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The transport sector in transition –

different pathways of handling transport data in urban regions of Helsinki, London, Oslo and Singapore

Abstract

The fourth industrial revolution is disrupting almost every industry in every country and the transport sector is not an exception in this discussion, with increasing mobility demands and evolving mobility needs in consideration of global sustainability goals. In light of these technological changes and discussions, public authorities are on the path of transition and the role of public transport authorities is still unclear for themselves, for business or even for society at large. This issue extends to transport data policies as there is still a lack a general overview concerning what pathways different cities are working on and implementing. Therefore, this study, as a part of Swedish research programme Mistra SAMS, aims to provide an overview of policies and the management of data connected with the transport sector in four selected city regions: Helsinki, London, Oslo and Singapore. Three research questions have been examined: 1. How do different transport authorities in urban regions approach transport data and perceive the value of data? 2. What kind of action plan is being implemented to create the *public* value of transport data within the public authorities? 3. How is all of this reflected in collaboration with third parties? Institutional theory is used in the multi-case analysis to guide the collection of data through document analysis and semi-structured interviews and provides a framework for analysis and structuring of the findings. The findings showcased different approaches to data and overall themes in the institutional context in different regions, which included themes such as policies, administrative reforms, technology, interoperability, partnerships and transport data repository. The final discussion identifies two main development paths: technology-led development and other mobility concept-led development. All regions work actively with transport data management, although each builds their approach on different ideas and practices. The proactive role of the public sector in regulating and implementing new technologies is discussed for each of the urban regions. Partnerships between the public and private sectors are more developed in the urban regions with technology-led development. The study outlines key areas of future research, like the role of public authorities, the importance of public-private partnerships, questions related to the digitalization and interoperability.

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Keywords: transport authorities, transport data, approach to data, decision-making

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1 Introduction

1.1 Problem background

The world is changing at a faster pace than ever before and the fourth industrial revolution is disrupting almost every industry in every country. This results in massive unprecedented non-linear development (Forbes, 2018a) that affects the way we live, work, or even relate to the new technologies, such as autonomous vehicles, Internet of Things and artificial intelligence (Forbes, 2018a; Schwab, 2017; CNBC, 2019.) Moreover, it even blurs the lines between physical, digital and biological spheres (Schwab, 2016). The transport sector is not an exception in this discussion, with increasing mobility demands and evolving mobility needs, where public transport providers and mobility solution providers need to adapt to satisfy the users with increasingly convenient, fast and predictable services (Arthur D. Little & UITP, 2018) while still taking into consideration sustainability goals.

At the core of the technological changes steered by the fourth industrial revolution is data. Already in 1989, Castells (1989) discussed the significance of raw material (information) and processing of information. In the twenty-first century, the data received even more attention, with proposals that data is the new oil, a new gold or even new currency (The Economist, 2017; Deloitte, 2013; Forbes, 2018b; BBC, 2017; TechCrunch, 2018). The phrase ‘data is the new oil’ was coined in 2006 by Clive Humby, the British mathematician and architect of the Tesco Clubcard, a supermarket reward program (Bridle, 2018; Forbes 2018), and was quickly afterwards adapted and amplified by marketers, entrepreneurs, business leaders and policymakers (ibid.). Humby’s original concept highlighted the idea that data needs to be processed just like oil to make a valuable product (ibid.). However, lately this interpretation and the phrase ‘data is the new oil’ has been receiving more and more criticism (Forbes, 2018b; BBC, 2017; TechCrunch, 2018; Wired, 2019). The arguments build upon the fact that even though data is power, it is also inexhaustible and more comparable with sunlight than with oil (BBC, 2017); secondly, that its value comes from employed data and reuse of data rather than the raw information (Forbes, 2018; Techcrunch 2018), and thirdly, that data can be difficult to monetize (Wired, 2019).

In light of these technological changes and discussions, public authorities, and transport authorities in particular, are on the path of transition. They have been given new opportunities to grow and expand, but also new challenges to address (Arthur D. Little & UITP, 2018). Therefore, transport authorities in urban regions around the world relate differently to this transition and develop individual approaches to data, and more specifically transport data, handling and innovations, especially while facing crucial issues related to the availability of data and the data-sharing conditions between public and private sectors. Moreover, the role of public authorities is still unclear for themselves, for business or even society and the studies investigating these issues provide valuable input in future decision-making. This issue extends to transport data policies as there is still a lack a general overview of what pathways different cities are working on and implementing. Therefore, this study, as a part of Swedish research programme Mistra SAMS, in which possible action spaces for public actors are discussed and identified, provides an overview of the cities with similar contexts to Sweden, like Helsinki and Oslo, and also investigates cities that are known to be world leading in terms of transport data management, like London and Singapore.

1.2 Research aim

The main aim of this report is to provide an overview of policies and the management of data connected with the transport sector in four selected city regions: Helsinki, London, Oslo and Singapore. The research questions were formulated: ‘How do different transport authorities in urban regions approach transport

data and perceive the value of data? What kind of action plan is being implemented to create the public value of transport data within the public authorities? How is all of this reflected in collaboration with third parties?

1.3 Structure of the report

The research is divided into five sections. Section 2 focuses on the theory and methodology guiding the work and describes the main concept underpinning the research as a whole as well as provides validation of the selected cities. The section 3 Findings is the main part of the paper as the aim is to provide an overview of existing strategies and practices. Furthermore, the report finishes with a brief discussion section, where theory combines with the findings and provides a comparison of multiple cases investigated. Finally, suggestions for future research are presented in Section 5.

2 Theory, methodology and main concepts

2.1 Theory

As this report investigates an approach to the technology, or better said changes in the information and innovation related to the technology, it is important to understand that technological change can only be understood through the social structure in which it takes place (Castells, 1989) and the main outcome of innovation is the process of transformation rather than the product itself (ibid.). Thus, scaling down this discussion to the subject of this research – public authorities and their practices – the idea taken from Castells concerning the changes in the social structure is applied only on the institutional setting and perceived through the lens of institutional theory.

Institutional theory is an extensive field that has traditionally been used to understand and explain institutional and individual actions (Dacin et al. 2012; Scott 2008; Barley and Tolbert 1997). More specifically, according to March & Olson (quoted by Mukhtar-Landgren et al. 2016:10), institutions are perceived as collections of rules and practices that, in regard to the available resources, make actions possible. Scott (2008: 48) builds on these ideas and suggests that ‘institutions are comprised of regulations, normative and cultural-cognitive elements, that, together with associated activities and resources, provide stability and meaning to social life’. Moreover, Barley and Tolbert (1997:94) refer to the interplay of these institutional elements as ‘blueprints for organizing’ activities and resources.

The three institutional elements – regulative, normative and cultural-cognitive – are perceived as the pillars of institutions by Scott (2008). The regulative elements include legally sanctioned documents such as laws, rules, sanctions or ‘multi-level interactive forms of governance’, like national action plans, visions, scenarios, subsidies and similar (Mukhtar Landgren et al., 2016:11). The primary function of regulative elements is to provide institutional constraints and regularize behaviour. Normative elements refer to the morally governing dimensions, such as values and norms. Scott (2008:54-55) provides these definitions of values and norms: ‘Values are perceived as conceptions of the preferred or desired, together with the construction of standards to which existing structure or behaviour can be compared and assessed. Norms specify how things should be done; they define legitimate means to pursue valued ends.’ The normative elements translate into social obligations through the creation of binding expectations and help to determinate goals and objectives (Mukhtar-Landgren et al. 2016:12). They include such things as rights and responsibilities, privileges and duties, licenses, and mandates (ibid.). Finally, cultural-cognitive elements are perceived as ‘the shared conceptions that constitute the nature of social reality and the frames through which meaning is made’ (Scott 2008:57). They attach meaning to action and behaviour through the identification and self-image of the organizations, individuals, and corporate culture (Mukhtar-Landgren et al. 2016). They help to determine the order in which information is prioritized, encoded, sustained, organized into the memory and thereafter interpreted. Furthermore, these elements directly influence evaluations, judgments, predictions, and inferences (Scott 2008).

This is the guiding theoretical framework that includes the regulative, normative and cultural-cognitive elements of institutions. However, instead of keeping the strict distinction between the three, it has been recognized as more applicable to divide them into two broad categories: a formal dimension, which includes regulative elements, and an informal dimension, which examines normative and cultural-cognitive elements. When discussing the formal and informal dimensions, Mukhtar- Landgren et al. (2016:11) state, and I agree, that: ‘To make a distinction between the formal and the informal is already challenging, and to further distinguish different informal features (i.e. norms, beliefs, values, culture etc.) can be baffling’. The suggested modification into two categories therefore decreases the complexity of the processing and structuring of collected data, thus maintaining the required depth of the analysis.

2.2 Methodology

The performed qualitative research is structured in a way that combines the collection of the data, analysis and structuring of the findings and finally, describing, comparing and exploring four cases in the multi-case analysis. The first step in the research was to hand-pick urban regions for research, with selection based only on their practices and approach to transport data. The subsequent collection of data combined document analysis and semi-structured interviews. This collected data was processed using content analysis with the guiding dimensions and themes from institutional theory and then combined into categories to explore similarities and differences within the multi-case analysis.

2.2.1 Selection of the cities

The investigation is based on four cases representing varying approaches and practices for transport data management and sharing around the world. Open government data is not a new practice and transport data was always part of it, though more strategic and planned sharing of data could be considered as a new ongoing process. Therefore, it is important to make a distinction that this report focuses only on this second phase of data sharing which is initiated with the agenda and should result in creating public value. The general overview of the city cases is presented below.

- Helsinki

When it comes to sharing of transport data, Finland is attracting a lot of attention due to new reforms that are restructuring the public transport sector and empowering Mobility as a Service (MaaS). One of the key documents in this process is the Act on Transport Services that entered into force in July 2018 under which all transport operators both public and private have to share their data in an open application programming interface (API) (LVM, 2018a). The key objective of the legislation is the provision of customer-oriented transport services, which is intended to enable the development and implementation of MaaS (LVM, 2018b). The Helsinki Regional Transport Authority, which includes the municipalities of Helsinki, Espoo, Vantaa, Kauniainen, Kerava, Kirkkonummi, Sipoo, Siuntio and Tuusula and has been operating since 2010, is right now in the midst of this transition prompted by the Act on Transport Services. This makes the Helsinki region an interesting case for investigation and comparison.

- London

The London urban region that represents Greater London was selected since it is considered to be a leader in the field of transport data sharing (Information Age, 2016). The history of transport data sharing in Transport for London (TfL) started in 2007 when they displayed embeddable widgets on their website to share information about their services, and continued in 2007-2011 with the introduction of an area for developers on TfL's website that provided real-time data about transit (ODI, 2018b). A breakthrough in the process came during the 2012 Olympic Games when TfL released live bus arrivals data, which led to successful apps only for bus transport. In 2014 the decision was made to develop TfL's unified API (in common format XML and JSON) and open it up for external use (ibid.). Transport data sharing is now in 2019 an integrated part of Transport for London.

- Oslo

Norway has also opened transport APIs and established a national access point for transport data – Entur. Entur is a state-owned company accountable to the Norwegian Ministry of Transport and Communications and was established in 2016 as part of the railway reform to improve the existing offering for customers and create a national access point for transport data. As a national register for all public transport data from 60 public transportation operators, the repository contains 21,000 daily departures on 3,000 routes that are open to use for developers (Entur, 2019). Based on the data in the national repository, Entur provides a public transport journey planner under the same name, Entur (ibid.), which is presented as an attempt to create publicly owned Mobility as a Service. All these changes address the development of the Oslo region and enable it with new data.

