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Why doesn't the UK make more Robots?

Understanding the barriers to manufacturing robots in the UK and how to overcome them

"Britain has world-class researchers and innovators, but we too often stop short of turning that brilliance into world-class production"

Foreword

As a former Business Minister and lifelong champion of British manufacturing, I believe robotics and automation are vital to unlocking the UK's full potential for growth and competitiveness. This report is both a clear signal and a blueprint for action.

Britain has world-class researchers and innovators, but we too often stop short of turning that brilliance into world-class production. We excel in developing the ideas and intelligence behind robotics, but far less of the value is captured here than it could be. This limits the economic benefit and the opportunity to create new jobs and capabilities at home.

The evidence is clear, too few of our factories are making full use of robotics today. Yet Make UK's own research shows that when businesses do invest in automation, they see real gains – higher productivity, better quality, safer workplaces, and stronger growth. If we want to unlock a £150 billion boost to UK GDP by 2035, we must make it easier for SMEs to adopt advanced technologies such as robotics and automation – not just the experimental innovations of tomorrow, but the proven, mature solutions available today.

The opportunity before us is significant. By acting now, we can boost productivity, strengthen our economy, and create high-value jobs in every region. This report sets out how we can make that happen – and why there is no better time to start than now.

The Lord Harrington of Watford
Chair, Make UK
Member of the House of Lords

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Executive Summary

The UK Robotics and Autonomous Systems (RAS) sector holds substantial economic promise, with the potential to significantly enhance national productivity and economic resilience. Despite notable strengths, particularly in software and artificial intelligence, the UK's ability to manufacture RAS domestically remains limited, leading to reliance on imported components. This dependence leaves the industry vulnerable to global supply chain disruptions and limits domestic innovation capacity. Moreover, the overall UK industrial capability to make RAS systems falls far short of international partners. The limited capability to make RAS within the UK feeds into low domestic uptake in general; Industry analysis reveals that the UK ranks only 24th worldwide in industrial robot density, significantly trailing other G7 nations.

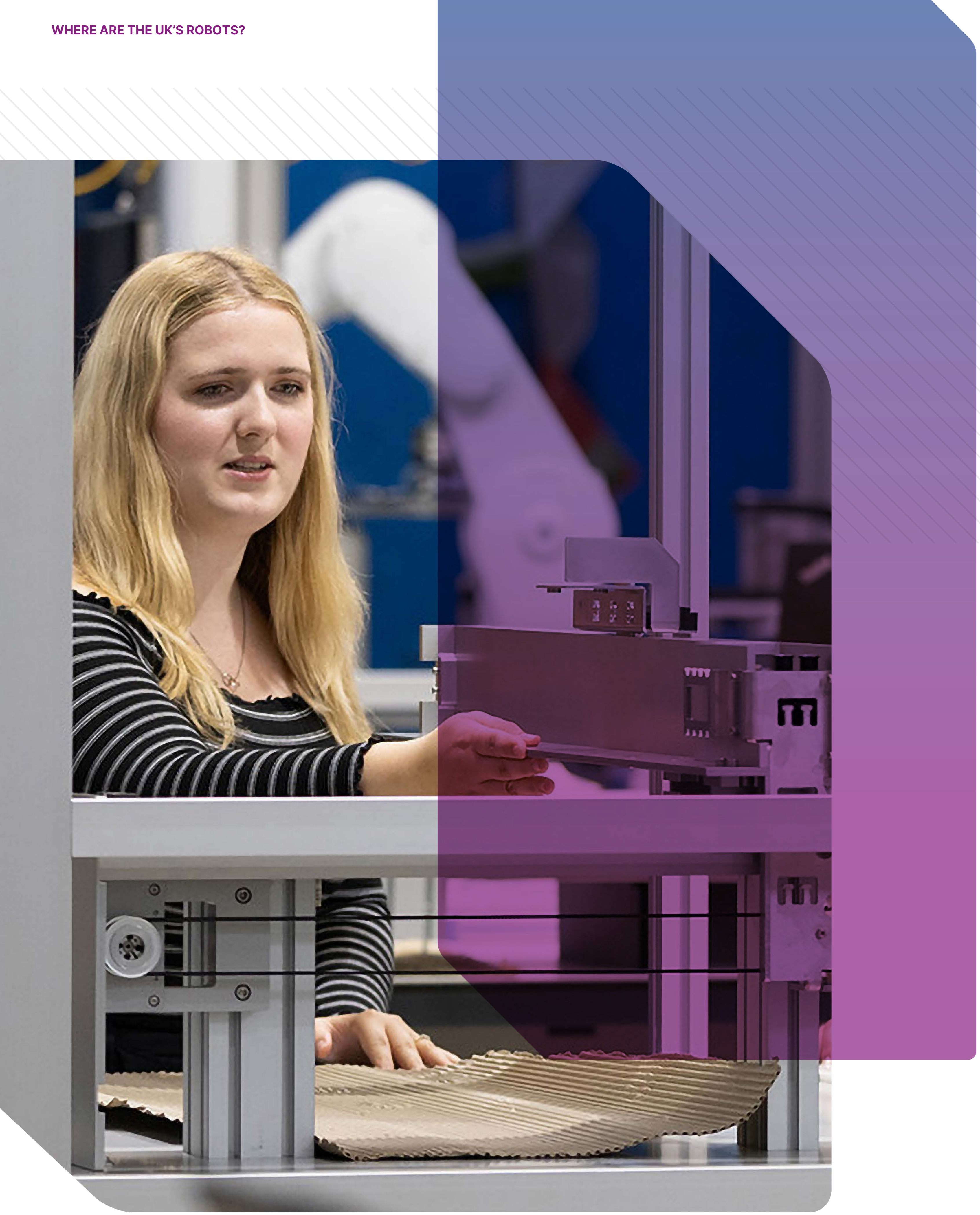
We undertook a comprehensive industry survey of ~10% of the UK industry actively making RAS domestically. We found that while structural and mechanical components are generally sourced domestically (reflecting strong local fabrication capabilities) the UK lacks significant manufacturing infrastructure for more sophisticated parts, predominantly procured from Asia, particularly China, due to perceived lower production costs and superior technical expertise. The survey highlighted that the UK RAS manufacturing ecosystem is fragmented and disconnected; indeed, in many cases there may be viable UK alternatives – but they are difficult to identify. To address these barriers, three strategic interventions are recommended:

- Firstly, establishing a **National RAS Registry** to enhance UK industry connectivity, collaboration, and visibility. Such a platform will enable companies to better identify local suppliers, partners, and innovation opportunities, significantly reducing isolation among SMEs and fostering domestic supply chain resilience.
- Secondly, the creation of a dedicated **RAS Component Adoption Hub** would facilitate hands-on testing, prototyping, and collaborative development, addressing current supply chain vulnerabilities by fostering domestic innovation and promoting local component manufacturing capabilities.
- Thirdly, investing in **targeted skills development** initiatives is critical. Structured apprenticeships, modular certification programs, and professional secondment schemes would address acute shortages in specialist robotics expertise, equipping the workforce to meet evolving technological demands and enhance the industry's competitive standing.

These recommendations need to be implemented on foundational circular economy principles. This includes designing robots for easier disassembly and recyclability, promoting material transparency, establishing regional end-of-life infrastructure, and incentivising sustainable practices through policy and automation investments.

Together, these initiatives form a comprehensive and cohesive strategy to transform the UK's fragmented RAS sector into a robust, innovative, and globally competitive manufacturing ecosystem, capable of achieving sustainable growth and resilience.

Contents



1 Introduction

Growth in the UK Robotics and Autonomous Systems (RAS) market is predicted to have a major impact on the UK economy and in turn on every aspect of our lives; the future of RAS will be defined by extraordinary diversity in form, function, and application. From agile drone swarms inspecting infrastructure, to humanoid assistants navigating care homes, to micro-robots performing precision tasks in surgery or manufacturing, RAS technologies will span virtually every domain of human activity. Rather than a single class of device, the RAS landscape will comprise a continuum of platforms, each tailored to its operational environment, user requirements, and regulatory context.

Current momentum in AI policy is welcome, but it does not automatically translate to a thriving RAS sector without complementary investment in hardware manufacturing, component integration, and scaled production systems. The success of RAS is not only about intelligence but embodiment (the motors, sensors, actuators, and control systems that allow machines to move, perceive, and interact with the real world).

However, currently the UK has a very limited capability to physically create RAS devices, leaving it heavily reliant on overseas components and knowledge for a societally critical technology. Indeed, the 2025 report 'The Humanoid 100: Mapping the Humanoid Robot Value Chain' by Morgan Stanley [1], listed one UK company as part of the vast supply chain for the most advanced 100 humanoids.

While the UK must maintain a global outlook for international relations and trade, recent geo-political events have highlighted that investing in local manufacturing, or reshoring/nearshoring is an essential move to build resilience. This is a challenge for the UK, which has systematically transitioned from manufacturing to a service-led labour market over the past century, leaving the nation vulnerable to fluctuations in costs, political will and global supply chains.

> "Currently the UK has a very limited capability to physically create RAS devices."

The value of RAS for the UK is enormous; A 2021 study commissioned by the UK Government estimates the total economic impact of RAS uptake in the UK to be in the region of £6.4 billion by 2035, placing £4.4 billion within the single sector, warehouse and logistics [2]. Prepared by London Economics, the report "The Economic Impact of Robotics & Autonomous Systems Across UK Sectors" also estimates an economic impact of £149.9 billion if all sectors in the study were to achieve their potential rates of automation. Evaluating opportunities for enhancing productivity, the report acknowledges that UK productivity is lower than in many peer economies such as the United States, France and Germany (as reported by international body The Organisation for Economic Co-operation and Development).

Aligned with the UK's low ability to manufacture RAS is poor uptake of robotic technology by industry. In 2025, the UK ranks only 24th worldwide in industrial robot density, the sole G7 country outside the top 20 [3]. With 111 robots per 10,000 employees, the UK lags far behind leaders like South Korea (1000/10k) and even the global average (141/10k). This low adoption reflects a weak domestic demand for robotics, which in turn dampens local manufacturing growth [4]. Currently in the Advanced Manufacturing sector 74% of UK SMEs in the sector operate without robots [5]. The government is looking to accelerate adoption of robotics with a new £40m programme for a new network for Robotics Adoption Hubs across the UK [6]. Alongside this, legislative reform is being pursued to overcome regulatory barriers to robotics adoption, for example in pavement robots and drones [7].

