ZENZIC

Scaling up by 2035: Opportunities for the UK CAM sector

An aggregation of key Zenzic insights

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United Kingdom

Zenzic was created by government and industry to champion the UK Connected and Automated Mobility (CAM) ecosystem and lead the UK in accelerating the self-driving revolution, with the goal of ensuring a safer, more secure, sustainable, and inclusive transport future.

Zenzic exists to make champions of others, and place the UK at the heart of the global CAM ecosystem. By leveraging the power of innovation, through collaboration, Zenzic promotes and enables UK organisations to play an impactful role in the future of mobility.

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Acronyms

Abbreviation	Definition
AI	Artificial Intelligence
AV	Automated Vehicles
BSI	British Standards Institute
CAM	Connected and Automated Mobility
CAV	Connected and Automated Vehicles
CCAV	Centre for Connected and Autonomous Vehicles
HD	High Definition
ML	Machine Learning
NCAP	New Car Assessment Programme
PAVE	Partners for Automated Vehicle Education
R&D	Research and Development
ROI	Return on Investment
SoS	System-of-Systems
TRL	Technology Readiness Level
V2X	Vehicle to Everything

1 / Introduction

Connected and Automated Mobility (CAM) has, in the past, experienced much hype and ambitious predictions of roll out – exemplified by expectations for CAM technologies peaking in the Gartner Hype cycle in 2015[1] and predictions such as the then UK Chancellor's announcement in 2017 that self-driving vehicles will be on the UK roads by 2021[2]. In 2023, these technologies are seen to be exiting the 'Trough of Disillusionment' and moving into the 'Slope of enlightenment'[3] – and this matches a shift that can been seen within the sector, with the focus of CAM technologies moving towards services and deployments.

Yet, the actual number of real-world commercial deployments around the world is still very limited[4]. As the sector looks to move from an R&D focus to one that can support large scale deployments, as is projected to be the case by 2035, a crucial question that requires answering is: *What are the key opportunities and barriers to scale by 2035?*

To achieve at scale sector operations, organisations would require a proven business model that can show profitability of product or service within a strong market. This work focusses on key elements necessary for achieving and positioning a favourable market proposition within the UK to organisations domestically and abroad, particularly one that is able to support the supply needed for a mass demand in CAM products and services with hundreds, if not thousands, of vehicles providing value on UK roads.

Zenzic has closely engaged with the UK CAM sector to better understand the requirements, challenges and opportunities for the market and brought together industry and government to focus on these aspects.

As such, this report brings together the key pieces of research that Zenzic has conducted to better understand the opportunities and challenges to enable CAM technologies and services to be deployed at scale on UK roads by 2035. This work draws upon several updates of the UK CAM Roadmap[5], two editions of in-depth analysis of the UK CAM supply chain[6], a look into the international CAM landscape[4], lessons and insights from the Zenzic CAM Scale-Up programme, as well as direct feedback from industry through the CCAV CAM Cohort industry event in Dec 2023.

As a result, the following sections outline the most prominent and urgent aspects that need to be addressed to unlock the potential of CAM at scale. Whilst these factors are presented individually, there is a great amount of interplay and dependencies between them, and all aspects should be addressed holistically to best prepare the UK for the advancement and deployment of CAM. It is worth noting that current CAM market intelligence sources have heavily focused on the technology aspect of development, in contrast this piece of work focuses on the broader factors underpinning the opportunities for sector growth. Figure 1 shows the interplay between these key areas. Previous research from Zenzic shows that, with timely action, the UK is well positioned in the international CAM landscape to be at the forefront of realising global commercialisation[4].

