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Maritime skills on the Clyde

Demand, supply and options for supporting skills growth

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Preface

The launch of the National Shipbuilding Strategy in 2017 and its refresh in 2022 have heralded a more coordinated approach to the UK's shipbuilding sector, which included setting up a National Shipbuilding Office (NSO) and articulating a 30-year cross-government demand signal for shipbuilders.

In Scotland, maritime and shipbuilding industries have a long history and heritage. The fluctuations in demand and volatility of the sector seen over the last few decades have, however, eroded some of the shipbuilding and maritime skills base. Competition for talent with other rapidly growing sectors in Scotland, such as offshore wind, are presenting further challenges for Scottish maritime companies in terms of recruitment, growth and retention of a skilled workforce.

The Glasgow Chamber of Commerce, on behalf of the Clyde Maritime Enterprise and in coordination with Skills Development Scotland (SDS), Scotland's national skills body, commissioned RAND Europe to undertake a review of skills availability across maritime companies on the River Clyde to start developing a more nuanced understanding of workforce demographics and the types of skills that may be in short supply. RAND Europe was also asked to explore options for attracting and growing the necessary skilled labour and whether there are international good practices from which Clyde maritime partners and SDS could learn. The research was carried out between June 2023 and August 2024.

This report presents the final analysis of RAND Europe's research findings and should be of interest to the Clyde Maritime Enterprise as well as wider stakeholders in the maritime sector, companies operating across the wider UK, government departments responsible for the acquisition of naval or commercial vessels and, of course, the National Shipbuilding Office. More broadly, this report might also provide insights for stakeholders in other sectors in need of long-term workforce development and planning.

RAND Europe is a not-for-profit research institute whose mission is to inform public policy and decision making through objective research and analysis. For further information about this study, please contact:

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Summary

The release of the National Shipbuilding Strategy in 2017 and its refresh five years later ushered in a more structured and future-focused approach to the UK's shipbuilding sector. Accompanied by the creation of the National Shipbuilding Office (NSO), the articulation of a 30-year pipeline of 146 vessels to be delivered for civil and defence purposes and a targeted work on skills development, the government at the time indicated its commitment to sustaining and growing the shipbuilding industrial base. At the time of report writing, early announcements from the newly elected Labour government indicated that this commitment was likely to continue.

RAND Europe was commissioned by the Glasgow Chamber of Commerce, on behalf of the Clyde Maritime Enterprise and in collaboration with Skills Development Scotland, to identify opportunities and challenges for workforce development on the Clyde and concrete options for enhancing skills growth.

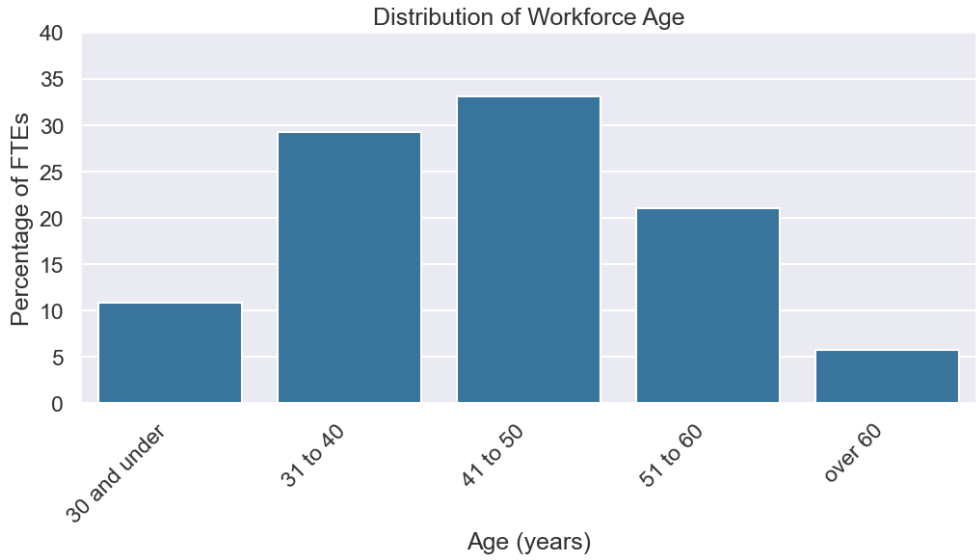
Revitalising the maritime sector on the Clyde will rely on stakeholders attracting and retaining skills against a vibrant competition

