

**The UK's Intended Move to Electric and Connected and Autonomous Vehicles: Are Infrastructural Barriers Preventing Successful Transition?**

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# **The UK's Intended Move to Electric and Connected and Autonomous Vehicles: Are Infrastructural Barriers Preventing Successful Transition?**

James Marson\* and Katy Ferris\*\*

## **ABSTRACT**

The advent of Connected and Autonomous Vehicles (CAVs) is poised to transform global transportation systems, offering unparalleled opportunities to enhance safety, sustainability, and efficiency. Given that CAVs are most likely also to be electric vehicles (EVs), and in the UK, CAVs/EVs are a central element of government efforts to modernise mobility while achieving net-zero emissions by 2050, it would seem the UK is ready to embrace the transition to this new and disruptive form of transportation. However, while technological innovation has surged, critical questions remain about the readiness of physical, digital, and policy infrastructures to support the widespread adoption of CAVs. In this paper we examine the UK's preparedness for CAV deployment, focusing on the pivotal role of Local Authorities (LAs) in bridging infrastructure gaps. Drawing on qualitative data from interviews with LAs and experts from a broader project and report, findings presented in this paper reveal significant disparities in preparedness, driven by funding constraints, inconsistent national policies, and public ambivalence. By situating these findings within the broader global context of CAV research, this paper underscores the urgency of coordinated strategies to align CAV integration with sustainable mobility goals.

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Keywords: Connected and autonomous vehicles; Infrastructure; Legal consciousness; Local authorities; Transport policies.

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The advent of Connected and Autonomous Vehicles (CAVs) is poised to transform global transportation systems, offering unparalleled opportunities to enhance safety, sustainability, and efficiency. Given that CAVs are most likely also to be electric vehicles (EVs), and in the UK, CAVs/EVs are a central element of government efforts to modernise mobility while achieving net-zero emissions by 2050, it would seem the UK is ready to embrace the transition to this new and disruptive form of transportation. However, while technological innovation has surged, critical questions remain about the readiness of physical, digital, and policy infrastructures to support the widespread adoption of CAVs. In this paper we examine the UK's preparedness for CAV deployment, focusing on the pivotal role of Local Authorities (LAs) in bridging infrastructure gaps. Drawing on qualitative data from interviews with LAs and experts from a broader project and report, findings presented in this paper reveal significant disparities in preparedness, driven by funding constraints, inconsistent national policies, and public ambivalence. By situating these findings within the broader global context of CAV research, this paper underscores the urgency of coordinated strategies to align CAV integration with sustainable mobility goals.

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## I. INTRODUCTION

Connected and autonomous vehicles (CAVs) are anticipated to be the greatest disruption to travel seen in at least a generation.<sup>1</sup> The term CAV is used to denote (self-driving) vehicles which are able to drive unaided, and which have the capacity to perceive their environment and navigate amongst other vehicles and human drivers. CAVs are not only expected to have positive effects on the environment and on road traffic accident reductions, they are also predicted to provide economic advantages in the countries which adopt the technology. For example, by 2030 the effects on the UK economy are estimated to include 20,000 new jobs in the automotive sector, with a 55% increase in new high skilled jobs and 420,000 new jobs generally, £62 billion in economic growth, and between 2019-2030 3,900 lives saved from deaths involving motor vehicles and a further 47,000 serious accidents being prevented over the same time period.<sup>2</sup> The Society of Motor Manufacturers and Traders<sup>3</sup> also predict that by 2030 1 in every 5 miles travelled by consumers (not to mention businesses

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<sup>1</sup> Litman, T. Autonomous Vehicle Implementation Predictions: Implications for Transport Planning. Available online: <https://www.vtpi.org/avip.pdf> (accessed on 8 December 2024).

<sup>2</sup> The Society of Motor Manufacturers and Traders. Connected and Autonomous Vehicles: The Global Race to Market. Available online: <https://www.smmmt.co.uk/reports/connected-and-autonomous-vehicles-the-global-race-to-market/> (accessed on 8 December 2024).

<sup>3</sup> This body identifies itself as the voice of the motor industry and supports and promotes the interests of the UK automotive industry. <https://www.smmmt.co.uk>.

which are predicted to account for a higher take-up rate of CAVs) could be automated.<sup>4</sup> This is not restricted to private transport, public sector transport and quasi-public (taxi services) and quasi-private transport (autonomous ride-share schemes) could rival entire transport sectors, sparking innovation, burgeoning markets and disrupted industries.<sup>5</sup>

In this paper we focus on the preparedness of local authorities across the UK to explore the effects of these bodies on transitions to new forms of transportation, to understand their decision-making in this regard and what rationale exists for those decisions, and we feel that the UK may be an interesting case study for an international readership and may identify features that might influence or resonate with other jurisdictions. The UK is a globally significant location for research into CAVs due to its unique combination of diverse road infrastructure, supportive regulations, and advanced research capabilities. Its varied road types, from urban centres with dense traffic to rural areas with challenging conditions, provide an ideal environment for testing CAVs across real-world scenarios. The UK government has fostered innovation with a forward-thinking regulatory framework, including the Automated and Electric Vehicles Act 2018<sup>6</sup> and the Auto-mated Vehicles Act 2024,<sup>7</sup> and early approval of

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<sup>4</sup> The Society of Motor Manufacturers and Traders. Connected and Autonomous Vehicles 2019 Report: Winning the Global Race to Market. Available online: <https://www.smmmt.co.uk/wp-content/uploads/SMMT-CONNECTED-REPORT-2019.pdf> (accessed on 8 December 2024).

<sup>5</sup> McGrath, M.M. *Autonomous Vehicles: Opportunities, Strategies, and Disruptions*; Independently published: 2018.

<sup>6</sup> Legislation.gov.uk. Automated and Electric Vehicles Act 2018. Available online: <https://www.legislation.gov.uk/ukpga/2018/18/contents> (accessed on 8 December 2024).

<sup>7</sup> Legislation.gov.uk. Automated Vehicles Act 2024. Available online: <https://www.legislation.gov.uk/ukpga/2024/10/contents> (accessed on 8 December 2024).

public road trials. Complementing this is the country's robust research ecosystem,<sup>8</sup> supported by leading universities, institutions including Zenic and the Centre for Connected and Autonomous Vehicles, and cutting-edge facilities such as the Millbrook Proving Ground and the UK Smart Mobility Living Lab, which enable controlled and live testing of CAV technologies.

In addition, the UK's urban congestion<sup>9</sup> and sustainability goals<sup>10</sup> make it a prime location to explore how CAVs/Electric vehicles (EVs) are a key contributor to reduce emissions and improve urban mobility.<sup>11</sup> Opportunities for integration with the UK's well-established public transport networks offer insights into mixed-traffic environments, while the nation's unique driving culture and laws provide valuable data for developing adaptable systems.<sup>12</sup>

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<sup>8</sup> Dbouk, W. (Ed.) *The Future of Connected and Automated Mobility in the UK: Call for Evidence*; Trustworthy Autonomous Systems Hub, University of Southampton: 2021; pp. 1–15. <https://doi.org/10.5258/SOTON/P0097>.

<sup>9</sup> Faculty of Public Health. Faculty of Public Health Transport Special Interest Group: Congestion Policy Brief. June 2024. Available online: <https://www.fph.org.uk/media/yigjzpl1/fph-tsig-policy-brief-on-congestion-for-website.pdf>(accessed on 8 December 2024).

<sup>10</sup> Gov.uk. UK and the Sustainable Development Goals. Available online: <https://www.gov.uk/government/topical-events/uk-voluntary-national-review-of-progress-towards-the-sustainable-development-goals> (accessed on 8 December 2024).

<sup>11</sup> Rahman, M.M.; Thill, J.-C. Impacts of Connected and Autonomous Vehicles on Urban Transportation and Environment: A Comprehensive Review. *Sustainable Cities and Society* 2023, 96, <https://doi.org/10.1016/j.scs.2023.104649>.

<sup>12</sup> Heimgärtner, R. Towards Cultural Adaptability in Driver Information and Assistance Systems. In *Usability and Internationalization: Global and Local User Interfaces, UI-HCII 2007*; Aykin, N., Ed.; Springer: Berlin, Heidelberg, 2007; Volume 4560, pp. 136–149. [https://doi.org/10.1007/978-3-540-73289-1\\_43](https://doi.org/10.1007/978-3-540-73289-1_43).

Strong international collaborations<sup>13</sup> and ties with the global automotive and tech industries<sup>14</sup> further amplify the UK's impact, making it a model for advancing CAV technology on a global scale. These factors collectively position the UK as a leader in shaping the future of autonomous mobility.<sup>15</sup>

The conclusion to be drawn from these factors is that countries such as the UK are moving rapidly towards an ever-greater adoption of CAVs,<sup>16</sup> yet it appears they may be unprepared for the full implementation of such a transition. Therefore, we see there being a number of issues that require consideration. First is the nature of the move to CAV use and whether the existing and proposed infrastructure is ready for this development. This not only includes physical requirements on the roads and within vehicles but also the views of the public as to their willingness to accept the use of autonomous public and private transport. Secondly, whether the legislation and governmental policies have considered the requirements for the evolution of autonomous vehicles and accepted the mindset shift necessary for their successful

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<sup>13</sup> Hopkins, D.; Schwanen, T. Automated Mobility Transitions: Governing Processes in the UK. *Sustainability* 2018, 10(4), 956. <https://doi.org/10.3390/su10040956>.

<sup>14</sup> See, for example, Remmele, B.; Blessing, V.; Dimakou-Bertels, A.; Bahr, V.; Loeffler, J. Stronger Together: Successful Business Relations Between Baden-Wurtemberg and the United Kingdom. 2020. Available online: [https://www.steinbeis-europa.de/files/steinbeis/dist/img/Dokumente/News/2020\\_gemeinsam\\_staerker\\_en.pdf](https://www.steinbeis-europa.de/files/steinbeis/dist/img/Dokumente/News/2020_gemeinsam_staerker_en.pdf).

<sup>15</sup> HM Government. Connected & Automated Mobility 2025: Realising the Benefits of Self-Driving Vehicles in the UK. 2022. ISBN 978-1-5286-3588-2. <https://assets.publishing.service.gov.uk/media/62ff438c8fa8f504cdec92df/cam-2025-realising-benefits-self-driving-vehicles.pdf>.

<sup>16</sup> <https://www.gov.uk/government/news/britain-moves-closer-to-a-self-driving-revolution> (accessed on 8 December 2024).

implementation. We argue that the current situation has not established this mindset change,<sup>17</sup> largely because of the problems with the charging infrastructure and lack of confidence in EVs being a viable replacement for internal combustion engine (ICE) vehicles.<sup>18</sup> Thus, the local authorities and their plans for the transition to EV use across the UK is crucial to the future success of autonomous vehicle use.

Local authorities (LAs) across the UK play a vital role in regulating public and private transport to ensure accessibility,<sup>19</sup> efficiency,<sup>20</sup> and sustainability.<sup>21</sup> They are responsible for developing and implementing local transport plans, managing road networks, maintaining infrastructure, and ensuring safety.<sup>22</sup> Authorities regulate public transport services such as buses, taxis, and private hire vehicles, setting licensing standards and routes while fostering partnerships with operators to meet local needs. For private transport, they oversee parking regulations, traffic enforcement, and initiatives like congestion charging or clean air zones. They use systems such as traffic management technology, real-time passenger information

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<sup>17</sup> Othman, K. Public Acceptance and Perception of Autonomous Vehicles: V Comprehensive Review. *Ai and Ethics* 2021, 1, 355 - 387.

<sup>18</sup> Kennedy, J.; James, K.; Hampson, B. Public Opinion and Understanding of the Impact of Electric Vehicles: A UK Experience. *Advances in Social Sciences Research Journal* 2023 10(10), 248–277. <https://doi.org/10.14738/assrj.1010.15615>.

<sup>19</sup> OECD (2020), *Improving Transport Planning for Accessible Cities*, OECD Urban Studies, OECD Publishing, Paris, <https://doi.org/10.1787/fcb2eae0-en>.

<sup>20</sup> Masi, C. Urban Governance, Public Transport and the Role of Organizing Authorities. *Public Transport International* 2009, 58(6), 4-6.

<sup>21</sup> Hull, A.; Tricker, R. Assessing Barriers to Sustainable UK Urban Transport Solutions. *Engineering Sustainability* 2005, 158(3), 171–180.

