Assessing Parking-Related Technologies to Increase Resilience for the Lambeth Council's Parking and Enforcement Department

An Interactive Qualifying Project Proposal submitted to the Faculty of WORCESTER POLYTECHNIC INSTITUTE in partial fulfillment of the requirements for the Degree of Bachelor of Science

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Abstract

The London Borough of Lambeth suffers from poor air quality and congested roads, and high parking demand is a major cause for these two severe problems. The goal of our project was to inform the Lambeth Council how smart parking apps, dynamic pricing, and autonomous vehicles may affect their ability to provide effective parking services. We interviewed Council employees, researched how future technologies may affect the borough and its parking services, and surveyed users of Lambeth's parking services to gauge how the public might react to these technologies. We recommended the Lambeth Council collect occupancy data for smart parking systems, explore opportunities for conducting dynamic pricing trials, and publish public status reports on parking services.

Executive Summary

Air pollution is the second largest public health concern in London, contributing to approximately 64,000 deaths in 2015 (Matthews-King, 2019). Lambeth's Brixton Road has the highest level of air pollution of any road in London, exceeding the annual legal limit for air pollution in only 6 days in 2017 (Cockburn, 2019). In 2017, London was the worst city in the UK for parking, which contributes 30% of traffic congestion and is a considerable source of poor air quality (London Councils, 2018; Williams, 2017; Zhang and Batterman, 2013).

The Lambeth Council has been developing strategies to address these problems of congestion and air pollution and has signed onto the Positive Parking Agenda (PPA), an initiative by the British Parking Association to raise parking standards and improve the public's understanding of parking management (Positive Parking Agenda, n.d.). To meet these standards and improve their parking and enforcement management, the Lambeth Council must understand how technology may develop to pose opportunities and threats for their services.

The goal of this project was to evaluate how parking-related technologies may affect the efforts of the Lambeth Council's Parking and Enforcement Department to advance the Positive Parking Agenda during the next 20 years. To identify elements of the Council's parking and enforcement services for advancing the PPA, we interviewed Council employees about current strengths and weaknesses of and goals for their parking services. We researched smart parking apps, dynamic pricing, and autonomous vehicles (AVs) to list and describe ways these parking-related technologies might affect parking and enforcement services in the short-, medium-, and long-term future. Additionally, we surveyed parking professionals and users of Lambeth's parking services about potential developments of these three technologies and their views about Lambeth's parking and enforcement services. Finally, we synthesized our findings to help the Lambeth Council identify opportunities and challenges for advancing the PPA that smart parking apps, dynamic pricing, and autonomous vehicles may present.

Core concerns for the Lambeth Council's services are environmental sustainability, public perception and quality of service, and strategies and performance of their operations. Since Lambeth faces high amounts of traffic congestion and air pollution, environmental sustainability was a major concern for how services could help mitigate these problems. Multiple interviewees also mentioned the diverse demographics in Lambeth and the current poor perception of services, leading to further discussion about how the Council could implement services that are fair and accessible to everyone in the borough. Additionally, many interviews noted considerations for how effectively services provided revenue, used resources efficiently, and carried out various strategies for collaborating with other boroughs to improve their services.

Currently, Lambeth Council is transitioning to mobile parking payment applications. In the next five years, these applications could include smarter services such as parking navigation and reservation. Such features could potentially reduce traffic congestion and air pollution by minimizing time spent searching for a parking space (Leslie, 2014). Another possible benefit is increased efficiency in the deployment of civil enforcement officers (CEOs) by using smart parking application data or sensor occupancy information to guide CEOs to illegally parked cars (SFpark, 2014). Smart parking apps could also reduce illegal parking and parking fine revenue for the Council (Gautam, 2018b).

Within 5-10 years, Lambeth Council may be able to implement dynamic pricing to reduce traffic congestion and air pollution if they can collect adequate amounts of parking space occupancy data (Xerox, 2011). In San Francisco's trials of dynamic pricing, traffic volume

decreased by 8%, time to park decreased by 43%, and greenhouse emissions decreased by 30% (SFpark, 2014). Dynamic pricing may also increase revenue as Justpark, a dynamic pricing solution company, reported an average increase in revenue of 20% when implementing their system (Justpark, n.d). However, public perception of dynamic pricing is less clear as adjusting prices of parking could both positively and negatively affect certain drivers (SFpark, 2014).

Due to obstacles of cost, cybersecurity, and regulations, it may take 10-20 years for fully autonomous vehicles (AVs) to significantly influence parking services. If AVs can efficiently and automatically find parking they may reduce traffic congestion and increase efficiency as drivers won't need to search for parking. AVs may also reduce the demand for curbside parking as they may only need to drop off passengers, causing the Council to lose parking revenue but allowing the Council to repurpose curbs for other uses that could provide revenue (Litman, 2019). Revenue may further decrease if AVs follow all traffic and parking regulations, however, the decrease in illegal parking would improve safety and efficiency of traffic (Morillo & Campos, 2014).

Recommendations

Based on our findings from research, interviews, and questionnaire results, we recommend that the Lambeth Council:

1. Improve current parking infrastructure to meet data collection demands for future smart parking technologies such as smart parking apps, to provide accurate information to guide drivers to parking spaces efficiently.

2. Consult with parking authorities that have conducted dynamic pricing trials to understand best practices for testing dynamic pricing. Dynamic pricing has yielded promising results for advancing the PPA by reducing congestion and improving air quality. However, implementing a successful large-scale model may be difficult due to the different priorities of many different stakeholders.

3. Follow BPA parking data standards for collecting and sharing data with other boroughs. A unified system across boroughs will allow drivers to move through boroughs and experience consistent services. Additionally, such consistency may enable features of technology that advance the PPA, such as AVs following local traffic and parking regulations.

4. Promote shared AV mobility options in areas with less access to public transit to provide last-mile offerings to complement public transit and reduce private vehicle ownership.

5. Publish an annual parking report to increase transparency and improve public perception of Lambeth Council's goals and projects for parking and enforcement services. An annual parking report would include parking statistics and objectives for improving parking services, and through publication, public perception may improve due to transparency of Council motivations and support for better parking management.

Conclusions

Parking and enforcement services help address traffic problems, such as congestion and air pollution, and help the community by improving road safety and managing the use of curbside spaces and urban areas. Our project explored how smart parking apps, dynamic pricing, and autonomous vehicles could affect the Lambeth Council's parking and enforcement services, in regard to both the opportunities and threats for the service and its perception by the public.

Innovations and developments in technology are a driving force for change in society, and London must form a united effort across its boroughs in order for parking and enforcement

to adapt effectively to these advancements and provide satisfactory services for the public. We provided the Lambeth Council with in-depth future-oriented analysis on smart parking apps, dynamic pricing, and autonomous vehicles for their potential effects on parking services and a model to track and explore other technologies for opportunities and threats to parking and enforcement.

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We would like to thank everyone who was involved in our work during the past seven weeks for making our project possible. First, we would like to thank our sponsor contacts, Mr. Jonathan Pook and Mr. Thomas Burgess, as well as the entire Lambeth Council, for giving us the opportunity to work with them and providing guidance for the duration of our project. Additionally, we would like to thank everyone who we interviewed, both in and outside the Council, for providing insight into parking and enforcement services in London, as well as everyone who completed our questionnaire. Finally, we would also like to express our gratitude to our advisers, Professor Seth Tuler and Professor Joel Brattin, for providing invaluable advice, direction, and support for the entirety of the project.

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Chapter 1: Introduction

Air pollution is the second largest public health concern in London, contributing to approximately 64,000 premature deaths in 2015 (Matthews-King, 2019). Brixton Road in Lambeth has the highest level of air pollution of any road in London; the air around this road reached the annual legal limit for air pollution in a single location before 6 January in 2017 and 30 January in 2018 (Cockburn, 2019). With approximately 30% of Lambeth's residents living in poverty, the borough is also hit harder than other more affluent areas in London, as differences in air pollution were highest in London based on socioeconomic status (Trust for London, n.d.; Wong, 2015).

Traffic of public and private vehicles is a primary factor of air pollution, which contributes approximately 50% of the most significant air pollutants affecting human health, NOx and PM10 (European Environment Agency, 2017; Quilter-Pinner & Laybourn-Langton, 2016). Traffic congestion is a considerable source of air pollutants, as the lower speeds and "increased number of speedups, slowdowns, stops and starts" can create up to "4-, 3- and 2-fold increases in CO, HC and NOx emissions, respectively" (Zhang and Batterman, 2013, p. 2). The 2016 Urban Europe report ranked London as the most congested functional urban area in selected EU states, with the average driver losing 101 hours a year to traffic, and approximately 30% of this congestion comes from drivers searching for parking (London Councils, 2018; O'Sullivan, 2016). In 2017, London was the worst city in the UK for parking, with 70% of drivers finding parking stressful while wasting an average of 67 hours, 26 gallons of fuel, and £1,104 each year in the search for parking (Williams, 2017).

The Lambeth Council has been developing strategies to address traffic-related problems, such as congestion and air quality, and has signed onto the Positive Parking Agenda (PPA). The PPA is an initiative by the British Parking Association to raise parking standards and improve the public's understanding of parking management (Positive Parking Agenda, n.d.). Additionally, in 2018, the Lambeth Council drafted the Lambeth Transport Strategy to assess the current transportation network in Lambeth and develop strategies to guide the future of mobility, accessibility, and public health in Lambeth for the next 20 years. The document listed multiple plans and strategies to address issues such as air quality, congestion, and accessibility to the rail and tube network, and was opened to the public for consultation and feedback. However, these plans, as well as other studies, lack analysis of potential developments for new and emerging technologies and strategies aimed at solving traffic and transport problems in the long term.

The goal of this project was to evaluate how parking-related technologies may affect the efforts of the Lambeth Council's Parking and Enforcement Department to advance the Positive Parking Agenda during the next 20 years. We achieved this goal by identifying elements of Lambeth Council's parking and enforcement services and strategies relevant for advancing the Positive Parking Agenda; listing and describing ways parking-related technologies might affect parking and enforcement services in the short-, medium-, and long-term future; and synthesizing our findings to help the Lambeth Council identify technologies for opportunities and challenges to advancing the Positive Parking Agenda. With an understanding of the potential influence of future technologies on parking and enforcement services, the Lambeth Council may better prepare for major developments in the parking industry and opportunities for improving public perception of their services.

Chapter 2: Background

This chapter describes major parking-related problems that London Boroughs face and explores strategies that the Lambeth Council uses to address these problems. Additionally, this chapter describes technology that may affect these strategies. Finally, this chapter elaborates on future-oriented analysis and its use to evaluate the influence of technologies on the future of parking services and management strategies.

2.1 Parking challenges in London

Finding parking in dense urban areas, such as London, continues to be a challenge as a dense population creates a high demand for parking spaces that cities struggle to supply due to the scarcity of land and the marginal cost of a parking space (A Better City, 2016). Drivers searching for parking cause approximately 30% of traffic congestion in London roads and cost the city approximately 6.2 billion pounds annually (London Councils, 2018).

In the future, London may face further parking-related problems due to an increasing population that may contribute additional cars searching for parking. Transport for London (2017) estimates that London's population will reach 10.5 million people by 2041 and traffic will increase by 23%.

2.1.1 Positive Parking Agenda

In addition to direct parking problems, local councils experience poor public perception. Often, the public views parking management solely as a revenue generator and local authorities want to convey its importance without experiencing a trial similar to Aberystwyth, Wales. In 2011, residents of Aberystwyth celebrated the removal of civil enforcement officers, until it became the "worst place in Britain to find a space, with motorists queueing for up to 35 minutes" (The Telegraph, 2012, para. 5).

To recognize local authorities' efforts in parking management and their benefits for the public, the British Parking Association (BPA) created the Positive Parking Agenda (PPA). The PPA is an initiative to improve the public's perception of parking management by raising parking standards and improving transparency and communication with the public (Positive Parking Agenda, n.d.). The PPA lists seven standards to push for improvement in parking management as a valued service, which include reducing congestion and improving road safety, air quality, accessibility, technology usage, efficiency, and fairness. By highlighting these parking standards, the PPA seeks to educate residents about the benefits of parking management. Additionally, the PPA serves to create consistent objectives across local councils and authorities, allowing for more collaboration on parking-related problems.

2.1.2 Parking management strategies

To reduce parking-related problems, such as congestion and pollution, city authorities, including those in London, take active measures to influence parking. Two important forms of strategies to improve parking include reducing and distributing the demand for parking.

The first form of parking management strategies focuses on reducing the use of private cars and the demand for parking spaces. One way cities reduce demand is by limiting available parking spaces. For example, in 2004, London passed legislation to limit the number of parking spaces for a new development rather than requiring a minimum number of spaces (Transport for London, n.d.). In the absence of parking minimums, new developments could become denser since parking spaces limit the number of possible housing units; this density further promotes the

use of alternative forms of travel as car ownership becomes increasingly inconvenient (A Better City, 2016). London also devoted traffic lanes to public transportation, cycling, and walking to encourage a shift away from private vehicles (de Andrade Guerra et al., 2016).

Another form of strategies distributes the demand for parking spaces. One strategy uses the model of dynamic pricing which San Francisco implemented to decrease cruising by 40% and use 31% more blocks that had low parking occupancy rates (London Councils, 2018). San Francisco achieved these results by changing the price for street parking in $0.25 increments on a monthly basis to work towards 80-85% parking occupancy which they monitored using embedded sensors and smart meters (Chatman & Manville, 2014; London Councils, 2018). With a similar objective of spreading out parking stress, London implemented controlled parking zones that restrict their usage to local permit holders at certain times (Lambeth Council, 2018). By reducing and spreading out the demand for parking spaces, cities can reduce traffic congestion and pollutants which are a major health concern.

2.2 Current state of parking and enforcement in Lambeth

About 320,000 people live in Lambeth, making it one of the most densely populated regions in England (Greater London Authority, 2017a). High population densities are associated with high levels of air pollution; boroughs in Central London—which have the highest population levels in London—had the highest levels of NO_2 and PM_{10} pollutants (Greater London Authority, 2017b). Within Central London, Lambeth was tied with City of London as the top boroughs to exceed limits for NO_2 and PM_{10} in 2015 (Greater London Authority, 2017b). Brixton Road is a major contributor to Lambeth's air pollution problem, which produces the highest level of air pollution out of all roads in London; in 2017 Brixton Road broke the legal annual limit for air pollution in a single location by 6 January, and in 2018, it exceeded the annual limit by 30 January (Cockburn, 2019).

2.2.1 Parking and enforcement practices in Lambeth Council

Under the governance structure in London, Lambeth Council offers services including education, housing, waste management, road safety, and parking enforcement. For parking services, the Lambeth Council sells resident parking permits, provides permits for disabled individuals (Blue Badges), sets parking restrictions, and collects payments and fines from drivers who violate parking regulations.

Recently, the Lambeth Council changed the department structure so that the overarching directorate of Resident Services oversees both parking enforcement (see Appendix A) and other day-to-day issues facing residents, including housing management and environmental protection.

To improve air pollution, Lambeth uses many London-wide parking management strategies to shift travel from private cars to alternative modes. Despite Lambeth's population increase of nearly 20% from 2001 to 2016, bike usage increased by 130%, car usage decreased by 35%, bus usage increased by 40%, and HGV (heavy goods vehicles, i.e., truck) usage decreased by 33% in that time (Department for Transport, 2017). By 2018, Lambeth residents used public transport over 75% of the time (Transport for London, 2018).

