THE FUTURE OF TRANSPORT

CLIENT PROJECT REPORT CPR4125

Impact of Autonomous Freight Vehicles in Central London

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1 Executive Summary

Cross River Partnership (CRP) commissioned TRL to undertake a study to analyse the impact that autonomous vehicles (AVs) for deliveries and servicing will have on wider transport and public space in central London.

The study was requested by the Central London Sub-Regional Transport Partnership (CLSRTP), a collective of transport specialists from eight central London boroughs convened by CRP on behalf of Transport for London (TfL).

This report outlines the physical, technical and governance based interventions central London boroughs should consider in the lead up to AV freight. AV freight vehicles have the capacity to perform all driving functions without the need for human supervision.

The primary benefits of deploying AVs for deliveries and servicing are identified as increased efficiency of logistics operations, reduced road congestion, reduced emissions and improved road safety. Barriers are identified as the lack of existing policy, the cost of investing in the technology and contested space in central London.

Recommendations

- **Government investment is required in the development and testing of new technologies, specifically freight and logistics.**
- **TfL funding needs to support logistics operators with the uptake of AV freight**
- **AV freight trials must focus on determining what infrastructure is necessary ahead of deployment**
- **Public perceptions of AV freight should be influenced by positive media coverage.**
- **Policy and regulation must be in place before AV technology is deployed.**

2 Methodology

Insight in to the current and potential barriers and enablers for AV freight has been gathered through a number of structured interviews with a cross section of key stakeholder groups; Central Government, Local Authorities, Logistics Operators, Original Equipment Manufacturers (OEMs) and the Automotive Industry, Academics, Insurers and London-based business improvement districts. The results from interviews were thematically analysed to identify the dominant themes relating to the uptake of AV freight. Case studies of information on AV freight technology are presented throughout.

3 Background of AVs in an urban context

3.1 Technology

Fully Autonomous Vehicles (AV) are those with the capacity to perform all driving functions on any road, in any environmental conditions, without the need for human supervision. The timescale for deployment of such vehicles is ambiguous and depends upon a number of factors: the speed of technological advancements; the readiness of the infrastructure, and the development of the legislative framework.

Ahead of the deployment of fully autonomous vehicles, we will see vehicles with varying degrees of autonomous functionality operating on public roads. The levels of automation can be split in to five categories, as displayed in Table 1.

Table 1: Categorisation of the five levels of automation (SAE, 2017)

Level of automation	1 Assisted driving	2 Partial automation	3 Conditional automation	4 High automation	5 Full automation
Driver role	Longitudinal and lateral control	Constantly monitoring the driving environment. Ready to take back control at any time.	Ready to take over in case of a request to intervene.	Not required in some driving environments or modes (e.g. specific routes, low speed driving).	Not required
System capabilities	Individual automated systems can sometimes be employed; for example steering and acceleration/ deceleration.	One or more driver assistance systems can work at the same time.	All aspects of driving task in certain environments (motorways). The system recognises if human intervention is needed and alerts the driver in good time.	All aspects of driving task (in some driving modes), even if the driver is not able to resume the control when required.	All driving tasks, under all environment al conditions.
Timeline for adoption	Now	2015-2019	2018-2022	2020 onwards	~2030

There are two different types of vehicles are currently being considered and tested for use on urban delivery cycles:

1

Small van-like vehicles which travel on the road and have various storage compartments.
The Udelv delivery vehicle (pictured left) can carry 700 pounds and operates in full autonomous mode. The orange vehicle is fully customized and powered by an electric powertrain (60 mile range). It features 18 cargo compartments and utilizes automatic doors "using a cloud-based proprietary technology that is shared between the vehicle, customers and merchants." (Udelv, 2018)

2

Small ground drones/robots which use pedestrian and cycle space and suitable for small deliveries in quiet environments. Their applications within freight range from the delivery of goods from a shop / restaurant within an urban area, to last mile deliveries whereby a small fleet of ground drones are loaded on a van from a large distribution centre which drives to a central delivery area and releases the ground drones for dispatch;

CASE STUDY 1: GROUND DRONE DELIVERIES, Starship Technologies (pictured above right)

Starship Technologies have developed a semi-autonomous delivery robot as a solution to last-mile deliveries. This robot operates on pavements and is capable of carrying goods up to 10kg. Navigation is controlled by GPS, computer vision and the use of ultrasonic sensors to detect obstacles. Although capable of speeds of 10mph, a 4mph speed limit is currently applied so that it can function alongside cyclists and pedestrians with limited risk.

Last-mile delivery solutions such as these have lower environmental impact, are time and cost-efficient. Currently, the technology is being trialled in the UK, USA, Germany, Switzerland and Estonia.

3.2 Benefit for businesses

AVs offer the potential to optimise delivery services by finding the quickest route in real time, adapting their speed to the surrounding environment in order to travel at the highest safe velocity, and driving for long periods without rest; thereby increasing efficiency and work to ease congestion in built up areas, enabling new operational models as well as reducing the risk of collision (SMMT, 2016). Operators can also make cost savings through the repurposing / elimination of the driver from the delivery task. This could provide cost savings as high as 40% per kilometre (DHL, 2014). The absence of a human occupant could reduce crashworthiness requirements for unmanned delivery vehicles and therefore allow lighter more fuel (or electrically) efficient vehicles with consequent advantages for vehicle and operational costs.