<sup>22</sup> McTiernan, D. Road Safety – Is it a Local Government Priority? (What does the Evidence Suggest?). *Journal of Road Safety* 2019, 30(1). <https://doi.org/10.33492/>.

systems, and Geographic Information Systems to monitor and optimise transport networks. These efforts are crucial for reducing congestion, promoting sustainable travel, and improving air quality in their jurisdictions.

In this paper we use empirical data collected through a project funded by the Property Research Trust<sup>23</sup> where we explored issues around the UK's preparedness for the transition to CAVs. These data are drawn from real-life accounts of decision-makers and policy personnel to provide first-hand accounts of the current state of readiness for the transition to CAV use and to identify good practices from the UK which may be of relevance and interest to policy-makers and operational staff in other jurisdictions. Other studies have raised issues regarding the introduction of CAV use in the UK, whether this is on privacy,<sup>24</sup> the efficacy of its legislative landscape,<sup>25</sup> the potential problems of the insurance regime<sup>26</sup> and the benefits for persons with disabilities – both domestically<sup>27</sup> and on an international basis.<sup>28</sup> However, in this

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<sup>23</sup> Marson, J.; Dickinson, J.; Parkes, S. *Autonomous Vehicle Use in Practice: Is the UK Ready?* Property Research Trust / Royal Institution of Chartered Surveyors, 2023. Available online: <https://www.propertyresearchtrust.org/autonomous-vehicle-use-in-practice.html> (accessed on 8 December 2024).

<sup>24</sup> Marson, J.; White, M.; Ferris, K. *The Investigatory Powers Act 2016 and Connected Vehicles: A New Form of Panspectric Veillance Looming?* *Statute Law Review* 2022, 44(1), 1. <https://doi.org/10.1093/slr/hmac004>.

<sup>25</sup> Marson, J.; Ferris, K.; Dickinson, J. *The Automated and Electric Vehicles Act 2018 Part 1 and Beyond: A Critical Review.* *Statute Law Review* 2019, 41(3), 395. <https://doi.org/10.1093/slr/hmz021>.

<sup>26</sup> Channon, M.; Marson, J. *The Liability for Cybersecurity Breaches of Connected and Autonomous Vehicles.* *Computer Law and Security Review: The International Journal of Technology Law and Practice* 2021, 43. <https://doi.org/10.1016/j.clsr.2021.105628>.

<sup>27</sup> Marson, J.; Dickinson, J.; Ferris, K. *Regulating Connected and Autonomous Vehicles Through a Lens of Inclusivity.* *Hong Kong Law Journal* 2021, 51(3), 983. Available online: <https://web.law.hku.hk/hklj/2021-Vol-51.php#part3> (accessed on 8 December 2024).

<sup>28</sup> van Vulpen, E.; Marson, J. et al. *Australia's Disability Standards for Accessible Public Transport and Connected and Auto-mated Vehicles.* Department of Infrastructure, Transport, Regional Development and Communications,

paper we focus on the work undertaken by local authorities in the UK to establish a functional mechanism for the introduction of CAVs and the infrastructure needed to facilitate this evolution in public and private transport.

The paper is structured first introducing contemporary examples of CAV-based research occurring globally. We continue by outlining the nature of CAVs and their synonymy with EVs. This is important given the diverse topography in the UK, its commercial and residential properties in urban, suburban and rural areas identify differing needs for the charging and recharging of these vehicles, and areas developed which increasingly focus on homes of multiple occupation. This raises issues for the efficacy of charging at home of EVs and given that CAVs will typically also be EVs, without a means of effectively charging these vehicles promptly and away from their homes and places of business will be a significant barrier to convincing people to transition to this vehicle type. We continue by explaining the methods used in collecting the data used in the project where these data derived. We present the findings from this empirical research which focuses on the decision-makers from various LAs across the UK to determine the problems they have faced in preparing for the influx of CAVs and EVs, and the efficacious tactics employed to successfully establish a basis for their use. We discuss these findings and place this work and its implications in the broader literature before presenting our conclusions.

## II. THE CURRENT STATE OF CAV DEVELOPMENT AND DEPLOYMENT

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Australian Government, 2021. Available online: <https://www.infrastructure.gov.au/sites/default/files/documents/dsapt-cav-main-report.pdf> (accessed on 8 December 2024).

Considerable research has been conducted on the developments of CAV work internationally and how these efforts have manifested in the deployment of such vehicles. In the UK, a cautious approach has been taken to the public use of CAVs, certainly at levels 4 and 5 SAE,<sup>29</sup> but this has not been the case on an international scale. In Sweden in 2013 the “Drive Me” project was launched with the aim of persuading families to use CAVs, deploying 100 autonomous Volvo vehicles on public roads in Gothenburg.<sup>30</sup> Italy conducted its first public road test without a human driver in Parma in 2013, navigating urban and freeway environments.<sup>31</sup> In the US and China, CAVs have had quite extensive public use. In 2016, Florida, US became the first State to legalise CAVs on public roadways<sup>32</sup> and has adopted Project Endeavour which aims to accelerate the deployment and adoption of CAVs through public trials.<sup>33</sup> In China, since 2022, Shenzhen began permitting fully autonomous vehicles to operate on specific roads (amounting to 944km of public roads for testing).<sup>34</sup> The Chinese

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<sup>29</sup> SAE J3016 Levels of Driving Automation. [https://www.sae.org/binaries/content/assets/cm/content/blog/sae-j3016-visual-chart\\_5.3.21.pdf](https://www.sae.org/binaries/content/assets/cm/content/blog/sae-j3016-visual-chart_5.3.21.pdf) (accessed on 8 December 2024).

<sup>30</sup> Victor, T.; Rothoff, M.; Coelingh, E.; Odblom, A. C.; Burgdorf, K. (2017). When Autonomous Vehicles Are Introduced on a Larger Scale in the Road Transport System: The Drive Me Project. In: Watzenig, D.; Horn, M. (eds) Automated Driving. Springer, Cham. [https://doi.org/10.1007/978-3-319-31895-0\\_24](https://doi.org/10.1007/978-3-319-31895-0_24).

<sup>31</sup> Broggi, A.; Cerri, P.; Debattisti, S.; Laghi, M. C.; Medici, P.; Panciroli, M.; Prioletti, A. (2014). PROUD-Public Road Urban Driverless Test: Architecture and Results. IEEE Intelligent Vehicles Symposium Proceedings, 2014 648-654.

<sup>32</sup> <https://www.chrisrussolaw.com/floridas-autonomous-vehicle-statute/#:~:text=Florida%20became%20the%20first%20state,roadways%20with%20a%20unanimous%20vote> (accessed on 31 December 2024).

<sup>33</sup> Tyler, N. (2020). Project Endeavour Starts First Public Trials. New Electronics [https://doi.org/10.12968/S0047-9624\(23\)60369-4](https://doi.org/10.12968/S0047-9624(23)60369-4).

<sup>34</sup> Rajpal, S. (2024) ‘Mainland China Autonomous Vehicle Development on a Different Track’ S&P Global Mobility, <https://www.spglobal.com/mobility/en/research-analysis/china-autonomous-vehicles->

government also launched major Artificial Intelligence research programs such as the Intelligent Vehicles Future Challenge to advance CAV technology.<sup>35</sup> Further, in the European Union, current research has focused on how CAVs can aid sustainable urban development, adopting autonomous collective transport in functional urban areas.<sup>36</sup> Such projects contribute to the EU's goal of wide-scale automated mobility deployment by 2030, addressing technological, regulatory, and urban planning challenges associated with CAVs utilisation. These projects helped to develop the first “soft law” measures, an approach taken due to the uncertainties surrounding the technology's risks, towards the emergence of “hard law” of legislation and frameworks as experience and familiarity with the technology grew.<sup>37</sup> Importantly, these regulatory approaches employed industry collaboration (particularly when establishing testing parameters) and mechanisms for insurance cover, along with cooperation with and through public authorities, to facilitate the use and testing on public roads.<sup>38</sup>

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development.html#:~:text=Shenzhen%20began%20permitting%20fully%20AVs,yuan%20in%20revenue%20by%202025 (accessed on 31 December 2024).

<sup>35</sup> Wang, F. (2017). AI and Intelligent Vehicles Future Challenge (IVFC) in China: From cognitive intelligence to parallel intelligence. 2017 ITU Kaleidoscope: Challenges for a Data-Driven Society (ITU K), 1-2.

<sup>36</sup> Gavanas, N.; Anastasiadou, K.; Nathanail, E. G.; Basbas, S. Transport Policy Pathways for Autonomous Road Vehicles to Promote Sustainable Urban Development in the European Union: A Multicriteria Analysis. *Land* 2024 13(11), 1807; <https://doi.org/10.3390/land13111807>.

<sup>37</sup> Van Uytsel, S. Testing Autonomous Vehicles on Public Roads: Facilitated by a Series of Alternative, Often Soft, Legal Instruments. *Perspectives in Law, Business and Innovation*. In Van Uytsel, S.; Vasconcellos Vargas, D. (eds.), *Autonomous Vehicles*, 39-64, Springer, 2021.

<sup>38</sup> Van Uytsel, S. Testing Autonomous Vehicles on Public Roads: Facilitated by a Series of Alternative, Often Soft, Legal Instruments. *Perspectives in Law, Business and Innovation*. In Van Uytsel, S.; Vasconcellos Vargas, D. (eds.), *Autonomous Vehicles*, 39-64, Springer, 2021.

Various projects have been reported across the literature highlighting the use of innovative practice which aim to accelerate the deployment of CAVs through the various safety and technological enhancements necessary for their full, autonomous, public use. Open-source platforms such as “OpenPilot” and “Apollo” are fostering collaboration and accelerating technological advancements in CAV technology.<sup>39</sup> Urban living labs are also emerging as testbeds for integrating CAVs into smart cities. This work has emphasised the importance of not just cloud-based systems, but on-board sensing, digital infrastructure and energy systems for their use.<sup>40</sup> “Project Endeavour” has been an example of a well-known public trial of CAVs which aimed at scaling CAV adoption.<sup>41</sup> Yet it is also clear that there remain challenges and obstacles to the more complete roll-out of this technology which includes addressing the complexity of the software which enable the autonomy and the collection and use of real-time data.<sup>42</sup> It has been suggested that in combating these issues, there is a need for coordination among academia, government, industry and society.<sup>43</sup> Most recently, research has tended to

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<sup>39</sup> Prajwal Gowda H, G.; Nayak, P.; Prajna; Pragathi; Prashanth Kumar B, C. (2024). An Open Approach to Autonomous Vehicles. *International Journal of Advanced Research in Science, Communication and Technology*, 2024 4(2) Available at: <https://ijarsct.co.in/Paper19248.pdf>.

<sup>40</sup> Mendoza-Armenta, A. A.; Félix-Herrán, L. C.; Silvestri, B.; Valderrama-Solano, A. C.; Tudón-Martínez, J. C.; Roccotelli, M.; Lozoya-Santos, J. D. Autonomous and Electric Vehicles in Urban Living Labs: Smart Mobility Strategies for the Future. *Energies*, 2024 17(21), 5399; <https://doi.org/10.3390/en17215399>.

<sup>41</sup> Tyler, N. Project Endeavour Starts First Public Trials. *New Electronics*, 2020. Available online: [https://doi.org/10.12968/S0047-9624\(23\)60369-4](https://doi.org/10.12968/S0047-9624(23)60369-4).

<sup>42</sup> Hussain, R.; Zeadally, S. Autonomous Cars: Research Results, Issues, and Future Challenges. *IEEE Communications Surveys & Tutorials*, 2018 21(2), 1275-1313.

<sup>43</sup> Mendoza-Armenta, A. A.; Félix-Herrán, L. C.; Silvestri, B.; Valderrama-Solano, A. C.; Tudón-Martínez, J. C.; Roccotelli, M.; Lozoya-Santos, J. D. Autonomous and Electric Vehicles in Urban Living Labs: Smart Mobility Strategies for the Future. *Energies*, 2024 17(21), 5399; <https://doi.org/10.3390/en17215399>.

concentrate on issues including improvements to user experience, consumer acceptance of the transition and improvements to safety and efficiencies.<sup>44</sup>

### III. CAVS AND EVS: DOES THE FORMER NECESSITATE THE LATTER?

The relationship between EVs and CAVs is not entirely co-dependent. This must be confirmed from the outset for us not to misrepresent the discussion that will follow in this paper. Conceivably, almost any vehicle could become a CAV, and indeed the nature of what is a CAV compared with what are simply advanced driver assistance systems is a matter beyond the scope of this paper.<sup>45</sup> However, it is clear from the available evidence that CAVs tend to be based on either a pure EV or a hybrid drivetrain.<sup>46</sup> Indeed, as far as in 2017 it was reported how nearly 80% of light-duty CAVs were based on electric and hybrid platforms<sup>47</sup> and advancements in this space tend to adopt EVs for their CAVs.<sup>48</sup> It is therefore relevant in any

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<sup>44</sup> Prajwal Gowda H, G.; Nayak, P.; Prajna; Pragathi; Prashanth Kumar B, C. (2024). An Open Approach to Autonomous Vehicles. International Journal of Advanced Research in Science, Communication and Technology, 2024 4(2) Available at: <https://ijarsct.co.in/Paper19248.pdf>.

