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**DOI**
10.1016/bs.atpp.2020.01.001

**Publication date**
2020

**Document Version**
Final published version

**Published in**
Policy Implications of Autonomous Vehicles

CHAPTER TEN

# Governance cultures and sociotechnical imaginaries of self-driving vehicle technology: Comparative analysis of Finland, UK and Germany

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*Advances in Transport Policy and Planning*, Volume 5
ISSN 2543-0009
https://doi.org/10.1016/bs.atpp.2020.01.001

## Abstract

As an emerging technology, the potential deployment of self-driving vehicles (SDVs) in cities is attributed with significant uncertainties and anticipated consequences requiring responsible governance of innovation processes. Despite a growing number of studies on policies and governance arrangements for managing the introduction of SDVs, there is a gap in understanding about country-specific governance strategies and approaches. This chapter addresses this gap by presenting a comparative analysis of SDV-related policy documents in Finland, UK, and Germany, three countries which are actively seeking to promote the introduction of SDVs and which have distinct administrative traditions. Our analytical framework is based on the set of premises about technology as a complex sociotechnical phenomenon, operationalized using governance cultures and sociotechnical imaginaries concepts. Our comparative policy document analysis focuses on the assumed roles for SDV technology, the identified domains and mechanisms of governance, and the assumed actors responsible for steering the development process. The results highlight similarities in pro-automation values across three different countries, while also uncovering important differences outside the domain of traditional transport policy instruments. In addition, the results identify different types of potential technological determinism, which could restrict opportunities for responsiveness and divergent visions of mobility futures in Europe. Concluding with a warning against further depolitization of technological development and a dominant focus on economic growth, we identify several necessary directions for further developing governance and experimentation processes.

**Keywords:** Automated vehicle, Smart mobility governance, Connected vehicles, Automated driving, Transport policy

## 1. Introduction

The landscape of urban mobility technologies is currently experiencing a period of significant change, with multiple emerging mobility technologies, which are by definition imbued with such features as uncertainty, prominent impact, and fast development (Rotolo et al., 2015). Focusing particularly on self-driving[a] vehicles (SDVs), there is a growing body of literature reflecting on the governance and policy implications in relation to multiple anticipated consequences (Blyth et al., 2016; Cohen and Cavoli, 2019; Fagnant and Kockelman, 2015; Faisal et al., 2019; Fraedrich et al., 2019; Guerra, 2016; Hopkins and Schwanen, 2018; Legacy et al., 2019; Milakis et al., 2017;

[a] Some other commonly used terms include automated and autonomous vehicles. The choice here was made based on the Aristotelian concept of *telos*, as end-purpose for the technological artifact, which in this case is assumed to be capacity to perform the act of driving (by) itself.

Porter et al., 2018; Stilgoe, 2018; Thomopoulos and Givoni, 2015). Starting from the fundamental governance rationales of efficiency, equity and ethics (Howlett, 2009; Lyons, 2018; Winfield and Jirotka, 2018), we observe that the domain of emerging mobility technologies such as SDVs faces a classic Collingridge double-bind dilemma.[b] This dilemma contrasts the early stage of development, when change is easy but there is uncertainty about consequences, with the later stages of technological maturity, associated with a lock-in when the technology has become societally embedded (Collingridge, 1980; Genus and Stirling, 2018). This dilemma is at the core of challenges for steering development of an emerging technology, highlighting the need for governing responsible innovation processes that would avoid different types of technological determinism (Wyatt, 2008).

While reflection about undesired consequences and responsible innovation is ongoing, there remains a gap in country-specific analysis of governance strategies (Milakis, 2019; Taeihagh and Lim, 2019). Addressing such gap is important for devising common and specific governance strategies across Europe, involving hybrid multi-actor networks. This research addresses this gap by comparatively reviewing national level SDV governance document for a set of three European countries: Finland, Germany and the UK. These countries have been selected as they are among the global leaders in SDV technology development and are actively developing related governance strategies. Moreover, each country represents a distinct administrative tradition of western democracy, namely Nordic, Rhinelandic, and "British Isles" (Loughlin et al., 2011), providing a useful dimension by which to compare and contrast. For achieving the above end, we form a novel framework for the analysis of technological innovation governance. The much-utilized Multi-Level Governance perspective often overlooks spatial variables (Pangbourne, 2010), and is more concerned with articulations between scale on the one hand, and the interplay of and the distribution of powers. Contrastingly, we draw theoretical constructs from both governance and technology studies to uncover additional political, cultural, historical and geographical factors, and consider their implications.

The chapter is divided into six sections. In Section 2, we set out our analytical framework, which synthesizes concepts of governance cultures and sociotechnical imaginaries, forming a technology-governance-culture triad.

[b] "attempting to control a technology is difficult … because during its early stages, when it can be controlled, not enough can be known about its harmful social consequences to warrant controlling its development; but by the time these consequences are apparent, control has become costly and slow" (Collingridge, 1980).

We then list three research questions and describe how we apply this framework to our analysis of public documents on SDVs from our three case studies. In Sections 3–5, we systematically explore our three research questions relating to the assumed societal roles for SDVs, the identified domains and mechanisms of governance of SDV deployment, and the assumed actants[c] responsible for steering the development process. Section 6 concludes with a summary of analysis, discussion of potential for technological determinism, and a set of recommendations for further research through establishing epistemological parallels between technology studies and transport studies.