2.2.2 Lambeth Council's parking enforcement systems

Aside from the implementation of parking strategies, the Lambeth Council must perform the duties of parking enforcement, such as distributing penalty charge notices (PCNs) and removing abandoned vehicles. The Lambeth Council uses multiple systems to process PCNs, permits, and complaints. To handle PCNs and parking permits, Lambeth uses a system called

Liberator, which the company Farthest Gate Limited provides. In addition to PCNs, this software deals with the appeals process through the Response Master system. Currently, Response Master uses automated responses to provide key information to drivers about how to appeal their PCN. Lambeth Council's compliance division receives complaints from patrons of Lambeth's services through the ICaseWork system, which allows Lambeth Council to remain up to date on concerns and complaints from its patrons (J. Edlin, personal communication, 15 May 2019).

2.3 Implications of current and emerging technology on parking-related services

For Lambeth Council to improve its parking services, technologies new to Lambeth may play an important role in shaping parking strategies. This section describes three categories of technologies: technologies that help drivers find parking, technologies that help pay for parking, and technologies that share data on parking and traffic.

2.3.1 Technologies for parking management systems

For parking management to be effective, drivers must be able to find a parking spot and park efficiently. Finding parking spaces efficiently leads to less time wasted by drivers and reduces traffic. One current system to aid drivers in finding parking uses sensors and signs to direct people to empty parking spaces. Two existing methods to collect occupancy information are cameras and sensors that detect whether a car is parked or not. Compared to sensors, cameras are relatively inexpensive and could rely on existing infrastructure, whereas funding for an entire sensor system in a car park can cost tens of millions of pounds due to the overhead installation price for each parking spot (Ross, 2011). However, parking spaces could conceal sensors in the ground, protecting them from vandalism and making them aesthetically appealing. A way to reduce costs for sensor systems is to equip cars with devices that can communicate with each other, allowing for the parking system to relay information, such as the availability of parking spaces, to the driver (Lu, 2009). However, these devices would need to exist in all cars to provide accurate information (Lu, 2009).

Information from sensors or cameras can update signs or smart parking apps, which would reduce cruising for spaces by directing drivers to open parking spaces. For example, a study found that a smart parking app ParkRight in Westminster, London could save drivers an average of £68 on petrol and reduce CO_2 emissions by 238 kgs per year (Peng, Nunes, & Zheng, 2017). However, such smart parking apps may lead to problems for people who are unable to access the latest technology, apps, updates, and upgrades needed to use the service (Jern, 2017).

Another parking method is an automated parking garage which utilizes lifts and dollies to place cars in underground or aboveground facilities. An automated garage would reduce the need for a driver to find a parking space as they would simply park on a platform at the entrance and enter a code when they wish to retrieve their car. Additionally, since pedestrians do not have to enter the garage, parking facilities may lower ceiling height, decrease the size of parking spaces, and remove pedestrian access ways. As a result of these changes, automated parking garages can take up to 60% less space and improve customer safety (Mathijssen, 2006).

2.3.2 Payment technology

Another important aspect of parking services is the payment method. One approach to paying for parking is for a driver to manually pay at a service area or payment kiosk. However, manual payment is inconvenient for drivers, since the process is slow and can cause congestion at the entrances and exits of parking areas (Parkmobile, n.d.). On the other hand, mobile payment systems are far cheaper than traditional payment methods, such as physical payment points at

parking locations. Future mobile payment systems could bill drivers based on their parking space and duration, potentially simplifying the transaction and improving customer satisfaction with the service. This system also reduces fees and the time a person spends paying for parking by allowing them to extend their parking time without having to return to a parking meter (Parkmobile, n.d.). However, accessibility problems may diminish the potential benefits since some members of the public would not have the ability or opportunity to use the technology necessary to access the service.

In the future, this payment system may become further automated to increase user mobility by either integrating developing technology directly into cars or evolving mobile parking apps to make automated payments. One approach to automate payment relies on communication between drivers and nodes at the entrances and exits of a parking space. Radio frequency identification technology (RFID) and other forms of wireless interfacing, such as Bluetooth, could facilitate increased automation (Pala, 2007). This system will handle payment automatically, allowing drivers to focus on other things and eliminating the need for parking attendants, as current parking areas still require attendants to help those who have difficulty with mobile payment systems (Pala, 2007).

2.3.3 Internet of Things

An external area of innovation that could cause change to Lambeth Council's parking services is the Internet of Things (IoT), which refers to a vast web of devices that communicate by collecting and using data from each other. Industry experts estimate that there will be 26 billion IoT units by the year 2020, which will create a denser network of information to provide more accurate and precise analysis (Alger, 2018). The greatest application of IoT will most likely be smart cities. Smart cities involve integrating devices and sensors within a city to unify thousands of different inputs to acquire data-driven results. Smart Cities will create "service sectors, such as Smart Governance, Smart Mobility, Smart Utilities, Smart Buildings, and Smart Environment" (Zanella et al., 2014, p. 23).

Some data that smart cities collect may monitor air quality, noise level, traffic, and congestion. Traffic and congestion monitoring could collect and quantify data to have the greatest effect on parking by giving an accurate depiction of traffic and congestion within a city. With an understanding of traffic and congestion, a smart city can get further insight into planning roads and directing traffic within congested areas (Zanella et al., 2014).

Other parking methods may use the possibilities of IoT in conjunction with autonomous vehicles to provide communication between vehicles in real time about location, speed, and other important details (Fagnant & Kockelman, 2015). This communication may then make the parking experience completely hands-off and eliminate the need for parking enforcement by allowing vehicles to identify empty parking spaces, park in that space, and pay automatically (Fagnant & Kockelman, 2015). With enough drivers using these vehicles, travel time may be able to decrease by 20% if cities use communication between vehicles to plan optimal routes to parking spaces (Pourazarm, Cassandras, & Wang, 2016).

2.4 Future-oriented analysis

In order for future parking-related technologies —such as autonomous vehicles and IoT devices—to provide the greatest benefit to the public, analysis of their potential socio-economic influence is key to understand the opportunities and threats they pose for society.

Future-oriented analysis can help decision-makers and businesses plan for prospective parking-related technologies by identifying and evaluating traffic and transport innovations for

their consequences on society. While this process is imprecise by nature, future-oriented analysis can provide insights that can provide a base for further research and improves resilience and preparedness for disruptive events to parking and enforcement services. Future-oriented analysis seeks to reveal the nature of change, promote forward-looking discussion among policymakers, and provide motivation to guide the process of change in society (Cagnin, Havas, Saritas 2013). However, because such analysis typically focuses on technologies in an experimental or theoretical phase, there is likely a deficiency of detailed information and research on such technologies and their effects. Furthermore, although the awareness and knowledge of potential effects of technologies could help minimize harms and capitalize on opportunities for society, barriers in reception and action in policy and decision making may minimize the benefits from forward-thinking; these impediments may include prioritization of current issues and skepticism stemming from lack of evidence and uncertainty associated with predicting the future (Cagnin, Havas, Saritas 2013).

Horizon scanning is a type of future-oriented analysis with the goal of identifying a broad range of future technological changes. The specific benefits that horizon scanning can bring to policymakers are twofold:

1. The information from horizon scanning allows policymakers to gain awareness of emerging trends and developments both within the areas they govern and from outside. The resulting knowledge provides time for them to allocate resources and plan strategies that prepare for the worst and use the best of future developments and scenarios. (Habegger, 2009)
2. Horizon scanning also "supports the envisioning of desired futures and emphasizes the creation of networks and knowledge flows between people and organizations" (Habegger 2009, p. 5). Ideally, these increased interactions between professional and policy communities lead to the emergence of better, more innovative policies (Habegger, 2009).

In summary, the background research in this chapter provides an overview of four areas relevant to assessing future parking and traffic technological developments in Lambeth: urban parking challenges, parking conditions in Lambeth, technological advancements in transportation, and future-oriented analysis. Each of these areas help identify issues that may affect the services of Lambeth's Parking and Enforcement team. Research on technology provided information on potential future advancements, and researching demographics and parking services of Lambeth provided context for predicting how these technologies may affect the Lambeth Council's services.

Chapter 3: Methods

The goal of this project was to evaluate how parking-related technologies may affect the efforts of the Lambeth Council's Parking and Enforcement Department to advance the Positive Parking Agenda during the next 20 years. We achieved this goal by identifying elements of Lambeth Council's parking and enforcement services and strategies relevant for advancing the Positive Parking Agenda; listing and describing ways parking-related technologies might affect parking and enforcement services in the short-, medium-, and long-term future; and synthesizing our findings to help the Lambeth Council identify technologies for opportunities and challenges to advancing the Positive Parking Agenda.

3.1 Objective 1: Identifying relevant elements of Lambeth Council's parking and enforcement services and strategies

In order to evaluate how technologies may affect the services of Lambeth Council's Parking and Enforcement Department and its efforts to advance the Positive Parking Agenda (PPA), we first assessed the current structure of Lambeth Council's services to determine what services were relevant for our project and which aspects of parking and enforcement Council employees viewed as significant. We used Hines et al.'s (2012) method of domain mapping to visualize the boundaries and key categories of our project and to organize the data we collected. Using the original brief as well as topics we identified in our background research, we created an initial draft of the domain map as a starting point for framing our project. To gather information about the Council's current services, we consulted our sponsor liaisons, Jonathan Pook and Thomas Burgess—the Lambeth Parking and Enforcement Operations Manager and Project Manager & Service Delivery Officer for Parking and Enforcement respectively—who provided an overview of these services, recommended people to interview, and suggested criteria for advancing the PPA.

We conducted semi-structured interviews with seven Council employees, one member of the British Parking Association, and representatives from PayByPhone and APCOA Parking who provide parking payment and enforcement services respectively for the Lambeth Council. In each interview with a Council employee or contractor representative, we asked about the parking services his or her team provides, the strengths and weaknesses in their services, the use of the PPA in his or her work, and the major goals for their parking services in the future. Documentation of the questions we used to interview Council employees and contract representatives appears in Appendix B.

After conducting the interviews concerning the current state of Lambeth Council's parking services and their priorities for the future, we analyzed the interviews by comparing common topics for priorities and areas of improvement in the Council's parking services. We then added the overlapping and recurring ideas we identified from the interviews to our criteria list (see Appendix C). We also used the data we gathered about the Council's parking services as a baseline for technologies the Council currently use in their parking and enforcement services.

3.2 Objective 2: Listing and describing ways parking-related technologies could influence parking services

During the second phase of the project, we described potential ways parking-related technologies not currently in Lambeth may affect the Lambeth Council's parking and

enforcement services in the future. To describe the potential effects of technologies, we used the domain map (see Appendix D) to identify general categories of technology to research for their influence on parking; main areas that we covered were smart cities, parking systems, and transportation technology. The main purpose of this phase was to gain scholarly evidence for scenarios about the possible ways future technology could affect parking, as well as the demands, harms, or opportunities they may bring to the Lambeth Council. To conduct research on the potential effects of technology, we divided the task into two steps: first, we looked for developments and features that could affect parking, and second, we described how each of those scenarios related to the list of criteria that we created in the previous phase.

To accomplish the first step, we used two types of sources: the interviews with Lambeth Council employees, and online research. During the interviews, we also asked about perceptions or opinions of technology that the Lambeth Council used for parking and enforcement, as well as how new technology could develop over time to affect their services. These interviews gave us a starting point for technologies to research, as well as inspiration for ways that these technologies could affect parking and enforcement. For online research, we mainly used Google, Google Scholar, Science Direct, and Engineering Village, focusing on search results that met the criteria in Table 1.

Content sought after:	**Content we avoided:**
Future-oriented information: information that specifically tried to predict or estimate what technologies could become available or integrated in society in the future, as well as how current technologies could develop or grow. Examples that fit this description include projections and forecasts, innovations, and visions and goals of the future	**Present information:** information that covered technology well known or that the Lambeth Council already considered, which does not fit the project goal of looking to the future. However, we accepted information about technologies that are currently present or in testing in places outside of Lambeth as future-oriented if the technology could take effect in the future of Lambeth
Parking specific: reports that covered how technologies could affect parking and considerations of how parking related matters, such as revenue, could change as a result; additionally, we researched recommendations and strategies for preparing for these technologies	**Technology Details:** information from articles that focused on the details of technologies, such as technical information regarding its specific designs, elements, and functions; such information was too focused and irrelevant for the Council's use. However, we used information regarding implementation and infrastructure, since it would help the Council prepare for the demands of future technologies

Table 1. Criteria for researching scenarios of technology online

We used the information we gathered from interviews and online sources to formulate scenarios about possible trends and developments in technologies. Each scenario description contained an overview of the technology, main areas of parking and enforcement services that it targets or affects, and the timeframe of the scenario; the timeframes we used were short-, medium-, and long-term which we defined to be the next five years, 5-10 years, and 10-20 years respectively. These time values followed the four five-year timeframes that our sponsor requested, combining

the 10-15 and 15-20 year timeframes because of the increased uncertainty in long-term futures. To describe how developments in the technologies could affect Lambeth's parking infrastructure and services, we organized the possible consequences using our list of criteria that appears in Appendix C. For each criterion, we indicated if the effect on parking services was positive, neutral, or negative, allowing readers to understand how a technology may benefit or harm parking services.

3.3 Objective 3: Synthesizing future opportunities and challenges for the Lambeth Council

During the final phase of our project, we synthesized the results of our research by creating models to visually convey the significance of technologies on parking and enforcement services over time. We first created a questionnaire that focused on gaining information about how smart parking apps, dynamic pricing, and autonomous vehicles could influence parking and enforcement services in the short-, medium-, and long-term respectively. We targeted the questionnaire to parking industry stakeholders, which included Lambeth Council employees, transport and parking industry officials and experts, and residents and workers in Lambeth that have experience with the Council's services. We used the questionnaire to learn about:

- What priorities respondents had for parking-related issues and their current perception of Lambeth Council's parking and enforcement services.
- Which criteria respondents thought each technology would significantly influence and whether this influence would be positive or negative.
- How each technology might affect respondents' perception of Lambeth's parking and enforcement services.
- What additional effects each technology may have on parking services, what factors may hinder the use of the technology, and how it might affect driver behaviors, such as private car ownership.
- How respondents' perception of parking services might change due to the technologies' potential use of data.
- If an annual parking report would be beneficial as an update on the state of the Council's parking services and projects

We then synthesized our research and data from the questionnaire to create two types of models to communicate the potential effects of technologies on parking and enforcement services:

1) An influence diagram that showed the relations between the developments we identified in each scenario and how those developments may affect specific aspects of parking and enforcement services. The influence diagram was a key visual aid for organizing the developments and features in a scenario into relations between the outcomes of technologies and potential benefits or harms to criteria of parking and enforcement services.
2) A matrix that provided a broad overview of how each technology and potential features of the technology may affect our criteria for parking services (see Appendix E). The matrix displayed if and how a technology may affect each criterion and could expand to display how specific features or developments of the technologies could affect the criteria.

Chapter 4: Findings

This chapter details the insights we gained through our methods and is organized by how they relate to the different themes of our research. Beginning with our analysis of interviews with members of the Council, it details the potential influences on the future of parking by smart parking apps, dynamic pricing, and autonomous vehicles. The chapter concludes by elaborating on the influences data collection and annual parking reports might have on the public perception of Lambeth Council.

4.1 Criteria for evaluating technologies' influence on the future of parking and enforcement services

In total, we interviewed seven employees from the Lambeth Council, a member of the British Parking Association (BPA), and employees from the Council's contractors, PayByPhone and APCOA Parking. From these interviews, we learned that three major areas of concern for parking and enforcement services were strategy, sustainability, and quality of service. Additionally, although Council employees typically were unaware of the Positive Parking Agenda (PPA), we learned that the Council already considered most of the standards in its work, such as congestion, air quality, accessibility and fairness; furthermore, major objectives for the Council's parking and enforcement services overlapped with those of the PPA.

