (2018)
[41] Dill and McNeil (2020); Jiao and Wang (2020).
[42] See Butcher (2012); Butcher and Demsey (2018)
[43] See e.g. Urry (2016).

range of sustainability concerns. If and where there are concerns that ridesharing may lead to increases in traffic there is a question of whether national and local governments concerns the powers and capacity to determine what services operate. This question will be considered below in looking at public sector franchising of mobility services.

2.4 Ridesharing, using platforms such as those which currently dominate, brings a further set of questions around data protection, data sharing, and interoperability of systems. Ride sharing, facilitated by digital data generates extensive data which can provide details of individuals lives and activities. This raises questions for data protection whether it is held by public or private organisations. It is beyond the scope of this report to discuss data protection in detail, and the questions are addressed elsewhere. [44]

A further, widely recognized concern is that certain platforms may become very prominent and that this can either give service providers substantial power within the mobility system, or can mean that the mobility system depends on the continuation of those platforms in order to continue operating. There are also questions around the willingness of service providers to provide data on their services which would be important for transport planning. These concerns raise complex questions for regulation. To begin there can be questions about the extent to which existing laws protect or facilitate monopolies by one or other platform. And further questions about the powers and capacity of governments at different levels to require private operators to either ensure that their platforms are compatible with those of public sector planners, or they are open to other service providers, and that relevant data is shared.[45]

2.5 Private car sharing: implications for sustainability may depend on price and availability, and the distribution of services in a way which reflects many of the questions for ridesharing. As for ride-sharing, there will also be questions around data protection and data sharing. As is the case for ridesharing, local governments may have tools available which are not available for ridesharing, for instance there may be provisions around parking which could be used to influence where and the extent to which private car sharing services operate. However as with ridesharing this is privately run and operated, there may be a quite fundamental question around the powers and capacity that transport planners although could governments have to negotiate so that service is operating in their jurisdiction facilitate accessibility for those who would otherwise face exclusion, but which do not contribute to increase traffic levels overall by inducing car dependent practices.

The services which are run and operated by the public sector, there is a greater opportunity to determine my service is needed and where they might need to merge shift from public transport or from walking and cycling and therefore be undesirable as a means of reducing traffic. The challenge for public sector providers it's particularly acute however in jurisdictions where the public sector has over some decades become a much less prominent and much less powerful actor but reduced incomes, under expectation of either public private partnerships or privatisation.[46] As noted above, in jurisdictions where the public sector does not provide services it may nevertheless plan what services do operate, through partnerships or franchising. The question this raises is as has been noted above, about whether, or the extent to which, public sector or the private sector is able to determine the distribution and nature for services which are run and much of this depends on the relative power of the different actors.

Community ridesharing or car sharing services maybe distinct from public sector services. These may be small scale services run at a local level and as such there are likely to be fewer concerns about their

[44] Finck et al. (2020).
[45] These challenges are recognised by governments, see for instance DfT (2019).
[46] Doherty et al. (2018)

contribution to increasing traffic levels overall - or at least such concerns would not arise and last the number of such services expanded substantially. The services may be expected to meet a local need, rather than being operated for profit. As such they bring potential to support social sustainability. regulatory issues concerning such services involve questions of safety standards, as they do with other right or car sharing services would stop there is also a question, which is not so much concerned with the services that operate, but rather with any suggestion that a public policy approach should look to such services to meet social needs for mobility. In such cases the concerns will be about whether those communities which most need the services are the ones the tap the capacity to implement them, so in short relatively affluent communities may find it relatively easy to bring the resource is required to run such a service but this may be more difficult the communities facing hardship.[47]

3. Automated vehicles

The uncertainties that surround the implications for sustainability of electric driving and ridesharing are relatively small compared to those surrounding autonomous passenger cars. Here considerations of what the implications might be, especially but not only, for those sustainability issues concerned with safety, employment, inclusion, energy use and traffic levels, rely on extrapolations from our theoretical and empirical understanding of the existing mobility system since there is nowhere at present in which autonomous cars are used in anything other than experimental conditions. In this section we will consider how major governance and regulatory issues can be identified and considered given uncertainties and the need to extrapolate from existing conditions and our understanding of those conditions.

These major regulatory issues for autonomous cars might be grouped into five broad categories:

3.1 Safety, responsibility and data: There are relatively longstanding questions concerning the levels of confidence about the operation of autonomous cars that should be required if they're to be allowed out on public roads. Then, relatedly, there are questions about the actions autonomous vehicles are programmed to make. Laws which frame road safety and responsibility where conventional vehicles are used do not necessarily map on to autonomous cars.[48] There has been significant attention to ethical questions of whether autonomous cars, would or should, protect occupants at the expense of other road users. Coupled with this are questions about reliability and responsibility where collisions take place, since with automated cars assumptions about driver responsibility may no longer hold and there may be complex questions around divisions of responsibility between manufacturers, any actors involved with maintenance and upkeep and owners. These questions of safety have been the focus of regulatory attention In Europe and in China. For instance, in the UK the automated and electric vehicles act attempts to establish the groundwork for legal responsibilities and liabilities. Similarly, in China regulators have devoted substantial attention to safety of automated vehicles responsibilities ability of owners and manufacturers.[49] These questions have also been prominent in academic research, and early attention two autonomous cars focused quite heavily on the ethical dilemmas associated with programming vehicles to decide how to act when there is a risk of collision.[50] More recently there have been concerns about implicit bias built into programming do you to albeit unintended bias in the data used in programming.[51]

3.2 Second are the concerns that increasing automation in transport and in other sectors will have implications full the number and types of jobs available to people. This raises questions which go far beyond transport and which are largely outside the scope of this report. It is worth noting however

[47] See discussion in Frenken and Schor (2019).
[48] De Sio (2017); Liu (2017).
[49] Xu et al. (2020).
[50] See e.g. Goodall (2014).
[51] Cunneen et al. (2019).

not automated vehicles may remove employment opportunities in ridesharing as well as in public transport. As noted below there might also be implications for inclusion.

3.3 The prospect of improving mobility for people who either cannot drive, or he preferred not to drive, is understood as one of the major benefits which automated vehicles might bring. As was noted in the sections on electric vehicles and ridesharing, access to cars can be crucial for social and economic participation especially in places that her car dependent. Elsewhere access to cars remain important for anyone unable to use other forms of mobility do you too physical or other difficulties in doing so. Governance intended to support sustainability might therefore include provision of automated vehicles where people might otherwise face exclusion, and there may be a case for doing this even where other uses of automated vehicles are discouraged for reasons such as risks that they will increase energy use or overall traffic levels (see below)[52] Although it might be expected that autonomous vehicles bring benefits for inclusion, there are also concerns and some evidence from increasing automation in public transport, but removal of transport workers can mean that people with disabilities are unable to access vehicles because there is nobody there to help them do so. There is not a necessary connection between reduction in transport workers and reduction in support for access ability people with disabilities as people might be employed to provide assistance, and there may also be statutory responsibilities to ensure that Accessibility is maintained. However experience in Britain where increasing automation in rail has seen a reduction in rail staff traveling on trains as indicated that there is a risk that levels of accessibility will reduce where numbers of staff reduce. Whereas people may have been able to arrive at their station and expect assistance, this may no longer be the case and they may need to make arrangements in advance thus reducing their flexibility to travel.[53]

3.4 The fourth and fifth categories both concern implications that automated vehicles might have for carbon emissions, other forms of pollution, and traffic levels. One category concerns the way in which automated vehicles might be expected to influence the way in which we travel and in particular reliance on vehicles. The other concerns the way in which autonomous vehicles and they use is assessed, particularly if assessment tools which have been prominent any decision making on transport continue to be used in the same way in a context well autonomous vehicles a widely used. since both categories are related to the wider issues in sustainable mobility about reliance on vehicles they might both be brought under one heading, however the risk in doing that is that we obscure an important distinction between considerations of what autonomous vehicles might mean for the mobility system and considerations of how we should make assessments to inform planning. The regulatory implications of each may also be different.

