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Connecting the UK CAM Supply Chain

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Disclaimer

The study is based on examination of survey, CAM sector knowledge and information that is publicly available regarding organisation involved in CAM in the UK. Efforts have been made to verify data where reasonable.

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Acronyms

Abbreviation	Definition
ADAS	Advanced driver-assistance systems
ADS	Automated driving systems
AI	Artificial intelligence
ASDE	Authorised Self-Driving Entity
BEV	Battery Electric Vehicle
CAM	Connected and Automated Mobility
CAPEX	Capital Expenditure
CAV	Connected and automated vehicle
CCAV	Centre for Connected and Autonomous Vehicles
EV	Electric Vehicle
HSE	Health and Safety Executive
MKCC	Milton Keynes City Council
NMUK	Nissan Manufacturing UK
ODD	Operational Design Domain
OPEX	Operating Expenditure
ROI	Return on Investment
VC	Venture Capital



Foreword / Arun Srinivasan



Arun Srinivasan

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Towards the end of 2023 the UK Connected and Automated (CAM) sector saw two major milestones – the UK government announcing their ongoing support for the sector until at least 2030 as well as the introduction of the Automated Vehicles Bill into parliament – both of which signal the clear intent of the UK to be at the forefront of development and deployment of these technologies and services. For the UK CAM sector to achieve this ambition it is critical that we understand what the UK brings to the table – what are our key strengths, where are the opportunities and how the UK can plot a path forward within the global CAM sector.

This Zenzic report explores the progress of the UK CAM landscape building upon the first edition of the analysis published in 2022. That work produced the framework and insights that have shaped interventions and helped support UK organisations to unlock the potential of CAM technologies. This report offers fundamental insights into the key opportunity areas for the UK, that will not only shape the future strategic decisions on CAM, but also place the UK as a competitor on the global stage.

The current landscape for advanced technologies is complex and moving at rapid pace such as the rise in Machine Learning & AI. These new fields will not only shape how we develop CAM technologies but also how we move people, goods and services but also come with challenges such as, understanding the commercial business case and regulation, building trust in the technology, and we see some of themes come through strongly in this research in the UK CAM sector. This continues to reinforce the collaborative effort that will be required from many sectors within the UK to progress CAM technologies from, 'one from the future' to 'one of the present' – bringing the UK tangible benefits from CAM by 2030.

It is critical that we understand what the UK brings to the table – what are our key strengths, where are the opportunities and how the UK can plot a path forward within the global CAM sector

Executive summary /

Since the last iteration of this work, the UK Connected and Automated Mobility (CAM) sector has become increasingly focussed on pushing towards realising commercial deployment.

This is evidenced by UK government's Commercialising CAM programme that supports seven early deployment consortia as well as thirteen supply chain projects – the scope of the latter was shaped by that previous iteration of work. In November 2023, the UK government reaffirmed its commitment to the CAM sector, announcing up to £150m of funding from 2025 to 2030 and the introduction of the Automated Vehicles Bill into parliament. CAM technologies continue to mature but the short-term economic backdrop provides a challenge for industry. The UK-specific findings of this work align with research in 2023 by Zenzic into the international CAM landscape suggesting a global trend in re-evaluating CAM approaches and the consolidation of the sector via acquisitions and investment. This research provides an update to the current landscape of the UK CAM supply chain – its strengths, challenges, and areas of opportunities for the UK to be a thriving part in the global CAM supply chain.

2024 Core Themes /

1 A global CAM market

To leverage its strong position the UK needs to maintain momentum by focusing on the inherent strengths and support high value opportunities that would give it the strong competitive advantage in a rapidly evolving international market. The UK CAM roadmap to 2035 update identified six areas in which the UK could create value through the development and exploitation of products services and solutions. Four of these are deployment use cases and the remaining two are Data & Infrastructure and V&V Assurance Services.

2 Revision of CAM approach

A continuous trend of sector consolidation has become apparent with industry taking a pause to re-evaluate future strategies and priorities. Consensus is rising around CAM's emergence from the inflated expectations and are on the "slope of enlightenment" having the chance to move onto addressing crucial challenges and barriers to the sector.

3 Early commercial opportunities playing out

Private capital access remains a challenge for CAM organisations of all sizes with near-term opportunities being prioritised. While the sector proposition is in the early stages of forming there is some "low hanging fruit" that is projecting shorter ROI periods and can aid drive private investment interest. Data and feedback from participants, indicate that these areas include vehicle connectivity (V2X) technologies, ADAS and off-road services applications.

4 Scale – moving from R&D to deployment: new era with new challenges

Since the first iteration of this analysis a shift in the sector's orientation towards deployments has been observed. This next stage of industry progress is associated with new supply chain challenges on the way to a scaled market. Supply chains in the sector are still forming or immature in nature and currently not in a position to support the load of the eventual move to commercialisation. Organisations are experiencing particular challenges with sourcing vehicles and components to equip their products and services, partially due to the lack of the native OEM/ Tier 1 (or a platform provider) presence in the UK. Currently there is a reliance on Chinese manufacturing capabilities and supply of sensing components that could have ramifications in a fast-changing political climate. While hardware capabilities exist in the UK there is a lack of domestically sourced at scale supply of technical solutions that underpin CAM such as dive-by-wire.

Fostering public acceptance and consumer demand are amongst the upcoming trends that need to be addressed in an environment of unfavourable CAM media coverage. Furthermore, at-pace continued legislative support for industry is seen as a necessary measure to ensure CAM development.

5 Private investment access is a challenge

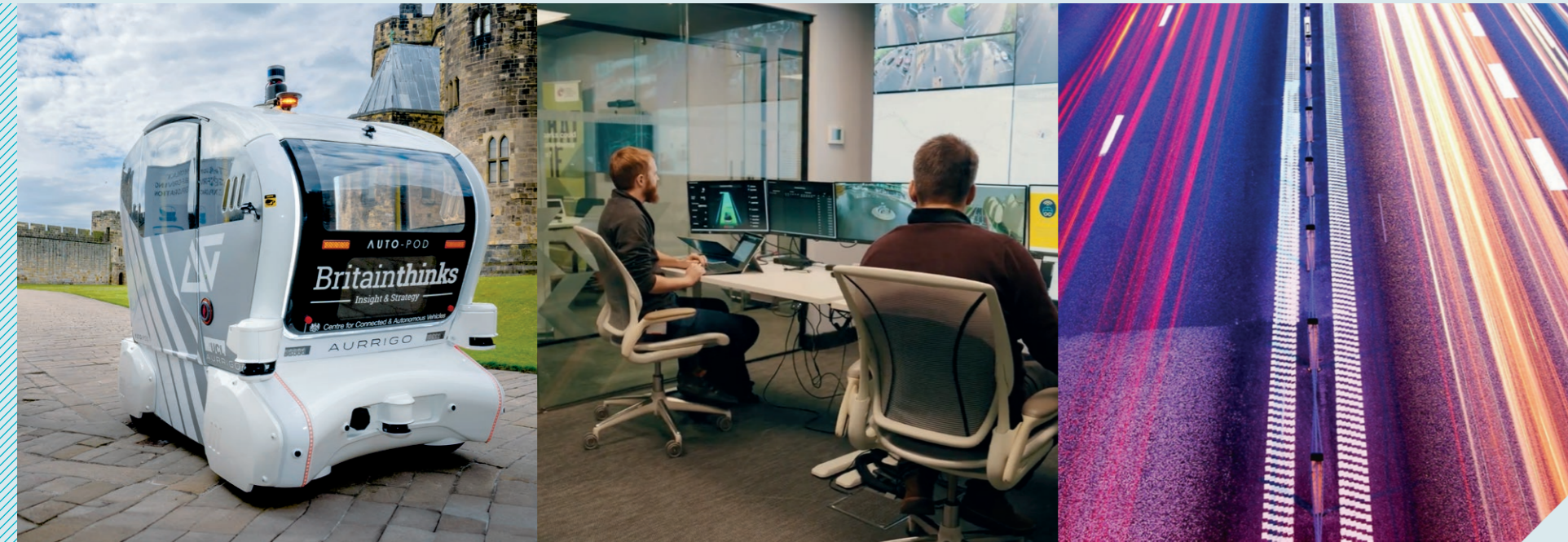
Access to private investment for the UK CAM sector poses a significant challenge due to (i) pressure from the global economic market with high inflation and interest rates coupled with (ii) private investment wanting to see a clear return on investment focusing at scale. However, organisations across the stages of development require investment to scale.

6 Regulation – domestic and global challenges

Regulatory and legislative frameworks are still viewed as a key blocker and potential enabler for the technological development. It is worth noting that the data behind this work was gathered before the announcement of the Automated Vehicles Bill, however, at the time of analysis the UK regulatory topic proved a more complex challenge. Long-term continuous engagement in international standardisation and harmonisation emerge as vital aspects for advancing the UK's proposition on a global level. In the short term, organisations are experiencing significant challenges complying with existing legislation in outsourcing skilled resources from overseas where these are not available domestically.

2022 Core themes – what has changed /

The inaugural work in 2022 produced five core themes relevant to the CAM sector. Now, almost two years later, the progress made is outlined in Table 1.



1 <https://zenzic.io/innovation/deployment/> 2 <https://zenzic.io/innovation/cam-supply-chain-uk/>

Table 1: 2022 Core theme progress

2022 Core theme	Progress
<p>1 Timely, coordinated activities to enable CAM Deployment</p> <p>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. Additional challenges exist in the fragmentation of policy and legislation across different bodies and government departments.</p>	<p>This remains the case in 2023, with the fragmentation of the sector impacting its development. The announcement of the AV Bill in November 2023 illustrates positive progression of CAM regulations.</p>
<p>2 Collaboration will unlock the UK's CAM development potential</p> <p>Collaboration across the sector is needed to improve UK competitiveness and enable leveraging domestic capabilities and expertise. There exists low awareness of skills, knowledge and capabilities between individual organisations within the ecosystem.</p>	<p>Collaboration remains at the heart of the UK CAM sector proposition, exemplified by the CAM Deployment UK¹ and CAM Supply Chain UK² competitions. This work, as well as others, continues to champion awareness across the sector. Industry concerns have tuned to the need for a consolidated UK CAM value proposition with strong visibility overseas.</p>
<p>3 Strong pull from the CAM Operation market</p> <p>A strong market pull is required to move from technology proving stage onto actual market-oriented development. This pull should also be backed up with early procurement commitments from the market to catalyse the development investments needed now.</p>	<p>The UK is in a strong position to be a leader in the race for commercialising CAM. It is important that the UK focuses on high-potential opportunity areas and application use cases to provide real-world services, exemplified by CAM Deployment UK.</p>
<p>4 A knowledge-based industry depends on skilled resources</p> <p>Severe limitations exist in the number of entry level cadres as well as seasoned engineers and experienced hires with the right combination of skills to undertake the volume of CAM development needed. Further in-employment training is required across the CAM supply chain due to existing inefficiencies stemming from limited understanding.</p>	<p>Skills challenges remain the same, with relatively little progress made.</p>
<p>5 Flexible, practical business support for the CAM industry and supply chain (near-term business support)</p> <p>Practical deployment support is needed to accommodate for the high proportion of SMEs that face challenges in long-term commitments to fixed costs as well as CAM-specific deployment requirements such as setting up infrastructure, workshops, staff relocation, etc. To date there has been limited small scale business support for CAM organisations.</p>	<p>Access to private capital is identified as a key blocker for players in all stages of business development, however, early-stage enterprises face additional challenges in lack of peripheral support. A lack of appetite for interaction with SMEs is seen from bigger industry players as well as crucial sector enabling organisations such as consultancies.</p> <p>Additional assistance is needed in this early stage of establishing credibility and recognition for start-ups and SMEs. Such strategic support for industry would help address important barriers in the sector such as the large gap between existing Tier 1/2 manufacturers and small hardware enterprises that are developing CAM specific products.</p>

Source: author generated

CAM Supply chain capabilities and strengths /

Figure 1 provides an overview of the top-level categorisation and capabilities of the UK CAM supply chain. The largest represented categories are **Software** (29), **Engineering Services** (23) and **Research Technology Organisations** (RTOs) (18) excluding the **Other** category. With least representation from **Finance** (4), **Insurance and legal** (6) and **Test Services** (8).

Table 2 highlights the current UK CAM supply chain strengths, as per the 2022 edition, it suggests the greatest strengths lie in areas that are not reliant on significant CAPEX. It shows that strong UK capabilities in CAM lie in **Software** (in particular data, Artificial Intelligence (AI), safety and security), **RTOs**, and categories that rely on knowledge such as **Engineering Services** (including the use of simulation) and the development and design of **Hardware**, in addition to **Insurance and legal services**. Relative to 2022, Hardware design and Engineering Services are now classified as "Strengths" whilst **Tools and Test Services** are now considered "Neutral", in the context of the UK's overall capabilities.

At the opposite end of the spectrum, the manufacturing of **Hardware** is seen as the UK's least strong CAM capability, in terms of vehicle and deployment infrastructure. This speaks to a significant challenge in being able to scale in the manufacturing of CAM **Hardware** in a global

competitive aspect but also leading to practical challenges for companies.

Table 3 shows the areas of opportunity for the UK CAM supply chain. This takes into account the UK's capabilities, competitiveness and growth potential, as well as an indication of the potential for the UK to develop significant business activity in that area. Some opportunities, such as in **Software, RTO** and **Tools**, would seek to maintain and enhance existing UK CAM supply chain strengths whilst others such as **Engineering Services, Communications and Data Infrastructure** and **Operators** have a greater emphasis on driving the UK forward to capitalise on potential growth and impact. For example, the theme of connectivity continues to be seen as an area with both an exciting growth potential and exploitation opportunity. In this edition, **Hardware** design and development has been added to better reflect the component design opportunities for the UK CAM Sector. There continues to be significant, barriers to the scalability of the **Hardware** organisations for manufacturing, such as higher costs in the UK compared to China. This edition also shows that the categories with the lowest proportion of UK headquartered organisations are **Tools** (50%), **Hardware** (54%) and **OEM/Authorised Self-Driving Entity (ASDE)** (55%) which may reflect the categories the UK is less able to influence or leverage.

Test Services have a strong opportunity for their role to increase and become a fundamental building block and enabler in the delivery of safe and secure commercial CAM deployments. However, this research has continued to highlight that it will be important to ensure that the scope of CAM Testbed UK goes beyond the UK domestic market and that they have opportunities to compete on a global scale. It should also be noted that many of these **Test Services** also provide **Engineering Services** or act as **RTOs** – which bolsters the opportunity for these organisations and there is evidence of these organisations redefining themselves into one of these categories instead.

New data within this update demonstrates a great level of uncertainty in terms of the CAM industry's expectations of growth in market value and export. In terms of market value, the greatest relative certainty can be found with the **OEM/ASDE** and **Hardware** categories – perhaps reflecting a greater knowledge of the physical hardware required for CAM technologies. The categories demonstrating highest uncertainty are **Finance, Test Services** and **RTOs**. For export potential, the greatest relative certainty is within the **Communications and Data Infrastructure** and **OEM/ASDE** categories, and most relative uncertainty within **Finance, Test Services** and **Hardware**.