Finding 1. The main areas of concern for parking and enforcement services are environmental sustainability, public perception and quality of service, and strategy and performance of services.

A common discussion topic in interviews was environmental sustainability, specifically problems with traffic congestion and air quality in Lambeth. At least four different managers we spoke to were concerned about the traffic levels within Lambeth. In our interview with Lambeth Council's Sustainability Manager, we learned that Council members, including the Parking and Enforcement Team, are paying increased attention to air quality problems, but may lack a comprehensive understanding of the air quality problems in the borough (A. Round, personal communications, 25 May 2019). Furthermore, social issues, such as fairness and inequality, are related to environmental sustainability, since residents with lower income are exposed to higher levels of air pollutants by living closer to main roads that have greater volumes of traffic and congestion.

In addition to the environmental sustainability concerns of interviewees, quality of service and public perception was another frequent topic in interviews. From interviews with the Assistant Director of Parking and Enforcement and the Senior Parking and Enforcement Compliance Officer, we learned that fairness and accessibility are important criteria for the Council to consider for its services and regulations. For example, while congestion zone charges seek to address environmental sustainability, they could affect poorer residents and drivers unfairly since lower income residents are more concentrated around major roads with high levels of congestion (N. Fenton, personal communication, 14 May 2019). Other factors of public perception and quality of service are how accessible and easy the service is to use. Since Lambeth is a very diverse borough with a high level of poverty and non-English speaking residents, the Council needs to address that wide range of user demographics in order for residents to use and be satisfied with their services. For example, the Senior Parking and Enforcement Compliance Officer described situations where elderly people who weren't well versed in technology would not park in a spot that only had the option to pay by app and would

instead drive to find a spot with a basic pay and display machine (J. Edlin, personal communication, 15 May 2019).

We also learned that education and report could benefit problems with public perception. In our interview with the Parking Enforcement Investigations Manager, she reported that public perception of her team is very positive since publications of their work in combating Blue Badge fraud has allowed for the public to understand and support the work they do.

The third major focus in our interviews concerned the performance, coordination, and strategy within the Council for creating and improving the services they provide to the public. The Strategic Director of Residence Services described that there was a pressing need for more collaboration between departments within the Lambeth Council, as well as between boroughs and other authorities and officials in London (B. Dosunmu, personal communications, 22 May 2019). Furthermore, according to the Assistant Director of Parking and Enforcement, we learned that in an ideal future, local authorities would provide unified services across London to simplify services and make them consistent for everyone in London (N. Fenton, personal communication, 14 May 2019).

Five out of the seven employees of the Lambeth Council that we interviewed mentioned the need to increase efficiency in their services and find alternative revenue sources, leading us to consider finance and efficiency as significant criteria for parking and enforcement services, since a substantial amount of revenue generation for the Council comes from penalty charge notices (PCNs) and parking permits. Lambeth's Principal Transport Planner recommended that as future technologies develop to affect traffic and parking, the Council should find additional sources of revenue and improve the efficiency of resource use for services (K. Taylor, personal communication, 20 May 2019).

4.1.1 Perception of parking and enforcement services

We obtained a total of 43 responses from our questionnaire, which represents the thoughts and opinions of officials and experts whose work concerns parking, as well as the current perception of Lambeth Council's services from 20 respondents that live or work in Lambeth. The respondents were typically older, with over 60% ages 45 and older. The strongest limitation for our findings based on the questionnaire is the sample size; since we only obtained a total of 43 responses, our results do not represent the whole population of parking and enforcement stakeholders. Furthermore, our questionnaire did not address demographics such as race and income, which could have been factors for differences in opinion between respondents that have experienced Lambeth's parking and enforcement services. Furthermore, about 56% of respondents classified him/herself as an official that works on parking for a government organization, which is a source of bias since people who work in parking would likely view parking and enforcement services in a better light than outsiders to the field of work.

Finding 2. The general public and government officials that work on parking share the same top three concerns of air quality, traffic congestion, and road safety; however, perception of the quality of services differed significantly between these two groups.

We found similarities and disparities in the perception of parking and enforcement based on how government officials and Lambeth residents ranked our list of criteria. Respondents from all classifications agreed on major issues, as they consistently ranked air quality, traffic congestion, and road safety as the top three criteria in order of significance. However, despite the fact that government officials that work on parking ranked revenue generation as least significant, people who don't work on parking perceived parking and enforcement as motivated

or focused on revenue generation, since responses to the question “What do you believe the role and function of parking enforcement is?” repeatedly mentioned or fixated on revenue collection. This pattern in responses shows a strong disconnect between the Parking and Enforcement team and the public that uses their services. In addition, Figure 1 displays the differences in perception of Lambeth’s parking and enforcement service by these two groups, as 6 out of 12 respondents not working in the parking industry responded negatively to the question “What is your perception of parking and enforcement services offered by the Lambeth Council?,” while 6 out of 7 respondents working in parking viewed the service positively.

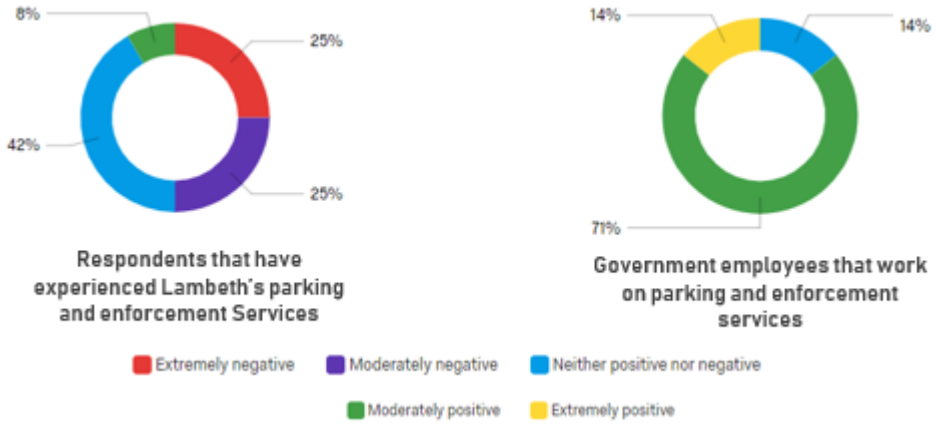

Figure 1. Disparities in perception of parking and enforcement services by respondents that live or work in Lambeth

4.2 Potential influence of smart parking apps on parking and enforcement services

Smart parking apps are any mobile application that aids in the parking experience. Currently, the Lambeth Council uses a mobile payment application called PaybyPhone to facilitate mobile payments. In the future, smart parking apps may develop to guide drivers to open parking spaces, allow drivers to reserve parking spaces, and pay for parking automatically. Figure 2 summarizes some of the potential ways that smart parking apps could develop to influence parking and enforcement services.

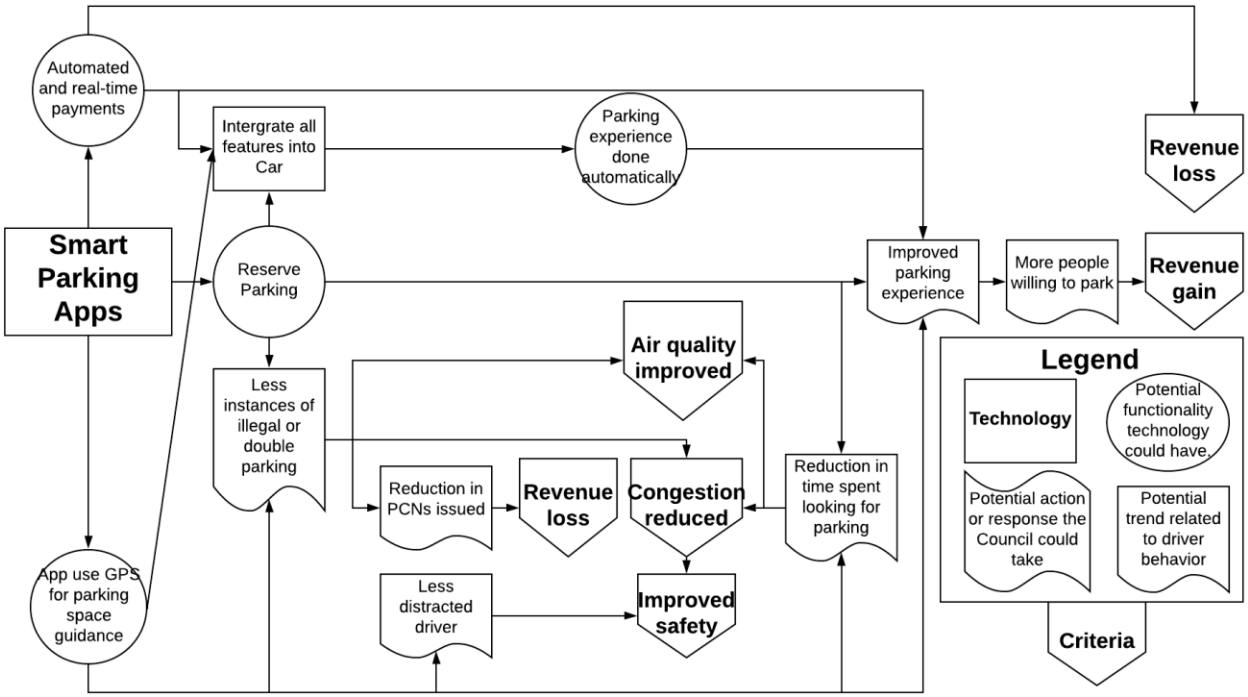

Figure 2. Diagram of potential ways smart parking apps may influence parking and enforcement services

Finding 3. Advancements in smart parking apps will be available to Lambeth's parking services within five years.

The Lambeth Council currently uses the parking payment app PayByPhone and advancements, such as in-car integration and the ability to guide drivers to parking spots, have the potential to come into existence within 5 years. According to the questionnaire, 23 out of the 30 respondents working in the parking industry indicated smart parking apps with these capabilities could come into existence within 5 years, while PayByPhone believes they can integrate smart parking features into cars by 2025 (R. Maisey, personal communication, 14 May 2019).

Finding 4. Smart parking apps may have a positive effect on the environment by reducing congestion and emissions.

According to the questionnaire, 22 of 25 respondents indicated smart parking apps would have a positive effect on congestion, and no respondents answered smart parking apps would have a negative effect on congestion. Similarly, out of the 18 respondents who believed smart parking apps could affect air quality, only two respondents thought they would have a negative impact. From our research, smart parking apps could reduce congestion by limiting cruising while looking for a parking space. An IBM (2011) study estimated that 30% of cars cruising in a city are looking for parking. Smart parking apps could reduce congestion by using a driver's phone or the car's GPS to guide drivers directly to a parking spot, thus reducing the amount of time a driver wastes when looking for parking.

Finding 5. Smart parking apps may improve revenue and efficiency.

Smart parking apps could increase parking revenue up to 30% by increasing total parking occupancy, creating new revenue streams, and improving the Council's use of resources (Carrol,

2016; Gautam, 2018a). One way smart parking apps can increase revenue is by providing parking authorities with new insight into user habits so they can deploy their resources efficiently (Gautam, 2019). For example, the Lambeth Council could deploy civil enforcement officers to areas that have a high level of parking infractions instead of equally enforcing all parking areas. Eventually, officers may be able to use real-time data to go directly to cars in violation of parking regulations to improve resource deployment (SFpark, 2014). However, smart parking apps may decrease PCNs and revenue due to fewer drivers parking illegally because they cannot find parking (Guatam, 2019).

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Finding 6. Smart parking applications may improve public perception may improve due to.

Of the 20 questionnaire respondents that lived or worked in Lambeth, 12 indicated that smart parking apps would improve their perception of Lambeth Council's parking and enforcement services. Only 3 of the 20 respondents, expressed it would make their perception worse. Respondents strongly believed smart parking apps would positively affect accessibility, fairness, and ease of use. 22 out of the 27 respondents that thought smart parking apps would have a significant effect on accessibility indicated a positive effect, 17 out of 21 respondents indicated smart parking apps would positively affect fairness, and 31 out of 34 respondents indicated smart parking apps would positively affect ease of use.

Smart parking apps have the potential to improve these criteria because these apps may make it easier for drivers to find and pay for parking (Leslie, 2014). Smart parking applications could further improve these criteria if car manufacturers integrate smart parking features directly into cars (R. Maisey, personal communication, 14 May 2019). Another consideration that may affect the perception of Lambeth Council's parking and enforcement team is accessibility of smart parking apps to the public. In the UK, the Telegraph reports only 1 in 5 citizens between the ages of 65 and 74 own a smartphone, so completely transitioning the parking experience into smartphone apps could suffer low adoption amongst the elderly (Rayner, 2015). However, in Lambeth, user adoption of paying for parking via mobile application is high at 92%, so accessibility may be less of a problem (T. Burgess, personal communication, 14 May 2019). An additional consideration that may improve public perception is if boroughs share the data smart parking apps collect with each other to create a seamless parking experience throughout London (A. Luck, personal communication, 3 June 2019). Smart parking application companies could also integrate this data from smart parking apps into other transportation services, such as ride sharing and trip planners, to improve a user's experience (Carroll, 2016; K. Taylor, personal communication, 20 May 2019). Finally, smart parking apps could reduce the amount of PCNs that civil enforcement officers issue and money that drivers have to pay money for illegally parking (Gautam, 2018b).

4.3 Potential influence of dynamic pricing on parking and enforcement services

Dynamic pricing for parking is a pricing strategy that increases the price of parking in areas of high occupancy and decreases parking prices in areas of low occupancy. Sensing technologies, such as in-ground sensors or ANPR, collect key data for this system. Dynamic pricing models could more evenly distribute parking occupancy due to drivers willing to drive to find cheaper parking spots. Figure 3 displays the various features and developments that could occur as a result of dynamic parking pricing, as well as their effects on criteria such as congestion, revenue, and public perception.