<sup>45</sup> Wienrich, J. Autonomous Driving: The Steps to Self-Driving Vehicles; ZF, 2022. Available online: [https://www.zf.com/mobile/en/technologies/automated\\_driving/stories/6\\_levels\\_of\\_automated\\_driving.html](https://www.zf.com/mobile/en/technologies/automated_driving/stories/6_levels_of_automated_driving.html) (accessed on 8 December 2024).

<sup>46</sup> McCauley, R. Why Autonomous and Electric Vehicles Are Inextricably Linked. Available online: <https://www.govtech.com/fs/why-autonomous-and-electric-vehicles-are-inextricably-linked.html> (accessed on 8 December 2024).

<sup>47</sup> Securing America's Future Energy. SAFE Analysis Shows 80 Percent of Light-Duty Autonomous Vehicles Use Alternative Fuel Powertrains, 2017. Available online: <https://secureenergy.org/safe-analysis-shows-80-percent-of-light-duty-autonomous-vehicles-use-alternative-fuel-powertrains/> (accessed on 8 December 2024).

<sup>48</sup> Navya. What Differences between Autonomous, Hybrid and Electric Vehicles. Available online: <https://www.navya.tech/en/autonomous-hybrid-or-electric/> (accessed on 8 December 2024).

discussion of the move towards CAV use that the conversation involves the issue of charging of EVs in the broader context of an examination of the infrastructure to be effective. This brings us to the first issue in setting the scene for the data to be presented later, the residential and commercial property structures in the UK which place into context the issues facing local authorities when establishing strategic and operational transition policies.

#### IV. HOUSING, TRANSPORT PLANNING POWERS AND THE RESPONSIBILITIES OF LOCAL AUTHORITIES

The UK's topography and settlement patterns are diverse, encompassing bustling urban centres, expansive suburban zones, and sparsely populated rural areas. As the nation transitions towards EVs and, ultimately, CAVs, developing an effective and inclusive charging infrastructure is paramount. The local authorities in the UK must embrace the challenges and opportunities in deploying EV charging facilities, tailored to the UK's varied landscapes and housing types, with a focus on urban, suburban, and rural needs, as well as the complexities of charging in Houses of Multiple Occupation.<sup>49</sup>

LAs in England are bestowed with a diverse range of powers and tasked with responsibilities to ensure effective transport planning and management. They are therefore an essential feature in the successful adoption and implementation of CAVs onto public streets across the UK. These responsibilities encompass several critical domains including their

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<sup>49</sup> See for example Mesicek, T. Challenges of EV Charging in Multi-Family Homes. Available online: [https://eu.landisgyr.com/blog/ev-charging-in-multi-family-homes?utm\\_source=chatgpt.com](https://eu.landisgyr.com/blog/ev-charging-in-multi-family-homes?utm_source=chatgpt.com) (accessed on 8 December 2024) and Bagloee, S.A.; Tavana, M.; Asadi, M. Autonomous Vehicles: Challenges, Opportunities, and Future Implications for Transportation Policies. *Journal of Modern Transport*. 2016, 24, 284–303. <https://doi.org/10.1007/s40534-016-0117-3>.

responsibility, every five years, to prepare and submit comprehensive Local Transport Plans to the Department for Transport.<sup>50</sup> These plans outline the long-term transport strategies, priorities, and planned investments aimed at enhancing local transport services. They oversee the management and maintenance of the local road networks, including the maintaining and repairing of roads, traffic signals, signage, and road markings to ensure safe and efficient travel. To ensure smooth traffic flow and enhance road safety, local authorities implement traffic management measures. These include traffic calming strategies, setting speed limits, and regulating road closures.

Importantly, beyond these strategic and structural matters, the LAs have a significant role in the administration of public transport use, despite the operation of much of the public transport stock being run by private companies.<sup>51</sup> Authorities collaborate with other transport providers to improve the quality, accessibility, and integration of public transport systems, promoting a range of active transport initiatives including walking, cycling, the development of cycle lanes, pedestrian crossings, and related infrastructure to encourage sustainable, healthy transport options.<sup>52</sup> They set parking policies, manage parking charges, and enforce parking regulations.<sup>53</sup> These measures help balance the needs of motorists, residents, and businesses. They also have the ability to determine charging systems for electric vehicles, their placement and maintenance, and often in-corporate real-time information held privately or shared with

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<sup>50</sup> Gov.uk. Find Local Transport Plans. Available online: <https://www.gov.uk/find-local-transport-plans/> (accessed on 8 December 2024).

<sup>51</sup> BBC News. Public-Private Partnerships in the UK. Available online: [http://news.bbc.co.uk/1/hi/in\\_depth/business/2001/ppp/1507970.stm](http://news.bbc.co.uk/1/hi/in_depth/business/2001/ppp/1507970.stm) (accessed on 8 December 2024).

<sup>52</sup> London Government. Green Transport Strategy. Available online: <https://www.london.gov.uk/programmes-strategies/transport/green-transport> (accessed on 8 December 2024).

<sup>53</sup> Via the Traffic Management Act 2004.

the public regarding parking and charging locations and their current use.<sup>54</sup> Finally in this very brief summary, LAs manage the quasi-public transportation through the operation of taxi and private hire services through licensing requirements for drivers and vehicles, ensuring safety and standards of service.<sup>55</sup> Consequently, LAs play a pivotal role in shaping the accessibility, safety, and sustainability of transport systems. Their strategic decisions and policies directly influence the efficiency and resilience of local transport services, impacting both communities and the broader environment.<sup>56</sup>

## V. MATERIALS AND METHODS

The study focuses on the strategic and operational practices of LA planners and policymakers in preparing for CAVs on UK roads. The data used in this paper derives from a broader study completed by one of the authors of this paper,<sup>57</sup> albeit we provide a greater focus and depth of discussion here regarding the preparedness for CAV introduction in the UK

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<sup>54</sup> Sharpe Pritchard LLP. The Legislative Framework for Public EV Charging Infrastructure. Available online: <https://www.sharpepritchard.co.uk/r-ev-olution/the-legislative-framework-for-public-ev-charging-infrastructure/> (accessed on 8 December 2024).

<sup>55</sup> Gov.uk. Licensing of Taxis and PHVs for Local Authorities in England, 2022. Available online: <https://www.gov.uk/government/collections/licensing-of-taxis-and-phvs-for-local-authorities-in-england> (accessed on 8 December 2024).

<sup>56</sup> Schepis, D.; Purchase, S.; Olaru, D.; Smith, B.; Ellis, N. How Governments Influence Autonomous Vehicle (AV) Innovation. *Transportation Research Part A: Policy and Practice* 2023, 178. <https://doi.org/10.1016/j.tra.2023.103874>.

<sup>57</sup> Marson, J.; Dickinson, J.; Parkes, S. Autonomous Vehicle Use in Practice: Is the UK Ready? Property Research Trust / Royal Institution of Chartered Surveyors, 2023. Available online: <https://www.propertyresearchtrust.org/autonomous-vehicle-use-in-practice.html> (accessed on 8 December 2024).

looking specifically at LA decision-making and broader policies. This research is timely, given the UK Government's commitment to all-electric vehicle sales by 2035<sup>58</sup> and CAV deployment from 2025,<sup>59</sup> coupled with constrained LA resources.<sup>60</sup>

In assessing preparedness for CAV introduction, we examine LAs responses and strategies for implementation, recognising the infrastructure challenges of such a transition. A multiple-case study approach was adopted,<sup>61</sup> involving five UK LAs selected based on ongoing or publicised CAV initiatives in their region, their collaboration with research institutes, and local characteristics like topography and strategic importance of CAV/EV deployment. Semi-structured interviews were conducted with 20 participants from departments such as transport, planning, and strategic development, focusing on authoritative officials involved in policymaking.<sup>62</sup> The data were collected over the period March 2022 – Nov 2022 through semi-structured interviews, typically lasting between 60-90 minutes. We used convenience sampling<sup>63</sup> to target LAs' actively engaged in CAV and EV deployment, ensuring access to rich

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<sup>58</sup> Gov.uk. Pathway for Zero Emission Vehicle Transition by 2035 Becomes Law. 2024. Available online: <https://www.gov.uk/government/news/pathway-for-zero-emission-vehicle-transition-by-2035-becomes-law>(accessed on 8 December 2024).

<sup>59</sup> HM Government. Connected & Automated Mobility 2025: Realising the Benefits of Self-Driving Vehicles in the UK, 2022. <https://assets.publishing.service.gov.uk/media/62ff438c8fa8f504cdec92df/cam-2025-realising-benefits-self-driving-vehicles.pdf>(accessed on 8 December 2024).

<sup>60</sup> Gray, M.; Barford, A. The Depths of The Cuts: The Uneven Geography of Local Government Austerity; Centre for Business Re-search, University of Cambridge, Working Papers wp510, 2018. Available online: <https://ideas.repec.org/p/cbr/cbrwps/wp510.html> (accessed on 8 December 2024).

<sup>61</sup> Per Yin, R.K. Case Study Research; SAGE Publications: 2014.

<sup>62</sup> Marsden, G.; Reardon, L. Questions of Governance: Rethinking the Study of Transportation Policy. *Transportation Research Part A* 2017, 101, 238–251.

<sup>63</sup> Lavrakas, P.J. *Encyclopedia of Survey Research Methods*; Sage Publications: Thousand Oaks, CA, 2008.

data while acknowledging limitations in generalisability.<sup>64</sup> While convenience-based sampling limits the study's generalisability,<sup>65</sup> insights are contextualised within UK-specific challenges and informed by international comparisons.

Qualitative methods were chosen to capture the nuanced, subjective behaviours and institutional approaches of the stakeholders.<sup>66</sup> This approach allows adaptability to emergent patterns and provides detailed insights into planning, modelling, and perceptions of CAV integration in diverse transportation systems.<sup>67</sup> The qualitative, multi-case design enhances understanding of the complexities surrounding CAV rollout, offering valuable contributions to local and global discussions on future mobility. We used convenience sampling as our non-probability sampling technique, selecting participants based not only on their accessibility and availability, but also due to the nature of the field of our enquiry. Given we were interested in the LAs' own identification of what their experiences of, and aims towards CAV deployment and readiness were, it was quite clear that they were best placed to identify the most relevant and experienced person in their organisation with whom to contribute to our study. Especially here, random sampling would have not just been impractical, it would have led to a missed opportunity to gain a genuine understanding of the efforts taken by LAs in their work to help introduce CAVs across the UK. The main limitation to this sampling method is generalisability of the findings. We do not intend for our findings to be generalisable, rather they provide a

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<sup>64</sup> Emerson, R.S.W. Convenience Sampling Revisited: Embracing Its Limitations Through Thoughtful Study Design. *Journal of Visual Impairment & Blindness* 2021, 115, 76–77.

<sup>65</sup> Bryman, A. *Social Research Methods*; Oxford University Press: Oxford, 2016.

<sup>66</sup> Creswell, J.W. *A Concise Introduction to Mixed Methods Research*; Sage Publications: Los Angeles, 2014.

<sup>67</sup> Sacks, T.K. New Pathways to Analysis through Thick Description: Historical Trauma and Emerging Qualitative Research. *Qualitative Social Work* 2015, 14, 753–757.

snap-shot of the current efforts and mechanisms behind the respondents' actions and identify the current difficulties faced by LAs in the UK in achieving the transition to CAV deployment.<sup>68</sup>

Being mindful of the potential problems with convenience sampling helped in our efforts to minimise potential bias. We requested respondents from roles across the LA which had an interest and experience of CAV use. This approach provided us with a broad perspective of strategic and operational roles across the LA participants.<sup>69</sup> We were often provided with policy documents and internal communications which helped us to triangulate our data and increase its reliability. These resources and interviews were shared between the research team to help provide an internal review mechanism, a range of perspectives and an understanding of the respondents' data and responses. Finally, whilst the use of semi-structured interviews is intended to facilitate a discussion with the respondent and enables follow-up questions to points of interest raised in the interview, it also allows for a consistent interview guide to reduce variability in questions posed to different participants. The use of semi-structured interviews allows flexibility in exploring responses while maintaining consistency in addressing the pre-defined core research questions. This method design is based on open-ended questions, but ensures all respondents address the core topics of the research.<sup>70</sup>

Data collection included interviews, transcriptions, and thematic coding, guided by both empirical findings and existing literature.<sup>71</sup> Key themes included planners' awareness of

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<sup>68</sup> Maxwell, J. A. *Qualitative Research Design: An Interactive Approach: An Interactive Approach*. Sage, 2013.