- Singapore

Singapore is known for being an innovation-driven urban region/country and the overall strategy of the Singapore city-state is to be a Smart Nation. In practice, the Smart Nation plan aims to encourage: ‘innovation and collaboration between citizens and companies in order to improve growth and the lives of people’ (ITU News, 2018). Moreover, due to its geographical limitation as an island city-state with a limited land area of 700 sq. kilometres (Asian info, 2019) and a population of 8.9 million that is estimated to increase to 14.3 million by 2020 (LTA, 2019a), the public transport authorities have the complex task of estimating the population and traffic growth in the future to ensure accessibility and mobility for all inhabitants. The government agenda is thus to create a people-centred land transport system with the main topics of safety, accessibility and service standard. (ibid.) They have a transport data repository and are actively working with publishing real-time traffic data for the industry to use (LTA, 2019b). This makes Singapore a compelling case to investigate and understand how this Smart Nation plan comes into discussions regarding transport data planning.

2.2.2 Data collection

Institutional theory suggests that valuable information about the research problem is divided between written sources such as documents, policies and strategies, but also embedded within the behaviour, moral beliefs and overall worldview of individuals working in the discussed agencies. In this study, document analysis is used to understand the formal dimension of the institutions that urban regions have legislated and are using in decision-making while working with transport data. According to Boven (2009:27), document analysis is explained as ‘a systematic procedure for reviewing or evaluating documents – both printed and electronic (computer-based and Internet-transmitted) material’ that requires thorough investigation and interpretation of sources to retrieve meaning, build new understanding and generate empirical knowledge (ibid.; see also Corbin & Strauss, 2008). In regard to the scope of the project, a minimum of three policies/strategies representing both national and regional levels were investigated per selected urban region and in the primary stage of investigation more than twenty official documents (see document list, Appendix 1) were analysed that were produced by or for the public transport authorities. However, the list of investigated documents ended up being much longer as supporting policies and reports were also incorporated during further research.

While performing the research, it soon became clear that existing conditions and practices for handling transport data were only partly reflected in the policy documents. Therefore, semi-structured interviews were performed to create a more holistic view of the research problem and these helped to fill in the gaps in the informal dimension of institutions. The semi-structured interviews made it possible to understand the problem from a new perspective and, as Brinkmann and Kvale (2015:150) suggest, ‘to obtain descriptions of the lifeworld of the interviewee with respect to interpreting the meaning of described phenomena’. The selection of the interviewees and the discussions were crucial parts of the research as they needed to represent multiple levels of governmental institutions, such as national and regional. The questions for the interviews were prepared after the primary document analysis was performed, which provided an overview of the existing situation and in combination with the theory guided the development of suitable questions. These questions were modified for each interview to fit the existing situation and the interviewee’s competence field. In the end, five interviews were conducted with representatives from Helsinki, London and Oslo. Unfortunately all the attempts to arrange interviews with representatives from Singapore were unsuccessful, although extended written data provided qualitative insights about transport data management in Singapore, which allowed this case to be included in the research nevertheless. The interviewees were as follows:

A representative from Helsinki Region Transport (HSL) in Finland → Int. 1

A representative from the Ministry of Transport and Communications in Finland → Int. 2

A representative from the Department for Transport (DfT) in the United Kingdom → Int. 3

A representative from Transport for London (TfL) in the United Kingdom → Int. 4

A representative from Entur AS in Norway → Int. 5 Norway.

2.2.3 Data analysis and structuring of the findings

All collected data from interviews as well as from document analysis were analysed using conventional content analysis and then identified categories and themes were processed with guidance from the theory into the multiple case study. Starting with the conventional content analysis, it is the qualitative research method that is used when theory and literature are limited and through the analysis of data, the categories and subcategories emerge (Hsieh & Shannon, 2005). The main aim of the method is to generate knowledge about the studied problems by utilizing participants' perspectives and ground this knowledge in the actual collected data (ibid.). The conventional content analysis was performed with an iterative approach, which means that after each interview the whole set of collected data from both interviews and document analysis was investigated through a reflexive process to extract new themes and categories that would be incorporated into upcoming interviews. This approach also involves an overview of the datasets from document analysis to make sure no valuable information is left behind. When the final categories and themes were defined based on the analysis of collected data, the findings section was written with a focus on each case separately with themes relevant to that specific urban region and only two themes are included in all cases: the approach to data and data repository¹. Both of these represented important parts of the project and allowed structuring around each case. Finally, in the discussion, the findings connect with theory and build upon the formal and informal dimensions to represent the regulatory side of the problem (what policies and strategies suggest) and, on the other hand, a more cultural and normative approach (how the problem is approached in real life). With the help of theory, the comparison of multiple case study was performed and differences in the urban region presented.

2.3 Main Concepts

The report utilizes the concept of transport data, data infrastructure and transport data infrastructure, though due to the lack of well-established definitions these need to be explained and selected versions validated.

2.3.1 Transport data

In this paper, the term 'transport data' is used in the wider sense and could be defined as all information and data related to transport and the management of its services. According to a report by Transport Systems Catapult (2015:5) transport-related data in the UK can be structured around nine main themes: 'Place & Space, Environment, People, Things & Movement, Disruption and event-related data, Public Transport Services, Personal Automobility, Freight connections, International Connections, and Consumption & transaction data'. Some examples of these themes when discussed as datasets can be map data, personal data, asset data, network disruptions, public transport schedule, vehicle location data, third-party service usage data, payment data and so on (ibid.) This understanding widens the traditional view of the data used in the transport sector by including both static and dynamic information as well as real-time data and statistics, and simultaneously provides a structural framework to approach the

¹ Repository - (in computing): 'A central location in which data is stored and managed.' (Source: <https://en.oxforddictionaries.com/definition/repository>)

complex and changing reality of the transport sector. However, it is important to point out that in this report, the term ‘transport data’ is used to describe both the entire set of information as presented there as well as fragmented parts of it, when the term is used to describe only some part of the whole. This is especially apparent during the interviews and interviews analysis. Moreover, in some parts of the research, transport data was discussed and included in the concept of open government data, which represent the data produced and commissioned by public bodies and then opened for the public to use freely by promoting transparency, accountability and value creation (OECD, 2019).

2.3.2 Data infrastructure

The concept of data infrastructure is gaining more and more interest due to increased awareness about data’s tradability and value within the global market (Oliveira and Loscio 2018). Docherty et al. (2018: 121) proposed that ‘In the smart future, data is the knowledge upon which the power to control the marketplace is built’. Moreover, the Open Data Institute (ODI 2019) moves even further and suggests that data infrastructure should be treated with the same significance as road, railway or energy networks and the understanding of it should include ideas, basic research and even the Internet (ODI, 2018). In practice, ODI’s suggestion would mean that data infrastructure would receive the same attention and valuation as other physical infrastructure. Moving forward, data infrastructure could be explained as the combination of three parts: the data assets, actors operating and maintaining data processes, and policies and guidelines that regulate the use and management of data (ODI, 2019; Open Data Charter 2019). Though some might argue that the fourth part – physical infrastructure – is missing in this description and Network World by IDG (2017) fills in this gap by proposing to define data infrastructure as a collection of hardware and software that expands from physical to software-defined virtual containers, cloud. However, even if defined differently, the overall idea of data infrastructure is to create a system that steers the efficiency and growth of the organizations involved (ODI, 2019).

2.3.3 Transport data infrastructure

The concept of transport data infrastructure represents the next step that combines transport data and data infrastructure in a cohesive unit. In recent years, the availability and variation of transport data increased, which ODI (2018:8) describes as ‘the sector shifts from data-poor to data-rich’. What is also apparent is the augmented importance of data for the physical infrastructure as it stimulates every aspect of economies and impacts the society (ibid.). In the discussion about the transport sector, the term ‘transport data infrastructure’ is already being mentioned in a number of articles, discussions and even tweets, although there is as yet no entrenched definition of it. As an example of transport data infrastructure, Transport for London’s activities were acknowledged by ODI (2018c) for transport agency efforts to introduce unified APIs and create value for public and private sectors. This report has no intention to introduce a definition of the term but instead uses it to describe the entire system that is involved in working with transport data within public transport authorities. The term has different meanings in the researched regions, as not all represented urban regions have already made a distinction concerning what transport data infrastructure means for them.

3 Findings

The following part of the report provides an overview of the four investigated cases. The structure for representing findings emerged from the different categories identified during the content analysis. As all cases have their own specific features and approach to data, themes vary depending on the case, though for creating some cohesion the first theme in all the cases is approach to data and the last one is transport data repository. This decision was made to not generalize and unify all other themes as this would result in losing relevant information and in inaccuracy of the findings. This approach also enabled showcasing the different perspectives of the urban regions and then validating them through exact actions taken according to the regulations and strategies. As in the previous section, urban regions are presented in alphabetical order: Helsinki, London, Oslo and, finally, Singapore.

3.1 Helsinki

3.1.1 Approach to data

The Helsinki region, as all of Finland, is on the path towards digitalization. According to the Corporate Sector Strategy 2016-2020 of the Ministry of Transport and Communications in Finland, 'Digitalisation is revitalizing practices, improving productivity and increasing growth' (LVM, 2016:3). The data policies are a significant part of this discussion. More precisely, in the transport sector, digitalization is a part of the strategic move to reform transport regulation into a single law – the travel chain (ibid.). This travel chain represents the whole seamless user journey from door to door that can be paid for using one mobile system that integrates all transport modes (Ertigo ITS Eupore, 2017; VR Group, 2016). Transport data is thus perceived as an enabling element for improving the transport sector and as a base for new services and Mobility as a Service (Int. 1) that are proposed to support the use of travel chains (HSL, 2015). On the other hand, transport data is also viewed in the 'bigger picture' of technological developments in the transport sector, which are believed will make it possible in the future to connect together mobility services, autonomous transport, transport infrastructure, traffic and fleet management into one holistic system that will promote bigger policy goals, like transport efficiency, safety, environmental and climate goals (Int. 1).

Therefore, the Finnish approach to transport data has a strong agenda of perceiving data as *an enabling element* in the creation of new transport services. In the Corporate Sector Strategy 2016-2020 (LVM, 2016:13), digital information is described as 'a source of prosperity and growth'. As an officer at the Finnish Ministry of Transport and Communications explains: 'Our goal is that data can be used in a responsible way and in a way that helps the market's actors to provide new and better services to customers' (Int. 1). The new mobility services/MaaS require the provision of data and data rules are perceived as a tool to facilitate this necessary flow of data and therefore 'the data rules are not in themselves a goal to us, but just a tool' (ibid.). Moreover, data is viewed as *a factor shaping the market* and something which facilitates the creation of new services. However, when discussing data ownership, the officer at the Finnish Ministry of Transport and Communications (ibid.) suggests: 'We do not like the term data ownership, because you can't own data as you would own another object'. The arguments to this approach are that from a legal point of view, data as a product can be copied in marginal cost and it does not reduce its value when used. The focus is therefore not on the ownership of data, but rather on the right to access and reuse data (ibid.).

Finally, when this agenda from the national regulative level reaches the regional public transport authorities, in this case, Helsinki Regional Transport Authority (HSL), it has a dual mission. Firstly, the internal data strategy in HSL requests using transport data in all the processes while decision-making; the

main focus at this time is on the customer data (Int. 2 Finland). The officer at HSL (ibid.) explains: ‘we would like to get an overview of how the larger pattern of trips of one customer are formed; [...] we would like to get the whole chain of trips for ourselves’. The second strategy of HSL is to provide all open transport data for the creation of new services for their customers that would enhance the passengers’ experiences. An important part of this data strategy is a ticket sale API that will provide possibilities for third parties to sell their tickets through their channels (ibid.). Both of these strategies reflect the mission described in the Corporate Sector Strategy 2016-2020 with the ideas of travel chains and MaaS.