Figure 1: Interdependencies of the key CAM opportunity areas for the UK to be able to scale by 2035
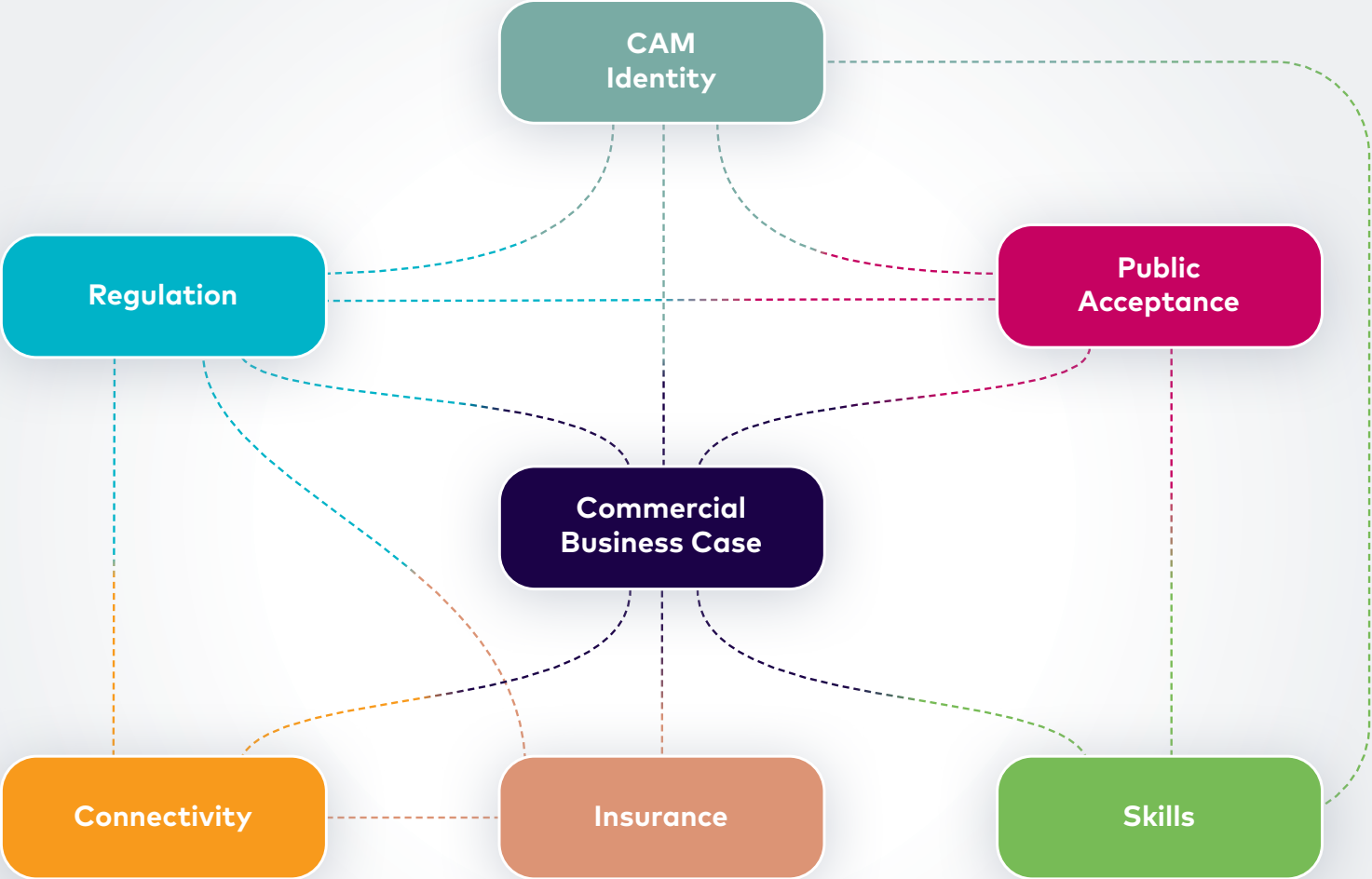
2 / CAM Identity

An examination of the global CAM landscape conducted by Zenzic[4] indicated the existence of formulated 'CAM Identities' by key nations in the international market.

The CAM identities of the countries included in the study have been shaped by a combination of factors:

- by technology application focus
- industry supply chain strengths (CAM specific and broader)
- early adoption of CAM market ready elements and/or
- societal direction of products and services implementation.

The UK CAM Roadmap to 2035 identified four key areas of application of CAM services in the UK which would deliver the most economic, societal and environmental benefits, namely[5]:

- off-highway (without public access) vehicles and services
- freight and logistics vehicles and services
- personal mobility vehicles and services
- public transport vehicles and services

These foundation applications can serve as the cornerstones for the formulation of the UK's CAM Identity. A strong market pull needs to be created to achieve the wider societal and economic benefits of CAM technologies. Moving away from a technology-proving phase into commercial operation, buy-in is needed from potential operators and commissioners of CAM services.