One of the prominent arguments supporting development of autonomous vehicles has been, and remains, the prospect that by removing the need for human driver, with their propensity to make errors of judgment, vehicles will be able to travel much closer together, and will also be able to drive in an energy efficient way which most human drivers failed to achieve. This is part of the reason for optimism that automated vehicles will lead to reductions in congestion, and improvements in energy efficiency.[54] However, there is an increasing body of modelling work which suggests that at best these benefits are context dependent, and that context may rely on the extent to which shared vehicles are favoured over private vehicles. More pessimistically, there is modelling evidence that automated vehicles risk increasing traffic levels and energy use.[55] One reason a simply that there is a lower cost in relation to last time traveling by autonomous vehicle than in driving since other activities can take

[52] Cavoli et al. (2017); Cohen and Cavoli (2019).
[53] See e.g. letter from Disable Person's Advisory Committee to UK Gov Department for Transport (2018) https://www.scribd.com/document/385014689/DPTAC-Letter#fullscreen&from_embed
[54] See discussion by Wadud et al. (2016)
[55] Cohen and Cavoli (2019); May et al. 2019; Wadud et al. (2016)

the place of driving. Moreover, even if there is a move to shared vehicles, then empty running could increase traffic. Some of the concerns around the implications of autonomous vehicles foot traffic levels mirror those of ridesharing. So here as with ridesharing regulation which enables transport planners to consider what services I needed to support a sustainable mobility system might be expected to mitigate some of the risks that autonomous vehicles would increase levels of traffic. If private provision distinct from engagement with transport planning is the dominant approach then it could be expected but levels of service and therefore levels of traffic would follow demand. The important difference between this and the discussion of ridesharing is the absence of the need for a driver, and this could have implications for supply- arguably this could lead either to an increase or a decrease in supply. Automated cars do not need breaks for their drivers since there are none, but since as noted in the section on ride-sharing, there is concern that poor levels of income for ridesharing drivers lead to increased working hours and therefore increased supply.

It can be noted that other approaches understanding travel behaviour also point to a risk that automated driving could increase levels of traffic and reliance on vehicles. Social practice theory, understands forms of mobility in the context of the activities which it facilitates or of which it forms a part. Research drawing on practice theory have argued but changing availability of transport contributes to changing activities. This in turn can then lock-in certain travel behaviour: for instance, increasing access to passenger cars can mean but activities taking place over longer distances become feasible and overtime become considered normal.[56]

A challenge for regulation seeking to support sustainability, is simply the uncertainty about whether autonomous vehicles would facilitate increasing reliance on vehicles and therefore increases and energy and in traffic. However, there is not a need to mistake uncertainty with having no means by which to judge what the implications autonomous vehicles could be. Further, there is a substantial risk in treating uncertainty as a reason to avoid efforts at regulation, especially given the sustainability problems which would be created if autonomous vehicles do need to increases in traffic and energy use.

3.5 The fifth category concerns implications autonomous vehicles for implementation of decision-making tools, especially cost benefit analysis. Prominent in transport planning is the approach of attributing a cost to travel time, and has been recognized for many years that technology could alter this cost if time spent traveling can also be put to other purposes.[57] Also prominent is the strategy of placing a cost on carbon emissions as a means of ensuring that decarbonisation is effectively represented in decisions, including those on transport planning. The carbon cost can be set at a level calculated to mean that planning decisions would only be 'justified' (according to the decision-making tool) if they are consistent with decarbonisation. However if (as is possible with autonomous mobility) the cost of travel time is reduced then it could appear that there are greater benefits of increased travel by vehicle when compared to the costs of carbon emitted. This could then justify transport measures which facilitate increased vehicular use and which therefore hamper efforts at decarbonisation. It would be possible to adjust the carbon price to take account of this altered value of travel time associated with autonomous vehicles and so reduce the risk of 'inadvertently' justifying planning decisions which undermine decarbonisation. The challenge would be a practical one: there would need to be (a) recognition of the need to adjust the cost of carbon (b) an effort to recalculate the cost to take account of the change in value of travel time (c) dissemination of updated valuations.

It is important to note that this matter is slightly separate to the question of whether it would be expected that autonomous vehicles would increase vehicular use all other things being equal. This

[56] See e.g. Urry (2016).

[57] The idea that technology can assist travellers in doing activities while they travel and so reducing the 'cost' of travel time has been recognised for many years, see e.g. Lyons and Urry (2005).

issue concerns the question of whether assessment tools might be implemented in a way that encourages decisions which seek to facilitate increases in traffic. Regulation concerned to ensure but this does not happen which needs either to reduce reliance on those assessment tools such as cost benefit analysis, or to give attention to the prospects that fixed values used in order to calculate cost benefits analysis may no longer function as intended if mobility system changes leading to changes in the costs attributed to travel.

4. Shared Bikes

As with other new mobility services, there is optimism that shared cycle schemes, including docked and dockless cycle schemes can support a sustainable mobility system by reducing reliance on private vehicles and so improving sustainability. They have some potential to retain benefits of cycling including minimal pollution, benefits of physical activity and taking limited space on roads. They may also address limitations of private cycle ownership, including costs of buying and maintaining a bike, problems of secure storage especially in small homes, and difficulties of carrying cycles on public transport.

Some of the regulatory challenges for shared cycle schemes reflect those for cycling more widely and include matters such as safety. These matters are not addressed in this report.

4.1 As with other new mobility services, there are questions about the extent to which the design and regulation of shared cycle schemes supports social inclusion. In part this relates to questions of whether they provide services in locations where they are needed, rather than only where there is high levels of demand.[58] Questions of inclusion are also raised by payment systems, and potential exclusion if there is a requirement to use digital payment.[59] As with other mobility services, the interests of actors providing shared cycle schemes may not align with needs of inclusion, and there will then be a question of whether regulation can mitigate or address misalignment.

4.2 Shared cycle schemes also raise challenges for data protection and potentially needs for data sharing. These challenges mirror those presented by other new mobility services such as ride- sharing.

4.3 Shared cycles schemes have become associated with a problems of pavement clutter and anti-social parking of cycles. Ostensibly this is a challenge of how to encourage or ensure that users park responsibly and in this sense might be seen as a matter of whether to implement rules or persuasion. However, as a number of researchers argue, this might also be understood as a matter for collaborative governance concerning the relations, interests and responsibilities of the different actors involved in shared bike provision and use.[60] If, as tends to happen, private actors design and provide services, they do not necessarily have a motivation to ensure that cycles are parked in a way that does not cause problems. Likewise users may not have an interest in ensuring they park responsibly. The wider public may have an interest in avoiding pavement clutter, but do not necessarily have powers to prevent it. Local planners and authorities may also have an interest in preventing clutter, and they have powers to regulate shared cycle schemes to prevent problems. The challenge for them is whether or how they can do this, while retaining (any) benefits of shared schemes.

[58] Dill and McNeil (2020); Jiao and Wang (2020); Nickkar et al. (2018)
[59] Golub et al. (2019).
[60] An et al. (2019); Jiahao and Geng (2018).

Developing a governance framework for new mobility services

1. Common regulatory issues for new mobility services

The major regulatory issues which the five mobility services raise, point to a set of implications for governance which broadly so into three categories, all of which are interlinked. These categories can be labelled as decision-making in conditions of partial knowledge, boundaries to the scope of trade-offs between objectives, and relations between actors influencing the mobility services. In this section we propose governance framework incorporating these three categories.

Beyond fundamental questions of legality, the major considerations in thinking about regulation and governance of new mobility services, concern our understanding what those services might do, how they might operate under different conditions, and so what their implications might be for aspects of sustainability. The account of the major issues for regulation for the five mobility services brings to the fore some of the challenges associated with developing this understanding.

First, the way in which services function is likely to be influenced by the conditions in which they function, these include regulatory and other social and economic and possibly environmental conditions. For instance, we saw this in reflecting on whether autonomous driving an electric driving would be associated with private ownership or ride-sharing. More than this, there may be uncertainty about how services operate which stem from the partial knowledge which we have in order to make these assessments. This latter point is not one of the difficulty in predicting future conditions, but simply a recognition that the theories of travelled behaviour and the case studies - which are what we have in order to make assessments - may themselves give only a partial understanding of the influences on mobility, and the operation of mobility services. One example of this is the question of whether ridesharing might operate as a form of public transport service, and if it did would this reduce reliance on private cars and would it reduce traffic. So it is important to distinguish between what could be the case, and what may eventually happen.[61]

A second source of uncertainty concerns our ability to assess the sustainability implications of mobility services both now and in the future. We do not necessarily have a complete understanding of what are sustainability implications of any mobility service, much less mobility system. Recognition of sustainability implications is something which develops overtime, partly because knowledge progresses, and partly because new conditions emerge. Our understanding of the social problems that severance caused by traffic can bring is one example of this. Although there has been attention to the way in which high levels of traffic can reduce social interaction since Appleyard's famous study, the understanding of what this means for the lives of different people is something which is only gradually being understood by researchers.[62] The problem of poor air quality associated with transport is another example of this. The understanding of the health impacts of nitrogen dioxide and particulates is something which is still developing.[63]

A different type of regulatory issue concerns the boundaries within which prominent assessment tools can support sustainable mobility, and the risks that they use beyond these boundaries might exacerbate rather than address sustainability concerns. Perhaps the most prominent example of this is the prospect that autonomous vehicles might reduce costs associated with travel time, and so

[61] Something recognised in literature on new mobility services such as Cavoli et al. (2017); Doherty et al. (2018); Fonzone (2018); Gebresselassie et al. (2018).
[62] Appleyard, D. (1980); and see Appleyard, B. (2020); Vaughan et al. (2019)
[63] See https://www.gov.uk/government/groups/committee-on-the-medical-effects-of-air-pollutants-comeap

hence, if that reduced cost is put into cost benefit assessments of transport measures, the assessment night appear to justify measures which increase carbon emissions.