Despite the growing strategic coherence within the UK shipbuilding and maritime sectors, skills sustainment on the Clyde remains confronted by a number of challenges. The total number of people working in the sector is far lower than it used to be, with a sustained decline in workforce numbers since the 1990s. The total pool of workers has shrunk and shipbuilding has struggled to develop an attractive image due to fluctuations in demand and working conditions that are often seen as more demanding than office-based roles and jobs in the service sector. Decades of limited investment in facilities, low levels of modernisation and the location of shipyards in often socially and economically deprived areas have made for less appealing working conditions compared to other sectors competing for the same skills. Several stakeholders consulted in this study also see a deprioritisation of vocational training in Scotland and a decline in public funding for further education that has disproportionately impacted shipbuilding, a sector reliant on technical training provided by employers, colleges and training providers. Finally, the sector faces mounting competition from adjacent sectors, such as the offshore wind industry, automobile industry and infrastructure, that demand the same skills, particularly electrical engineering, mechanical engineering and welding. This is in addition to natural competition for talent among the maritime companies themselves.

Maritime industries on the Clyde have a strong supply of young labour force, but high turnover creates concern vis-à-vis future demand

The current maritime workforce on the Clyde from across the surveyed companies comprises over 8,000 full-time equivalent employees (FTEs).[1] This workforce displays a healthy age demographic profile, with about one third of the workforce currently aged between 31 and 40 and only about one fifth of employees aged between 51 and 60 years old. This is shown in Figure 0.1. Such balanced age distribution means that there are more opportunities for knowledge transfer from more experienced (typically older) workers and greater certainty that a demographic 'cliff edge' can be avoided. Finally, a more balanced age demographic typically enables smoother transition from earlier career stages through to more senior roles, backfilling posts as more experienced personnel leave or retire.

Figure 0.1. Age demographics of the maritime workforce on the Clyde



Source: RAND Europe analysis of industry workforce survey data (2024).

On the flipside, however, companies on the Clyde saw high hiring rates but also high loss rates over the last five years, resulting in modest net growth of workforce until 2023. RAND Europe's system dynamics model shows that this net growth would not be sufficient to support an overall growth in workforce to deliver against an increased demand signal. Skills gaps across technical, structure, outfitting as well as management and manufacturing support skills would likely persist until the late 2020s if demand rose by up to 15 per cent.

Looking at specific skills, several companies participating in this study flagged high levels of concern about sourcing sufficient numbers of electrical and mechanical engineers, as well as steelworkers, platers, boilermakers and welders – all of which are required in high numbers. Companies must compete for these skills among themselves as well as with other sectors, such as construction, renewable energy and infrastructure. This further highlights the challenge of high turnover, as these skills can be highly mobile,

[1] Surveyed companies include BAE Systems, Babcock International, Ferguson Marine, Dales Marine and the Malin Group.

with a range of employment options available. In addition, companies are concerned about future supply of skills for specific roles requiring niche expertise and long-term experience on the job, specifically team leaders in fabrication and outfitting, programme control, quality assurance and control as well as specialised skills such as combat system integration, systems engineering skills, systems analysis and structure welders. Robust retention strategies, upskilling and succession plans are important for these roles, as they are highly critical but also sensitive to fluctuations in supply.

The Clyde Maritime partners should capitalise on regionalisation of skills and seize the opportunity to collaboratively solve workforce challenges

As this study demonstrates, the Clyde Maritime Enterprise partners represent a significant sector within the national and regional economy and are willing to collaborate and share information where they see opportunities to find solutions to commonly faced challenges. At the same time, as the running of the Clyde Mission initiative[2] was transferred from the Scottish government to Glasgow City Region,[3] there is a timely opportunity to bring together the needs and ambitions of the Maritime Enterprise stakeholders and the Glasgow City Region's economic growth agenda around the centrality of developing skills for the future.