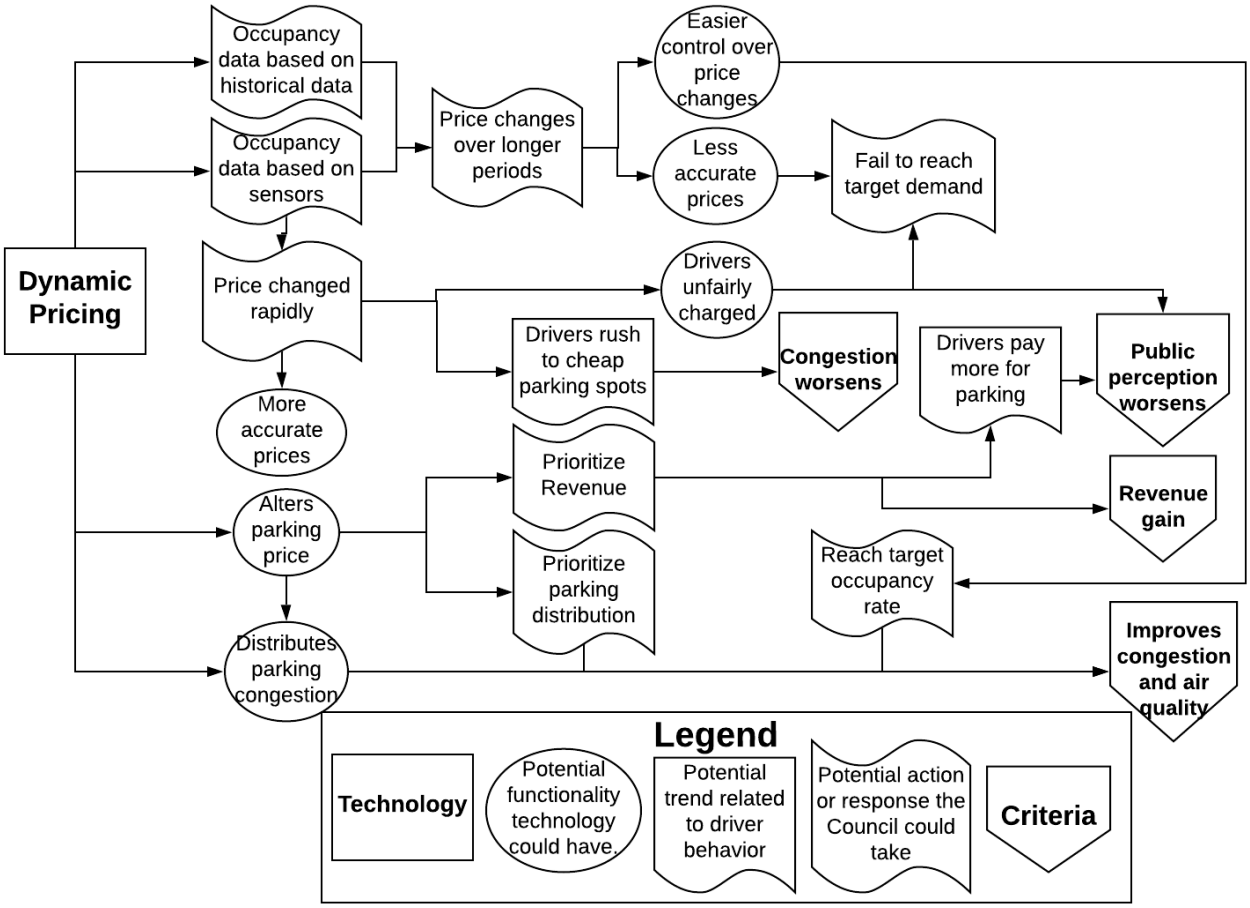

Figure 3. Diagram of potential ways dynamic pricing may influence parking and enforcement services

Finding 7. Implementation of dynamic pricing may be possible within five to ten years

The Lambeth Council will likely be able to implement dynamic pricing for its parking services within five to ten years (Xerox, 2011). Implementing a dynamic pricing model will depend on the Lambeth Council's ability to collect adequate occupancy information of parking spots. From our questionnaire, 19 of the 30 parking professional respondents agreed that Lambeth could implement dynamic pricing within five to ten years.

Finding 8. Dynamic pricing could have a positive effect on the environment by reducing traffic congestion and vehicle emissions.

According to our questionnaire, over 90% of respondents believed that dynamic pricing could have a positive impact on air quality and congestion.

Dynamic pricing could improve congestion by using the price variability to distribute parking occupancy and directing drivers to cheaper, open parking spaces. As a result of this system, drivers could potentially be more willing to drive away from congested areas to cheaper less congested areas (Xerox, 2011). In 2014, San Francisco conducted a trial of dynamic pricing, which demonstrated dynamic pricing could improve congestion. In San Francisco's trial, traffic volume decreased by 8%, the time to find parking decreased by 43%, and greenhouse emissions decreased by 30% in trial areas (SFpark, 2014).

Finding 9. Dynamic pricing may increase the revenue generation for the Lambeth Council

According to our survey, 22 out of 24 respondents thought that dynamic pricing could positively affect the Council's revenue. Parking authorities could receive more revenue because the price of a parking spot will accurately reflect the demand drivers are willing to spend for parking so overall revenue should increase even though there will be cheaper parking spots (Flanagan, 2017). In San Francisco's dynamic pricing trial, revenue increased by £73.70 per parking spot per month (GSMA, 2017). Facilitators of trial in a Los Angeles private garage l reported that revenue increased by 35% a month (Flanagan, 2017). Similarly, Justpark, a dynamic pricing solution company, reports an average increase in revenue of 20% when implementing their system (Justpark, n.d). Dynamic pricing models must balance parking distribution and revenue generation to be effective. If the pricing model prioritizes revenue too much, then drivers would be less likely to park further away in a cheaper spot and might not park at all due to the high prices (Gautam, 2018). If the model prioritizes parking distribution using lower prices to incentivize drivers then the parking authority may lose revenue (Mackowski, 2015). Additionally, as dynamic pricing may reduce parking congestion, illegal parking and PCNs may reduce due to drivers finding spaces more easily (Gautam, 2018b). In San Francisco's dynamic pricing trial PCNs went down 23% (SFpark, 2014).

Finding 10. Dynamic pricing requires additional trials and research to understand how specific models and features could influence public perception of parking and enforcement services

Overall, there is no clear evidence that dynamic pricing will affect public perception one way or the other. Based on our questionnaire, 5 out of 20 respondents expressed that their perception of Lambeth Council's parking enforcement team would not change as a result of dynamic pricing, while 7 out of 20 respondents indicated that dynamic pricing would positively affect their perception of parking services, and another 7 respondents believed it would negatively affect their perception.

The ranking of dynamic pricing's influence on the criteria of accessibility, ease of use, and fairness also reveals that respondents believe dynamic pricing could positively or negatively affect their public perception. When we asked respondents to rank dynamic pricing's effect on accessibility and fairness, 7 out of the 17 respondents indicated that dynamic pricing would positively affect accessibility and fairness, and 8 out of 17 respondents said dynamic pricing would negatively affect accessibility and make parking less fair.

These questionnaire results are consistent with our research, as dynamic pricing has aspects that could positively improve perception, as well as negatively affect perception. Dynamic pricing could positively affect public perception of Lambeth Council's parking services by providing drivers with a wider range of choices for the price of parking (Xerox, 2011). On the other hand, dynamic pricing may force drivers who are in a hurry or geographically constrained to park in more expensive parking spaces, leading to worse public perception of parking services (SFpark, 2014).

4.4 Potential influence of autonomous vehicles on parking and enforcement services

In this section, we describe how autonomous vehicles (AVs) may develop to influence parking and enforcement services. Figure 4 summarizes the developments and features of autonomous vehicles we considered when describing how AVs could influence parking and

enforcement services. We focused on fully autonomous vehicles to assess a greater range of possible functionality that could affect the future of parking. For example, fully autonomous vehicles could allow for a driverless ridesharing network, obey all parking or traffic regulations, and handle parking and transport in the city automatically.

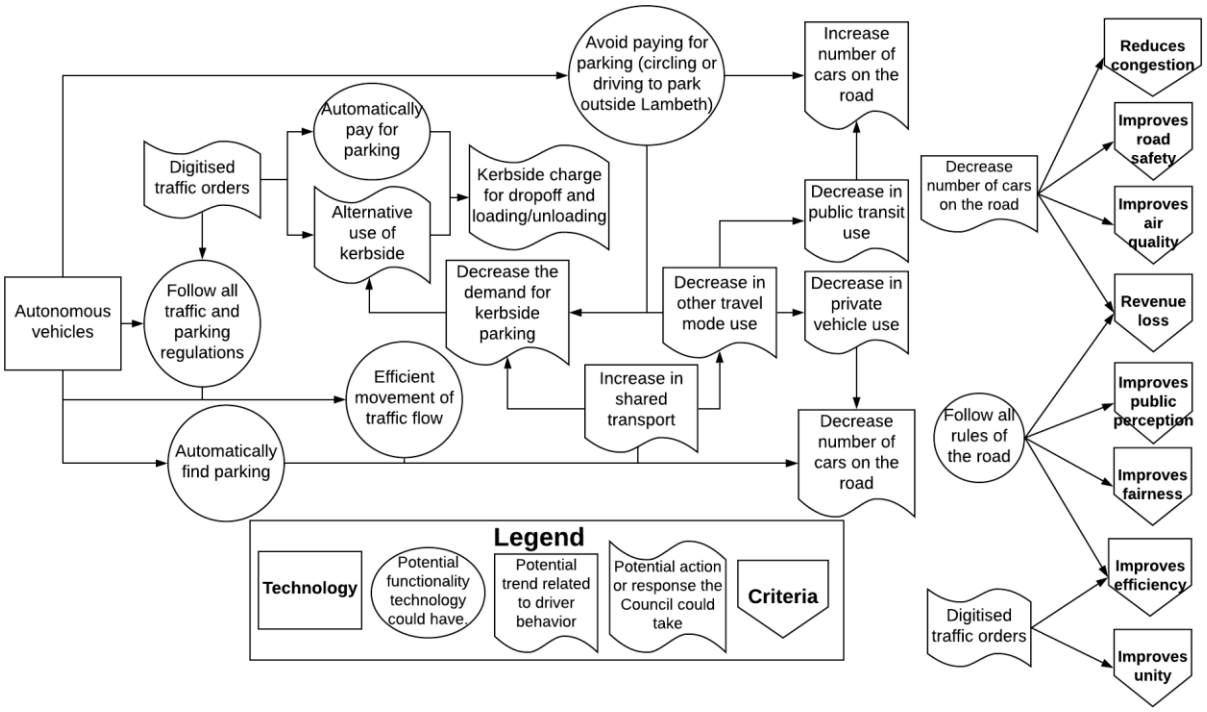

Figure 4. Diagram of potential ways AVs may influence parking and enforcement services

Finding 11. AVs are a long-term technology and are most likely to have a significant influence on parking services between 10 and 20 years in the future.

We obtained 30 responses from individuals working in a parking-related industry indicating what timeframe the respondent thought AVs would significantly affect parking services. Of these 30 responses, approximately 43% indicated that AVs would significantly influence parking services in the next 10 to 20 years, while 27% indicated it would take longer than 20 years for AVs to have a significant influence. Some obstacles that respondents described for the implementation of AVs included the cost, public acceptance, data sharing regulation, cybersecurity, and integration into the urban traffic system of the technology. Cybersecurity is a major concern, as Upstream Security (2018) describes the possibility for hackers to manipulate sensory data to cause an AV to engage in unexpected behavior and create safety and trust problems. Additionally, Litman (2019) describes that "it will probably be the late 2030s or 2040s before [autonomous vehicles] become affordable to middle-income households, and [even] later before they are affordable to lower-income motorists" (p. 30). However, AVs may still influence parking earlier than ten years, as the UK envisions having self-driving cars on the roads by 2021 (Burgess, 2018).

Finding 12. AVs may improve the environmental sustainability of Lambeth Council's parking and enforcement services by improving traffic congestion and air quality.

Of the 30 questionnaire respondents who indicated that AVs would significantly influence air quality, only one individual marked that AVs could worsen air quality, while all 24 respondents who thought AVs would significantly influence traffic congestion indicated that this influence would be positive. Additionally, based on our research, we found that AVs could improve air quality by maximizing fuel efficiency with more controlled acceleration and decelerations compared to human drivers (Litman, 2019). Furthermore, HERE (2017), a location data company, predicts that although AVs will likely worsen congestion initially, it will ultimately reduce congestion once connected, autonomous vehicles are able to move through traffic efficiently as a connected unit.

However, AVs may also lead to a shift away from public transit to shared autonomous mobility or private vehicle usage due to the increased comfort level and productivity for an AV passenger (K. Taylor, personal communication, 20 May 2019). In addition to the lower occupancy of private or shared AVs compared with public transit, both private and shared AVs may stay in traffic after dropping their passengers off. Shared AVs would continue driving to pick up their next passenger while private AVs may circle the streets to avoid paying for parking (Litman, 2019).

Finding 13. AVs may decrease the revenue the Lambeth Council receives from its parking and enforcement services

AVs may decrease the revenue that the Council generates from PCNs and parking payments as there may be a decrease in the need for parking regardless of trends towards private or shared AVs. If there is an increase in the use of private AVs, a primary concern for parking enforcement is that people may have their cars drop them off and then continue to drive around to avoid paying for parking (Litman, 2019). In the case that AVs create a primarily shared mobility market, AVs would simply drop off an individual and then drive to the next person using the service, requiring curbside space briefly for loading and unloading passengers (Litman, 2019). Additionally, if local authorities provide digital traffic orders containing regulatory data, AVs may use this data to understand and follow traffic and parking regulations (A. Luck, personal communication, 3 June 2019). If AVs follow all of the rules and receive no violations, the Lambeth Council would lose part of the substantial revenue they receive from PCNs.

However, if AVs did reduce demand for parking, the Council may be able to use the curbside for other purposes that generate revenue, such as automatically charging for drop off, unloading, and loading, as well as renting out the curb to local businesses when there is less parking demand (N. Fenton, personal communication, 14 May 2019; A. Luck, personal communication, 3 June 2019). In addition to alternative revenue sources, AVs may help improve the efficiency of the Council's use of parking spaces by decreasing demand for parking spaces and the ability of an AV to save space by parking closer to the curb in on-street spaces or behind numerous rows of cars in off-street parking (Nourinejad, Bahrami, & Roorda, 2018; Reimer, Mehler, and Coughlin, 2016). As AVs require less space, parking bays are able to accommodate more cars, and if AVs are able to access digital traffic orders, they may pay automatically for only the time they use (A. Luck, personal communication, 3 June 2019). Additionally, AVs may decrease the number of potential parking and traffic violations and the need for civil enforcement officers (CEOs) by following the rules of the road or decreasing the demand for parking (K. Jaffery, personal communication, 28 May 2019).

Finding 14. AVs may improve public perception of Lambeth Council's parking and enforcement services

Later in the questionnaire, we asked how the respondent's perception might change if the Council implemented policies to promote the use of shared mobility or automatic payment for curbside parking. In response to policies promoting shared mobility, five of the eleven respondents not working in a parking-related industry indicated their perception would stay about the same while five thought their perception would improve. Additionally, there were several responses expressing concern about the accessibility of shared mobility services and how convenient it would be to access. The promotion of a shared network may help address such accessibility concerns of both shared AVs and public transit (World Economic Forum, 2018). Similarly, six of eleven respondents thought their perception would improve if there was automatic payment for curbside parking, while only one response indicated worsened perception. Automatic payment may also improve the ease of parking and fairness by allowing smaller transactions such that drivers only pay for the time they're parked.

4.5 Public perception of data collection and publication of an annual parking report

In the final part of our questionnaire, we asked respondents about how their perception of smart parking apps, dynamic pricing, and AVs may change due to the data collection these technologies may require for the Council's services. Additionally, we asked respondents how an annual parking report, which documents parking statistics and future projects, could affect their perception of Lambeth Council's parking and enforcement services.

4.5.1 Public perception of data collection for parking-related technologies

When prompted about how data collection would affect their perception approximately 4 out of the 13 respondents that work or live in Lambeth and do not work in the parking industry indicated that their perception of the three technologies would be worse. Public perception of the collection and usage of traffic and parking data to facilitate the technologies of smart parking apps, dynamic pricing, and AVs was slightly worse from the public's perspective compared to the opinions of respondents that worked in parking; however, Figure 5 shows that concerns over data will likely not inhibit the implementation of technologies that use this data, nor will these concerns strongly affect perception of the services, as most respondents responded with no change to their opinions of the three technologies in the questionnaire.