## 2. Methodology

### 2.1 Analytical framework

In order to develop our analytical framework, we first establish our understanding of SDV technology as a complex sociotechnical phenomenon (e.g., Mladenović, 2018, 2019). As a central premise of this perspective, technologies are understood not just as utilitarian artifacts, but as underpinned and shaped by dynamic interactions with human values and norms (Feenberg, 1999; Kroes and Verbeek, 2014; Kudina, 2019; Mladenovic et al., 2019; Verbeek, 2011). In fact, technologies mediate human activities and experiences, co-constructing decisions and moral standpoints. Understanding that we cannot treat technologies as merely objects and humans as subjects interacting with them has important implications for moral agency, as a hybrid affair of networked human beings and acting, networked, artifacts. In this way, we proceed by terming both humans and technologies as *actants* (Latour, 1992, 1996). Another important premise is that emerging technology has *interpretative flexibility*, where functioning of technology is the result and not the cause of it becoming a successful and acceptable artifact, often assessed through the lens of particular social groups (Pinch and Bijker, 1984).

Having grounded our analytical perspective on the understanding of emerging technology as a complex social-technical phenomenon, we identify two key concepts necessary for our analysis. First concept are *sociotechnical imaginaries*, as "imagined forms of social life and social order reflected in the

[c] Rather than the more common term, actor, which is reserved for humans and their organizations in this chapter, actant is a term introduced to overcome human-only connotations for action in technological innovation processes.

design and fulfillment of nation-specific scientific and/or technological projects" (Jasanoff, 2004; Jasanoff and Kim, 2015). This concept lies beneath intertwined processes of (national) identity construction and visions of technological innovation (Ryghaug and Toftaker, 2016). Such visions often include co-construction of hopes and fears among specific institutions and actors that exist in the midst of processes of technological emergence (Kaplan and Tripsas, 2008; Sturken et al., 2004). Clearly, sociotechnical imaginaries of one country will differ from that of another, due to the differences in cultural context in which they are embedded. Therefore, we can use this concept to inform our understanding of the institutionalized practices for testing and deploying knowledge claims in a society. Many knowledge claims are made about emerging technologies such as SDVs, which are highly complex innovations involving many different fields of knowledge and innovation. Such knowledge claims are associated with the ways in which the members of the given society imagine any given technology and its relationship to the social order. Thus, sociotechnical imaginaries will be used as one of the lenses for interpretation and comparison.

The second key concept for developing the analytical framework is that of *governance culture*, which underlines cultural meanings and values in relation to acceptable purposes and appropriate mechanisms of governance practices (Paulsson et al., 2017; Rogge and Reichardt, 2016; Stead, 2018). Here, we perceive that the governance of emerging technologies often faces an institutional void intertwined with distributed responsibility in hybrid networks of relevant institutions (Sclove, 1995; Wetmore, 2004). Following the ongoing discussion in the domain of technology ethics related to the responsibility gap for actions of learning automata, we recognize that responsibilities are formed during, often unstructured, negotiations between different groups of actants, such as designers, legislators, and users (Felt et al., 2017; Noorman, 2014; Schulzke, 2013; van de Poel, 2011). Furthermore, with the initial premise that SDV technology is a complex artifact, we recognize a potentially wider web of governance actants, beyond the human ones. In fact, technological development can be referred to as a "problem of many hands," where governments, transnational tech companies, individuals, and even technological devices themselves influence the redistribution of power and morality (Collingridge, 1980; Susskind, 2018; Winner, 1980). Therefore, our analytic framework has to provide a means of interpreting the wider cultural context in which these institutions are embedded, rather than solely focusing on the structure of institutional arrangements (Marsden and Reardon, 2017; Voß and Freeman, 2016).

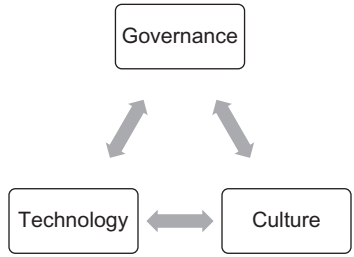


**Fig. 1** Graphical representation of the technology-governance-culture triad.

Rather than reducing governance analysis to describing sets of bureaucratic institutions, the governance culture lens enables us to include a range of organizational mechanisms, operational assumptions, modes of thought, and consequential activities.

Combining the above concepts into a *technology-culture-governance triad* (Fig. 1) enables a deeper understanding of how emerging technologies are being framed, assessed and responded to in different national contexts. By synthesizing the concepts of governance cultures and sociotechnical imaginaries into a single framework, we are better able to analyze the discursive meanings of technology found in governance documents by setting them alongside broader (national) cultural assumptions. Thus, in addition to deepening the concept of emerging technology, we acknowledge rhetorical functions of governance (Mladenović, 2019; Pangbourne et al., 2019). Rhetoric is an important mechanism in the social construction of technology and challenges that technologies are supposed to address (Berkhout, 2006), and thus is crucial in the development of sociotechnical imaginaries.

## 2.2 Research questions and policy documents reviewed

In order to reveal the cultural interpretations of SDVs in Finnish, UK and German policies we ask three questions which are considered in turn in the next three sections of this chapter:

1. What are the assumed roles of SDV technology and its development process?
2. What are the identified domains and mechanisms of governance in relation to anticipated challenges and risks in SDV technological development process?
3. Who are the assumed actants responsible for the SDV technological development process?