The UK needs to be clear on its 'CAM identity', what does it want to be known for and what is its single clear 'Mission' which will maximise its position in the global CAM market.

Linkages
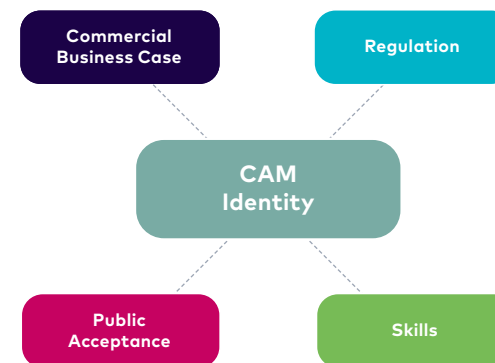
CAM Identity

Challenges

- A clear market pull is required to advance the market forward. It is required to move from technology proving stage onto actual market-oriented development.

- The UK CAM sector requires a clear and consolidated vision for the development and implementation of regulatory measures to enable the sector and the deployment of technology.

- UK-based supply chains are still forming and are not developed enough to support the eventual commercial demand.

- Visibility of UK activity in CAM space abroad is low with lack of clarity of a UK CAM identity, lowering the awareness of domestic strengths from potential overseas customers.

Opportunities

- A strong consolidated CAM identity will help propagate UK sector messaging on a global level and within the UK.

- The supply chain is still maturing – now would be the time to set out the priority focus aspects of technology development and application, coupled with societal and economic priorities to formulate a CAM identity and rally the sector around a consolidated vision.

- Opportunity to develop identity around the cluster of development, for example passenger services or freight deployments in particular regions and locations.

- Early engagement with operators and commissioners (and end users (Section 7)) will drive a 'needs-based' technology development, fostering better public and workplace acceptance and attracting skills to the sector.

Recommendations

- Creation of a coordinated sector level development strategy.

- Engagement with global industry bodies is good however, in addition, the UK needs to broadcast internationally a CAM identity that promotes and aligns with what progress is happening to attract players.

- Collaboration between the tech providers and potential operators to ensure that CAM is on roadmaps for commissioners, operators and OEMs is crucial to formulating the business case for service operation and driving a strong demand for CAM solutions.

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3 / Commercial business case

CAM services are mostly still in the R&D phase around the world with very little real world commercial deployment with some exceptions in USA and China[4].

Pressures from the global economic market, with high inflation and interest rates, make it more important to demonstrate a clear ROI to be able for organisations to secure private investment – making it a challenge for CAM applications and services to secure these funds. Private investment to date has centred more around enabling technologies which can pivot into other domains using the core capabilities developed.

It is important to have a strong market pull to support use-cases. It is often citied that the UK is strong in innovation but often not seen as best in capitalising on it. Demonstrating commercial business cases for CAM services will enable the UK CAM market to scale, not just for UK-based deployments but in export opportunities too.

Linkages

CAM Identity • Connectivity • Regulation • Commercial Business Case • Public Acceptance • Insurance • Skills
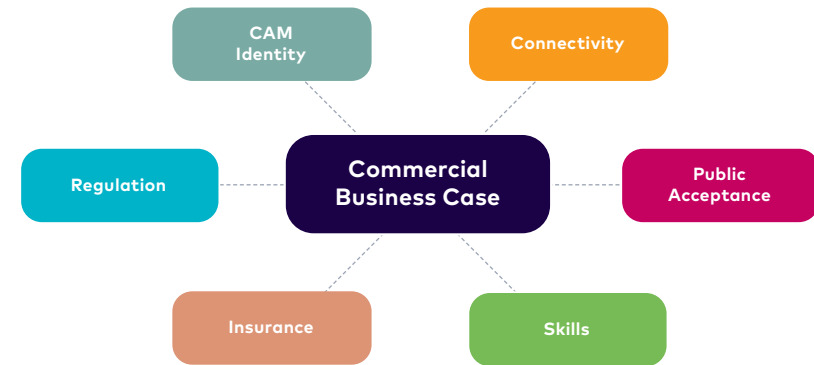
Commercial Business Case

Challenges

- The UK is seeing uncertainty in how the technologies will develop and lack of consistent focus on use-cases.

- Technologies are still maturing and often require public sector support to prove out business case.