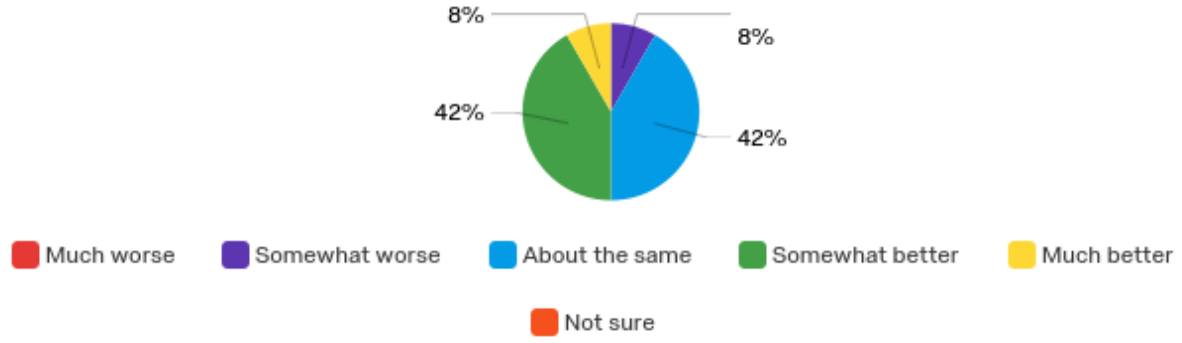

Figure 5. Changes in perception of technologies due to user data collection

4.5.2 Value of an annual parking report

Responses to questions asking about the value of an annual parking report (a report that covers key statistics such as the number of permits and PCNs issued, as well as goals and projects for parking and enforcement services) showed that such a report would overall be beneficial for the Lambeth Council to produce, as Figure 6 shows that 20 out of the 30 respondents who worked in parking would agree that such a report would be worth the resources. Additionally, Figure 7 shows that 4 out of the 11 respondents who live or work in Lambeth think a parking report would improve their perception of parking and enforcement services while only one respondent thought their perception would worsen.

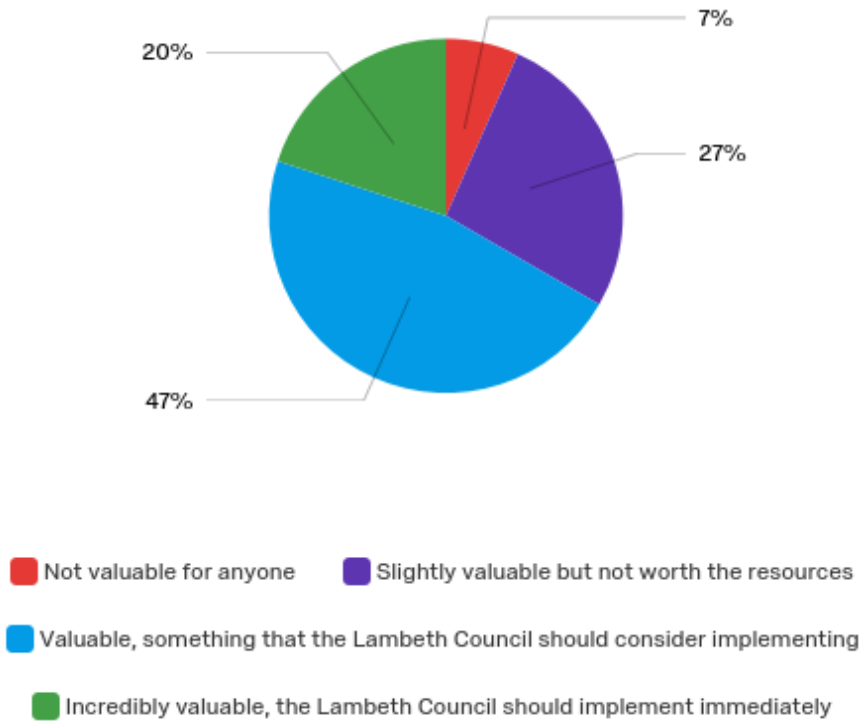

Figure 6. Value of an annual parking report based on people that work in parking

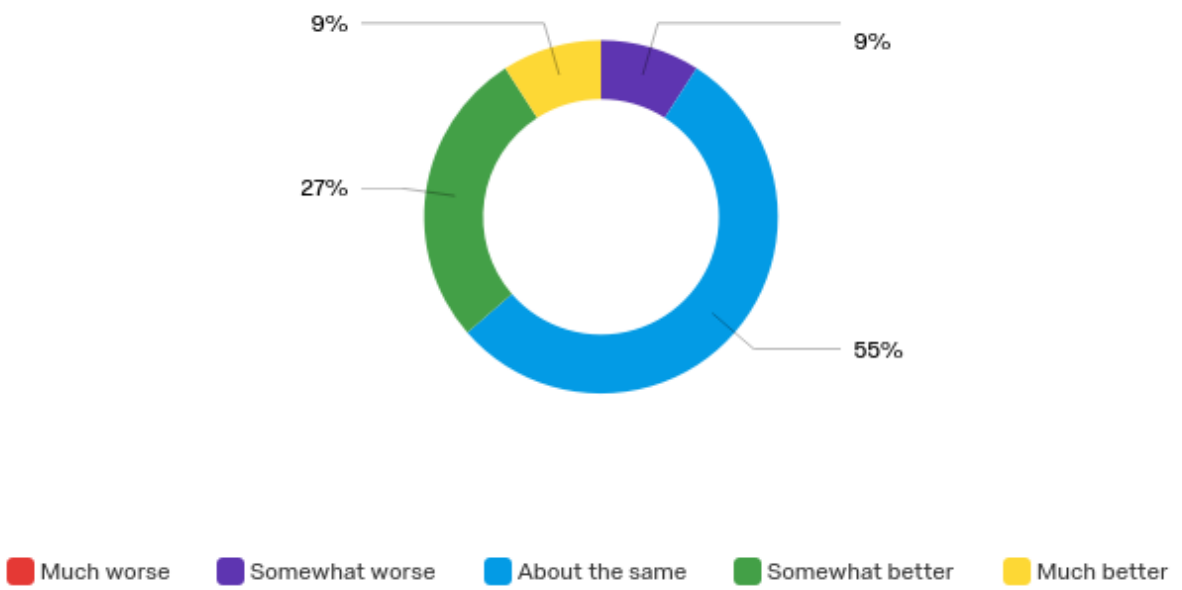

Figure 7. Responses from people that live or work in Lambeth for how their perception of parking and enforcement would change if an annual parking report was created

Chapter 5: Recommendations

Based on our findings, we present the following recommendations for future actions that can help Lambeth Council's Parking and Enforcement team advance the Positive Parking Agenda (PPA) and prepare for future technologies.

5.1 Recommendations for reacting to future parking-related technologies

Recommendation 1. We recommend that the Lambeth Council research methods to collect parking occupancy data as this data will be vital in implementing smart parking solutions.

Various methods of collecting occupancy data include in-ground sensors, existing ANPR technology, and RFID chips. These sensing technologies will enable further development of smart parking apps and may improve public perception of Lambeth Council's parking and enforcement services. Additionally, smart parking apps may help advance the PPA by improving the ease of finding a parking space; by making parking easier, smart parking apps minimize the time spent looking for parking and therefore reduce congestion and air pollution. However, it is important that alternative options remain for people that do not have smartphones or are unable to use the service.

Recommendation 2. To get the most out of smart parking apps, we recommend the Lambeth Council collaborate with other councils to share data and use the same application for their parking services. A unified system across boroughs will allow drivers to move easily across boroughs using one application. If boroughs do not share data openly, drivers may need to use multiple applications, thus making access to parking services more difficult and worsening public perception of parking services. Additionally, sharing this data with other transportation services would allow for a seamless transportation experience around London.

Recommendation 3. We recommend that Lambeth Council consult with other parking authorities that have conducted dynamic pricing trials to understand best practices for testing dynamic pricing. Based on our findings, dynamic pricing has yielded promising results for advancing the PPA by reducing congestion and improving air quality. However, implementing a successful large-scale model may be difficult due to the different priorities of many different stakeholders. Additionally, we recommend the Lambeth Council consult with PayByPhone about dynamic pricing, as smart application contractors will most likely facilitate the development of dynamic pricing.

Recommendation 4. We recommend that Lambeth Council consider ways to promote shared AV mobility options in areas with less access to public transit. While shared AVs may provide an alternative to private AVs and better access to public transit, they may also compete with public transit, worsening traffic congestion and air quality since more vehicles are needed to transport the same number of passengers. Additionally, some potential ways to promote shared mobility, such as an occupancy-based road charges, could provide an additional revenue stream and reduce traffic congestion. Furthermore, Finding 7 describes that the general concept of policies promoting shared AV mobility could improve public perception; however, the Council may need to emphasize the purpose of such a policy and conduct further research on the public perception of the policy.

Recommendation 5. We recommend that Lambeth Council digitize traffic management orders (TMOs) by following the BPA's parking data standards to enable functionality for AVs. According to Finding 6, AVs could use digitized TMOs to advance the PPA by improving road safety, efficiency, and revenue since AVs would know and follow traffic and parking regulations. By following these regulations, AVs may behave consistently with the rules of the road to improve road safety, as well as effectively adapt to dynamic regulations and curb management to increase revenue generation. Additionally, by following a common set of standards, the Lambeth Council may be able to collaborate with other London boroughs to provide a more unified user experience across London. Furthermore, Finding 7 describes that the existence of automatic curb payment, which digitized TMOs may enable, could improve public perception, however, this is the perception of a small sample, and the question did not raise the possibility of additional curbside charges that the Council could implement as a result of automatic curbside payment.

5.2 Recommendation for improving parking and enforcement public perception

Recommendation 6

We recommend that Lambeth Council consider publishing an annual parking report to improve public perception of parking and enforcement services based on our preliminary research. 67% of respondents to our questionnaire who are in the parking industry agreed that an annual parking report would benefit the Lambeth Council. In addition, 36% of questionnaire respondents who live or work in Lambeth indicated that a report may improve their perception of parking and enforcement services, while only one respondent marked that it would worsen. Since Lambeth is an inner borough (the 13 boroughs in the center of London) with a high volume of traffic, a detailed report of this information would be beneficial to track large scale trends or changes in parking and traffic and allow for the Council to understand and adapt their parking and enforcement services to these trends. An annual parking report that highlights successes by the Lambeth Council's Parking and Enforcement Team similar to the publications by the Fraud Investigations Team, as well as goals and future projects to advance their services, could improve public perception of the parking management that Lambeth Council provides.

Chapter 6: Conclusions

The purpose of our project was to describe how technologies could affect the future of Lambeth Council's parking and enforcement services. From interviews with Council employees, we learned that at the core of Lambeth Council's services are concerns for sustainability, service, and strategy. We focused on smart parking apps, dynamic pricing, and autonomous vehicles; the scenarios that we constructed for these technologies led us to recommend that the Lambeth Council prepare measures to collect and share data between boroughs to enable additional functionality and opportunities for the technologies we analyzed. By doing so, Lambeth Council could simultaneously take steps to prepare for the integration and adaptation of their services to these technologies as well as improve their public image as a valuable service that meets the needs and concerns of the public. Additionally, our recommendations could help the Lambeth Council better understand the future of technology by identifying the various effects they could have on parking and enforcement services, thereby minimizing risk and maximizing benefits in the actions of the Council for even the most unexpected cases.

The implications of our project extend beyond the Lambeth Council; innovations and developments in technology are a driving force for change in society, and London must form a united effort across its boroughs in order for parking and enforcement to adapt effectively to these advancements and provide satisfactory services for the public. We provided the Lambeth Council with in-depth future-oriented analysis on smart parking apps, dynamic pricing, and autonomous vehicles for their potential effects on parking services and a model to track and explore other technologies for opportunities and threats to parking and enforcement.

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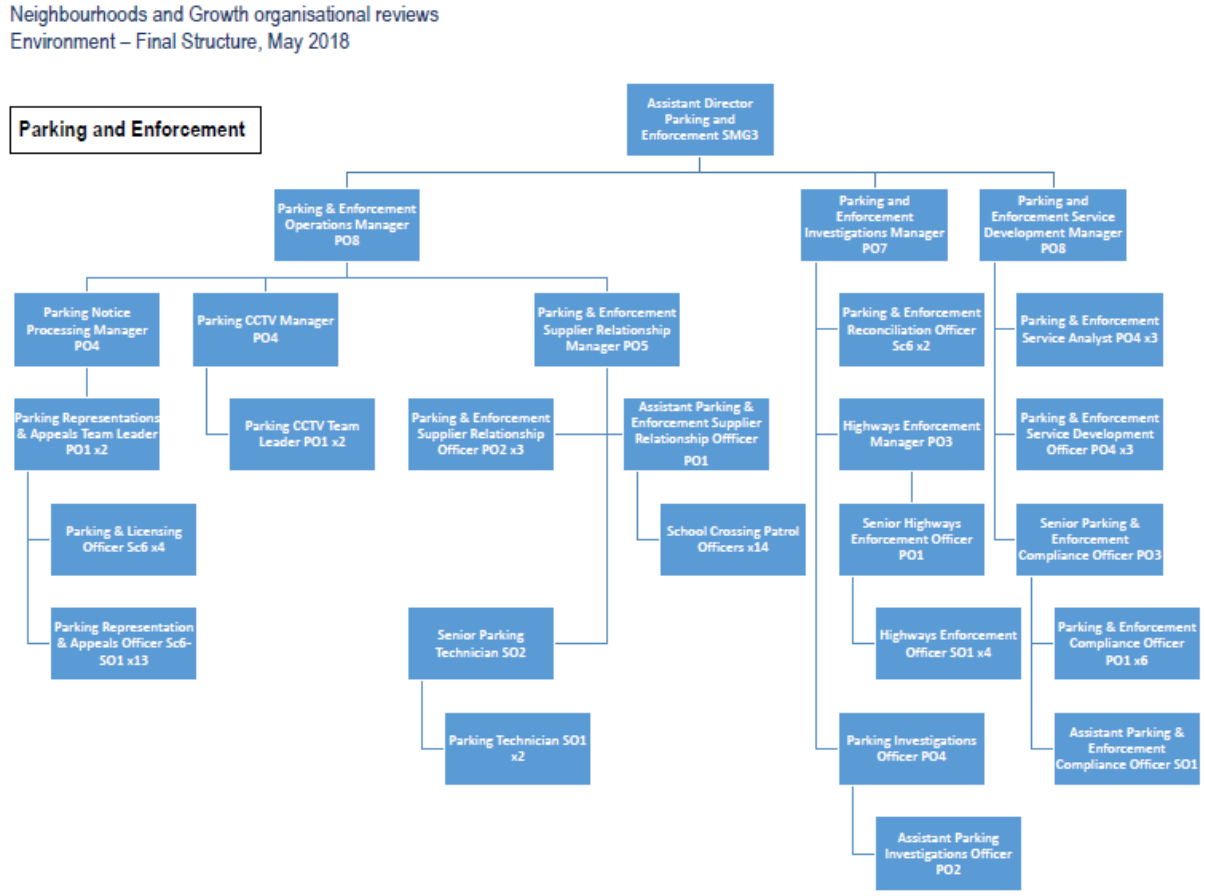
Appendix A. Organizational chart of the Lambeth Council's Parking and Enforcement Division

The below figure displays the organization of Lambeth Council's Parking and Enforcement Division, which we used to identify relevant employees to interview for information on elements of parking and enforcement services and strategy.



Appendix B. Interview questions for key parking stakeholders

We used the following sets of interview questions to structure our interviews with various employees of Lambeth Council, as well as other relevant stakeholders in the parking and enforcement industry. The questions covered a wide range of topics, including current perception of parking and enforcement services, major concerns for parking and enforcement services, existing knowledge of the Positive Parking Agenda (PPA), current uses of technology, perception of potential technologies that the Council could use, and specific questions for individuals based on their work.

PayByPhone (14/5/2019): Parking mobile app & payment solution

Service Questions:

1. What is PayByPhone? What are you currently doing and what are you trying to do? Are there any stats on how PayByPhone improves parking and congestion?
    a. In what ways?
2. Are there any projections on what the next step is beyond paying with phone?
3. What outreach is done to make sure user adoption is as high as possible?
4. Have different cities had different experiences adopting pay by phone?
5. What does PayByPhone perceive as biggest challenges and obstacles to overcome in parking?
6. What is normally the turnaround time for adoption by a city after agreeing to implement your system?
7. Have you started doing anything with data collection?
    a. What obstacles do you face with data collection in the UK?
8. What are the goals and/or standards that you seek to meet through the actions of Pay by Phone?