Figure 1: UK CAM capabilities by category 2023



Source: Author generated

Table 2: Current UK CAM supply chain strengths

Strength	Neutral	Challenges
Software (in particular data, AI, safety and security)	Tools (Simulation, test and analysis)	Hardware Manufacturing (including infrastructure for deployment)
RTO (Research and Technology Organisation)	Communications and Data Infrastructure	Finance private investment proving difficult to secure for CAM products and services
Engineering Services	OEM/ASDE* (established & new)	
Hardware (design and development)	Operators	
Insurance and legal*	Test Services	

*ASDE refers to the Authorised Self-Driving Entity as defined in the Law Commission report (2022)
 *Based on traditional strength rather than CAM specific capabilities
 Source: Author generated

Table 3 : Areas of opportunity for the UK CAM supply

Category	Potential UK opportunity	Comments
Software	★★★	In particular data, AI, safety and security
Engineering Services including Test Services	★★★	Build on strength, focus on areas with (exportable) high value knowledge and 'know-how'. Test Services are likely to have a strong role in V&V and the safe deployment of CAM in the UK.
RTOs	★★★	Technology challenges still exist and need to be solved e.g., large scale DBW systems
Hardware (design and development)	★★★	Focus on utilising knowledge and understanding
(New) OEM/ASDE*	★★	Potential opportunity in new vehicle segments rather than existing OEMs/segments. This rating also recognises feedback from industry on the need for organisation that brings the technology together.
Operators	★★	In particular Operators to drive "the pull"
Tools	★★	In particular simulation, test and analysis. Tools sets are important but some challenge in the proportion of UK based Tool organisations.
Communications and Data Infrastructure (connectivity)	★★	Large opportunity for connectivity focused solutions
Insurance and legal	★★	Building on traditional UK strengths
Hardware (niche/ manufacturing)	★	Smaller scale hardware possible, significant challenges to scale. May need to think about critical hardware

*ASDE refers to the Authorised Self-Driving Entity as defined in the Law Commission report (2022)
 Source: Author generated



The path forwards /

Global market & revision of CAM

The UK would benefit from a clear “CAM identity” that outlines the UK CAM sector value proposition on the international stage through focusing on strengths and high-potential opportunity areas and early application use cases to help address crucial challenges and barriers to the sector. This would build on a previous recommendation from the 2022 report, for a long-term CAM strategy to reach deployment - with visible and communicated regulations, etc, sensible lead times, and consistently exploited across somewhat fragmented government departments.

Early commercial opportunities playing out

Early commercial opportunities require practical support, enabling regulation and funding to serve as a way of accelerating commercialisation. Leveraging these opportunities would bring understanding of effective methods to moving the sector at-pace. This would continue to build in a previous recommendation for a strong market pull and compelling use case development.

Scale – moving from R&D to deployment

The UK should continue to support research and technology development for key enabling technology areas – e.g. drive-by-wire or sensing - building up supply chain resilience domestically through interventions and internationally through strengthened relations with global players.

Private investment

It is important that industry, with the support of organisations such as Zenzic, continues to expand and build compelling business case with a clear ROI to help facilitate and attract private investment. The need remains for continued public finance support to de-risk CAM development and deployment. In particular for clear priority use cases and high potential areas.

Regulation

Industry support for primary regulation through the AV Bill and follow-on secondary legislation is critical. In addition, further work is needed to better understand impact of Brexit as well as continued support for future international harmonisation.

In addition, the following recommendation from 2022 remain valid:

CAM skills support

On-the-job training funding, secondment programmes/exchanges funding and academic teaching are some suggestions to explore and enhance the UK CAM supply chain.

1.0 / Project Overview

1.1 Introduction

This study examines current UK CAM supply chain capabilities, its geographic distribution and identifies areas of UK strength and potential opportunities for the UK. This report builds on the 2022 edition (Zenzic, 2022) that created an analytical framework. To aid in the clarity of insights, this project has been tightly bound as such:

In Scope

- Follow up mapping and assessment of the current "state of play" CAM UK supply chain/ecosystem to provide an informed view of the growth in supply chain capabilities.
- Maintain and improve the framework thereby providing greater clarity on the areas of investment, opportunities and UK strengths. Clarity on the areas of investment, opportunities and UK strengths include:
 - o Exploration the strengths of UK capability
 - o Continue to explore the of the CAM sector; identify capabilities required to secure high value UK capability and gaps of capabilities/data.

Out of Scope

- Detailed planning or delivery of follow-on activities and interventions including creation of investment case, project scoping etc.
- Understanding the lessons from other sectors and which sector have the skill and knowledge to pivot into CAM.
- Establishing the linkage between supply chain and early deployment activities
- Analysis of the impact of potential interventions, economic or otherwise



1.2 Objectives and outcomes

Objectives

- Map the progress of growth in UK CAM supply chain capabilities to inform the UK government and industry.
- Maintain and improve the framework, thereby providing greater clarity on the areas of investment, opportunities and UK strengths.
- Maintain and enhance the analysis undertaken using this framework e.g. to understand areas of opportunity for UK based companies or market failures where further government intervention is required to ensure a sustainable UK based CAM supply chain.

Outcomes

This annual work is set to maintain and further the understanding as well as monitor the progress in the state of the UK CAM supply chain - providing a strong holistic view as well as the ability to explore detailed information. Analysis under the framework utilise key sector data to provide an informed view of the changes in landscape and increase the effectiveness of the future interventions. As a result, this enables the sector to understand potential growth and ability to explore and test policy views and future interventions.

This annual work is set to maintain and further the understanding as well as monitor the progress in the state of the UK CAM supply chain

2.0 / Methodology

This updated analysis follows the same method as the previous study – outlined in Section 2 of the 2022 report (Zenzic, 2022). The insights for this work are generated from a combination of a detailed survey and interviews of organisations within the UK CAM sector as illustrated by Figure 2.1.

The previous survey was updated for this iteration and ran from 06 September to the 31 October 2023, with interviews taking place at the same time - the full list of survey questions can be found in Appendix 1. The project aimed to conduct 30 interviews as well as survey up to 100 organisations across the UK CAM sector.

Figure 2.1: Insights generation process



Table 2.1: Top-level CAM supply chain categories

Category
RTO (Research and Technology Organisation)
Finance
Tools
Hardware
Software
OEM/ASDE*
Engineering Services
Test Services
Communications and Data Infrastructure
Operators
Insurance and legal
Other

*ASDE refers to the Authorised Self-Driving Entity as defined in the Law Commission report (2022)
Source: Author generated

The UK CAM supply chain survey focused on three areas:

- 1 About the organisation**
 Captured key information regarding UK operational geography, size of organisations and CAM related activities.
- 2 Their role in the UK CAM supply chain**
 i.e. types of customers
 Details around who and what type of organisations use their products and/or services.
- 3 Their CAM supply chain requirement**
 i.e. their needs
 Details around who and what type of organisations supply them with products and/or services.

3.0 / Categories and framework

3.1 Categories

As previous, as part of the detailed data gathering, respondents were allowed to select a primary top-level category as well as a secondary category thus capturing a truer representation of UK CAM capabilities. Table 3.1 shows full list of top-level and respective sub-categories with full descriptions for each in Appendix 2.

Hardware represents the physical components that are use within CAM related technologies – the list of sub-categories focused on the most CAM related components.

Software is split into five main areas – mapping & path planning, control systems, connectivity/V2X, HMI software and data & cyber security – which represent the critical software elements of CAM technologies.

Engineering Services contain traditional automotive vehicle development services as well as more CAM related activities such as simulation and safe case/auditing.

Finance is split between public and private funding streams.

Research and Technology Organisations sub-categories align with the definitions developed by the Department for Business Innovation and Skills in 2015 (BIS, 2015).

Test Services reflect the different environments found within the comprehensive testing facilities of CAM Testbed UK (CAM Testbed UK, 2022).

Tools represent the main toolsets utilised for the development and deployment of CAM technologies and services e.g., simulation software or testing tools such as crash test soft targets.

Operators and the OEM/ASDE categories both represent the main use cases/deployment domains expected for CAM technologies.

Insurance and legal also includes regulator/consumer testing in addition to the expected sub-categories.

Communications and Data Infrastructure not only includes communication infrastructure sub-categories but also includes data/web services that support the processing and storage of the vast amount of data generated by CAM technologies.

Finally, **Other** category captures organisations that do not fit into one of the main categories e.g., consultancies or EV charging infrastructure.

Table 3.1: Top-level CAM supply chain categories and sub-categories

Top level category	Sub-categories
Hardware	Cameras / RADAR / LIDAR / Onboard Mapping Hardware / Odometry sensors / Ultrasonic sensors / Sensor supporting hardware / Embedded controls hardware / Passive control systems and computing components / ECU hardware / Other electronic & architecture / V2X equipment / Cyber secure modem / Safety related HMI hardware / Localisation hardware / Drive by wire / GNSS and IMU / Powertrain/propulsion hardware / Actuators
Software	Mapping & path planning / Control systems / Connectivity and cybersecurity / HMI software / Data & cyber security
Engineering Services	Vehicle development / Simulation / Security / Infrastructure / Safety cases/auditing / Other services
Finance	Private funding e.g. VC / Public funding body
Research and Technology Organisation	Academic Institution / Research organisation / Public Sector Research Establishments' (PSREs) / Public Research Organisations (PROs) / Other RTO i.e. Catapults
Test Services	Controlled environment / Semi-controlled environment / Public environment / Other - please specify
Tools	Simulation / Testing / Other – please specify
Operators	Passenger Transit / Freight & Logistics / Last mile delivery / Highway Authority / Personal mobility
Insurance and Legal	Insurance / Legal / Regulatory/Consumer testing
Communications and Data Infrastructure	Data/web services / Communication infrastructure / Mapping /geospatial
OEM/ASDE	Passenger Transit / Long-haul freight (>10km) / Short-range deliveries (<10km) e.g last mile / Personal mobility

Source: Author generated



3.2 Analytical framework

The conceptual flow and linkages between the top-level categories remain unchanged from 2022 – as shown in Figure 3.1. Unlike traditional automotive supply chains, the top of a CAM deployments chain is the **Operator** (as opposed to an OEM) which in turn is fed by the **Communications and Data Infrastructure, OEM/ASDE** and **Finance** categories. Interestingly, the **OEM/ASDE** tends to be supplied by a Tier 1/ADS platform (that combines **Software, Engineering Services** and **Hardware** into a compelling offering), as well as flows from **Tools, Test Services, Insurance and Legal** and **Engineering Services** – usually with a Tier 1 or a platform provider being the focal point for the consolidation of the core CAM technology.

3.3 Data

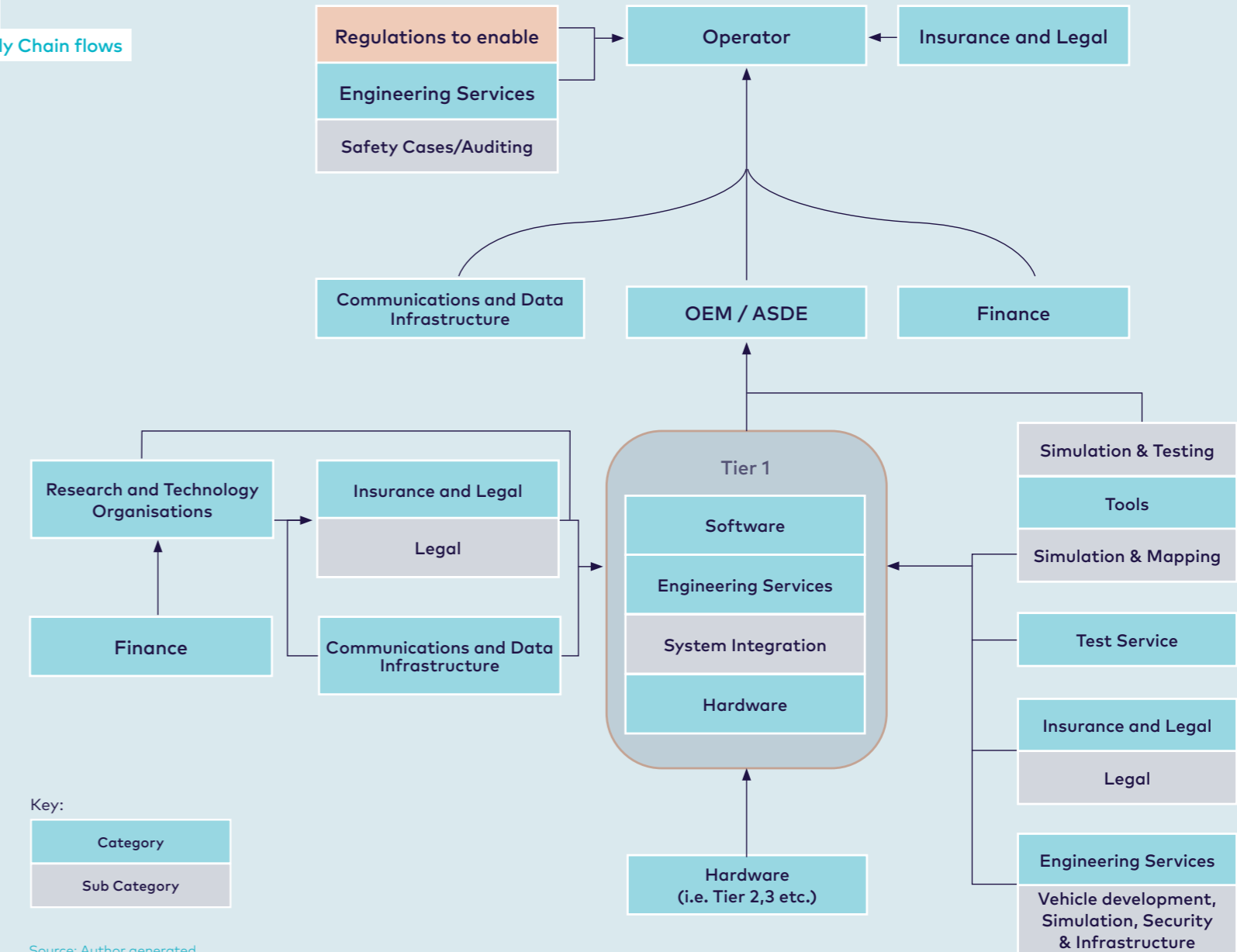
The analytical framework is designed to allow the generation of insights to support strategic decision making and to allow for continued and repeated analysis in the future. Data point gathered from the 2022 remain the same but with the removal of the core skills question (as this is addressed by other UK Automotive Council research) and this addition of the questions relating the HQ location of an organisation, market value and export potential estimates. As such the main and new data variables gathered and explored through this analysis are shown in Table 3.2.