- Commercial use-cases are only really starting to be proven out, with case studies conducted by Zenzic highlighting the unanimous challenge of higher investment costs due to supply chain immaturity and incurred costs from safety staff presence[6]

- Some challenges in lack of alignment on where the high value areas in a CAM supply chain will be (most likely the services)

Opportunities

- New business cases mean new services that are more efficient and inclusive – i.e. those that can serve an under-served regional market.

- Emerging opportunities in early use-cases particularly around 'off-highway' as its regulatory regime currently differs, handled by the Health and Safety Executive, with new restrictions from upcoming regulations for self-driving vehicles compared to on-road application[4].

- Create technology stepping stones by learning from off-highway applications to implement better solutions for on-road applications.

- Big market opportunity projected to amount for a potential £66bn economic boost by 2040[7].

Recommendations

- Interventions and industry focus should be on areas of high opportunity and focused on providing a CAM service. Those services need to align with the nine guiding principles of the government's published Future of Mobility strategy[7].

- Continued public sector support (through procurement, grant funding and other means) required to help bridge the gap and help industry to better understand the commercial business case.

- Focus on early commercial opportunities as stepping stones to increased service deployment.

- Continue to understand the UK's strength and opportunity on the international level
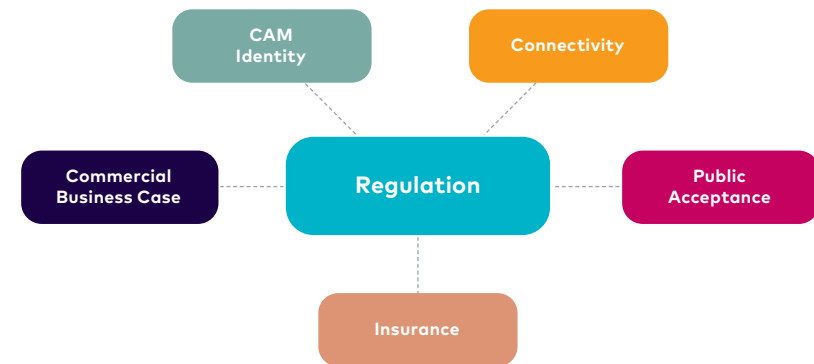
4 / Regulation

In January 2022, the Law Commissions of England and Wales, and Scotland published a report that made over 300 recommendations on individual pieces of regulation which need to be amended or created to accommodate the changes brought about by automated vehicles[8].

Regulations have been a common topic for a long time in the CAM sector, particularly as more trials and research have been carried out in the UK. With the passage of the AV Bill through Parliament[9], these conversations and actions are now at the forefront of action.

There is much independent work being carried out in different countries on CAM regulation. Therefore, international alignment is a must to ensure harmonisation and act as an enabler for CAM.

Looking forward there needs to be clarity about the details of the secondary legalisation to enable the deployment of CAM services. Understanding needs to be built around the practice of enforcing current and upcoming CAM regulations, the tools and mechanisms needed to be create to ensure the safe and reliable operation of CAM products and services.

Linkages

Regulation

Challenges

- Risk-averse political environment

- Unclear path and uncertainty of the timeline for creating secondary legislations and regulations.

- Better understanding is needed on the support required from the CAM stakeholders beyond regulators – industry, academia, and other adjacent sectors.

- Ensuring safety of public is the topmost priority for UK deployments of CAM, managing the balance with operational effectiveness of CAM to define the path forward.

- The UK CAM sector is currently made up of multiple pre-existing industries and emerging CAM-specific and broader technologies. The challenge lies in leveraging all segments of the sector efficiently and strategically to achieve optimum results.

- CAM is a new sector with more unknowns than knowns increasing the perceived risk from technology impacting the current regulations significantly.

- Industry lacks a clear understanding of how the work they are doing on real-life deployments can support the development of regulations

Opportunities

- There is a strong possibility for the UK to become a world leader with clear regulations and streamlined path for deployment of CAM.

- Conditions are favourable for the UK to be a strong voice in the international harmonisation of CAM standards supported with evidence.

- Flexible legislations and regulations to support learning, and update through the evolution of ongoing deployment at scale.

- Creating an environment with transparency at its centre, to foster relations between industry, academia, and government with clear understanding of the role of industry and academia in regulation.

- Collaboration across different government departments, joint strategies and cohesive interventions and initiatives, and the external understanding of the roles, responsibilities and strategies.