While mobility has long involved multiple actors, new mobility services have brought an expansion of in the number and range of actors. We can see the numerous ways in which this creates regulatory challenges, such as the challenges in aligning development of electricity infrastructure with policy to electrify mobility system, other potential problems associated with bike sharing schemes and the sometimes divergent interests of service providers, transport planners and citizens.

These broad issues which are common to the new mobility services we are considering have some very practical implications for governance. Specifically, they make the case for adaptive, reflexive and collaborative governance. However, we suggest that there are characteristics of the mobility services and their relation to sustainability which have rather particular implications for the ways in which these governance approaches could be adopted in order to effectively enable new mobility services to contribute to sustainable mobility. These governance approaches and their application for new mobility services will be considered in the final two sections of this report.

2. Adaptive, relational and collaborative governance

Before exploring how these governance in relation to new mobility services let us give a brief outline of what they consist in and of the reasons but they have been given attention in wider research on governance. There are two major components underpinning these approaches to governance. One concerns knowledge and uncertainty, and the other concerns the relations between organisations and actors involved in planning, service development and delivery.

Adaptive, and reflexive governance, are particularly concerned with questions of knowledge, and the uncertainties, facing decision makers involved in public policy. This might concern understanding of desirable outcomes, for instance knowledge of what a sustainable outcome might look like. It can also concern knowledge about how those outcomes can be achieved. As has been noted by Wyborn, adaptive governance can be understood as an analytic lens and as a normative approach.[64] As an analytic lens, it aims to understand how governance does adapt to emerging knowledge. We can see numerous examples of how governance has taken account a changing knowledge for instance, for instance decision-making in light of emerging evidence about climate change. As a normative approach, it is concerned with understanding how governance can take account of emerging knowledge and uncertainty. As Wyborn goes on to argue, since decision-making may need to take account of emerging knowledge, this is important that process is of decision-making include mechanisms to enable that emerging knowledge to inform decisions.[65] Consequently, she argues that adaptive governance can be understood as a process of co-production between science and policy. Reflexive governance is in some ways a related concept. Reflexive governance can be understood as bringing to the full the idea that decision-making is a process of social and policy learning. That learning may lead to quite minor changes which do not challenge underlying rationales. For instance, if a government brought in loans for the purchase of electric vehicles in order manage the problems that some people face in paying a large amount at once, then this might be understood as a relatively small adaptation of an overarching policy of promoting electric vehicles. However, advocates of reflexive governance also encourage consideration of whether there is a case for re-framing some policy areas in light of emerging knowledge and new understanding. For instance, we might consider how matters

[64] Wyborn (2015)
[65] Wyborn (2015)

such as climate change, which have tended to be framed as an environmental concern, are increasingly understood as something which also directly concerns human health and welfare.[66]

A normative conception of adaptive or reflexive governance has implications for the types of decisions made. It speaks against decisions which lock in one policy approach, or which rely on the success of one solution. This however, presents challenges if it acts as a deterrent to developing robust, long term, policies necessary to deal with acute challenges. One strategy for designing planning under conditions of uncertainty is to consider alternative potential scenarios and to investigate what decisions, if any, that lead to desirable outcomes under each of these scenarios.[67] A limitation of this approach is that we are uncertain about what those future scenarios might be nevertheless the exercise of thinking about different possibilities may help in designing policies which allow some flexibility. Given this, adaptive or reflexive governance may also need to emphasise the importance of continuous process of critical reflection on the effectiveness of policies and other decisions if conditions change all new understandings and knowledge emerges.

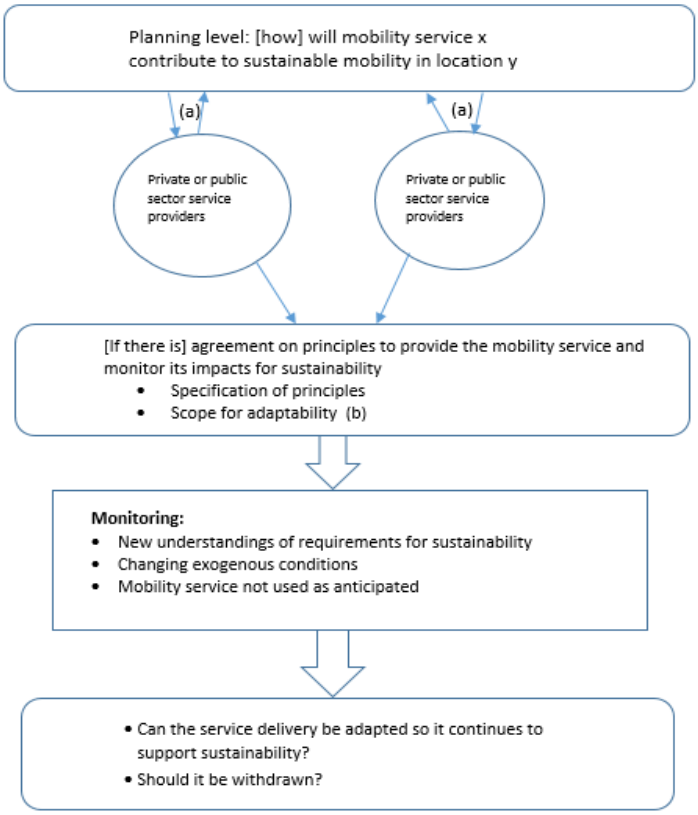
Collaborative governance places focus on relations between actors and organisations. It can be helpful to identify two strands to this approach. First, and as with adaptive and relational governance collaborative governance involves attention to knowledge and understanding which inform decisions. So, it takes seriously the problem of decision-making under conditions of uncertainty. It also recognises that actors involved in decision making may have different expertise and indeed this distribution of knowledge can be one of the motivations for the collaboration. The second strand concerns the differing motivations and interests of different actors. Collaborative governance has developed in response to recognition that more traditional arrangements where the focus is on the self-interest of actors and arrangements for joint working assume but the responsibilities of each party must be fully specified at the point but they agree to work together. Collaborative governance does not deny the self-interest of actors, but it maintains that uncertainty means it is unrealistic fully specify responsibilities in advance, and that efforts to do so will lead to problems when events do not unfold as predicted. Instead, collaborative governance holds but actors should identify projects which are not fully specified in advance but which are framed by high level guiding principles and which sufficiently meet the interests of each to motivate participation. An example might be a collaboration between planners and service providers to provide public or shared transport. This is not always an easy thing to achieve, actors might have quite differing interests and especially where there are power imbalances, there can be a risk that one party may settle for a project that they consider unfair but which they nevertheless feel they could not improve in the circumstances.[68]

The agreement between the parties should recognise that specific activities may change over time as circumstances change. Of course, such an arrangement requires a commitment to negotiation of responsibilities, and a level of trust that neither party will seek to exploit the flexibility in the arrangements. To support this trust advocates of collaborative governance emphasised the significance of transparency in decision-making, monitoring of decisions and actions, and benchmarking. Even with such measures in place, there are risks two collaborative arrangements, particularly around disagreement about division of responsibilities. It can be noted however but similar problems occur with more traditional agreements, since if or when events did not unfold as predicted the parties need to reconsider responsibilities, but in this context they may need to do so without support of the strategies which collaborative governance should put in place and potentially without having a common agreed project to which they are both committed.

[66] Mullen and Marsden (2016)
[67] Banister and Hickman (2013).Lyons and Marsden (2019).
[68] See for instance Doherty et al (2018); Hrelja et al. (2018).