Each of these questions is addressed through reviewing policy documents. Our data consists of a selection of national documents concerning transport and technological development policies in Finland, Germany and the UK. Several types of documents are reviewed, including strategies, policy statements, and governmental webpages. These span a period of 7 years, from 2013 to 2019, in order to try to identify the dominant discourse and governance culture that are embodied in the policy documents. A full list of the documents we sourced and examined is presented across Tables 1–3 (for Finland, UK and Germany respectively). In line with our analytical framework, we review these documents as political artifacts produced in a particular cultural context, which represent the stabilized agreements of negotiations among often-heterogeneous groups of people and organizations (Jasanoff and Kim, 2015). The analysis focuses on (a) explicit goals as expressions of sociotechnical imaginaries and (b) underlying assumptions and ideals expressed with specific terminology or visuals.

**Table 1** Documents relevant to technological visions for transport in Finland and produced by governance actors, in chronological order of publication (accessed by the authors via source websites).

| Year | Title | Source |
|---|---|---|
| 2013 | Toward a new transport policy: Intelligence in Transport and Wisdom in Mobility | Finnish Ministry of Transport and Communications |
| 2014 | Fair and Intelligent Transport | Finnish Ministry of Transport and Communications |
| 2014 | 100 opportunities for Finland and the world: Radical Technology Inquirer (RTI) for anticipation/evaluation of technological breakthroughs | Committee for the Future, Parliament of Finland |
| 2014 | Innovation policy options for sustainability transitions in Finnish transport | Finnish Funding Agency for Technology and Innovation |
| 2015 | A Nordic Model for Human-centered Personal Data Management and Processing | Finnish Ministry of Transport and Communications |
| 2017 | Road Traffic Act | Finnish Ministry of Transport and Communications |
| 2017 | Finland's Age of Artificial Intelligence | Ministry of Economic Affairs and Employment |

*Continued*

**Table 1** Documents relevant to technological visions for transport in Finland and produced by governance actors, in chronological order of publication (accessed by the authors via source websites).—Cont'd

| Year | Title | Source |
|---|---|---|
| 2018 | Act on Transport Service | Finnish Ministry of Transport and Communications |
| 2018 | Societal transformation 2018–37: 100 anticipated radical technologies, 20 regimes, case Finland | Committee for the Future, Parliament of Finland |
| 2018 | Work in the age of artificial intelligence | Ministry of Economic Affairs and Employment |
| 2019 | The impact of automated transport on the role, operations and costs of road operators and authorities in Finland | Finnish Transport and Communications Agency |

**Table 2** Documents relevant to technological visions for transport in the United Kingdom and produced by governance actors, in chronological order of publication (accessed by the authors via source websites).

| Year | Title | Source |
|---|---|---|
| 2015 | The pathway to driverless cars: A code of practice for testing | Department for Transport |
| 2016 | Pathway to driverless cars: Proposals to support advanced driver assistance systems and automated vehicle technologies | The Department for Transport; Centre for Connected and Autonomous Vehicles |
| 2016 | Funding competition: connected and autonomous vehicles 2 | Department for Business, Energy & Industrial Strategy |
| 2017 | Vehicle technology and aviation bill | UK Parliament |
| 2017 | New measures set out autonomous vehicle insurance and electric vehicle infrastructure | Centre for Connected and Autonomous Vehicles; Centre for Protection of National Infrastructure; Department for Transport |
| 2017 | The key principles of vehicle cyber security for connected and automated vehicles | Department for Transport |

**Table 2** Documents relevant to technological visions for transport in the United Kingdom and produced by governance actors, in chronological order of publication (accessed by the authors via source websites).—Cont'd

| Year | Title | Source |
|---|---|---|
| 2017 | UK Testing Ecosystem for Connected and Autonomous Vehicles | Centre for Connected and Autonomous Vehicles |
| 2017 | Industrial strategy: The grand challenges | Department for Business, Energy & Industrial Strategy |
| 2018 | Automated and Electric Vehicles Act | UK Parliament |
| 2018 | The fundamental principles of automotive cyber security—Specification | Department for Transport; Centre for the Protection of National Infrastructure |
| 2019 | Code of Practice: Automated vehicle trialing | Department for Transport |

**Table 3** Documents relevant to technological visions for transport in Germany and produced by governance actors, in chronological order of publication (accessed by the authors via source websites).

| Year | Title | Source |
|---|---|---|
| 2015 | Strategy for Automated and Connected Driving | Federal Ministry of Transport and Digital Infrastructure |
| 2017 | Road Traffic Act | Federal Ministry of Justice and Consumer Protection |
| 2017 | Report of the Ethics Commission on Automated and Connected Driving | Federal Ministry of Transport and Digital Infrastructure |
| 2017 | Data protection law recommendations of the Federal Commissioner for Data Protection and Freedom of Information for Automated and Connected Driving | Federal Ministry of Transport and Digital Infrastructure |
| 2018 | Report on the Implementation of the Automated and Connected Driving Strategy | Federal Ministry of Transport and Digital Infrastructure |
| 2018 | National Platform "Future of Mobility" | Federal Ministry of Transport and Digital Infrastructure; Federal Ministry of Economy |

## 3. What are the presumed roles of SDV technology in society?

In analyzing the sociotechnical imaginaries for the role of SDV technology in society, we identified a set of common visions across all the three case countries, as well as some differences in focus and terminology. Across all the three countries, it is evident that SDVs are considered important for addressing significant national and global challenges around transport system efficiency, traffic safety, energy demand and sources in transport, and carbon neutrality. However, we found evidence that the societal role for SDV technology is not just imagined in relation to the transport system needs, but is shaped also by other assumptions about social needs and economic opportunities, as highlighted before by Stilgoe (2018).

