# 7 Transport and Mobility Subsystem: Findings from Data Analysis

## 7.1 Factors Affecting Bristol's Transport and Mobility subsystem

Drawing on the interview data analysis, we have formulated the causal model of Bristol's transport and mobility subsystem, as shown in Figure 10[13], and briefly explained below.

Our interviewees note that, whilst the common perspective is that a smart transport and mobility system implies the adoption of electric vehicles (EV) across private and public transport, this does not quite hold within the transport and mobility sector in Bristol. In fact, **alternative fuels**, such as bio-gas (as used by Bristol's First Bus company) and hydrogen **are perceived to be more viable solutions for local public transport** (e.g. P10: *"Biofuels in Bristol are quite big; they've got quite a few biofuel buses. When I say 'they', I'm talking about First Bus because they're a predominant operator."*). This is motivated by the state of practice in the *EV battery sector*, as well as by the *local geographical characteristics of Bristol*. As noted by one interviewee (P10):

> *…We've had lots of problems with electric vehicles …when we put the bid in, there were several electric minibuses on the market. By the time the project started, most of them had been withdrawn from the market because of battery life issues; and in Bristol particularly, it's very hilly. Within the bus industry, there's some scepticism about whether electric buses will ever really become mainstream.*

EV adoption for private and fleet use (e.g. for car clubs or delivery fleets) is also impacted by concerns about battery life, as well as by the availability of *charging points* and the overall vehicle price. Furthermore, while fleet operators opt to install their own charging points (so as to maximise asset utilisation and reduce risk of dependency on others), private EV ownership is impeded by the lack of charge points around Bristol. Similarly, a *lack of qualified EV engineers* for vehicle maintenance is a concern for both private and fleet operators.

On the other hand, many citizens of Bristol are very *concerned about the environmental impact* on their lifestyles (including the use of fossil fuels for transportation), and this motivates their transition to electric bikes and vehicles. The *BCC policy* of a clean air zone in Bristol city centre, as well as the drive to address Climate Emergency challenges, drives adoption of EVs within taxi services and other car fleets.

Another hurdle for Bristol's car fleet operators' adoption of EVs is in the challenge of *formulating a business model* that would deliver sufficient value. This is challenging in Bristol, in particular due to the insufficient *population density* with *large distances* and non-grid *road layout*, both of which render the multipoint-to-multipoint (i.e. shared taxi) and other similar models unworkable. Clearly, additional revenue streams (e.g. from selling energy to the grid or providing frequency response services) would be a welcome addition to such fleet businesses.

## 7.2 What skills are needed for the Transport and Mobility Subsystem presently and in the future?

The skills deemed relevant by our interviewees to each of the areas of Bristol's Travel and Mobility ecosystem are summarised in Figure 11 and are detailed below, while also being aggregated into generic types.