3.1.2 Act on Transport Services

The Act on Transport Services entered into force on the 1st of July 2018 and marks a fundamental change in the way the Finnish government addresses the future transport system. The main stated aims of the legislative reform are to improve transport services and increase freedom of choice for the users in the transport market (Finnish Government, 2018a). It brings together all legislation regarding the traffic/transport market, creates the preconditions for digitalization of transport and new business models, and promotes more efficient use of data (LVM, 2017a). The officer at the Ministry of Transport and Communications explains: ‘We do not want to burden the market actors with new rules. [...]; we want new opportunities for the transport sector’ (Int. 1). However, globally the Act on Transport Services is highly praised as ground-breaking legislation for supporting the creation of Mobility as a Service (MaaS Alliance, 2019).

The Act on Transport Services is implemented in three stages. The first entered into force on the 1st of July 2018 and focused on the provision of road transport; the second stage combines the air, maritime and rail transport markets and focuses on the qualifications of transport personnel and opening of the data (LVM, 2017a) and as Minister of Transport and Communications Anne Berner highlighted: ‘The opening of data is central in this change and is emphasized in the second stage of the Act’ (Finnish Government, 2017). The third and final phase is proposed to streamline transport sector qualification training and promote transport digitalization and preparedness. This phase entered into force on the 1st of April 2019 (Finnish Government, 2019). To have a control over possible effects, the Parliament has insisted that the Finnish Government closely monitor the effects of the legislative reform and act actively to change or amend the regulation if needed (Finnish Government, 2018b). The first follow-up report of the first stage of the Act on Transport Services was submitted on 10 December 2018 and, in the press release it was explained that according to the report and observation, the preliminary legislation’s effects largely met the expectations (ibid.). However, no specific details were provided to validate this statement.

The Act on Transport Services is composed of five parts that include a wide range of topics, though in this paper only the key selected legislative changes concerning transport data and the problem are presented below. One of the most significant regulations in the document concerns *the obligation to provide information*. According to the Act on Transport Services, all passenger transport services providers, both public and private, have an obligation to provide information in an electronic format that would fulfil the request of interoperability² of data and information systems (LVM, 2017b). The officer in the Finnish Ministry of Transport and Communications explains: ‘The requirements to open data are symmetrical for

² ‘Interoperability is the property that allows for the unrestricted sharing of resources between different systems. This can refer to the ability to share data between different components or machines, both via software and hardware, or it can be defined as the exchange of information and resources between different computers through local area networks (LANs) or wide area networks (WANs). Broadly speaking, interoperability is the ability of two or more components or systems to exchange information and to use the information that has been exchanged.’ (Technopedia, 2019)

both publicly owned transport companies and privately-owned transport companies' (Int. 1). The minimum essential data, like routes, stops, timetables, prices, availability and accessibility, should be up to date and freely available from an information system (open interface) in a standard, easy-to-edit, and computer-readable format (LVM, 2017b). What is more, the general requirements for the opening of interfaces such as 'support services, terms and conditions of use, software, licences and other services that may be required to access them shall be offered on fair, reasonable and non-discriminatory terms' (ibid., 13). Part 2 section 2 'Interoperability of ticket and payment systems' is especially important in the implementation of MaaS services. The section requires that all road and rail passenger transport service providers would give mobility service providers and providers of integrated mobility services access to the ticket sales API and payment system, which would make third-party sales available (ibid.). Finally, the activities of public authorities were reconsidered also in regard to the Act on Transport Services. The Finnish Transport Safety Agency took over a general supervisory authority role over the compliance with this legislation, while the Finnish Transport Agency 'shall monitor the demand for and supply of mobility services and coordinate their development' (ibid. 20).

3.1.3 Administrative reform

The Finnish transport sector is undergoing the transition to this new administrative model embedded in digitalization, travel chains and MaaS and the organizations within public authorities are reforming simultaneously. From 2016 to 2018, the focus was on the legislative and regulative changes that redefined the agencies and their responsibilities based on the three pillars: network, information and services (LVM, 2016).

The starting point is the transformation in the Ministry of Transport and Communications. Three years ago (about 2016), the previous structure of having different organizations for communication policy and separately for transport policy was reformed and now consists of unified departments: data department, service department, network department and steering department (Int. 1). The reasoning for the reform is the changing nature of transport and communication that becomes more and more intertwined with technologies like connected and autonomous transport (ibid.). This was followed by a restructuring of the transport agencies that was symmetrical to the changes in the Ministry of Transport and Communications.

The transport administration reforms took effect on 1 January 2019 and two new agencies – the Finnish Transport Infrastructure Agency (in Finnish: Väylä) and the Finnish Transport and Communication Agency (Traficom) – replaced the old ones. The Finnish Transport Infrastructure Agency, earlier known as Finnish Transport Agency, focuses on planning, developing and maintaining the network of roads, railways and waterways; coordinating transport and land use; and organizing traffic control and winter navigation (Väylä, 2019). Traficom, on the other hand, is an entirely new agency that merged the Finnish Transport Safety Agency, the Finnish Communications Regulatory Authority and certain functions of the Finnish Transport Agency into one administrative unit (Traficom, 2019). The main responsibilities include transport licences, qualifications, supervision, and safety (ibid.).

3.1.4 Helsinki Regional Transport Authority

All the changes and policies discussed in this part about the Helsinki region have been initiated and led by the national governmental authorities in a regulatory and legislative role. However, an important question to ask is how the regional public authorities relate to these new regulations and strategies when they are the ones that need to introduce them within daily routines?

One of the daily responsibilities for the Helsinki Regional Transport Authority is to collect and analyse transport data. The transport modes in the region are managed (like routes, schedules) through the custom-made program that has been in use for about 20 years (Int. 2). The program provides HSL with different APIs to their system, for example the route planner in GTFS data format. However, some modes of transport, like long-distance rail transport, operate on their own systems and just provide input for the HSL, which is uploaded to the system (ibid.). The officer at HSL explains there have not been many changes in the transport data in the region for about 10 years and the information they didn't have themselves they bought from the private sector, such as data about traffic congestion from TomTom (ibid.). The officer in HSL (ibid.) clarifies that this was only a minor amount of data in comparison with data they have themselves. However, according to the Helsinki Region land use, housing and transport MAL 2019 (HSL, 2018), the new actions will be utilized to enable data collection through the inventory of existing data resources and identification of new opportunities, like parking garages, speed cameras, and positioning of public transport vehicles.

3.1.5 Data standard and interoperability

As important as the Finnish approach to data is as an enabling element for the creation of new services, the requirements for interoperability and data standards are simultaneously considered crucial in the digitalization of the transport sector. When it comes to interoperability, a whole chapter in the Act on Transport services is dedicated to 'interoperability of data and information systems', where topics like essential data requirements that connect closely to technical operability, operability of ticket and payment systems, promotion of interoperability in public procurement, and interoperability of services that link services and interfaces are regulated and legislated (LVM, 2017b). The interviewed officer at the Finnish Ministry of Transport and Communications confirms that one of the key goals with new data policies is to improve interoperability in the transport system (Int. 1). As the officer explains, the availability of data is not enough, it should be possible to move the data between different service providers, especially in relation to the ticket sale data: 'interoperability would allow the sell tickets to other customers as a part of their services offering and this way these custom-made mobility chains are possible, and the system is easily scalable' (ibid.).

The data standard is closely related to the interoperability, though touches upon a different side of handling data. As the officer at HSL explains, there are different transport data formats in use in Finland and currently there is 'pressure' for all the stakeholders and cities to use the GTFS³ format (Int. 2). However, the officer at HSL continues that this data format is quite complicated to work with when combining different variants in one line and due to this, they experience problems in the processes (ibid.). Moreover, according to the data exchange protocol existing at an EU level, the required standard from 2017 for the member countries is in NetEx format (EU, 2017). Authorities in Finland are thus working to introduce a common GTFS data standard; however, it is not in line with the EU regulations.

3.1.6 Transport Data Repository

In the discussion of Finnish Transport data repository or, better said, open transport data, four publicly owned web portals need to be presented: FiNAP, Digitraffic, digitransit, and HSL Open MaaS Developer Portal.

³ 'The General Transit Feed Specification (GTFS), also known as *GTFS static* or *static transit* to differentiate it from the GTFS real-time extension, defines a common format for public transportation schedules and associated geographic information. GTFS 'feeds' let public transit agencies publish their transit data and developers write applications that consume that data in an interoperable way' (Google developers, 2016).

Firstly, the Act on Transport Services obliges all transport service providers to open their data and submit essential information on their services via digital machine-readable interfaces in the national access point (NAP) located at <https://finap.fi/#/>. According to information in the Finnish NAP (FiNAP, 2019), the definition of transport services includes a wide range of passenger transport services (road, sea and air), but also information about stations, vehicle-for-hire services and commercial shared mobility services or even parking services. The FiNAP web portal is designed to allow transport service providers and developers to access transport service information and interfaces. This information is considered open government data, which means no registration is required to access NAP information and it is licensed under Creative Commons (Attribution 4.0 International (CC BY 4.0))⁴, which is one of the licenses suggested by the European Commission legislation in regard to public sector information (EU, 2014). The web portal is managed by Traficom.

Another web portal significant in the discussion of open transport data in Finland is Digitraffic (<https://www.digitraffic.fi/en/>). The main function of the web portal is to provide real-time traffic information about road, rail and marine traffic in open APIs (Digitraffic, 2019). The data accessible via Digitraffic is a collection of datasets from the Traffic Management Finland, the Finnish Transport Infrastructure Agency and the Finnish Transport and Communication Agency Traficom (ibid.). The provided data is categorized as road traffic, railway traffic, marine traffic and experimental, which at the time of investigation contained one source: bridge vibrations. Digitraffic started in 2002 as a joint project to improve services for traffic telematics between VTT Technical Research Centre of Finland and Helsinki University of Technology (now Aalto University) and after the research stage, it was administered by different government authorities. Then, from 2014 to 2018 it was the responsibility of the Finnish Transport Agency and during this period Digitraffic developed into fully open real-time data deployed in a cloud service and expanding to cover information from the rail and marine transport. Currently, Digitraffic is operated by Traffic Management Finland, a state-owned company with the task to ‘provide and develop traffic control and management services in all traffic forms as well as ensure safe and smooth traffic in a responsible manner’ (TMFG, 2019). As with FiNAP, the Digitraffic web portal does not require registration and is licensed under Creative Commons (Attribution 4.0 International (CC BY 4.0)).

Finally, two other web portals more specific to the Helsinki region should be mentioned: Digitransit and HSL Open MaaS Developer Portal. Digitransit (accessible at <https://digitransit.fi/en/developers/>) is presented as ‘an open source journey planning solution’ that provides and combines open source components to achieve a route planning service (Digitransit, 2019). The web portal includes both route-planning algorithms and transport data APIs and also provides digital tools for creating a mobile-friendly user interface, map tile serving, geocoding, and various conversion tools (ibid.). Digitransit uses two licenses: Creative Commons for general information and Open Database License for the journey planner’s data geometry, and address data is all extracted from OpenStreetMap (HSL, 2019). The HSL Open MaaS Developer Portal (available at <https://sales-api.hsl.fi/>), on the other hand, has the main function of providing ‘an open-for-all ticket sales interface for acquiring HSL mobile tickets’ (HSL Open MaaS Developer Portal, 2019). The user of this web portal is obliged to register and sign a contract with HSL for using HSL OpenMaaS API access for the ticket sale (ibid.). Both web portals are managed by HSL.

3.1.7 Overview

Approach to data is connected with the digitalization and transformation of transport regulations into single law – travel chains. Data is perceived as an enabling element for improving the transport sector and

⁴ More information about Creative Commons: <https://creativecommons.org/licenses/by/4.0/>.

as a base for new mobility services and MaaS. Focus is on the use of the data and not the ownership of it. From the HSL position, there is a dual mission: focus on the customer data for internal activities and opening ticket APIs for third-party sales.