<sup>69</sup> Etikan, I.; Musa, S. A.; Alkassim, R. S. Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics* 2015 5(1), 1-4. <https://doi.org/10.11648/j.ajtas.20160501.11>.

<sup>70</sup> Bryman, A. *Social Research Methods*; Oxford University Press: Oxford, 2016.

<sup>71</sup> Glaser, B.; Strauss, A. *The Discovery of Grounded Theory: Strategies for Qualitative Research*; Sociology Press: Mill Valley, CA, 1967.

CAV technologies, planning needs based on projected use, and reflections on existing strategies (such as net-zero,<sup>72</sup> clean air<sup>73</sup> and sustainability).<sup>74</sup> Thematic analysis identified patterns and discrepancies in the findings, which were triangulated with broader observations to ensure consistency and reliability. Full ethical approval was provided by Sheffield Hallam University prior to the commencement of data collection.

## VI. FINDINGS AND THEIR IMPLICATIONS

The findings from our research both complement the existing work on CAV preparedness through the operational and strategic policies enacted by LAs, and raise new and emerging trends which will help focus the attention of planners who are, perhaps, at an earlier stage in their preparations and decision-making. The themes presented represent the main topic areas of our enquiry, based primarily on the literature on CAV research and transitional opportunities and barriers. We begin with equity and inclusion given the nature of this type of technological developments and the history of CAV and EV use being in the more affluent areas of regions and cities. We were also interested in the respondents' thoughts on the implications of autonomous private vehicles having an effect on the commuting distances in their regions, and their experiences of any effect this might have had for members of other parts

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<sup>72</sup> Local Government Association. Delivering Local Net Zero. Available online: <https://www.local.gov.uk/delivering-local-net-zero> (accessed on 8 December 2024).

<sup>73</sup> Gov.uk. Air Quality Strategy: Framework for Local Authority Delivery, 2023. Available online: <https://www.gov.uk/government/publications/the-air-quality-strategy-for-england/air-quality-strategy-framework-for-local-authority-delivery> (accessed on 8 December 2024).

<sup>74</sup> Local Government Association. Toolkit: Sustainability in Council Services. Available online: <https://www.local.gov.uk/our-support/sustainability-hub/climate-change-resources/toolkit-sustainability-council-services> (accessed on 8 December 2024).

of the LA organisation, such as planning departments. This would help us to understand the joined-up thinking on the CAV transition that was happening across the LA. We asked about EV charging points due to the nature of CAV use being primarily EV use too. Thus, in order to successfully transition the public to CAV use (in their private vehicle guise), an effective EV charging strategy (away from home or for vehicles parked with no off-street parking facility) would be needed. The issue of funding was raised given the high costs involved in new technology use and to identify what implications this had for LAs across the UK (some of which were in very affluent districts and others in quite economically poor areas). We also enquired about the existing and proposed digital and automated systems in place to identify the current readiness of the LA, its understanding of the needs surrounding CAV introductions and what examples it might have of existing projects which demonstrate their innovations for the transition to CAV use. We continued our discussions with the respondents, enquiring about their strategies for CAV introductions and to what extent was this topic a matter for the agenda of planning meetings. The final aspect of the findings was one which grew organically from our semi-structured interviews and conversations with the respondents. It quickly became clear that engagement with the community, with third-party external organisations, and with other like-minded members of the LA community had significant effects on the respondents' interest, awareness and readiness for CAV deployment. This led to our continued examination of this topic when applying the lens of legal consciousness to the decisions and strategies adopted by the LAs.

As will be demonstrated in this section of the paper is the recurring theme among respondents regarding the introduction of CAVs into public and private domains, aligning with

the insights of Guerra,<sup>75</sup> was the recognition that CAVs should not be viewed solely as a solution to planning challenges such as congestion, traffic accidents, and pollution. While CAVs are often associated with mitigating pollution—particularly in city centres and high-traffic areas, given their alignment with EV technology<sup>76</sup>—respondents also highlighted potential drawbacks. For instance, nine LA representatives expressed concern that CAVs might exacerbate congestion due to their convenience and the possibility of vehicles idling or looping on roads while awaiting passenger commands.

The primary challenge for LAs, however, was integrating CAVs into established, linear frameworks for transport planning.<sup>77</sup> Active travel remained a central focus of planners' strategies, given its clear health and wellbeing benefits for individuals.<sup>78</sup> This emphasis on active travel also carried significant implications for public transport, as well as the design of shopping and social spaces in city centres and surrounding areas.<sup>79</sup> Notably, our findings diverged from those of Freemark et al.,<sup>80</sup> as respondents did not perceive CAVs as posing a

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<sup>75</sup> Guerra, E. Planning for Cars that Drive Themselves: Metropolitan Planning Organizations, Regional Transportation Plans and Autonomous Vehicles. *Journal of Planning Education and Research* 2016, 36(2), 210–224.

<sup>76</sup> Monios, J.; Bergqvist, R. The Transport Geography of Electric and Autonomous Vehicles in Road Freight Networks. *Journal of Transport Geography* 2019, art. no. 102500. <https://doi.org/10.1016/j.jtrangeo.2019.102500>.

<sup>77</sup> Friedrich, M.; et al. Integrating Automated Vehicles into Macroscopic Travel Demand Models. *Transportation Research Procedia* 2019, 41, 360–375.

<sup>78</sup> Mytton, O.; Panter, J.; Ogilvie, D. Longitudinal Associations of Active Commuting with Wellbeing and Sickness Absence. *Preventive Medicine* 2016, 84, 19–26.

<sup>79</sup> Freemark, Y.; Hudson, A.; Zhao, J. Are Cities Prepared for Autonomous Vehicles? *Journal of the American Planning Association* 2019, 85(2), 133–151.

<sup>80</sup> Freemark, Y.; Hudson, A.; Zhao, J. Are Cities Prepared for Autonomous Vehicles? *Journal of the American Planning Association* 2019, 85(2), 133–151.

substantial risk to their respective cities, suggesting a more optimistic outlook among the participants of our study, but this did not mean that our respondents were oblivious to potential problems during the testing and eventual roll-out of CAVs in their regions.

## A. EQUITY AND INCLUSION

We begin our presentation of the issues raised by respondents with potentially positive benefits of CAV introduction, but which need to be carefully managed and will not simply emerge as a natural consequence of CAV deployment. It has been identified that CAV use could potentially revolutionise transport for persons with disabilities, providing an independence with full door-to-door transport for groups of people who currently require the assistance of others and are typically unable to travel independently.<sup>81</sup> These views were acknowledged by our respondents who saw the potential benefits of CAV use on such a macro scale.

Respondents observed that while CAV transport might lengthen commute times due to strict adherence to speed limits and predominantly autonomous route planning, it could offer significant advantages to travellers. Passengers could utilise their commute for focused work or access entertainment in more convenient and enjoyable ways, particularly when using public transportation systems.<sup>82</sup> However, the respondents were also mindful of making private

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<sup>81</sup> van Vulpen, E.; Marson, J. et al. Australia's Disability Standards for Accessible Public Transport and Connected and Auto-mated Vehicles. Department of Infrastructure, Transport, Regional Development and Communications, Australian Government, 2021. Available online: <https://www.infrastructure.gov.au/sites/default/files/documents/dsapt-cav-main-report.pdf> (accessed on 8 December 2024).

<sup>82</sup> Elbanhawi, M.; et al. In the Passenger Seat: Investigating Ride Comfort Measures in Autonomous Cars. IEEE Intelligent Transportation Systems Magazine 2015, 7, 4–17.

vehicle use a passenger-mode of transport, moving individuals from using public transport to private-CAVs. This might alleviate one of the problems associated with transposition to CAVs - encouraging the population to use the technology – and with a greater use by the public would come the assistance to LA-planner in convincing budget-holders to invest in this new form of transportation (including much more investment in EV use).

What will likely happen is that there will be a shift towards vehicles that are cleaner, more automated, but remain personal vehicles, and that will cause more congestion, and that will become a disincentive to people using those modes. I think it will become harder for LAs to embed that personal travel from people’s everyday lives. The air quality argument would have gone, but the comfort and the independence of that personal travel mode will become even more difficult to shift. People will be happy to sit in their car for longer, you know, their thirty-minute commute becomes a fifty-minute commute because of congestion, but they don’t mind because they’re watching Netflix, or playing games, or doing their work, or sleeping or whatever. (Ethics Specialist)

A further, practical, issue was emerging too that should be noted for planners when considering embarking on CAV testing and use in their regions. It was commented that current CAV testing and roll-out was taking place in economically privileged areas and some respondents were mindful of the potential negativity that this might create across LA boundaries – essentially instilling a notion of a disconnect between the “haves” and the “have-nots.” Respondents warned that uneven deployment of CAVs in particular could exacerbate existing inequalities [76] and this being evident even in the testing stage of these vehicles where the focus was in the “safer” areas of the city:

If deployment focuses on affluent areas, we risk exacerbating inequalities in mobility access. (Ethics Specialist).

It should be a way of getting past inequality because certain areas, low-income areas, tend to not have good transport or bus links and stuff like that right, [they] kind of get left out. So, that's the balance between inequality in the service, the availability of the service, and how it can either be used to entrench inequality further or alleviate it. (Engagement Specialist)

Of course, it is not simply areas of cities and suburban districts where inequality could be found in the use of CAVs/EVs. Despite their potential to benefit people living in rural areas,<sup>83</sup> the effects of CAVs reducing driving effort<sup>84</sup> may impact suburban housing and house prices.<sup>85</sup>

[The introduction of CAVs] could make things much worse, and it could make outlying areas of town more expensive because they become viable for commuting, and so people on lower incomes end up having to live further out from the city centres, and then commuting further in. So you just push the issue further out in a way and make

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<sup>83</sup> "Rural communities are often left out of these conversations, yet they stand to benefit significantly from autonomous mobility" (LA JD7).

<sup>84</sup> Waldrop, M.M. Autonomous Vehicles: No Drivers Required. *Nature* 2015, 518, 20–23.

<sup>85</sup> Fuller, B. Cautious Optimism about Driverless Cars and Land Use in American Metropolitan Areas. *Cityscape: A Journal of Policy Development and Research* 2016, 18(3), 181–184.

life harder for those people on lower incomes, often like key workers who have to come in to the town centres to do their jobs. (Ethics Specialist)

These concerns align with Guerra,<sup>86</sup> who highlighted the risk of social exclusion in CAV adoption if policies fail to account for diverse regional needs. However, this should not be seen as a given result, especially where the LA makes a concerted effort to mitigate against such potential inequality. Lu et al.,<sup>87</sup> in the context of a Transit-Oriented Development scheme, explains how road corridors were used to enhance the viability of public transport systems in urban areas beyond city centres, with the result of CAV introduction in public sector transport leading to a marked increase in passenger numbers. The transformation observed extended well beyond the anticipated benefits of clean air and environmentally friendly transportation associated with CAVs, highlighting broader implications for urban development.

## B. EV CHARGING POINTS

Charging points and readying for the influx of demand on the grid with EV charging for private vehicles was a further issue which demonstrated strategic partnerships internally and externally among LAs. The respondents noted that decisions had been made in recent years which did not account for the preparation of CAV/EV use and charging, and this would require a change in use of existing infrastructure to allow for street lighting to be repurposed as housing

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<sup>86</sup> Guerra, E. Planning for Cars that Drive Themselves: Metropolitan Planning Organizations, Regional Transportation Plans and Autonomous Vehicles. *Journal of Planning Education and Research* 2016, 36(2), 210–224.

<sup>87</sup> Lu, Z.; Du, R.; Dunham-Jones, E.; Park, H.; Crittenden, J. Data-Enabled Public Preferences Inform Integration of Autonomous Vehicles with Transit-Oriented Development in Atlanta. *Cities* 2017, 63, 118–127.

for EV charging points – particularly important for several of the respondents whose city housing stock included terraced houses with no available off-street parking.