Indeed, maritime skills now fall within the Future Skills Programme under the 2021 Glasgow City Region's Economic Strategy.[4] The purpose of the Future Skills Programme is to support, at a regional level, the development of a 'skilled workforce to meet the current and emerging demands of the public and private sector'.[5] This ambition is in line with the Glasgow City Region's increasing regional collaboration beyond merely implementing the Glasgow City Deal[6] to include other pertinent economic growth enablers, like skills. Implementing a more regionalised approach to skills planning and delivery was also one of the recommendations of a recent Organisation for Economic Co-operation and Development (OECD) review on local job creation, examining in detail the skills system in the Glasgow City Region,[7] and a key recommendation of the Withers review of the skills delivery landscape in Scotland. Specifically, this review recommended that regional partners be empowered to 'develop their own solutions' based on understanding of their strategic workforce opportunities and needs.[8]

[2] Clyde Mission is a place-based initiative to support growth and transformation along the River Clyde, funded by the Scottish government, with the aim of revitalising the area around the river to drive economic growth, sustainability and a more inclusive regional economy.

[3] Glasgow City Region (2023).

[4] Glasgow City Region (2021).

[5] Glasgow City Region (2021).

[6] The Glasgow City Deal was agreed in 2014 between the UK and Scottish governments and eight local authorities to provide funding for major infrastructure projects in Glasgow and the surrounding areas, now totalling over £1 billion in investment. Glasgow City Region (n.d.).

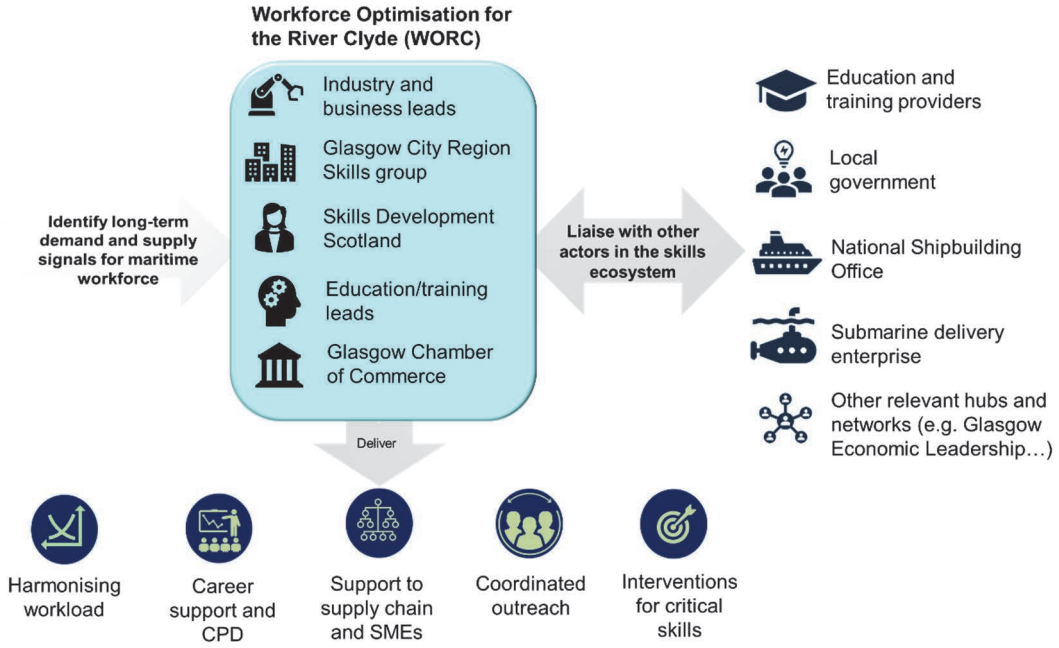
[7] OECD (2024).

[8] Scottish Government (2023a).

RAND Europe recommends setting up a Workforce Optimisation planning group to drive better workforce utilisation and growth

Drawing on the analysis conducted for this study, and taking into account the wider opportunities for regionalisation of skills development on the Clyde, the RAND Europe study team proposes the establishment of a Workforce Optimisation for the River Clyde (WORC) planning group. This group would convene initiatives currently pursued by companies or training institutions under one umbrella and act as a central oversight and delivery body for maritime skills development on the Clyde. It would be comprised of industry, local government, education and training sector representatives, as shown in Figure 0.2, and its role would be to identify long-term demand and supply signals to strategically plan workforce utilisation and development.