Indeed, the central assumption present in all three countries is that innovation in the domain of SDV technology should contribute to the national economic growth, which is often equated with national identity characteristics such as prosperity and sense of pride. The arguments about economic growth also tend to be framed in some similar ways across Finland, the UK and Germany, as necessary responses to social imperatives. For example, the theme of the aging population is discursively related to challenging national demographic dependency ratio, directly related to the problems in economic productivity. It is also common for governance documents in all three countries to associate explicitly economic growth with competitiveness in the global labor and product market, not only between firms but also between nation states and regional blocks. Thus, governance imaginations center on narrating a global role for the specific nation in leading some aspect of the technological development of SDVs. We present examples over the next few paragraphs.

In Finland, the vision of economic development through technological innovation is shaped by long-term transition to knowledge economy and carving out a niche for specialization among large actors outside of EU, such as US or China. Thus, economic growth is portrayed as essential for national survival. In addition to challenges similar to UK and Germany (see below), Finnish documents mention several other challenges, such as lack of raw materials and dependence on foreign energy resources, late and underutilized urbanization hand in hand with the loss of rural livelihood, and the need for large infrastructural investments for a relatively large area compared to population. Thus, SDV technology finds its role in the general shift

of the Finnish nation's focus on being an information and knowledge economy, in contrast to its industrial past (Halme et al., 2014), and decoupling the prospect for economic growth from geographic factors. In particular, in the document "100 opportunities for Finland and the world," SDVs are listed among the 100 technologies that have the potential to develop into world-changing technology, and the value-networks developing SDV technology are already considered to be among the 20 most important value-networks for Finland's future. The significance of this role for SDV technology is pinpointed as arising from a specific synergy between innovation policy in the domains of digitalization, automation, and servitization,[d] exemplified with a focus on development of artificial intelligence (AI) application, and increasing citizen's digital literacy. Other significant national projects are also framed as supporting development of SDVs, such as development of 5G telecommunication technology and investments into know-how of building sensor components.

In contrast to Finland's imperative of "national survival," UK and German imaginaries of the role of SDVs in relation to economic growth are centered on perceived existing or intended global leadership in technological development. From the UK, we highlight this statement from its Industrial Strategy:

> We will become a world leader in shaping the future of mobility.
>
> ***(DBEIS, 2017, p. 48).***

A similar example about perceptions or aspirations for global technological leadership comes from the landing webpage of Germany's Strategy for Automated and Connected Driving:

> The motor car was invented in Germany. We have revolutionized it time and again. And today, we are still at the top of the international league table when it comes to innovations in the automotive sector. All the major innovations associated with the car - from the four-stroke engine to the anti-lock braking system - come from Germany.
>
> ***(FMTDI, 2015, no page).***

These two examples of the UK and German rhetoric exemplify important differences in the perceived nation's roles in being innovation leaders. UK governance documents see emerging opportunities from increased digitalization and intelligence in vehicles to attract foreign investment and develop high-skill, well-paying, jobs. On the other hand, the German vision for SDV

[d] Focus on providing services as oppose to products. In line with service economy concept.

technology is firmly based on its historically important contributions to the automotive industry, and reflects the continuing of strong partnerships between the industry and public sector.

Despite some similarities, there is a striking point of divergence between the UK and Germany in the assumed role for SDV technology. The UK policy documents highlight resilience and readiness of the industry, and links it to questions of national security. In the UK, an opportunity is perceived to use certain requirements of SDV technology to stimulate associated growth in the cybersecurity sector as well as to strengthen its citizens' responses to such threats. This latter point contrasts with Finland's focus on the digital literacy of citizens. The threat that the German industrial strategy centralizes is that of the climate crisis, and the vision of taking the global leading role in addressing that crisis. Finally, both UK and German governance documents base their arguments, for the important role to be played by investing in SDV technology as a key platform for economic growth, on the quality of their transportation, logistics, and telecommunication infrastructure. However, those arguments in the UK rhetoric are focused on the need for improving the failing infrastructure, while those in Germany are focused on infrastructure providing an excellent basis for technological testing.

## 4. What are the domains and mechanisms of governance?

### 4.1 Liability

Assumptions about underlying risks and adverse effects shape how different governance cultures perceive their domains and mechanisms of action. Overall, all three governance approaches have an underlying premise that risks are problems to be managed, without recognizing potentially unanticipated consequences (see also Taeihagh and Lim, 2019). One of the risks to be managed is the focus on liability in the case of traffic crashes, as a traditionally relevant question for the automotive industry. Here, it is interesting to note that the driver does not have a legal definition in the Finnish law, which refers to road user. Legally, the responsible user of the vehicle must be identifiable, but that person can legally have access to the vehicle via remote operation. Such cases of remote operation have been specifically included in the recent updates to Finnish legislation. In the UK, changes in the legislation have laid out a comprehensive list, clarifying the liability of insurers and SDV owners, ensuring that liability for accidents remains under the existing vehicle insurance scheme. In contrast, German legislative

changes have gone one-step further, with the requirements that SDVs must have a black box recording during the entire journey to determine liability during collisions, and have doubled the maximum liability limits.