The transport sector is experiencing transformation on both the regulatory level, like the Act on Transport Services, and also on the administrative level, with a restructuring of organizations due in part to the mentioned legislation. The Act on Transport Services proposes to improve transport services and increase freedom of choice for the users in the transport market. The legislation is globally discussed for its ground-breaking approach to enable MaaS. One of the most significant regulations in the document is *the obligation to provide information*: all passenger transport services providers, both public and private, have an obligation to provide information in an electronic format. The minimum essential data, like routes, stops, timetables, prices, availability and accessibility, should be up to date and freely available from an information system (open interface). Moreover, regulations require all road and rail passenger transport service providers to give mobility service providers and providers of integrated mobility services access to the ticket sales API and payment system, which would make third-party sales available.

The administrative reforms in transport agencies reflect the previously performed restructuring in the Ministry of Transport and Communications, when changes are based on the ideas of three pillars: network, information and services. Moreover, these administrative changes also directly correlate with new responsibilities presented in the Act on Transport Services. Two new agencies – the Finnish Transport Infrastructure Agency (in Finnish: Väylä) and The Finnish Transport and Communication Agency (Traficom) – were formed on 1 January 2019 to replace the previous agencies.

All the changes and policies discussed in this section about the Helsinki region have been initiated and led by the national governmental authorities in a regulatory and legislative role.

Interoperability is showcased as an important topic in data policies in Finland as it helps to achieve governmental goals, such as the ability to easily move data between different service providers, especially in relation to the ticket sale data, and to make the system easily scalable.

The desired national transport data standard – GTFS.

Open transport data can be found on different websites:

National access point <https://finap.fi/#/>

Open Transport data in Finland <https://www.digitraffic.fi/en/>

HSL 'an open source journey planning solution' <https://digitransit.fi/en/developers/>

HSL Open MaaS Developer Portal <https://sales-api.hsl.fi/>

The first three websites are open to use with a Creative Commons licence while HSL Open MaaS Developer Portal requires contract with HSL to use their data.

3.2 London

3.2.1 Approach to data

In the United Kingdom, transport data is viewed through the complex lens of opportunities and threats. The transport data and utilization of it is widely discussed in a number of national and regional policies and strategies, as for example: the Department for Transport (DfT) Single department plan (DfT, 2018a), Transport Investment Strategy 2017 (DfT, 2017), Industrial Strategy (HM Government, 2017), Mayor's transport strategy 2018 (Mayor of London, 2018) and even the TfL business plan (TfL, 2019a). The main point made in the written documents builds on the role of data as a factor of impact across the transport sector for infrastructure providers and equipment manufacturers (DfT, 2016), and in this approach open data is already identified as 'a key governmental priority' (DfT, 2018b:6) and 'as a key enabler for the government's digital transport strategy' (ibid.:9). Free and open transport datasets are discussed as an element empowering the new and innovative products and challenging traditional thinking about solutions to solve transport challenges (Mayor of London, 2015). In this context, the governmental role is to respond actively to the opportunities and challenges associated with this technological development (ibid.).

On the other hand, the officer at DfT expresses hesitance when people praise data as a new oil or gold and questions ideas about data as an asset, as new oil or new old and even raises question: 'is it [data] really an asset for example?' (Int. 3). The argumentation regarding these questions comes from the understanding that a dataset is useless until it is used and shared (ibid.). Moreover, the officer at DfT explains that data does not create value for those who produce it, but it does create benefits for the developers and as there is no market for data sharing and it cannot be traded, there are no incentives to do so. (ibid.). Lauren Sager Weinstein, the chief data officer in Transport for London, shares similar ideas in regard to the value of data, though she explains: 'just holding lots of data isn't enough. To get value from it, we have to turn it into useful information for our customers and into tools to plan and run our services' (Womanthology, 2018.).

The UK still does not have a national data strategy as it is under development and will be formulated only in coming years. The main questions that this upcoming strategy will clarify are, according to the officer at DfT in the UK: 'how we use data internally, but also how we want data to be used and shared within the wider transport industry' (Int. 3). The officer at DfT continues that the UK is taking a long look at how extensive changes like this can vary from embracing market-led approaches without governmental intervention or, on the other hand, the introduction of new regulation (ibid.). The only thing that is clear in this process of creating strategies responsible for data and new technologies according to the officer at DfT is that: 'We want to be inclusive that we do not get excluded' (ibid.). Therefore, governmental organizations are looking into other countries, like Finland, and other sectors, like finance, for comparison and possible synergies (ibid.).

3.2.2 Strategic ambitions

The UK has high ambitions to lead the world in the fourth industrial revolution⁵, according to UK Prime Minister Theresa May (HM Government, 2018). This aim is to be achieved through the Industrial Strategy (HM Government, 2017) that raises four 'grand challenges' to put the country at the forefront of the industries of the future: Artificial Intelligence (AI) and Data economy, Future of Mobility, Clean Growth, and Ageing Society. The government's approach to achieving its goals is through a partnership with

⁵In the Industrial Strategy (HM Government, 2017:32), the fourth industrial revolution is described as 'a fusion of technologies that is blurring the lines between the physical, digital and biological worlds'.

businesses, academic institutions and society: ‘governments cannot do this on their own, instructing and planning but never listening or consulting’ (ibid.:22) In regard to the scope of this report, the most important part of the strategy is the Future of Mobility, which is meant to contribute to the UK becoming ‘a world leader in shaping the future of mobility’ (ibid.). To stimulate the grand challenge, the government identified four early priorities that deal with (1) the flexible regulatory framework, (2) moving from hydrocarbon to zero-emission vehicles, (3) preparedness for the new mobility services, and (4) exploration of data for creating new mobility services and making operations more efficient. The first priority builds on the ideas of the regulatory review of all relevant documents, which should allow the UK to continue being ‘one of the most open environments in the world for transport innovation and new services’ (ibid.:50). The second is not very relevant for the scope of this paper, and we will thus move to the third priority, which addresses preparedness for the new mobility services that require autonomy and a blurring of differences between what is perceived as private and public transport. All of this will be described in the Future of Urban Mobility Strategy that is currently being prepared (ibid.). Finally, the fourth priority explores the new ways of working with data through investment in research and development and testbeds (ibid.) However, it is important to clarify that even though all these priorities touch upon transport data and new mobility services, the main focus in the challenges is on connected and autonomous vehicles, which connect with one of the missions for the country to become a global leader in designing and manufacturing zero-emission vehicles (ibid.).

In the light of the national ambitions, the Mayor’s Transport Strategy (Mayor of London, 2018a) builds on the approach of healthy streets, where TfL has the responsibility to deliver this strategy. The aim is to achieve high-quality transport services that suppose to ‘connect seamlessly to other forms of active, efficient and sustainable travel’ (ibid.: 14). This strategy will not be discussed, apart from a few interesting parts that are relevant to the paper presented. One of the things that becomes clear while reading the Mayor’s Transport Strategy is the focus on data-led decision-making in infrastructural planning, like improving cycling conditions by utilizing strategic cycling analysis or establishing and monitoring baselines of ecological data to follow changes in biodiversity (ibid.). Moreover, the use of data to improve citizen experience is discussed in several parts of the strategy in light of walking, biking or using public transport. Thus, transport data utilization is extended from public transport to walking and biking and should be accessible through online journey planning and navigation tools, but it should also improve communication of the traffic situation via multiple customer channels with the help of real-time data, information and visualizations (ibid.). On the other hand, the Mayor’s Transport Strategy also identifies an active role for transport agencies in understanding the effects that innovations and new mobility services can have on society. Therefore, TfL has a responsibility to monitor any transport services or technology that can impact the way Londoners travel or experience London’s streets (ibid.).

The high ambitions mixed with the dual approach to data results in not only responsibility for public authorities to encourage innovations via official policies, but also responsibility to take an active role of monitoring and taking actions when needed. The UK approach to the transport sector as a whole as well as more specifically to the transport data is very technology driven with a strong focus on innovations, where policy and regulation need to respond to the new opportunities and challenges. Thus, the whole discussion about technology demands public authorities to be active and aware of rapid technological changes. The London Infrastructure Plan 2050, which provides long-term development goals for the region, proposes to track and shape new technologies as they emerge and put them to use to improve customer experience (Mayor of London, 2015). Furthermore, the strategy indicates that ‘innovation is not just about technology, it is also about policy, processes, behaviour and delivery’ (ibid.:54), which means that the success of the implementation of the technology into the system is as important as the technology itself.

3.2.3 Public transport sector and TfL

There is a visible division between the overall transport system management in the UK and that of the TfL alone. The national Transport Investment Strategy 2017 (DfT, 2017) builds upon the ideas from the Industrial Strategy (HM Government, 2017) and highlights ‘the importance of driving growth across the whole country and creating the right institutions to bring together sectors and places’. This requires a clear institutional decision-making framework to which the UK Government will provide capital investment (ibid.). The strategy is constructed around the idea of devolution of transport functions and responsibilities, which should result in bringing power to the local communities, where local authorities can merge together to create combined authorities with an elected mayor (ibid.) The expectations are to provide greater freedom and power, and also to drive economic growth outside of London through partnerships like Transport for the North. In this process, Greater London is perceived as an example where responsibility for transport and planning has been devolved to the Mayor for almost 20 years and Transport for London is ‘now responsible for virtually every aspect of transport in the capital’ (ibid. 44). In this model, the mayor is required to produce development strategies and TfL takes over the fulfilment of them.

When it comes to transport data and data sharing, the differences between the London region and the rest of the United Kingdom become even more evident. Transport Systems Catapult⁶’s research report on the transport data revolution (Transport Systems Catapult, 2015) states that TfL is leading the way in transport data, whilst other local authorities are still working on developing digital strategies. Due to this lagging behind, the report on transport data conducted by North Highland Consultancy for DfT showed that large amounts of data are being collected and stored in isolation by both local authorities and the private sector (DfT, 2018b) and according to the report, the success of transport data sharing of TfL has not been replicated (ibid.). There are some challenges in regard to this, such as difficulties accessing data when the private sector technology is used in the collection and processing of data, resulting in local authorities being forced to buy back this data to maintain local operations (ibid.) or the question of data ownership within local authorities, when separate teams are responsible for capturing and analysing data and there is no single owner. This issue becomes compounded considering that only 18% of survey respondents in the report on transport data performed by North Highland Consultancy for DfT (ibid.) have a dedicated team for data and analytics in their local authority.

As already mentioned, Transport for London is leading the way in transport data sharing both nationally and globally. The report by Open Data Institute (ODI) on using open data for public services explains that publishing open data is a central part of TfL’s customer information strategy (ODI, 2018b) as, with more than 31 million separate journey segments made daily (TfL, 2019b), TfL has a responsibility to keep transports moving. By sharing real-time information by themselves and through third-party organizations, TfL provides data about service locations, routes and delays to passengers far beyond their own online and offline services (ibid.) The strategic decision to open up the unified APIs in common format (XML⁷ and JSON⁸) was made in TfL in 2014 and this data covers information about timetables,

⁶ Transport Systems Catapult is the UK information centre for Intelligent Mobility founded in 2013 (Source: <https://ts.catapult.org.uk/about-us/who-we-are/>)

⁷ ‘Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable’. (Source: <https://en.wikipedia.org/wiki/XML>)

⁸ ‘JavaScript Object Notation (JSON) is an open-standard file format that uses human-readable text to transmit data objects consisting of attribute–value pairs and array data types (or any other serializable value)’. (Source: <https://en.wikipedia.org/wiki/JSON>) According to TfL (TfL, 2019e) ‘JSON is quickly becoming the de facto data format for web and mobile applications, due to its ease of integration into browser technologies and server technologies that support Javascript’.

stations, facilities, transit status, disruptions, accessibility, fares, walking, cycling and even air quality (TfL, 2019c). This marked an important change in TfL – from publishing data about transport modes on different formats and structures that were complicated to use for developers into sharing of data in a consistent structure with a common format suitable for the development of the multimodal application (Transport Systems Catapult, 2015). The value of this opening and sharing was evaluated in a report ordered by TfL and performed by Deloitte in 2017 (Deloitte, 2017) in which publishing data was assessed in regard to its monetary value and partnerships. According to the Deloitte report, in 2017 there were over 13,000⁹ registered developers ranging from multimodal companies to individual developers, over 600 apps were developed, 42% Londoners use an app built on TfL data and 83% use its website with similar data (ibid.). The annual economic benefits and savings reach up to £130 million for travellers, London and TfL (ibid.).