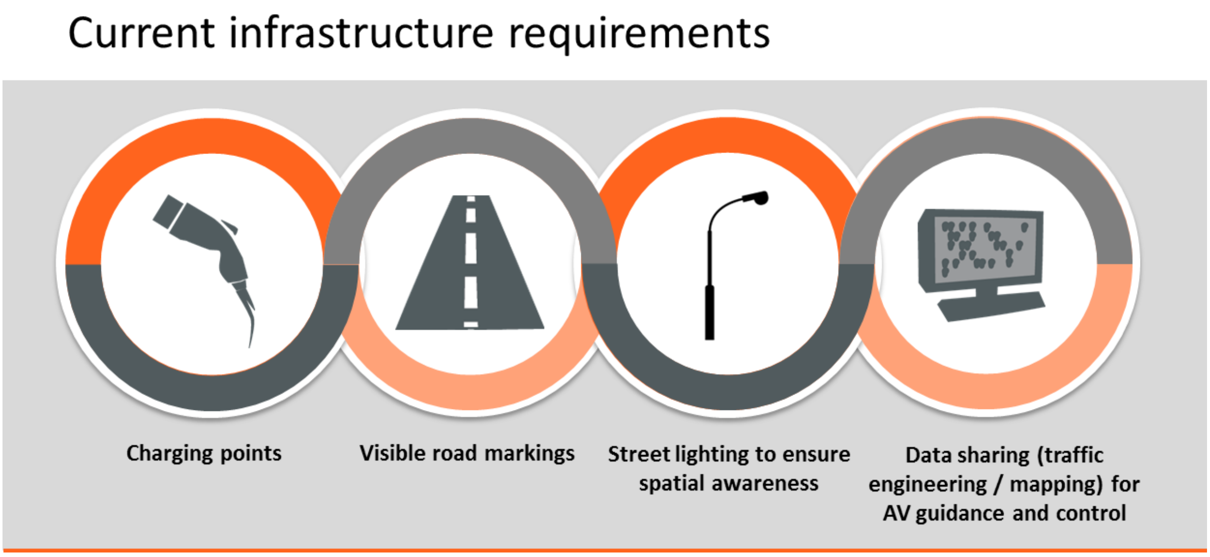
3.3 Benefit for consumers

The continual rising popularity of online consumerism has driven the freight market to be increasingly unsustainable. Consumers, particularly the younger population, have shown willingness to pay additional tariffs for the convenience of same day delivery (McKinsey & Company, 2016), which is subsequently leading to an increasing number of vans with less-than-full loads on the roads performing dedicated trips for a single customer. The introduction of autonomous vehicles, in particular ground drones could help ease unsustainable impacts of congestion and fuel inefficiency associated with responsive deliveries. However, ground drones could work as a demand generator rather than a solution to this issue, adding to existing traffic.

3.4 Impact on infrastructure

AVs will require the implementation of new urban infrastructure and designated space for the movement of vehicles. Infrastructure to enable communications is already in place as existing 4G networks (and, in time, 5G networks) can be utilised.

Additional infrastructure to allow vehicle-to-vehicle and vehicle-to-infrastructure communications may be required in the future, though the necessity for this has not yet been proven.



In some cases pedestrian, cycling, and road spaces will need to be upgraded and expanded to accommodate the AV freight traffic which as a new independent user group will increase demand on such infrastructure. Conversely, it has been argued that AV freight will facilitate the more efficient use of existing land space such as parking areas and garage spaces that will gradually become redundant, thereby mitigating the negative impacts of additional users within pedestrian, cycling, and road spaces (WSP Parsons Brinckerhoff & Farrels, 2016). However, the efficiency benefits of AV freight may not be yielded until there is significant use of AV freight technologies. Therefore there will likely be a transitional period during which increased demand on current public infrastructures leads to congested pedestrian, cycling, and road networks.

To manage the challenges associated with a transitional period, London Boroughs should take authority to control the number of AV freight organisations have deployed at one time.

3.5 Barriers and enablers

Before the full deployment of many AV freight vehicles the following issues, Table 2, need to be addressed and enablers considered.