There's a whole bunch of nonsense about cables [connecting the EV to a charger from within a house] on streets... We [had] moved all the [on street] lighting columns to the back of the footway because we thought that was a much better way to [improve accessibility]. But actually, it would be better to have them at the front of the footway if you're going to [use it for EVs when] providing electricity. (LA J1)

Yet other respondents had considered EV charging and its potential and future impact for the city and its residents. This included identifying high volume areas and introducing a system of charging points to help transition users to an EV.

We had a clear objective to increase the number of EVs used in the city so we've embarked on quite a large [project to produce the] highest density of charging points than anywhere else in the country outside of London. It's been very much targeted, the deployments of the infra-structure, where we would both see a need and growing of the market around this. So high profile destination charging locations, having the right charging in workplaces, recognising that putting chargers on the street for people without a drive is difficult, so can we look at it in a different way by creating hubs, creating charging opportunities at the local shops, leisure centres etc. So we've created a fairly extensive network of over 400 chargers within the city, many of them concentrated in hubs and locations and that's working pretty well for us because we're seeing an uplift in growth in vehicles, ownership in the area. (LA S4)

## C. FUNDING CONSTRAINTS

The respondents in this study collectively expressed enthusiasm for CAVs/EVs and the opportunities they present. They demonstrated a forward-looking perspective, having considered the potential implications of CAVs on transport, mobility, equality, and social cohesion, and were optimistic about the transformative benefits these technologies could deliver. However, all respondents had direct experience with the challenges of funding projects related to CAV implementation. They were accustomed to securing bids from public funding sources but noted a decline in such resources in recent years, attributed to factors such as political instability and global events, including the Covid-19 pandemic.<sup>88</sup> While few explicitly voiced complaints, respondents acknowledged the constraints of restricted budgets and the need to make savings in other departments, which exacerbated difficulties in securing funding for further work on CAV initiatives. These challenges extended to the allocation of their own time, reassignment from existing responsibilities, and addressing the infrastructure modifications required to ensure the safe and reliable deployment of CAVs.

We've had such a reduction in funding in local government that it makes it very hard... We had another opportunity where [we] could lead a bid for the north of England [other LAs] said they just didn't have the capacity to do it and then it came to me. In the end I felt I would love to do it but with my role... the idea that I can just somehow spend half my time on doing this [CAV-preparation work] is just not feasible and to create jobs on the off-chance is just not feasible either. (JD 2)

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<sup>88</sup> Odgen, K.; Phillips, D. How Have English Councils' Funding and Spending Changed? 2010 to 2024. Institute of Fiscal Studies, 2024. Available online: <https://ifs.org.uk/publications/how-have-english-councils-funding-and-spending-changed-2010-2024> (accessed on 8 December 2024).

... and if you've been speaking to local authorities you know everybody's cash strapped and risk averse at the moment, so I think there's got to be lots of investment now to potentially make some of these [CAV] trials happen, to create them, to put them in front of the public and start to build those business cases, start to mainstream that technology before then you start to unlock the opportunity for others to utilise it. (SP 3)

We've started putting in EV chargers incrementally, but grid capacity remains a challenge. Scaling this for CAVs will require substantial investment. (LA J5).

Many of the respondents explained the issue of funding available publicly through central government. Whilst this had been plentiful in the early years of CAV/EV availability in the private sector with many government grants available to interested LAs. More recently the funding streams had become more difficult to obtain and LAs were increasingly told to partner with private organisations to fund these initiatives.

[CAVs by 2035] The challenge for us, it's not unrealistic but it needs to be backed by funding. The problem is as a combined authority or even a LA we don't have the money to initiate one of these trials or projects or services on our own. (LA S6)

The result of not having incentives and initiatives operated by central government for CAV/EV deployment and infrastructural development is that LAs may simply revert to existing forms of transport and funding these until CAV/EV use becomes more mainstream.

It's still perhaps too much of a leap of faith for a LA to spend significant amounts of money to enable this to happen. I'm sure of the technology, the public response to them and the return on investment, it's still far easier for LAs to invest in what's understood... bus services or walking and cycling. (LA S4)

And even where money is not a problem, the implementation of a strategy that involves EV public charging is the capacity available regionally.

[A private organisation collaborator] did a piece of work for [UK government body] and... every LA is to develop an EV strategy which should be a partnership working with an external provider unless the LA can cover all the costs. They gave examples of how many they're expecting over the next few years, ours is thousands, we've got 100 in and we're talking tenfold. Our [power] grid can't cope, our grid's folded basically... we need four times the grid capacity. (LA J5)

These findings align with those of Guerra,<sup>89</sup> who noted that inadequate funding is a major barrier to the implementation of autonomous mobility solutions, particularly in regions with aging infrastructure. Of the respondents to our study, without an established research base in the region (namely Universities of world-leading reputations who were working in this area), the physical location which aligned its existing road-network to facilitate easier testing of CAVs, or the location being home to established motor vehicle manufacturers, funding and external partnership development was a clear barrier to proactive preparedness.

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<sup>89</sup> Guerra, E. Planning for Cars that Drive Themselves: Metropolitan Planning Organizations, Regional Transportation Plans and Autonomous Vehicles. *Journal of Planning Education and Research* 2016, 36(2), 210–224.

## D. DIGITAL CONNECTIVITY

Digital infrastructure emerged as another critical area of concern. Respondents highlighted the reliance of CAVs on high-speed connectivity, particularly 5G networks, for vehicle-to-infrastructure (V2I)<sup>90</sup> and vehicle-to-vehicle (V2V)<sup>91</sup> communication. It is common for the LAs to have sophisticated plans and structures in place with 5G networks as they embrace the concept of becoming smart cities.<sup>92</sup> The connectivity of CAVs, as well as the communication between vehicles and between vehicles and infrastructure, is essential for real-time tracking of vehicles and real-time communication between vehicles.<sup>93</sup> As part of their initiatives to identify traffic issues and ensure efficient and effective responses, some authorities are planning to use these CAVs to collect information. They are using tracking devices through CCTV systems to do this.

Our current local transport plan has a fairly strong nod to the role that CAVs could make... Now we're starting to think about our next local transport plan, and very much it's now coming into mainstream that CAVs will have a role to play... [We] looked at

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<sup>90</sup> Petrov, T.; Pocta, P.; Kovacikova, T. Benchmarking 4G and 5G-Based Cellular-V2X for Vehicle-to-Infrastructure Communication and Urban Scenarios in Cooperative Intelligent Transportation Systems. *Appl. Sci.* 2022, 12(19), 9677. <https://doi.org/10.3390/app12199677>.

<sup>91</sup> Yaacoub, E.; Zorba, N. Enhanced Connectivity in Vehicular Ad-Hoc Networks via V2V Communications. 2013 9th International Wireless Communications and Mobile Computing Conference (IWCMC) 2013, 1654–1659.

<sup>92</sup> Gohar, A.; Nencioni, G. The Role of 5G Technologies in a Smart City: The Case for Intelligent Transportation System. *Sustainability* 2021, 13, 5188.

<sup>93</sup> Hugo, D.; Eichler, G.; Rosowski, T. A Holistic Communication Network for Efficient Transport and Enhanced Driving via Connected Cars. *International Conference on Innovations for Community Services* 2019, 11–24.

a timeline of when we think these things are going to manifest themselves within the city running between now and 2030 and we recognise you can connect to vehicles, connect to systems and building infrastructure in the city to support that connectivity. Our last project in this area was working to create a 5G network that we could start connecting vehicles and everything that moves over a real time information base. So, recognition that connectivity, smart parking, smart traffic signals etc will be the natural thing that is already emerging in cities. (LA S4)

It was noted by a LA respondent that sophisticated systems have been developed to identify the effects that CAV deployment might have on the city.

So, we created a scenario with inter-set points within the city where people can be picked up, dropped off, use these [CAVs] and can be efficiently going to what effectively could be like the front of an airport - drop off, next person uses them and moves around in that vehicle. We developed a transport model to look at that and how that would impact on the city and the business side of that - housing, business parks, whatever. We looked at a number of “what if” scenarios if and when we might have 10, 30, 50, 80% of highly capable CAVs on the network and see what impact that had on the city. We also did a secondary study on this notion that could a connected and autonomous vehicle create road capacity where the all-knowing car might be able to operate on a highway better than a human and if you have that capability could you tinker with modelling parameters to demonstrate whether this actually increased capacity on your highways? (LA S4)

These examples were of respondents in cities where internet coverage was well established and could be scaled to ensure the CAV deployment was effective. Moving away from the cities resulted in evidence of the fragmented state of digital infrastructure in the UK, which contrasts with nations like the Netherlands, where consistent connectivity has been prioritised (KPMG, 2020).<sup>94</sup> This has negative implications for the roll-out of CAVs and smart cities given the need for connectivity for the full benefits and implementation to be realised.<sup>95</sup>

## E. THE AUTOMOBILE-CENTRIC CITY

Established research has identified a prevalent tendency among planners to adopt an automobile-centric perspective regarding the deployment of vehicles generally, and this may also apply to CAVs/EVs. These studies highlighted how urban environments have been predominantly shaped around private car usage, with road infrastructure, building developments, and economic strategies frequently designed to accommodate and pro-mote car dependency.<sup>96</sup> Duarte and Ratti<sup>97</sup> succinctly encapsulate one of the most compelling aspects of CAV adoption, observing that, “it has already become a consensus among transport planners

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<sup>94</sup> KPMG. Autonomous Vehicles Readiness Index, 2020. Available online: <https://assets.kpmg.com/content/dam/kpmg/xx/pdf/2020/07/2020-autonomous-vehicles-readiness-index.pdf>(accessed on 8 December 2024).

<sup>95</sup> Bolívar, M.P.; Pereira, G.V.; Pardo, T. *Introduction to the Minitrack on Smart and Connected Cities and Communities*. Hawaii International Conference on System Sciences 2022. <https://doi.org/10.24251/hicss.2022.332>.

<sup>96</sup> Guillen, P.; Komac, U. Motorisation and the City: America Leads the World. In *City Form, Economics and Culture*; Springer-Briefs in Architectural Design and Technology; Springer: Singapore, 2020. [https://doi.org/10.1007/978-981-15-5741-5\\_8](https://doi.org/10.1007/978-981-15-5741-5_8).

<sup>97</sup> Duarte, F.; Ratti, C. *The Impact of Autonomous Vehicles on Cities: A Review*; Informa UK Limited, 2018.

and urban designers that [CAVs] might redefine urban mobility in the near future.”<sup>98</sup> As with our findings, broader concerns about transport and mobility were very much part of the decision-making guiding policies [90]. While our findings did not strongly reflect this consensus, they partially supported Duarte and Ratti’s assertion that CAVs are likely to act as a catalyst for change. However, the specific nature and trajectory of this change remain uncertain and far from self-evident.

We are looking at it all cohesively, pulling it all together, gradually getting there but it’s small steps... It’s really hard to convey the significance of it to people internally, we don’t really quite get it, all this smart city business, lots of people, the chief executive included [asks] “where’s the benefit coming to us now”, and it isn’t now is it, it’s in the future. (LA 8)

Yet for some LAs, the entire concept of CAV deployment was at a level of uncertainty that they could not foresee a pragmatic way of spending diminishing resources on preparing for a new form of transport which may not be visible in the foreseeable future.

We’re not absolutely 100% certain that [CAVs] will have a role to play in the city so we’re still at the relatively small scale. We’re getting close to an operational service to deploy and that will build confidence in LAs to invest some money in these areas. (LA S4)

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<sup>98</sup> Duarte, F.; Ratti, C. *The Impact of Autonomous Vehicles on Cities: A Review*; Informa UK Limited, 2018, p.

Yet, as the same respondent continued, the decision-making as to whether to invest in making the city CAV-ready was ultimately a concern of value for money and a cost-benefit analysis.

If it's a cheaper option or a better option to subsidise and create these services rather than continue to subsidise traditional buses, if we get more return on our investment and can demonstrate that, that's when cities will start investing more heavily into these types of services and be braver in what it does to enable them to happen. (LA S4)

Almost immediately in our discussions, the respondents would typically return to the issue that CAV/EV introduction was predicated on the pragmatic and reality of the infrastructure available in the region.