Marketing questions:

1. How do people perceive app over standard payment systems?
2. What are some of the talking points used to promote Pay by Phone?
3. What do you look for to appeal to users/consumers of Pay by Phone products?
4. What are the trends that you see in future consumer behavior or expectations of payment systems?
5. Are there any common complaints when using Pay by Phone?

APCOA (14/5/2019): Parking enforcement contractors

Product and Service Questions:

1. What are the most utilized services offered by APCOA?
2. Where do you believe parking services are headed in the future with APCOA?
3. How do you believe the public perceives parking enforcement?
4. What are the challenges in expanding role of civil enforcement officers?
5. What customer data are you collecting from APCOA's products and services?
6. What are the goals and/or standards that you seek to meet through the products and services of APCOA?

Marketing questions:

1. What are some of the talking points used to promote APCOA products and services?

2. What do you look for to appeal to users/consumers of APCOA products?
3. What are the trends that you see in future consumer behavior or expectations of parking services?
4. Are there any common complaints when using APCOA?

Neil Fenton (14/5/2019): Assistant Director of Parking and Enforcement for the Lambeth Council

General Questions:

1. What current projects are in place that are looking to improve parking in Lambeth?
2. How have people of Lambeth reacted to new parking technologies?
3. In what ways have you worked with neighboring boroughs on parking issues?
4. What are the known complaints or issues that you are working to address with Lambeth parking services?
5. Are there any challenges that you notice with parking services?
6. What are some of the hardest obstacles you face when performing your job?
7. What innovations do you think will have the greatest impact on parking within Lambeth?
8. Is there anyone in the council that you believe would be useful for us to talk to?
9. Do you have any recommendations of contractors we can reach out to?
10. What are some of the biggest parking challenges that the council will have to overcome in the future?

Positive Parking Agenda Questions:

1. In what ways is the council using the Positive Parking Agenda (PPA)?
2. What are challenges to its implementation with regards to issues such as funding, staffing, public opposition, legal authority, etc?
3. In what ways could the parking divisions of the Council improve the implementation of the PPA?
4. Are there things that are not part of the PPA that you think could be done to improve parking?
5. What do you think will be the biggest challenges to parking in the future and in the next 20 years?
6. Does the PPA actively come into consideration when projects or policies are being made?
7. Are there criteria in place that evaluates to what degree a service or policy meets the PPA?

James Edlin (15/5/19): Senior Parking and Enforcement Compliance Officer for the Lambeth Council

General Questions

1. What methods/technology are you using to collect complaints?
2. What are the most common complaints received by compliance division?
3. Are there trends in the types of complaints that you receive?
    a. What are patterns that you see with different complaints? What kinds of complaints are likely to naturally stop over time?
4. How does the compliance division handle complaints?
5. Does compliance use the Positive Parking Agenda?
6. What is the “ideal” world for parking i.e., what situations or systems would satisfy customers the most?

7. What are the unique selling points of parking enforcement?
8. How does legislation affect the actions of the compliance division?
9. Are there any current initiatives looking to improve the image of parking and enforcement team?
10. What measures do you take when considering the customer's experience/perspective?
11. What are some of the ways technology could help address parking complaints?
12. Is your division taking any steps to prepare for more automated parking and as a result less fines/penalties?
13. Is your division implementing systems to make compliance run more efficient? What would be potential ways to do this?

Ashley Brandon (15/5/2019): Parking Enforcement Investigations Manager for the Lambeth Council

General Questions:

1. In what ways does environmental enforcement differ from parking enforcement?
    a. Service wise
    b. Socially (dealing with people instead of cars?)
    c. Public perception issues
2. What are existing interactions/intersections between environmental and parking enforcement?
3. What are some areas of improvement for how the two operate, both independently and together?
4. What are the benefits of combining the two together in the future, as well as the challenges?
5. In what ways is the Council using the Positive Parking Agenda (PPA)?
6. In what ways could the Council improve the implementation of the PPA?
7. Does the PPA actively come up during decision making?
8. Are there criteria in place that evaluates to what degree a service or policy meets the PPA?
9. What are some of the hardest obstacles you face when performing your job?
10. Are there any challenges that you notice with parking services?
11. What are some of the biggest parking challenges that the council will have to overcome in the future?
12. Is there anyone in the council that you believe would be useful for us to talk to?

Shannon Consses (16/5/2019): Parking and Enforcement Service Development Manager for the Lambeth Council

General Questions:

1. What current projects are in place that are looking to improve parking in Lambeth?
2. What are projects in place that contractors are working on?
3. What is the projection of parking services/projects for the future?
4. In what ways have you worked with neighboring boroughs on parking issues?
5. What are the known complaints or issues that you are working to address with Lambeth parking services?
    a. What methods have you found effective in conveying results to the public to improve customer satisfaction?

6. Are there any challenges that you notice with managing parking services?
7. What are some of the hardest obstacles you face when performing your job?
8. What are some of the legislative issues that you face when implementing parking enforcement services?
    a. What are some of the potential legislative issues you face specifically when integrating new technologies into your services?
9. What are some of the budgeting or funding issues that you've faced in these projects?
    a. Are there any current projects or plans that could provide additional revenue?
10. Who should we get into contact with at TfL, and what part of TfL do you think would be relevant to our project?
11. Is there anyone in the council who you believe would be useful for us to talk to?

Questions about technology trends and developments:

1. What technologies do you think will have the greatest impact on parking within Lambeth?
    a. What parking technologies are feasible for Lambeth to install?
2. What are some current technologies that are being developed or tested?
    a. What are examples of these technologies being tested?
    b. What are the shortcomings of current technologies that aren't able to address current issues?
3. What are some technologies that are being proposed or in a conceptual phase?
    a. What are the potential opportunities and/or harms that these technologies could have for parking services?
    b. Who is the intended user of these technologies?
    c. What problems or goals do these technologies seek to address or resolve?
    d. What is the timeline for these technologies, from development to implementation/release?
4. Who can we get in contact with for experts on research and developments of these technologies?

Positive Parking Agenda Questions:

1. In what ways does your division use the Positive Parking Agenda (PPA)?
2. In what ways could the Council improve its implementation of the PPA?
3. Does the PPA actively come up during decision making?
4. Are there criteria in place that evaluates to what degree a service or policy meets the PPA?

Bayo Dosunmu (22/5/19): Strategic Director of Resident Services for the Lambeth Council

General questions:

1. How does management at your level work for residence services in general? How do you "balance" issues between housing, environment/streetcare, and businesses and residential services?
2. How do you want the public to perceive your services? What initiatives and future plans do you have to pursue this?
    a. What is the current state of parking perception and what efforts have the Council undertaken to improve the image of parking?

    b. What local communities do you work with on issues related to parking?
    c. What factors in Lambeth affect the image of parking/how parking services are perceived/changed?
3. What strategies do you have for the short, medium, and long-term concerning parking and enforcement? How have you considered emerging technologies that may influence these?
    a. Will parking and enforcement still be a separate division in the future?
    b. How will the industry change as time goes on?
    c. What problems do you foresee in parking that could arise in the future?
    d. What does sustainability mean in the context of parking and enforcement? Funding? Environment? What else?
4. In what ways do you see a decrease in PCNs and use of private vehicles affecting revenue? What are some possible solutions?
5. How have you worked with neighboring borough councils on strategies and initiatives for parking?

PPA questions:

1. In what ways is the Council using the Positive Parking Agenda (PPA)?
2. In what ways could the Council improve the implementation of the PPA?
3. Is there any current marketing besides websites that looks to share the PPA with the general population?
4. Does the PPA actively come up when making policy decisions?
5. Are there criteria in place that evaluates to what degree a service or policy meets the PPA?

Andrew Round (23/5/2019): Sustainability & Road Safety Manager for the Lambeth Council

General Questions:

1. General questions
    a. What are the main issues we currently face in "Lambeth's environment" and how are we tackling car pollution now and in the future?
    b. What is the public's perception of the air quality here, how does Lambeth Council work to increase the public's awareness of this?
    c. How is the service funded, are there capital programmes, where does the funding come from?
2. How does pollution and congestion affect people of different classes differently? Is there anything being done by the council being done to combat this?
    a. How about specifically for Low Emission Zones? Beyond existing grace period for residents?
3. What is the Lambeth Council doing to encourage people to stop using cars and switch to public transport, other than emission based charges for permits?
4. How do the parking and enforcement teams work with the sustainability team?
    a. What are overlapping issues that are being addressed between the two?
    b. What does sustainability mean in the context of parking and enforcement? Funding? Environment? What else?
5. Are there any internal sources that report on emission levels within Lambeth?

6. Are there any experts or sources that we can consult on sustainability issues with parking in Lambeth or in general?
    a. How about sources on the future situation of sustainability in parking?

Regulation questions:

1. What do you think of charging drivers based on emission levels in a parking zone? Are there any other solutions you can think of that do this, but are not as unfair?
2. What other parking-related environmental/sustainability issues can enforcement and regulation help solve?

Kaleem Jaffery (28/5/2019): APCOA contract manager

1. How do you monitor parking now?
    a. Do you cover both on street and off street parking?
    b. What areas of parking do you manage, and how will they change in the future?
2. What inefficiencies do you observe in the parking system?
    a. What technologies may help these problems?
        i. Examples of technologies: ANPR, RFID
        ii. What trends and areas of technology will be relevant to parking? Automation of services?
    b. How have technologies been incorporated in the past?
    c. What technologies are you considering for selling/use in contracts?
3. How do they perceive parking enforcement officers?
    a. Has parking enforcement already started to become a blended service with environmental enforcement?
    b. What is the role of CCTV in parking enforcement?
    c. Does CCTV contribute to the image of parking enforcement?
4. What are you considering to improve the parking services you provide?
    a. What are your projections about the parking services that you provide in the future?
5. How does APCOA you incorporate the customer into their plans and services?
    a. What are ways that APCOA as a contractor can improve the public perception of parking?

Andrew Luck (3/6/2019): London Councils Transport Manager

Technology Questions:

1. How does technology influence parking?
    a. What areas of technologies affect parking and parking services?
    b. What strategies are in place to specifically meet/adopt/adapt technologies into parking?
    c. How will the public respond to new technologies that are integrated into parking?
2. How ready do you think the London Councils are for technology to drastically change how their services are run?
3. What data does the British Parking Association (BPA) believe is most valuable to collect?
4. Are there data sets that would be useful to parking that councils are not currently allowed to collect under data standards

Public Perception Questions:

1. What is the BPA?
    a. What authority does the BPA have regarding parking and how does it shape the parking industry?
2. What are initiatives that are in the works that BPA is looking to utilize to help improve parking?
3. Do you think councils across London could use the PPA could be used in a more active way?
4. What would go into connecting parking platforms across boroughs of London? Is this something that the BPA could get behind?
5. Do you think the PPA has helped councils of London?
    a. In your words, what does the PPA do for public perception?

Appendix C. List of criteria for significant aspects of parking and enforcement drawn from interviews.

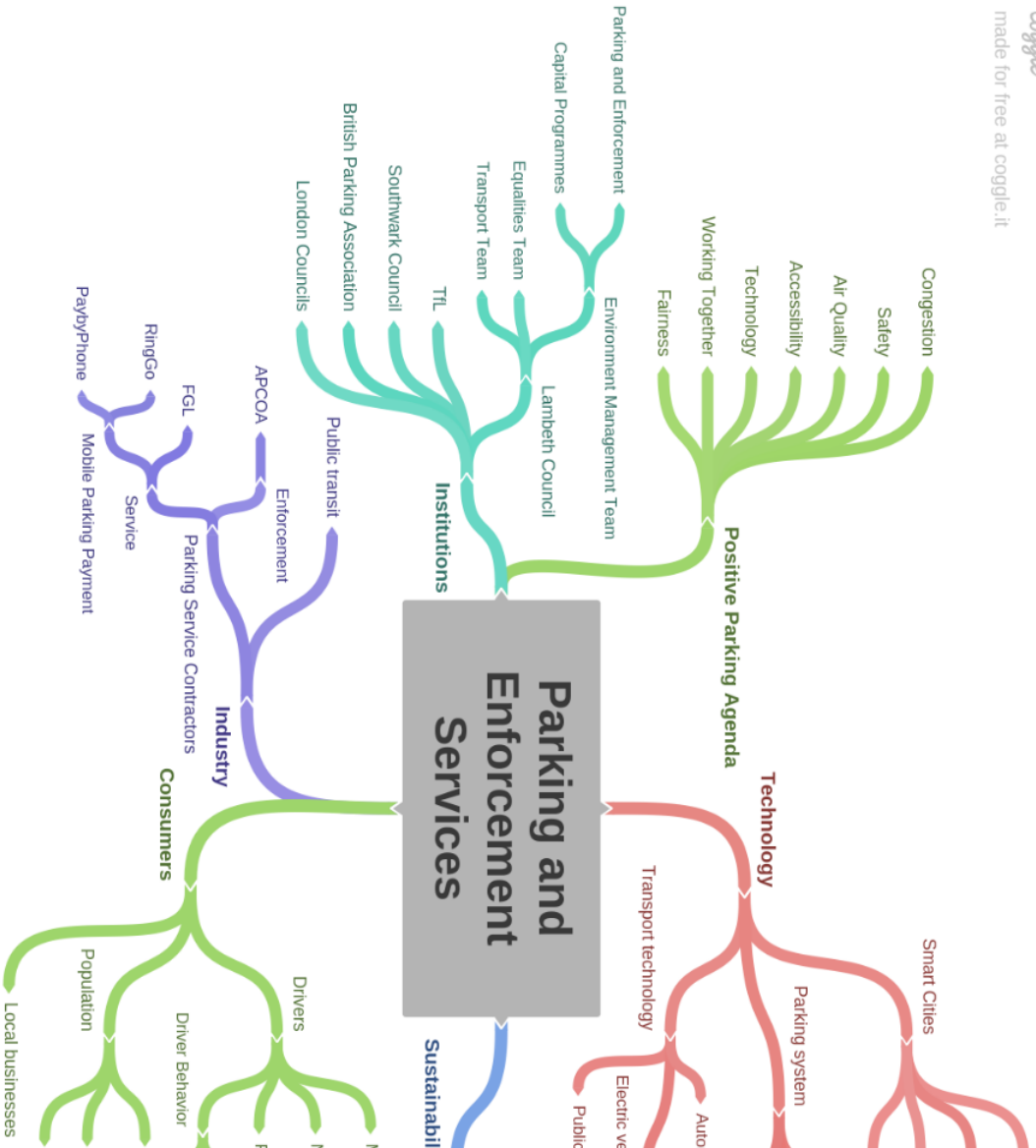
The table below contains the final ten criteria that we created based on the significant areas of concerns we discussed in interviews with parking industry stakeholders, which includes employees of the Lambeth Council, contractors of the Council such as PayByPhone and APCOA Parking, and other parking officials from the London Council and the British Parking Association. We used these criteria to evaluate how the developments and features of future parking-related technologies may affect important aspects of Lambeth's parking and enforcement services.