Table 2: Barriers and Enablers to AV Freight Deployment

Barriers	Enablers
Technology must be proven **to be robust enough to ensure sensors can identify risks and prevent collisions even in adverse conditions (Ford Media Centre, 2016). AVs are not capable of following instructions from traffic officers and cannot predict the movement of other objects or vehicles (Hamers, 2016).** Technology must be affordable **enough to make it a commercially attractive investment for freight operators.** Accountability **relating to accidents will fall with the manufacturer, service provider, software provider, or the user (Bonnefon, 2016). Insurance providers are responsible for adapting policies accordingly.** Cybersecurity **is a significant concern for AVs, particularly larger freight vehicles. The vehicle could be used as a weapon or as a means to transport hazardous items. A multi-level and ongoing approach to security has been outlined by DfT, CPNI & CCAV (2017).**	**Financial and Policy-based Investment** in development of AV technology will ensure safety features are as robust as possible **Positive media coverage** of the benefits of AV can help improve public perceptions of the technology **Legal assurance** for the security of AV systems must be addressed **Government provisions** can also work to accelerate the uptake of AV freight vehicles through supporting the development of a worldwide platform to facilitate the industry to develop the technology. Government legislation to ensure that the insurance sector is provided with a framework for insuring AVs. **Government requirements** stipulating the use of AVs in specific use cases, such as drone applications in the city **Smart Mobility Living Lab: London** is being established with Government investment to support the deployment of AV technologies in order to generate evidence of performance and develop evaluation and benchmarking methods to assist city and commercial adoption of these technologies.

4 Stakeholder Engagement

A high level summary of findings can be found at the end of section 4.

4.1 Technological Review

4.1.1 Application of AV Freight

Stakeholders in the automotive industry were asked to give examples of how automated vehicles could be used in urban freight applications. The application of autonomous freight for last mile deliveries was a predominant suggestion. The continual rising popularity of online consumerism has elevated the demand on last mile deliveries, and AV technology is widely recognised by the automotive industry as an efficient solution to the current inefficiency of conventional vehicles performing many urban deliveries at short notice. A suggested use case is to use AVs to travel between urban consolidation centres and residential areas to perform deliveries.

Case Study 2: Marble

Marble have trialled similar delivery pods for food delivery in neighbourhoods in San Francisco, with the intention of expanding in to deliveries of pharmaceuticals and groceries. The pods navigate pavements using lidar, cameras and ultrasonic sensors.

The small size and electric propulsion of such ground drone technologies may provide a viable solution to the growing individualistic delivery service culture which is proliferating within the industry; reducing the impact of the physical deliveries on the existing urban freight transport network, and removing the associated tail-pipe emissions from cities.

4.1.2 Benefits

> "AVs are best suited to controlled environments. Localised last-mile delivery distribution networks with low speed, local roads are ideally suited for AV freight vehicles"
> OEM industry stakeholder

Increased fuel, time and space efficiency are at the core of what makes AV technology beneficial in comparison to its conventional predecessor according to logistics operators. Electric pods could contribute to improved air quality in urban areas. Quieter vehicles mean that in the future, it will be possible for night-time deliveries in urban areas where night-time deliveries from conventional vehicles has previously been impracticable, restricting businesses' operating hours which contribute to peak congestion periods during the day. Additionally, operating vehicles that do not have the same rest requirements as human delivery personnel means that the vehicle can be in operation for much longer periods of time (notwithstanding charging time for EVs). Space efficiency is particularly apparent when operating pavement-mounted delivery pods. Taking vehicles off the road eases congestion which is a major issue in built up urban areas; however, this does impact on pavement capacity which is also in competition and could inhibit the possibility of achieving goals set out in the Healthy Streets Agenda. This issue is further discussed in section 4.2.1.

Urban AV freight solutions could offer sustainable last-mile delivery solutions between urban consolidation centres and customers which may then integrate with inter-urban AV freight concepts such as HGV platooning. HGV platooning aims to reduce fuel consumption through driving support systems which allow up to three lorries to follow closely to one another yielding aerodynamic benefits from slipstreaming. Integration of these two concepts could transform conventional logistics operations as it is known today and ensure efficiency at all stages.

> "A significant barrier to the development and growth of AVs within the urban freight market is the lack of standardised platform between OEMs"
> OEM industry stakeholder

4.1.3 Concerns

A common issue for freight within urban areas is the high incidence of conflicts with vulnerable road users, often caused by human error which accounts for 90% of road accidents (Pincent Masons, 2016). AVs are equipped with numerous sensors designed to avoid collisions with other objects, vehicles or pedestrians. By removing the possibility for human error in driverless vehicles, numbers of road collisions will significantly drop and overall road safety will increase. However, the current capabilities of these systems are limited since they lack the ability to predict the movements of others and do not have the capacity to assess the course of actions that result from braking suddenly. For instance, whilst the capacity to stop instantly if a human were to step in front of the vehicle is clearly advantageous, the act of braking suddenly to avoid a harmless object, such as an empty box, could have knock on implications that cause increased danger to other road users. This is of particular concern in the transition period where roads are shared between automated and conventional vehicles.

Concern was expressed by logistics operators that the technology is at an early stage and the benefits and drawbacks are not yet fully understood. Logistics is an industry that typically operates with small profit margins and the capacity to explore the use of AV is limited; it is a risky investment in an industry that is traditionally risk averse. To overcome this, trials of the technology are necessary to demonstrate the safety features and assure investors of the readiness of the technology. Furthermore, the public should be given visibility in to these trials as the public's acceptance of the technology will minimise resistance and ensure a more successful deployment of AVs.