Figure 0.2. Overview of the key functions of the WORC planning group



Source: RAND Europe analysis.

The WORC planning group would both provide strategic direction and plan for workload optimisation as well as set up centralised delivery teams for specific initiatives. These include:

- **Workload optimisation:** The WORC could act as a facilitator between companies that may experience short- or medium-term fluctuations in workload to more effectively transfer workforce, for example through secondments, temporary contracts and placements. This presupposes setting up specific agreements and pre-agreed subcontracts to allow such transfers as well as a set of underpinning training and development courses to ensure staff are upskilled/trained for the new job they may need to perform. Workload optimisation activities would be primarily led by business leads in the effort to better manage potential peaks and troughs in workload demand across the wider maritime enterprise on the Clyde. This could also help absorb larger workloads and enhance efficiency.

- **Career support and continuous professional development (CPD):** The WORC could also act as a central body to coordinate career support for all career stages. The group could be a central 'match-maker' between industry and the education sector, identifying which training or education courses may be relevant as CPD or where there might be gaps in education provision that should be addressed through new courses or curriculum updates.
- **Support to supply chain and small and medium-sized enterprises (SMEs):** The WORC's career support services could include talent management services to support SMEs' effective workforce utilisation, facilitating the upskilling and training of employees and offering secondments from larger shipbuilding companies to SMEs to help plug their skills gaps while also strengthening relationships and collaboration between shipbuilding companies and the supply chain. These secondments from primes to SMEs could be particularly valuable in providing specialist skills that may be needed on a more ad hoc basis.
- **Coordinated outreach:** The WORC could lead the design and delivery of a sustainable and long-term public outreach campaign that would explicitly seek to raise awareness about the sector and the wide range of career opportunities within shipbuilding. This intervention would require a strong narrative conveying the importance of the maritime industries in terms of national security and prosperity, as well as opportunities for innovation and the development of interesting technical careers that allow for good mobility and intellectual challenge. It should explicitly seek to act as a unified vehicle for outreach, with the aim to reach wider audiences and untapped talent pools.
- **Specific interventions to ensure supply of critical skills:** Concrete interventions should focus on growing and/or sustaining specific critical skills, such as welding, systems engineering, electrical and mechanical engineering and naval architecture skills, that are at greatest risk of skills gaps. Short-term opportunities could include the promotion of vocational training and further education to ensure enough people are attracted to these courses. The modernisation of shipyards to improve work environment could also make welding careers more attractive. In the longer term, certain skills gaps could also be addressed through automation and robotics, and the WORC could explicitly focus on growth and investment in digital and automation skills, supporting the wider regional agendas for economic growth and prosperity.

As the WORC group is established and receives wider support from all relevant stakeholders (the Clyde Maritime Enterprise partners, Glasgow Chamber of Commerce, Skills Development Scotland, education and training providers, and Glasgow City Region), over time, it could expand its focus from workforce and skills to other areas, for example, accessing joint funding for innovation or other regional resources. It was beyond the scope of this study to develop full implementation plans for each intervention and roadmaps for growth. However, this would be a natural next step worth undertaking as a follow-on from this study.

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Abbreviations

AWD	Air Warfare Destroyer
CAD	Computer-aided design
CPD	Continuous professional development
CTE	Career and Technical Education
EU	European Union
FTE	Full-time equivalent employee
MRSS	Multi-Role Support Ships
NMIS	National Manufacturing Institute of Scotland
NSO	National Shipbuilding Office
SDG	Skills Delivery Group
SDS	Skills Development Scotland
SIB	Submarine Industrial Base
SME	Small and medium-sized enterprise
SMTP	Scottish Marine Technology Park
STEM	Science, Technology, Engineering and Mathematics
UKSST	UK Shipbuilding Skills Taskforce

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While the above contributions were all essential to delivering this study, any errors in this report are the sole responsibility of the authors.

1. Introduction

This chapter provides a brief overview of the study's context, methods and caveats, and outlines the content of this report.