We've also got a high percentage of properties that don't have off-street parking... So even if you're looking at things like [charging] hubs [to facilitate electric vehicles, and thus more likely CAVs], it's not straight forward for us. We're very interested in getting involved [but] it's about trying to predict what's going to happen, it's about trying to pick up what's already out there. (LA JD7)

The infrastructure was a dominant feature throughout all of the responses. This manifested in several ways throughout the responses we received, which also was largely dictated by the physical location of the region in which the respondent was based and also on

their involvement (or not) in the various “test-beds”<sup>99</sup> and (pre)roll-out initiatives publicly funded to analyse the efficacy of CAVs in regions in the UK.

I mean, the basics of autonomy... are that you need to maintain the road infrastructure in good condition, so you need to keep your white lines good, you need to keep your road signs clear and at the moment local authorities are having to abandon ship on all of that and the level of basic maintenance infrastructure is really very poor. Now, of course that can be put right with money and it would have to be I assume as the level of autonomy increases. (PE 03)

Thus, even the most basic elements of the road infrastructure – signage, the painting and maintenance of lines on roads so the CAV can “see” where it is travelling are issues with which LAs are concerned. These are also responsibilities which require dedicated funding and attention, without which CAV deployment could be negatively impacted. Hence once again, matters of basic infrastructure and funding return in the respondents’ experience of CAV preparedness.

## F. PHYSICAL INFRASTRUCTURE AND FUNDING CHALLENGES

Respondents highlighted the critical need for infrastructure changes, improvements, and ongoing maintenance—particularly concerning elements such as paths and curbs, traffic lights, road widths, and road markings. There was a consensus among respondents that their approach to CAV and EV infrastructure was dictated by the physical framework of their region.

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<sup>99</sup> Wordsworth, S. Corridor of Connection. Traffic Technology International 2019, 1. [https://doi.org/10.12968/S1356-9252\(23\)40136-0](https://doi.org/10.12968/S1356-9252(23)40136-0).

As provided in the example above, one LA had established a policy of moving streetlamps back to the pavements; however, because electric vehicles are re-quired to have charging points and this region is predominantly comprised of terraced properties without private driveways, repurposing streetlamps as both lamps and charging stations was not feasible without causing a nuisance or hindrance to pedestrians. In this respect, our findings somewhat contradict those of Freemark et al.<sup>100</sup> that the redesign of streets (to accommodate CAVs) was of a lesser importance in planning policy.

In response to these concerns, respondents started using existing structures, such as parking lots, park and rides, and so on, as charging points, thereby allowing travellers to have access to charging facilities when parking close to their homes may not be as convenient as when charging at a charging station. In some of these initiatives, charging speeds were dynamically adjusted based on the specific use of the resource. In accordance with government direction, respondents advocated establishing policies that mandate new buildings provide electric vehicle charging stations, encouraging employers to in-stall these in employee car parks, and working with private sector organisations to im-prove charging station accessibility.

Accordingly, several local governments were seriously considering the possibility of using CAVs and were well underway in the process. The problem, however, remained unsolved and was not addressed for the respondents at least, regarding the capacity of power grids to support the growth of electric vehicles on a scale comparable to ICE vehicles currently in use.

We built a big performance arena, holds about 3500 people, we recognised there would be a need for people to park nearby so we built a multistorey next door to it. On the ground floor, you've got a number of electric charge points. The carpark works in two

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<sup>100</sup> Freemark, Y.; Hudson, A.; Zhao, J. Are Cities Prepared for Autonomous Vehicles? Journal of the American Planning Association 2019, 85(2), 133–151.

ways. In the daytime it acts as a commuter carpark, so people could park up and charge slowly for the next 8 hours, yet in the evenings people are coming to an event that might last 2 or 3 hours and they may be coming from a greater distance so therefore they probably need a rapid charge. [This gives] an idea of how we're thinking and how that's starting to influence our own choices around EVs and charge points. (LA J9D)

We're working with [a private company] to develop electric car share so we can put those vehicles into communities and start to develop the sharing notion of vehicles. If autonomous vehicles come in the future, a sharing culture would lead to market growth, especially if they're electric. [Our concern was if the previous user forgets to charge the vehicle], we're working with [the company] to demonstrate a wireless charging solution - the vehicle will drive over a pad and pick up the charge - it's all automated and so you can start to see a situation where an autonomous vehicle would be able to do that and drive over a pad. We're working with a university to get the charge rate up to about 20 kwatts (so it's a meaningful charge)... [This will have implications] for disability groups, they find it difficult to lug cables out of the back of the car and plug in. So it's helping with the car share market and it's helping out the use of EVs too. (LA S4)

It does need to be countenanced at this stage that whilst the above respondents were in LAs that were clearly developing strategies and operationalising the influx of CAVs/EVs, this was not a universal finding. Other respondents noted the lack of infrastructural developments which hindered attempts to fully prepare for CAVs/EVs. The absence of targeted infrastructure adaptations was not only a limitation acknowledged by respondents but also a broader barrier

to achieving seamless CAV travel across the UK.<sup>101</sup> While motorways are increasingly being prepared for higher SAE-level CAV operations,<sup>102</sup> the lack of a coherent and strategically implemented approach to infra-structure compliance remains a significant impediment.<sup>103</sup> To enable the full potential of CAV technology—including fully driverless capabilities and a seamless door-to-door travel experience—a unified infrastructure strategy tailored to CAV requirements is essential.

We've got a clear direction of what we want to do... and we've started putting chargers in car parks incrementally, but then of course you hit the thing of you can't just add another charger, assuming you've got the money you've got to make sure there's a supply coming to that location which would mean a complete redesign. (LA JD7)

## G. STRATEGIC PLANNING

Part of our assessment of the UK's preparedness for the implementation of CAVs/EVs was to not only identify the current state of LA activity in this regard but, and perhaps of more significance, was to determine where CAV/EV deployment was in the strategic plans of these authorities.

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<sup>101</sup> Liu, Y.; Tight, M.; Sun, Q.; Kang, R. A Systematic Review: Road Infrastructure Requirement for Connected and Autonomous Vehicles (CAVs). *Journal of Physics: Conference Series* 2019, 1187, 042073. <https://doi.org/10.1088/1742-6596/1187/4/042073>.

<sup>102</sup> SAE J3016 Levels of Driving Automation. [https://www.sae.org/binaries/content/assets/cm/content/blog/sae-j3016-visual-chart\\_5.3.21.pdf](https://www.sae.org/binaries/content/assets/cm/content/blog/sae-j3016-visual-chart_5.3.21.pdf) (accessed on 8 December 2024).

<sup>103</sup> Fuller, B. Cautious Optimism about Driverless Cars and Land Use in American Metropolitan Areas. *Cityscape: A Journal of Policy Development and Research* 2016, 18(3), 181–184.

To prepare and deploy CAV successfully, it is crucial that a long- and short-term plan is developed,<sup>104</sup> a strategic approach involving key partnerships with external actors is developed,<sup>105</sup> there are sufficient funding streams to plan and operationalise infra-structure support, and key personnel champion<sup>106</sup> and lead the development of CAVs. We have, therefore, contributed to the evidence base for research-based practice, which according to Freemark et al.,<sup>107</sup> was lacking in preparing LAs for this new mode of transportation and consequently has implications for cities and the built environment. While we observed that CAV preparation was not yet an integral part of formal planning and operational employment in several LAs, we found that the process had not yet reached a critical point of importance.

I think it's quite difficult for a LA to understand exactly where everything is with autonomous vehicles, I think we see a lot of glossy stuff [but] from the LA perspective, we don't get any questions about autonomous vehicles, it doesn't really come up yet.  
(LA J1)

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<sup>104</sup> Gaffar, A.; Monjezi Kouchak, S. Undesign: Future Consideration on End-of-Life of Driver Cars. 2017 IEEE SmartWorld, Ubiquitous Intelligence & Computing, Advanced & Trusted Computing, Scalable Computing & Communications, Cloud & Big Data Computing, Internet of People and Smart City Innovation (SmartWorld/SCALCOM/UIC/ATC/CBDCOM/IOP/SCI), 2017, 1–5.

<sup>105</sup> Harrison, J.S.; St. John, C.H. Managing and Partnering with External Stakeholders. *Academy of Management Perspectives* 1996, 10, 46–60.

<sup>106</sup> Freemark, Y.; Hudson, A.; Zhao, J. Are Cities Prepared for Autonomous Vehicles? *Journal of the American Planning Association* 2019, 85(2), 133–151.

<sup>107</sup> Freemark, Y.; Hudson, A.; Zhao, J. Are Cities Prepared for Autonomous Vehicles? *Journal of the American Planning Association* 2019, 85(2), 133–151.

I just think everyone is still trying to understand the timelines, what preparation they may need, and how their strategies will need to evolve to cope with this kind of technology. I think there was a feeling that it was around the corner at this time about three or four years ago. But I think people have become a lot more kind of realistic in their thinking and I do think that it has slipped down the priority. (Smart Specialist)

Yet, the absence of explicit references to CAVs/EVs in strategic policies for some LAs was not necessarily indicative of a disregard for their role in current and future transport strategies. Instead, it reflected a deliberate strategic shift away from private car usage, driven by objectives such as achieving clean air targets and encouraging more active modes of travel. Many LAs noted their movements towards active travel alternatives to private, and even public forms of transport.

We've got to take 36% of the cars off the road and we've got to do that quickly. We need to go through a huge behaviour change programme. We'd prefer people to be more active. We've invested in scooters and bikes... We think mass transit's important so we're looking at how do we connect local mobility hubs into the mass transit network to get people where they need to go. (LA S6)

We don't love electric vehicles because they're still cars... so back to the point, yes in suburbia that's a good way of reducing your CO2 and your particulates etc, but once you're in the city centre and you're starting to think about place and how vehicles and having road space impacts on something else you could do with that land then you start to think about we probably still don't want cars in the city centre - whether electric or not. (LA J1)

Broader issues associated with CAV deployment, in particular, had been raised in the work of Freemark et al.<sup>108</sup> This included the potential reductions in transportation employment,<sup>109</sup> challenges to social equity,<sup>110</sup> and increases in congestion<sup>111</sup> and, to some extent, segregation.<sup>112</sup> Across our interviews, these were issues which were all, to varying extents, acknowledged by respondents. However, these issues were not perceived as alarming but rather as challenges to be addressed. The more immediate, pressing and long-term concern identified by the respondents was the absence of clear direction and guidance from central government regarding the nationwide readiness and implementation of CAVs and to an extent, EVs. Responsibility for engagement with and preparedness for this emerging technology was largely left to the discretion of individual LAs. Respondents emphasised that issues raised nearly a decade ago in the UK's Parliament<sup>113</sup>—such as the need for road infrastructure enhancements, their scheduled maintenance, strategic investment across highways, and

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<sup>108</sup> Freemark, Y.; Hudson, A.; Zhao, J. Are Cities Prepared for Autonomous Vehicles? *Journal of the American Planning Association* 2019, 85(2), 133–151.

<sup>109</sup> Beede, D.N.; Powers, R.; Ingram, C. The Employment Impact of Autonomous Vehicles. Available online: <https://ssrn.com/abstract=3022818> (accessed on 8 December 2024).

<sup>110</sup> Robinson-Tay, K. The Role of Autonomous Vehicles in Transportation Equity in Tempe, Arizona. *Mobilities* 2023, 19, 504–520.

<sup>111</sup> Brown, P.N. A Tragedy of Autonomy: Self-Driving Cars and Urban Congestion Externalities. 2019 57th Annual Allerton Conference on Communication, Control, and Computing (Allerton), 2019, 981–986.

<sup>112</sup> Fox, S. Planning for Density in a Driverless World. *Northeastern University Law Journal* 2016, Forthcoming. Available online: <https://ssrn.com/abstract=2735148> (accessed on 8 December 2024).

<sup>113</sup> Public Accounts Committee. Maintaining Strategic Infrastructure: Roads—Report Published, 2014. Available online: <https://committees.parliament.uk/committee/127/public-accounts-committee/news/183976/maintaining-strategic-infrastructure-roads-report-published/> (accessed on 8 December 2024).

comprehensive asset management strategies each remain decisions made at the individual LA level. A recurring theme was the “silo effect”<sup>114</sup> within their work, where the lack of an integrated, collaborative approach to planning and development placed the burden on individual actors or groups to coordinate efforts.<sup>115</sup> This led to a very interesting finding to our study – the emerging of informal CAV/EV “champions” within LAs (see section 7.2).

Ultimately, the respondents emphasised that CAV/EV use and implementation was to be viewed as a further feature in an existing transport system, rather than treating them as standalone entities or solutions. Indeed, even LAs without a concrete plan to integrate CAVs into their transport strategies recognise the importance of establishing the necessary structural and infrastructural foundations to support their eventual inclusion in these policies.