CASE STUDY 3: OCADO DRIVERLESS DELIVERY VAN

In 2017, Ocado online supermarket ran the first UK trial of an automated grocery delivery vehicle, the CargoPod as part of the TRL led GATEway project. The vehicle was developed by UK firm Oxbotica as a solution to last-mile deliveries and assisted trials were performed in the Royal Borough of Greenwich to assess human reactions to the presence of an automated vehicle. The CargoPod is capable of carrying up to 128kg of groceries in secure crates and has the capacity to drive at 25mph on public roads, though was limited to 5mph during the trials. In practice, it is intended that the vehicles will be unmanned and recipients will unload their own deliveries when notified that the vehicle has arrived at their location. The vehicle can access areas that larger vans are not able to, but are limited to smaller delivery loads. (Ocado Technology, 2017). Responses from the public exposed to the trials have been entirely positive thus far (Guardian, 2017).

4.1.4 Opportunities

Opportunities for uptake of automated technology can be tailored to the specific needs of businesses. OEMs suggested that the move to autonomy presents a business opportunity for the development of a package or solution to a particular customer. OEMs can add value to the proposition by tailoring the technology or offering different levels of autonomy for different prices to enhance existing technology. One obstacle that emerged was the requirement for harmonised development of the technology. This would mean that OEMs would need to collaborate to develop a standardised platform to ensure that there are not numerous methods of reaching the same end solution. It was suggested that this standardisation should be a top-down government led strategy.

Demonstrating and quantifying the benefits of AV technologies poses a challenge. Engagement from London Boroughs and TfL in demonstration projects, such as Smart Mobility Living Lab (London) will support the development of evidence which will support the case for adoption in real use cases.

4.2 Physical Review

4.2.1 Benefits and concerns

Delivery robots, such as Starship Technologies' self-driving ground-drones, are intended to operate on pavements, sharing space with pedestrians. A beneficial aspect of this is that freight transferred on pavements reduces the amount of freight transferred on the road, thus easing road congestion, though increasing the demand on pavement space. Local Authority stakeholders from London's central boroughs expressed concerns that some of London's old roads are already narrow, with no space available for widening walkways. The way that humans will interact with pods is not yet known; it has been suggested that pavement mounted pods may incur a safety concern as humans tend to be less mindful when walking on pavements in comparison with roads. However, it is likely that as pods become more commonplace, the public will learn to become more mindful.

> **"AVs do not require a big change to road space- this is an opportunity to assess priorities, enable a better use of space and achieve current goals"**
> London Borough Local Authority stakeholder

As mentioned in section 4.1.2., concern was also expressed for the impact on pavement space and the public's capacity to walk and cycle. London's Healthy Streets Agenda promotes active travel; by adding congestion to pavements this agenda could be threatened if people feel discouraged to walk or cycle due to the safety concerns associated with contested space. Conversely, it was also expressed that AVs would actually act as an enabler for active travel. By reducing road congestion, more road space is available for cyclists who may feel safer cycling alongside sensor-equipped AVs in comparison with human-driven freight.

4.2.2 Options for change

A suggestion to counteract safety concerns in shared spaces would be to implement segregated lanes for AVs which would reduce conflict over space and ensure delivery vehicles' journeys are not frequently interrupted by the need to avoid collision with pedestrians or conventional vehicles, thus improving time efficiency of deliveries. However, across local authorities in central London there is a sense that assigning space to AVs is not feasible given the narrow architecture of inner-city roads. Giving AVs priority on the street could have negative implications for active travel, or could be disregarded by pedestrians who know that AVs are programmed to stop to avoid collision. Furthermore, there may be negative implications for disabled people who require wider access on already narrow streets.

In London, there has already been public debate on how implementing new cycle lanes has worsened congestion by slowing traffic in busy areas, which has the knock on effect of worsening air quality in the city. Though this notion was heavily contested by cycle campaigners (Independent, 2017), a similar debate is likely to ensue if space is allocated to slow-moving delivery vehicles which may impede other forms of travel. This issue is particularly precedent during the transition period in which there will be peak contest for space, but is likely to ease as more freight moves from conventional vehicles to AVs.

"The transition period will be challenging - we can envision a final destination once the technology is fully deployed, but a period of shared space is inevitable"

London Borough Local Authority stakeholder

4.2.3 Infrastructure considerations

Consideration will need to be given to the implementation of the necessary infrastructure for AV freight. Such infrastructure includes road signs and charging points, and may be extended to include infrastructure to enable an AV connectivity network if this is deemed necessary. Local authority stakeholders expressed concern that the addition of new infrastructure will add clutter to already crowded streets. However, as AV do not have the same requirements for on-street parking as conventional vehicles, there is also a possibility that existing space could be made available and could be utilised for dedicated AV lanes or for supporting infrastructure.

It is envisioned that AV will have the capacity to identify an appropriate location to unload goods, such as a roadside container, and will then move on to the next delivery point, reducing the current space issue caused by freight vehicles parking on-street in cities which can create localised congestion and hazardous road conditions for vulnerable road users. Former freight loading bays could consequently be repurposed to expand on valuable road space, in turn easing congestion; or increase pedestrian capacity. Moreover, with less time spent parked, AVs will be capable of more deliveries in a shorter period of time, making them more cost effective for businesses. Vehicles will be kept and charged at locations outside of the city where space is less contested.