Congestion	This criterion focuses on how parking-related technologies and parking and enforcement services could increase or decrease traffic congestion in Lambeth.
Air quality	This criterion focuses on how parking-related technologies can improve or worsen air quality. For example, the use of electric vehicles will lower emissions compared to diesel or gasoline. Additionally, dynamic pricing aims to reduce emissions by creating financial disincentives for driving during the most congested hours.
Safety	This criterion focuses on how parking related technologies can improve or worsen safety problems in traffic and parking. For example, automated parking garages improve safety, since there is no longer a risk of a human-vehicle accident occurring within the garage. Additionally, autonomous vehicles can improve or reduce safety, depending on how they are designed, and how the other drivers on the road react.
Accessibility	This criterion focuses on barriers and difficulties the public might face in using a service. For example, the PayByPhone app is inaccessible to anyone who doesn't have a smartphone and a credit card. Accessibility issues also occur for individuals who aren't comfortable using specific technologies such as elderly people.
Collaboration	This criterion focuses on efforts to work with other boroughs, authorities, companies, or organizations to create and improve their services. For example, Parking Enforcement Investigations teams from different boroughs could allow teams to manage more cases with less manpower by collaborating to create a London-wide database of individuals who fraudulently obtained Blue Badges.
Ease of use	This criterion focuses on how easily the public can use a product or service. This criterion differs from accessibility, since ease of use focuses specifically on the product or service itself, rather than asking if the public could even use the service in the first place. Automation of services is a general trend to improve ease of use, since it makes the service simpler and requires less human involvement.

Fairness	This criterion focuses on equity of services or regulations across different groups. For example, emissions-based pricing could be unfair since they can potentially create a greater financial burden on lower-income individuals that are financially unable to adapt to the system.
Finance	This criterion focuses on how parking-related technologies can influence revenue generation from services. For example, there is concern that increased prevalence of autonomous vehicles could lead to a decrease in revenue from PCNs, since manufacturers program these vehicles to obey traffic and parking regulations.
Unity	This criterion focuses on providing consistent and simplified services to the consumer or provider. For example, the creation of a single app to allow for an individual to manage penalty charge notices across all London boroughs would create a unified experience and remove the need to have different accounts for each borough. In addition, a tool that allows a contractor to see in one place any abandoned vehicles, skips, and falsely used Blue Badges on a given street would allow for more results with less effort.
Efficiency	This criterion focuses on how effectively parking services use resources. For example, an automated system that efficiently allows for employees to resolve common issues would reduce the number of people needed to speak to a human, reducing the required manpower. Such systems would also reduce an organization’s costs, freeing up money for other uses.

Appendix D. Domain map of key external factors and stakeholders that affect parking and enforcement services

The domain map below displays all of the frequently mentioned concepts from interviews with Lambeth Council employees and other parking industry stakeholders. We organized the map into two main categories based on direction. The first category covers groups and organizations that create change to parking and enforcement services, which are the institutions, PPA, and industry branches facing leftwards. The second category includes all the external factors subject to changes and developments that could influence parking, enforcement regulations, and services; the branches include technology, sustainability, and consumers, all of which point to the right. After we organized these various categories, we used this map to conduct research in the smaller sub categories of smart cities, parking systems, and transport technology.


coggle
made for free at coggle.it
Parking and Enforcement Services
Positive Parking Agenda
Congestion
Safety
Air Quality
Accessibility
Technology
Working Together
Fairness
Institutions
Parking and Enforcement
Capital Programmes
Equalities Team
Transport Team
TfL
Southwark Council
British Parking Association
London Councils
Environment Management Team
Lambeth Council
Public transit
Industry
Enforcement
APCOA
Parking Service Contractors
FGL
RingGo
PaybyPhone
Service
Mobile Parking Payment
Consumers
Drivers
Navigation
Parking Permits
Driver Behavior
Vehicle Ownership
Ride sharing
Population
Densification
Housing Developments
Minority Communites
Local businesses
Technology
Smart Cities
Smart Parking
Intelligent Transport
Big Data/Data monitoring
Smart Networks/Connectivity
Parking system
Payment methods
Parking storage
Parking Monitoring
Transport technology
Autonomous vehicles
Charging Infrastructure
Electric vehicles
Smart Charging
Sustainability
Public Transport
Environment
Pollution
Carbon Emissions
Air Pollutants
Congestion
Infrastructure
Kerbside spaces
Funding
PCNs
Parking Fees
Mobility
Resources
Service Costs

Appendix E. Matrix for tracking effects of technologies

This matrix organizes our findings into one table. On the x-axis there is a list of the technologies we examined. On the y-axis is the list of criteria we used to evaluate each technology. If a corresponding cell is green, the technology enables the criteria, if it is red, then the corresponding technology is an obstacle to the criteria. Yellow means the technology could either enable a criteria, or be an obstacle. An electronic version of this matrix will be available which provides more detailed notes of how the technology will affect the criteria. The sources we used to create the matrix are below. The bracketed numbers correspond to the footnotes below.

Stakeholder Goals	Smart Parking Apps	Dynamic Pricing	Autonomous vehicles (AVs)	Follow regulations	Shared AVs
Congestion	E [1]	E [2]	S [3]	E [4]	E [5]
Safety	S [6]	E [7]	E [8]	E [9]	N
Air Quality	E [10]	E [11]	E [12]	N	S [13]
Accessibility	S [14]	N	S [15]	N	E [16]
Collaboration	S [17]	N	S [18]	N	N
Fairness	N	S [19]	S [20]	S [21]	N
Finance	E [22]	S [23]	O	O [24]	O [25]
Unity	S [26]	N	E	E [27]	N
Efficency	E [28]	N	E	E [29]	N
Ease of use	E [30]	N	E [31]	N	N

E	Enabler: The Technology Enables the goal to be met
O	Obstacle: The Technology is an Obstacle to achieving the goal
S	Sensitivity: The Technology has both positive and negative benefit to the goal
N	Neutral: No significant impact either way based on the evidence we found

Matrix footnotes

[1] Smart parking apps could limit congestion because drivers will be directly guided to a parking spot, via their phone or car GPS, and not waste time circling looking for parking (Xerox, 2011).

[2] Dynamic pricing has the ability to improve congestion because, if done properly, parking occupancy will be distributed by directing drivers to open parking spaces that are offered at a cheaper price. As a result of this system, drivers could potentially be more willing to drive away from congested areas to cheaper less congested areas (Xerox, 2011).

[3] HERE (2017) predicts that AVs will eventually improve congestion once connected, autonomous vehicles are able to move through traffic efficiently as a connected unit, but will likely worsen congestion initially until most cars are connected and autonomous. Additionally, private AVs may circle the streets to avoid paying for parking, remaining in traffic to add to congestion (Litman, 2019). However, if AVs do park they may decrease congestion by collaborating to allocate parking for each vehicle and decrease cruising to

look for a space (Papa & Ferreira, 2018).

[4] Due to the increase in traffic flow efficiency, vehicles may spend less time on the road contributing to congestion.

[5] Self driving shared fleets could greatly reduce the need for private vehicles, reducing the number of cars on the road and traffic congestion (Dia & Javanshour, 2017).

[6] Smart Parking apps will most likely have a positive impact on safety because instead of being distracted looking for parking, drivers will be able to simply go to an open parking space via GPS (Gautam, 2018). Also limiting traffic stress could have a positive impact on safety (Wang, 2010).

[7] Dynamic pricing may improve safety because of better occupancy distribution leading to less congested areas (Xerox, 2011; Wang, 2010).

[8] HERE (2017) describes Subaru results from vehicles with automated crash prevention technologies, such as automatic emergency braking and lane departure warning, are 60% less likely to be involved in a crash. As automation increases, there will likely be further reduction of human involvement and error which may account for up to 90% of car crashes currently (Papa & Ferreira, 2018).

[9] Since over 90% of car accidents occur due to driver error, AVs, would improve vastly improve road safety via vehicle detection and risk prevention algorithms. Built into these systems would be the ability for the AV to know the traffic regulations and how to properly obey them. Furthermore, with collusion and pedestrian detection systems, safety issues related to parking, such as crowded streets on-street parked cars distracted pedestrians and drivers would be mitigated by AVs. However, potential new safety problems need to be prepared for and addressed due to limitations of the technology, such as false alarms, system failures, data deficiency, and cyber attacks (Trubia, Giuffrè, Canale, Severino 2017).

[10] Smart parking apps may help reduce emissions because of the reduction of idling and cruising looking for a parking space. This will limit the amount of time cars are looking for a parking, thus reducing the amount of emissions released from a car (Leslie, 2014).

[11] Air quality can be improved because of limiting time it takes to find parking and more evenly distributing parking occupancy (SFpark,2014).

[12] AVs could improve air quality by maximizing fuel efficiency with more controlled acceleration and decelerations compared with human drivers (Litman, 2019)

[13] While shared AVs may help decrease private vehicle usage by improving access to public transit, AVs may also compete with public transit due to the increased convenience, potentially leading to less cars on the road but more vehicle miles driven producing emissions (World Economic Forum, 2018).

[14] In the UK, it is reported that only 1 in 5 citizens between the ages of 65 to 74 own a smartphone, so completely incorporating the parking experience into smartphone apps could cause adoption issues for elderly citizens (Rayner,2015). However, in Lambeth's case user adoption of paying for parking via mobile application has been high at 92% (Thomas Burgess, personal communication, 14 May 2019).

[15] AVs may increase accessibility of transport for those in areas with low access to public transit, who are also unable to operate a vehicle themselves (Papa & Ferreira, 2018).

[16] Shared AV fleets may provide a cheaper alternative to access self-driving services compared to private vehicles. Additionally, shared AVs may provide more accessibility to public

transit with first- and last-mile offerings (World Economic Forum, 2018).

[17] Smart parks won't directly contribute to collaboration, however parking apps will greatly benefit from it. A potential situation that could arise in the future is open sharing of data between boroughs, and smart parking companies. This would make it so that important information for parking is available for all companies to take advantage of and use in their application (A. Luck, personal communication, 3 June 2019).

[18] While AVs may not have a direct influence on collaboration, they may require collaboration on standards for regulatory and real-time data sharing across boroughs.

[19] Dynamic pricing could positively affect fairness by giving drivers more choices in how much money they pay for parking. It could also decrease fairness as many drivers will be forced to pay more for parking (SFpark, 2014).

[20] If infrastructure adapts to accommodate the features of AVs, they may prioritise parking services for those with the socioeconomic status to afford to use AVs (Papa & Ferreira, 2018).

[21] With the elimination of human decision making and intervention when driving, AVs eliminate human bias when crashes occur. However, human bias can be inherently present in these algorithms, so different priorities based on a situation, and full transparency are necessary, to make AV's decision making as fair as possible (Xu, 2019).

[22] Smart parking apps could increase parking revenue due to an increase in total parking occupancy, the creation of new unique revenue streams, and improved use of resources (Carrol, 2016). It is estimated that revenue can improve as much as 30% (Gautam, 2019).

[23] Revenue could be increased because the price for parking will accurately depict the demand of a given parking spot, and though there will be parking spots that are cheaper, overall revenue should increase (Flanagan, 2017). Revenue could decrease due to dynamic pricing because PCNs may be issued less (SFpark, 2014).

[24] Reduction in PCNs

[25] Reduce demand and payment for parking due to a potential shift from parking to dropoff, however, with the reduced need for parking the Council may repurpose the curb for other uses that may generate revenue (Papa & Ferreira, 2018).

[26] Smart parking apps could positively contribute to the connectedness of services, because they could be incorporated into other trip planning apps, to make traveling through London a seamless process from one form of transportation to the other (K. Taylor, personal communication, 20 May 2019). Additionally, CEOs could use the data collected for smart parking apps to improve their enforcement efficiency (Gautam, 2019).

[27] Similar to the potential increase in fairness, passengers of self-driving vehicles would have the same experience across different areas as AVs automatically adjust for local regulations.

[28] A benefit towards efficiency enabled by smart parking apps is, the Lambeth Council can use collected parking data to gain new insights into driver behavior and more appropriately deploy enforcement officers (Gautam, 2019).

[29] Reducing illegal parking would lead to traffic to become more efficient as vehicles won't need to waste time by deviating around an illegal act (Morillo & Campos, 2014).

[30] Smart parking apps could increase ease of use because these applications could create a seamless, easy to use parking experience (Leslie, 2014).

[31] World Economic Forum (2018) surveyed potential 5,500 AV users and found that the top consumer benefit came from the vehicle automatically finding parking.

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Appendix F. Questionnaire

This appendix contains the questionnaire that we created and sent to parking professionals and users of Lambeth's parking services. One should note that certain questions depended on how the respondent classified him or herself at the beginning of the questionnaire.

WPI Lambeth Survey

Start of Block: Informed Consent

Q1.1
We are conducting a survey in collaboration with the London Borough of Lambeth to learn more about how new technologies may affect parking and enforcement services. This survey is being sent to you by students from Worcester Polytechnic Institute in the United States (www.wpi.edu) who are completing an academic project with the Department of Interdisciplinary and Global Studies.

We are seeking input from people with experience in work related to parking and enforcement services as well as people that have used or interacted with these services in Lambeth to better understand the potential consequences of introducing new technologies for parking and enforcement services in the Borough.

We would greatly appreciate your input by Friday, 14 June 2019, as you have been identified as a key stakeholder in the Borough.

In this survey you will be presented with information relevant to parking and technology and asked to answer some questions about it. Please be assured that we will keep your responses completely confidential.

Thank you.

- ○ I consent; begin the study (1)
- ○ I do not consent; I do not wish to participate (2)

End of Block: Informed Consent

Start of Block: Parking relations

Q2.1 To start, please answer the following questions about your relationship to the parking industry.

Q2.2 How would you classify yourself?

- ○ Not involved in parking related work or industry (1)
- ○ An employee of a government organization and involved in work that affects parking and enforcement services (Lambeth Council, British Parking Association, London Council, etc.) (2)
- ○ Works on parking and parking-related issues such as traffic and transport, but not employed in a government organization (transport researcher/scholar, contractors/service providers, etc.) (3)

Q2.3 Do you live or work in the London borough of Lambeth?

- ○ Yes (1)
- ○ No (2)

End of Block: Parking relations

Start of Block: General

Q3.1 Rank the following issues on order of importance to you (most important at the top), by clicking and dragging to reorder.

_____ Traffic congestion (1)

_____ Road safety (2)

_____ Air quality (Greenhouse gas emissions and air pollutants) (3)

_____ Accessibility of parking services (being open and accessible for everyone regardless of background) (4)

_____ Fairness of parking services (equal and consistent services for everyone) (5)

_____ Ease of use (how easy service is to use) (6)

How would you classify yourself? = Not involved in parking related work or industry

_____ Unity of services (being able to use one service interface across Lambeth and other London boroughs) (7)

How would you classify yourself? != Not involved in parking related work or industry

_____ Revenue generated from services (8)

How would you classify yourself? != Not involved in parking related work or industry

_____ Collaboration/working with others to reach the same goal (9)

How would you classify yourself? != Not involved in parking related work or industry

_____ Efficiency of resource deployment (10)

Display This Question:

If Do you live or work in the London borough of Lambeth? = Yes

Q3.2 What is your perception of parking and enforcement services offered by the Lambeth Council?

- ○ Extremely negative (1)
- ○ Moderately negative (2)
- ○ Neither positive nor negative (3)
- ○ Moderately positive (4)
- ○ Extremely positive (5)

End of Block: General

Start of Block: Transition

Q4.1 The following questions present a scenario of a future technology as it relates to parking, and end with some follow up questions. We understand that the future isn't certain and most of these answers involve speculation, please try to answer each question as best you can.

End of Block: Transition

Start of Block: Short-term

Q5.1 **Short-term scenario: Smart parking apps** Within the next 5 years, parking payment services will move almost entirely to online mobile parking applications, such that payment for parking can be done within your car. These online mobile services will be available as both an app on your phone or integrated as part of your car similar to a GPS navigation system, and can also be developed further to go beyond simply paying for parking. Some of the functions they would allow you to do are: See where parking spaces are available and direct you to them Allow you to reserve parking in advance Pay for your parking and access other services from your car

Q5.2 Rank the following developments on how much they might benefit you.