Recommendations

- Understand the demand for services in the UK and focus on the use-cases that have the most benefits on society and economy.

- For Government to provide a path for future regulation and provide certainty around the regulatory process.

- Independent oversight and monitoring of CAM technologies can help increase confidence in technology and public acceptance. Clarity on mechanisms and processes for creating them would foster transparency.

- To collate and assess current research to get a broad understanding of the aggregate, and a view of further research required.
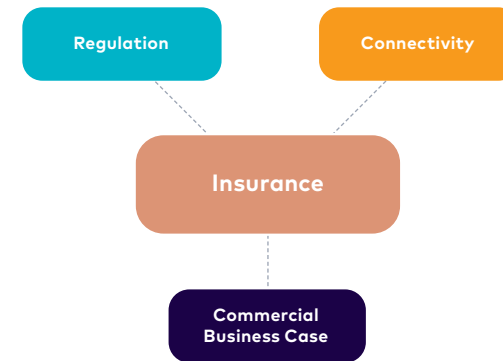
5 / Insurance

Insurance is a key enabler for CAM services and deployments. Many trials have taken place in the UK that have required an insurance solution to be in place to enable the service to be on the road.

During the trials, two aspects of insurance are generally considered – vehicle insurance and trial insurance (often in the form of liability cover). These insurance products have been provided on a one-to-one basis, rather than a common approach within different insurance organisations. Currently, there exists no 'off the shelf' insurance product for the mass-rollout of CAM services and the insurance of an AV fleet in the UK.

There are key questions regarding the shift in liability from drivers to vehicles or OEM/ASDEs, data access, and for shared mobility i.e. cyber security play a role into understanding risk and liability.

The insurance industry needs to better understand both what the risks associated with CAM are, and how to quantify and measure them, to be able to fairly price their products and services – a critical element to being able to support a sustainable business case.

Linkages

Regulation

Connectivity

Insurance

Commercial Business Case

Insurance

Challenges

- Automotive insurance is a lucrative and competitive business, but there is still lack of understanding how CAM services can be integrated into the current automotive insurance model.

- Lack of understanding the new class of cyber risks brought by CAM.

- Understanding what the business model for insurance would look like- disruptive change for their business model or an evolving one.

- Uncertain what path CAM will take – i.e. a route of traditional vehicles with added connectivity and automated features or a complete overhaul with new vehicle type, or both. These approaches all bring their own sets of challenges.

- Future intelligent vehicles will be increasingly connected to the internet, accept over-the-air updates, become Wi-Fi hotspots, and communicate with other internet-enabled devices such as vehicles or infrastructure. This means that the risks of the most severe security threats are yet to emerge.

Opportunities

- The UK has been recognised as a leader in the global insurance industry and has an opportunity to be a pioneer for its CAM applications – positioning the UK strongly in the international market

- Insurance is seen as a key enabler to the safe deployment of CAM services. To learn from insurance models in other technology areas that involve cyber and human behaviour aspects.

Recommendations

- Insurance must be a central tenant in the development of CAM, it is imperative that new risk models are developed so CAM services and technologies can be priced fairly and be ready for the mass roll out of these technologies.

- Insurance organisations should maintain strong collaborative efforts to find a collective solution, and work with the other relevant sectors.

- Explore dynamic insurance models during deployment projects and other trials to understand common lessons and learnings.

- Ensure the insurance industry's input into the CAM development and regulation process.

- A clear collective understanding of the future risks that cyber poses to the ability to insure critical components of the infrastructure against attack.

- Those in the CAM industry must continue to engage with the insurance sector to find optimal solutions.
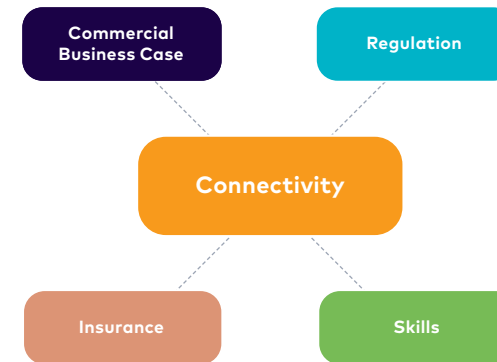
6 / Connectivity

Increasingly developers are looking at remote monitoring and teleoperation to augment the fully automated operations of the vehicle.