Table 3.2: Key data explored in the 2023 CAM Supply Chain study

Original data	New data
Geographic distribution of UK CAM activity	Location of the organisation's HQ
Top-level (primary & secondary) category and sub-categories	Estimates for market value for now, 2030 and 2035
Size of organisation as well as CAM related activities (personnel and turnover)	Estimates for export potential for now, 2030 and 2035
Categories of organisation they supply products and/or services to	
Proportion of those they supply that are UK based (%)	
Categories of organisation that they are supplied by	
Proportion of supplier organisation that are UK based (%)	
View on UK competitiveness	
Estimates in growth percentages for CAM related activities in the UK (personnel and turnover)	

Source: Author generated

Figure 3.1: CAM Supply Chain flows



Source: Author generated

4.0 / Key findings

4.1 2022 core theme progress

The inaugural work in 2022 produced five core themes relevant to the CAM sector. Now, almost two years later, this update is able to shed light on the progress made – as shown below and in Table 4.1 – as well as illuminating new emerging themes as the UK CAM sector develops. The key shifts in these trends have been:

Fragmentation of sector development impacting commercialisation on the global stage

Shift in Themes 1 and 2

The early stages of CAM market development and establishing capabilities in siloed pockets is seen as an inhibitor to a strong market proposition on the global scale. As outlined in Table 4.1 collaboration is a driving factor to enable at pace technology development with industry concerns tuning to the need for a consolidated UK CAM value proposition with a strong visibility overseas.

Focusing down from broad sector development to specific areas/use cases

Shift in Theme 3

Since the last iteration of this work, the awareness of global market trends and international positioning has increased leading to demand for prioritisation of technology implementation. As can be seen in Figure 4.4 the UK is in a strong position to be a leader in the race for commercialising CAM, however, due to inherent strengths and challenges an effective pursuit of sector acceleration is sought through focusing on specific high-potential opportunity areas and application use cases to provide real-world services, exemplified by CAM Deployment UK. Leveraging and supporting CAM technologies with nearer ROI would be beneficial in evidencing the sector business case to enable wider industry's access to funding streams.

Different strategic support needed to bridge gaps between stages of industry development

Shift in Theme 5

While support and direction from regulatory framework formulation is required at a sector level the practical support needs of organisations across the different stages of development vary greatly. As will be discussed in Section 4.2 below access to private capital is identified as a key blocker for players in all stages of business development, however, early-stage enterprises face additional challenges in lack of peripheral support. A lack of appetite for interaction with SMEs is seen from bigger industry players as well as crucial sector enabling organisations such as consultancies. Additional assistance is needed in this early stage of establishing credibility and recognition for start-ups and SMEs. Such strategic support for industry would help address important barriers in the sector such as the large gap between existing Tier 1/2 manufacturers and small hardware enterprises that are developing CAM specific products.

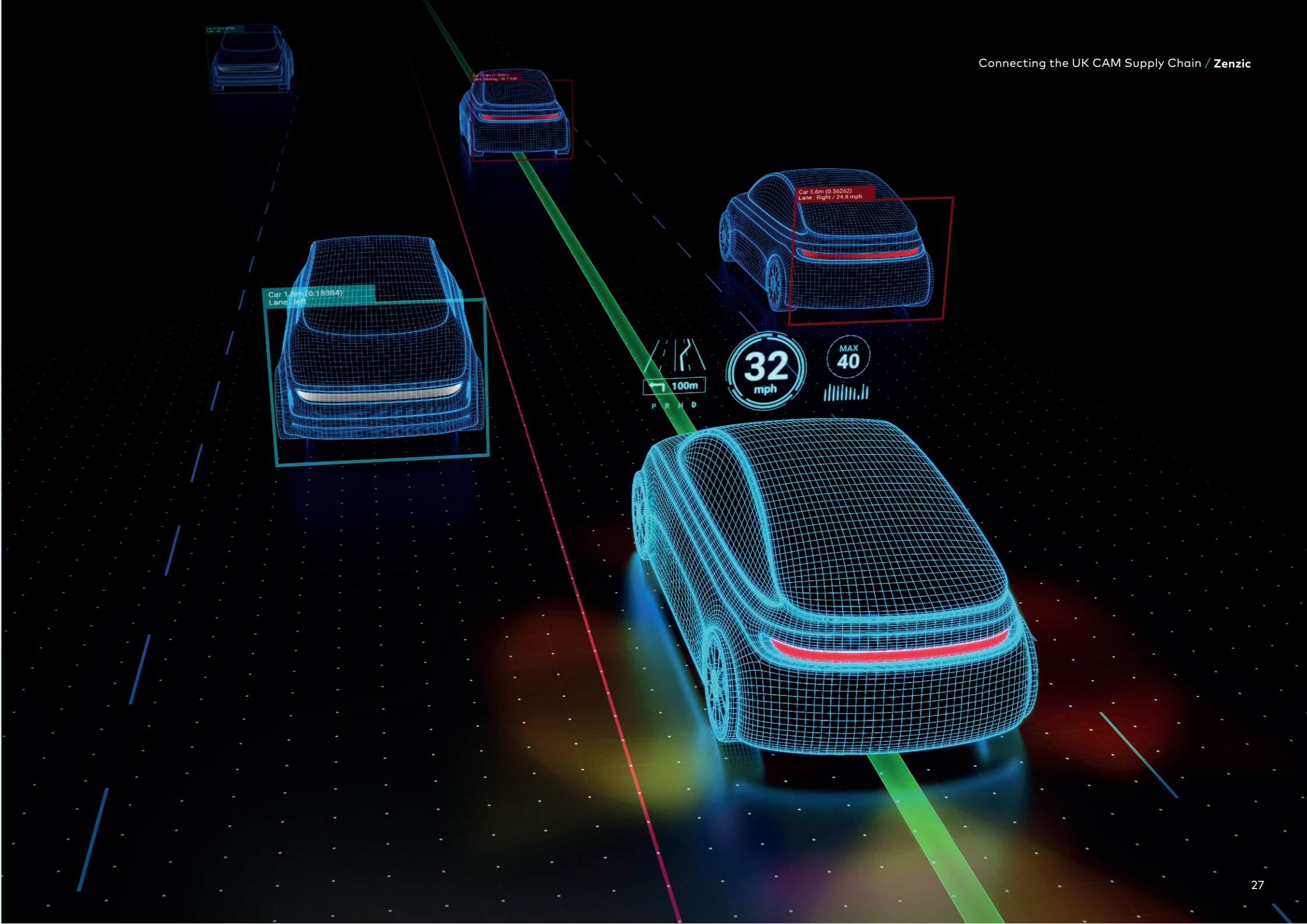
The UK is in a strong position to be a leader in the race for commercialising CAM



Table 4.1: 2022 Core theme progress

2022 Core theme	Progress
<p>1 Timely, coordinated activities to enable CAM Deployment</p> <p>The UK CAM requires a clear and consolidated vision for the development and implementation of regulatory measures to enable the sector and the deployment of technology. Additional challenges exist in the fragmentation of policy and legislation across different bodies and government departments.</p>	<p>This remains the case in 2023, with the fragmentation of the sector impacting its development. The announcement of the AV Bill in November 2023 illustrates positive progression of CAM regulations.</p>
<p>2 Collaboration will unlock the UK's CAM development potential</p> <p>Collaboration across the sector is needed to improve UK competitiveness and enable leveraging domestic capabilities and expertise. There exists low awareness of skills, knowledge and capabilities between individual organisations within the ecosystem.</p>	<p>Collaboration remains at the heart of the UK CAM sector proposition, exemplified by the CAM Deployment UK and CAM Supply Chain UK competitions. This work, as well as others, continues to champion awareness across the sector. Industry concerns have tuned to the need for a consolidated UK CAM value proposition with strong visibility overseas.</p>
<p>3 Strong pull from the CAM Operation market</p> <p>A strong market pull is required to move from technology proving stage onto actual market-oriented development. This pull should also be backed up with early procurement commitments from the market to catalyse the development investments needed now.</p>	<p>The sector needs to focus on clear use cases to provide this market pull</p>
<p>4 A knowledge-based industry depends on skilled resources</p> <p>Severe limitations exist in the number of entry level cadres as well as seasoned engineers and experienced hires with the right combination of skills to undertake the volume of CAM development needed. Further in-employment training is required across the CAM supply chain due to existing inefficiencies stemming from limited understanding.</p>	<p>Skill challenges remain the same, with relatively little progress made.</p>
<p>5 Flexible, practical business support for the CAM industry and supply chain (near-term business support)</p> <p>Practical deployment support is needed to accommodate for the high proportion of SMEs that face challenges in long-term term commitments to fixed costs as well as CAM-specific deployment requirements such as setting up infrastructure, workshops, staff relocation, etc. To date there has been limited small scale business support for CAM organisations.</p>	<p>A variety of strategic support is required to help overcome the challenges the CAM sector faces.</p>

Source: Author generated



4.2 2024 Core Themes

In addition to the progress that has been made on the 2022 core themes, new emerging themes have been drawn out from the new interview and survey responses.

1 A global CAM market

The International Connected and Automated Mobility Landscape report (2023) authored by Zenzic provides a comprehensive overview of the global trends of the emerging market as well as positioning of key international players in the race for commercialisation. The analysis under this work resonates with its core theme of need for strategic global UK positioning. To leverage its strong position the UK needs to maintain momentum by focusing on the inherent strengths and support high value opportunities that would give it the strong competitive advantage in a rapidly evolving international market.

The UK CAM roadmap to 2035 (Zenzic, 2023b) update identified six areas in which the UK could create value through the development and exploitation of products services and solutions. Four of these are deployment use cases and the remaining two are Data & Infrastructure and V&V Assurance Services.

The UK CAM roadmap to 2035 (Zenzic, 2023b) update identified six areas in which the UK could create value through the development and exploitation of products services and solutions.

2 Revision of CAM approach

A continuous trend of sector consolidation has become apparent with industry taking a pause to re-evaluate future strategies and priorities. The impact of recent global events such as the COVID-19 pandemic, growing inflation and cost increase have led to a compressed but more focused and targeted investment in R&D. Consensus is rising around CAM's emergence from the inflated expectations and going through the process of demystifying the technology and now having the chance to move onto addressing crucial challenges and barriers to the sector.

3 Early commercial opportunities playing out

Private capital access remains a challenge for CAM organisations of all sizes with near-term opportunities being prioritised. While the sector proposition is in the early stages of forming there are some "low hanging fruit" that is projecting shorter ROI periods and can aid drive private investment interest. Data and feedback from participants, indicate that these areas include vehicle connectivity (V2X) technologies, ADAS and off-road services applications partly due to lower impedance from regulatory changes and direct productivity benefits.

4 Scale – moving from R&D to deployment: new era with new challenges

Since the first iteration of this analysis a shift in the sector's orientation towards deployments has been observed. This next stage of industry progress is associated with new supply chain challenges on the way to a scaled market. Supply chains in the sector are still forming or immature in nature and currently not in a position to support the load of the eventual move to commercialisation. Organisations are experiencing particular challenges with sourcing vehicles and components to equip their products and services, partially due to the lack of the native OEM/ Tier 1 (or a platform provider) presence in the UK. Currently there is a reliance on Chinese manufacturing capabilities and supply of sensing components that could have ramifications in a fast-changing political climate. While hardware capabilities exist in the UK there is a lack of domestically sourced at scale supply of technical solutions that underpin CAM such as drive-by-wire.

Looking ahead to deployment of CAM technology there are other contributing factors that are emerging as potential challenges to industry of scale. Fostering public acceptance and consumer demand are amongst the upcoming trends that need to be addressed in an environment of unfavourable CAM media coverage – also reflective of global trends (Zenzic, 2023). The safety and reliability of technology that underpins public confidence and enables sector prosperity is to be of the key concern for the forthcoming primary regulatory framework. Furthermore, at-pace continued legislative support for industry is seen as a necessary measure to ensure CAM development.

5 Private investment access is a challenge

Access to private investment for the UK CAM sector poses a significant challenge due to (i) pressure from the global economic market with high inflation and interest rates coupled with (ii) private investment wanting to see a clear return on investment focusing at scale. However, organisations across the stages of development require investment to be able to scale. Moreover, there is a growing pool of up-and-coming competing hubs, historically less competitive in innovation activity, but on the rise from Europe such as Amsterdam and Stockholm, potentially diverting international capital away from the UK.

6 Regulation – domestic and global challenges

Regulatory and legislative frameworks are still viewed as a key blocker and potential enabler for the technological development. It is worth noting that the data behind this work was gathered before the announcement of the AV Bill (HM Government, 2023) , however, at the time of analysis the UK regulatory topic proved a more complex challenge. Long-term continuous engagement in international standardisation and harmonisation emerge as vital aspects for advancing the UK's proposition on a global level. In the short term, on the other hand, organisations are experiencing significant challenges complying with existing legislation in outsourcing skilled resources from overseas where these are not available domestically.

4.3 UK CAM supply chain overview

The data explored within the project came from one of three sources (1) responses to the new survey (2) a 1:1 interview or (3) additional organisations identified based on resources such as the UK CAM Roadmap to 2035 (Zenzic, 2023b)³. Some 2022 survey data was also reused where possible.

Organisations self-categorise and reflect where they see themselves within the UK CAM supply chain (with some data cleaning reallocating a handful of organisations). Table 4.2 breaks down the 349 organisations identified within the UK CAM supply chain by top-level (primary) category – an increase of 99 compared the 2022 study. This change in the number of identified organisations is reflective of a greater reach of this study and does not necessarily suggest sector growth.

The categories with the largest representation are **Software** (69), **Hardware** (43), **OEM/ASDE** (42) and **Engineering Services** (39) and whereas **Test Services** (8), **Finance** (9) and **Tools** (21) had fewest organisations. **Test Services** appears to be the only category with less organisations than last year, this appears to be due to the reallocation of activities within **RTO** and **Engineering Services** categories.