Finally, TfL is responsible for virtually every aspect of transport in Greater London and recently it is becoming more self-sufficient in financing itself. The reason for this change in funding comes from a political decision to withdraw governmental operating grants for the budget year, 2018/2019, that on average were expected to bring in around £700 million over five years (Mayor of London, 2018b). As a result, it makes London one of the only cities in the world without government funding to support the operating cost of the transport network (London Assembly, 2018). The decreased finances require administrative changes and new revenue streams, which brought changes in the administration of TfL. One of the changes is the decreasing number of employees to make the system more efficient and the officer at TfL shares their experiences with this: ‘We were stripped of our government funding and so there were cuts. [...] We lost a lot of experienced people. We used to be in more specialized teams but the teams have become more general with generic job titles and job descriptions’ (Int. 4) The officer at TfL continues that there is an ongoing requirement to make things more efficient and to be conscious of money (ibid.). In the TfL business plan 2019/20 to 2023/24 (TfL, 2019a:6), the agency reflects on these changes and describes this process as making the ‘operating model leaner and more efficient’ to secure £111 million in annual recurring savings. Moreover, this also encourages TfL to find new ways of financing their activities, such as through commercial income, which has been a real success in the last years (London Assembly, 2018), and the question to answer now is: ‘how much further it wants to commercialize. We (Budget and Performance committee) think this merits a public debate.’ (ibid.:5).

3.2.4 Technology and transport data

As was already presented, TfL holds responsibility for every aspect of transport in Greater London, which means that they are responsible for all the operational and maintenance details that are left behind the scene. To keep the smooth flow of 31 million travel segments performed every day (TfL, 2019b), the public authority is required to stay ahead of all technological innovations and solutions, and data and data analytics play an important role in these processes. Lauren Sager Weinstein, the chief data officer, explains: ‘We’re continually thinking of new ways our tools and analysis can tackle London’s transport challenges’ (Womanthology, 2018). In action, this means that technology is being utilized to understand how things are happening and then translated into action to run transport services (ibid.). To this is added the importance of transport data as the mission is to make the most out of existing data in regard to the challenges and then find ways to analyse it and to create a suitable solution (ibid.).

During this investigation, the asset data and personal data were mentioned and discussed in the collected material. Starting with the asset data, TfL is working on developing a new system that will incorporate

⁹ In 2019 the official information from the TfL website: 17000 registered users. (Source: <https://tfl.gov.uk/info-for/open-data-users/open-data-policy>)

different asset data from various currently used systems into one common system (Int. 4). One of the reasons for this technological change, according to the officer (ibid.) is the fact that the operating licenses are expiring in the very near future and TfL wants to move to this one system with all assets in one place instead of working with the separate systems along with each other. Moving further, when it comes to personal data, Lauren Sager Weinstein assures that TfL considers privacy obligations seriously and does not share this data with any third parties without customers being fully aware of it (Womanthology, 2018). One of the examples of TfL and personal data work is the WiFi data collection pilot¹⁰ performed in 54 Tube stations around central London in December 2016 (TfL, 2019c). This provided more than 509 million depersonalized WiFi requests from 5.6 million devices (TfL, 2017) and the purpose was to get new knowledge about crowding and collective travel patterns with the use of cost-efficient methods. The WiFi pilot evaluation report (ibid.:45) concluded that this was a successful project from the technical and analytical point of view: "The pilot showed that the connection data generated as a by-product of our WiFi services can offer substantial benefits for us and our customers."

3.2.5 Partnerships

Both DfT and TfL are working on establishing partnerships with the actors representing the private transport sector to achieve data sharing. It is important to mention that the transport sector became privatized in the 1980s and, for example, all railway is franchised, and the bus industry is also privatized and unregulated, according to the officer at DfT (interview with an officer at DfT, 2019). (Though it is important to mention that the London region gained their devolution of power at about the same time and thus this description does not apply to the London transport system.) The officer explains that when it comes to collaboration with private transport operators in data sharing there is a 'case by case' approach, as with railway operators there is a joint action plan between the UK government and railway industry, but with the bus industry special regulation was required for them to open their data (ibid.). The officer at DfT (ibid.) also considers possible future regulation in regard to big international corporations and one of the common concerns is to make sure that there would not be a handful of companies holding all transport data as this would reduce competition, increase prices and provide huge competitive advantage to control the market.

Through open data published by TfL, TfL is engaging in conversation and in partnership with other companies. The ODI report on open data use in the public sector (ODI, 2018b) suggests that due to the opening of the data, TfL benefited from engagement with companies such as Waze, Apple and CityMapper. Moreover, some of these companies provided access to their data (ibid.) that provided data on areas TfL does not itself collect, like crowdsourced traffic data (Deloitte, 2017). Moreover, new services and products from companies like ITO World, TransportAPI, TomTom and Elgin were developed that combined TfL open data with other sources of information and resulted in aggregated data feeds and additional services to developers and other organizations (ODI, 2018b). Moreover, since Uber regained its operating license in London in 2018, it opened the anonymized data of its London riders to everyone, called Uber Movement (Uber, 2018), and in spring 2019 incorporated open transport data from TfL in their app, allowing users to compare journeys on other services (The Guardian, 2019a). This includes information about tube, bus, rail, tram and riverboats (ibid.). The reporter Gwyn Topham in the article for *The Guardian* (ibid.) suggests that this is a significant move for Uber to become 'a one-stop shop for transport and other services'. On the other hand, similar service provider CityMapper moved even further and launched the 'CityMapper Pass', which provides unlimited travel in zones one and two for a fee lower than that on an official TfL Oyster card (The Guardian, 2019b). The app already offers a premium pass that also includes a cycle hire network and £10 a week credit on another experimental service, the 'Smart

¹⁰ Full report: <http://content.tfl.gov.uk/review-tfl-wifi-pilot.pdf>

Ride' bus owned by CityMapper (ibid.). Alex Hern in this article for *The Guardian* (ibid.) presents a concern that this is a company's attempt through burning its funding to establish a large base of users for gaining the power to battle city authorities for better terms, as Uber and Airbnb did in cities like San Francisco, New York and Paris.

3.2.6 Transport data repository

TfL has been publishing structured and unified open data about transport for around five years through their official web portal in the section for open data users (link: <https://tfl.gov.uk/info-for/open-data-users/>) and unified API can be accessed through Transport for London Unified API website (link: <https://api.tfl.gov.uk/>). Open data users is the general section that can direct users to more relevant themes, like open data policy, unified API, open data, design and branding, and widgets. Data is presented in three main ways: static data files (rarely changing), feeds (updates at regular intervals) and API (enabling a query from an application to get a bespoke response and depends on the parameters supplied) (TfL, 2019d). Unified API is provided in JSON and XML formats, while other data feeds and datasets are available in a number of different formats (ibid.). The Unified APIs include data on different transport modes, as well as on all stations and platforms from the national Naptan Standard, which is an identification scheme supported by the DfT nationally that allows the API to integrate data from public authorities in the other regions in the UK (TfL, 2019e). Moreover, it provides data in real-time with high volume and low latencies (ibid.). Data from TfL can be accessed in the following themes: air quality, general, tube, bus, coach and river, roads, cycling, walking, Oyster, accessibility and toilets, network statistics and planning (TfL, 2019c). Finally, to access the unified API, users need to go through Transport for London's Unified API website, where registration is mandatory and developers receive users' personal Application IDs and Keys, which they use as part of their request (TfL, 2019f). The users sign terms and conditions to use TfL's free transport data services that are based on version 2.0 of the Open Government Licence with specific amendments for Transport for London (TfL, 2019g). The web portal of transport data is owned and managed by TfL.

3.2.7 Overview

Approach to data:

Data as a factor of impact across the transport sector, for infrastructure providers and equipment manufacturers.

Open data as 'a key governmental priority' and 'as a key enabler for the government's digital transport strategy'

The national data strategy is under development.

The officer at DfT: 'We want to be inclusive that we do not get excluded'.

The UK approach to the transport sector as a whole as well as more specifically to the transport data is very technology driven with a strong focus on innovations, where policy and regulation need to respond to the new opportunities and challenges. Thus, the whole discussion about technology demands public authorities to be active and aware of rapid technological changes.

There is a strong difference in approach between TfL and the rest of the UK:

Firstly, the devolution of power – the new strategies build upon the idea of devolution of transport functions and responsibilities countrywide as this was done only in London almost 20 years ago.

Secondly, TfL works with transport data and sharing of it while other authorities still work on developing digital strategies. Moreover, publishing open data is a central part of TfL's customer information strategy. The transport data is provided in unified APIs that have a consistent structure with a common format suitable for the development of the multimodal application.

Thirdly, London is now one of the only cities in the world without government funding to support the operating cost of the transport network. This results in administrative changes and new revenue streams, for example from commercial incomes.

TfL is utilizing digital solutions to understand how things are happening and then translated into action to run daily transport services. To this is added the importance of transport data as the mission is to make the most out of existing data in regard to the challenges and then find ways to analyse it and to create a suitable solution. New data collection methods are being tested, like Wifi data collection pilot.

Partnerships between private and public entities are handled on a 'case by case' basis at the national level. At the London regional level, through the opening of data, TfL benefits from engagement with companies like Waze, Apple and CityMapper, as some of these companies provided access to their data on areas that TfL does not itself collect, like crowdsourced traffic data.

All information about open data can be found on <https://tfl.gov.uk/info-for/open-data-users/> and unified APIs can be accessed at <https://api.tfl.gov.uk/>. To access data, users sign terms and conditions that are based on version 2.0 of the Open Government Licence with specific amendments for Transport for London.

3.3 Oslo

3.3.1 Approach to data

It was not possible from the data collected and analysed for this report to identify a clear Norwegian approach to data, although some ambitions in regard to data are evident. To start with, the National Transport Plan (NTP) 2018-2029 perceives digitalization and new technologies as an element bringing a radical change in the way people plan their trips and how they travel, and to the transport sector as a whole: 'Grasping the opportunities the new technologies offer is vital for achieving the objectives and goals for the transport sector' (The Norwegian Ministry of Transport and Communications, 2016:18-19). Thus, some of the recent goals were to digitalize the public transport sector and also to open up data for the public. Moreover, in this discussion, data becomes the relevant subject, especially as different solutions might require using the same data and, therefore, the transport agencies must establish standards and guidelines to enable interoperability between different systems, reuse of data, data security and privacy, and also facilitate sustainable operating models and responsibilities (NTP, 2016). Finally, in 2016 the state-owned company Entur AS was established to serve as sales provider for rail operators and national hub for public transport information, with a mission 'to enable and increase the use of public transport in Norway' (Entur, 2019a). According to Entur (ibid.), the goal is to provide transport data to developers that help to make public transport the first national choice for moving, and one of the ambitions of the company is that the travel data should be referred to as often as weather data (Entur,

2019b). However, the establishment of Entur can also be discussed as national efforts to monopolize the management of transport data in the hands of the state-owned company.