These developments are reflected in the issuing of Remote Driving guidance from the Law Commissions in February 2023[10], Furthermore, the British Standards Institute produced a flex standard in August 2023[11].

V2X features are emerging on current vehicles across use-cases, and from 2027 V2X is set to become part of the Euro NCAP assessment[12]. The variety of the features being offered is developing over time with the increasing emergence of software defined vehicles.

In the longer-term CAM solutions have to become an integrated part of the wider transport 'System-of-Systems'. To benefit from the emergent properties for societal, economic and environmental gain, the communication interfaces between geographically dispersed elements of the system are vital.

Linkages

Commercial Business Case

Regulation

Connectivity

Insurance

Skills

Connectivity

Challenges

- Understanding the connectivity and infrastructure requirements for respective use-cases against timelines

- Understand the true linkage between 5G and associated equivalents roll out and CAM capability for safety critical decision making in real time, for example in the use of remote monitoring and tele-operation.

- Understand the wider drivers of connectivity requirements and how that links to the connectivity required to meet regulatory requirements for in use data requirements.

- Understand the data requirements and its usage and implications across a range of stakeholders.

- Having a clear understanding of an infrastructure digital twin and the implications for CAM.

Opportunities

- Connectivity is a foundation for the safe operation of CAM services, whether remote monitoring or full remote operation. Therefore, it could unlock significant benefits for the UK.

- The provision of HD maps for a deployment area (ODD) which is developed and maintained by the road operator in collaboration with users of the road through the mutual sharing of data.

Recommendations

- Identify use-cases and stakeholders for data packages.

- Creation of data standards and data sharing frameworks.

- Understand the current and planned 5G coverage and infrastructure strategy and assess how CAM requirements fit into the future landscape.

- CAM inclusion in the National Digital Twin Programme

- Standardisation and maintaining HD-Maps in real-time.

- Continuous collaboration between different stakeholder groups is essential for establishing and propagating optimal data and infrastructure requirements for CAM.

- Identify the gap in skills needed to achieve and implement the required level of connectivity services and products.
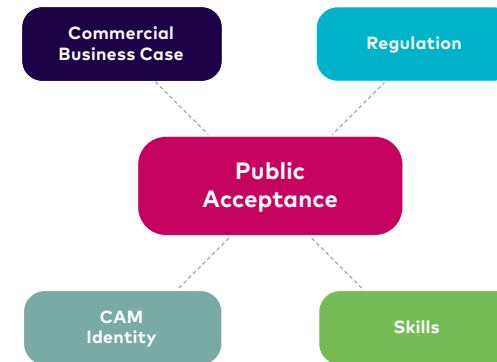
7 / Public acceptance

CAM is an emerging sector with the potential to transform the way society travels, works and lives at large. The path to public awareness and acceptance of CAM remains unexplored in detail despite the rising scrutiny of the sector.

Studies suggest that over 50% of the public could be unhappy sharing public roads with automated vehicles[13]. Public transport and logistics services are indicated to be favoured amongst the public for CAM implementation[14].

To ensure CAM can deliver it's promised socio-economic benefits, further work on CAM perception is needed. An example is broadcasting that technology development and regulation are working together to keep safety as a minimum requirement for service implementation. CAM is in a position to undertake a similar journey to the net zero transformation, through clear identification and articulation of the impact that CAM technologies can bring to the public, fostering public acceptability.

Linkages

Public Acceptance

Challenges

- Globally public acceptance is minimal, linked to the low numbers of deployments, and influenced by both positive and negative media coverage[4].

- Safety is portrayed as a key benefit for the public; but if safety is assumed by the service approval process a more impactful element is needed to get public buy-in.

- Reshaping of existing skill sets (e.g. commercial drivers) and its impact on society at large needs investigation and clear communication to the public.

Opportunities

- Safety and dependability are critical to ensure high level of confidence in anticipation of at scale deployments.

- The enhanced safety of CAM is a key benefit, but to engage and retain the public interest a more direct and tangible impact on the everyday life can be explored i.e. wider societal benefits.