Table 4.2: CAM organisation by primary category and source

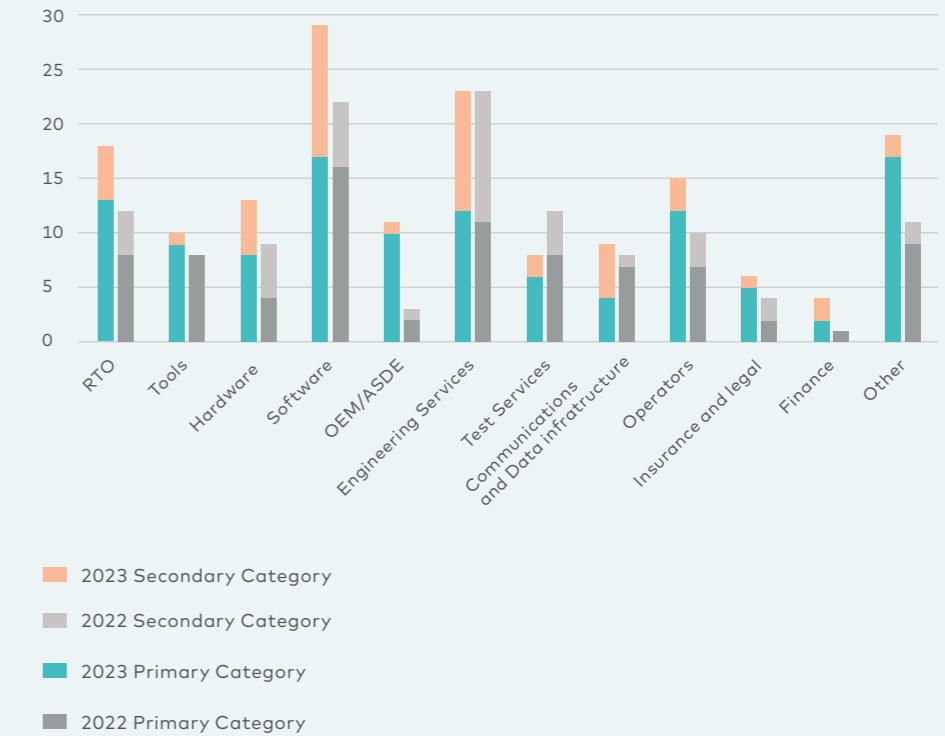
Category	Additional	Interviews	Survey Responses	Total	Change from 2022*
RTO (Research and Technology Organisation)	10	3	10	23	-
Tools	12	4	5	21	+8
Hardware	35	2	6	43	+21
Software	52	4	13	69	+23
OEM/ASDE	32	4	6	42	+15
Engineering Services	27	3	9	39	+1
Test Services	2	1	5	8	-2
Communications and Data Infrastructure	19	0	4	23	+4
Operators	13	5	7	25	+5
Insurance and legal	17	1	4	22	+8
Finance	7	2	0	9	-
Other	8	1	16	25	+16
Grand Total	234	30	85	349	+99

*This is the change in the number of identified organisations and not reflective of sector growth
Source: Author generated

³ The additional organisation identified were categorised by the project delivery team at a primary category level. No additional data was recorded beyond this categorisation

Some caution should be used when drawing conclusions from this full list of organisations as the level of involvement, maturity and size of the organisation within CAM is not known. As such, Figure 4.1 provides a stronger representation of the UK CAM capabilities, showing the breakdown of organisation when primary and secondary top-level categories are combined within the detailed data; now the largest represented categories are **Software** (29), **Engineering Services** (23) and **RTOs** (18) excluding the **Other** category. With least representation from **Finance** (4), **Insurance and legal** (6) and **Test Services** (8). It is interesting to note that **Engineering Services**, **Finance** and **Communication and Data Infrastructure** have approximately 50% split between primary and secondary categories, suggesting that these capabilities cut across other categories within the UK CAM supply chain.

Figure 4.1: CAM capabilities within the detailed data (primary and secondary) by category



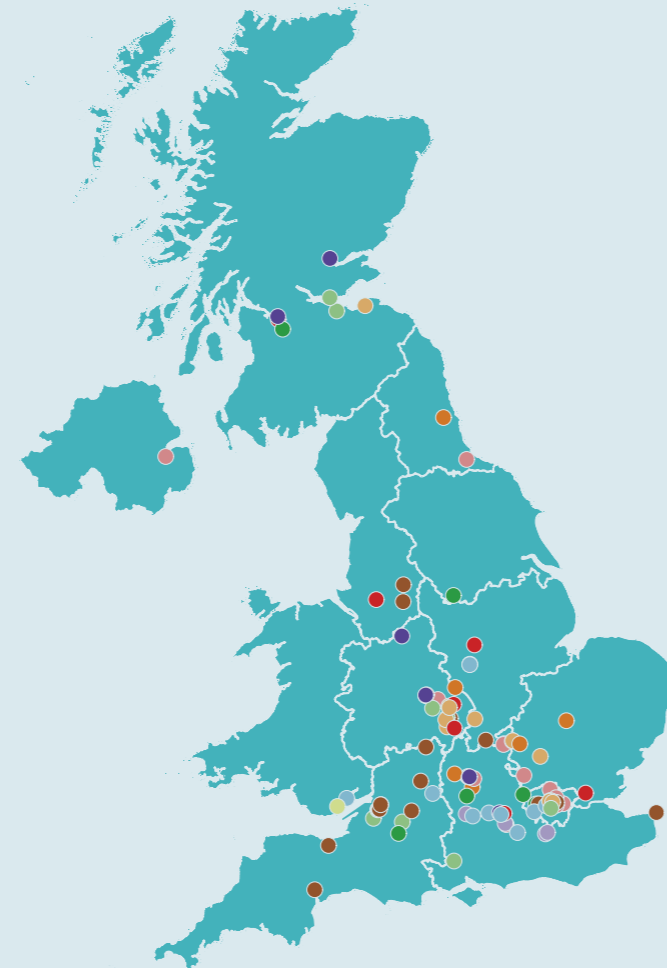
Source: Author generated



Figure 4.2:
Map of main UK locations by primary category

High-level Category

- RTO (Research and Technology Organisation)
- Finance
- Tools
- Hardware
- Software
- OEM/ASDE
- Engineering Services
- Test Services
- Communications and Data Infrastructure
- Operators
- Insurance or Legal
- Other



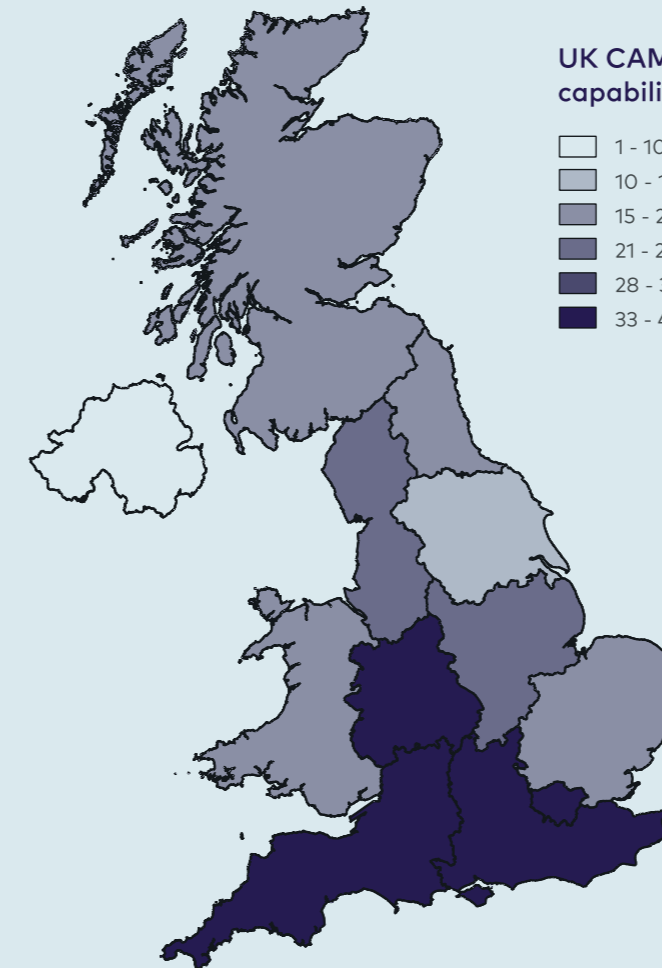
Figures 4.2 and 4.3 shows the geographic distribution of identified organisations within the CAM supply chain. Both figures show a concentration of activity in the South East, West Midlands, London and the South West. Compared to 2022, regions where additional organisations have been identified are Scotland and the South West of England. Figure 4.2 represents the main location of organisation's UK activity whereas Figure 4.3 represent the distribution of all CAM organisation capabilities across the UK – for example, an organisation may have its primary based of operations in London (this would be shown in Figure 4.2) but may operate in additional regions such as the South East or South West England (this would be shown in Figure 4.3).

Source: Author generated.
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Figure 4.3:
Distribution of UK CAM organisation by regional capabilities across the UK

UK CAM organisational capability by region

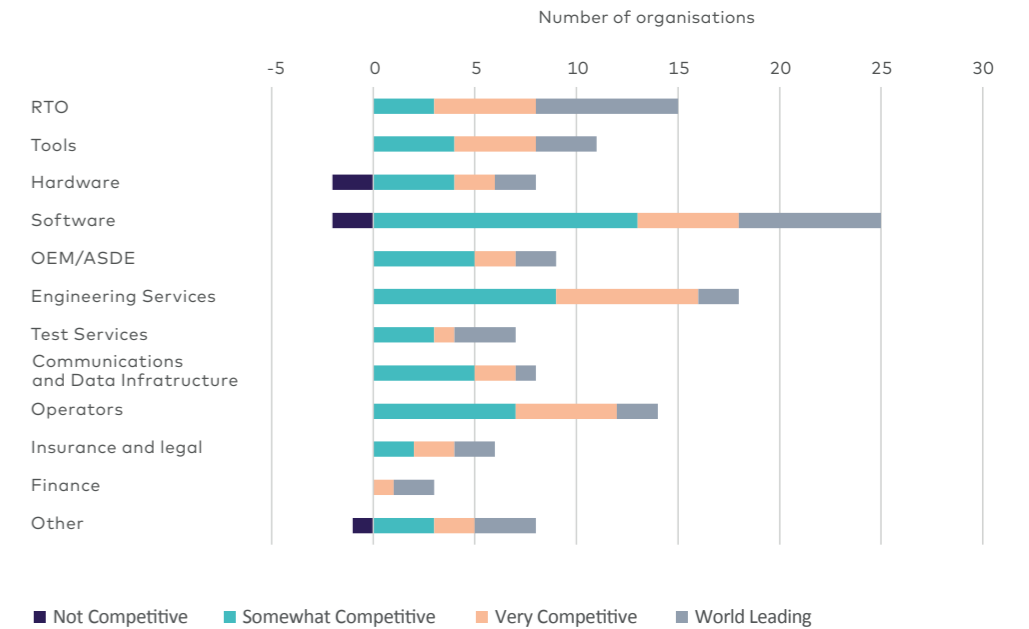
- 1 - 10
- 10 - 15
- 15 - 21
- 21 - 28
- 28 - 33
- 33 - 45



Source: Author generated.
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Organisations' views on the competitiveness of the UK are largely unchanged from 2022 - as shown in Figure 4.4. This update reinforces the fact that the UK CAM supply chain is strong in **Software, Engineering Services, RTOs** and **Tools**. Interestingly, **Hardware, Software** and **Other** are only categories for which any respondents indicated that the UK was not competitive - the reasoning behind this difference of opinion warrants further study.

Figure 4.4:
View on UK competitiveness by primary category



■ Not Competitive ■ Somewhat Competitive ■ Very Competitive ■ World Leading

4.4 UK strengths and challenges

As with the 2022 edition of this research, this work indicates that the UK CAM supply chain strengths lie in areas that are not reliant on significant CAPEX. Table 4.3 shows the UK CAM strengths as identified by the project. This is based on in-depth interviews, views on UK competitiveness, and growth potential for the UK CAM supply chain (people, turnover, market value and export potential).

It shows that strong UK capabilities in CAM lie in **Software** (in particular data, AI, safety and security), **RTOs**, and categories that rely on knowledge such as **Engineering Services** (including the use of simulation) and the development and design of **Hardware**, in addition to **Insurance and legal services**⁴. At the opposite end of the spectrum, participants viewed the manufacturing of **Hardware** as the UK's least strong area of CAM both in terms of vehicle and deployment infrastructure. This speaks to a significant challenge in being able to scale in the manufacturing of CAM **Hardware** both in a global competitive aspect but also with some practical challenge in companies being able to scale. Relative to 2022, **Hardware** design and **Engineering Services** have moved up into the "Strength" bucket whilst **Tools** and **Test Services** have moved into the neutral bucket due to the relative commercial outlook.

Private **Finance** continued to be a category in which it was a challenge to gather data. However, as outlined in Section 4.2, there are significant challenges for the CAM sector in securing private funding streams. Despite this the UK has a relatively strong public financing system via government (local and national) competitions (and Innovate UK programmes).

There is embedded strength within **Communications and Data Infrastructure** for example in traditional vehicle development or with communication infrastructure respectively however interviewees and survey responses indicate that this potential for CAM has yet to be fully leveraged in the UK.

Table 4.3: Current UK CAM supply chain strengths

Strength	Neutral	Challenges
Software (in particular data, AI, safety and security)	Tools (Simulation, test and analysis)	Hardware manufacturing (including deployment infrastructure)
RTO (Research and Technology Organisation)	Communications and Data Infrastructure	Finance - private investment proving difficult to secure for CAM products and services
Engineering Services	OEM/ASDE (established & new)	
Hardware (design and development)	Operators	
Insurance and legal*	Test Services*	

Source: Author generated

*Backed by strong research/engineering skills

*Based on traditional strength rather than CAM specific capabilities

⁴ This is mainly based on traditional UK strengths rather than CAM specific insurance and/or legal activities

4.5 Areas of opportunity for the UK

Based on the core themes, interviews and survey data, Table 4.4 shows the areas of opportunities for the UK CAM supply chain as well as an indication for the size of the potential for the UK to develop a significant and commercially attractive business activity in that area. It should be noted that this does not necessarily mean that these areas require government intervention. The size of the potential has not been quantified (although some estimates are provided in Section 4.6) as this is out of scope for this project. A category has been deemed to be an opportunity area through a combination of:

- 1 The strength of the capability within the UK**
(i.e. UK presence, number of organisations etc)
- 2 UK competitiveness**
- 3 Potential growth**
(personnel and turnover)
- 4 Market value and export potential data**
- 5 Feedback from the interviews and surveys**

Table 4.4: Areas of opportunity for the UK CAM supply chain

Category	Potential UK opportunity	Comments
Software	★★★	In particular data, AI, safety and security
Engineering Services including Test Services	★★★	Build on strength, focus on areas with (exportable) high value knowledge and 'know-how'. Test Services are likely to have a strong role in V&V and the safe deployment of CAM in the UK.
RTOs	★★☆	Technology challenges still exist and need to be solved e.g., large scale DBW systems
Hardware (design and development)	★★☆	Focus on utilising knowledge and understanding
(New) OEM/ASDE	★★	Potential opportunity in new vehicle segments rather than existing OEMs/segments. This rating also recognises feedback from industry on the need for organisation that brings the technology together.
Operators	★★	In particular Operators to drive "the pull"
Tools	★★	In particular simulation, test and analysis. Tools sets are important but some challenge in the proportion of UK based Tool organisations.
Comms and data infra (connectivity)	★★	Large opportunity for connectivity focused solutions
Insurance and legal	★★	Building on traditional UK strengths
Hardware (niche/ manufacturing)	★	Smaller scale hardware possible, significant challenges to scale. May need to think about critical hardware

Source: Author generated

Software

This is seen as a strong area of opportunity for the UK CAM supply chain; in particular data, AI, safety and security building on the current strengths that exist. The data indicates that there is strong expertise and growth potential for UK based organisations.

Engineering Services

The UK CAM supply chain has a strong presence of **Engineering Services** and this speaks to generation of strong (often digital) knowledge and “know-how” for CAM development. The use of simulation in particular came out strongly as an area of opportunity from the interviews and surveys. There appears to be strong growth potential for the UK in this category.