3.3.2 Entur

One of the most important changes in the Norwegian transport sector and transport data has been establishing a state-owned company, Entur AS. The investigated document suggests dual governmental needs in the process. Firstly, in May 2015 the Norwegian government released a new rail reform that proposes to modernize the national railway in a way that would result in improving passenger experience, providing a new offering for the freight industry, and increasing governmental gain through resource allocations in the sector (Entur, 2019a). Secondly, the Norwegian National Transport Plan 2018-2029 required establishing a common national access point for all transport data (NTP, 2016). Therefore, in 2016 the Norwegian Ministry of Transport and Communications established Entur, both to serve as sales provider for rail operators and as a national hub for public transport information (Entur, 2019a).

Focusing only on the task of being a national hub for public transport information, Entur is in charge of collecting, managing and publishing transport data through a digital platform. The Professional Transport Act obliges all public transport companies to submit their data about routes to Entur's database, which means that Entur in their servers have complete travel data for all of Norway and provide access to it through a digital platform (Entur, 2019b). The company as a neutral and national body provides all data free of charge and offers open interface APIs for developers (ibid.). There are also plans to extend datasets and include mobility data, such as car sharing and bike sharing (Int. 5). The officer from Entur explains that through their work they should both serve the public with the data through their channels, but also enable innovations for other parties, service providers and public transport authorities and, therefore, they are not allowed to put any limitations on the data they collect: 'data belongs to the society' (ibid.). What is more, Entur was commissioned to retrieve product and price information from the public transport providers as a prerequisite to sell tickets on behalf of other companies and this resulted in the Norwegian public transport price and product portal that could be used by companies to maintain their data (Entur, 2019b). However, the officer explains that there is a challenging administrative landscape, as Entur is state-owned while most of the public transport in Norway is financed and run by the regions or the counties (Int. 5).

Moreover, based on the data available from the digital platform, Entur created a national journey planner, also called Entur, available as both a website and an app. This journey planner includes the transport modes, such as bus, train, ferry, tram, rail and planes, and it aims to provide an easier and smoother experience while using public transport (Entur, 2019). Thus, Entur produces its own passenger data from website and app, though the officer at Entur admits that they have not yet started the work on big data analysis due to the number of other tasks to be performed (interview with an officer at Entur, 2019). Furthermore, users can buy travel tickets via the digital platform from Ruter and Vy¹¹ and Entur is actively working to extend this to other companies, and the goal is to make tickets to all public transport available to customers in the next two years (Entur, 2019b). There are a number of ticketing systems for such a small country as Norway (interview with an officer at Entur, 2019) and Entur is working to simplify this, and to secure interoperability and seamless ticketing nationwide. If other actors are, like Entur, to distribute tickets on behalf of other transport authorities or operators, agreements need to be set up between the different parties (ibid.). The officer at Entur suggests that in comparison to, for example,

¹¹ Vy, formally Vygruppen AS, before NSB, is a Norwegian transport group working with passenger train and bus transport in Norway and Sweden. The Vy is owned by the Norwegian State through the Ministry of Transport and Communications. (Source: <https://sv.wikipedia.org/wiki/Vy>)

Finland, where public transport tickets can be distributed freely, in Norway the process is more complicated (ibid.).

3.3.3 Ruter

Ruter, the public transport authority in Oslo and Akershus regions, is an important element in understanding ongoing processes and transformation of the transport sector in the Oslo region, but also in the whole of Norway. The main agenda for Ruter is to transition from the role of transport service provider to mobility service provider (Wessel, 2018). In 2015 Ruter presented a strategy, called M2016, where M stands for 'future mobility solutions' and in which the step was taken from public transport strategy to creating a mobility strategy (Ruter, 2019a). In M2016, transport is approached in a holistic and more contextual way in which mobility is instead considered as a mode of travelling (ibid.). The strategic vision for the future builds upon closer and more integrated mobility services, which provide the freedom and flexibility of everyday life without owning a car (Ruter, 2019b). Moreover, the strategy suggests that individually adapted information solution and mobility services must be developed in collaboration with users (ibid.).

Ruter has adapted the concept of combined mobility to describe their activities (Ruter, 2018). In regard to combined mobility, a range of activities related to planning and testing pilots in 2019 are being performed through the joint mobility project 'Smarter transport in the Oslo region'¹² which includes the Norwegian Public Roads Administration, the City Environmental Agency in Oslo municipality and Ruter (ibid.). The important part of this joint collaboration is the implementation of those pilots that investigate solutions, like cooperative intelligent transport system (C-ITS), Mobility as a Service (MaaS) and autonomous vehicles (Statens vegvesen, 2019). Moreover, one of the Ruter pilots is based on data collection and analysis to provide a 'seamless service' for the transport users. By the help of Bluetooth e-beacons and other data collection technologies, the pilot should enable Ruter to collect real-time rider data (Wessel, 2018).¹ In this pilot, the scenario assumes that the customer voluntarily allows collecting personal data about movement (ibid.) and the aim is to gain a better understanding of commuters' habits in order to improve a multi-modal framework (ibid.).

At first glance, the current transformation of Ruter does not have a direct connection to transport data, but in the bigger picture, this shows new opportunities and new dataflow for the regional transport authority. The integration of new mobility services within their activities results in closer partnerships with new transport sector actors and new data from these services, which means that Ruter will have access and information that was not available before.

3.3.4 Data standard

As it was identified during document analysis and presented in 4.3.1 Approach to data, data standardization is an important topic for Norwegian transport authorities. The extensive need for an established data standard was also presented in the report assessing the need for a digital interaction platform produced for the Norwegian Ministry of Transport and Communications (Hobi & Wangsnæs, 2015): 'Through the interviews, it has emerged that it should be an authority task to define a common standard for the storage of transport data. It is important that the actors adapt to the standards that are set and commit to using established, international standards where this exists'. Therefore, the European standard for transport data NeTEx was adapted and is currently being implemented (NeTEx, 2019). The goal is to incorporate all data exchange of public transport information in Norway into NeTEx. A NeTEx/IFOPT-compliant national database for Stop Places and Points-of-Interest was also established,

¹² In Norwegian: Smartere transport i Oslo-regionen - STOR.

which contains all fixed objects including equipment and facilities used for public transport (ibid.). In regard to the real-time feeds, the SIRI interface is used for exchange and collection for the national real-time proxy (ibid.) According to the NeTEx official website (ibid.), 19 of the 25 major providers of public transport shifted to NeTEx by May 2018 and this number was expected to grow by the end of 2018. The office at Entur shares a view that the greatest challenges in the implementation of NeTEx have been the fact that in Norway there are a lot of small actors that needed to move to a common standard and provide qualitative data: 'With several companies having to adapt to the new standards, the transition phase has been long for some of the operators' (Int. 5).

3.3.5 Transport data repository

The transport data repository, which is also referred to in the documents as a national access point or a national hub for public transport information, is managed by Entur on the website <https://developer.entur.org/>. Entur was established in 2016 and covers the public transport data that is mandatory under the Professional Transport Act (Entur, 2019b). The website provides options to select between Web APIs and Streaming APIs, where Streaming APIs provide real-time data on the SIRI 2.0 format (SIRI XML or SIRI Lite) (Entur, 2019d) and Web APIs include data about Geocoder, journey planner, national stop registry and other options to choose from (Entur, 2019c). The information on the Entur repository is available via Norwegian License for Open Government Data (NLOD) 1.0¹³ which, as the officer at Entur explains, is a standard license for open data in Norway and there is no obligation to register (Int. 5). The officer continues that there are about 300 users of Entur APIs, though they are not sure who everyone is and only the biggest ones such as Google, Apple and Moovit can be identified (ibid.)

3.3.6 Overview

According to the analysed documents, Norway still lacks a clear approach to data and transport data, though some goals in this direction are identified:

to digitalize the public transport sector,

to open up data for the public,

to establish data standards and

To enable interoperability between different systems.

The state-owned company Entur was established in 2016, in part to achieve these goals.

Entur has two main missions:

1. To modernize the national railway;
2. To serve as a national hub for public transport information.

The Professional Transport Act obliges all public transport companies to submit their data about routes to Entur's database, which means that Entur has complete travel data for all of Norway and provides access to it through a digital platform. Moreover, Entur was commissioned to retrieve product and price information from the public transport providers as a prerequisite to sell tickets on behalf of other

¹³ Link to the license: <https://data.norge.no/nlod/en/1.0>.

companies, and this resulted in the portal for Norwegian public transport price and product. Moreover, they created national journey planner based on data and show some ambitions to become state-owned MaaS operators.

Ruter is on the path to transition from the role of transport service provider to mobility service provider. In the public transport strategy M2016, transport is approached in a holistic and more contextual way in which mobility is instead considered as a mode of travelling. Ruter also has adopted the concept of combined mobility and is attempting to test it in 2019 through the joint mobility project 'Smarter transport in the Oslo region'. In regard to transport data, Ruter is testing a data collection and analysis pilot in which data is collected through Bluetooth e-beacons.

The European standard for transport data, NeTEx, was adapted and is currently being implemented. 19 of the 25 major providers of public transport shifted to NeTEx by May 2018 and this number was expected to grow by the end of 2018.

Transport data is shared via Entur websites: <https://developer.entur.org/>. The information on the Entur repository is available via Norwegian License for Open Government Data (NLOD) 1.0, which is a standard license for open data in Norway and there is no obligation to register.

3.4 Singapore

3.4.1 Approach to data

When it comes to approach to data, Singapore has a very strong overall agenda of use and exploitation of the digital solutions to steer the development of growth of the city-state. Data is perceived as an enabling element for the digital transformation and even more the 'new oil' of the 21st century (Ministry of Communication and Information, 2015) or even as a currency with endless possibilities (Smart Nation, 2019c). Therefore, Singapore has a clear digital vision of 'Smart Nation' that is included in all sector and industries within the city-state. The government supports the growth and innovation across all domains, which also includes the public sector (Smart Nation Singapore, 2019a) and in the programmes, the key enablers of 'the pervasive adaptation of digital and smart technologies' are perceived as the strategic national projects that extend through topics of national digital identity, e-payments, smart national sensors platform, smart urban mobility, moments of life, and core operations, development environment, and eXchange (ibid.).

3.4.2 Technology and humans

The use of data is embedded in the decision-making and overall governing of the nation of Singapore. The Smart Nation programme builds upon the importance of harnessing emerging technologies to improve the formulation of policies and operations through the use of data, connectivity and computing (Smart Nation Singapore, 2019b). One of the themes within this programme is governmental-led digital disruption (EDB Singapore, 2017) that would require changes within the public and private sectors. From the government side, it means 'significant re-engineering' of the public sector through the use of common digital and data platforms SGTS (Smart Nation Singapore, 2018). As it is described in the Digital Government Blueprint (ibid.), the Singapore Government Technology Stack (SGTS) is presented as a collection of common digital services and infrastructure that combines services from all governmental agencies to build their digital applications and includes layers, like data, infrastructure (data centres and common hosting infrastructure), application infrastructure (platform-as-a-service) and library of microservices, for example common authentication and payment services. Moreover, the strategy identifies the value of artificial intelligence (AI) for deployment in the government's processes, which

includes ‘automating rule-based tasks, providing personalized and anticipatory services, and anticipating situations such as traffic or security incidents’ (ibid: 16).

However, technology represents just one side of the coin and human interaction to the changes brings different discussions and challenges. As Microsoft highlights in their study about digital transformation in Singapore (Microsoft, 2017), the main driver for the digital transformation is humans. In the discussion of the Smart Nation vision, Diaan-Yi Lin, senior and managing partner at McKinsey & Company Singapore, suggests that ‘These goals have challenged Singapore’s public officials and agencies to devote considerable creativity, effort and resources to achieving them’ (EDB Singapore, 2017). In the Digital Government Blueprint, this is addressed through the governmental work motto ‘think big, start small and act fast’ (Smart Nation Singapore, 2018:24) and encouraged through the mindset of ‘dare to try’ (ibid.:25), which should allow seizing new opportunities in the fast-paced technological world. However, on the other hand, the programme also identifies the need for relevant technical skills and leadership in the public sector to work with ICT and Smart systems (ibid.), and universities therefore provide courses and education in data analytics and big data analysis (Cheah et al., 2016). Moreover, in 2017 the Singapore government announced that over the next four years, 10,000 governmental officials will be trained in areas such as using data science and data analytics for policy-making, service delivery, corporate services and cybersecurity (GovInsider, 2017a). The Smart Nation programme identifies the benefit of preparing professionals in that it creates possibilities within internal capabilities to deal with highly complex issues on short notice, and makes it possible to increase productivity and efficiency in the digitally enabled workplace (Smart Nation Singapore, 2018).