3. Applying adaptive reflective and collaborative governance to new mobility services

The account of adaptive reflexive and collaborative governance, coupled with the summary of major regulatory issues for new mobility services, point to a number of implications for the governance of new mobility services. The first consideration is how a mobility service could contribute to a sustainable mobility system in a given jurisdiction and context. Even at this level, there is complexity and uncertainty both of which mean that decisions on mobility services may need to alter over time. Closely following this are considerations of whether or how different actors involved in service provision are able to collaborate effectively to provide the service so that it supports rather than hinders sustainability. These broad considerations, their relation to each other, and the resulting outline of a governance framework might be illustrated as shown below.



Outline of governance framework

Point (a) refers to interactions between service providers and planners in determining how a mobility service could contribute to sustainable mobility, and interactions which consider what (if any) provision a service provider can provide. Point (b) refers to assessment of whether the mobility service can be adapted to respond to new understandings of sustainability or new events. Both points are discussed below.

In relation to (a). This approach also brings to the fore the role of co-production, that is, a need to put in place mechanisms to allow new knowledge to inform decision making and adaptation. This is in relation to scientific and social scientific knowledge, and it may also be in relation to recognising experiences of different sections of society. This approach also emphasises the need for continued monitoring of whether decisions are achieving what they were intended to do. In this the matter of

process becomes central: decision-making should enable new knowledge to inform decisions on which recognises that decisions might need to change.

For the reasons outlined in the previous section, collaborative governance may mitigate some of the challenges brought by the increase in numbers of actors involved in mobility services. In the case of new mobility services, there are particular challenges in developing a common project, and interests between the different actors appear to be very divergent. Service providers have an interest in maximising the use and hence the profitability of their services, whereas transport planners have an interest in service provision which supports a comprehensive network and which may include services delivered to places where there is low demand. Given the uncertainty about whether, or the circumstances in which, new mobility services were contributed to sustainable mobility, there may also be a case for provision to withdraw some services if they are found to create problems for sustainable mobility. At national or at local level, planners may have the ultimate decision about whether service providers are able to operate at all. This might appear to put them in a strong position in negotiations with service providers. Yet an overly prescriptive approach by public sector planners might inhibit innovation and development. Put simply the argument is that innovative service providers need an incentive to innovate. One potential resolution to this tension could be to place a greater emphasis on reward for innovation rather than actual service delivery. This would amount to a change in emphasis for at least some of the investment which governments, at local and national level put into mobility systems.

In relation to (b). One major implication, given that decisions are made under conditions of uncertainty, is that decision-makers at national, international and local levels, should be wary of approaches attempting to address major sustainability issues by relying on the effectiveness of one strategy. For instance, there is a case for caution about over-reliance on technology to address major sustainability concerns, and a case for caution about over-optimism that new mobility services will tackle transport-related exclusion or congestion. The recognition that we do not have a complete understanding of how new mobility services will work, and that there may be risks associated with some of our approaches this decision making, should also lead to an openness to reflect on whether decision-making tools, are helpful in different circumstances. In other words, are they doing what they need to do in order to support sustainable mobility? This, for instance, has implications the use of cost benefit analysis, in relation to autonomous vehicles, or for the circumstances in which we might use tradeable credits. The key point here is an awareness of the importance of openness to critical reflection on the conditions, if any, in which assessment tools should be used.

Regulatory Framework for Tradable Credits Scheme

Introduction

With no specific new technology or service being offered, Tradable Transport Credit[69] Schemes (TTCS) have some fundamental differences to the other services and measures being considered in UPASS in their regulatory issues and potential governance frameworks. In this section, we consider if such a scheme could be legally developed that would be expected to reduce car use and emissions while not increasing (or better reducing) transport related social exclusion. In doing so we consider governance and planning of TTCS through the following two spheres: Legality & Regulation and Design & Implementation.

[69] Sometimes referred to as Permits rather than Credits - see later discussion.

Background to Tradable Transport Credit Schemes

TTCS are being proposed as an alternative to road pricing or taxation, which lack public acceptance[70] as an economic response to reducing congestion and environmental externalities, though have not been implemented in practise.[71] First proposed in the late 1960s for water pollution, the theoretical cost-effectiveness was proven in the early 1970s, and was considered for road transport in the late 1990s.[72] TTCSs are commonly understood as the allocation of: [73]

"*individual proportions of car use to drivers based on an aggregate target (formulated in, for example, units of distance or fuel consumption) that can be used and traded according to personal aspirations and prevailing market prices."*

Variations in TTCSs, and their advantages and disadvantages are set out in Table 1. The complexities of such schemes raise many issues of fairness and governance with the process of initial allocation being the most politically sensitive.

Table 1: User-Oriented Tradable Credit Road Transport Schemes[74]

Tradable Asset	Policy Target	Advantages	Disadvantages
Fuel	Fuel Consumption	Don't need to reschedule activities	May not impact on peak travel congestion
Access Rights	Congestion	Focuses on specific problem area	May increase congestion elsewhere
Driving Days	Vehicle Journeys	User can have choice over which days	May save up trips so no overall mileage reduction
Parking	Vehicle Journeys	Company parking offers the greatest potential	Assumes alternative mode chosen

Legality & Regulation in England[75]

Relevant Existing Legislation

In the UK ,road transport is already heavily regulated through numerous legislation. Although there is no explicit mention of TTCS in any of these, there are opportunities for amendments and scope that may cover TTCS design elements. Perhaps the most potential may be drawn from analogous road pricing schemes, that are already in place.

The Highways Act 1980[76] sets out general provisions for Highways Authorities, as well as classification, creation, maintenance, improvements and restrictions of roads and streets. There are provisions within this for stopping up/diverting highways (eg for crime prevention, environmental protection or maintenance works). Section 283 gives the Minister power to conduct experiments on highways for

[70] See, for example Dogterom et al. (2018)
[71] Brands et al. (2019).
[72] Verhoef et al. (1997), Fan et al. (2015)
[73] Dogterom et al. (2018)
[74] Based on Verhoef et al. (1997), Fan et al. (2015) and Grant-Muller and Xu (2014)
[75] In the UK, the devolved countries have some differences in law and policy relevant to transport and hence to tradeable credits affecting transport. In this section we focus on England rather than all the devolved countries of the UK as the geographical context here is serving as a case study, and in order to avoid confusion over the applicable legal and policy context
[76] HMG (1980)

the purpose of a) improving the construction or b) testing the effect of various classes of vehicles. It could be that a TTCS relating to vehicle class could fall under part b**.**

General provisions for traffic regulation are set out in the Road Traffic Regulation Act 1984,[77] with in particular relation to TTCSs, Traffic Regulation Orders (TRO) and Experimental Traffic Orders (ETO). TROs *"may make any provision prohibiting, restricting or regulating the use of a road, or of any part of the width of a road, by vehicular traffic."* They can be set up by transport authorities for numerous reasons that can be related TTCS policy objectives, such as avoiding danger or damage, or improving amenities or environment. A common example of a TRO is the bus only lane. Similarly, EROs allow for experimental schemes of traffic control (up to 18 months), through modification or suspension of existing enactments for the "*convenient and safe movement of traffic", "providing suitable and adequate on-street parking facilities" or "preserving or improving amenities".* All of these may be policy objectives related to TTCSs.

The Road Traffic Reduction Act 1997[78] requires local authorities to report on levels of road traffic and growth forecasts alongside specifying reduction targets and scheme proposals. It came into force in 2000, and no substantive amendments have been enacted since. In original versions of the Bill, the Secretary of State (SoS) was required to use these reports to draw up national plans, but this was omitted in the enacted version.[79] It seems that the SoS only requested these reports once, but due to concerns of meeting deadlines it was superseded by the Road Traffic reduction (National Targets) Act 1998.[80] This obliges the SoS to set and publish traffic reduction targets and related measures and was supplemented with Public Service Agreements within Transport White Papers to address urban congestion.[81] There is little detail on the requirements of these targets, measures and reports, but as such they do not explicitly exclude TTCSs, which could be introduced as appropriate measures.