1.1. Maritime industries on the Clyde have been part of the local DNA for centuries, although their global position has declined over time

The shipbuilding and maritime industries on the River Clyde were a key enabler for establishing Britain's status as a global maritime and trade power. Shipbuilding on the Clyde helped make Glasgow a key economic centre during the industrial revolution and continues to provide employment opportunities as well as wider benefits to the local economy. Although most historic Clyde shipbuilders, such as John Brown & Company, Fairfield Shipbuilding or William Denny and Brothers, have stopped operating or merged with other companies since their peak in the 19th and 20th centuries, Glasgow's legacy as a maritime hub has endured.[9] Major players including BAE Systems, Babcock, Ferguson Marine, the Malin Group and Dales Marine operate on the Clyde.

However, the UK's maritime industry, including shipbuilding in Scotland, has seen a general decline over the past decades. While the UK produced 61 per cent of the world's vessels prior to World War I, the share has decreased to one per cent of Europe's total and to a small fraction of the world's total.[10] This decrease can partly be explained by the UK's shift towards a post-industrial economic model but still compares poorly to France, Italy and the Netherlands, which have continued to deliver high shipbuilding outputs.[11]

1.2. The National Shipbuilding Strategy brought long-term commitment but delivering it will require focused attention on skills and enablers

The launch of the National Shipbuilding Strategy in 2017 and its refresh in 2022 have heralded a more coordinated approach to the UK's shipbuilding sector, which included setting up a National Shipbuilding Office (NSO) and articulating a 30-year cross-government demand signal for shipbuilders. Although it is not yet clear how much of the stated demand will be delivered by UK industries, in early 2024, the then Secretary of State for Transport coined the phrase 'Golden Age of shipbuilding' to describe the prospects

[9] Clyde Waterfront (n.d.).

[10] BAE Systems (2023).

[11] UN Trade and Development (2024).

for UK shipbuilding today. The recently elected Labour government has since its election reaffirmed the commitment to shipbuilding and expressed a clear desire to ensure a healthy order book for UK shipyards to deliver over the next decades.[12] Moreover, the new Chancellor of the Exchequer, Rachel Reeves, expressed a preference for domestic contract awards in a recent speech.[13] As the Labour government looks to implement its new Industrial Strategy,[14] which explicitly identifies defence and advanced manufacturing as growth sectors, there are opportunities to capitalise on and grow the strengths of UK's maritime industrial base. As shown in detail in Chapter 3, the largest customer for UK shipyards, including those on the Clyde, continues to be the UK government. In addition, the Scottish government, along with local councils, are also investing heavily, for instance through education programmes and research and development (R&D), in supporting maritime skills development. Many of these initiatives and activities are described in more detail in Chapter 5.

Delivering against the envisaged demand, however, will not only require substantial government funding but also a ramp-up of industrial skills. In recognition of this need, the UK's first Shipbuilding Skills Taskforce was set up in 2022 to deliver a strategic-level analysis of the shipbuilding skills base in the UK, and prepared a public report, 'A Step Change in UK Shipbuilding Skills', released in 2023.[15] The report articulates both high-level opportunities and challenges to skills supply and provides a toolkit for employers to better navigate the wider opportunities within the skills ecosystem, such as specific education programmes, apprenticeship schemes and links to key actors within each devolved administration. As shown in more detail throughout this report, our analysis confirms many of the findings of the Taskforce's report and enhances the analysis by examining a more detailed picture of skills demand and supply for selected companies on the Clyde. The analysis confirms that companies compete for similar skills, while the sector as a whole faces increasing competition from other growing sectors, such as offshore wind. This competition takes place against a background of insufficient visibility and sometimes challenging reputation, making it difficult to attract talent, particularly in high-growth areas such as automation and clean energy where skills are already in high demand.[16]

1.3. After decades of decline, a revival of the maritime industrial base is taking place, with major investments to revitalise the sector

With very limited commercial shipbuilding, there is a clear focus on naval shipbuilding in Scotland, building on a strong legacy of naval shipbuilding and repository of skills.[17] Despite the overall decline in shipbuilding activity over the last few decades, the Clyde is still home to a concentration of expertise in the construction of naval ships and naval engineering. In recent years, and particularly in the aftermath of the National Shipbuilding Strategy (2017), the region has seen increased investment to revitalise the industrial

[12] Allison (2023a).

[13] Henderson (2023).