With UK supply and demand for RAS low, new initiatives are required to break this vicious circle. Several strategy documents propose to kickstart the UK RAS industry. The 2024 report "A New National Purpose: The UK's Opportunity to Lead in Next-Wave Robotics" [8] calls for a national RAS strategy to align efforts, set priorities, and scale innovation. It emphasizes the need for sustained investment, shared infrastructure, and long-term policy commitment as well as highlighting the importance of developing RAS-specific skills pipelines. The Smart Machines 2035 strategy (published in February 2025) [9] provides recommendations to promote the uptake and adoption of smart machines (to grow demand and start the development flywheel requiring supply and demand), alongside creating a UK-based ecosystem around knowledge for innovation.

This report examines the UK's current capacity to design and manufacture RAS systems domestically, identifies the barriers preventing scale, and proposes targeted interventions to unlock growth. Based on direct industry engagement, survey data and ecosystem mapping, it provides a detailed portrait of a sector that is inventive but underpowered, fragmented yet full of potential. As the global race to build smart, autonomous machines accelerates, the UK must act now to solidify its position as a leader; not just in R&D or software, but in the robust, domestic production of high-value robotic systems.

> "The UK must act now to solidify its position as a leader; not just in R&D or software, but in the robust, domestic production of high-value robotic systems."

2 The UK RAS Manufacturer Landscape

2.1 Introduction

Mapping the UK RAS (Robotics and Autonomous Systems) manufacturing ecosystem is inherently complex. This is because RAS comprises numerous interconnected subcomponents, each with diverse applications. A 2023 'HowToRobot' market insights report [10] identified 480 robotics and automation suppliers in the UK with ~10% of these manufacturers. The remainder included approximately 64% integrators, 14% distributors, 18% sub-component suppliers, and 4% classified as other. Most of these suppliers were small to medium-sized enterprises (SMEs), employing fewer than 50 people. Notably, eight manufacturers had more than 5,000 employees, suggesting they are likely multinational corporations.

We undertake our own analysis (supported by UK Department of Science, Innovation and Technology data) by combining company Standard Industrial Classification (SIC) codes (assigned at company formation) with manual web-based research and classification filtering. For the purposes of this analysis, we define the RAS manufacturing ecosystem to include industries where more than 50% of operations are core robotics-related. Relying solely on SIC codes is problematic due to vague category definitions and the frequent use of broad "other" classifications. This can lead to misclassification and limit insight into a company's actual activities. For instance, a company manufacturing robots might be categorized under several different codes as shown in table 1.

SIC Code 2830	Manufacture of office, accounting, and computing machinery: This can cover manufacturing for robotic systems, especially those used in computing and automation.
SIC Code 2851	Manufacture of machinery for mining, quarrying, and construction: While this is primarily for machinery, it can encompass robots used in heavy industries, such as construction or mining automation.
SIC Code 3320	Installation of industrial machinery and equipment: This includes companies that install robotic systems into industrial environments.
SIC Code 7210	Research and development in industrial technology: Many robotics companies involved in developing robotic systems fall under R&D activities for industrial technologies.
SIC Code 7112	Engineering Services: Companies that design and develop robotics for various industries often fall under this code for engineering and technical services. As can be seen, this could encompass many different types of manufacturer and does not lend itself to interrogation.

Table 1 Industry SIC Codes for RAS Manufacturers

2.2 Ecosystem Structure and Participants

Our study identified 1453 UK based industrial RAS companies with a focus on introducing new RAS to the UK. We exclude companies that install or operate robots, for example UAV drone operators or factories that buy and use RAS. We classified businesses into several categories:

1. UK-based RAS Manufacturers
(97 companies)

These firms design and build physical robots and autonomous platforms. They handle mechanical engineering, electronics integration, and basic control systems to produce everything from mobile ground vehicles to robotic arms.

2. RAS Software Engineering Companies
(265 companies)

Focused on writing the code that makes robots move and make decisions, these organisations develop everything from low-level firmware to high-level control software. They may specialise in navigation algorithms, real-time operating systems, or safety-critical code.

3. RAS Resellers
(240 companies)

Resellers act as intermediaries, purchasing RAS hardware or software from manufacturers and vendors and then selling them—often bundled with installation, training, and support—to end users. They expand market reach and provide a single point of purchase.

4. Fractional RAS Businesses
(450 companies)

These are lean start-ups or small teams that offer parts of the RAS value chain on an on-demand basis. For example, they might rent out robotic equipment, provide pilot deployments, or supply modular software components for specific projects rather than handling an entire system.

5. RAS Systems Integrators
(118 companies)

Systems integrators bring together hardware, software, and networking to create turnkey robotic solutions. They tailor systems to a client's unique environment, handling custom configurations, onsite installation, and end-to-end testing.

6. RAS Consultancies
(233 companies)

Consulting firms advise organisations on strategy, feasibility studies, and implementation roadmaps for RAS. They conduct market analyses, risk assessments, and ROI calculations, guiding clients from initial concept through to deployment planning.

7. AI RAS Software Focus
(50 companies)

Specialising in artificial intelligence that powers autonomy, these companies develop machine-learning models, computer vision algorithms, and decision-making frameworks. They often supply AI toolkits or cloud-based services to be integrated in a wide range of robotic platforms.

We estimated percentage error in our estimate of the number of RAS companies to be an underestimated of up to 50%. Our rigorous process (including human vetting of each company profile and excluding dissolved companies) makes us highly confident there are at least 1453 UK based organisations. But this will be an underestimate as there are inherent uncertainties in sourcing, such as inconsistent or incomplete company descriptions, overlapping business functions, and limitations in public databases and business registries. Additionally, the fast-paced and often fluid nature of the robotics sector (where companies frequently pivot, merge) adds further ambiguity. While every effort was made to cross-validate and classify companies accurately, some firms may have been misclassified or unintentionally omitted due to minimal online presence or vague operational focus. This estimated error range helps frame our findings as a robust but not exhaustive mapping of the UK RAS industry.

2.3 International Benchmarking

While global data on the adoption of Robotics and Autonomous Systems (RAS) is readily available [3], there remains a significant gap in information regarding the manufacturing base that develops and produces emerging RAS technologies. A detailed comparative study has concentrated specifically on humanoid robots. In February 2025, Morgan Stanley released an in-depth global report titled *"The Humanoid 100: Mapping the Humanoid Value Chain"* [1], which revealed that Arm Holdings (the UK-based semiconductor design company) is the sole UK representative within the global value chain of the top 100 humanoid robots. The report further highlights the UK's relatively marginal position in this field. Over the past five years, the UK ranked 14th worldwide in the number of humanoid robot-related patents, filing only 18, dramatically trailing China's 5,688 filings, and behind countries such as Poland and Brazil.

3 Domestic Manufacturing Patterns

To gain deeper insights into the UK RAS manufacturing ecosystem, we conducted a survey targeting 'UK-based RAS manufacturers' and 'UK RAS system integrators' involved in both hardware and software development. We analysed responses from 29 organisations (approximately 10% of the eligible population) of which 90% were SMEs.

3.1 Classification of RAS Subcomponents

Future robots will take on a wide variety of forms, from traditional robotic arms used in manufacturing, to robotic vacuum cleaners, wheeled logistics robots in warehouses, and general-purpose humanoid assistants. Despite their diversity, all robots are built from a set of fundamental components. *The Humanoid 100 report* [1] simplifies these into four core elements: Sensors, Brain, Actuators, and Movement.

Here we classify under the categories of software and hardware components. Table 2 outlines the subcomponent descriptions used in this analysis.

> UK suppliers [are praised] for "better quality management and customer service" and the ability to resolve issues quickly in person.

Hardware	
Chassis	The structural frame that supports and holds together all the components of a mobile ground robot.
Bodywork or Casing	The protective outer shell that shields internal parts and gives the robot its finished shape.
Manipulators	Mechanical arms that provide the reach and articulation needed for the robot to interact with objects.
End Effectors (Hands/Grippers)	Specialized attachments at the end of a manipulator—such as grippers or tools—that grasp or manipulate items.
Steering and Suspension	The systems that enable a mobile robot to turn accurately and absorb shocks for smooth movement.
Large Motors (for Mobile Robots)	High-torque electric drives that power the robot's wheels or tracks for locomotion.
Precision Actuators	Fine-control devices that allow exact positioning and delicate movements of robotic parts.
Electronics	The circuit boards and wiring that distribute power and carry signals throughout the robot.
Processors	Computer chips that execute control software and process incoming sensor information.
Sensors	Devices that detect physical inputs—like light, distance, force, or temperature—to inform the robot about its environment.

Software	
Algorithm/Fundamental AI Development	The design and implementation of core software routines and machine-learning models that govern how the robot thinks and acts.
Data Collection	The systematic gathering of raw operational and sensor data for analysis and training AI models.
Sensor Setup	The calibration and positioning of sensors to ensure they capture accurate and reliable measurements.
Data Processing/Markup	The cleaning, labelling, and organizing of collected data to prepare it for analysis or machine learning.
Validation of AI Models	Rigorous testing to confirm that the robot's AI behaves correctly and meets performance standards.
Systems Architecture Delivery	Defining and integrating the overall design blueprint so all robotic subsystems work together seamlessly.
Software Development	Writing, testing, and maintaining the code that controls every aspect of the robot's operation.
User Experience/UI Design	Creating interfaces and controls that make interacting with the robot intuitive and efficient.
Testing and Validation of Software Platforms	Running the robot's software through various scenarios to verify stability, functionality, and safety.
Software Management and Analysis	Overseeing version control, deployment processes, and performance monitoring to keep the robot's software reliable and up to date.

Table 2 Key Elements of RAS Systems

3.2 The Origins of Hardware Components

We asked the survey pool the origin of components within their RAS (figure 1). The hardware results show that structural and mechanical parts (e.g. chassis, body frames, wheels/steering) are predominantly sourced within the UK, often produced in-house, whereas motors, electronic control components, and high-tech sensors tend to be imported, primarily from Asia, USA and China.