RTOs

Feedback from participant clearly show that the CAM sector still requires fundamental, as there are many technological challenges that remain. For example, the design and manufacturing of suitable redundant drive-by-wire systems for larger sized automated vehicles (such as bus). **RTOs** are seen as an importance part of research and development of CAM technologies and UK CAM supply chain.

Hardware (design and development)

Closely linked to the opportunity presented by **Engineering Services**, there is a clear opportunity in the design and development of hardware technologies, e.g. RADAR sensors, by leveraging the knowledge and expertise within the UK.

(New) OEM/ASDE

Whilst the UK is limited on traditional automotive OEM, there is an opportunity for the UK CAM supply chain to establish new **OEM/ASDE(s)** in innovative/disruptive use cases. Feedback from participants suggested that there is a growing industry need for organisations that are able to pull together core CAM technologies, whether that be an OEM or a Tier 1 like platform provider. There remains a strong growth potential in this category although challenges remain to be able to unlock this potential.

Operators

Seen as a critical part to enable the “pull” operators are an important element of the UK CAM supply chain as the UK moves away from demonstrations and trials to more early deployment initiatives. It remains the case that that the Highway Authorities, one aspect of operators, would benefit for additional support to foster solutions that use CAM innovations.

Tools

The importance of simulation for the development, testing, analysis and ultimately certification of CAM technologies was articulated strongly during the interviews. Many of the largest toolset providers with the UK are not headquartered within the UK (see section 4.6). Whilst, the UK has an opportunity to build on its simulation and testing strength it does remain seen as to how UK organisation can compete with existing tools.

Communications and Data Infrastructure

The lack of focus on the “C” part of “CAM” continues to be a theme that ran through the interviews as well as survey data with the sentiment being that the UK CAM market has yet to tap in the benefits of connectivity proper. There is a suggestion that several “quick wins” could come in the form of capitalising on relatively strong connectivity capabilities – reinforced by data shown within Section 4.6 that consistency shows the clear growth potential of this category.

Insurance and legal

As the UK has shifted focus towards supporting the development of commercial deployments, the sectors has started to see the inherent strength of these sectors in the UK starting to show within the UK CAM sector. However, previous research has shown that insurance market is not yet ready for the mass roll out of CAM technologies (Zenzic, 2023), as such much work remains to ensure the insurance sector can properly support the application of CAM technologies.

Test Services

These services are expected to have a clear and important role in the testing and certification of CAM technologies so their contribution to the CAM supply chain is critical. However, this does seem to suggest that it may be limited in scope beyond the serving the UK domestic market. These **Test Services** also provide **Engineering Services** or act as **RTOs** – which bolsters the opportunity for these organisations reinforcing the importance of **Test Services** as critical part of the UK CAM supply chain.

Niche hardware (manufacturing)

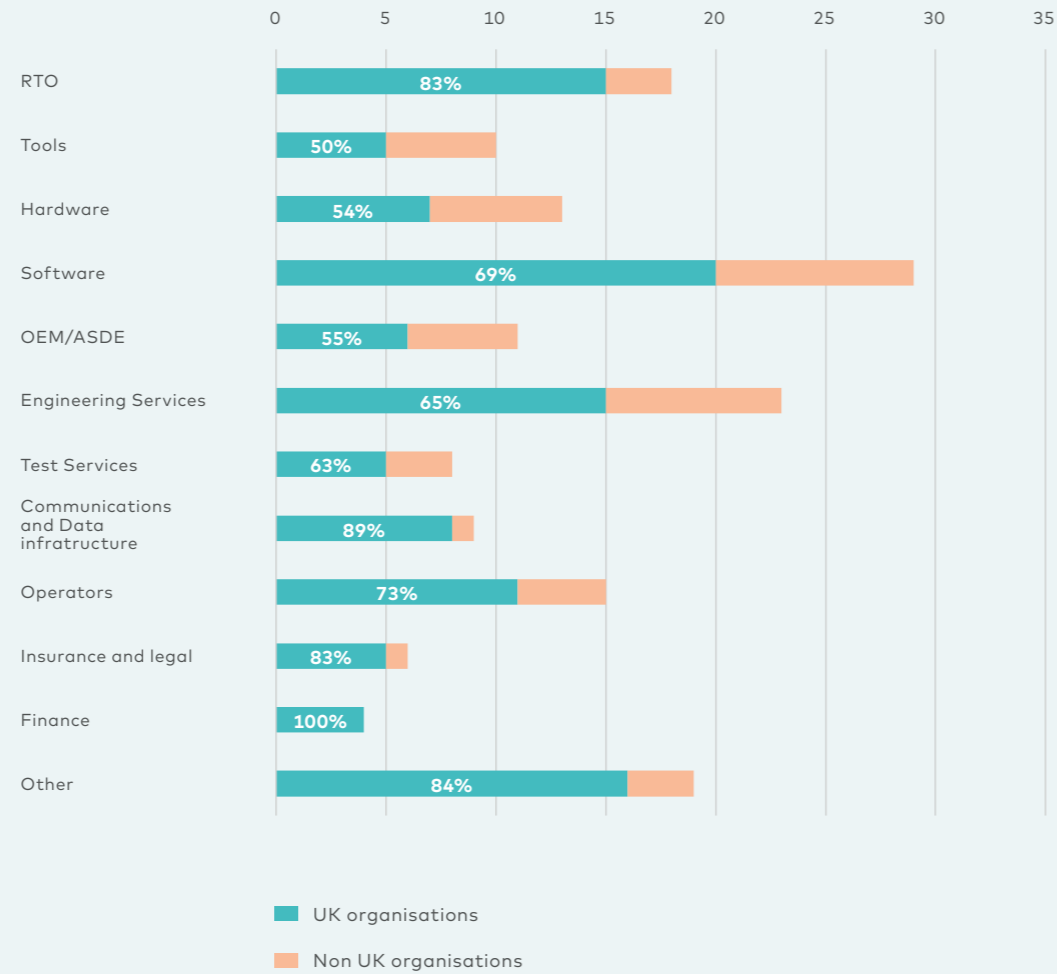
Data from this update reinforces the fact that there are significant, and arguably insurmountable, barriers to the scaling of the **Hardware** organisations in terms of manufacturing e.g. higher costs in the UK than compared to other regions such as China. As such, the opportunity for the UK is to develop niche or critical components and not in the large-scale production of hardware components.



4.6 Category-level data summary

As outlined in Section 3.3, this year's iteration of the research explored several new data points. The first of which is the location of an organisation's HQ. Figure 4.5 shows the split by category of whether organisations are headquartered within the UK. The categories with the lowest proportion of UK headquartered organisations are **Tools** (50%), **Hardware** (54%) and **OEM/ASDE** (55%) which may reflect the categories for the UK is less able to influence or leverage. On the other hand, excluding the **Finance** category due to the small sample size, **Communications and Data Infrastructure** (89%), **Insurance and legal** (83%) and **RTO** (83%) have the greatest proportion of UK HQ'd organisations.

Figure 4.5: UK HQ based organisations distribution by category



Source: Author generated

Table 4.5 shows the percentage of responses classified as unknown by respondents to the questions about Market Value and Export Potential, across all the categories this table indicates a large amount of uncertainty in market and export potential growth. In terms of market value, the greatest relative certainty can be found with the **OEM/ASDE** (30% unknown) and **Hardware** (41%) categories – perhaps reflecting a greater knowledge of the physical hardware required for CAM technologies and the most relative uncertainty being Finance (92%), **Test Services** (75%) and **RTOs** (74%). For export potential, the greatest relative certainty is within the **Communications and Data Infrastructure** (0%) and **OEM/ASDE** (10%) categories, and most relative uncertainty within **Finance** (75%), **Test Services** (63%) and **Hardware** (62%).

Table 4.5: Percentage of responses classified as unknown by respondents to the questions about Market Value and Export Potential.

Category	Market Value % unknown	Export Potential % unknown
RTO	74%	46%
Tools	60%	57%
Hardware	41%	62%
Software	56%	39%
OEM/ASDE	30%	10%
Engineering Services	48%	38%
Test Services	75%	63%
Communications and Data Infrastructure	48%	0%
Operators	73%	42%
Insurance and legal	67%	56%
Finance	92%	75%
Other	56%	37%

Source: Author generated



Caution must be taken with inferring too much from these figures, given some relatively small sample sizes, However, there are some additional trends that can be explored that give an indication of areas of opportunity and value. Figures 4.6 and 4.7 show the average organisational value per category for Market Value and Export Potential respectively. Whilst the precise figures are estimate, there are some interesting trends. Figure 4.6 indicates an expectation of steady growth in value for all categories from present day to 2035. The categories that have the highest average organisations value are **Hardware, Software, OEM/ADE** and **Operators** with a the most rapid growth appearing to be in **Communication and Data Infrastructure**. Figure 4.7 tell a slightly different story with many categories (**Tools, Hardware, Software, OEM/ASDE, Communication and Data Infrastructure and Operators**) all appearing to indicate a large jump in export potential between now and 2030 – which could suggest areas of potential early growth for the UK.

Figure 4.6: Average Organisation Market Value by category

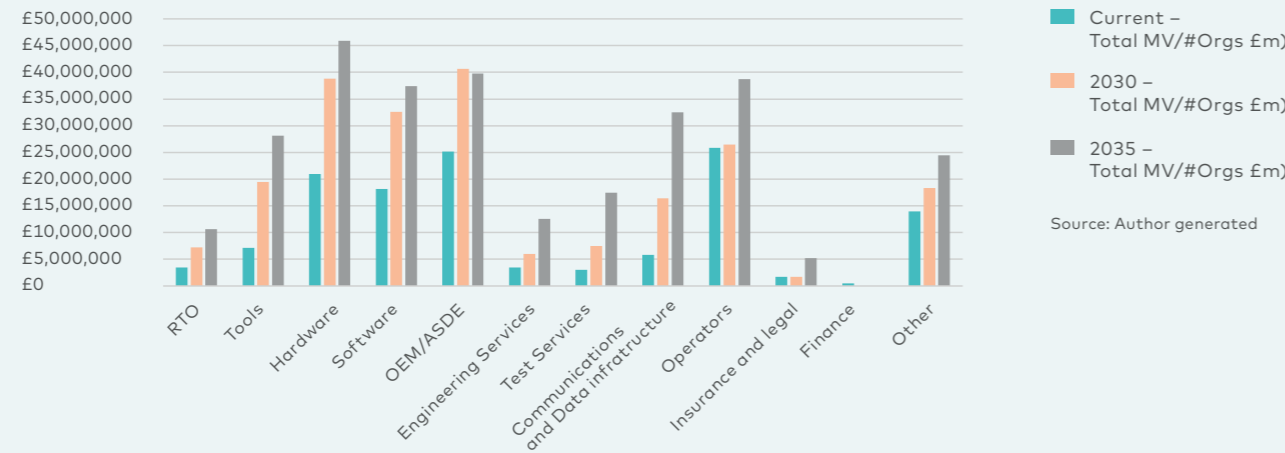
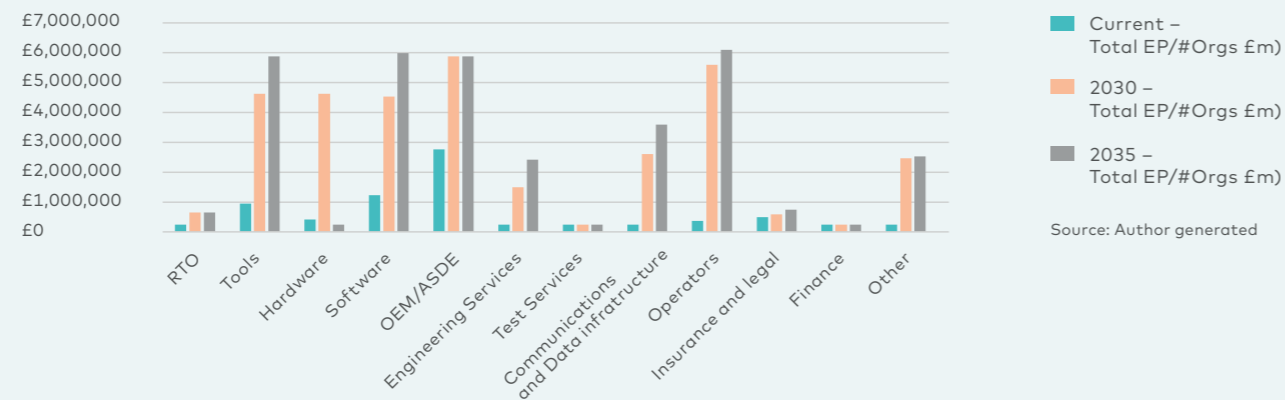


Figure 4.7: Average Organisation Export Potential by category



Figures 4.8 and 4.9 show the proportion of UK based suppliers (supplied by) for each category as well as the proportion of customers/ consumers of that category that are UK based (supply to) respectively. They show clear trends across all categories in terms of which serve a domestic market e.g. **Operators, RTOs, Insurance and legal** and **Test Services**. In addition, the data also indicates that categories such as **Software, Tools and Communications and Data Infrastructure** show more export potential. These figures also highlight the differences in which categories are more dependent on supplied from outside the UK e.g., **Hardware, Tools** and **OEM/ASDE**.