_____ See where parking spaces are available and direct you to them (1)

_____ Allow you to reserve parking in advance (2)

_____ Pay for your parking and access other services from your car (3)

Display This Question:

If How would you classify yourself? = An employee of a government organization and involved in work that affects parking and enforcement services (Lambeth Council, British Parking Association, London Council, etc.)

Or How would you classify yourself? = Works on parking and parking-related issues such as traffic and transport, but not employed in a government organization (transport researcher/scholar, contractors/service providers, etc.)

Q5.3 Could smart parking apps significantly affect parking within the next 5 years?If not, do you think smart parking apps will become significant later than 5 years?

- ○ Yes (1)
- ○ No, after 5 years (2)
- ○ No, smart parking apps will not have a significant effect on parking (3)
- ○ Not sure (4)

Carry Forward Displayed Choices from "Rank the following issues on order of importance to you (most important at the top), by clicking and dragging to reorder."

X→

Q5.4 Select the standards that you think smart parking apps will significantly affect.

- ☐ Traffic congestion (1)
- ☐ Road safety (2)
- ☐ Air quality (Greenhouse gas emissions and air pollutants) (3)
- ☐ Accessibility of parking services (being open and accessible for everyone regardless of background) (4)
- ☐ Fairness of parking services (equal and consistent services for everyone) (5)
- ☐ Ease of use (how easy service is to use) (6)

How would you classify yourself? = Not involved in parking related work or industry

- ☐ Unity of services (being able to use one service interface across Lambeth and other London boroughs) (7)

How would you classify yourself? != Not involved in parking related work or industry

- ☐ Revenue generated from services (8)

How would you classify yourself? != Not involved in parking related work or industry

- ☐ Collaboration/working with others to reach the same goal (9)

How would you classify yourself? != Not involved in parking related work or industry

- ☐ Efficiency of resource deployment (10)

Carry Forward Selected Choices from "Select the standards that you think smart parking apps will significantly affect."

X→

Q5.5 In what way do you think smart parking apps may influence each standard you selected?

	Extremely negative	Slightly negative	Neither positive nor negative	Slightly positive	Extremely positive	Not sure

Q5.6 Are there any other standards, besides the ones mentioned above, that you believe smart parking apps may significantly affect?

_____

_____

_____

_____

_____

Display This Question:

If Do you live or work in the London borough of Lambeth? = Yes

Q5.7 How would your perception of the Lambeth Council's parking and enforcement services change if the Council were to implement smart parking apps?

- ○ Much worse (1)
- ○ Somewhat worse (2)
- ○ About the same (3)
- ○ Somewhat better (4)
- ○ Much better (5)
- ○ Not sure (6)

Q5.8 If smart parking apps made parking easier, would you be more inclined to own and drive a personal vehicle as opposed to taking public transit, biking, or walking?

_____

_____

_____

_____

_____

Display This Question:

If How would you classify yourself? = An employee of a government organization and involved in work that affects parking and enforcement services (Lambeth Council, British Parking Association, London Council, etc.)

Or How would you classify yourself? = Works on parking and parking-related issues such as traffic and transport, but not employed in a government organization (transport researcher/scholar, contractors/service providers, etc.)

Q5.9 In what other ways do you think smart parking apps may affect parking services?

_____

_____

_____

_____

_____

Display This Question:

If How would you classify yourself? = An employee of a government organization and involved in work that affects parking and enforcement services (Lambeth Council, British Parking Association, London Council, etc.)

Or How would you classify yourself? = Works on parking and parking-related issues such as traffic and transport, but not employed in a government organization (transport researcher/scholar, contractors/service providers, etc.)

Q5.10 What political, social, economic, or technological obstacles do you believe could hinder the effective use of smart parking apps?

_____

_____

_____

_____

_____

End of Block: Short-term

Start of Block: Medium-term

Q6.1 **Medium-term scenario: Dynamic Pricing** In roughly 5-10 years data collection will make dynamic pricing possible, which is a system that adjusts prices for parking depending on local factors such as traffic levels and parking demand. This means that drivers will pay more for parking in congested areas and pay less in areas of low parking stress. At first dynamic pricing may draw from parking apps and manual data collection. Eventually, Internet of Things and smart cities will allow for real time dynamic price changes. Some implications of dynamic pricing include: Altering how much you pay for parking Guiding where you park based on price

Display This Question:

If How would you classify yourself? = An employee of a government organization and involved in work that affects parking and enforcement services (Lambeth Council, British Parking Association, London Council, etc.)

Or How would you classify yourself? = Works on parking and parking-related issues such as traffic and transport, but not employed in a government organization (transport researcher/scholar, contractors/service providers, etc.)

Q6.2 Could dynamic pricing significantly affecting parking within the next 5-10 years?If not, do you think dynamic pricing will become significant earlier than 5 years or later than 10?

- ○ Yes, it will affect parking in 5-10 years (1)
- ○ No, before 5 years (2)
- ○ No, after 10 years (3)
- ○ No, dynamic pricing will not have a significant effect on parking (4)
- ○ Not sure (5)

Carry Forward Displayed Choices from "Rank the following issues on order of importance to you (most important at the top), by clicking and dragging to reorder."

Q6.3 Select the standards that you think dynamic pricing will significantly affect.

- ☐ Traffic congestion (1)
- ☐ Road safety (2)
- ☐ Air quality (Greenhouse gas emissions and air pollutants) (3)
- ☐ Accessibility of parking services (being open and accessible for everyone regardless of background) (4)
- ☐ Fairness of parking services (equal and consistent services for everyone) (5)
- ☐ Ease of use (how easy service is to use) (6)

How would you classify yourself? = Not involved in parking related work or industry

- ☐ Unity of services (being able to use one service interface across Lambeth and other London boroughs) (7)

How would you classify yourself? != Not involved in parking related work or industry

- ☐ Revenue generated from services (8)

How would you classify yourself? != Not involved in parking related work or industry

- ☐ Collaboration/working with others to reach the same goal (9)

How would you classify yourself? != Not involved in parking related work or industry

- ☐ Efficiency of resource deployment (10)

Carry Forward Selected Choices from "Select the standards that you think dynamic pricing will significantly affect."

X→

Q6.4 In what way do you think dynamic pricing will influence each standard you selected?

	Extremely negative	Slightly negative	Neither positive nor negative	Slightly positive	Extremely positive	Not sure

	-5 -4 -3 -2 -1 0 1 2 3 4 5
Traffic congestion ()	
Road safety ()	
Air quality (Greenhouse gas emissions and air pollutants) ()	
Accessibility of parking services (being open and accessible for everyone regardless of background) ()	
Fairness of parking services (equal and consistent services for everyone) ()	
Ease of use (how easy service is to use) ()	
Unity of services (being able to use one service interface across Lambeth and other London boroughs) ()	
Revenue generated from services ()	
Collaboration/working with others to reach the same goal ()	
Efficiency of resource deployment ()	

Q6.5 Are there any other standards, besides the ones mentioned above, that you believe dynamic pricing may significantly affect?

_____

_____

_____

_____

_____

Q6.6 How willing would you be to accept paying more for parking if there is a net benefit to factors such as a reduction of congestion and emissions?

- Extremely unwilling (1)
- Somewhat unwilling (2)
- Neither willing nor unwilling (3)
- Somewhat willing (4)
- Extremely willing (5)

Display This Question:

If Do you live or work in the London borough of Lambeth? = Yes

Q6.7 How would your perception of Lambeth Council's parking and enforcement services change, if the Lambeth Council implemented dynamic pricing?

- Much worse (1)
- Somewhat worse (2)
- About the same (3)
- Somewhat better (4)
- Much better (5)
- Not sure (6)

Display This Question:

If How would you classify yourself? = An employee of a government organization and involved in work that affects parking and enforcement services (Lambeth Council, British Parking Association, London Council, etc.)

Or How would you classify yourself? = Works on parking and parking-related issues such as traffic and transport, but not employed in a government organization (transport researcher/scholar, contractors/service providers, etc.)

Q6.8 In what ways do you think dynamic pricing will affect parking services?

_____

_____

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Display This Question:

If How would you classify yourself? = An employee of a government organization and involved in work that affects parking and enforcement services (Lambeth Council, British Parking Association, London Council, etc.)

Or How would you classify yourself? = Works on parking and parking-related issues such as traffic and transport, but not employed in a government organization (transport researcher/scholar, contractors/service providers, etc.)

Q6.9 What political, social, economic, or technological obstacles do you believe could hinder the effective use of dynamic pricing?

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End of Block: Medium-term

Start of Block: Long-term

Q7.1 **Long-term scenario: Autonomous Vehicles** In the long-term future, autonomous vehicles (AVs) will become fully autonomous, functioning both in and out of London. The AVs will rely on parking information drawn from a smart city network that captures traffic and parking data in real time such that an AV will: Allow for an automated, driverless ridesharing networkObey all parking or traffic regulations Handle your parking and transport in the city automatically

Q7.2 Rank the following developments on how much they may influence parking services.

_____ AVs allow for an automated, driverless ridesharing network (1)

_____ AVs obey all parking or traffic regulations (2)

_____ AVs handle your parking and transport in the city automatically and efficiently (3)

Display This Question:

If How would you classify yourself? != Not involved in parking related work or industry

Q7.3 Do you think AVs will significantly affect parking in the next 10-20 years?

- Yes (1)
- No, sooner than 10 years (2)
- No, later than 20 years (3)
- No, AVs will not have a significant affect on parking. (4)
- Not sure (5)

Carry Forward Displayed Choices from "Rank the following issues on order of importance to you (most important at the top), by clicking and dragging to reorder."

Q7.4 Select the standards that you think autonomous vehicles will significantly affect.

- ☐ Traffic congestion (1)
- ☐ Road safety (2)
- ☐ Air quality (Greenhouse gas emissions and air pollutants) (3)
- ☐ Accessibility of parking services (being open and accessible for everyone regardless of background) (4)
- ☐ Fairness of parking services (equal and consistent services for everyone) (5)
- ☐ Ease of use (how easy service is to use) (6)

How would you classify yourself? = Not involved in parking related work or industry

- ☐ Unity of services (being able to use one service interface across Lambeth and other London boroughs) (7)

How would you classify yourself? != Not involved in parking related work or industry

- ☐ Revenue generated from services (8)

How would you classify yourself? != Not involved in parking related work or industry

- ☐ Collaboration/working with others to reach the same goal (9)

How would you classify yourself? != Not involved in parking related work or industry

- ☐ Efficiency of resource deployment (10)

Carry Forward Selected Choices from "Select the standards that you think autonomous vehicles will significantly affect."

X→

Q7.5 In what way do you think AVs will influence each standard you selected?

	Extremely negative	Slightly negative	Neither positive nor negative	Slightly positive	Extremely positive	Not sure

	-5 -4 -3 -2 -1 0 1 2 3 4 5
Traffic congestion ()	
Road safety ()	
Air quality (Greenhouse gas emissions and air pollutants) ()	
Accessibility of parking services (being open and accessible for everyone regardless of background) ()	
Fairness of parking services (equal and consistent services for everyone) ()	
Ease of use (how easy service is to use) ()	
Unity of services (being able to use one service interface across Lambeth and other London boroughs) ()	
Revenue generated from services ()	
Collaboration/working with others to reach the same goal ()	
Efficiency of resource deployment ()	

Q7.6 Are there any other standards, such as the ones mentioned above that you believe autonomous vehicles will affect?

_____

_____

_____

_____

_____

Q7.7 Would you be more inclined to own a private AV, or use a shared AV service, such as an Uber or Zipcar? What would factor into your decision?

_____

_____

_____

_____

_____

Display This Question:

If Do you live or work in the London borough of Lambeth? = Yes

Q7.8 How would your perception of the Lambeth Council's parking and enforcement services change, if the Lambeth Council implemented:

	Much worse (3)	Somewhat worse (4)	About the same (5)	Somewhat better (6)	Much better (7)	Not sure (8)
Policies to promote the use of shared AVs (1)	○	○	○	○	○	○
Automatic payment for kerbside parking (2)	○	○	○	○	○	○

Display This Question:

If How would you classify yourself? != Not involved in parking related work or industry

Q7.9 How do you think the quantity of personal vehicles on the road will change due to AVs in 10-20 years?

- ○ Much less (1)
- ○ Somewhat less (2)
- ○ About the same (3)
- ○ Somewhat more (4)
- ○ Much more (5)
- ○ Not sure (6)

Display This Question:

If How would you classify yourself? = An employee of a government organization and involved in work that affects parking and enforcement services (Lambeth Council, British Parking Association, London Council, etc.)

Or How would you classify yourself? = Works on parking and parking-related issues such as traffic and transport, but not employed in a government organization (transport researcher/scholar, contractors/service providers, etc.)

Q7.10 In what other ways do you think AVs will affect parking services?

_____

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Display This Question:

If How would you classify yourself? = An employee of a government organization and involved in work that affects parking and enforcement services (Lambeth Council, British Parking Association, London Council, etc.)

Or How would you classify yourself? = Works on parking and parking-related issues such as traffic and transport, but not employed in a government organization (transport researcher/scholar, contractors/service providers, etc.)

Q7.11 What political, social, economic, or technological obstacles do you believe could hinder the effective use of autonomous vehicles?

_____

_____

_____

_____

_____

End of Block: Long-term

Start of Block: Follow up

Q8.1 For these technologies to work properly, they may collect anonymized data, such as location, parking trends, and travel trends. How does this change your opinion on the utilization of the previously mentioned technologies?

- Much worse (1)
- Somewhat worse (2)
- About the same (3)
- Somewhat better (4)
- Much better (5)

Display This Question:

If How would you classify yourself? = An employee of a government organization and involved in work that affects parking and enforcement services (Lambeth Council, British Parking Association, London Council, etc.)

Or How would you classify yourself? = Works on parking and parking-related issues such as traffic and transport, but not employed in a government organization (transport researcher/scholar, contractors/service providers, etc.)

Q8.2 How valuable do you think an annual parking report (a document that shows various yearly parking data and projects moving forward, such as how the Lambeth Council may respond to

technological change) would be?

- ○ Not valuable for anyone (1)
- ○ Slightly valuable but not worth the resources (2)
- ○ Valuable, something that the Lambeth Council should consider implementing (3)
- ○ Incredibly valuable, the Lambeth Council should implement immediately (4)

Display This Question:

If How would you classify yourself? = Not involved in parking related work or industry

And Do you live or work in the London borough of Lambeth? = Yes

Q8.3 If the Lambeth Council were to publish an annual parking report (a document that shows various yearly parking data and projects moving forward, such as how the Lambeth Council may respond to technological change), how would your perception of the Council and its parking and enforcement services change?

- ○ Much worse (1)
- ○ Somewhat worse (2)
- ○ About the same (3)
- ○ Somewhat better (4)
- ○ Much better (5)

Q8.4 What do you believe the role and function of parking enforcement is?

_____

_____

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_____

_____

Q8.5 Are there any other comments or concerns you would like to add about parking and enforcement services and future technologies?

_____

_____

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_____

End of Block: Follow up

Start of Block: Demographics

Q9.1 Nearly done! Just a few demographic questions to allow us to interpret our data more effectively.

Q9.2 What is your job title/description?

_____

Q9.3 What is your age range?

- ○ 18 - 24 (1)
- ○ 25 - 34 (2)
- ○ 35 - 44 (3)
- ○ 45 - 54 (4)
- ○ 55 - 64 (5)
- ○ 65 - 74 (6)
- ○ 75 - 84 (7)
- ○ 85 or older (8)
- ○ Prefer not to answer (9)

End of Block: Demographics

Start of Block: Submission

Q10.1 Thank you for your time. Please click continue to submit your results, or abandon to delete your responses without submitting.

- ○ Continue and submit (1)
- ○ Abandon and delete data (2)

End of Block: Submission