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[13]This model can be simulated through this url: `https://energysystems.blogs.bristol.ac.uk/2021/03/08/transport/`
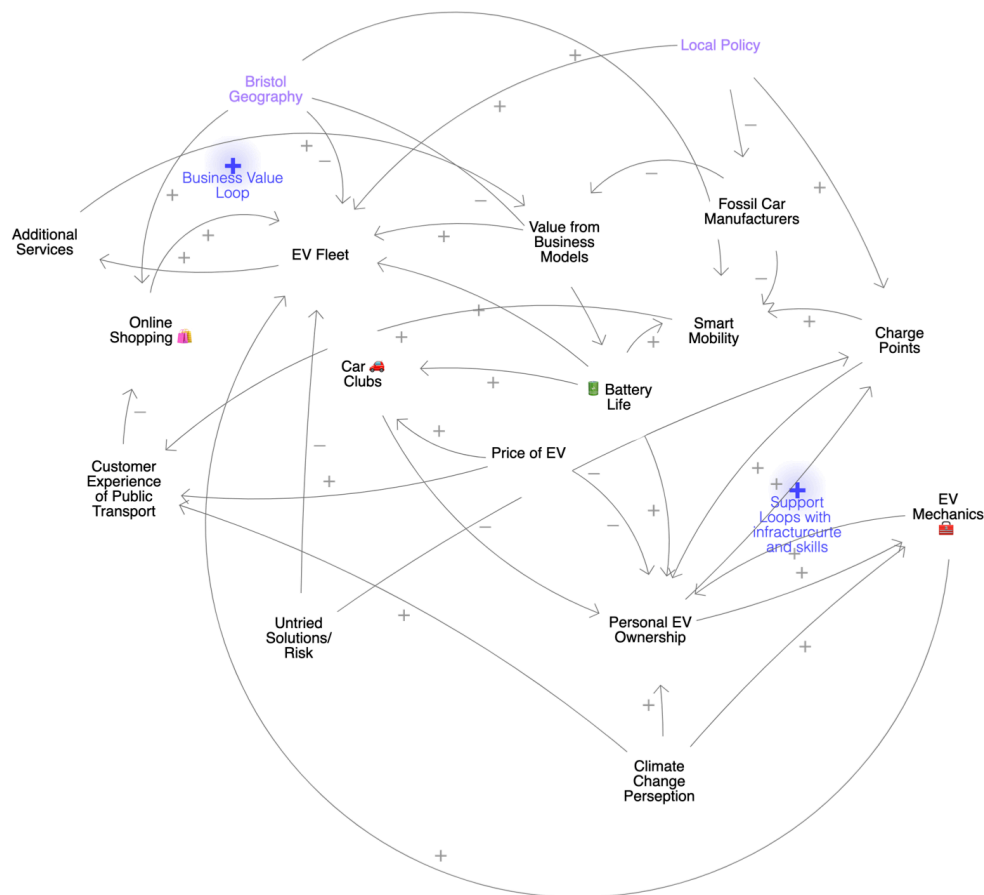
Figure 10: Causal model of the Bristol's Transport and Mobility Subsystem (factors local and specific to Bristol are presented in purple).

### 7.2.1 Engineering Skills for the Transport and Mobility subsystem

Engineering skills are noted to be the most in-demand and hard to come by within the Transport and Mobility sector. Here, a wide range of Engineering skills are required:

- *Software Engineering* skills are short across all areas of the software life cycle, including:

  - *Requirements Engineering*, where the engagement for requirements elicitation is often carried out by non-technical people which leads to a "big decoupling" of what is expected and what the technology can deliver (P20);

  - *Software Systems Architecture*, where various components must be integrated to construct a software system;

  - *Programming*, where fluency in various programming languages is expected, e.g. "Node developers are quite a premium" (P21),

  - *Deployment*, where dependency on external conditions and user experience must be accounted for "putting a big burden on the user and …that's what you want to avoid" (P20), etc.

Figure 11: Skills in the Causal model of the Bristol's Transport and Mobility Subsystem.
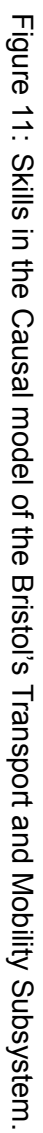
- *Systems Engineering and Integration* requires accounting for *interoperability* between technologies (e.g. P21: "…connect it to this and it will be easy-peasy and then when you actually get to do it, actually these little challenges pop up."), their *reliability*, *maturity*, *security*, as well as their *adherence to the expected (industry or company) standards*, e.g. "The charge points that we looked at, they all claimed to be OCPP 1.6 compliant …the reality is they didn't" (P21);

- *Algorithms are designed* for a wide variety of activities: from route planning to resource use and optimisation, e.g. "…our algorithms can be used to forecast the energy demand and then match that to when the vehicles need charging, but also in terms of when they need to do their deliveries" (P20);

- *Data Analytics* learn about the "big data and …behaviour" (P10) of software system users, and publicise the results, etc.

- *Networking and Telecommunications* skills ensure that the various devices (such as EVs, charge points, energy pricing system, etc.) are able to connect and exchange data in a secure way.

- *Electronics Engineering* skills are deployed in hardware components design and integration (e.g. microchip integration into electric bikes (P20)), etc.

- *Multidisciplinary Collaboration* skills are also required of engineers in this domain, as EV systems pool together skills from various areas: e.g. "you might be a mechanical engineer, but you're also working in software electronics …" (P21).

- *Research and Simulation Skills* should be applied to evaluate possible scenarios both of technical viability and of societal behaviours as well as their impacts.