Figure 4.8: Proportion of UK based suppliers (supplied by) and consumers (supply to) by category (mean)

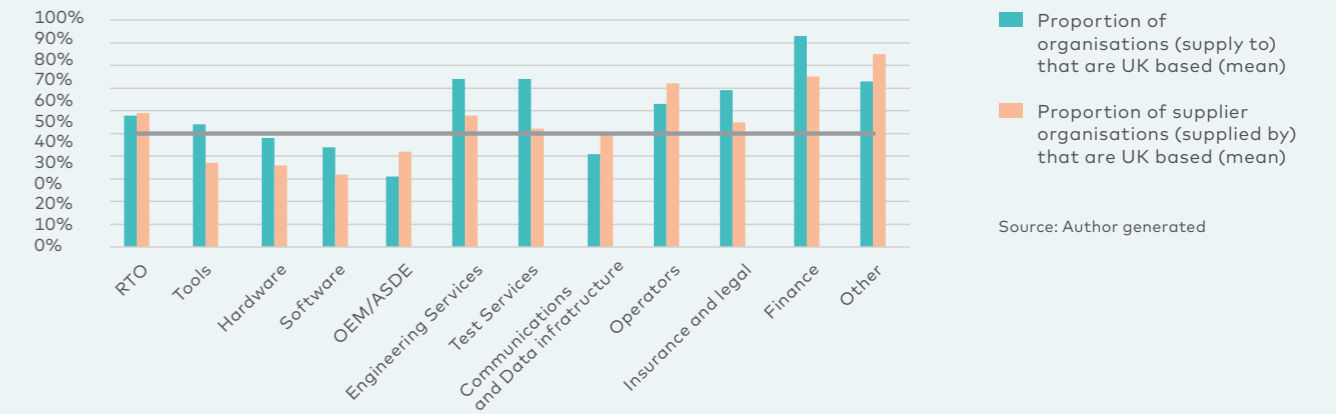
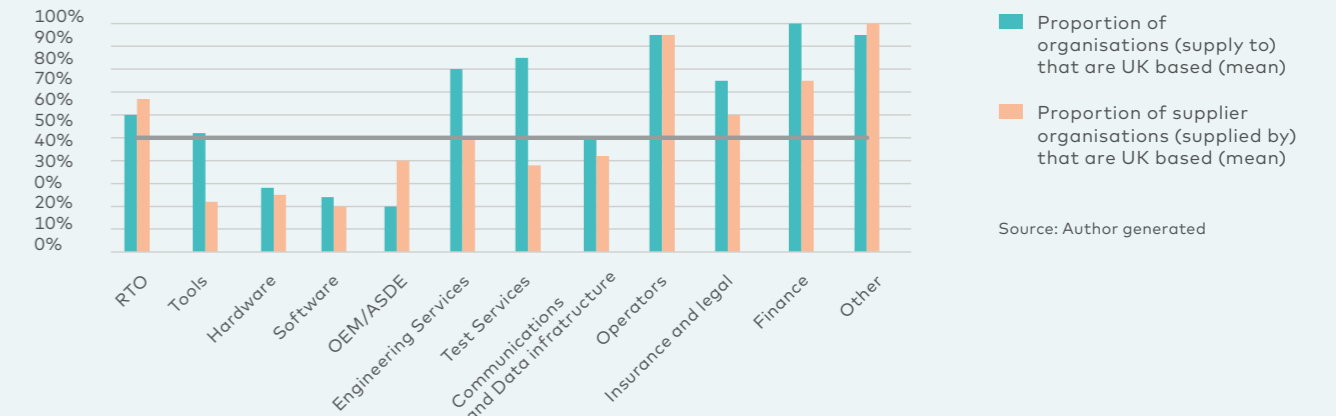


Figure 4.9: Proportion of UK based suppliers (supplied by) and consumers (supply to) by category (median)

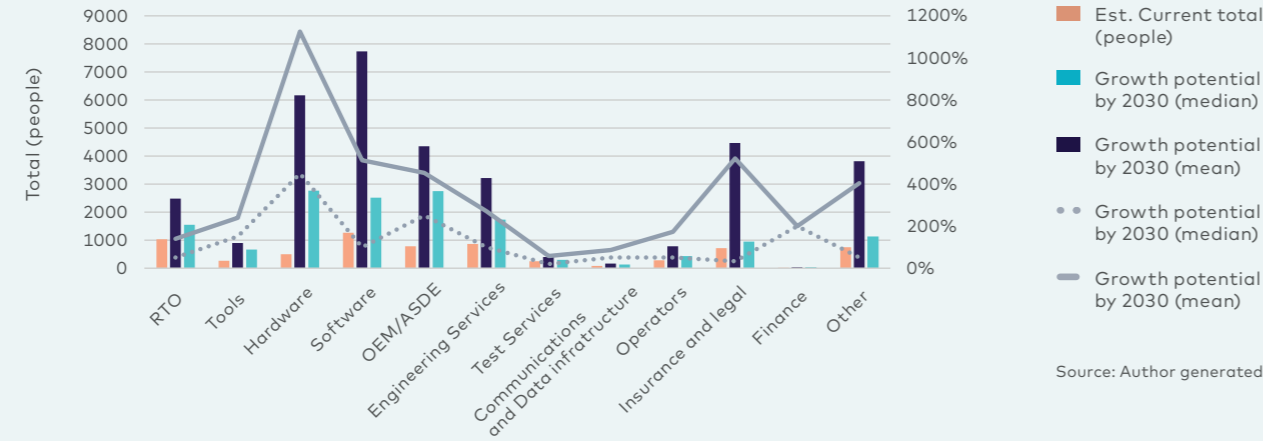


Figures 4.10 and 4.11 estimates the total number of people that will be involved in CAM related activities by 2030 and total turnover for the same timeframe by category. Whilst data for 2035 was also captured, there was too much uncertainty and extreme growth estimates that make it difficult to draw any definitive insights or conclusions. Consistently high trends for growth in people and turnover were indicated **Operators** and **Software** which is suggestive of expectations for achieving commercialisation pre-2035.

The data suggests:

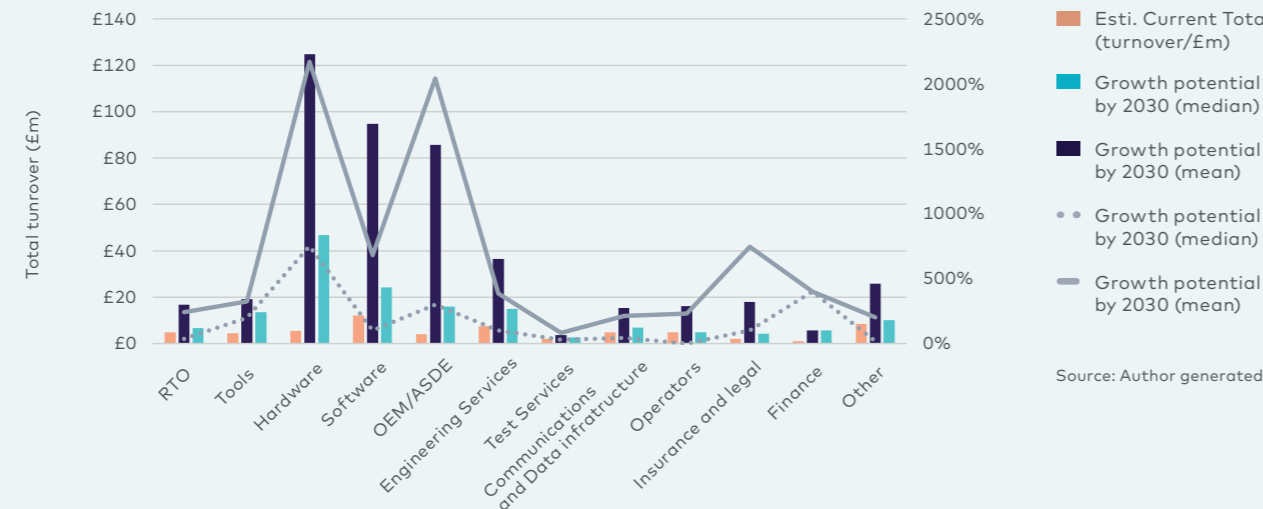
- The expectation is that there is unlikely to be much growth in personnel from **Test Services, Communications and Data Infrastructure, Operators** and **Tools** categories (Figure 4.10)
- Larger growth in personnel is expected in **OEM/ASDE, Engineering Services, Insurance and legal, Hardware, and Software** (Figure 4.10)
- Turnover tells a slightly different story with large growth in turnover expected for **Hardware, Software, OEM/ASDE** and **Engineering Services** whilst the other categories are more subdued (Figure 4.11)

Figure 4.10: Estimates of total people involved in CAM related activities by category and growth potential by 2030



Source: Author generated

Figure 4.11: Estimates of total turnover involved in CAM related activities by category and growth potential by 2030



Source: Author generated



5.0 / Spotlight on

5.1 V-CAL

An interview with Nissan Manufacturing UK

Nissan Manufacturing UK's (NMUK) Sunderland plant offers a great deployment ground to evaluate the benefits of automated vehicles in live logistics operations. A private road runs between Nissan's third-party logistics partner Vantec's warehouse and the NMUK site, followed by internal roads for plant business traffic, finished product movements, and pedestrians.

V-CAL is the successor project to 5G-CAL, which pioneered automated logistics movements with one prototype tractor, demonstrating the ability to deliver from local supplier to factory loading door, with remote monitoring to supervise safe crossings.

V-CAL takes this a stage further, with three prototype tractors undertaking last mile deliveries from Vantec's warehouse as well as moving finished products from the end of line to compound while last mile trailers are unloaded. This higher utilisation is aimed at demonstrating the commercialisation of the earlier project outcomes.

Supply chain partners

NMUK has partnered with Vantec for over 20 years. This collaborative familiarity has been essential in building a detailed understanding of operations and improving efficiency challenges through the use of automated vehicles. With the expanding supply base in the North East increasing demand, there is a growing competition for talent. Therefore, automated solutions will be sought to alleviate the shortage of skilled staff in logistics wherever possible.

Other project partners include Streetdrone, Newcastle University, North East Automotive Alliance, Sunderland City Council, Nokia, Angoka, BP, and Womble Bond Dickinson (UK) LLP (see Figure 5.1).

The below "Spotlight on" studies provide an inside view of the experience as part of a CAM supply chain in the current industry state, and illustrate practical challenges and opportunities arising from the themes described in Section 4. The studies were composed based on interviews with key organisations part of the V-CAL, CAVForth II and StreetCAV projects - selected from the consortia projects under the CAM Deployment UK and CAM Supply Chain UK competitions - with a focus on understanding the service consumer/customer perspective.

Business case

Pathway, Scaling

In NMUK's view, to be proven commercially viable, automated vehicles must:

- Be technically capable to replace current vehicles and be compatible with operations processes.
- Meet service level requirements in multiple roles.
- Offer lower total cost (CAPEX plus OPEX) in less than 10 years.

V-CAL will evaluate this total cost underpinning the business case and look at the future potential for costs to lower with technical maturity or volumes.

Barriers

Nissan recognises a trend towards automation in logistics globally. UK activities play well in this global positioning, both demonstrating UK organisations' capabilities and benefiting from public funding support. With automotive sector investment budgets prioritised into product electrification, the 5G-CAL and V-CAL projects could only happen with government funding. The upfront investment costs, which logistics partners such as Vantec will have to incur, are currently too high.

Key opportunity

If automation is to be introduced, it will be on EV tractors replacing current diesel versions. There exists an opportunity to adopt EVs and automation in tandem, to realise both environmental and efficiency benefits through one investment. The CAM community therefore needs to take advantage of this one-off opportunity.

Lessons learned

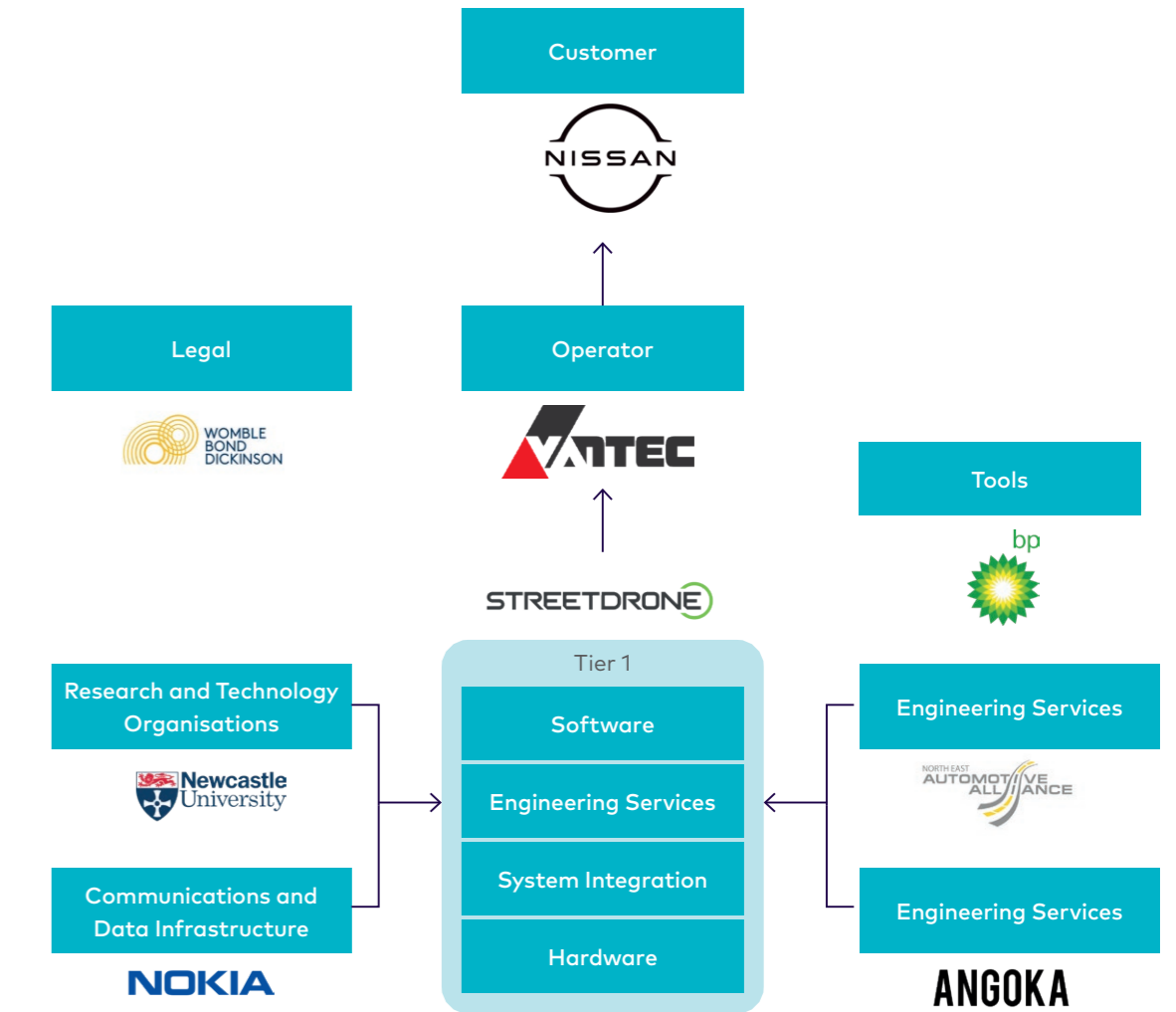
Operations under 5G-CAL project were a success. Some issues and delays were encountered with implementing a private 5G network, but these were overcome. Meanwhile, non-technical aspects, such as workforce acceptance, were also considered. The completion of the 5G-CAL project was celebrated within Nissan, overcoming internal dissent, and laying the groundwork for V-CAL.

Future outlook

Alongside decarbonisation, automation will have a transformative impact in the manufacturing logistics sector, which has been stagnant for a long time. NMUK recognises the future challenges to reduce overheads and overcome skills shortages, with an ambition to improve operational efficiency through automated vehicles. A new supplier park underway in Sunderland will be a prime site for a coherent holistic automated logistics solution, with key engagement from Sunderland Council for use of local public roads.

The timeline for this transformation is now, and needs to be delivered within five years, to match NMUK's transition to BEV-only production and associated suppliers in Sunderland.

Figure 5.1: VCAL (CAM Deployment UK) project supply chain diagram





5.2 CAVForth II: voice of the operator

An interview with Stagecoach

As with most passenger transit operators, CAVs remain more of an R&D topic at Stagecoach, building experience until ADS technology reaches operational readiness. In 2017, Stagecoach undertook a project to understand automated navigation at a bus depot through cleaning, refuelling, and parking functions, and have subsequently been involved in further CAM projects in East Scotland, Cambridge, Sunderland and the Highlands, with several ADS developers supporting different stages of development.