As we look at policy I don't think we're designing things and making decisions with fully autonomous vehicles at the forefront but if we return to the version we're dealing with now in terms of electric vehicles, connected vehicles, that is starting to drive a lot of the policy thinking... So I suppose that's almost a key example of policies starting to evolve and it's impacting on some of the decisions we're taking but it's more electric vehicles than autonomous vehicles at this point of time. (LA J9D)

Essentially what we've done is just focus on the full direction of getting us there and I've been progressing with all the bits of join up to get us to where we need to be... So

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<sup>114</sup> This issue is not limited to the UK – see Scott, I.; Gong, T. Coordinating Government Silos: Challenges and Opportunities. GPPG 2021, 1, 20–38. <https://doi.org/10.1007/s43508-021-00004-z>.

<sup>115</sup> Potluka, O. Roles of Formal and Informal Leadership: Civil Society Leadership Interaction with Political Leadership in Local Development. In Handbook on City and Regional Leadership; Sotarauta, M.; Beer, A., Eds.; Edward Elgar: London, 2021. <https://doi.org/10.4337/9781788979689.00015>.

it's little by little, keep in mind the overall vision, make sure you're positioned in the right place for the future so you have joined it up so that everyone understands the value of the data and what their individual process is to contribute to the whole and make sure you have the infra-structure there so then you don't find you're way behind when the opportunity arises. (LA 8)

## H. THE NEED TO ENGAGE WITH THE COMMUNITY

It is a trite comment that one of the main hurdles to the successful transition to CAVs/EVs that face a LA is the funding of the testing,<sup>116</sup> use<sup>117</sup> and infrastructure<sup>118</sup> needed for the move from human driven ICE vehicles to CAV/EVs. A critical finding from our research highlighted the necessity of forming external partnerships with private sector organisations and companies to provide financial support and share the costs associated with the development

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<sup>116</sup> Gov.uk. Code of Practice: Automated Vehicle Trialling, 2023. Available online: <https://www.gov.uk/government/publications/trialling-automated-vehicle-technologies-in-public/code-of-practice-automated-vehicle-trialling> (accessed on 8 December 2024).

<sup>117</sup> See for instance Urban Transport Group. Automatic for the People? Issues and Options for Transport Authorities on Connected and Autonomous Vehicles, 2020. Available online: <https://www.urbantransportgroup.org/resources/types/report/automatic-people-issues-and-options-transport-authorities-connected-and> (accessed on 8 December 2024); and for a positive example of use of CAVs by LAs see West Midlands Combined Authority. Solihull Leads the Way in Driverless Technology, 2021. Available online: <https://www.wmca.org.uk/news/solihull-leads-the-way-in-driverless-technology/> (accessed on 8 December 2024).

<sup>118</sup> Gov.uk. Preparing the Way for Self-Driving Mass Transit Services in Remote, Rural, and Urban Areas, 2023. Available online: <https://www.gov.uk/government/news/preparing-the-way-for-self-driving-mass-transit-services-in-remote-rural-and-urban-areas> (accessed on 8 December 2024).

and deployment of CAVs/EVs. LAs that demonstrated the most successful transitions toward CAV preparedness had established robust collaborative relationships with external partners, particularly in the automotive and technology sectors. Additionally, active engagement with businesses and the local community emerged as an essential component of effective planning and participation in CAV testing initiatives.

We want to take a role of understanding what will develop and trying to accelerate the good things. That project was a consortium across Europe looking at how cities are prepared for the introduction of CAVs and what that tried to do was understand in the framework where cities were in their route towards being knowledgeable and understanding the role of CAVs in their locality. We also developed approaches and ways of engaging with people, because part of this is hearts and minds and understanding what people's attitudes are towards CAVs. We looked specifically at the private vehicle and what role that might have... our view is they're unlikely to be privately owned, it's a shared resource and who would they be used in the city. (LA S4)

We've got very strong relationships with a number of key industry partners, so we do have a range of contacts and I tend to speak more to business contacts in my day to day job than I do to council colleagues because a lot of this is driven by the business models, recognising that the council hasn't got funds to throw at things, it's all well and good having nice little pilot projects that run for a couple of years then disappear, it's about sustainability, how do you build the capability that then is a sustainable service or technology that then can develop to support industry or more mobility in the city? So our focus is very much on developing those partnerships and developing sustainable business models to keep these trials, move them from trials to actual services. (LA S4)

## VII. LEGAL CONSCIOUSNESS

The empirical data presented above demonstrates the desire, particularly among the respondents to this study, for individuals within LAs to advance the infrastructure necessary for the introduction of CAVs/EVs. Indeed, “champions” have emerged within these authorities, particularly on an informal and self-appointed basis, where like-minded people meet to share their experiences, indeed arguably extending their collective experiences to form models of “best practice.” Further, a powerful finding from this empiricism is the absence, certainly felt by several respondents, of clear and meaningful direction from central government as to the “how, what and when” of changes to policy and infrastructure needed at a local level to facilitate the movement towards facilitating CAV use, either for public-sector forms of travel or in accommodating the increasing use of private vehicles which are progressing up the SAE scale of autonomy. Yet, and in spite of the absence of such specific guidance, many of our respondents noted their own strategic plans and policy development for the influx of CAVs in their regions.

The respondents did not speak directly of the source from which the authority for their policy development derived. In those cases where members of the LA had begun to form policies and strategies they simply stated that they had in essence “seen the future” of this form of travel. They were given permission by immediate supervisors to invest some of their time, and with funding some resources were allocated to this task, to undertake work in this area. Further they, with like-minded people in other organisations and LAs, had begun to establish the rules and processes for successful implementation. This, without necessarily their explicit knowledge, was based on a tacit legal consciousness, with legal pluralism underpinning their actions and offering the guidance so needed in CAV/EV deployment in the UK. Thus began

the process of legal assimilation of the respondents' understanding, appreciation and operationalising of the government's ideology.<sup>119</sup> They demonstrate sufficient judgment and adherence to the established legal structures, quantifying legal knowledge, but continue to progress beyond such an apprenticeship phase and implement the legal and policy rules they have established to achieve the goal of implementing an emerging and dynamic practical, legal and regulatory technology.

#### A. WHY LEGAL CONSCIOUSNESS?

The UK government has invested funds both to private sector organisations and to LAs, often through competitive bidding exercises, to operate pilot programmes to assess and operationalise the trialled use of CAVs in their locality. These measures have con-firmed the State's desire for CAV use as quickly as is a pragmatic reality, establishing as they do the legal framework for the insurance<sup>120</sup> and use<sup>121</sup> of autonomous private vehicles on public roads. Yet, as noted by our respondents, despite some early enthusiasm in respect of funding available to these LAs, this funding source quickly diminished and consequently it became more difficult to persuade budget holders to release funds for projects involving a technology which was not ready for public use (indeed perhaps little more than a proof of concept at this stage). This resulted in personnel in local authorities who had a passion for, and commitment towards the

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<sup>119</sup> Kubal, A. *Socio-Legal Integration: Polish Post-2004 EU Enlargement Migrants in the United Kingdom*; Ashgate: London, 2012.

<sup>120</sup> Legislation.gov.uk. Automated and Electric Vehicles Act 2018. Available online: <https://www.legislation.gov.uk/ukpga/2018/18/contents> (accessed on 8 December 2024).

<sup>121</sup> Legislation.gov.uk. Automated Vehicles Act 2024. Available online: <https://www.legislation.gov.uk/ukpga/2024/10/contents> (accessed on 8 December 2024).

future use of such technology in establishing their own policies and frames of reference to fill the lacunae left through the funding cuts and lack of practical direction as to what was needed on an infrastructure level to enable CAVs to be safely used on the roads under which they had ultimate responsibility. So many features of the use of CAVs were missing from the existing legal landscape, albeit many had been widely discussed in academic and professional literature. It was incumbent upon several of our respondents, in their own words, to establish systems which went beyond the “mere” legal regulation of the deployment of this technology, and thus a local and region-specific legal consciousness was forming.

Legal consciousness is, according to Merry<sup>122</sup> a subtle understanding of “how people comprehend and utilize law.”<sup>123</sup> Some see it as a means of resistance to an existing legal framework<sup>124</sup> but we see its positioning more aligned to Merry<sup>125</sup> and Boittin’s<sup>126</sup> ideas of individual legal perceptions converted into action. The outcome is the emergence of a collective within a specific society (such as the decision-makers in LAs)<sup>127</sup> that critically

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<sup>122</sup> Merry, S.E. *Getting Justice and Getting Even: Legal Consciousness Among Working-Class Americans*; University of Chicago Press: Chicago, 1990.

<sup>123</sup> Merry, S.E. *Getting Justice and Getting Even: Legal Consciousness Among Working-Class Americans*; University of Chicago Press: Chicago, 1990, p. 5.

<sup>124</sup> Engel, D.; Munger, F. *Rights of Inclusion: Law and Identity in the Life Stories of Americans with Disabilities*; University of Chicago Press: Chicago, 2003.

<sup>125</sup> Liu, Y.; Tight, M.; Sun, Q.; Kang, R. A Systematic Review: Road Infrastructure Requirement for Connected and Autonomous Vehicles (CAVs). *Journal of Physics: Conference Series* 2019, 1187, 042073. <https://doi.org/10.1088/1742-6596/1187/4/042073>.

<sup>126</sup> Boittin, M.L. New Perspectives from the Oldest Profession: Abuse and the Legal Consciousness of Sex Workers in China. *Law & Society Review* 2013, 47(2), 245–278.

<sup>127</sup> Cooper, D. Local Government Legal Consciousness in the Shadow of Juridification. *Journal of Law and Society* 1995, 22, 506–532.

examine the legal and pragmatic frameworks (which for CAV/EV use are very limited), evaluates the surrounding environment (looking to their region and the work of others across the LA network), and identifies existing gaps (the need for policies that ensure the inclusion of CAV/EV deployment plans in strategic and operational materials used across the LA and its departments). This process culminates in a sophisticated interpretation that underscores the role of LAs in facilitating conditions for the private sector's adoption of a technology previously unutilised in a public context.

It was Ewick and Silbey's [110] work where academics were encouraged to explore the intricate and nuanced ways in which law intersects with everyday life, examining their nature of being deeply embedded in the routine and seemingly mundane activities of individuals. It is an approach which supports a more comprehensive and holistic understanding of the law's pervasive role within society. This is why the use of empirical evidence from decision-makers in LAs was so important to an understanding of the preparedness of the UK for CAV/EV deployment. The respondents noted the lack of meaningful direction and policies from central government as to what LAs should be actioning to enable the full introduction of CAV/EVs. The UK was clear that its intention was to allow CAV use on public roads by 2021,<sup>128</sup> it had an established policy to restrict new car sales to be 100% EV by 2035,<sup>129</sup> and it sought to be an international leader for CAV/EV innovation through testing and use of CAVs. Despite this clear signposting of its intentions, it had failed to inform and instruct LAs as to their role in ensuring this transition.

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<sup>128</sup> Automated Lane Keeping Systems (ALKS) became legal in 2021, with strict limitations as to the location and speed – but was, perhaps, a first step towards introducing autonomous vehicles in the UK.

<sup>129</sup> <https://www.gov.uk/government/news/pathway-for-zero-emission-vehicle-transition-by-2035-becomes-law> (accessed on 8 December 2024).

I'm shying away about writing an infrastructure strategy for EVs across the whole city for the public as well as private because to be honest it could change next week 'cos we don't know what the government's doing. (LA JD7)

Given the nature of the regional government of the UK, with LAs largely responsible for traffic regulation and management within its jurisdiction, for a seamless and integrated system of CAV/EV use between the LAs, joined-up strategies were necessary. This resonates with Ewick and Silbey<sup>130</sup> who, when discussing the concept of "legality", was described as "the recognised meanings, sources, authority, and cultural practices that are accepted as legal, irrespective of the user or the purpose."<sup>131</sup> Thus, the practice of developing "champions" of CAV/EV use in these LAs allowed for the development of the social and cultural practices to inform practices across the LA-spectrum.

## B. CHAMPIONS

The respondents to the study raised several points, whilst almost always favourable to the development of the EV charging infrastructure and the possible benefits CAVs could bring, regarding the negative impression they had of a lack of governmental policy-making, strategic guidance, or operational requirements to ensure they had benchmarks and targets by which they could test their own LA's preparedness. In their absence, the LAs were beginning to establish their own such policies and (informal) benchmarking schemes, but they reiterated that

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<sup>130</sup> Ewick, P.; Silbey, S. *The Common Place of Law: Stories from Everyday Life*; University of Chicago Press: Chicago, 1998.