[14] Department for Business and Trade (2024).

[15] City of Glasgow College (n.d.).

[16] Maritime Skills Commission (2023).

[17] Interview with RAND Europe, 2024.

base. Initiatives include, but are not limited to, a planned £12 million Applied Shipbuilding Academy at the BAE Scotstoun shipyard looking to upskill workforce and attract new talent. At the Govan shipyard, BAE Systems is investing in a modern shipbuilding hall as part of a five-year £300 million investment in the Glasgow region, while Babcock is investing in a technologically advanced shipbuilding facility at Rosyth, harnessing automation and transforming the working environment for greater efficiency and productivity.[18] These investments are taking place against the backdrop of wider growth and regeneration of the area around the River Clyde under the Clyde Mission initiative[19] as well as large-scale infrastructure investments under the Glasgow City Deal.[20] Despite recent growth in confidence due to a clearer demand picture and funding enabling the large-scale investments in the first place, however, maritime industries face challenges in ensuring a sustained pipeline of skilled workforce to deliver against the demand.

1.4. This study provides a nuanced picture of the skills demand and options for supporting growth to deliver the shipbuilding backlog

Although the Shipbuilding Skills Taskforce's skills report provided a rich analysis of the opportunities and challenges for national shipbuilding skills development, the momentum for implementing some of the report's recommendations had slowed down. To invigorate the focus on skills development and identify practical steps that could be implemented collaboratively between industry, academia and the Scottish government, in 2023, RAND Europe was commissioned by Glasgow Chamber of Commerce, on behalf of the Clyde Maritime Enterprise partners and in collaboration with SDS, to provide a more in-depth analysis of shipbuilding on the Clyde, focusing specifically on analysis of industry-supplied workforce data. This study is thus a contribution to the Clyde Mission, a Scottish government-led initiative launched in January 2020 to unite actors and relevant stakeholders on the Clyde to collaboratively identify and implement opportunities for enhancing the growth and prosperity of the Clyde and the surrounding region, with spillovers into Scotland more broadly.[21] The purpose of this study is to fill the research gap in terms of developing a detailed understanding of the workforce demographics picture across the maritime industries on the Clyde and identifying insights to inform strategic workforce planning across the wider enterprise. This study is also intended to support further growth of collaboration and sharing of resources among Clyde maritime partners, and propose suggestions for more formalised mechanisms for cooperation.

[18] Project Scotland (2024).

[19] Clyde Mission is a place-based initiative to support growth and transformation along the River Clyde, funded by the Scottish government, with the aim of revitalising the area around the river to drive economic growth, sustainability and a more inclusive regional economy.

[20] The Glasgow City Deal was agreed in 2014 between the UK and Scottish governments and eight local authorities to provide funding for major infrastructure projects in Glasgow and the surrounding areas, now totalling over £1 billion in investment. Glasgow City Region (n.d.).

[21] Optimat & Scottish Maritime Cluster (2021).

1.5. RAND Europe has used a mixed methods approach to identify future skills needs and potential interventions to address them

RAND Europe's research team has used a mixed methods approach of qualitative and quantitative data collection and analysis to identify future skills needs for the Clyde's maritime industry. This approach was first and foremost based on engagement with the industrial players on the Clyde, specifically: Babcock, BAE Systems, Dales Marine, Ferguson Marine and the Malin Group. Each of these companies has contributed to the study by providing RAND Europe with data on company workforce demographics, mapped against a standardised RAND Europe taxonomy of maritime skills; as well as data on current, past and anticipated hires and insights on anticipated demand. The details of RAND's data collection tools are included in the Annexes.

The study team further complemented the industry survey data through a series of engagements with other institutional stakeholders. These included governmental and military entities as well as local authorities, training providers and industry representatives. A full list of consulted stakeholders is included in Annex B.

The study team undertook several analytical tasks, utilising qualitative and quantitative methods to:

- Identify **key workforce demographic trends** across the aggregated data from participating industries and assess the health of the skills base in terms of skills distribution, demographics, experience growth and retention;
- Estimate potential **workforce implications of different demand scenarios** in terms of delivery of shipbuilding and maritime activities;
- Identify **examples of good practice in skills management and sustainment** at an enterprise level to draw out potential features of good practice that could be relevant for the Clyde; and
- Develop **suggestions for interventions to enhance skills growth**.