On the other hand, the Transport Act 2000[82] was designed to create a "*more integrated transport system"* with a focus on reducing congestion and pollution. It considers the management of air traffic services, local transport and railways, as well as enabling road user charging (outside London) and workplace charging levies. The Greater London Authority Act 1999[83] establishes the Greater London Authority, defining powers and establishing Transport for London, the Metropolitan Policy Authority and London Fire and Emergency Planning Authority. In relation to TTCSs, it sets provision for the establishment and operation of road user charging and workplace charging levies within London. Stemming from this, the Local Transport Act 2008[84] also addresses congestion and local transport (specifically buses) by setting out responsibilities for local transport plans, operation of services, defining Integrated Transport Authorities and establishing road user charging schemes. There is a potential for amendment of the road user charging and work place parking levy provisions, to widen the scope to TTCSs. As set out currently, charging schemes are defined as *"a scheme for imposing charges in respect of the use or keeping of motor vehicles on roads."* An amendment to encompass TTCSs would require the definition of that scheme as proposed in the next section. The Road User Charging Schemes (Penalty Charges, Adjudication and Enforcement) Regulations 2003[85] came into force in 2013 to makes provision for road user charging schemes set out in the Transport Act 2000. It sets out where penalty charges can be imposed, how rates should be specified and communicated,

[77] HMG (1984)
[78] HMG (1997)
[79] Butcher (2010)
[80] HMG (1998)
[81] Butcher (2010)
[82] HMG (2000)
[83] HMG (1999)
[84] HMG (2008)
[85] HMG (2013)

provision around notices, appointment of adjudicators, and civil enforcement These can be used a basis for certain aspects of TTCSs.

At a European Level, the Air Quality Directive 2008[86] sets out a requirement for Air Quality Plans (AQPs) in areas where pollutant thresholds are exceeded. As many UK urban centres are experiencing exceedances, they are obliged to develop actionable and demonstrable AQPs, and a number of these in the UK are considering introducing some form of road user charging similar to the London Emission Zone as part of a Clean Air Zone. It is likely that AQPs will remain in place even after the full withdrawal of the UK from the EU. Draft legislation, The Air Quality (Mandatory Road User Charging Schemes) (England) Regulations 2017 was drawn up but not enacted[87].

Existing Road Pricing Schemes

There are a number of road pricing schemes in operation in the UK, most notably the London Congestion and Low Emission Zones, as well as a number of toll roads, such at the M6. In any case, not all public roads allow all motorised vehicles on them. Such charging schemes or restrictions rely on provisions within relevant regulations (as set out above). Louise Butcher sets out what road charging schemes are and how they can be implemented in the UK.[88] She sets outs that a road charge is based on *"The idea is that motorists should pay for the additional congestion they create when entering a congested road"* but that they are generally seen as politically unacceptable due to perceived mobility rights by motorists. Although Vehicle Excise Duty (VED) is paid by car owners it is not allocated specifically for road use[89]. Road charging is used to not only to reduce congestion but also address air quality. As set out in the previous section, they can be introduced by local authorities through the Local Transport Act 2008 and Greater London Authority Act 1999, but only if they can facilitate policies in the Local Transport Plan. To do so, the LA introduces an order (which may or may not be consulted upon), which most contain the following aspects:

- *Designate the relevant roads;*
- *The circumstances under which a charge will be imposed;*
- *The classes of motor vehicle(s) in respect of charges will be imposed; and*
- *State the duration of the charge.*

In addition the operational aspects of charging and differential charging can be set out in the scheme. Leading from this TTCSs could be set out in a similar way, with some additions to regulate the characteristics of the scheme as set out in the next section.

The London Congestion Charge Zone[90] has been in operation since 2003. This is a daily charge (£15) charged using ANPR to any vehicle entering the designated area (within London's inner rings road) at certain times (7am-10pm), though discounts and exemptions are given to individuals with certain needs (eg residents, disabilities), certain vehicle classes (eg emergency, registered taxis, roadside recovery) and ultra low emission vehicles. The same area has since 2019 also been designated a Ultra Low Emission Zone (ULEZ) at all times, where vehicles not meeting certain Euro standards are charged

[86] EU (2008)
[87] https://consult.defra.gov.uk/airquality/implementation-of-cazs/supporting_documents/Draft%20secondary%20legislation%20%20consultation.pdf
[88] Butcher (2018)
[89] see later discussion on allocation
[90] See detail at: https://tfl.gov.uk/modes/driving/congestion-charge/congestion-charge-zone (accessed 03/11/20)

an additional £12.50 a day (£100 for buses/lorries). Individuals currently exempted as per the congestion charge have been granted a grace period to meet the standard. Penalty Charges of up to £160 (£1000 for lorries/buses) for the ULEZ and £240 for the Congestion Zone are applied if the they are not paid on time. Both of these are managed by Transport for London on behalf of the Mayor of London, and any income is invested in the city's road network and improving air quality. A number of legal cases related to the congestion or low emission zones have been made, and two key cases are set out in Table 3 (others were individual appeals against charges).

Table 2: Key cases related to Congestion Charge[91]

Judgement Date	Case	Outcome
July 2019	[2019] EWHC 1997 (Admin) Removal of exemption for private hire vehicles (PHV) discriminated against BAME, female and disabled drivers. BAME drivers make up majority of PHV drivers and female or disabled drivers are more likely to be part-time.	Rejected (Appeal outstanding) – proportionate means if achieving the legitimate aim of congestion reduction.
July 2002	[2002] EWHC 2440 (Admin) Challenge to introduction of congestion charging as environmental assessment was deficient, there should have been a public consultation and there were breaches of the Human Right Act 1998 as property value would diminish.	Refused – expert environmental evidence was appropriate under statutory functions, evidence that a consultation was sufficiently considered and there was no evidence of impact on property values.

There are limited examples of road pricing outside London. Toll roads, such as the M6 in the Midlands and the Tyne Tunnel in the North East have charges imposed to pay for the infrastructure itself and as such are operated as private entities, rather than having a payment to specifically meet a transport related policy objective. An exception to this is a £2 daily congestion charge in a small zone within Durham City Centre, which is in operation at certain times (10am-4pm, Monday-Saturday) with exemptions for certain users (not emission related).[92] A £50 charge is applied if not paid within the day. This was in operation from October 2002 (predating the London congestion zone). It was reported to effectively reduce traffic volumes by 85% within the first year.[93] When first opened, payment was made at payment machines at the boundaries with rising bollards, but now it is implemented through ANPR. As this predates the Road User Charging Schemes (Penalty Charges, Adjudication and Enforcement) Regulations 2003, they do not apply. An alternative to charging that was considered was a TTCS, but instead the road charging provisions of the Transport Act 2000 were taken advantage of to differentiate between essential and non-essential users.[94]

Proposed Road Pricing Schemes – Clean Air Zones

In response to Air Quality Management Plans, a number of regions are considering setting up some form of Clean Air Zones (CAZ). Two areas of England, Birmingham and Leeds, intended to introduce CAZs in summer 2020 (delayed to January 2021 due to coronavirus). In addition, the previously discussed London ULEZ is due to be expanded in October 2021. Guidance on low emission zones was produced in 2009[95] and a CAZ Framework was launched by the UK Government in May 2017 and

[91] Obtained from Westlaw UK (uk.westlaw.com)
[92] DCC (2020)
[93] Wafer (2012)
[94] Wafer (2012)
[95] DEFRA (2009)

updated in February 2020.[96] This document sets out definitions and operational principals for CAZ's in England. Within this, standards and requirements for charging zones are detailed, and these would presumably apply to TTCS as much as pricing schemes. As set out in Table 4, minimum requirements need to be met in implementing a CAZ, including considering impact and mitigation measures, and as well as the required planning and preparations (including consultation needs), the primary legislation for charged access restrictions is confirmed as being the Transport Act 2000 (Part 3), which requires charging authorities to set out certain other matters.

Table 3: Clean Air Zone Vision, Themes and Legal Requirements[97]

CAZ Vision
"*Clean Air Zones improve the urban environment to support public health and the local economy, making cities more attractive places to live, work, do business and spend leisure time. They support cities to grow and transition to a low emission economy thus ensuring these benefits are sustainable for the long term*."
CAZ Outcome Themes
• supporting local growth and ambition (decoupling growth and pollution). • accelerating the transition to a low emission economy. • immediate action to improve air quality and health.
Minimum Requirements for CAZ
• Be in response to a clearly defined air quality problem, seek to address and continually improve it, and ensure this is understood locally; • Have signs in place along major access routes to clearly delineate the zone; • Be identified in local strategies including (but not limited to) local land use plans and policies and local transport plans at the earliest opportunity to ensure consistency with local ambition; • Provide active support for ultra low emission vehicle (ULEV)^{2} take up through facilitating their use; • Include a programme of awareness raising and data sharing; • Include local authorities taking a lead in terms of their own and contractor vehicle operations and procurement in line with this framework; • Ensure bus, taxi and private hire vehicle emission standards (where they do not already) are improved to meet Clean Air Zone standards using licensing, franchising or partnership approaches as appropriate; and • Support healthy, active travel.
Local Authority Matters for Charging Zones
• The roads and classes of vehicles subject to a charge; • The charges imposed; • The manner in which charges are to be made, collected, recorded and paid (which designates ANPR to be used for vehicle detection) • The period for which a scheme is in force (including hours of operation if they are not continuous); • Exemptions and reduced rates from charges; and • Enforcement regimes and penalties for non-payment of charges.