<sup>131</sup> Ewick, P.; Silbey, S. *The Common Place of Law: Stories from Everyday Life*; University of Chicago Press: Chicago, 1998, p.23.

evidence-informed policymaking as essential for identifying the challenges in urban transport planning and determining the role that CAVs/EVs were to play in addressing transportational and social issues. In its absence, the LAs recognised that the task fell to them to advocate for CAV adoption, recognising the long-term benefits that may take time to materialise and might not be immediately apparent when attempting to convince budget-holders of their intentions.

It doesn't entirely feel connected up, so that's where I think policymakers need to think about the entire ecosystem. That kind of the classic policy about policymaking barriers which are around lack of good evidence, so lack of evidence that describes the problem and potential solutions. So lack of evidence which is transferable and understandable for policymakers, or if there is evidence it tends to be a fairly poor quality, so it's lack of good quality evidence. (Planning Specialist)

Evidence was beginning to be gathered by some of the respondents and through this process they began to appreciate the role in advancing CAV/EV use in their region and of others to whom they were in contact who may have acted in a position of “champion” of such an internal initiative.

It's so complicated because when you're thinking about the policy making process, it relies on someone... trying to try to head towards, right, the policy. (Engagement Specialist)

Certainly within [the local authority] there's probably a couple of individuals who are championing it there. [In another authority] although they're lagging behind, there's

probably three or four people that would champion connected and autonomous vehicles. Both authorities are very innovative. (LA S6)

The respondents also explained how “champions” could be found within LAs but also in working in conjunction with external partners and when groups of like-minded representatives from different departments in the LA worked together, the moment had the best possibility for creating an atmosphere of transitional-possibility into transitional-efficacy.

It’s almost like someone needs to show us the full picture first of what that looks like so we can then steer ourselves around that. (LA JD7)

In [the LA] we are lucky because we have, I think, 6 or 7 autonomy companies active [and various private companies] and the economy is very much driven by innovation. We have had other LAs come to us ask us about our trials, asking us how we have worked with them and how they can engage... I think people in a LA do want to understand this technology. (Mobility Specialist)

I think as an authority our approach has always been it’s important to learn from others, see what others are doing. We’re all on a voyage of discovery on this one so that collaboration and networking’s key... highways, transport, road markings, drop kerbs, environmental impact - are within the regeneration directorate which pretty much all of those different services sit under, so a number of officers sit on shared groups. As an example, [we are] working on with the parking strategy that’s got people from all those different consenting areas sat on, so planners are on there, transport planners are on there, highways people are on there, climate change people are on there. I think we’ve

always been quite good as a council at working across service areas and bringing those that are the experts round the table. (LA J9D)

One finding of note, however, was that whilst “champions” existed and could help to move the CAV/EV agenda in an LA, this was not to be viewed as something imposed upon LAs. Some LAs, it was recognised, were simply not at the stage or lacked the re-sources to include a CAV/EV agenda to their existing responsibilities and transport strategies. This, we found, was often due to hesitation at a senior management level in the LA or due to an unwillingness to embrace the technology needed for the transition.

We’ve got some very archaic people working for the local authorities and they will not change... So we’ve done that tech, we’ve done the innovation, we’ve moved forward, other cities who are now saying “actually let’s investigate that”, sometimes we lose out as a lead authority because not everyone follows, or not everyone is as geared up as the innovation manager and they find it difficult to adapt to change. (LA SP1)

I think the role of local authority is often massively underestimated in this because government can’t impose the technology. It can’t say do trials in this area... [but the link between the local authority and technology partner] is essential to [deployment] effectively. (Eval Specialist)

## B.I. CHAMPIONS IN ACTION

There was a disparity between LAs as to their progress in facilitating the infra-structure for CAV/EV deployment. Some had very clear and developed strategies which informed

practices across the LA, others had no policy, no current and short-term planning and no provision or intention for the testing of CAVs in their locality. However, these respondents volunteered to participate in our study because of their interest in the use of CAVs/EVs and this was clear from their general enthusiasm and wish to be included in discussions and informal groups across LAs. The internal policy-development context proved crucial in determining whether investment and commitment to CAV deployment were guided by clear strategic frameworks or instead left to smaller, motivated groups and interested personnel to explore and implement. Importantly, the individual decision-makers in our studies were often the key actors in this process, not merely awaiting direction from central government but taking action themselves. They were the individuals who began to establish policies that incorporated CAV/EVs into broader discussions of traffic policies, clean air initiatives, reducing congestion and so on. Further, even in the absence of their own LA having a policy document on the subject, these respondents demonstrated engagement with some form of CAV deployment strategy. What further cemented the development of champions who lead the local initiative into CAV/EV use was where they partnered with external organisations to not simply wait for the testing and use of CAVs in their region, but rather they proactively engaged with its testing and introduction.

There's a recognition that CAVs over the interim period will need some support and assistance, hence the work that we did on the 5G network because we learnt from our first deployment that the connectivity wasn't secure enough or good enough to allow you to start taking the safety operator out of the vehicle because we wanted to run the CAVs from a control centre. So we started to look at, rather than building lanes and upsetting motorists, could we look at it in a different way and improve the connectivity and get to the control room as a first step using level 4 and traffic controllers. That still

may need some segregation on some routes to maximise safety and get through problematic junctions, but that is a natural step and we think beyond that that's when the fully autonomous will come in, that's still probably five to ten years away. (LA S4)

Significantly, the respondent continued

But we don't want to wait five to ten years until that's all developed and done. We want to be leading and starting to think about and integrating these services into the city now because we've identified a real need and a real opportunity to move to that step fairly quickly. (LA S4)

The guys would come in first thing in the morning, the road's clear, test it, map it, works wonderful. Come the time to launch the actual testing... and see how it operates in a real-life environment, they couldn't get out of the car park because... there's a constant flow of pedestrians... looking down and not worrying about what's happening. The vehicle will not go forward because of safety reasons. So... we've got a solution... effectively as a normal human being would do it starts gradually nudging out in a very, very low speed. So those were the real-life scenarios, you couldn't have tested that in a closed circuit, you couldn't have envisaged putting that technology in or envisaged developing that bit of software, this is what you do in a real-life scenario. (LA SP1)

The development of legal consciousness scholarship is notably advanced by Young's<sup>132</sup> introduction of the concept of second-order legal consciousness, which marks a significant shift

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<sup>132</sup> Young, K.M. Everyone Knows the Game: Legal Consciousness in the Hawaiian Cockfight. *Law & Society Review* 2014, 48(3), 499–530.

toward emphasising the relational dimensions of legal understanding. Second-order legal consciousness is defined as the perceptions individuals hold regarding the legal consciousness of others, whether individuals or groups. This conceptualisation invites inquiry into how individuals' understanding of others' (legal) beliefs and attitudes may shape their own orientations toward the law. Young argues that second-order legal consciousness functions as an intermediating variable, influencing individual tendencies toward legal systems and norms. This proposition expands the view of legal consciousness beyond a personal construct shaped by direct interactions with legal institutions, re-framing it as a social construct influenced by perceptions of how others engage with and interpret the law. By foregrounding the collective and relational aspects of legal consciousness, this framework highlights the expressive power of law and underscores the necessity of understanding how legal beliefs and attitudes are shared, communicated, and transformed within social groups<sup>133</sup> (such as members of different LAs).

In exploring the relational dynamics of legal consciousness,<sup>134</sup> it becomes clear that legal consciousness is inherently individual, being unusual for two actors to possess identical orientations toward legality even when they share similar social identities [116].<sup>135</sup> However, it appears that where individuals engage in close interactions, collaboratively (re)constructing

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<sup>133</sup> Pleasence, P.; Balmer, N.; Denvir, C. *How People Understand and Interact with the Law*; PPSR: Cambridge, 2015. Available online: [https://www.thelegaleducationfoundation.org/wp-content/uploads/2015/12/HPUIL\\_report.pdf](https://www.thelegaleducationfoundation.org/wp-content/uploads/2015/12/HPUIL_report.pdf)(accessed on 8 December 2024).

<sup>134</sup> Harding, R.; Keeling, A. Raising Relational Legal Consciousness Through Co-Production Research? Making Law More Accessible. *Journal of Law and Society* 2024, 1–16. <https://doi.org/10.1111/jols.12500>.

<sup>135</sup> Hull, K.E. Legal Consciousness in Marginalized Groups: The Case of LGBT People. *Law & Social Inquiry* 2016, 41(3), 551–572.

their understanding of legality, such a limitation to development of a consciousness disappears.<sup>136</sup>

Our study did not seek to explore legal consciousness in the LAs, but this emerged strongly as a feature of their relationships – and often growing organically as liked-minded individuals rather than on the basis of some conscious effort to network. The respondents differ in respect of their regional backgrounds, the size, scope and resources available to the LA in which they are based, and the commitment or otherwise of their own LA to support CAV/EV use, but they all operated under the same national legislative framework and were subject to the same national government emphasis on CAV/EV roll-out in the short-term. As such, their experiences and development of their own rules and processes to facilitate the transition to CAV/EV use was instructive of their understanding of legality and their reaction to the lacuna in the law. They had begun to establish their own set of rules which were being shared between them and used (almost) as a benchmark for others further down the CAV/EV-ready LA to adopt. This is an area prime for further research and understanding, and it is our hope that by raising it here it inspires others to undertake comprehensive research and to generate a solid foundation upon which definitive conclusions may be drawn.

## VIII. CONCLUSIONS

The findings from the respondents are instructive to an understanding of issues facing LAs when attempting to introduce a new, disruptive and uncertain form of transportation, especially during times of economic uncertainty and restrictive public sector budgets. It is clear from the results of the interviews that the adoption of CAVs faces several systemic barriers that

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<sup>136</sup> Silbey, S.S. *After Legal Consciousness*. *Annual Review of Law and Social Science* 2005, 1, 323–368.

hinder the widespread adoption of autonomous vehicles in the UK. The infrastructure requirements are being addressed by various LAs, and these are often led by internal “champions” and supported by external collaborations with industry and academia. CAVs depend on sophisticated infrastructure, including on-board high-definition mapping, sensors, and advanced communication systems, but also need the basic features of good quality roads, accurate and maintained road signs, effective and clear road markings and so on. Whilst manufacturers have the obligation to make sure the CAV is sufficiently intelligent to operate independently of a person “behind the wheel,” the vehicle will still need to “see” the usual markings and instructions which occur in real-time and on an ad-hoc basis. Thus, there exists a symbiosis between the manufacturer of the CAV and the LA to ensure the safety of all road users and pedestrians. Hence the development and deployment of such infrastructure demands substantial investment from both public and private sectors.

It was also evident from our study that there are many within LAs who are very positive about the possibility of the introduction of CAVs, and there are also examples of work being undertaken for the creation of smart cities with an emphasis on connectivity for V2V and V2I, and the charging infrastructure for EVs to embrace this new form of transport. Many respondents were already completing their own projects on bringing EV stock to the public transport in their regions, and were ready to embrace the next phase of CAV deployment in accordance with governmental initiatives and legislative action, if not in accordance with the absent government guidance in the form of actual policy. The result is the advent of a legal consciousness being developed within and between LAs, and the realisation of individuals perceiving and interpreting legal boundaries through their subjective experiences. This continues to an understanding of how these individuals’ perceptions shape their reliance and creation of systems to address everyday problems. Specifically, this has been how their subjective understandings of the law and regulation of CAV/EV introductions in their localities

have influenced their legal mobilisation and we have witnessed their inclination to turn to alternative, informal methods for resolving issues in the lacuna of direct governmental instruction on LAs role in the transition to CAV use across the UK.

By emphasising these dynamics, our study offers a preliminary insight into the practical implications of legal consciousness in the daily life of LA planners and decision-makers when venturing into a largely unknown form of transport. They are having to create their own systems for the transition to CAV use and have already demonstrated many innovative and thoughtful mechanisms to overcome existing practical and logistical problems. Ultimately the UK does have some way to go for the full transition to CAV/EV use, but our evidence has demonstrated a commitment from key personnel in LAs to its fruition and the emergence of “champions” as key to understanding the interaction between formal and informal appreciation of the approaches to legal challenges and problem-solving. Such perspectives not only advance theoretical discussions on legal consciousness, but also explain the real-world impact and applications of these concepts to the UK’s transition to CAV/EV adoption.