## 4.2 Public experiments

In addition to liability for accidents, a related domain of governance is emerging in all three countries—public experiments. Based on its current governance framework, Finland allows SDV trials on the entire road network. Several governance documents recognize the potentially challenging environmental conditions, such as winter and night, so encouragement of experimentation is seen a viable approach to managing technological risks. In addition, Finnish governance documents are mentioning the need for systematic classification of features for operational design domains (ODDs) as a response to anticipated impacts. Similarly, public trials in the UK have also been increasing. These trials are accompanied with the development of business plans and roadmaps for SDVs. In contrast with the legislation on accident liability, manufacturers are also protected under the Consumer Protection Act, if they demonstrate that vehicle was not defective at the time it was supplied, or that defect was detected only later, due to technological advancements. In addition, UK is the only country having recently proposed Code of Practice for public SDV experimentation. Thus, both Finland and UK seem to have opted for more experimental approach to governance, with a focus on informing and incentives as opposed to constraints and punishment-oriented legislation. German approach has focused on developing digital test beds on different road types (e.g., motorways, urban areas), for trials in real traffic situations. Similar to Finland and UK, this development approach has engaged actors from different sectors and levels, emphasizing the need for cooperation. In contrast to Finland and UK, German approach to testing has more explicitly been focusing on interoperability, exemplified with establishing a digital test bed together with France.

## 4.3 Data management

Hand in hand with experimentation, the question of data management in its widest sense has been identified as a domain in several governance documents. For example, even the Finnish Road Traffic Act, traditionally focused on transport legislation, has included that detailed location data on roads, signs, traffic lights and other control mechanisms should be available for SDVs operators to use. In general, the Finnish approach has focused on deregulation, opening public data sources, and providing supporting

digital interfaces. Transport Service Law has played a particularly important role in this legislative change, influenced by the identified synergy between SDVs and development of working business models for the operation of the transport system (e.g., Mobility as a Service concept). Other governance documents have openly acknowledged that the Finnish ecosystem is missing prototype-level automotive hardware computing platforms and is lagging with industry investments. Thus, major focus remains of data "utilization," with assumption that "customers" will provide data on trip destination and origins, as this would be essential for traffic management mechanisms. The focus on data as synergetic with innovation incentives, domain of governance has been associated with financial mechanisms, such as adjustments in taxation and dedicated development strategies from the Finnish Funding Agency for Technology and Innovation. On the contrary, privacy and security issues are left aside, "to be solved," thus neglecting that data protection is not protection of personality, as exemplified with the quote below, from "The impact of automated transport on the role, operations and costs of road operators and authorities in Finland":

> It is assumed that for all automated vehicles the origin and destination are known, as this information is present in the vehicle when it commences the trip (the security and privacy issues have to be solved). Knowing the origin and destination is important to facilitate effective routing of the vehicles.
>
> ***(FTCA, p. 119).***

Slightly different from the Finnish understanding of the governance domain, the UK governance has explicitly focused on cybersecurity, recognizing challenges related to data theft and hacking. The guidelines recommend that manufacturers follow ISO standards, asking for personal information is "managed properly." For example, highlighted aspects include data storage and transmission, as well as ensuring that SDV user is able to delete "sensitive" data, although more specific definitions of "proper" management or "sensitive" data are not provided. In addition, as mentioned in relation to the role of SDV technology, UK governance underlines system design for resilience to attacks and having appropriate responses under failure. Thus, both Finnish and UK governance cultures neglect the importance of privacy as the important domain for public resistance, as has already proven decisive in the case of proposal for reforming road-pricing regulation in Finland to enable continuous driving monitoring. However, it is interesting to note that a governmental attempt from 2015 in Finland named "A Nordic Model for Human-centered Personal Data Management and Processing," or MyData in short, has fallen down in importance in the later governance documents. Developed as a form of data activism, MyData

initiative assumed citizens and consumers being more active about their personal data, capable of controlling the gathering, sharing and analysis of personal data. Contrary to the dominant GDPR understanding, where data is considered as part of individual's personality, MyData treats personal data as a resource, which the individual can access, control, and benefit from. Ideologically provoking, this initiative is driven by "parallel development of digital rights, innovation and business growth," aiming to push for design of new services. Thus, as a form of data activism, MyData fails to address discrepancy between technological and social data activism (Lehtiniemi and Ruckenstein, 2019).

Contrary to the Finnish and UK approach, German governance culture has taken a more control-oriented approach regarding data access and processing. In addition, one distinct feature of German governance approach is the recognition that federated structure might spur innovation, but that consistency would require intervention on a federal level. Thus, federal cohesion is a secondary, but still an important governance mechanism. German data protection regulation is very similar to GDPR regarding the definition of personal data as any information with the slightest relation to an individual. Similar to GDPR, these regulations pertain to all data, and emphasize on complete transparency and drivers' full authority over the use of such data. As ethics has been central value of Germans national self-understanding and self-representation (Sperling, 2004), such emphasis is especially evident in its governance culture. In fact, Germany is the only EU country having formed a national Ethics Commission on SDVs, and provided 20 ethical guidelines for SDV development. Those guidelines are the first to suggest algorithms embedded in SDV technology as a necessary governance domain. For example, this document states that it is unethical for SDV algorithms to use any individual's data (e.g., age or gender) as discriminatory decision-making criteria during unavoidable accident scenarios. Moreover, these guidelines are underlying data protection with the notion of personal autonomy and informational self-determination, as important ethical concepts, largely missing from Finnish and UK governance rhetoric.