Although this could serve as a basis for implementing a TTCS in order to meet the objective of a CAZ, it is not directly accommodated within the Framework itself, which only classes CAZs into two categories: Non-Charging and Charging. The framework does suggest engaging with local communities to raise awareness and understanding, working with businesses to encourage uptake of action, developing infrastructural and digital technology options to optimise traffic management, and supporting and facilitating the uptake of ULEVs (though both incentivisation and technology provision). In particular, there is a call to support innovation, but this is limited to technological solutions, rather than policy. However, the standards set in this document will be considered in the context of TTCSs later in this paper, but it will be shown that they can be applicable with little deviation.

[96] HMG (2020)
[97] HMG (2020)

Design and Implementation

Despite the numerous studies that advocate for TTCSs there are few that critically assess the barriers to design and implementation. Most tend to set about proving the acceptance, viability or economic feasibility of a simple scheme. However, in order to fully assess TTCSs as a whole we must consider the many complex variation in such schemes. Alongside this, existing legislation related to traffic management, road charging, air quality/clean air zones and emissions trading (as discussed in the last section) may all apply or be adapted for TTCSs. In this section we also discuss where those apply and what additional or amended legislation is required to make such scheme ethical and sustainable. As identified through the literature, a robust TTCS requires the following features: Policy Objectives and Target; Allocation; Trading Rules, Implementation & Acceptability.

Policy Objectives and Target

A policy objective drives the implementation of a TTCS, and is usually some form of negative externality, eg poor air quality or congestion. This policy objective itself may not be directly measurable within a credit system, and so a measurable policy target is required. The policy target is to be set by the regulator in line with policy objectives, and should be in consultation with key stakeholders. Targets include emissions, vehicle technology, fuel use, car ownership, VMT, trip rates or parking. Problems for determining the target mainly relate to having something that is measurable and monitorable, in particular for collecting baseline data. The measured unit should be the best way of achieving the desired objective. Selecting a target reduction is aspirational but could be unachievable (ie a target of zero would mean no travel at all). Assessing and deciding how much could be achievable requires numerous value judgements and normative assumptions that could make it problematic. A target that is too achievable could be seen as a waste of time. An alternative to this could be to set no reduction – but to not allow any growth, though this would not tackle existing problems. Therefore, the best target would be to consider what is a manageable level (of congestion or emissions) – though this in itself would likely be accepting (indeed allowing) that some suffering is permissible (through air quality related health, noise, stress etc as well as environmental degradation). Furthermore, the spatial and temporal zone of operation may be contentious – decisions need to be made on boundaries and also operational periods. In short, when deciding on the policy target, all options raise issues of monitoring and enforcement, partially due to their spatial and temporal nature. One option could be through smartphone applications. We have not even considered here non-car journeys, shared car journeys or passengers.

We should ask ourselves what is the 'good' that is being distributed, and is this something that should be traded? For example, it is arguable that car use is a good in itself – it provides (in most cases) a quicker and more convenient method of travelling from origin to destination over other modes, hence its dominance in society. However 'car use' is a somewhat vague concept, and moreover, it must relate to the objective of the TTCS, as well as the policy target that is being monitored. Taking again a CAZ as an example, the 'good' to be distributed is car access into the zone[98]. Taking this into account, what would a credit represent in a TTCS. It would be the right to enter that zone. However, the policy target limits the number of individuals that will be allowed the right to enter the zone at any point in time. This in itself has implementation issues.

[98] It may be somewhat problematic to consider car use or fuel use as a 'good' – this would imply that these are vital or beneficial elements required for living. The actual good per se is the quick and convenient access to a destination, which at present may be provided by the personal car. This is an unfortunate result of our current car centric transport systems, and as such, a TTCS that focuses on car use, should perhaps only be seen as a temporary solution to solving air quality issues as we refocus towards more sustainable mobilities.

Emissions could be estimated if the vehicle engine size/type and VMT are known –though this makes it secondary data. It would be unlikely (due to tech costs/availability) that emissions would be directly measured. Using the reported emissions output of a vehicle in combination with VMT is questionable as this is dependent on real world road and driving conditions, not just the distance travelled, and a device would be required that accurately measured VMT or for this to be reported by the individual. The device could also be used to give some indication of driving style. Ideally access would be required to vehicle on-board computers of power output throughout a journey. Furthermore, such considerations only apply to conventional vehicle tailpipe emissions. For emissions related to EVs, although power output and/or VMT could be collected, you would also need to know the emissions related to the electricity that was used to charge the vehicle for the journey. Finally, PM emissions, which are particularly concerning for public health arise from tyre and braking, which are also not directly measureable.

In Clean Air Zones, the objective is to reduce emissions in order to improve air quality within a certain area. As set out previously, the UK CAZ framework also require the support to local growth. The source of the emissions that are problematic is that arising from vehicles, most notably personal cars. It is not technically feasible to directly measure emissions from individual cars so to reduce the emissions a blanket approach of reducing car use is adopted. This also has secondary benefits of reducing congestion with its many known externalities. If a specific area is designated, then access and egress by vehicles into the zone can be monitored, as can the result change in local air quality, in order to assess success.

Vehicle technology (engine size/type) is already used as a proxy for some traffic regulation – eg VED, Low emission zones, congestion Charging, Parking permits – in these cases the vehicle type is used to determine if the vehicle itself is permissible, and/or determine the price level.

Fuel use of vehicles could be measured through purchases – could also be used as a proxy for emissions if vehicle technology known.

Car ownership is easily measureable and ownership rights could in theory be traded. However, monitoring the **use or user** would be more difficult. Access to car (eg through a car sharing scheme) could also be allocated and traded – only one person can drive that car at a time. Zonal access is already something that can be monitored and regulated - most regularly through well established ANPR systems. Examples include congestion zone and car park access, as well as being the main tool for identifying traffic offenders.

VMT of an individual vehicle could be possible from the mileage of the vehicle. Establishing where that mileage has been carried out is more difficult, and would presumably require GPS technology. Assigning that mileage to a specific individual would have to be assumed the owner of the vehicle. VMT of an individual is possible through sophisticated smartphone applications with mode detection – however this is not always accurate, and again – we can only accurately determine that this was the trajectory of the device – not necessarily the person.

Trip rates may be similar to zonal access, and of particular interest for congestion reducing policies. However, they are temporally and spatially dependent.

Parking, as mentioned previously, may be monitored in geo-fenced areas using ANPR, but in cases where the user relies on street parking it is less obvious how it can be managed, other than through traffic wardens patrolling areas.

In short, when deciding on the policy target, all options raise issues of monitoring and enforcement, partially due to their spatial and temporal nature. One option could be through smartphone applications. We have not even considered here non-car journeys, shared car journeys or passengers.

Setting a baseline

Furthermore, in order to set a policy target, the regulators must first collect baseline data regarding the current policy objective (eg VMT, emissions), scoping studies on how much they would like to reduce it by (eg the target) and potentially balance this with an amount that it may be practical to reduce it by. Collecting accurate data is notoriously difficult and most transport planning relies on models (and their underlying assumptions). Selecting a target reduction is aspirational but could be unachievable (ie a target of zero would mean not travel at all). Assessing and deciding how much could be achievable requires numerous value judgements and normative assumptions that could make it problematic. A target that is too achievable could be seen as a waste of time. An alternative to this could be to set no reduction – but to not allow any growth, though this would not tackle existing problems. Therefore, the best target would be to consider what is a manageable level (of congestion or emissions) – though this in itself would likely be accepting (indeed allowing) that some suffering is permissible (through air quality related health, noise, stress etc as well as environmental degradation).

Credit or Permit?

Although often used interchangeably within the literature, within an emissions trading context, permit and credit are viewed as having very different meanings, which may be relevant to the design of the transport schemes discussed here.