The Mayor's Transport Strategy gives consideration to the next generation of road user charging systems, aiming to support efficient transport movements. To discourage unnecessary journeys by freight, the mayor proposes for London boroughs to introduce road pricing and encourage the retiming of deliveries to off-peak hours; AV freight could aid efficient and off-peak journeys and allow operators to avoid road user charging.

The uptake of AVs for public use will also have an impact on the overall amount of space dedicated to parking in central London. As AVs become a realistic, convenient and cost-effective means of transport for the public, private car ownership is likely to decrease, freeing space on roads and in parking bays for AVs to function without contest.

4.3 Governance Review

The lack of existing governance relating to the general concept of AVs is a barrier which may slow development and uptake of all types of AV technology.

OEMs expressed that it is essential that legislation supports the move to automation if uptake is to be successful. Legislation which drives customer demand would be advantageous in terms of managing investment risk for technology developers. Certifying that customers will uptake the technology ensures AV freight vehicles are a less risky commercial proposition and affords OEMs the opportunity to invest more certainly in developing and producing vehicles. A suggestion of how to drive uptake would be for the government to take control and enforce managed zones stipulating the use of AV for urban freight deliveries. Otherwise, incentivising the uptake of AVs in the same way that taxi drivers have been encouraged to uptake electric vehicles would have a positive impact on the growth of AV applications. In April 2017, the government announced plans to offer grants of up to £7500 to taxi drivers purchasing electric vehicles (LEVC, 2017). Similarly the funding of government research initiatives into AV technologies akin to the funding initiatives for Low Emissions Freight and Logistics Trial and Low Emissions Bus Scheme may help to provide much needed independent real-world demonstrations of the technology to encourage operators and the industry to consider AV solutions, and drive development.

"Policies which force the supply chain to invest in AV freight would speed implementation"
London Business Improvement District stakeholder

4.3.1. Concerns

Concerns were also expressed that the complexity of the development of suitable policy and regulation covering all aspects of AVs may slow the uptake, and even once suitable policy has been developed, agenda does not always translate quickly in to physical change. Developing a realistic regulatory framework for AVs for both public and private use has been identified as the biggest barrier to deployment by those working in the public sector. The scope of the regulatory framework must be broad enough to determine where and how AVs can operate, taking in to consideration the constraints applied to AV users and other road users and whether these constraints are acceptable to all parties.

4.3.2. Developing policy

> **"An open and flexible approach from legislators that are willing to work hand in hand with technologists to find sensible and workable solutions would help overcome barriers and accommodate AV freight"**
> Central Government stakeholder

Stakeholders working in London's central local authorities expressed that they, at present, have little influence over shaping policy and governance as this power is held by central government. However, these individuals are most aware of the particularities that could enable or prevent a successful deployment of AVs in their local authority area. It is sensible to include council figures in the decision making process when developing legislation. With discussions already taking place at a national level, the needs of specific cities and areas within those cities could be overlooked. AVs are considered in the upcoming national transport strategy which will be completed before the technology has been fully developed or widely adopted. The drawback with this approach is that it is too early to discern the complexities of issues that may become apparent once the technology is adopted and so policy is not reactive to these issues. However, it is suggested that the most sensible approach is to identify the key principles of how government and local authorities envision AVs to function at this early stage and for the technology to be developed in accordance of these principles, rather than writing policy in retrospect of the technology emerging.

To ensure a satisfactory framework is developed, a thorough analysis of the benefits and drawbacks of automation for all groups must be undertaken and referenced to ensure that the benefits of implementing the technology will outweigh the challenges. Although there is a call for local authorities to be involved in discussions to develop policy, the idea of local governance of AVs has been widely rejected as this could lead to a fragmented approach across the UK and even within London.

4.4 Market Review

4.4.1 Benefits

Logistics operators have shown a willingness to adopt AVs for freight transportation, though this consideration is currently high level due to the very early stage of the technology. The primary business case for adopting this technology was the potential cost saving of having a driverless fleet. This cost saving not only comes from the lack of requirement for a driver, but from improved efficiency across operations.

Efficiency is improved in terms of accessibility to areas that are otherwise hard to reach, such as campuses, pedestrianised areas or cycle lanes, where conventional vehicles do not have access. This is dependent upon the legislation outlining where AVs will be allowed to operate, but could have implications for ease, speed and facilitation of delivery. This legislation could specify pedestrian and cyclist protection measures.

> **"AV freight offers more control over when vehicle movements happen, in particular by allowing out of hours deliveries. This would ease congestion which would have major economic benefits"**
> London Borough Local Authority stakeholder

Moreover, perhaps the greatest benefit of AV freight comes from the opportunity to expand delivery hours. AV freight can operate for longer periods of time without the limitation of the requirement for rest periods. Later deliveries will also improve operational efficiency; if deliveries can be unloaded to a secure site without human intervention, deliveries can occur through the night without causing noise disruption in residential areas. This would have the added benefit of easing road congestion during daytime and in turn improving safety for vulnerable road users during the day through the reduction of freight vehicles during day-time hours.