CAVForth II is the “UK’s first autonomous commercial bus service” offering public transport between a park and ride site in Fife, and Edinburgh Park transport interchange, 14-miles away. As such, it has received very high exposure and international interest. The emphasis on “service” is illustrated by the inclusion of a registered timetable, fare collection, and inclusive customer access.

Supply chain partners

Stagecoach is the bus operator. As one of Stagecoach's main OEM suppliers, Alexander Dennis Limited is the vehicle supplier, with an ADS stack provided by Fusion Processing Limited. Other project partners include Edinburgh Napier University providing the consortia with societal research, and University of West England, supported by Transport Scotland (Figure 5.2).

Business case

Pathway, Scaling

CAVForth II addresses both CAM technology and functional maturity within a seven days per week passenger transit application.

But the business case for automated passenger transit remains unexplored, with no knowledge yet about operational cost saving opportunities through avoiding road collisions, reducing maintenance, improving fuel economy, or reuse on different routes.

Higher investment costs and initially higher staffing costs need to be addressed without raising fares. There will need to be positive commercial benefits for all supply chain partners, therefore investment and ROI for vehicle OEMs and ADS developers need greater scrutiny.

Barriers

In Stagecoach's view, barriers for CAM passenger transit services exist in:

- 1 Unclear ADS technology maturity without certification and regulatory processes, and an overrepresentation of ADS technology capability without detailed application experience.
- 2 Unknown functional maturity to deliver onboard customer services, assisting in incidents, or responding to public behaviour, which are dealt with today at a human drivers' discretion.
- 3 Unknown acceptance among groups using public transport possibly leading to social exclusion.

Key opportunity

Since CAM passenger transit services are not financially viable within current contract mechanisms, authorities need a vision of where automation will unlock wider benefits. The very small current UK market will grow once more councils develop serious interest in the potential benefits to safety, efficiency, customer experience, dwell times, staffing levels, and publicity, while appreciating the risks if anything goes wrong and understanding the effort required to integrate with existing systems.

Lessons learned

As a UK first, Stagecoach have found there is no blueprint to follow. All operational considerations needed to be tried and tested for the first time. CAVForth II has been treated as a service deployment to gain real operational learning, but, in reality, CAM projects are still research that bring complexity and uncertainty.

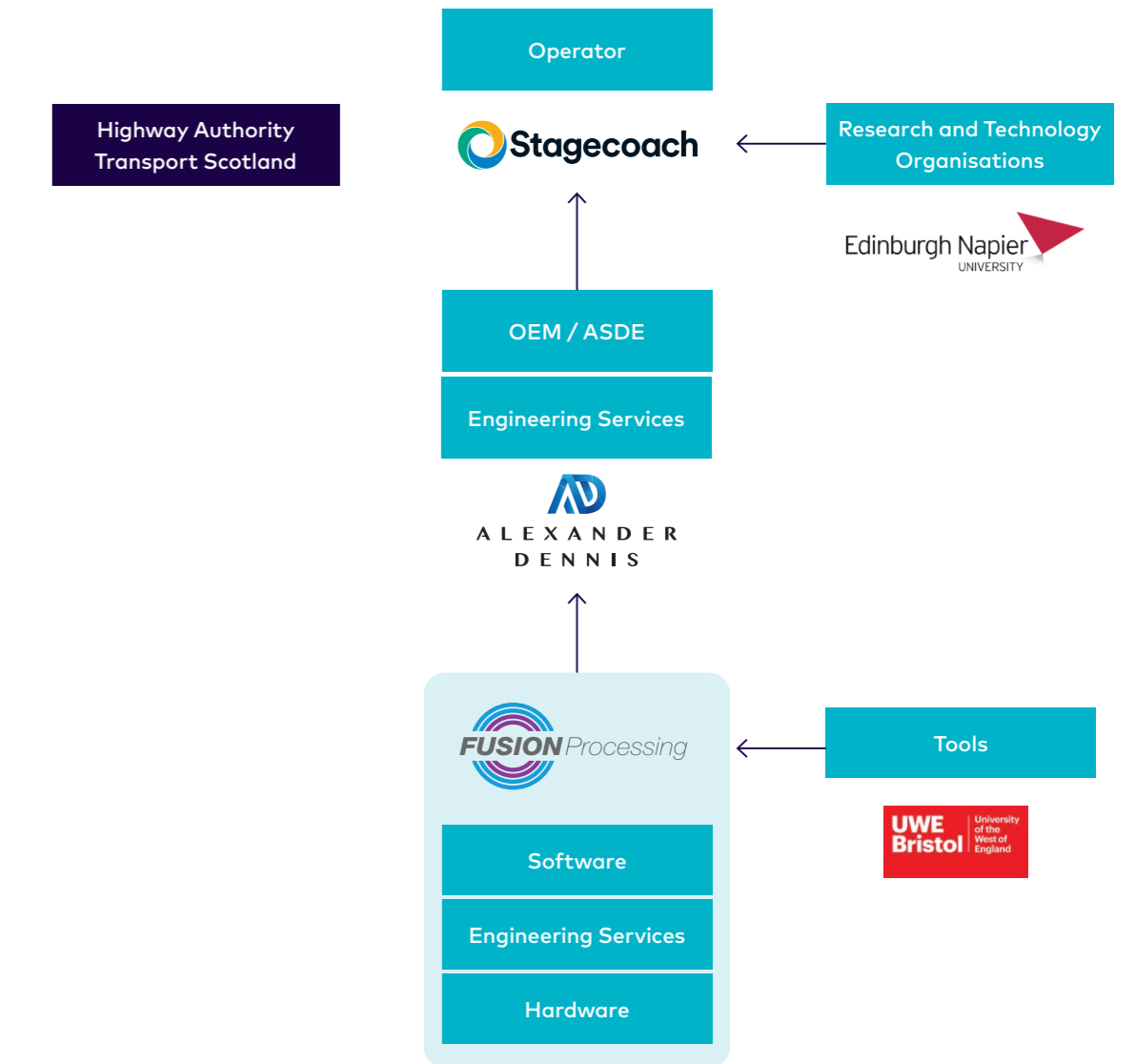
CAVForth II's human factors studies have provided valuable learning, especially around safety drivers and the new Bus Captain role, while union support has facilitated staff engagement and training. Public engagement has been helped with visibility online, through integration of the service with existing systems, and strong marketing and communications.

Future outlook

Through more projects, both the CAM industry and passenger transit service industry will improve the understanding of each other's requirements and capabilities. These will help gain greater understanding of all the costs involved in the business case analysis that will be needed.

Stagecoach recognises a difficult learning process ahead for all service providers to prepare for CAM services. Leading councils are, in future, expected to procure specific automated services according to various funding mechanisms.

Figure 5.2: CAVForth II (CAM Deployment UK) project supply chain diagram





5.3 StreetCAV: the voice of the integrator

An interview with Smart City Consultancy and Ohmio

Milton Keynes has hosted several CAM projects including Fetch, LivingLAPT and recently, StreetCAV. StreetCAV involves the operation of automated shuttle buses on a city route and acts as a means for employee transportation at the Red Bull campus. Vehicle operation is enabled by remote monitoring through small cell 5G connectivity infrastructure. This street-side equipment is intended for multi-use to improve the cost effectiveness, so StreetCAV can explore the wider commercial models.

Supply chain partners

Smart City Consultancy plays the role of integrator, incorporating Dell 5G infrastructure and an Ohmio shuttle vehicle with V2V and V2I capability and an open approach to data sharing (Figure 5.3). Milton Keynes City Council (MKCC) is the facilitator and has long-term activities planned to foster public acceptance of CAM technologies.

Business case

Pathway, Scaling

Access to a sizeable market will become important to technology providers with the development of CAM industries globally. The UK market is currently limited, but Ohmio is planning to establish a UK hub to support projects across Europe, particularly in the Netherlands, Luxembourg, and Finland. StreetCAV is already benefitting from learnings that Ohmio gained through an earlier deployment in Luxembourg. From integrators and operators to CAM technology developers, reliable, consistent access to skills is important to scale. Training and recruitment potential are available through collaboration with Cranfield University's Robotics MSc as part of the project.

Remote monitoring is required for the successful integration of the shuttle operations, which depend on connectivity. Therefore, the rollout of connectivity infrastructure becomes a prerequisite to scaling.

Strong, long-term engagement from the responsible transport authority is necessary to undertake the steppingstone projects before commercial deployment. Fortunately, MKCC is a unitary authority, with cross-party leadership support for an ambitious future growth plan to double the population, including automated urban transport instead of more private car ownership. To that end, MKCC has supported CAM trials over many years, collecting public feedback to help guide public acceptance, and to understand the timing and readiness of automated solutions.

Barriers

Additional costs for the required connectivity infrastructure must be mitigated through collaborative sharing and multi-use to help alleviate pressures for both integrators and potential operators. Additional cost for the presence of safety drivers will be resolved once legislation exists to allow operation by remote monitoring, and standards and certification agencies clarify interpretations of their expectations.

Key opportunity

The forthcoming legislation must balance safety expectations against the overhead associated with assurance. The assurance requirements will have to be agile to avoid becoming a bottleneck.

To boost development and maturity up the supply chain, a strong market pull needs to be fostered starting with the collaboration between customers, operators and integrators.

Both MKCC and Red Bull campus have made business case calculations, highlighting the need for innovative commercial models to fund the service. Service operators more widely need evidence of stronger commercial cases, which may necessitate greater corporate sponsorship or public subsidies until volumes grow and costs reduce.

As such, new operation centre models will be needed as well as high reliability digital systems.

Smoother engagement with overseas suppliers and partners will also be needed to facilitate future at scale demand.

Lessons learned

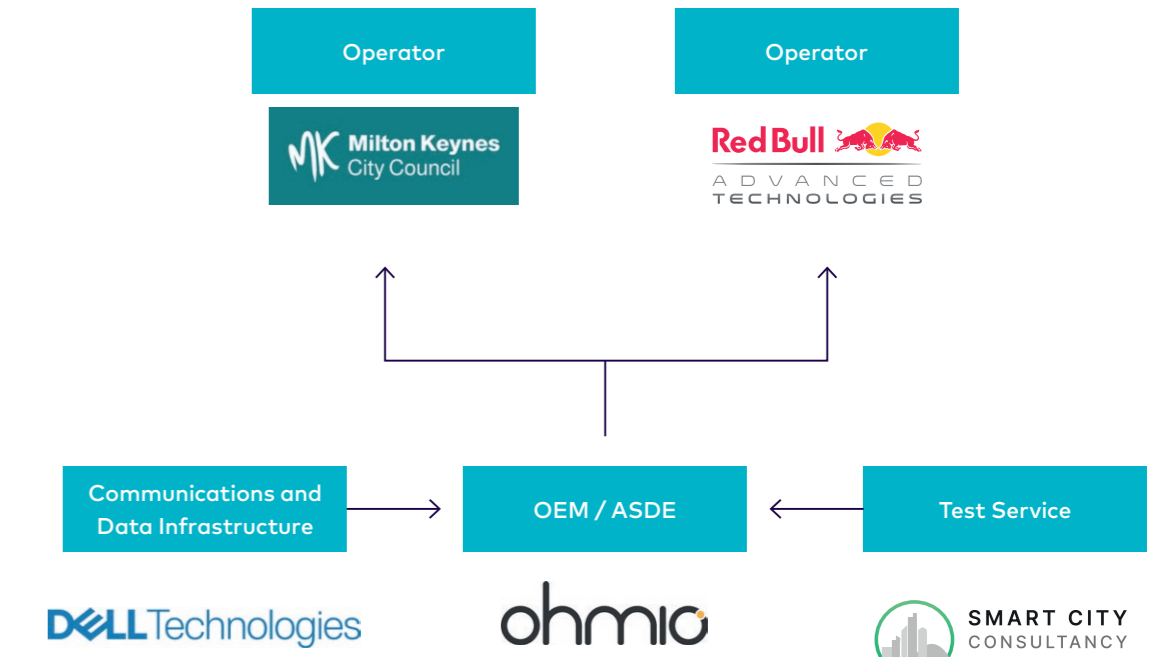
Scaling depends on access to skills, as such Ohmio established cooperation with Cranfield University, including providing access to data systems for training. MKCC has also made deployment datasets available to help learning.

Since the new assurance requirements in the forthcoming legislation are unlikely to resemble current requirements for trials, development activities must be pragmatic. A multi-layered holistic design requires a combination of both vehicle and infrastructure-based solutions. This can pose problems with current public funding approaches, which are too vertically siloed and do not lend themselves to cross-functional place-based solutions where new synergies can unlock new commercial opportunities. Locally focused, long-term engagement and funding support would have greater impact.

Future outlook

Progress with new legislation offers great opportunities. Conditional to its success and international engagement becoming smoother, there is enthusiasm and ambition for Ohmio's UK hub to serve an international market.

Figure 5.3: StreetCAV (CAM Supply Chain UK) project supply chain diagram



6.0 / Participants

Table 6.1 provides a list of organisations that responded to the survey or were interviewed as part of this study and provided permission to be named within this report.

Table 6.1 UK CAM organisations by primary category, 2024 edition

High Level Category	Organisation	
RTO (Research and Technology Organisation)	CAVT Ltd Reed Mobility Royal College of Art	Thatcham Research University of Surrey (CAV-Lab)
Tools	AB Dynamics IPG Automotive UK Ltd	Keysight National Instruments (NI) rFpro
Hardware	Chassis Autonomy Oxford RF Solutions Ltd Phlux Technology Ltd	Robert Bosch GmbH (Bosch) Swarco
Software	Albora Technologies ANGOKA Ltd Connected Places Catapult dRISK Eloy Humanising Autonomy	Nicander Limited one.network ParkIT Solutions Ltd Sharpcloud Software Limited Xtract360 Ltd YoGoKo
OEM/ASDE	Conigital Limited MooVita Pte Ltd NISSAN	Robotiz3d Limited ZF Services UK Ltd
Engineering Services	6GCAM Agility3 Inspiring Company Ltd JN Consulting	JRM Advanced Engineering Ltd LEVE Ltd Silvera Automotive Solutions

High Level Category	Organisation	
Test Services	Moshon Data Ltd NAVCERT Newcastle University	Transport for West Midlands UKAEA RACE UTAC Millbrook
Communications and Data Infrastructure	Jenoptik UK Vesos Services Ltd Vodafone Group	White Willow Consulting Yunex Traffic
Operators	Dromos Oxfordshire County Council	Transport Scotland WJ Group
Insurance and legal	Admiral Insurance Ben Gardner	LexisNexis Risk Solutions
Other	Beam Connectivity DVSA Eaton Connected Solutions Limited Fusion Processing Ltd KPMG LLP Met Office	Nova Modus Ltd Pluscharge Quarterre Studio Strathcarron Temple Transformation Ltd Valuechain Technology Ltd



7.0 / Conclusions and next steps

7.1 Conclusions

Since the last iteration of this work, the UK Connected and Automated Mobility (CAM) sector has become increasingly focussed on pushing towards realising commercial deployment. This is evidenced by UK government's Commercialising CAM programme that supports seven early deployment consortia as well as thirteen supply chain projects – the scope of the latter was shaped by that previous iteration of work. In November 2023, the UK government reaffirmed its commitment to the CAM sector, announcing up to £150m of funding from 2025 to 2030 and the introduction of the Automated Vehicles Bill into parliament. CAM technologies continue to mature but the short-term economic backdrop provides a challenge for industry.