Specifically, >70% of respondents who use bodywork/casings obtain them from UK sources (reflecting strong local fabrication capability), and over 75% source chassis and suspension parts domestically. In contrast, >85% of firms source motors from overseas (most citing China or other Asian countries), with only ~15% obtaining motors in the UK. Similarly, more than 70% rely on foreign suppliers for precision motors (actuators) and over 60% for advanced sensors and processors. Standard electronics (circuitry, PCBs) are a mixed case, about two-thirds of respondents keep electronics sourcing domestic, but one-third still import electronics, often for cost reasons. Notably, manipulators and end effectors show a roughly even split (about half of companies' source these domestically, half abroad), reflecting varied strategies depending on in-house capabilities and product focus.

> Some components are being solely manufactured in China at the scale required.

One critical factor is availability of expertise and capacity. Some advanced components are believed to not be widely available in the UK today. For example, several companies noted a lack of UK manufacturers for certain motor types or high-end sensors. As one respondent lamented, *"Some components are being solely manufactured in China at the scale required."* Even where UK options exist, their limited production scale can mean longer lead times or higher unit costs. This aligns with wider observations that the UK has "very little research on manufacture of enabling robotic technology," leading companies to go overseas for those enabling components.

On the positive side, the fact that mechanical parts and even some electronics are sourced locally by many indicates there is a foundation of domestic suppliers and skills to build on. Respondents praised UK suppliers for *"better quality management and customer service"* and the ability to resolve issues quickly in person; advantages that motivate a "UK-first" approach when feasible. Indeed, some companies have explicit policies to prioritize UK suppliers for non-commodity parts. But when it comes to items that UK industry does not produce at scale (motors, certain chips), they feel they have little choice but to import. The resultant dependence on foreign supply chains was highlighted as a pain point, especially during recent disruptions. For instance, a mobile robot maker shared that *"reliance on external manufacturing nations for key components (e.g. China, Japan, EU) [is a major risk]."*

Several illustrative comments capture these dynamics:

- *"[We have] company policies to source local wherever possible so that any issues can be resolved quickly via an in-person meeting. This does increase costs in the short term; the intention is that the more we and other companies buy and support local, [costs] may decrease."* (UK manufacturer in military/nuclear sector). This quote shows the commitment to local sourcing for quality and responsiveness, despite a cost penalty, in hopes of long-term improvements as local volumes grow.
- *"Motors, control units, electronics...cost of production [is the reason we source from China]."* (RAS SME) Many echoed that cost is the primary reason for sourcing from China for core hardware. Lower labour costs, economies of scale, and aggressive pricing by Chinese suppliers make it hard for UK producers to compete on price.
- *"Availability of expertise [is why we go overseas for some parts]."* For components like specialized sensors, manipulators, or precision gearboxes, several firms indicated they use overseas vendors because the technical know-how or manufacturing capability for those parts is stronger abroad. One respondent noted that local suppliers for certain advanced robotic parts simply "don't exist or are very few," pushing them to countries with the requisite expertise (e.g. Germany for manipulators, the US for high-end sensors, etc.).

3.3 The Origins of Software Components

In sharp contrast to hardware, virtually all software and AI-related work is undertaken in-house in the UK (figure 2). Every respondent indicated they use software or AI in their systems, and the overwhelming majority (over 90%) develop each software component domestically (often internally). Only a handful of firms outsource certain software tasks overseas, and even those are limited to very specific functions. Specifically, no respondents outsource critical integration tasks like sensor setup/calibration, system architecture, or data management; these are done by UK teams universally. Routine software development and testing are also almost entirely in-house (only ~7% had any external help). The areas with slightly higher outsourcing were AI algorithm development and user interface (UI/UX) design, around 14% of firms tapped overseas talent for these. For example, a couple of companies collaborated with U.S. partners for AI development, and a few hired design contractors in Asia/Africa for UI graphics. Even so, 85%+ kept those functions local. Data processing/annotation for AI models saw a small amount (~7%) of outsourcing, to places like India where large-scale data labelling is cost-effective.

This uniformity reflects the UK's strength and strategic approach in RAS software. Many UK robotics firms originate as spin-outs from academia or started with a software-first focus (e.g. AI or control algorithms), so they possess strong internal expertise in software development. Moreover, unlike hardware, outsourcing software offers less advantage; labour cost differentials exist, but for cutting-edge robotics software, having the engineers on-site (or at least in-country) collaborating closely with hardware teams is crucial. Several respondents noted the *"bespoke nature"* of their solutions requires deep knowledge and quick iteration, making it impractical to send work offshore. The survey data supports this: respondents overwhelmingly kept core competencies like algorithms, systems engineering, and testing in-house.

There is also a security and IP consideration; companies may be reluctant to outsource AI code or sensitive logic abroad due to intellectual property protection and data security concerns (one respondent wrote simply: *"Security"* when asked about software outsourcing). Additionally, the UK has a relatively large pool of software talent compared to hardware manufacturing talent. Universities produce a large number of software/AI graduates, and while there is competition for AI experts, our results suggest robotics firms can find or train the talent domestically for their needs. One respondent clarified that for them, *"Software these days is often a multi-location approach; we use UK, US and India resources."* This indicates some companies leverage global talent networks but still anchor the development leadership in the UK.

> "Software these days is often a multi-location approach; we use UK, US and India resources."