Another driving factor for the uptake of AV freight vehicles by logistics operators was the positive association of being at the forefront of new technology and the benefits this would have for brand image. However, this was widely outweighed by the risk of brand image being damaged if the technology were not to be successful and the loss of money that would be incurred with an unsuccessful investment. It was felt that technology would need to be proven before smaller companies in particular invested money.

4.4.2 Concerns

The impact of AVs on the job market is a contentious issue that was perceived with mixed reactions across stakeholder groups. Whilst cost savings can be achieved in the case that businesses will no longer need to employ and pay an individual to drive, it is apparent that an employee may still need to be present to carry out the handover of goods. The presence of this employee would negate the benefit of driver related cost savings; whilst the wages for a non-driver would be reduced other costs such as pensions and payroll would still apply, and the bottom line cost saving would be marginal.

> **"The implication on jobs will pose a challenge to implementing AV freight, though the lack of drivers will be matched with an increase in jobs to develop the technology"**
> Central Government Stakeholder

The social impact of numerous drivers facing unemployment must also be considered. The UK is currently facing a driver shortage which has negative impacts upon the logistics sector- if a delivery cannot be made because no driver is available, the company will incur the costs. This driver shortage is expected to worsen following Brexit when the pool of potential employees gets smaller. Automation of driving can be seen as a way to remedy this. Logistics operators assert that job loss may not be significant, but instead we are likely to see a shift in the types of job available. Whilst individuals are deskilled in terms of professional driving, there may be opportunities to upskill in other areas which could overall allow the operator to create a better service, such as better customer service, visibility of freight, security of the load or maintenance of the vehicle.

The development of AVs is set to create 320,000 jobs (SMMT, 2016). However many of these jobs are likely to be technical and require highly skilled expertise, and thus cannot be seen as a direct solution to driver job loss. Whilst unemployment may be offset, a social cost may emerge if job quality and job satisfaction decrease if drivers are expected to move in to low-skill positions, such as delivery attendants, and do not feel that they are being well utilised.

Stakeholder Engagement: Summary

Technological Review

- AV Freight primarily takes two forms; driverless vans and pavement mounted ground drones
- AV Freight should enable increased time, space and fuel efficiency
- Safety features must be rigorously tested ahead of deployment

Physical Review

- The space capacity for walking and cycling may be reduced by AV freight
- AV Freight is able to operate in previously restricted areas
- Existing 4G network infrastructure can be utilised for communication
- Space previously dedicated to parking and loading will be freed with increased uptake

Governance Review

- Legislation could be a tool to drive uptake of AV freight
- A multi-level approach to policy development is necessary
- Governance of AV freight should occur at a national level to avoid fragmentation

Market Review

- Considerations of AV are still at a high level for many operators due to the early stage of the technology
- Increased efficiency and lower business costs are the primary business case for the adoption of AV freight
- Driver job loss is balanced by the creation of more highly skilled jobs in the development phase

5 State of Play

The current state of play with AV freight is a feeling of uncertainty across all stakeholder groups. We are currently at the early stages of a technology that will have impact across society, not limited to those working in the logistics industry. The introduction of this technology may result in a restructure of deliveries and servicing and the wider impacts of this can only be speculated at this stage. It is possible, nevertheless, to envision how the deployment of AV freight could impact London, and how the rate of deployment could alter these impacts.

5.1 London specific issues

Central London is already facing challenges brought on by the shortage of space; traditional narrow streets cannot accommodate expansion to allow additional lanes for AV freight to utilise. This issue is already at the forefront of discussion with increased demand for space for cyclists given London's Healthy Streets Agenda which promotes active travel. London has an inflexible road network which makes adjustments to infrastructure complex and in some cases impossible. It is possible that the introduction of AV freight on roads will exacerbate this issue. It is important that future transport strategies clearly outline priorities in areas of shared space. In the introduction phase of AV freight, an attendant should be present to ensure AV freight vehicles are fully adapted to London's complex driving conditions.

High levels of congestion already exist in Central London with numerous negative implications. Increased journey times are an issue, with a five mile trip across Central London taking an average of 30 minutes in comparison with the Outer London journey time of 20 minutes (Financial Times, 2016). Congestion has worsened in the past five years despite a significant drop in private car use in the inner city. This has been attributed to the rise of Uber and Amazon deliveries. For freight, congestion slows delivery times, decreasing utilisation. If this can be overcome, logistics operators will benefit from being able to access more customers over a shorter period.

The number of cyclists injured in collisions with goods vehicles is considerably higher in central London in comparison with other urban areas. In 2014-2017, HGVs were responsible for 70% of cyclist deaths in the inner city. Means to combat this were discussed in 2016, with the proposed introduction of a safety rating based on visibility from HGVs, with only vehicles with the highest rating being allowed to enter central London. The introduction of AV freight could provide an alternative solution. AV sensors are significantly safer in avoiding collision than reliance on human reactions.