## 5. Who are the governance actants?

### 5.1 Non-humans

As highlighted in the previous section, one of the clearly recognized actants is the driver, or the road user in Finland, which can also be a remote operator. However, all the governance cultures in Finland, UK, and Germany do

not recognize explicitly the role and power of non-human actants, taking a neutral stance to the meaning of technology. For example, an interesting change in the Finnish Road Traffic Act is replacing the continuous yellow lines on Finnish roads to white, as these are easier for machine vision detection. In this context, one could argue that technology has clearly acted on the governance actors, resulting in an unusual addition to the legislation that is otherwise not foreseen in such a document. Moreover, one can notice the importance of data as an actant, being at the center of major governance changes. For example, the Finnish Road Traffic Act asks for integrated detailed location data on road control devices, which could be used by SDV operators. Thus, the crucial point here is in neglecting the "missing masses," as Latour named artifacts whose power is not accounted for in innovation processes (Latour, 1992).

## 5.2 Experts

Aside from neglecting the power of technological actants, there is a dominant focus on particular expert-based roles in the transport, ICT, and economic sectors, and related practices of foresight and technological assessment in governance processes. Despite the fact that these three countries are considered leaders of the democratic Western world, such focus on narrow expertise can be central to non-democratic technological dogmatism, reducing societal reflexivity and inclusive deliberation. In particular, dogmatism persists due to the lack of process transparency, or in case of groups unable to exercise independent views of the technology, often being unduly optimistic and serving the particular needs of organizations by which their expertise is commissioned (Collingridge, 1992). Moreover, the challenge of dogmatism is highlighted even more if there is a tendency for domination of the field and risk estimation by a handful of experts.[e] Altogether, such expert-based practices do not only lack in process ethics, but could fail to deliver a careful balance between equity and efficiency, failing to establish high quality processes of responsible innovation.

In Finland, such tight network of human actors is spread across public, semi-public, and private organizations. In addition, there has been an ongoing division and restructuring of organizations in the transport sector. The Ministry is still the organization responsible for political and strategic

[e] Kehoe problem refers to "the leading scientific authority on environmental lead in the 1930s, whose findings came to determine an erroneous threshold limit for safe exposure to lead," as stated in Genus and Stirling (2018).

guidelines and legislation. However, recent changes have resulted in three other organizations. First, the Finnish Transport and Communications Agency, as responsible for transport licenses, competences, supervision, and safety. Second, the Finnish Transport Infrastructure Agency responsible for planning, developing, and maintaining road, rail, and maritime transport infrastructure, and on the coordination of transport and land-use. Third, the Traffic Management Finland Group, a state-owned company with a special mission to focus on traffic control tasks for road traffic, rail traffic, and maritime routes. In addition, there are also regional Centers for Economic Development, Transport and the Environment, and various other regional or municipal organizations, in close interaction with private sector. In fact, the Finnish governance documents explicitly recommend cooperation and dialogue between automotive industry, and national, regional, and local road operators and authorities. Similar networked governance roles of experts are visible in both UK and Germany. The UK was the first to set up a specific government department, the Centre for Connected and Autonomous Vehicles, followed later on by Germany with national platform "Future of Mobility," where one out of six working groups is "Digitization, Automated Driving and New Mobility Concepts." In addition, in all three countries, it is evident that assumed roles needed for governance of SDVs are not just in transport or ICT sector, but also in the economic sector, such as Department for Business, Energy & Industrial Strategy in the UK. However, the UK governance network was noticeably more focused on including security experts, such as those from the Centre for the Protection of National Infrastructure and National Cybersecurity Centre.

## 5.3 Citizens

Following the concept of *citoyen*[f] from the European tradition of French revolution, it is important to highlight that such a conception of an individual cannot be found in the existing governance imaginaries. In fact, words such as customer, consumer or user are more often used than the word citizen. The relation to such imagined "customer" is establishing a mediating or subordinate relation over citoyens. Several documents focus on a need to steer behavior toward consistency and predictability, arguing for familiarizing users with the rules. In addition, such "customer" is only expected to ask

[f] Envisioned as a citizen highly active in exercising her civil rights, while sharing the values of liberté, égalité, and fraternité, contrasted to the narrow interpretation of citizen in contemporary nation states.

for more functional service, but not for such aspects as social justice, exemplified with a quote below, from "The impact of automated transport on the role, operations and costs of road operators and authorities in Finland":

> The customer most likely wants a vehicle that can manage a large part of the journey by itself so that the vehicle occupants can utilise the travel to other uses than driving.
>
> ***(FTCA, p. 124).***

Surprisingly, despite the societal value of equality and legacy of social democracy, Finnish approach emphasizes that public sector organizations have to "show the public that they are actively involved in the development," which is supposed to increase trust and willingness to use new technologies, minimizing time for uptake. The recommendations continue with even suggesting joint communication campaigns with the industrial partners. Similarly, even German ethics commission does not take a usual stance as with some previous emerging technologies of accounting for citoyens in the governance network (Burri, 2015). Although social movements have historically played an important role in shaping discourses of technological innovation in Germany, the hypothetical individual of the ethical guidelines still relies on intervention of the state for ensuring her own personal autonomy. Altogether, governance roles for citizens are not envisioned as the one of equal partner in steering technological futures, but only as an actor that can potentially resist new technology. Consequently, in the German governance culture, issues of legitimacy and trust have to be tackled through linear information exchange or digital education initiatives.