3.4.3 LTA and transport data

Established in 1996, the Land Transport Authority is a one-stop centre for all matters related to land transport in Singapore. LTA is the world’s leading tech-savvy transport agency, highly dependent on digital solutions in all the processes ranging from planning transport network, designing mass transit networks, determining public transport capacity, licensing, collecting taxes or even providing information for services (Choudhury, 2015). The technology used in LTA activities includes large-scale sensor networks on roads and in train stations, smart cameras, contactless smart cards for transit fares, big data for advanced data analytics and location-tagged systems for speedy reporting and better information services (ibid.).

LTA quite early recognized the need for becoming a technology-driven public transport authority. Already in 2006, LTA began to face technical challenges like insufficient processing power. According to Rosina Howe-Teo, LTA’s chief innovation officer and chief data officer in 2015, the agency entered into a research collaboration with IBM Watson Lab in 2008 ‘to learn the techniques of data analytics’ and ‘understand commuters’ travelling patterns and behaviours, and the influence of events and incidents on these journeys’ (ibid.). By 2010, LTA felt the need to form a data analytics team dedicated to researching, experimenting and exploiting the use of big data (ibid.) and in 2011 the agency entered into a partnership with Microsoft and launched the DataMall web portal to facilitate the real-time public transport data and traffic information sharing (LTA, 2014).

Altogether, what happened in these years was that LTA went through an important shift in the way it has perceived its main responsibilities as a transport regulator and planner within the mindset and with the technology. Choudhury (2015) suggests that LTA started to understand the importance of day-to-day operations and the data collection and analysis connected with it not only for planning purposes but also for smooth maintenance of the overall transport system.

From the technological side, data analytics is used extensively within LTA activities. However, according to technological scanning performed by Cheah et al. (2016), data management is still a major challenge in regard to storing data, determining the usefulness of data and organizing data. This becomes particularly apparent when the discussion moves to real-time data management and analytics, which require constantly evolving the technology to improve decision-making (ibid.). However, the analysis of collected data for this report identified three technologies that LTA utilizes to address this challenge. Firstly, the data warehouse and business intelligence platform Planet (Planning for Land Transport Network) was designed and implemented to meet the new needs of working with complex and high-volume transport data. The purpose of Planet is to empower transport planners with data analytics from cross-functional data sources to validate policy assumptions and evidence-based decision-making (Choudhury, 2015). Moreover, LTA has entered into a new phase of collaboration with IBM Watson that works on the train network solution name Faster (Fusion AnalyticS for public Transport Event Response) that will combine a variety of descriptive, predictive and prescriptive analytics with data from LTA, public transport operators and the telcos (ibid.). Finally, LTA signed a contract with a consortium formed by Siemens and ST Engineering Electronics (STEE) to design and deploy the rail enterprise asset management system that would consolidate asset information and maintenance records from multiple systems operating on individual rail lines into one (BINDT, 2018).

3.4.4 Transport data strategies

Smart Urban mobility is one of the key areas for development in Singapore's Smart Nation plan. The main focus, according to the investigated documents, is directed at the Intelligent Transport System (ITS) solutions. In the Smart Mobility 2030 (LTA, 2014:4) plan, LTA suggests a shift in the ITS from infrastructure related to 'data collection, analytics and the availability of relevant information on-the-move'. The transport agency also identifies changes in 'users' appetite for transport-related information', when information previously perceived as 'unimportant' becomes 'good-to-have' or even 'must have' (ibid.: 23). Thus, the main aim of the strategy is 'paving the way for a more comprehensive and sustainable ITS ecosystem in Singapore' (ibid.:4). This is also reflected in Singapore' Smart Mobility 2030 vision and its three main strategies for development:

Implement innovative and sustainable smart mobility solutions;

Develop and adopt ITS standards;

Establish close partnerships and co-creation. (ibid.: 19)

These strategies reflect upon two main themes identified in the analysis of the Singapore transport data case: the importance of transport data and new roles and partnerships/collaborations with third parties.

The first and second strategies in Smart Mobility 2030 focus on the different sides of transport data. This includes the adaptation of new technology for data collection, big data analytics, delivery of relevant and high-quality transport information, introducing the common standard and enhancing security (ibid.). The main expected results in these processes are to facilitate better transport planning and management and increase overall system efficiency and interoperability (ibid.).

3.4.5 Partnerships

The third strategy, which is all about establishing close partnerships and co-creation, is more complex to explain. LTA (ibid.) suggests that public and private sector partnerships are key to 'innovative co-creation' as the expertise and strengths could be shared to achieve common needs: 'It allows the convergence of the

research and industry efforts to be in line with the goals of the public agencies' (ibid.:40). The strategy suggests that in the future, public agencies, industry players, and academic and research institutions have their different roles to fulfil for this 'innovative co-creation'. Public agencies will continue to have a crucial role in driving the ITS initiatives and programmes to achieve ITS Smart Mobility 2030 goals through 'gathering and understanding the ground sentiments and end-user requirements' (ibid.:39), and they continue to play an important part in regulating public transport through the use and integration of ITS technologies to create a more sustainable transportation system. However, they will play only an instrumental role in coordinating with other stakeholders the development and implementation of smart mobility solutions and services (ibid.). On the other hand, industry players will become key technology drivers for the success of Smart Mobility 2030 as they already have expertise and skills about sensors, vehicles, in-vehicle telematics, navigations and location-based technologies. Finally, academic and research institutions will be an important and integral part of delivering technological innovations in transportation through in-depth research and experimentations. This also should strengthen local ITS research capabilities and steer them towards addressing transportation research challenges and making Singapore a key transportation research and test-bedding hub (ibid.).

Examples of the already existing private-public partnerships created in line with Smart Mobility 2030 include Beeline, GrabShuffle and NTU-NXP Smart Mobility Consortium. Piloted in 2015 and launched in 2016, Beeline was Singapore's first marketplace for crowdsourced bus services launched by GovTech¹⁴ and LTA. This is an application for crowdsourced bus services when the government share anonymized data with privately owned bus operators to suggest new community-demanded routes (Medium, 2018). The GrabShuffle services, which allow commuters to pre-book seats on the bus, were launched in 2017 as an extension of Beeline through a partnership between GovTech and ride-sharing company Grab. GrabShuffle uses routes determined by crowdsourced requests and anonymized public transport data from Beeline when analysed data showcase the need for more direct bus routes where people need to make multiple changes (GovInsider, 2017b). The final example is Smart Mobility Consortium, in which Nanyang Technological University (NTU) School of Electrical and Electronic Engineering and NXP Semiconductors N.V., the world-leading automotive semiconductor supplier in secure connected cars, joined with 12 industry companies to form NTU-NXP Smart Mobility Consortium in 2017 (NTU, 2017). NTU campus will serve as the living test bed where the consortium will harness an international wireless standard for vehicular use known as vehicle-to-everything (V2X) communication technology and all 12 companies will test and develop smart mobility solutions in this V2X ecosystem (ibid.). The companies behind industry partners are Panasonic, 'American software multinational Red Hat, automotive system manufacturers Schaeffler and Denso, as well as ST Kinetics, the land systems and speciality vehicles arm of ST Engineering' (ibid.).

3.4.6 Transport data repository

In 2011 the Land Transport Authority launched the DataMall web portal (<https://www.mytransport.sg/content/mytransport/home/dataMall.html>) to facilitate real-time public transport data and traffic information sharing (LTA, 2014). This is the LTA and Microsoft collaboration in sharing an LTA repository of land transport data for public access through the DataMall hosted on the enterprise-grade cloud platform Azure (Microsoft, 2015). LTA identifies two key aspects of this collaboration with the third parties through DataMall: information dissemination, when strategies and tools are used to disseminate the information to the public, and use of advanced transport data analytics

¹⁴ Governmental Technology Agency in Singapore.

that should help effectively manage and integrate transport information (LTA, 2011). The repository provides a variety of transport datasets that include both static and dynamic/real-time information. The static data combines the geospatial data and facts and figures, while the dynamic data includes datasets about active mobility, public transport and traffic, and is updated live and published as APIs. Using data from the website requires registration in DataMall and acceptance of the Singapore open data License and API Terms of Services (LTA DataMall, 2019a).

Currently, in 2019, the DataMall transport data is used in a number of transport-related apps. According to LTA (LTA, 2014), since the launch of the web portal, it has attracted strong interest from business, research institutions and third-party app developers and has resulted in numerous innovative transport and location-based applications. One of the apps that uses the DataMall transport data is Mytransport.sg, which was released by the Land Transport Authority in 2011 and has been provided with public transport, traffic information, taxi-stand locations, vehicle and cycling-related information (ibid.). In the App Zone on the DataMall, the 46 additional apps are listed as the ‘applications developed by third parties and LTA’ (LTA DataMall, 2019b).

3.4.7 Overview

Approach to data could be described as positive, with descriptions used in legal documents such as: an enabling element for the digital transformation, the ‘new oil’ of the 21st century, and a currency with endless possibilities. The use of data is embedded in the decision-making and overall governing of the nation of Singapore.

In the Smart Nation strategy, the government supports ‘the pervasive adaptation of digital and smart technologies’ across all domains, which also includes the public sector. The Smart Nation programme builds upon the importance of harnessing emerging technologies to improve the formulation of policies and operations through the use of data, connectivity and computing. The governmental-led digital disruption means ‘significant re-engineering’ of the public sector through the use of common digital and data platforms, SGTS (the Singapore Government Technology Stack).

The Singapore government pays a lot of attention to the officers working in the public organizations. In the policies, their working motto is described as ‘think big, start small and act fast’ with the mindset of ‘dare to try’. The government also invests in digital education for its employees and in 2017 it was announced that over the next four years, 10,000 governmental officials will be trained in areas such as using data science and data analytics for policy-making, service delivery, corporate services and cybersecurity.

Singapore’s Smart Mobility 2030 vision has three main strategies for development:

Implement innovative and sustainable smart mobility solutions;

Develop and adopt ITS standards;

Establish close partnerships and co-creation.

When it comes to establishing close partnerships and co-creation, the vision describes different roles: 1. public agencies will continue to have an important role in driving ITS initiatives and programmes and regulating public transport through the use and integration of ITS technologies, but they will only play an instrumental role in coordinating with other stakeholders the development and implementation of smart

mobility solutions and services; 2. industry players that will become key technology drivers; and 3. academic and research institutes will be an important and integral part of delivering technological innovations in transportation through in-depth research and experimentations.

In the last few years, LTA has understood the importance of day-to-day operations and the data collection and analysis connected with these not only for planning purposes but also for smooth maintenance of the overall transport system. Already in 2008, LTA entered into a research collaboration with IBM Watson Lab 'to learn the techniques of data analytics' and 'understand commuters' travelling patterns and behaviours, and the influence of events and incidents on these journeys'. By 2010, the agency had formed a data analytics team dedicated to researching, experimenting and exploiting the use of big data.

LTA and other public agencies are actively working in collaboration with companies to create new services for the users, with examples such as Beeline and GrabShuffle.

The real-time public transport data is shared via the DataMall web portal:

<https://www.mytransport.sg/content/mytransport/home/dataMall.html>. To use it, users are required to be registered in DataMall and accept the Singapore open data License and API Terms of Services.