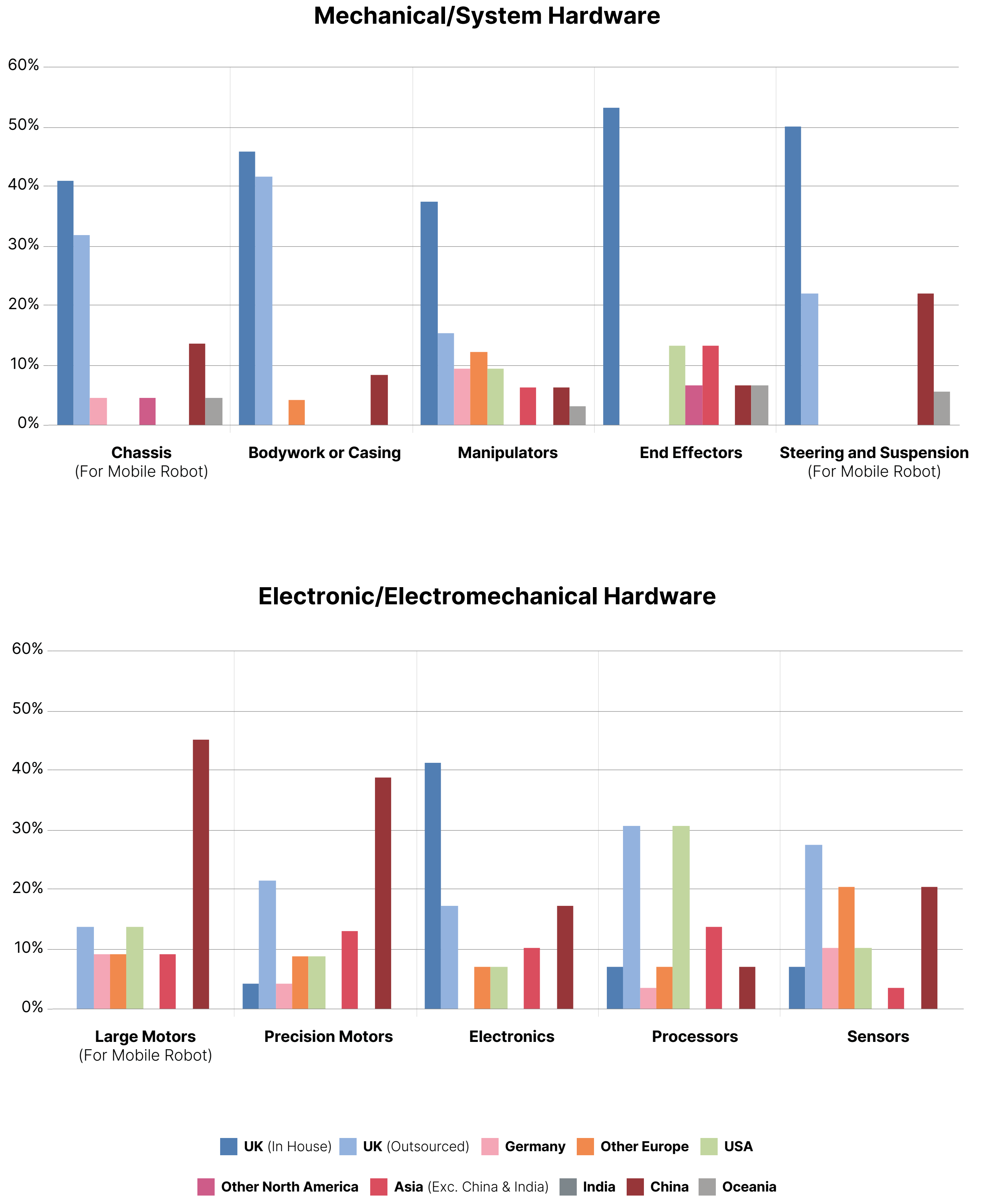


Figure 1 Origins of Hardware Components

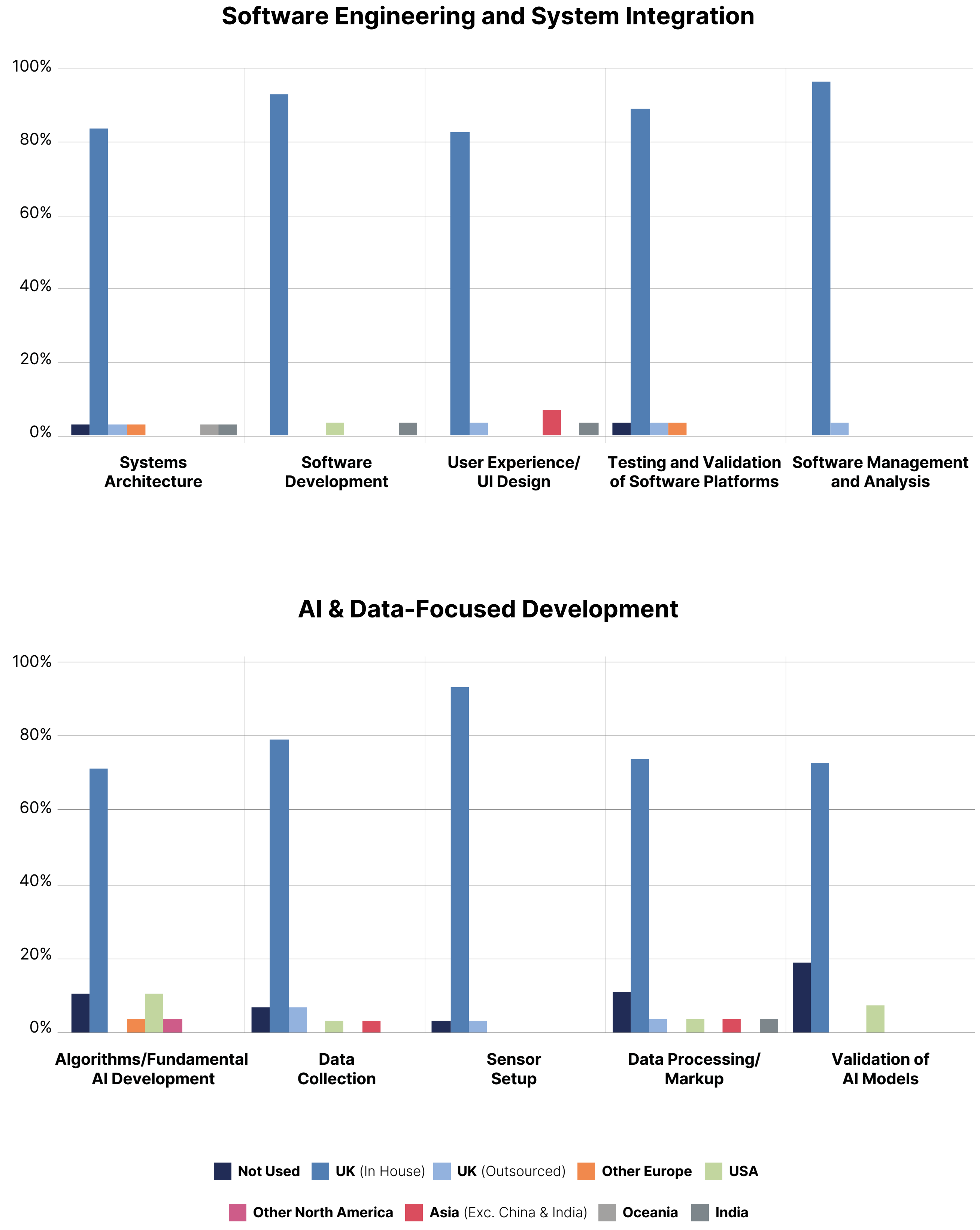
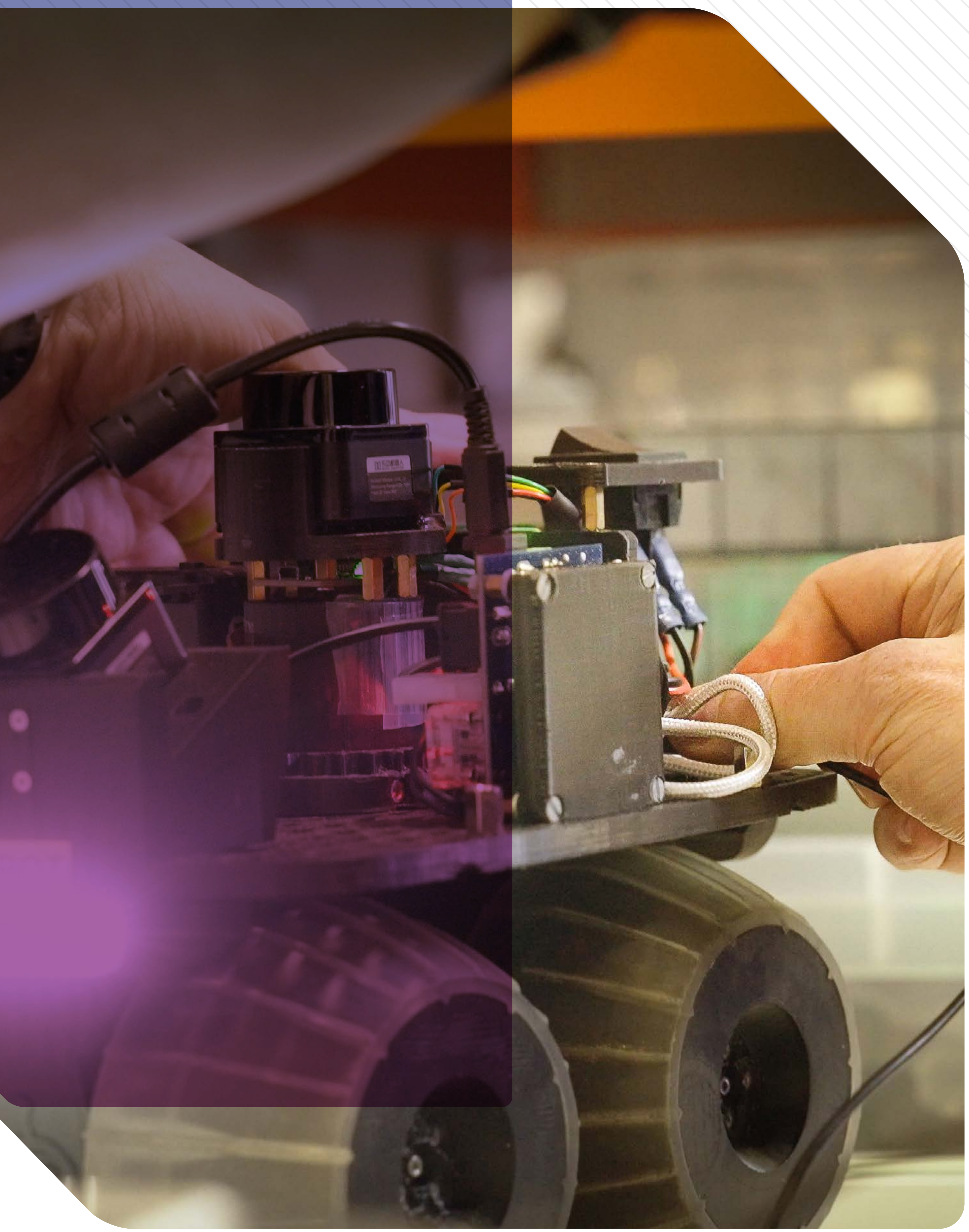


Figure 2 Origins of Software Components



4 Factors Influencing the Origins of Hardware Components

Within the survey, respondents selected the reasons for choosing the sourcing location of hardware components (respondents could select multiple reasons) such as *cost of production, availability of expertise, availability of physical resources or materials, manufacturing capability, quality/customer service, speed of delivery (figure 3)*. Two factors stood out:

- Cost factors: *Cost of production* was the single most cited reason behind sourcing choices for components that were obtained overseas. For example, every respondent who imports motors attributed it mainly to cost advantages. Similarly, cost was a dominant reason for those importing control electronics and processors. High UK labour and production costs appear to make locally made motors or electronics several times more expensive, so companies feel compelled to buy from lower-cost countries. Additionally, *cost of raw materials* was mentioned in a few cases (making it cheaper to source the whole component from abroad than to import materials to make it in the UK).

- Availability of capability: The next most common reason was the *availability of expertise or manufacturing capability* in the chosen source location. This reason was often given when respondents sourced a component from abroad not purely due to price, but because the component is not readily available from UK suppliers at the required level of sophistication. For instance, several companies sourcing advanced electronics and processors overseas said they did so because of expertise; implying that foreign suppliers (e.g. in Silicon Valley or East Asia) offer technology or know-how that no UK supplier currently matches. In the case of specialised sensors or robotic arms, some respondents looked to countries known for those niches (one mentioned sourcing manipulator arms from Denmark, home of a leading collaborative robotics manufacturer). For chassis and mechanical parts, even when sourced in the UK, *manufacturing capability* was often listed - i.e. the UK supplier had the requisite machinery and skills to fabricate the part, which justifies keeping production local.

Other reasons surfaced to a lesser extent: *availability of physical resources* (e.g. access to specific raw materials or components in the supply chain) was mentioned for both local and foreign sourcing decisions. For example, one might source certain high-grade alloys or electronics from abroad because the supply chain is stronger there. *Time/speed of delivery* was occasionally cited; a few companies kept sourcing local because it was faster to get parts made nearby than wait for imports. Whereas in one case a company imported because an overseas supplier could deliver faster at scale. *Quality of customer service* came up in favour of UK sourcing: respondents appreciate that UK suppliers communicate well and resolve problems swiftly, which adds value beyond just the part itself. Conversely, one respondent alluded to policy environment – noting that in some countries there are fewer regulatory burdens, which indirectly makes manufacturing cheaper and more efficient.

It is important to note that some respondents have adopted a strategic preference for local sourcing despite the cost penalty. One respondent working in the military/nuclear sector stressed that their industry is increasingly trying to "[remove] all overseas components with an undefined or unknown origin" for security and reliability reasons. This company has a "UK-first" policy for sourcing where feasible, valuing the control and quick support local suppliers provide. They acknowledged this approach "does in the short-term increase costs," but expressed the intention that if they and others buy and support local, economies of scale could improve, and costs might decrease. This viewpoint underscores a desire for supply chain sovereignty, especially in sensitive sectors, and a willingness among some UK companies to pay a premium to achieve it.

Skills shortages and a lack of specialised expertise are also major concerns. The UK has increasingly become service-oriented, resulting in diminished domestic manufacturing capacity and weakened workforce skillsets. Respondents specifically note the limited availability of experienced RAS engineers and skilled technicians as a barrier, hindering the sector's potential for innovation and expansion. Investment and funding constraints also significantly impede industry growth. Respondents' express frustration with the limited availability of venture capital, government incentives, and risk-tolerant funding, particularly during early stages of innovation. The UK's investment climate is often compared unfavourably to countries like the US and China, which possess more ambitious investment markets and more tolerant approaches to risk-taking in deep-tech sectors. To reduce dependence on imported components, respondents suggest encouraging foreign component manufacturers to establish operations within the UK. Facilitating greater domestic manufacturing capabilities, especially through targeted state-level interventions and investments, could strengthen the local supply chain, reduce vulnerabilities, and enhance overall competitiveness.

> "High UK labour and production costs appear to make locally made motors or electronics several times more expensive."