### 7.2.2 Energy Domain Skills for Transport and Mobility subsystem

- *Understanding of Energy Domain and Technologies* is considered relevant to those working in T&M domain, as "…in effect, an electric vehicle is just a mobile battery on wheels" (P21), and when not used for transportation, would serve as a battery to both supplement the owner's income and help with the energy system demands. Although much of the engineering knowledge and skills in the energy domain remain unchanged (e.g. how to measure current), a whole host of new renewable energy technologies have emerged and the public should be acquainted with these as well (P20).

### 7.2.3 Trades Skills for Transport and Mobility subsystem

- *Installation engineers* are required for installing telemetric units, cameras, charge points, etc.

- *EV Maintenance* skills are growing in demand as more fleets and private car owners are moving away from fossil-fuelled to electric cars.

### 7.2.4  Managerial Skills for Transport and Mobility subsystem

- *Partnership building* is essential as there are many stakeholders involved who need to trust and coordinate with each other: "you've got people like charge point manufacturers, you've got energy utilities and you've got vehicle manufacturers. …I think if we can try to remain technology agnostic …we could be a little bit more credible when we say, perhaps you should consider this type of charge point …So I think in terms of forging those relationships …we're going to have to do that as well as the actual technical delivery" (P21).

- *Technical Project Management* is "…desperately lacking from industry, …" but where this is in place and "…the engineers [are] also the project managers …" (P20), the project runs better and more smoothly.

### 7.2.5  Finance Skills for Transport and Mobility subsystem

- *New Business Model Development* is imperative for many stakeholders within the T&M section, as the traditional route operation or car/taxi services are becoming less and less viable on their own" …Via, for example, has a tie-in with Mercedes Benz who are looking at creating a new market for their vehicles because they see car ownership as reaching a point where perhaps it's going to go down …" (P10). Thus, various income streams are to be considered and combined into a business model.

- *Financial modelling* is relevant when planning on revenue stream integration (e.g. from car clubs, multipoint-to-multipoint taxi service, to using EV batteries for vehicle-to-grid energy trading and grid frequency support). Since the geography of a given locality will have an impact on the viability of the smart mobility model (e.g. the low population density and non-grid layout of Bristol make multipoint-to-multipoint service unprofitable (P10)), the income, costs, and constraints of each service would need to be modelled in order to set up a viable T&M business.

- *Creating Value from Data* is a "challenge and a skillset" (P21) of identifying monetisation opportunities of data while keeping to the privacy and security regulations (GDPR) and other organisational constraints.

### 7.2.6  Policy Skills for Transport and Mobility subsystem

Here, the respondents noted the impact of local policies as well as identifying several areas where necessary regulations are missing:

- *Local policy* (e.g. clean air zones in Bristol, restricting parking and increasing parking fees, building city-wide cycle lanes and networks) provides a positive impetus for transition away from the fossil-fuelled transport. Thus, linking up such policies to the local needs and changes is a valuable skill.

- *Compliance with the Regulations on Charge Point Standards* is, at present, voluntary. This makes it impossible to ensure that all the various charge points within Bristol are interoperable, which increases the risk to EV asset utilisation and forces the EV fleet owners to invest in their own charge points. This, in turn, makes the transition to the EV project even

more expensive. Thus, a regulation for installing only OCPP (Open Charge Point Protocol) standard compliant chargers within a given locality (i.e. Bristol) could help break this barrier to a better local EV adoption.

- *Lobbying for SLE SoS Transition in Transport and Mobility* is about engaging with pressure groups (e.g. Transport Focus), understanding travel habits, constraints, and opportunities so as to influence the local and national authorities to foster SLE SoS transition in the T&M sector.

### 7.2.7   Legal Skills for Transport and Mobility subsystem

- *Regulation on Cybersecurity* is noted as a key open issue to be addressed for the smart EV charging and control: "…cyber security is a bit of an open door that they [the regulators] haven't really considered …" Should a charge point be hacked, it would lead to "…huge reputational damage". The current state of cybersecurity controls within T&M is said to be "…the equivalent of just leaving a window open and a ladder" (P21).

- The skill of *Transferring Previous Learning* is missing, e.g. in transferring learning on regulation around smart meters and their security to the EV charge point domain. Such learning and transfer of skills could help to legislate for a deregulated, yet also interoperable and trustworthy solution, for EV charge points.

- *Handling User Data in a GDPR-compliant way* is another missing key skill: T&M companies must learn to share, exchange and monetise user data while also complying with the GDPR. The current lack of skills to interpret this regulation leads to a lack of collaboration and business development around the data sharing/use opportunities.