4 Discussion

The main aim of the study was to provide an overview of the policies and strategies that are used to manage transport data in the urban regions of Helsinki, London, Oslo and Singapore. This aim was fulfilled in Section 3. Therefore, this final discussion focuses more on the comparative side and builds upon theoretical ideas of the formal and informal dimension of institutions and how findings relate to the research questions: (1) How do different transport authorities in urban regions approach transport data and perceive the value of data? (2) What kind of action plan is being implemented to create the *public* value of transport data within the public authorities? (3) How is all of this reflected in collaboration with third parties?

- The incentives

As discussed in this report, technological change can only be understood through a social perspective, which, in this case, has motivated the application of an institutional approach. This means that the main emphasis is put on the process of transformation rather than on the product itself. What is apparent from the findings is that there are two strong informal institutional dimensions (in other words, values and norms) combined with the shared ideas and incentives that have resulted in varying collective actions within the four regions. In Singapore and London, the industrial and technological needs guide the process, while in Helsinki and Oslo discussion follows new mobility concepts and transformation of the transport sector. Therefore, both Singapore and London exploit technologies by utilizing the existing administrative structure with the minimum transformation of the public sector on the regulatory or administrative levels. However, the interview with a representative from DfT suggests that on the idea level, the future scenarios of possible ways to handle data are being discussed discuss how to proceed in data management. Moreover, London and Singapore are exploring new methods and technologies to improve their practices, which includes investments in both technology and humans. One of the reasons for this way of working in the transport sector is that the urban regions have the complicated task of handling a huge number of daily trips and keeping the movement going combined with years of experience in the field, which has taught them data management and analysis and they are ready to move forward. This also showcases the shared understanding that technological and social changes will be adopted to the existing transport system. On the other hand, Oslo and Helsinki are undergoing strong administrative changes that have been initiated/regulated via strategies and implemented within public transport agencies. This has resulted in new agencies and companies, like the Finnish Transport Infrastructure Agency (in Finnish: Väylä), the Finnish Transport and Communication Agency (Traficom) or Entur AS, or in the shift of traditional roles, as in the case of Ruter. Even more importantly, this reflects upon the new perception of mobility through the idea of travel chains in Finland or the shift from transport service providers to mobility service providers in Oslo. The overall shared ideas within both Finland and Norway suggest that there is a way of thinking about transport systems as “disrupted” by new technologies and, therefore, there is a need of transforming the existing one into new systems. The focus is on carrying out the reforms and fulfilling the new requirements while at the same time managing daily traditional responsibilities. The impression from the collected data suggests that due to this new load of work they are responsible for, the work with data analysis in Oslo and Helsinki is lagging behind in comparison with London and Singapore. It can be argued that both Oslo and Helsinki just started reforms and require time to make order out of all the changes.

- Approach to transport data and policies

The approach to transport data in most cases is regulated in the policies and strategies in selected urban regions. In Helsinki, the national legislation suggests perceiving transport data as an enabling element for improving the transport sector and as a base for new mobility services and MaaS, and regulation in regard to transport data is even imposed on the transport market for both public and private entities via the Act on Transport Services. As discussed from the informal dimension of the institution, the overall goal of this legislation is to use data in a responsible way and in a way that helps the market's actors to provide better services to their customers through increased freedom of choice. Thus, the value of data is discussed in regard to creating public benefits and also empowering the transport actors to create new services. Singapore addresses data usability for improving societal needs through their Smart Nation strategy and Smart Mobility 2030 with a clear focus on governmental-led digitalization of the public and private sectors with data-led decision-making. In comparison with Helsinki, Singapore quite early on, and to a much stronger extent, understood the value of transport data and through collaborations with third parties tried to learn about data analytics techniques. Moving to London, TfL has had a strong open data strategy for more than five years. As TfL has such independence that it can make the decisions about their own activities, actively working with transport data was one of the strategic moves that transport authorities took responsibility for. This comes with the understanding that shared and open data provides space for innovation and services that would not be available otherwise. However, a lack of national strategy for transport data in the UK comes with threats from big mobility service providers like Uber or CityMapper. Finally, in Oslo, strong efforts are being made to monopolize the management of transport data in the hands of the state-owned company. The power over transport market and new mobility solutions is being controlled through the belief that a national company will create more value to society than leaving this to the private sector. However, as with other urban regions, Oslo perceives transport data as public data that society needs to have access to. One of the most important differences that these approaches are initiated by different governmental levels, like in Helsinki, where a strong push from the national level brings pressure to the region to perform, while in London, due to devolution of power, the region is showing more individual actions that make them a frontrunner in transport data sharing in the country.

- Public value

The question of the creation of public value within the daily activities of transport authorities can be likewise discussed. In this case, three different paths can be identified. In the first, Singapore and London are working on adding and analysing new data about transport and related areas to datasets that can be used for developers to create new services and also to improve/make daily management of the system more efficient. Taking another path, Helsinki builds on the ideas of mobility as a service and open ticket digital interface to enable new commercial actors to deliver new services that would make mobility package purchasing possible for the users and simultaneously make it easier to use different travel modes. Finally, Oslo works on standardizing and centralizing data by making it easier both for the state-owned company to build new services and for third parties to innovate by using the national access point. All four regions are working to improve the quality of the trips for the passengers, yet the way this is approached varies depending on individual strategic ambitions and stage of development.

- The role of public authorities

It is clear that all the selected countries place importance on the active role of governmental bodies and fast-paced decision-making while working with new technologies in their policies and strategies. This marks an important shift in institutional dimensions both formal and informal as the mindset has changed and this is validated in new strategies and policies. These new shared ideas build upon the

responsibilities of public authorities to make regulations and adapt to the changes while safeguarding the transport sector and the society at large from possible technological disruptions. The discussed urban regions have already understood that this massive unprecedented non-linear technological development affects human lives, work and travels, which means that the traditional slow-paced decision-making cannot be effectively controlled or even adapted to the changes and innovations. This in turn means that responsible bodies are required to take this proactive role due to the new pace of technological developments, but also due to the need not to be left out. The investigated urban regions showcase active market-led developments with both stringent and light regulation from public authorities as well as active public sector control over the market. It is not worth speculating on which of the presented strategies is the most relevant or useful as this is all still very new and it is difficult to see results in such a short time.

- Partnerships

Understanding the relationship between the public and private sectors in this time of disruptive technological development was one of the objectives of this report. Though the report was not able to generate a clear image of ongoing collaborations and partnerships due to the short time period of the project, at least some traces of ongoing activities were identified. One of the first realizations was that Singapore and London are actively working on creating new partnerships with third parties, while Helsinki and Oslo are much more focused on their own internal activities in regard to transport data management. In the case of London, the officer from DfT explained that the government is an active player in collaborating with third parties and the tactics for this vary depending on the case. Moreover, Singapore as a small island city-state well known for being innovative and business-oriented and partnerships with big international companies are part of its national strategies. However, it would be unfair to say that in Finland and Norway there is less need for collaboration, but rather that at this time of transformation the focus, energy and money are put on the other priorities. Another realization was that even though all four regions have and manage transport data repositories, at present closer collaborations and new joint partnerships with third parties that use data from the websites are developing only in Singapore and London.

- Transport data repositories

The transport data repositories in Helsinki, London, Oslo and Singapore have different licenses and requirements for the users of their services. While all four urban regions clearly express that public data about transport is publicly owned and everyone has the right to it, the terms and conditions, as the registration requirements, differ between each case. Helsinki and Oslo provide open access, as they treat transport data as any other open government data, which means services can be used without registration and access to the ticket APIs in Helsinki only requires a contract with HSL and registration. On the other hand, Singapore and London have registration requirements for all the users, which provides them with information about every company or individual developer using the data. This could be a topic for discussion, though not necessarily as a reason to make it easier to build public-private partnerships.

To sum up, if the findings of this report are discussed in the light of institutional theory and the research questions, it divides the regions into two groups, where one represents more technology-led development, like in London and Singapore with technology leading the way, and the other represents mobility concept-led development, like in Helsinki and Oslo, where transport services are being transformed to meet the new visions. All regions work actively with transport data management yet build their approach on different ideas and practices, even if all of them are trying to achieve similar goals of improved transport systems, comfort for the users and enabling new commercial transport services. Moreover, all urban

regions identified the importance of the public sector taking a proactive role in regulating and implementing technological developments, though as previously the strategies of achieving it range widely. Finally, partnerships between the public and private sectors are more developed in the urban regions with technology-led development.

5 Suggestions for future research

This overview of policies and the management of data connected with the transport sector in four selected urban regions points to a number of issues that future research can address.

- To start with, the scope of the study was limited due to time constraints, and therefore more prolonged and detailed research would identify deeper issues related not only to daily activities surrounding transport data within transport authorities, but also to systemic changes due to changing technologies and needs. This can be extended to the discussion of the implementation of new strategies.
- The study tried to touch upon the topic of creation of public value through the use of transport data. However, the findings were quite poor in this discussion. Therefore, the suggestion would be to conduct new research with a focus on understanding how transport data can contribute to the creation of public value and sustainable transport systems.
- The partnerships between the public and private sectors are intensifying and due to this, the roles of transport authorities are changing. Future research can prepare different scenarios to understand how different approaches to the partnerships from the public sector affect the transport sector as a whole.
- This study discusses interoperability and data standards as two of the topics in the urban regions, and suggests differences in the reasoning for these measures, but the data formats also vary. One of the questions to answer is how different choices made in regard to transport data handling, such as data standards and interoperability, can affect the policy goals and creation of sustainable transport systems.
- One of the global trends drastically affecting the transport sector is digitalization and public authorities need to be proactive or at least reactive in this process. Therefore, a suggestion for future research would be to investigate how public authorities address the overall process of digitalization and how traditional institutions are changing in both the formal and informal institutional dimensions.
- Finally, this paper utilizes institutional theory in the research, although in future research, socio-technological theory would be a suitable choice that would enable analysis of the handling, management and production of transport data in light of the new digital transport infrastructure.

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8 Primary sources:

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A representative from Entur AS in Norway, 2019. Interviewed by Erika Kriukelyte on 5th of April.

A representative from The Ministry of Transport and Communications in Finland, 2019. Interviewed by Erika Kriukelyte on 9th of April.

A representative from the Department for Transport (DfT) in the United Kingdom, 2019. Interviewed by Erika Kriukelyte on 25th of April.

A representative from Transport for London (TfL) in the United Kingdom, 2019. Interviewed by Erika Kriukelyte on 25th of April.

Appendix 1

Document list:

	Helsinki	Oslo	London	Singapore
Policies on the national level	<ol style="list-style-type: none"> 1. Act on Transport Services, 2. Digital information, innovative services, good connections Ministry of Transport and Communications Corporate Sector Strategy 2016-2020	<ol style="list-style-type: none"> 1. The Norwegian National Transport Plan, 2. Professional Transport Act 3. The Constitution of the Kingdom of Norway 4. Freedom of Information Act 	<ol style="list-style-type: none"> 1. Department for Transport single department plan, 2. Transport Investment Strategy 2017, 3. Transport Infrastructure Skills Strategy: building sustainable skills, 2016 4. Industrial strategy, Building a Britain fit for the future, 2017 	<ol style="list-style-type: none"> 1. Smart Mobility 2030, ITS strategic plan for Singapore, 2. Land Transport Master Plan (LTMA) 2040, 3. Singapore Oden Data License and API Terms of Services, 4. Digital Government Blueprint
Policies on the regional level	<ol style="list-style-type: none"> 3. HLJ- Helsinki Region Transport System Plan, 4. Letter of intent on housing, land use and transport (MAL) 2016-2019 	<ol style="list-style-type: none"> 1. Integrated Land Use and Transport strategy – Oslo region 2016 	<ol style="list-style-type: none"> 1. Mayor's transport strategy 2018 2. London Infrastructure Plan 2050: Transport supporting paper 3. TfL business plan 	