Plans to pedestrianise Oxford Street by the end of 2018 will impact the movement of conventional freight. At present, freight has access to Oxford Street at all hours but this has negative implications of excessive noise, pollution and congestion. Between 2012 and 2015, a collision between vehicles and pedestrians occurred every seven days, including some fatalities. AV freight vehicles which operate in pedestrianised zones could present a solution to the restrictions of access to Oxford Street by allowing the safe, quiet and efficient delivery of goods to businesses.

London is also trying to tackle the issue of vehicle based emissions as a means to improve air quality which in turn will have positive health benefits for those living and working in the city. The introduction of the Ultra-Low Emission Zone in April 2019 will be a big step toward reducing emissions, and this can be further improved by the reduction of conventional freight vehicles on the road if they are to be replaced by electric AVs.

6 Future scenarios

Three future scenarios have been outlined below to consider the impact that a fast, medium or slow deployment of AVs for freight may have.

Fast (1-3 years)

+ Short-term economic benefits
- Limited testing
  Enhanced media scrutiny could damage public acceptance
- Job loss

Medium (3-6 years)

+ Localised uptake,
+ Findings aid benefit case
- Slow market penetration
- Evidence base not as strong

Slow (6 years +)

+ Strong evidence base
+ Reduced risk
+ Informed decision making
- Market leader status
- Manufacturing output and skills

6.1 Fast Uptake

+ Being at the forefront of developments would be desirable for the image of UK companies. A quick penetration in to the market would have positive economic consequences.

- It is imperative to ensure that the technology required for functionality of all features of AV is in place and has been robustly tested and approved ahead of deployment. As well as ensuring the technology is able to perform its intended purpose, of vast importance is the need to ensure all safety features are faultless. With fast deployment, the technology is likely to attract media and public attention and will be at the scrutiny of critics. Any collision or injury due to a fault with the automated control system of an AV or other element of the delivery solution could have obvious and considerable harmful impact, not only on human welfare but also on public perception of AV technology. If the technology is not seen as robust, this could be harmful to public perceptions and acceptance, which are integral to the success of AVs.

The social impact of a fast uptake of the technology may also prove to inhibit success. The impact of job loss may be felt more severely with a fast uptake of the technology given that employees, namely drivers, will not be afforded the opportunity to make provisions for new employment. Consequently, the economy may suffer an immediate fall and the backlash from the public against the technology may be heightened.

In the case of a fast uptake, mitigating against backlash through positive media coverage and publically accessible vehicle trials is a priority.

6.2 Medium Uptake

A medium paced uptake may see localised uptake of AV technology in specific use cases. Uptake is most likely in locations with test beds already in place where AV freight would be immediately compatible. This would allow for a good understanding of the capabilities of AV freight which could be monitored and closely controlled, though any findings would be limited to that use case scenario. These findings could be used to validate the case for using AV freight and could be applied to future planning.

The benefit of this approach is the reduction of risk associated with a fast uptake, allowing more time to prove and test AV freight technology and ensure it is implemented in a measured way. The UK would, however, not have the advantage of becoming an early adopter within the AV freight market.

Whilst data from use case scenarios is valuable and more time can be allocated for testing, this approach will not realise the full benefit of AV freight in a timely manner. The findings from use cases will be limited, and therefore the evidence that can be applied to inform decisions is equally limited.

In the case of a medium uptake, the risk of entering the market too quickly or too slowly is reduced, but the data gathered from test beds is limited.

6.3 Slow Uptake

+ A slow uptake of AV freight would give the UK the opportunity to assess and learn from early-adopter experiences, both negative and positive, of implementing AV freight in other countries. This would enable the UK to learn from best practice and minimises the risk associated with being at the forefront of developments. Moreover, if successful deployment of AVs is evident elsewhere, logistics operators are better able to assess the business case for adopting AV freight and are able to make a business case.

There would also be the opportunity to spend time analysing priorities for the travel agenda and making informed decisions of how and where AVs will operate, as well as the opportunity to make infrastructure provisions ahead of deployment.

- A slow uptake of AV freight could leave the UK lagging behind other countries and missing the opportunity to reap the benefits of being a market leader in this technology.

UK based freight solutions providers may find themselves being overtaken by those who are already successfully implementing AV business models elsewhere. The relative unsophistication of the UK's delivery service would offer an opportunity for others to takeover and make efficiency gains.

In the case of a slow uptake, ensuring UK manufacturers do not suffer as a consequence of being behind market trends is a priority.

7 Recommendations and Interventions

If managed effectively, the implementation of autonomous freight vehicles in Central London for deliveries and servicing could have a multitude of positive impacts; businesses could run more efficiently with lower driver related costs and extended delivery hours; congestion could be reduced with fewer freight vehicles using the road; emissions could be lowered by the adoption of more fuel-efficient vehicles; reduced business costs could be passed on to customers who will pay less for deliveries; road safety could see a huge improvement; and the UK could be the market leader in the deployment of this emerging technology.