- ***"Permit trading**, also known as cap-and-trade, means that there is an absolute cap on aggregate emissions. This aggregate amount is then distributed among firms in the form of permits for e.g. a ton of CO2".*[99] (Example – EU ETS)

- ***Credit trading** (also known as baseline-and-credit), on the other hand, is based on a relative emission standard that sets a maximum level of emissions per unit of some input or output by the firm.*[100] (Example – US EPA)

Based on these definitions, it would appear that for most of the targets discussed, a Permit (cap-and-trade) system would be appropriate. However, in certain circumstances Credit (base-and-credit) may be preferable. It is important to recognise that in the translation between industry and individual, terminology can have different meanings and interpretations. Overlooking this can be powerful. In practise, common understanding of the terms 'permit' and 'credit' may indeed be interchangeable.

"permit"
(Noun)
1. *Permission or liberty, esp. formally granted, to do a particular thing.*

(Verb)
2. *To allow the occurrence of (an action, etc.); to allow (something) be carried out or to take place; to give permission or opportunity for.*

In the context of road transport using the above definitions, we'd be considering an absolute amount of resource that an individual is allocated and it is their choice how much (if any) they use - and how

[99] Boom and Dijkstra (2009)
[100] Boom and Dijkstra (2009)

much they are willing to trade. They may even decide not to trade and not use the permit.[101] Variations on this could be that within the initial allocation there is a certain amount that cannot be traded (ie some sort of basic allowance to prevent exploitation).

Regarding road transport, many individuals may be comfortable with the term 'permit', as this wide-spread used in areas of restricted parking or access for example (in the UK at least). Individuals accept that one requires a permit to park/access that area, and generally these can be obtained by meeting some criteria (eg residential status), and usually at some cost relevant to the constrained resource (often though negotiation between council and residents). This however, may only hold if the item which is proposed to be included in the tradable permit scheme either already is permitted, or is recognised as being a limited resource (So it follows that permits are required to manage that resource as per similar situations). What may be different in this case is that the permit may be limited - 1 permit per person/household, or that it is not freely distributed to each individual who might wish for one (ie it has to be paid).

However, should the resource being permitted be one that is currently freely available, this may be more problematic in some ways. Analogous to this is the well-recognised resistance to road pricing. Part of the argument towards this that although the objective may be recognised, the underlying fact that mobility may be restricted by economics is unfavourable. In other words – at present we are free to drive where we like (on public roads, excepting certain zones already designated eg London congestion zones). If this becomes restricted, and to gain more access one has to pay, then it follows that this will favour the more affluent. Further restricting opportunities for the poorer. This may limit 'permitting' to only certain zones (citing London as a precedent). However, once permits are 'tradeable', and assuming initial allocation is fair (see later), then the system should not restrict opportunity to travel and in fact provide those who travel less with an opportunity for profit. In reality, in our car-centric locked-in society, the choice to travel less, especially for the poorest, may not be an option – hence ensuring initial fair allocation.

"credit"[102]
(Noun)
"14

a. *In various informal or fictional contexts: a unit of currency. Later also: a unit used as a measure of a person's entitlement to use of a particular resource, service, product, etc.*
b. *(The balance of) prepaid money which a person has available for the use of a service, product, etc.*

(Verb)
To trust or allow to take money or goods, or to use services, without immediate payment; to supply (a person) on credit

As defined above credit trading differs from permit trading as rather than sharing the maximum amount of resource between users and allowing them to trade between them, credits would set a maximum for each user and allowing them to trade credits that they don't use within that. Similar to Permits, there are options of ensuring that a certain amount is protected from trade.

Credit could mean obtaining goods before payment, which could have cognitive impacts on the use of this term. ie if an individual thinks of their "credit" as being something they will have to pay for - or are currently getting for free (Depending on personal attitude these can lead to different behaviour). In this way, credit can also be taken as a "method of paying for goods and services" Alternatively it can refer to the acknowledgement of praise (or an achievement) - this could again have cognitive implications if an individual were to feel that they had 'earned' their credits and gave them some sort

[101] Harwatt et al. (2011)
[102] https://www.oed.com/view/Entry/44113?rskey=1qlhHX&result=1#eid

of right to use them without obligation. Furthermore, the process of allocation could then place moral value on the credits – making those assigned more credits as more 'deserving", which demands an assurance that initial allocation is fair and close attention to be paid to issues of need and merit (see later). The idea of "credits" as a currency is often used in fictional works, in particular science fiction, where these are usually electronically managed in some way (tying to the concept of payment methods). Additionally a credit could be something that has already been paid for (eg phone credit). Indeed, "credit" in terms of money lent or borrowed, or the value of goods and services without immediate payment dates back to the 16th century, though as an informal or fictional currency as a measurement of entitlement to a resource, service or product has only evolved over the last century.

The strong link to money can be seen as somewhat problematic, as can the link to merit. The latter may be overcome through the initial allocation (and indeed access to trade). Conflating credits to currency could be seen as simple carbon pricing. As a market price will arise through the free market trading of credits this is then putting a price on the resource being traded- setting a minimum price which thoroughly accounts for all externalities is imperative. However, as we live in a society of high income inequality, introducing a new currency that is so obviously fiscally linked may be undesirable.

Fundamentally these would appear to be the same, and it is how the resource allocation is determined that is different - the individual will receive the same amount of permits/credits (assuming same rules apply). For permits the entire resource is determined then allocated between individuals (According to some rule) whereas for credits a resource per individual is determined, which would presumably be treating each individual the same and allocating fair shares. Although this gives the individual the feasibility to choose if they use the full amount - it would seem to be problematic if the differing needs of the individual are not taken into account (see later).

Allocation

Assuming that a policy objective and the unit/form of measurement is agreed, then the initial number of credits to be distributed that correspond to achieving the target is required. This may be subjective to the unit of measurement, and could be integrated with the process of initial allocation. A key part of this may be through addressing the questions *who should be allocated credits* and *how should credits be allocated between them.*

Who should be allocated credits?

Many papers just assume an initial group and allocation method (eg fair shares or by historic use).[103] In most cases the scheme being considered includes the whole population of a country, hence there is no need to discuss who should be included in the allocation, though there are some mentions on if it should be per person, household or vehicle and if children should be included. This may be further complicated by the zoning of the TTCS – within what area would individuals be eligible for inclusion. If a TTCS is just a certain zone of a city, would just individuals living or working within that zone be included, or also the wider population of the city. Indeed, how would individuals from outside the city or region be included (especially in the case where they may not make regular tips to the area). There is little critical analysis of these choices. Different allocation strategies relating to equal shares for personal carbon trading (credits) for transport focusing on fuel use (per capita or per vehicle, including or excluding non-vehicle owners) have been considered.[104] A stated preference survey on the acceptability of personal carbon trading found a preference towards credits including children and

[103] See for examples: Grant-Muller and Xu (2014), Goddard (1997), Harwatt et al. (2011), Lahlou and Wynter (2017), BrohÉ (2010), Burgess (2016)
[104] Wadud et al. (2008) and Wadud (2011)

including additional allowances according to needs.[105] Even once private individuals to be included are agreed within a TTCS, how to include businesses (such as deliveries, services and for administrative visits) and public transport operators (including taxis) needs to be considered. It could however be assumed that emergency services would be made exempt.

How should credits be allocated?

The allocation problem is not unique to TTCSs. There is a large body of work to draw upon from discussion around distributive justice and Personal Carbon Trading[106]. Such theories could be operationalized into five principles within the transport sphere[107]:

1. Equal shares
2. Egalitarian
3. Maximum range between groups
4. Minimum floor of impacts i.e. Rawls
5. Equal proportions.

In explaining these approaches, we will consider a theoretical TTCS where the policy target is to reduce emissions and credits are based on car-use, but without reducing (or improving) equity in accessibility.

Equal Shares

Perhaps the most simple approach, and one adopted by many studies, is equal shares across the population of car drivers. An entirely equal distribution, that each individual receives exactly the same allocation of credits, may seem inherently the fairest approach, and one that follows from the current situation – that they all currently have equal rights to access the zone whenever they please (or subject to paying a fee if already a charging zone). However, there are various arguments to doing so, as raised by previous authors. In particular, individuals will have a different needs for access into the zone and opportunities for choosing alternative transport, and this is not reflected in an equal shares approach. It is for this reason that in many congestion pricing schemes, residents of a zone, or disabled individuals may be exempt. If this is recognised in such a way in existing approaches, then equal shares would not be an acceptable approach, unless such groups had different provisions – thus making the scheme no longer 'equal shares'.