### 7.2.8   Soft Skills for Transport and Mobility subsystem

- *Communication with Citizens on Technology* is often challenging, as there is a gap in understanding between technologists and non-technologists, and communication is often undertaken by people who do not understand the technology well themselves. This can be overcome by undertaking communication through a " …team of people who are not just doing the technology, but are also doing the engagement" (P20).

- *Engaging People with Engineering* is another critical skill set, as the ever increasing need for engineers is a certain trend for transition to SLE SoS. Although this is challenging, such an engagement can be carried out through "…engineering outreach and trying to engage with …the wider public" (P20).

## 7.3   Training needs for Transport and Mobility System

### 7.3.1   Areas of Training Needs

The key areas in T&M where training is considered to be particularly necessary are:

- *Engineering*, or more specifically, *Software Engineering, Electrical and Electronics Engineering and Systems Engineering*. This is not surprising, as within the SLE context, Transport

and Mobility is one of the core subsystems, which both provides transportation service, and also acts as a massive distributed battery system which stores electricity generation, provides flexibility services (e.g. by deferring or pushing forward the charging times) and regulates grid frequencies. Thus, engineers must be trained to deliver and maintain this smart subsystem. A highlighted focus is placed on such skills as:

- – Requirements Engineering (so that the right system is built);
- – Systems integration (so that the various components, such as EVs, charge points and pricing systems, can exchange data and exercise control);
- – *Programming*, so that various monitoring, learning, control, and evaluation solutions are developed.

- *SLE SoS and Renewable Energy knowledge*, helping to show how T&M interacts with and contributes to the SLE SoS agenda at large;

- *New Business Model Development*, so that commercially viable organisations are set up and endorse the agenda for T&M in SLEs;

- Developing *Local and National Policy* that furthers T&M in SLES agenda (e.g. clean air zones; charge point installation only for OCPP standard products with cybersecurity considered essential).

### 7.3.2 Modes of Training

When discussing how training should be delivered, the respondents noted a variety of training modes and levels, given that both highly-skilled and generic trades skills are needed. However, under the SLES, the T&M sector is becoming more skilled and more digital:

- *Higher education degrees* are considered to be prerequisites for many roles. For example, the algorithm developers (e.g. for resource/route optimisation problems) are expected to have PhD degrees; those working with telemetries and data analysis would have an MSc or a Bachelor's level qualifications - mostly in ICT or Electronics Engineering and Power Systems/Energy. However, university education is also sometimes considered to be too theoretical and graduates are expected to supplement the degrees with practical experience.

- *Further education colleges* and HND qualifications are relevant for those employed on the "shop floor" (P21) of the manufacturing sections of the T&M firms;

- *Internal Training at a Company* is utilised where there is a "business case" (P21) for extra training and external training providers are invited to deliver short courses. However, in SME's "…there aren't enough people for everyone to have a specific task" (P20) so each worker tends to be trained in a few specialities;

- *Placements and Secondments* are considered to be a good way (for undergraduates) to supplement their theoretical university degrees. The *sandwich year*/year with industry programmes are considered to be particularly beneficial, as these allow for the students to get a good grasp of the jobs they could step into following their graduation. Shorter term placements (e.g. 6 weeks to 3 months) are considered to be less productive.

- *Online Courses*, such as those from Linked-In Learning, are noted as a way of keeping up-to-date with relevant topics, as is "micro training" (P10) through listening to Blinkist which "abbreviates books on all sorts of topics into a 15-minute précis of the key ideas and just gives you an insight into all of that value" (P10).

## 7.4 Insights and Recommendations on Bristol's Transport and Mobility Subsystem

The transport and mobility sector is comprised of a large set of assets including the road and rail networks, traffic control equipment, vehicles, refuelling and maintenance stations, public transport etc. When transitioning to the SLE SoS context, much of the assets and infrastructure stock will remain, although the vehicle stock, refuelling and maintenance stations would have to be replaced. In addition, a new control infrastructure would need to be developed to integrate the EVs and their charging stations into the core of the Smart Local Energy System.