Some of raw comments give life to the views of the survey respondents:

- *"[The] UK is slow to adopt, slow to move out of academia, lack of government support."* – This encapsulates market and policy in one line. The slow transition from lab to market and perceived lack of government backing are seen as bottlenecks.
- *"Very weak domestic market for robotics."* A blunt assessment that came up multiple times. Low local demand means limited revenue to reinvest in UK manufacturing capability.
- *"Risk appetite of customers in the UK... [and] initial investment ecosystem [to] support companies in the earliest stages [is lacking]."* This highlights the double-sided conservatism: end-users are cautious about buying new UK-made robots, and investors are wary of funding early-stage robotics manufacturers.
- *"Cost of entry [is a barrier]."* & *"Cost of implementation of innovation."* These speak to the financial hurdle: whether starting a manufacturing line or getting a first-of-kind robot into a factory, the costs are high and often untenable without help.
- *"More companies in UK that produce sensors and motors that compete internationally."* This directly points to filling the supply chain gaps. It's essentially a plea for either growing such companies domestically or incentivising them to come to the UK.

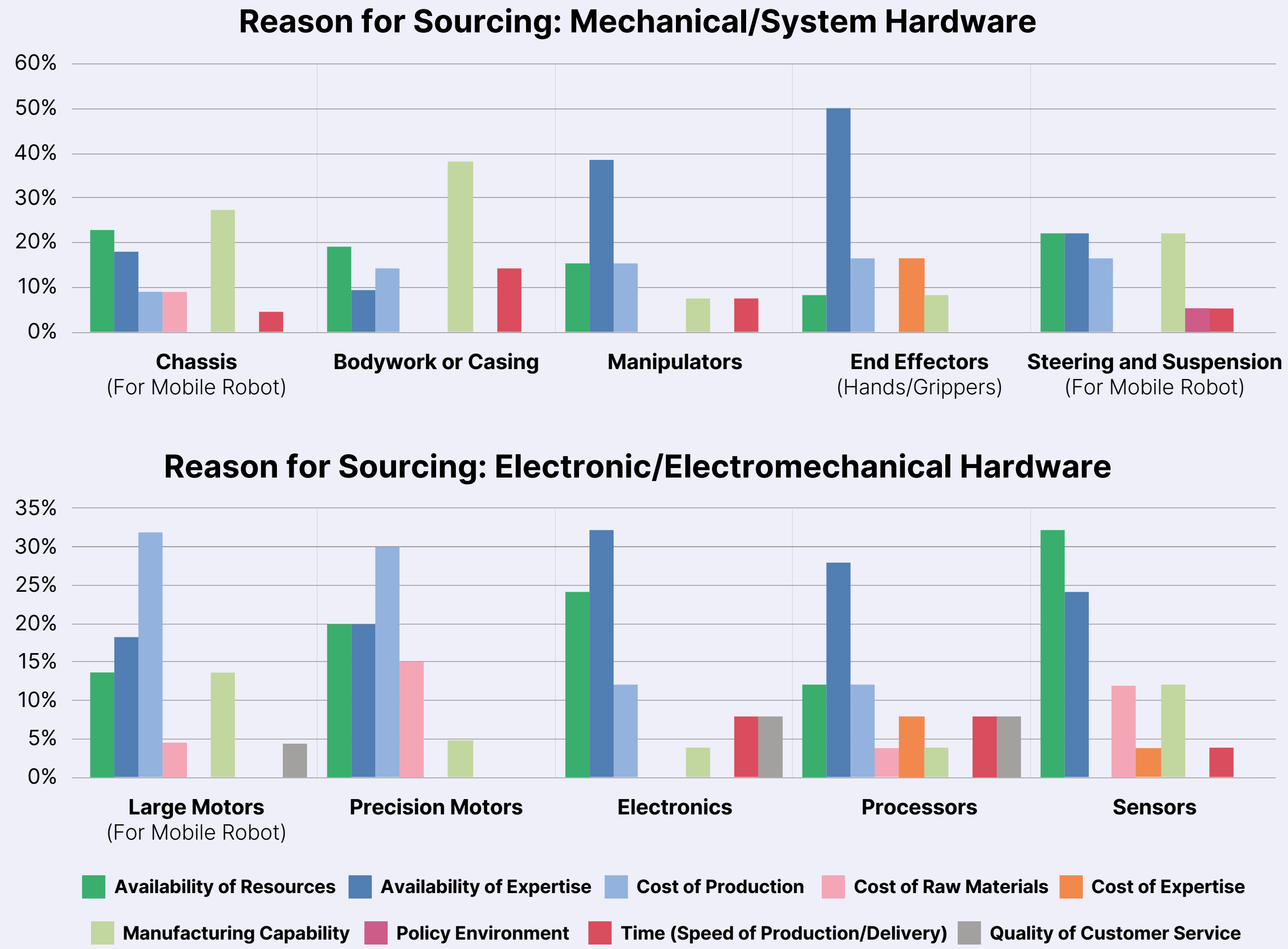


Figure 3 Factors Influencing the Origins of RAS Hardware Components Hardware

5 Challenges to Scale-up Manufacturing

Most UK RAS manufacturers currently operate at a small scale, typically producing up to two units per month. This presents a major obstacle to transitioning from batch production to large-scale mass manufacturing. Scaling up requires a fundamental shift in design and operations: components and systems must be re-engineered for manufacturability, standardisation, and ease of assembly; often at the expense of the customisation and precision possible at smaller scales.

The supply chain also becomes more complex, demanding robust sourcing strategies, supplier diversification, and advanced inventory management to ensure the reliable and timely delivery of components. At the same time, production facilities must be upgraded or expanded to accommodate automated assembly lines, enhanced testing protocols, and quality assurance systems capable of supporting high-volume output.

Companies must navigate a steep learning curve to upskill their workforce, adapting production planning methods, and ensuring compliance with industry and safety regulations. Maintaining consistent performance and reliability across large batches introduces new quality control and systems integration challenges, particularly for complex RAS products that rely on seamless interaction between mechanical, electrical, and software components.

To explore how these barriers can be addressed, we convened a summit "UK mass manufacturing of smart machines Summit" at the Royal College of Art, London that involved thirty industry participants, from both SMEs and large companies. The result was a 17-point guide outlining key challenges and factors towards overcoming them.

> "Scaling up requires a fundamental shift in design and operations."

1. **Secure multiple sources of funding**

   Don't rely only on traditional loans; investigate innovation grants, R&D tax credits, and venture capital early.

2. **Start simple and build from there**

   Focus first on your core product. Avoid building everything at once. Scale functionality in stages.

3. **Build your team around skills you'll need to grow**

   Work with universities, training providers, and industry networks to find or develop the people you'll need.

4. **Align with UK manufacturing priorities**

   Stay connected to government strategy. Support policies that promote domestic manufacturing and make your voice heard.

5. **Create space to innovate**

   Encourage calculated risk-taking in your team. Failure during testing is part of progress.

6. **Don't build everything yourself**

   Make sure of reliable suppliers for specialist parts or components; they have invested capital and training to be great at what they do (and are often affordable).

7. **Build financial resilience for supply shocks**

   Have backup funds ready to manage delays, price hikes, or sudden material shortages.

8. **Reduce long lead times by sourcing early and widely**

   Diversify your supplier base now; not after delays start affecting delivery.

9. **Plan for where and how you'll test your product**

   Access to realistic, reliable testing environments is vital. Use regional centres or build in-house testing if possible.

10. **Understand what scaling involves**

    Prepare for increased operational complexity; this involves more logistics, compliance, and coordination.

11. **Raise growth capital before it's urgent**

    Mass production is expensive. Secure investment before customer orders arrive.

12. **Validate your market before building at scale**

    Research your buyers and secure early commitments to avoid manufacturing a product no one will buy.

13. **Prioritise safety and certification from the beginning**

    If your product must meet industry standards, involve certification experts early in the design phase.

14. **Capture and retain knowledge**

    Document processes. Make sure knowledge doesn't leave when staff move on after short-term contracts.

15. **Avoid dependence on any single supplier or country**

    Global supply chains can be fragile. Build a diverse, reliable network of suppliers.

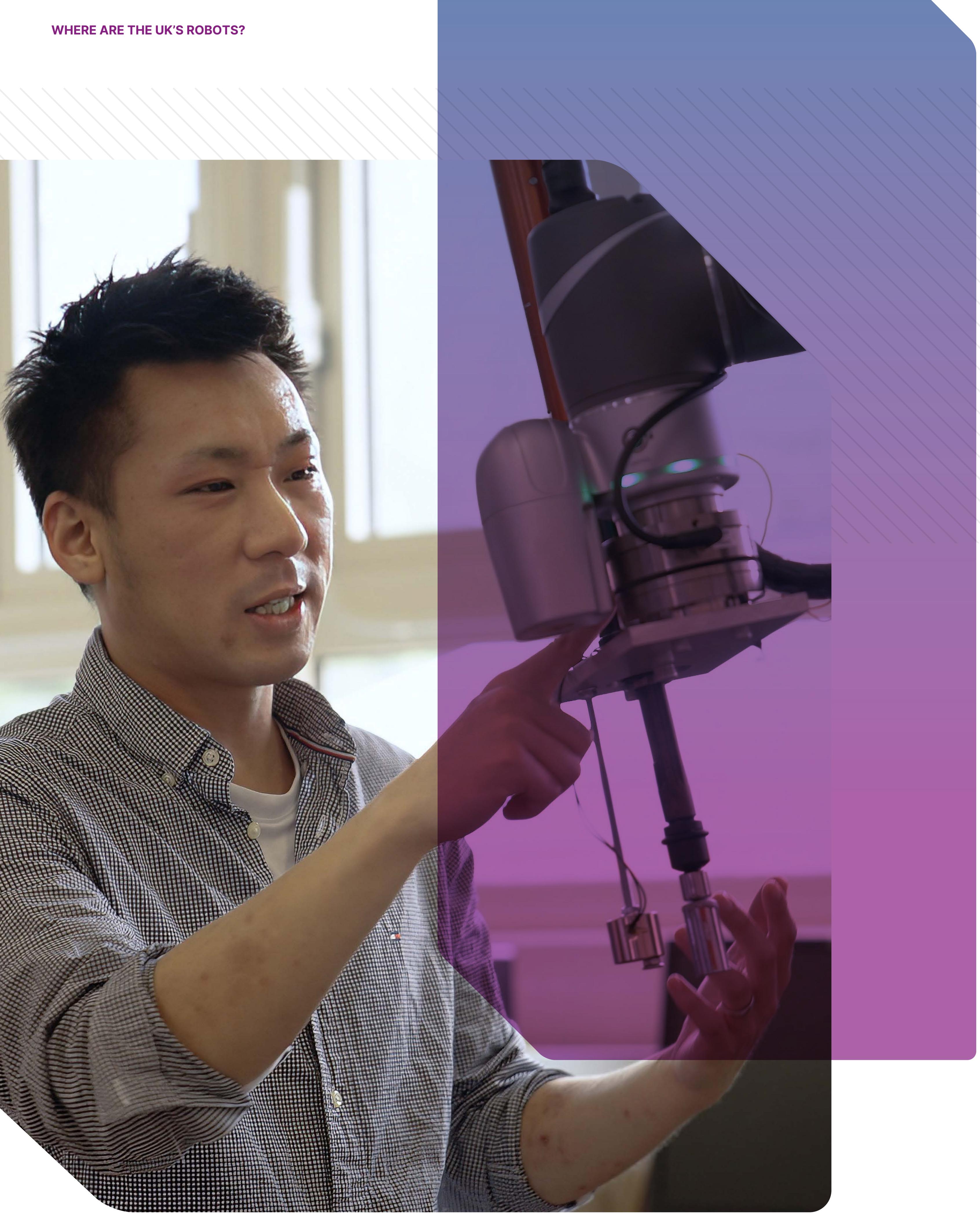
16. **Track your full financial journey, from prototype to scale**

    Map out all production costs. Don't move to mass manufacturing until your cash flow model supports it.