## 6. Discussion and conclusion

### 6.1 Summary discussion of findings

This chapter has analyzed the country-specific approaches to the governance of SDVs in Finland, Germany and the UK. In order to do so, policies for the automation of mobility have been reviewed in the light of the sociotechnical imaginaries and governance cultures. First, we compare assumed roles of SDV technology in three societies, second we relate governance efforts to representations of benefits and risks, and thirdly, we expose the assumed roles of responsible governance actors, including assumptions of state-society relations. The starting point for analysis is that sociotechnical imaginaries are simultaneously being enacted, constructed and reconstructed, each of which shape the form of political action. Returning to

Collingridge's dilemma for responsible innovation, we argue that the process of developing innovation governance is showing initial signs of reflection on unanticipated and undesired consequences, beyond the initial focal points, such as traffic safety and digital security.

The analysis of SDVs roles in all three countries highlights a strong relation to national economic growth, although with some differences in reasoning. While such economic growth for Finland might be a matter of long-term societal survival, UK and Germany are struggling to maintain a global image as leaders, while reconciling some additional values, such as security or environmental justice. Such aspects of national identity play a major role in shaping the assumptions about the role of SDV in the future. In understanding the governance relation to technological risks, all three countries focus on risk management approach, underlying that innovation requires both infrastructure and enabling regulation. In addition to the traditional transport governance domain of liability in case of accidents, all three countries are developing strategies for emerging domains of data and public experimentation. However, Germany has distinguished itself with the first set of ethical guidelines for SDV development, specifically including algorithms as the necessary domain of governance.

Despite this effort, no country recognizes the need for expanding the governance actant network to include citoyens as active entities in exercising their civil rights. On the contrary, the dominant framing of issues in relation to the constitution of expertise and the dissemination of knowledge leads to a re-stabilized notion of normativity through which technology is supposed to engage with other social institutions. The key findings that distinguish the three approaches are summarized in Table 4. Contrasting imaginaries do not mark rigid characteristics of the respective Finnish, UK or German political cultures. However, probing the tacit assumptions underlying governance documents through sociotechnical imaginaries has highlighted crucial aspects of SDV governance, discerning some distinct elements of how particular political cultures envision and respond to technological futures.

## 6.2 The treat of technological determinism for responsible innovation

Coming back to the initial point about fundamental governance rationales of efficiency, equity and ethics when faced with Collingridge's dilemma, the analysis points out an important set of questions for responsible innovation processes. The analysis points that expectations of benefits over risks are

**Table 4** Summary of key findings from Finland, Germany and the UK according to the key research questions.

| | Finland | UK | Germany |
|---|---|---|---|
| 1. Roles of SDV technology in society | • Finding a global market niche<br>• Digital society and knowledge economy agenda | • Industry resilience and competitiveness<br>• National security | • Automotive leadership role<br>• Climate action |
| 2. Domains and mechanisms of governance | • Extensive public experimentation<br>• Data utilization and transport services development<br>• AI and digital literacy | • Liability and insurance<br>• Public experimentation and business plans<br>• Cybersecurity<br>• Digital infrastructure | • Liability and ex post transparency<br>• Public-private collaboration<br>• Personal data privacy and algorithms<br>• Federal cohesion |
| 3. Governance actants in SDV development | • Artifacts decoupled from accountability<br>• Tight network for expert-based foresight and assessment<br>• Citizens as rule-following consumers | • Artifacts decoupled from accountability<br>• New research and government organizations beyond transport sector<br>• Citizens as resilient users | • Artifacts decoupled from accountability<br>• New research and government organizations beyond transport sector<br>• Citizens as subjects needing protection |

highly weighted, bringing about asymmetry between hopes in future applications, hiding dissonance and conflict over desired futures. Thus, at the core of governance challenge is the understanding that technology is not a neutral and default-positive actant, and that technological development is irreducibly a political and value-driven choice rather than an instrumental facilitation of what is an inevitable (automated) future. In more details, the analysis indicates a threat of three different types of technological determinism, namely justificatory, methodological, and normative—which could be leading to potential technological myopia and somnambulism (Winner, 2014). Each of these types of technological determinism brings about a challenge for transparency, accountability, and responsiveness mechanisms in technological governance processes.

The above-identified aspects of national identities play a major role in shaping the assumed role of SDV technology in society, potentially leading to a version of justificatory technological determinism and techno-optimism. Justificatory determinism argument focuses on the point that specific technological change is necessary to achieve unquestionable benefits (Wyatt, 2008). Here, framing SDV technology through the lens of international competition is an important aspect that could have at least two challenges for responsiveness. First, as already highlighted by Collingridge, competition can actually serve to restrict the number of alternatives. Instead of sharpening reflexivity, a particular version of technology can become intrinsically embedded in the imaginaries, with the focus being on minimizing time to deployment as opposed to exploring alternatives. Second, responsiveness can be inhibited by potential fear from diseconomies of scale, increasing the cost per unit due to capital intensiveness and dependence on large-scale infrastructure, if decisions are subsequently found to be mistaken. Similarly, the investment in digital infrastructural layers is considered as an important factor as a potential challenge for automation. Thus, due to inherent uncertainty about future costs while under potential threat for increased cost, decision-making might prefer low sunk costs associated with incremental improvements of existing technological infrastructures as opposed to more different technological alternatives.