- Need to identify the direct link to the real benefits to the end users (passengers, and consumers)

- Building trust with the enhancement of end user convenience vs. the perception of loss of control

- Whilst CAM is an emerging sector, there is an opportunity to take the public on this journey of development rather than appear to force the technology when it is ready

- Being transparent with the pros and cons of CAM

Recommendations

- Visibility of UK activity in CAM space abroad – engagement with global industry bodies is good but UK needs to broadcast internationally what progress is happening to increase visibility and lead on 'CAM – Made in the UK' products and services.

- Government and industry collaboration that focuses on the public perception of CAM and its benefits including safety. Whilst some good work has already been done, this needs to continue as deployments take shape.

- Leverage public outreach organisations such as PAVE UK and learn from PAVE EU, PAVE US and others.

- Shaping the influence as CAM being part of the future transport solution rather than a replacement of existing transport solution
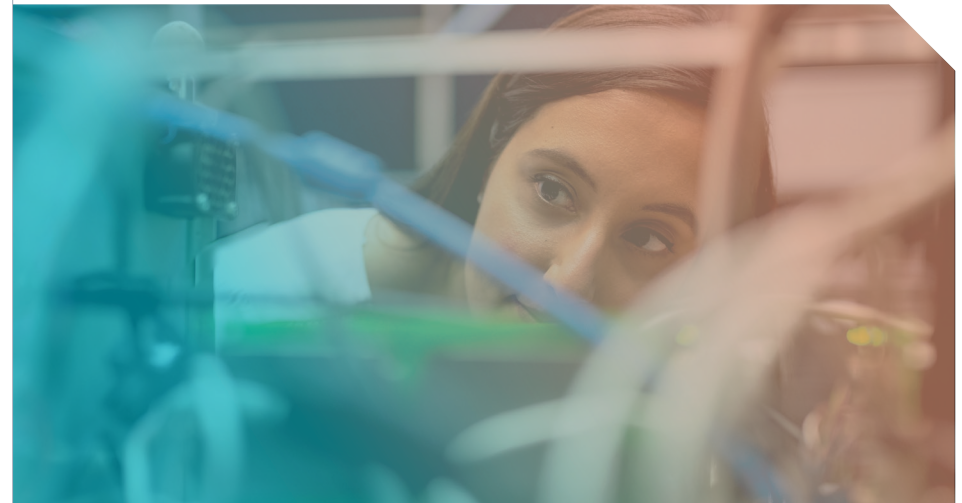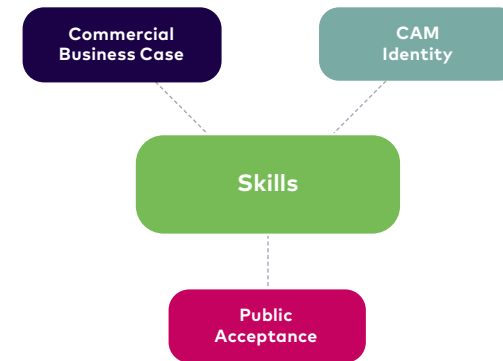
8 / Skills

Industry feedback from several sources, including the latest update to the state of the UK CAM supply chain indicate an unclear path for skills required and to develop for the sector[6].

The set of skills needed to sustain a CAM vehicle through its life cycle, from concept to fruition, through operation to decommissioning, is currently undefined. Severe limitations exist in the number of entry level candidates, as well as seasoned engineers and experienced hires with the right combination of skills to undertake the volume of CAM development needed.

There is a lack of understanding and focus on exploring skills that can be transferred from other sectors and what are the non-technical skills required for scaling up the sector, which have long-term implications particularly in the area of facilitating public acceptance.

Linkages

Skills

Challenges

- Lack of definition of the skills landscape currently in existence as well as a prognosis of future requirements.

- Skills for remote operation, connectivity, maintenance of CAM vehicles and infrastructure are only now being understood as they are 'innovative roles' but essential for industry success.

- The skills of operators and roles and responsibilities of an operator over the lifetime of a CAM vehicle needs to be better understood.

- Challenges with outsourcing skills overseas where those are not available domestically.

- Internal dissemination of the 'CAM journey' for implementation is a challenge to communicate with 'non-specialists' within organisations.

- Re-shaping of skills and demand for new unexplored skillsets – e.g. shift from on-board drivers to remote monitors.

Opportunities

- Need to define the skills needed across all areas, if not most of CAM as it stands today: 'technical' vehicle engineering, cybersecurity, AI/ML, software, simulation, data analysis/management; 'non-technical' – public relations and engagement, human factors and others.