For this to be successful, it is integral that the following provisions are considered:

7.1 Government investment is required in the development and testing of new technologies, specifically freight and logistics.

Investment must be made in AV freight and logistics. This can be driven by government funding through current mechanisms and resources such an Innovate UK and local London Boroughs where appropriate. Investment should be used to develop new test beds and exploit existing test beds in partnership with freight and logistics operators.

Robust technology is fundamental to the successful uptake of AVs. Businesses need certainty in order to invest money in to developing technologies. Manufacturers are working alongside research institutes to develop effective technology using public funding from Innovate UK. An example of this is the Smart Mobility Living Lab: London, where over £100 million has been invested in AV projects. This presents a commercial opportunity for OEMs when scaled up and tailored to specific business needs.

Existing freight and logistics service operators will have the opportunity to drive efficiency, improved services and new service models, whilst retail businesses which rely on successful completion with the end consumer will have new, cost effective services to satisfy rising customer demand.

It is suggested that investment in developing and testing AV technology continues, but with a stronger focus on freight and logistics test beds.

7.2 TfL funding needs to support logistics operators with the uptake of AV freight

Customer demand for AV technology would spur existing OEMs to invest money in to research and development, and could see new OEM entrants in the market. Logistics operators have shown willingness to trial new technologies as they emerge; for example

Waitrose is trialling a number of compressed natural gas vehicles in London to assess the commercial opportunity for doing so. This willingness seems likely to expand in to trialling AVs, though as an industry logistics operators are typically risk averse and would require an incentive beyond investigating new opportunities.

Government funding to support logistics operators would increase the number prepared to uptake the technology. At a London centric level, this funding should come from Transport for London. Outside of London, other existing test beds can be exploited; one example is Coventry's City Lab. OEMs must lobby central government for funding in AV testing, but it is essential that technology providers, insurers and central government collaborate to establish a strategy for testing the technology and driving uptake.

7.3 AV freight trials must focus on determining what infrastructure is necessary ahead of deployment

Road signage and markings are crucial to allow AVs to function and must be up to standard ahead of testing or deployment of AV freight. Beyond this, it is not yet clear what further infrastructure is required for safe deployment. This area requires further investigation. Communications infrastructure may or may not be necessary to enhance safety. Projects aimed at deploying AV freight on roads or pavements should aim to understand what infrastructure would make the technology work better. Real-world projects are necessary before the full functionality of AV freight is uncovered.

Localised trials in different settings will help identify what further infrastructure is needed for wider deployment.

A focus on determining what infrastructure is required should be a key element of AV freight trials.

7.4 Public perceptions of AV freight should be influenced by positive media coverage.

Positive publicity in the media highlighting the benefits of AVs would be beneficial in managing public perceptions. Whilst the benefit of AVs for private use may be more pertinent with the public, demonstrating how AV freight may also improve their daily lives will allow insight in to an industry that the public do not necessarily feel closely invested in.

Inherently there is public suspicion over automation, but this could be managed by engaging with the public and directly addressing fears or uncertainties. Public workshops, forums and providing experiences for interacting with AVs would provide opportunities for this engagement to take place. Examples of this are TRL's GATEway programme at the Smart Mobility Living Lab and Coventry's City Lab which can be used to facilitate such forums.

Publicity around trials is integral to conveying a positive image. Communications plans tailored to connected and autonomous vehicles should be developed discreetly from electric vehicle communications plans to ensure the needs of AVs are met.

From this, local authorities are able to identify which services would be suitable for replacement by AV freight and collaborate with OEMs to develop an autonomous solution.

Allowing visibility in to trials of the technology would demonstrate to the public the safety features which would have a direct improvement on road safety.

There should be a media push to engage the public with developing AV freight technologies and address any concerns in a public sphere.

7.5 Policy and regulation must be in place before AV technology is deployed.

Perhaps the most important intervention in the lead up to AV freight is the need for the government to outline policy and regulation. Development of technologies is happening at pace and so it is inevitable that policy and regulation will lag the technology. However, early demonstration and on-road activity can develop evidence to inform the next stage of policy, regulation and approvals regimes. Further discussions relating to policy development should be inclusive of stakeholders including local authorities, technology developers, vehicle manufacturers, service operators, customers, and should be informed by evidence.

At the current stage, there is a sense of apprehension among manufacturers developing technology before they are aware of any political constraints that may affect its functionality. This has not necessary had the impact of slowing development; many UK OEMs are investing and developing AV technology, though a sense of uncertainty exists and some stakeholders expressed concern that uptake by the automotive industry must be driven to an extent by policy and regulation. Conversely, policy makers cannot make decisions before they know the full extent of the technology. To ensure that this situation does not result in a standstill which delays deployment, policy makers should take the lead in outlining the key principles that AVs can help to achieve. Changes in regulation are required before commercial systems can go in to operation. In the mean-time, vehicle trials should be continued to increase understanding of the extent of the technology and to ensure the technology is ready to be deployed once regulation is in place.

Once AV policy is in place, technology developers will be able to move capabilities forward at a faster pace.

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Impact of Autonomous Freight Vehicles in Central London

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