Egalitarian

An egalitarian approach would imply the aspiration of achieving an equal situation (e.g. all individuals would have the same level of accessibility). In order to do this, credits would need to be distributed according to 'need'. Within this process, the determination of what is classed as a need (and identifying who has that need), regarding whatever the credit represents within the scheme and in terms of accessibility needs to be examined, which in itself would have complex ontological thought. One approach to this could be through some meeting some form of criteria, making it also administratively complex.

[105] Bristow et al. (2010)
[106] See later discussion
[107] Though not regarding tradable credits. Suggested by Thomoplous and Harrison (2015), based on Khisty (1996) and (Martens,
2009; Mouter, 2014; Thomopoulos, 2010; van Wee, 2011).

Maximum Range

Rather than attempting to create equality (which may not be possible in the complexities of reality), one may wish to limit the gap in equality (eg in accessibility). In such a case, credits should be distributed in such a way that each individual is equally allocated a minimum number of credits (that would represent an agreed minimum acceptable level of accessibility), but also setting a cap on the number of credits that can be owned (or used) within a certain time period.

Minimum Floor

Taking a more Rawlsian approach, it may be more practical to limit the lowest level of accessibility than actual accessibility gap. In such a case, credits could be distributed in such a way that a minimum number of credits is distributed equally to all individuals (as with maximum range), with no upper limit as per maximum range. Although this does not take on board 'need', it should still provide opportunity for those with higher needs for those needs to be met.

Equal Proportions

Similar to the egalitarian approach, equal proportions would imply that credits should be distributed according to need (perhaps by meeting some certain criteria, but this does not have the aspiration to achieve equality. Alternatively, this could be based on current levels of accessibility. However, questions could be raised if current accessibility is directly related to need for all individuals.

Distributive Justice and Carbon Trading

Peter Singer describes approaches to equitable distribution of emission allowances between nations in order to meet global emission reduction targets for the avoidance of irreversible climate change.[108] The first two follow Robert Nozicks theories of social justice that we can view equitable distribution as either 'historical' or 'time-slice'. Under the historical proposition, we take account of how the problem came about – an approach also thought of as 'polluter pays'. In this sense, we would argue that historical car use of individuals should be taken into account when allocating future car use. However, should this lead us to conclude that those with more 'historical' car use should be allocated more or less? In one way, there is a claim that they may have 'used up' their allocation of car use, now that we have agreed that car use should be limited. The counter-claim to this is that their higher car use could be an indication of their base-line need. In short, if a historical approach is taken, we must first decide on over what period it is over. Arguably, as with many global arguments from industrialised countries against stricter limits due to higher historic emissions, there is a claim of ignorance, that it was not known that car use would lead to be such a problem, the environmental effects were not recognised, so they cannot be held accountable for them and it would be unjust to be penalised in the future because of it. Although this may be rebuffed, that despite the ignorance, there is still clear responsibility. However, in the case of reducing car use/emissions regarding air quality in a certain zone, this is not dependent upon historic use – it is concerned with current use, as air quality is related to recent vehicular emissions (demonstrated most recently by significant impact of COVID lockdown transport use and related urban air quality, with NO2 reductions in the region of 30-40% over a two month period).[109] In this way, we could not argue that historic car use if responsible for local pollution, in the same way the historic energy use is responsible for global climate change, so individuals with high historic use may not be held accountable in the same way. In any case, we do not have access to

[108] Singer (2002)
[109] AQEP (2020)

data regarding an individuals historic car use, no matter what period we consider (assuming that individuals would not be accurate or forthcoming in providing that information themselves).

Assuming that historic car use is not an appropriate metric to base allocation on, then we then turn to time-slice principles of distribution. This is based on considering the existing distribution of a good and asking if that satisfies ethical principles. Assuming that this is 'car use', we can consider this to be the current car use of individuals within the area. Similarly to historic principles, we do not have access to individual car use data, only traffic counts (or models) of overall daily car use within a certain zone. Furthermore, we do not have access to accurate information on how many cars are in that zone at any time – just counts and estimates on how many access and egresses there have been. Even if we do know the number of cars in a zone at any certain time, and the number of vehicles that leave and arrive throughout the day we would not know at if there have been (say) 100 vehicles come and go one each or 50 vehicles that have make a return visit. Furthermore, we do not know the reasons that these vehicles have entered the zone, to what degree their relative need to do so was. The problem of 'who' could be solved by collecting baseline data, implementing ANPR monitoring in the area for some time before implementing the TTCS. To do this, consideration of privacy issues would be required, and it would still not provide reasons for the journeys, who is in the vehicle, or even much relevant detail on the vehicle owner. In such case, we cannot assess the current distribution of car use across the population, and must develop distribution rules based on more generic principles. Singer offers three approaches to considering this. The first is equal shares, though proportional to current use. If the access is for the vehicle and ANPR has been used for baseline use, this may be possible. However, as previously raised, the reason for the journey should be considered within the allocation. The argument for this is that needs are more important than wants (i.e. someone having to access the zone for work as opposed to leisure).

Changing allocation over time

It should be expected that the overall credits within the scheme could be reduced over time in line with the policy target, and assumed that this will be reduced proportionally across the credit holders. However, there needs to be a mechanism for including newcomers into the scheme. One approach to this may be to have a certain amount of credits that are unallocated and held by the government that could then be released when needed. If these were included in the trading it would not be appropriate for the government to profit, though there may be some argument that some funding for the implementation and monitoring of the scheme may be required. Otherwise, the scheme would not be open to newcomers within any one trading period – leading to questions on how long this period should be. Under this situation the assumption would be that the newcomer would not be able to obtain their free allocation within their initial trading period, but would be able to enter the trading scheme to purchase credits.

Trading Rules, Implementation and Acceptability

It must be recognised that all forms of trading risk abuse, speculation and 'black' markets. In addition to this, TTCSs will likely highly rely on new technologies, which may have low level of public trust – both related to the reliability of the technical operation itself and the increased risk of corruption.

Trading can only occur between individuals, with no government or private profit, though small costs to cover transaction fees may be imposed. However, speculative purchasing must be prevented to ensure the fairness of the system. It can also not be overlooked that some parties may be tempted to sell credits and opt for less desirable levels of accessibility if they have less financial capital to begin with. It is to some degree arguable that it is up to the individual how they value commodities, and as at present, more affluent individuals travel more, and so would require more. Should the initial

allocation be equitable, and poorer individuals are willing to sell, then this could be acceptable. Two important aspects of ensuring trading rules are adhered to, and the scheme operates as theoretically planned, are monitoring and enforcement. The success of these is dependent on initial design and choice of objectives that are measurable within real-time and there are mechanisms in place to prevent abuse. This is critical in success as the prevalence of abuse will not only lead to scheme failure in achieving the desired target, but also public mistrust and acceptability (further embedding scheme failure).

Within the sphere of trading rules, we can also consider when trading can occur and for how long a credit is valid. A daily credit may not be plausible – anyone who journeys in the morning would be a clear advantage of those travelling later in the day, and may cause issues elsewhere if everyone wanted to use their allocation at the same time and there is some form of queueing or circling instigated, should the area by 'full' and there becomes a 'one-in-one-out' situation. Similar issues could occur for any time period – 1 hour or even 15 minutes for instance. Baseline studies of access to the area will be required to understand how this would work most efficiently.

Institutional agreements for the implementation of TTCSs will be complex as many actors will be involved, including the authorities, service providers and technology providers, which are required for the various stages of implementation (eg planning/design, operation/customer service, monitoring/enforcement). Allocation requirements alone may create large administration costs, so research into contractual arrangements with operators is required.[110] Further to this, as there may be various actors wishing to be involved in the TTCS market, competition law will play a factor. In addition, as it can be assumed that the TTCS will involve a large use of individual private data, GDPR will apply and questions will be raised over ownership of that data.

Acceptability of TTCSs relies on principles of distributional justice. This in itself can be contentious as there are no universally accepted rules of distribution. Acceptability of road pricing schemes is low (most commonly due to freedom and fairness concerns) but sensitive to socio-demographic factors[111] suggesting the design of the scheme and allocation of permits would require detailed decision-making. There are similar debates to personal tradable carbon allowances, which have found public opinion favours TTCS over taxation, however a survey found that Chinese participants are more accepting of TTCSs than the Dutch, believing it is more effective and fairer than existing road restrictive schemes.[112] A large part of acceptability may also relate to the affordability of the TTCS and impacts on accessibility.

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[110] Fan and Jiang (2013)
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