The analysis under this iteration of the work enhances the established framework for understanding the UK CAM supply chain and explores the interlinkages between the categories identified. The report addresses the capability areas for the UK and explores important factors for their strategic leveraging such as geographical distribution, growth, market and value potential. As a result, this analysis updates the current UK CAM supply chain strengths (see Table 7.1) as well as areas of opportunity for the UK within the global UK supply chain.

Table 7.1: Current UK CAM supply chain strengths

Strength	Neutral	Challenges
Software (in particular data, AI, safety and security)	Tools (Simulation, test and analysis)	Hardware manufacturing (including deployment infrastructure)
RTO (Research and Technology Organisation)	Communications and Data Infrastructure	Finance - private investment proving difficult to secure for CAM products and services
Engineering Services	OEM/ASDE (established & new)	
Hardware (design and development)	Operators	
Insurance and legal*	Test Services*	

Source: Author generated

*Backed by strong research/engineering skills

*Based on traditional strength rather than CAM specific capabilities

An examination of UK's strengths and opportunities shows that high potential lies in areas of the CAM supply chain that have lower capital expenditure requirements – as show in Table 7.2. Therefore, this report recommends that these areas should be the priority focus of future interventions – as well as provide a strong steer to industry as to where there are strong opportunities for the UK.



Table 7.2: Opportunity areas for the UK CAM supply chain

Category	Potential UK opportunity
Software	★★★
Engineering Services including Test Services	★★★
RTOs	★★
Hardware (design and development)	★★
(New) OEM/ASDE	★★
Operators	★★
Tools	★★
Comms and data infra (connectivity)	★★
Insurance and legal	★★
Hardware (niche manufacturing)	★

Source: Author generated

7.2 The path forwards

This work is the second iteration of analysis evaluating the state of the UK CAM supply chain, summarising the progress and proposing further recommendations to validate and expand the insights outlined in Section 4 and inform strategic decision.

7.2.1 Core themes recommendations – the path forward

The UK would benefit from a clear “CAM identity” that outlines the UK CAM sector value proposition on the international stage through focusing on strengths and high-potential opportunity areas and early application use cases to help address crucial challenges and barriers to the sector. This would build of a previous recommendation from the 2022 report, for a long-term CAM strategy to reach deployment - with visible and communicated regulations, etc, sensible lead times, and consistently exploited across somewhat fragmented government departments.

Early commercial opportunities playing out

Early commercial opportunities require practical support, enabling regulation and funding to serve as a way of accelerating commercialisation. Leveraging these opportunities would bring understanding of effective methods to moving the sector at-pace. This would continue to build in a previous recommendation for a strong market pull and compelling use case development.

Scale – moving from R&D to deployment

The UK should continue to support research and technology development for key enabling technology areas – e.g. drive-by-wire or sensing - building up supply chain resilience domestically through interventions and internationally through strengthened relations with global players.

Private investment

The need remains for continued public finance support to de-risk CAM development and deployment. In particular for clear priority use cases and high potential areas. It is important that industry, with the support of organisations such as Zenzic, continues to expand and build compelling business case with a clear ROI to help facilitate and attract private investment.

Regulation

Industry support for primary regulation through the AV Bill and follow-on secondary legislation. In addition, further work is needed to better understand impact of Brexit as well as continued support for future international harmonisation.

In addition, the following recommendation from 2022 remain valid:

CAM skills support

On-the-job training funding, secondment programmes/exchanges funding and academic teaching are some suggestions to explore and enhance the UK CAM supply chain.





7.2.2 Vision for annual update

There remains a strong need to continue to gather data over time to (a) enhance the accuracy of this analysis (b) track progress over time and (c) to better understand the value and potential growth of the UK CAM supply chain. Zenzic will continue to interact with organisations within the UK CAM supply chain to gather analysis and distribute insights at a regular cadence. To serve these purposes the focus of each future update will be tailored to reflect the up-to-date needs of industry and government.

Future iterations of this work is likely to include:

1 Data flows

Once a significantly large set suitable for analysis has been gathered, additional in-depth examination of flows at a sub-category level should be undertaken to better understand the linkages within the UK CAM supply chain.

2 Value and impact

To be determined on an update-level basis to maintain work's relevance and allow for tailoring to industry and government needs.

3 Cross-sector potential

An area out of scope of this project, further research is required to understand the skill and CAM potential of other sectors in which the UK is strong e.g., gaming and motorsport.

4 Further visualisation

It would be beneficial to have data presented in a more interactive manner to aid analysis as well as exploration and dissemination. Efforts have been put in creating –a “CAM Directory” located in Section 6 that is to be maintained and expanded as part of work exploitation.

5 Evaluation

Continued review of the domestic and global CAM market is recommended with a view to understand progress as interventions are deployed as well as develop new recommendations.

The framework has now been adopted by CCAV and the UK Automotive Council to aid in understanding of CAM in the UK for both the government and industry respectively. The framework provides a reusable tool in the analysis and understanding of the UK CAM supply chain as such will continue to be refined by feedback from the UK CAM sector.

The intention for this work is to maintain its relevance and impact by regularly updating the underlying data through surveys and research. Zenzic welcomes any organisation who wishes to be included in this analysis to get in touch and complete the survey.

8.0 / References

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9.0 / Appendix

Appendix 1 – Survey questionnaire

Section 1: About your organisation

1. Organisation Name
2. CAM supply chain category; please select the category that fits you best
 - a. If hardware what Tier?
 - b. Sub-categories
3. Secondary CAM supply chain category
 - a. If hardware what Tier?
 - b. sub-categories
4. For your main areas of the UK supply chain; how competitive is the UK?
5. Is your corporate HQ located within the UK?
6. The region(s) for where you organisation is based in the UK
7. Postcode for the location of your main UK operations
8. Size of your organisation - number of employees
9. Size of your organisation - approximate annual turnover
10. Number of employees involved in CAM related activities based within the UK

11. Approximate annual turnover of CAM related activities based within the UK
12. Given the potential opportunity for CAM, what could your potential growth be for your organisation by 2030?
 - a. CAM personnel in the UK
 - b. CAM turnover in the UK
13. Given the potential opportunity for CAM, what could your potential growth be for your organisation by 2035?
 - a. CAM personnel in the UK
 - b. CAM turnover in the UK
14. What is your current estimated market value for your CAM products/services?
15. What is your projected estimated market value for your CAM products/services?
 - a. by 2030
 - b. by 2035

Section 2: Your role in the UK CAM supply chain

1. Do you supply products or services to any of the following categories? (and sub-categories)
 - a. Hardware
 - b. Software
 - c. Engineering Services
 - d. Finance
 - e. Research and Technology Organisation
 - f. Test Services
 - g. Tools
 - h. Operators
 - i. Insurance and Legal
 - j. Communications and Data Infrastructure
 - k. OEM/ASDE
 - l. Other
2. Are there any types of organisations that you would like to supply for which you currently do not?
3. What proportion of those you supply are based within the UK? Please provide an approximate % figure

Appendix 1 – Survey questionnaire

Section 3: Your CAM supply chain requirement

- | | | |
|--|--|---|
| <p>4. Who are your key CAM customers? Please provide the name of organisations</p> <p>5. Which other types of organisations (non-customers) in the UK CAM ecosystem do you most regularly work with?</p> <p>6. Please describe your USPs for CAM?</p> <p>7. What is level of your current CAM exports?</p> <p>8. What is level of your projected CAM exports?
 a. by 2030
 b. by 2035</p> <p>9. Have you been involved in any UK government funded CAM related trials and/or R&D in the UK? Please state all trials/R&D projects</p> | <p>1. Do you use products or services from organisations that provide (and sub-categories):</p> <p>a. Hardware
 b. Software
 c. Engineering Services
 d. Finance
 e. Research and Technology Organisation
 f. Test Services
 g. Tools
 h. Operators
 i. Insurance and Legal
 j. Communications and Data Infrastructure
 k. OEM/ASDE
 l. Other</p> <p>2. Which of these suppliers are UK based?</p> <p>3. Why did you elect to procure from these suppliers? (e.g. technical specifications, cost, lead times, cooperation model, etc.)</p> <p>4. What proportion of your CAM suppliers are UK based? (%)</p> | <p>5. Is your current supply chain needs entirely met by UK based companies?</p> <p>6. Could your current supply chain needs be met by UK based companies?</p> <p>7. What would make you switch suppliers to these UK companies?</p> <p>8. What areas do you believe there is a strong opportunity for UK suppliers? (and sub-categories)
 a. Hardware
 b. Software
 c. Engineering Services
 d. Finance
 e. Research and Technology Organisation
 f. Test Services
 g. Tools
 h. Operators
 i. Insurance and Legal
 j. Communications and Data Infrastructure
 k. OEM/ASDE
 l. Other</p> <p>9. What challenges/barriers do you face in your supply chain?</p> |
|--|--|---|

Appendix 2 – Full category list

Category	Sub-category	Description
Hardware	Cameras	Vision-based sensor system
	RADAR	Extrinsic object detection system using radio waves
	LIDAR	Extrinsic sensor using laser light detection
	Onboard Mapping Hardware	Storage device for maps held on vehicle
	Odometry sensors	Vehicle sensor for determining the precise movement of the vehicle based on for example wheel rotation.
	Ultrasonic sensors	Extrinsic short-range sensor
	Sensor supporting hardware	Specific hardware to support sensors on vehicle such as specific power supplies or processing capabilities
	Embedded controls hardware	Hardware for control of one or more components of the vehicle hosted on those components
	Passive control systems and computing components	Control systems and their components on the vehicle which are not actuating physical systems. An example maybe driver monitoring.
	ECU hardware	Electronic Control Unit – controls one or more of the electrical systems of a vehicle
	Other electronic & architecture	On-board electronics forming part of an overall EE architecture for the vehicle
	V2X equipment	Equipment supporting the communications from and to the vehicle from: infrastructure, other vehicles and pedestrians
	Cyber secure modem	Hardware which cyber secure to protect it from malicious attack. This hardware is a gateway enables the vehicle to connect to the external world to send and receive data.
	Safety related HMI hardware	Displays, audible notifications or haptic notifications
	Localisation hardware	Hardware which enables the vehicle to know its exact location on a map and its surroundings.
	Drive by wire	The control of vehicle actuators such as propulsion, braking and steering by use of electronic and electro-mechanical systems in place of traditional all mechanical solutions
	GNSS/GPS and IMU	Global Navigation Satellite System/Global Positioning System/Inertial Measurement Unit
Powertrain/propulsion hardware	Hardware and actuators for the propulsion of the vehicle	
Actuators	Devices for the physical operation of vehicle systems such as steering, braking and propulsion	

Appendix 2 – Full category list

Category	Sub-category	Description
Software	Mapping & path planning - computer programming	Writing and then testing of software for the planning of vehicle motion
	Mapping & path planning - computer consultancy	Consultancy support for the development of path planning software
	Mapping & path planning - other IT technology and services	Supporting services for software development
	Mapping & path planning - data processing and hosting	Data and processing support for software development
	Control systems - computer programming	Writing and then testing of software for the control of vehicle systems
	Control systems - computer consultancy	Consultancy support for the development of control systems software
	Control systems - other IT technology and services	Supporting services for software development
	Control systems - data processing and hosting	Data and processing support for software development
	Connectivity/V2X - computer programming	Writing and then testing of software for connectivity and communication
	Connectivity/V2X - computer consultancy	Consultancy support for the development of communications software
	Connectivity/V2X - other IT technology and services	Supporting services for software development
	Connectivity/V2X - data processing and hosting	Data and processing support for software development
	HMI software - computer programming	Writing and then testing of software for the Human Machine Interface i.e. the display of information and sound/haptic alerts
	HMI software - computer consultancy	Consultancy support for the development of HMI software
	HMI software - other IT technology and services	Other IT services for the development of HMI software
	HMI software - data processing and hosting	Data hosting and processing for for the development of HMI software
	Data & cyber security - computer programming	Writing and then testing of software for security against cyber attack
	Data & cyber security - computer consultancy	Consultancy support for the development of path planning software
	Data & cyber security - other IT technology and services	Supporting services for software development
	Data & cyber security - data processing and hosting	Data and processing support for software development




Category	Sub-category	Description
Finance	Private funding e.g. VC	Funding from a private investor
	Public funding body	Funding from a public body
Research and Technology Organisation	Academic Institution	University whose primary activity is research
	Research organisation	Private organisation whose primary activity is research
	Public Sector Research Establishments' (PSREs)	Institutes sponsored directly by government departments or UK Research Councils
	Public Research Organisations (PROs)	Public research organisations including those that set standards to government and business
Tools	Other RTO e.g Catapults	Public research groups focussed on specific groups such as SMEs
	Simulation	Tools for the creation and use of simulation models
	Testing	Tools to enable testing and measurement
	Mapping services	Tools to enable location and/or mapping
Operators	Other - please specify	
	Passenger Transit	Operators serving the movement of passengers (e.g., bus services)
	Freight & Logistics	Operators concerned with the movement of goods to service other sectors
	Last mile delivery	Last mile in supply chain management and transportation planning is the last leg of a journey comprising the movement of people and goods from a transportation hub to a final destination.
	Highway Authority	An organisation that is responsible for the maintenance of public roads
Insurance and Legal	Personal mobility	Operators offering mobility solutions for the individual
	Insurance	Provision of protection against accident and damage for stakeholders in the operation and use of AVs
	Legal	Expertise in interpreting and then giving guidance on compliance with legislation
Regulatory/Consumer testing	Regulatory/Consumer testing	Testing for conformance to regulation Testing to give consumer assurance

Appendix 2 – Full category list

Category	Sub-category	Description
Communications and Data Infrastructure	Data/web services	Service and data exchange between two devices connected to each other via the internet
	Communication infrastructure	Offboard communications equipment for network communications
	Mapping /geospatial	Mapping and/or geospatial (locational) services
	Low latency communication infrastructure	Communication network equipment to enable the high-speed communication of data to support near real-time performance.
OEM/ASDE	Passenger Transit	Makers of vehicles for the movement of people in larger numbers (e.g., Bus)
	Long-haul freight (>10km)	Vehicle designed for carrying larger loads over longer distances
	Short-range deliveries (<10km) e.g last mile	Vehicle designed for carrying smaller loads over shorter distances
	Personal mobility	Vehicle designed for the transport of the owner for their purposes
Test Services	Controlled environment	Facilities with capabilities to control the parameters of the test environment.
	Semi-controlled environment	Test facilities incorporating aspects of real life environment such as public roads.
	Public environment	Test facilities composed of real life environment such as public roads.
Other	Consultancy	Role performed by organisation(s) to provide expert advice in a given field.
	EV charging/infrastructure	Public and private facilities for the charging of electric vehicles
	Other	



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