The findings indicate that all three governance approaches have an underlying premise that risks are problems to be managed, without recognizing potentially unanticipated consequences (see also Taeihagh and Lim, 2019). With such an approach, there is a potential threat of a second version of techno-determinism—methodological, which renders technology opaque, simplified, and with transferred assumptions from earlier

technologies without questioning them (Wyatt, 2008). Such an example regarding SDV technology is transference of assumptions built into existing urban traffic control technology since the 19th century (Mladenovic et al., 2016). These unquestioned but transferred assumptions neglect the fact that technology is another actant in the web of responsibility, and not inanimate object, upon which human subjects act. The crucial stance here is not just in neglecting the "missing masses," as Latour named artifacts whose power is not accounted for in innovation processes (Latour, 1992). In fact, the crucial aspect is in consequent decoupling of technology from political accountability and intervention, which can be interpreted as a third category of technological determinism—normative (Wyatt, 2008).

From the findings, we can conclude that technological development is not based on the democratic enhancement of dialogue between state and society. Perhaps, an expectation might be that citoyens are lacking skills and knowledge to deliberate about advantages and disadvantages of this emerging technology. Thus, ideological zeitgeists of these three democratic societies in relation to SDV technology do not aspire to the very democratic ideals constituting their legal and moral foundations. Framing citizens as well-informed and willing consumers raises the question of potential loss of the notion of the commons in transport provision, if SDV development is largely intertwined with a commercialized overhaul of mobility markets. As previously identified by Lyons (2018) and Noy and Givoni (2018), there might also be a misunderstanding of relation between commercial and sustainability considerations related to technological development. In fact, European innovation processes could be overwhelmed by a large-scale commodification of the mobility commons, potentially erasing an important dividing line for moral limits of mobility markets. The resulting corruption of the nature of the transport good itself, and further transfer of existing monetary inequalities, as argued in general by Sandel (2012), could further push large groups of people to the position of subordinate dependents.

## 6.3 Further research and development needs

The use of technology studies concepts can help in opening new pathways for reconceptualizing SDV technology and associated governance processes. For example, reconceptualization of emerging automated mobility technologies will need to critically reflect on the ways SDV technology mediates human practices, experiences, and value frameworks (Mladenovic et al., 2019), or through heteromation, pointed out by Ekbia and Nardi (2017),

as capital accumulation from extracting value through low-cost or free human labor redistributed in computer-mediated networks. In addition, further research should pay closer attention to trajectories of technological imaginaries across cultures and various segments of society, as they transform through heterogeneous cultural perceptions, experiences and identities. A particular focus should be paid to histories of success and failure in technological innovation, and their influence on shaping national identities and emotional relations to technological artifacts. Further analysis of the Finnish governance trajectory, as a society with reduced social hierarchy, could be enlightening new conceptualizations for collaboration in technological innovation processes.

As already recognized by Collingridge, governance of technological innovation is fundamentally about "muddling through" in the context of incumbent powers and vested interests. Similarly, current SDV technological development processes are largely depoliticized. If they are to be repoliticised, issues of interorganizational learning practices will be more challenging. Further studies of policy design should pay attention to dissonances between governance perspectives on the national, supranational, and subnational level. In particular, future studies should pay more attention to patenting regulation and regulatory structures for establishing ownership models that could balance monopolistic technological development processes. Moreover, transport studies can learn from the ongoing discussion in the domain of AI regulation, where strong levels of quality control are encouraged through robust data-sharing agreements, access rights for different stakeholders, and audits (Cath et al., 2018; Johal and Urban, 2017; Kerber and Frank, 2017). Some aspects of data collection, storage, sharing, ownership, liability, and pricing related to SDVs have already been identified (Brown et al., 2018). In the European context, the starting point for developing potential responses is the existing General Data Protection Regulation (GDPR) law on data protection and privacy. Further development of innovation indicators and public access to those would help in avoiding "gold plating" certain technological alternatives through financial subsidies or taxation allowances, in line with Collingridge's approach of incrementalism being more appropriate for generating and preserving technological alternatives in order to avoid unanticipated consequences arising once path dependence is too firmly established.

Finally, there is an urgent need to develop experimentation processes used for different stages and by different responsible actors, while reformulating procedures for openly collaborative technological

development. In particular, it is necessary to have wider societal inclusion and empowerment of the missing "outsiders" (Van de Poel, 2000), as has already been identified before (Blyth et al., 2016; Cohen et al., 2018; Mladenović, 2019). More useful frameworks for enabling the practice of critical citizen engagement and participatory deliberation will be an essential component of such development (Flipse and Puylaert, 2018; Macnaghten and Chilvers, 2014; Mladenović, 2019; Mladenovic and McPherson, 2016). In developing such frameworks, we should not aim for creating artificial consensus over technological alternatives, but in exploring dissensus and perhaps inevitable conflict of societal values designed into SDV data structures and algorithms (Genus, 2006; Mladenović, 2019). In this strand of research, understanding how to reinforce accountabilities will inevitably lead to a larger question of how to govern by strengthening democracy itself. If these much-needed efforts are not taken seriously and technological development processes fail to reinforce accountability, we will potentially create conditions not just for loss of trust in technology or associated governing institutions, but also for legitimate moral preconditions for civil disobedience.

## Acknowledgments

This chapter is dedicated to the memory of Moshe Givoni, a very dear friend and colleague who helped to develop the initial idea for this chapter during his sabbatical at Aalto University. Sadly, Moshe passed away before the chapter was finalized. This research received partial support from WISE-ACT COST Action (No. 16222), the Academy of Finland, through PROFI 4 initiative, as well as through the FINEST Twins Centre of Excellence.

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