17. **Integrate all parts of your business into the scale-up plan**

    Your engineering, operations, finance, compliance, and sales functions all need to grow together.

Within the current ecosystem, businesses can seek support to navigate the journey from prototype to scale, with organisations like Innovate UK Business Connect [11] and the UK Catapult Network [12] offering targeted support for growth and innovation. These services provide access to funding opportunities, expert guidance, specialist facilities, and collaborative R&D partnerships across a wide range of sectors. However, there is a lot more support that is required as proposed in this report recommendations.



6 The Perceived Level of Manufacturing Resilience

Resilience to global disruptions refers to the ability of a business to anticipate, absorb, adapt to, and rapidly recover from global-scale disruptions such as pandemics, geopolitical tensions, climate change events, cyberattacks, or supply chain shocks. We asked respondents to estimate their current resilience level as well as providing justification for this score. On a scale of 1 (not at all resilient) to 10 (completely resilient), the median score was 5 and the mean ~5.2, indicating a mid-level self-assessed resilience (see figure 4).

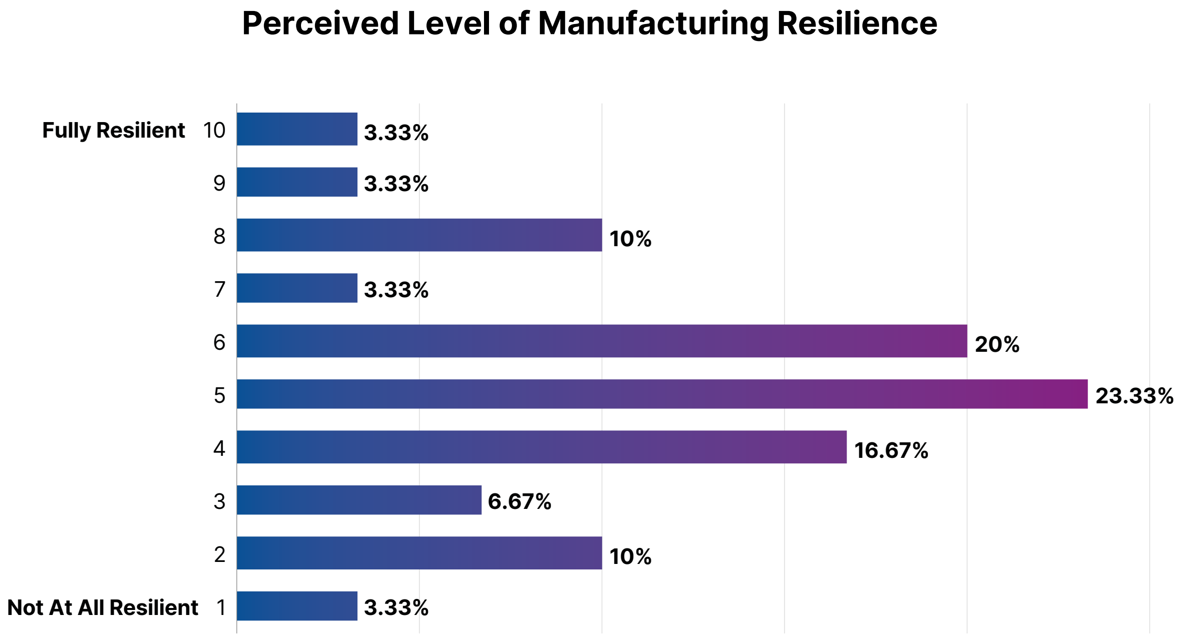


Figure 4 The Level of Manufacturing Resilience

Only one respondent rated themselves a perfect 10 ("fully resilient"). Conversely, only one rated as 1 ("not at all resilient"). Most clustered around 4, 5, and 6. The distribution shows 5 and 6 were the most common scores, each chosen by about 6–7 firms, while a few gave 2 or 8. In short, most companies see themselves as somewhat resilient but with significant vulnerabilities.

This cautious self-assessment likely reflects recent experiences and ongoing exposure to global risks. UK RAS firms have endured the COVID-19 pandemic, supply chain crises, and geopolitical uncertainties (e.g. trade tensions), which have stress-tested their resilience. A score of 5–6 suggests that companies feel they can manage some disruption, but not without difficulties. They likely have taken steps to buffer against shocks (perhaps diversifying suppliers or holding extra inventory) but still feel far from immune. The lack of high scores (9 or 10) indicates a recognition that current strategies leave them vulnerable, especially given the barriers discussed earlier.

Key vulnerabilities mentioned in their open-ended comments on resilience include global supply dependencies, competition surges, and regulatory shocks. For example, one respondent (who rated their resilience a 6) explained they lost a contract due to a sudden new overseas competitor product; showing how a market disruption (new entrant) quickly impacted them. Another (score 5) noted *"some components are solely made overseas at the required scale,"* implying if that supply were cut off or delayed, their production would grind to a halt. This ties back to heavy reliance on imports for certain parts; companies know this is a weakness.

> Key vulnerabilities include global supply dependencies, competition surges and regulatory shock.

Additionally, those who lived through COVID-related supply issues still recall the pain: delays on parts, price spikes, etc. One company cited *"Tariffs, parts availability and export controls are a large risk,"* highlighting that changes in trade policies or export restrictions abroad (like we've seen for semiconductors) could severely disrupt their operations. Brexit-related changes may also be behind some concerns (though not explicitly cited, the mention of tariffs and export controls is).

Many SMEs in this space are nimble and can adapt designs if one part becomes unavailable, which gives a baseline resilience. But structural issues like low cash reserves or dependency on single suppliers keep their resilience only moderate.

Some illustrative commentary on resilience:

- *"Take Covid for example, we survived as a company, but it really hurt us financially...to the point of considering closing."* (Score 5) – This candid reflection shows that while the company made it through the pandemic, it was nearly existential. They "survived" (hence not giving a 1) but the impact was severe and recovery perhaps ongoing. It underscores why they wouldn't claim to be highly resilient; one big shock nearly knocked them out.
- *"We know most of the good [suppliers], but it is always good to know of new companies to us."* – This comes from a resilience comment and interestingly ties resilience to networking. The company implies that expanding their supplier network (knowing more good suppliers) is a resilience strategy. This directly feeds into the idea of a registry (next section) – connectivity can improve resilience by providing alternatives and support.
- *"Tariffs, parts availability and export controls are a large risk."* (Score 4) – This company explicitly lists global trade and supply issues as threats. A score of 4 indicates they feel quite exposed; perhaps they have not yet found ways to mitigate those risks other than hoping such scenarios don't occur or trying to stockpile parts.

In summary, raising that average resilience from ~5 to, say, 8 in the coming years will involve de-risking the environment in which these firms operate. That means fewer single points of failure (courtesy of diversified local supply options), better intelligence and preparation for global shocks, and perhaps a safety net for extreme events.

7 The Circular Economy

7.1 Sustainable End-of-Life Practices

RAS, like any other complex engineered product, are built from a combination of valuable materials, many of which are difficult to recover, reuse, or recycle. When considering manufacturing, it is also vital to consider establishing sustainable end-of-life (EoL) practices

RAS contain critical raw materials, such as rare earth elements, copper, cobalt, and advanced composites, that are finite, expensive, and often sourced through environmentally damaging and geopolitically unstable supply chains. Without a system for recovery, these materials are lost to landfill or incineration. Worse still, the environmental cost of robotic waste (especially electronic components) can be high in terms of energy, toxicity, and embodied carbon.

The circular economy provides a framework to address this challenge. It prioritises designing products for durability, reuse, and recovery. Applied to RAS, this means considering the entire lifecycle from the very beginning, including modularity, ease of disassembly, material separability, and recyclability.

7.2 Critical Challenges in End-of-Life Robotics

End-of-life design must be considered during the initial engineering phase, as retrofitting recyclability or disassembly features later is often inefficient and costly. Effective sequence planning is crucial, as disassembling one high-value component may require removing several others, increasing both cost and energy use. Key components like actuators, batteries, and PCBs are often deeply embedded, making recovery uneconomical without thoughtful, sequence-informed design. Additionally, many robots are built with fused, moulded, or glued composite structures that are difficult to separate using automation, highlighting the need for redesigns that prioritise material recovery. While automated disassembly is feasible, its success depends heavily on the specific design context and component layout.

7.3 UK Initiatives Leading the Way

Two major UK led projects are tackling these challenges head-on.

(EPSRC) Manufacturing Research Hub in Robotics, Automation & Smart Machine Enabled Sustainable Circular Manufacturing & Materials (RESCu-M^2)

The University of Birmingham is leading a national hub that aims [13] to transition the UK to a circular manufacturing ecosystem, supported by £11m from the Engineering and Physical Sciences Research Council (EPSRC) and £23.6m from project partners.

Part of UK Research and Innovation's 'Manufacturing research hubs for a sustainable future' programme, RESCu-M^2 will address two major challenges: the sustainable use of critical materials and the productivity of Re-X processes, which include reuse, repurpose, repair, re-manufacture and recycle; both using robots and applied to robots. These processes are currently more labour-intensive than traditional manufacturing, leading to significant material waste.