### 7.4.1 Transport and Mobility - Core SLE SoS Subsystem

As previously noted, EVs are "batteries on wheels" (P21). Presently, these 'batteries' and their charging stations are becoming tightly integrated into the electricity grid, both as electricity consumers, and as a distributed storage, flexibility providing and frequency regulating component. The intersection of these two subsystems (i.e. electricity and T&M) has already begun to grow. In the medium to long term future, these subsystems are likely to become very tightly coupled with *transport and mobility becoming a core part of the electricity grid.*

From the skills perspective, such a tight integration will lead to the emergence of *new professionals: those with strong backgrounds in both Energy and Transport/Mobility.* Demand for such professionals has already emerged in smart mobility companies, and will continue to grow.

### 7.4.2 Behaviour change

Decarbonising transport is one of the biggest challenges we face in the transition to SLE SoS. Unlike transitioning to renewable electricity which has been mostly hidden from consumers, transport decarbonisation **requires both significant behavioural change to shift away from vehicles powered by diesel and petrol, and the development of a new infrastructure**.

#### 7.4.2.1 Infrastructure Development

To support infrastructure development, many local authorities have already committed substantial investments into charge points. However, given that vehicle asset utilisation is dependent on charge point availability, and EV car mechanics, the car fleet operators see risks in the likely unavailability and lack of compatibility and security in the type of charge points they'd need. Therefore, they find it necessary to invest in their own charging stations, which increases the cost of EV adoption by fleet operators and businesses.

In addition, the transition requires development of new safe walking and cycling networks, as well as new ride-sharing models.

From a skills perspective, the ability to define local (and national) policies that de-risk investment into EVs, as well as reducing the cost of transition, is highly sought after. In addition, engineers and tradesmen who will install, maintain and operate the infrastructure will need to be trained.

### 7.4.2.2 Change of Vehicle Stock

The change of fossil-fuelled to electric car types in private ownership is mostly impacted by the high price of electric and hybrid cars, concerns about the lack of charging point availability, as well as worries about costs and availability of car maintenance services.

Indeed, EV *car maintenance skills are expected to be in high demand* by all respondents, and thus, are an area of a high training need.

Furthermore, the better integrated the EVs become with the electricity grid, the more positive impact they can have on the decarbonisation agenda of Bristol. Thus, a wide-spread training and education initiative is necessary for informing and engaging the general public (see more in section 5) with the transition agenda via exchanging their personal cars to EVs, electric bikes and alike.

### 7.4.3   COVID-19 Impact

While the recent lockdowns and restriction of mobility within the UK has affected all transport and mobility businesses, it has also served as a growth impetus to many areas of smart mobility. In particular, areas that work with retail delivery (optimising resource use and route planning) have continued to grow.

For the T&M skills from SLE SoS perspective, there has been a notable increase in demand for algorithm designers and programmers who would understand both the transport and the electricity subsystems' state and dependencies.

### 7.4.4   Local Geography Impact

Given the current properties of the commercially available EV batteries, we observe that the local geographies have a profound impact on whether, and if so, what kind of EV ecosystem would develop within a given area.

For example, with the low population density and 'hub-like' structure of Bristol's roads, multi-point-to-multi-point ride sharing schemes would not be viable in Bristol. Moreover, the hilly physical landscape would poorly suit electric vehicles that carry large loads. Thus, the hilly landscape of Bristol makes it more likely that bio-fuels/bio-gas/ or hydrogen are more likely to be adopted for bus services and city service vehicles (e.g. recycling and refuse collection).

### 7.4.5   Scale Up Concerns

While the T&M sector in Bristol is well placed in the transitioning to SLE SoS agenda, our study participants noted several factors that might impede this transition, namely:

• The **hardware** within the SLE T&M sector is still somewhat **immature**, in that many charge point manufacturers **do not keep to the OCP (Open Core Protocol)**. This, in turn, both complicates interoperability between various charge point makers, and also impedes provision of sufficient security guarantees to the infrastructure users.

• *Scale Up through Public-Private Partnership* for local authorities was discussed in section 5. A similar set of partnerships (e.g. for charge point operators and EV fleet operators) can be initiated within Bristol's City Leap project for the T&M sector too. This will help to scale up investment, as well as de-risk longer term returns for such an investment for the industrial partners.

- A *Pro-Active Local Regulation* which promotes the SLE SoS T&M agenda (i.e. more clean air zones in the city, parking charges and space regulation, opportunities for participating in "battery services to grid" initiatives for the EV owners, collaboration with local universities and colleges on teaching and training provision targeting local needs, etc.) will also foster a smoother and speedier transition.