- Through taking a holistic view of the skills landscape and future shift, reshaping of current skill sets can be better relayed and evidenced to interested parties such as Unions and HR departments.

- There are opportunities to access skills pools that exist in unrelated fields but have the potential to be transferred and developed into valuable assets across all areas of expertise needed for CAM.

- Opportunity to learn from comparable innovative industries having undergone a skills transformation to uncover learning from their areas and what could be transferred to CAM – i.e. examine the journey holistically and not focus solely on 'innovative skills'.

Recommendations

- A strategy to attract talent from adjacent industries and retaining it in CAM through crystalising the potential for sector and personal progression opportunities.

- Investment into earlier stages of technology research – TRL 2-4 – in critical areas of missing capability in industry would help fill technology gaps that inhibit CAM development. This would also raise the level of CAM-specific engineering and technology skills grown in academia.

- Engaging with organisations that already try to tap into upskilling underutilised skill pools (in the sphere of re-training and adult skills services) to understand how CAM-specific skills can be added to the upskilling agenda or a similar concept organisations/programmes can be created.

- Develop operators' understanding of the roles' evolution with the introduction of CAM and reduce the concerns it raises in the job market.

- Leverage assets like annual UK CAM Supply Chain analysis in the future to gather organisational data on existing skills gap.

- Long term investment into STEM in schools and academia providing the skills needed for the future.

9 / Recommendations

Create a clear CAM focus

Create a clear CAM focus	Recipients for recommendation
Creation of coordinated sector level development strategy, with interventions and industry focus on areas of high opportunity and focused on providing a CAM service	🏛️ ⚙️
Focus on early commercial opportunities as stepping stone to more ambitious and complex deployments.	🏛️ ⚙️
Understand the demand of services in the UK and focus on the use-cases that benefit the society and economy directly.	🏛️ ⚙️ 🎓

Recipients for recommendation

🏛️ Government

⚙️ Industry

🎓 Academia

Enable deployments (Market pull and regulation)	Recipients for recommendation
Collaboration between the technology providers and potential operators and service commissioners to formulate the business case and drive demand.	🏛️ ⚙️
Continued public sector support required to help bridge the gap and provide support to understand the commercial business case.	🏛️
Providing a path of how the process for regulation would look like	🏛️
Independent oversight and monitoring of CAM technologies	🏛️
Collating and assessing the different research that is completed	🏛️ ⚙️ 🎓
Development of new risk models compatible with CAM services and technologies	🏛️ ⚙️
Insurance organisations to work together to find a collective solution and collaborate with the other sectors involved such as cyber and AI.	⚙️
Trials that look at dynamic insurance models during deployment projects and other trials with a common lessons-learned report cascaded amongst industry.	⚙️
Provide input into the CAM development and regulation process ensuring channels for feeding into regulation, legislation and standardisation continue to exist	⚙️

Strengthen the UK's global position	Recipients for recommendation
Continue to understand the UK's strengths and opportunities at the international scale	🏛️ ⚙️
Provide visibility of UK activity in CAM abroad	🏛️ ⚙️

Connectivity	Recipients for recommendation
Creation of data standards and data sharing frameworks including standardisation and maintaining HD-Maps in real-time	🏛️
Understand the current planned coverage and infrastructure strategy	🏛️
CAM inclusion in the National Digital Twin Programme	🏛️
Identify use-cases and stakeholders for data packages	🏛️ ⚙️

Public acceptance	Recipients for recommendation
Focus on the public perception of CAM and its benefits – whilst some good work has already been done, this needs to continue as deployments take shape.	🏛️ ⚙️
Shaping the influence as CAM being part of the future transport solution rather than a replacement of existing transport solution	🏛️ ⚙️ 🎓

Skills	Recipients for recommendation
Formulate a strategy for attracting talent from adjacent industries and retaining it in CAM as well as develop a pipeline of new talent by investing in STEM	🏛️ ⚙️ 🎓
Investment into earlier stages of technology research (TRL 2-4) in critical areas of missing capability in industry	🏛️ ⚙️
Develop operators' understanding of the roles' evolution in the job market related to CAM.	⚙️
Leverage assets like annual UK CAM Supply Chain analysis in the future to gather organisational data on existing skills gap	🏛️ ⚙️ 🎓

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