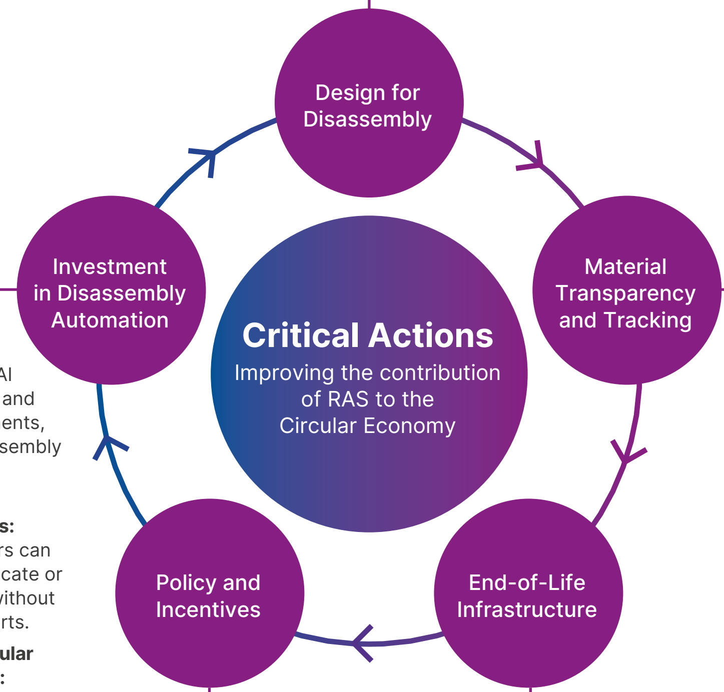
EPSRC The Circular Robot 5.0

The Circular Robot 5.0 project [14] is a £1.9 million EPSRC-funded project led by the Royal College of Art (RCA) that aims to advance a circular economy for industrial robots in manufacturing production lines. By strategically integrating AI-driven predictive maintenance powered by authentic performance data, secured through tamper-proof and traceable blockchain technology, along with comprehensive life-cycle assessments, the project seeks to extend the operational lifespan of industrial robots and enable end-of-life re-manufacturing and recycling of embedded critical raw materials. This three-year programme brings together leading academic institutions including Loughborough University, King's College London, UCL and the Manufacturing Technology Centre (MTC), in collaboration with major industry partners such as NVIDIA, Omron, ASTM International, KATLAS Technology, Wootzano and Inovo Robotics.

7.4 The Application of Circular Economy Principles to RAS

We propose five action areas to improve RAS for the circular economy:

- **Modular architecture:** Designing robots with modular components allows individual parts to be replaced, repaired, or upgraded without discarding the entire system.
- **Non-destructive fasteners:** Using screws, clips, or snap-fits (well designed to be dismantlable) instead of glue or welds enables easy separation of parts during maintenance or recycling.
- **Standardised components:** Incorporating industry-standard parts improves compatibility, simplifies repairs, and facilitates reuse across different systems.



- **AI-powered identification:** Vision systems powered by AI can quickly recognise and classify robot components, streamlining the disassembly process.
- **High dexterity Force-sensitive robotic tools:** Advanced manipulators can carefully separate delicate or complex assemblies without damaging reusable parts.
- **Swarm-based or modular disassembly systems:** Distributed robotic systems can work collaboratively to disassemble complex machines more efficiently and flexibly than single large robots.

- **Label components by material type:** Clear labelling helps recyclers identify and sort materials correctly, reducing contamination and improving recovery rates.
- **Use digital twins for lifecycle tracking:** Digital representations of robots can store data on materials, usage, and repair history, supporting more efficient end-of-life decisions and material recovery.

- **Extended Producer Responsibility (EPR) for robotic systems:** Mandating that manufacturers are responsible for the full lifecycle of their products encourages sustainable design and take-back schemes.
- **Tax relief for sustainable design practices:** Financial incentives can motivate companies to adopt eco-friendly materials and design choices that support circularity.

- **Regional centres for robot refurbishment or disassembly:** Localised facilities enable cost-effective and low-emission pathways for repairing, reusing, or dismantling robotic systems.
- **Automated sorting and testing systems:** Integrating automation into disassembly centres can improve speed, accuracy, and safety when processing robots at the end of their lifecycle.

8 Recommendation 1:
A National Registry for RAS Industry

Building on the evidence gathered within this research, we propose the UK creates a national registry for the UK RAS industry.

8.1 Aims of a Registry

Building on previous work, the aim of a National RAS Registry is to establish a unified, accessible platform that maps the UK's robotics and autonomous systems ecosystem, linking manufacturers, suppliers, integrators, researchers, and service providers.

This registry will strengthen national connectivity, enabling companies to discover potential collaborators, local suppliers, talent, and innovation partners. Given the current fragmentation and lack of visibility across the UK RAS sector, the registry will reduce isolation among SMEs, foster strategic partnerships, and accelerate knowledge exchange. It will also support supply chain resilience by making it easier to identify domestic alternatives to imported components and services, a need highlighted by recent global disruptions. Additionally, the registry will function as a tool to attract investment, talent, and research collaboration by increasing visibility for UK-based companies, especially smaller or niche players.

> "93% of respondents answered "Yes" when asked if they would find a UK-based RAS manufacturers/suppliers registry useful."

8.2 Community Need

We asked our survey to pole their views on a National Register for RAS. The survey results show there is near-unanimous support among UK RAS manufacturers for a National Registry of robotics companies, with the vast majority willing to participate. Approximately 93% of respondents answered "Yes" when asked if they would find a UK-based RAS manufacturers/suppliers registry useful, and a similar 93% indicated they would like to be part of such a registry (only 2 respondents said "No" in each case). In essence, almost all companies see value in better connecting the UK RAS ecosystem and want to join a platform that facilitates this.

This strong mandate suggests a gap in the current landscape: there is no easily accessible directory or forum that brings together all players (manufacturers, suppliers, integrators, researchers) in UK robotics manufacturing.

Our survey has revealed companies find it time-consuming to discover who else is out there beyond their immediate network. A registry would lower the barrier to find collaborators or local vendors for components (which, as we saw, can aid resilience and reduce outsourcing). The enthusiasm also stems from the recognition that networking can unlock opportunities, whether sales leads, partnerships for R&D, or simply shared knowledge.

8.3 Expected Benefits from a UK RAS Registry

The survey outcome reveals network-building and business development are the dominant motivations for a registry (figure 5).

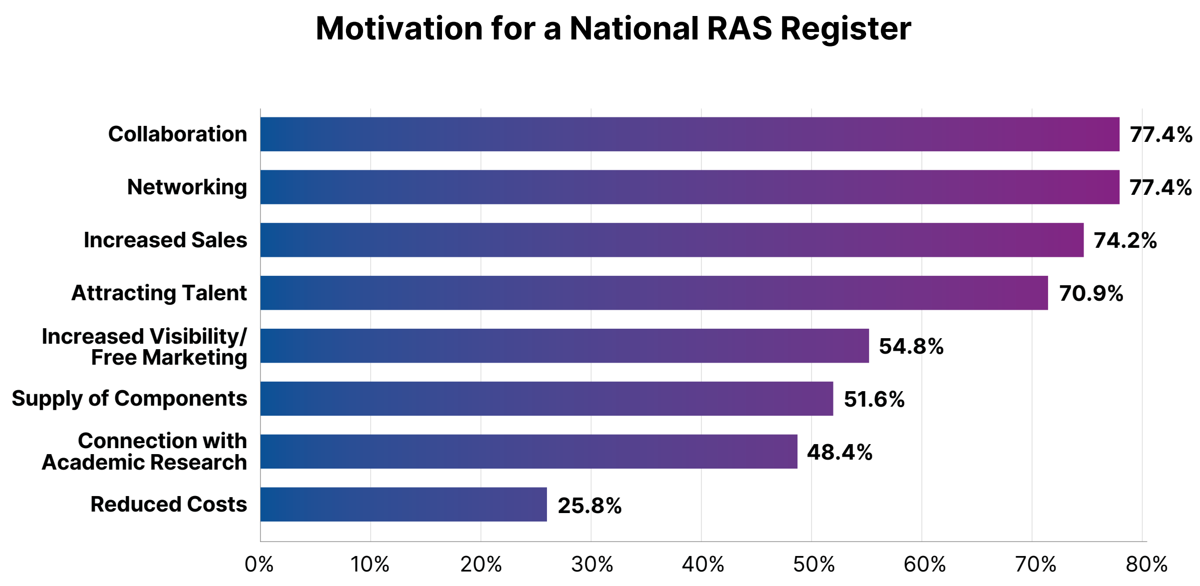


Figure 5 Motivation for a National RAS Register

It is evident that UK companies are keen to collaborate with other domestic firms, as reflected in statements such as: *"We want to connect and collaborate to grow our business and innovate."* Collaboration and networking were each cited by 76% of respondents, highlighting a strong appetite for partnership; whether for co-developing products, engaging in joint ventures, or exchanging knowledge.

Increased sales (72%) also emerged as a major motivator, suggesting that a registry could serve as a valuable marketing tool that will help companies attract potential clients or be discovered by end-users and integrators. Similarly, "increased visibility," cited by 52%, underscores the desire to gain market exposure. When combined, sales- and marketing-related motivations (sales + visibility) were mentioned by approximately 90% of respondents, making this a dominant theme. "Connection with academic research" at 45% indicates almost half see value in linking with universities and labs through the registry. This could mean easier access to research findings, partnering on grants, or recruiting graduates. It underscores the importance of involving academia in the network.

"Attracting talent" was cited by 72% of respondents, making it a major theme. Many companies report difficulties in hiring specialised personnel, and a registry could enhance their visibility to job seekers or support talent-sharing initiatives. It could also help connect firms to academic pipelines which is reflected in the 45% who selected "connection with academic research.". This suggests that organisations value links with universities and research institutions, whether to access cutting-edge research, collaborate on grants, or recruit graduates. It reinforces the importance of involving academia in the network. In contrast, "reduced costs" was selected by only 24%, indicating that most companies do not expect immediate cost savings through networking. However, nearly 48% saw potential benefits in the "supply of components", (such as bulk ordering or identifying more cost-effective suppliers) pointing to some recognition of long-term operational efficiencies.

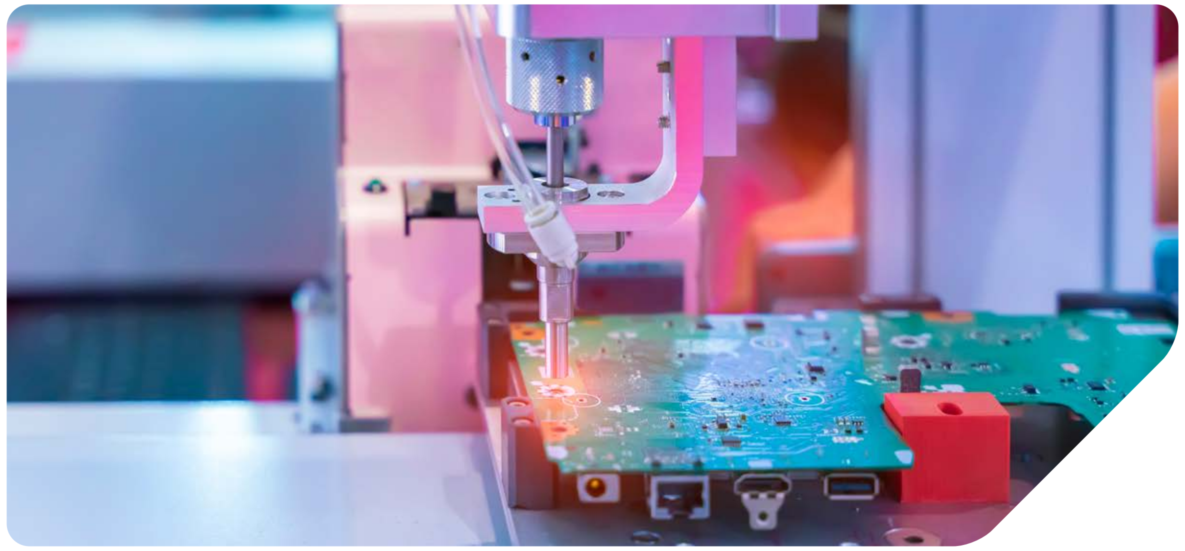
> "We want to connect and collaborate to grow our business and innovate."

9 Recommendation 2:

Establishing a RAS Component Adoption Hub

To fully realise the potential of the UK's Robotics and Autonomous Systems (RAS) sector, it is imperative to establish a dedicated *RAS Component Adoption Hub*. This facility will directly address a critical barrier identified throughout our research: the significant lack of visibility and coordination among organisations involved in developing, manufacturing, and integrating robotic subcomponents across the UK. This fragmentation limits domestic growth and innovation, particularly in crucial areas such as precision motors, sensors, and advanced electronic control systems, where companies frequently rely on overseas suppliers.

The RAS Component Adoption Hub would serve as a central, neutral platform where SMEs, large corporations, academic institutions, and government bodies can converge to showcase, test, and collaboratively develop new robotic subcomponent technologies. Building upon the narrative articulated in the Smart Machines Strategy 2035 [9], this facility aligns closely with the UK's ambition to foster world-leading smart machine capabilities by enhancing collaboration, innovation, and domestic supply chain resilience. As well as providing organisations dedicated support for mass manufacturing of RAS technologies.



Specifically, the Hub would provide:

- **Physical Demonstration Spaces:** Interactive showcases and practical demonstrations of UK-manufactured components, allowing potential Adoption and integrators to see and evaluate cutting-edge innovations in action. Such spaces promote transparency and confidence in local supply capabilities.
- **Hands-on Testing and Prototyping Labs:** Facilitating the direct, hands-on testing and integration of various subcomponents, these labs will lower the barrier to domestic adoption and encourage the use of homegrown technology. It supports the "try-before-you-buy" ethos, critical for risk-averse industries and essential in validating performance and interoperability.
- **Collaborative Development Zones:** Dedicated areas for joint development projects where companies and researchers from diverse sectors can collaborate to co-create solutions. This environment fosters open innovation, cross-sector learning, and faster development cycles by leveraging diverse expertise.
- **Supply Chain Networking Events:** Regular networking sessions and events designed explicitly to connect suppliers, integrators, and end-users, thereby building robust domestic supply networks. This initiative will strengthen supply chain resilience and reduce dependency on external markets.
- **Market Intelligence and Gap Analysis:** Leveraging insights from the National RAS Registry, the Hub would highlight gaps in the UK's robotics supply chain, directing investment and research funding towards areas with significant potential for domestic growth, such as precision actuators and advanced sensing technologies.
- **Support scale up mass manufacturing for RAS technologies.** Support organisations in the mass manufacturing scale up of RAS through expert technical advice, and structured collaborations to programmes such as made smarter [15], Innovation accelerators and catapult centres [13].

By amplifying the capabilities showcased through the National Registry for RAS, the Component Adoption Hub acts as a strategic catalyst, converting digital visibility into tangible economic and technological outcomes. It will enable the UK RAS ecosystem to flourish, securing its competitive edge and resilience by nurturing domestic capabilities, reducing vulnerabilities to global supply chain disruptions, and accelerating the innovation-to-market pipeline.

10 Recommendation 3:
Skills and training

Skills and training emerged as a recurring theme throughout the survey. The UK currently faces gaps in specialised knowledge and a shortage of trained experts capable of delivering high-impact results. Addressing this challenge requires a workforce that is adaptable, technically versatile, and equipped to drive innovation. Unlocking the UK's full potential in RAS manufacturing will depend on developing talent that combines advanced engineering, software expertise, and hands-on system integration skills.

- **Interdisciplinary Competence:** Engineers must effortlessly integrate mechanics, electronics, AI, and software, mastering real-time control, sensor fusion, and modular robotics design.
- **Continuous Upskilling Pathways:** As robotics systems evolve, so must professionals; requiring agile CPD routes into areas like digital manufacturing, digital twins, human–robot interaction, and safety standards.
- **Hands-on, Industry-linked Learning:** Classroom theory must be augmented with live labs and secondments within manufacturing and technical-demonstrator facilities to mirror real-world complexities.
- **Professional Recognition & Mobility:** Technical roles need clear career structures, peer recognition, and mobility between academia and industry, reducing attrition and building expertise.

To solve these challenges, we propose three recommendations:

1. **Centre-based Apprenticeships in RAS Manufacturing**

   Launch advanced, industry-sponsored apprenticeships embedded within collaborative innovation centres. Apprentices would split time between classroom instruction and practical roles in robotics-focused pilot facilities, focusing on mechatronics, software integration, modular systems design, and industrial deployment.

2. **National 'Secondment & Showcase' Scheme**

   Establish a funded exchange programme where technicians and early-career engineers rotate between universities, research centres, and manufacturers. This ensures continuous learning, fosters cross-sector collaboration, and builds a shared community of RAS-skilled technicians

3. **Modular Micro-Certification for Emerging RAS Skills**

   Create a stackable certification system covering core RAS skill sets e.g., AI in robotics, sensory interfacing, disassembly automation. These micro-certificates (available through training providers and online) allow professionals to upskill rapidly and visibly progress their careers.

EPSRC UK RAS STEPS (Robotics & Autonomous Systems Strategic Technical Platform)

UK RAS STEPS (Robotics & Autonomous Systems Strategic Technical Platform) [16] is a UKRI and EPSRC funded initiative launched in 2024), designed to empower Research Technical Professionals (RTPs) in robotics and autonomous systems. Rooted in a community driven model, STEPS unites 37 universities and research centres to elevate technical careers and strengthen the UK's RAS research infrastructure.

The programme supports skilled technicians by offering funded training, mentorship, knowledge exchange placements, networking events, and participation in Special Interest Groups (SIGs) focused on niche areas like liquid handling robotics and AI autonomy. A flagship Technical Showcase, workshops, and international visits encourage collaboration and skills sharing across academia and industry. Placements—both short- and longer-term—facilitate cross-institutional exchange and real-world experience.

Structurally, STEPS pursues three strategic goals: bolstering individual technical skills and career development; fostering community-building, knowledge sharing, and advocacy; and delivering an inclusive, ethical, and sustainable platform. With its combination of professional development, networking, and infrastructure support, UK RAS STEPS aims to elevate the status and impact of technical talent - ensuring a robust pipeline of expertise to sustain and advance the UK's robotics research leadership.

11 Summary and Conclusions

The analysis presented within this report clearly indicates that while the UK has foundational strengths in robotics and autonomous systems (RAS), there are significant barriers hindering the transition into a globally competitive manufacturing ecosystem. Currently, a substantial proportion of UK RAS manufacturing involves partial domestic assembly, dependent heavily on imported critical components such as motors, sensors, and advanced electronics. Conversely, domestic software and AI capabilities are notably robust, reflecting a strong local expertise base.

To fully leverage and grow existing strengths and effectively address identified shortcomings, the UK must strategically enhance its domestic RAS manufacturing ecosystem. Specifically, the sector requires coherent action targeting visibility, collaboration, skills development, and supply chain resilience.

Firstly, establishing a National RAS Registry will significantly improve visibility and interconnectedness within the industry, enabling easier identification of local suppliers and potential collaborators. This registry will facilitate more robust domestic supply chains, reduce dependency on external markets, and stimulate inward investment.

Secondly, the creation of a dedicated RAS Component Adoption Hub is recommended to enhance collaboration and innovation at the subcomponent level. This facility will allow organisations to showcase capabilities, conduct collaborative development, and accelerate adoption and market readiness. Such a hub will directly tackle current domestic supply chain vulnerabilities, particularly in strategically critical areas like precision motors and advanced sensors.

Thirdly, investment in targeted skills and training initiatives is essential. Addressing the existing gap in specialised knowledge and technical proficiency demands structured industry-linked apprenticeships, modular micro-certifications, and professional secondments. These initiatives should foster interdisciplinary competencies, continuous professional development, and robust career pathways, ensuring that the workforce can effectively meet evolving industry needs.

Finally, applying circular economy principles within RAS manufacturing will significantly enhance sustainability, resilience, and resource efficiency. This involves prioritising design for disassembly, increasing material transparency, developing regional end-of-life infrastructure, and implementing policy incentives for sustainable practices. Investment in automation for disassembly and refurbishment processes will further bolster the sector's sustainability and economic viability. Collectively, these recommendations form an integrated roadmap to elevate and grow the UK RAS sector from fragmented research and assembly practices into a cohesive, resilient, and innovative manufacturing powerhouse. By strategically aligning these efforts, the UK can secure long-term competitiveness, robust supply chains, and sustainable economic growth in the robotics and autonomous systems industry.

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