1.6. This study, summarised in six chapters, is subject to several caveats to be considered when using the study's findings

Whether by design or due to the limitations of the data collection, this study's findings are subject to a number of caveats:

- **Diversity in terms of scale, nature and size of operations:** This study presents the results of a data collection and analysis aggregated across multiple maritime industries on the Clyde. The companies involved operate at significantly different scales in terms of output and numbers of full-time equivalent employees (FTEs), and there is also diversity in terms of the nature of goods and services they deliver. Babcock and BAE Systems are involved in naval shipbuilding and in-service support, while Dales Marine provides mostly dry dock facilities for naval and commercial vessels maintenance, Ferguson Marine services civil and military vessels, and the Malin Group looks after heavy lift and haulage. This means that trends identified from the aggregated data analysis may be driven by one or two companies with large FTE numbers. Wherever possible, the RAND Europe study team sought to highlight any significant divergence of trends between the smaller companies

and the larger primes, but it was explicitly outside the scope of this study to identify individual company-level trends.

- **Not all companies possess a full range of skills:** As mentioned above, the companies involved in providing the underlying industry survey data for this study operate in different segments of the shipbuilding, servicing and maritime markets. As such, their FTEs possess a range of different skills and only the two primes involved in the survey (BAE Systems and Babcock) have personnel involved across most of the skills groups listed in the RAND Europe skills taxonomy. As a result, aggregated data across the skills groups sometimes aggregates across two companies, while other times across all six. It is a condition of this study that no data is reported if it comes from only a single company. As such, the findings of this study are valid only at the aggregated level of the enterprise and may or may not be fully applicable to each individual company involved.
- **Companies had to map their own taxonomies to the RAND Europe taxonomy:** The RAND Europe study team is deeply grateful for the significant amount of time and effort companies undertook in mapping their own workforce against the RAND Europe skills taxonomy. Conscious of the fact that different companies capture skills differently, there is not always a perfect match between the RAND Europe taxonomy and companies' own taxonomies, and we have tried to highlight any significant discrepancies in the analysis.
- **Submarine industrial skills are excluded from the analysis**: By design and the stated terms of reference for this study, submarine industrial skills have been excluded from this analysis. It is important to note, however, that the Clyde's maritime industries face competition for skills also from the submarine sector, principally those operating in Barrow-in-Furness and HMNB Clyde. Drawing on RAND's past and ongoing work on the submarine industrial base, therefore, we qualitatively point out where considerations related to the submarine base are relevant for the discussion. This is to present a more rounded analysis and identify relevant interlinkages between surface ships and submarines.
- **Data on future demand and delivery profiles** of ships in development and build **have not been provided by industry** as part of the workforce industry survey, with some companies noting their demand has a steady profile and others submitting the survey responses without filling in these sections, including after follow-up requests from RAND Europe. As such, the RAND Europe study team conducted an open-source review of future demand trends, summarised in Chapter 3, and modelled three hypothetical demand scenarios to estimate the potential skills gaps that may occur in relation to each of these scenarios, outlined in Chapter 4.

In addition to this introduction, the study consists of five chapters, as follows:

- Chapter 2 provides an overview of the general skills challenge the shipbuilding sector is facing in the UK, as well as challenges to skills growth on the Clyde specifically;
- Chapter 3 examines the demand outlook for the maritime sector on the Clyde to better understand the scale of skills development needed;

- Chapter 4 presents RAND Europe's analysis of the future supply and demand of maritime skills on the Clyde, based on company data;
- Chapter 5 explores potential interventions that could support skills growth on the Clyde; and
- Chapter 6 provides an overview of our findings and recommendations.

2. Current skills: challenges and opportunities

This chapter summarises the broader labour market trends in shipbuilding, both on the Clyde and in the UK more generally, and outlines high-level opportunities for skills growth. This analysis draws on a broad review of existing literature, specific reports on shipbuilding, maritime skills and the Scottish labour market, and insights from interviews with a range of stakeholders, including political, military, academic and industry experts.

2.1. Foundations have been laid for more coordinated action to improve skills gaps in the maritime industry

Maritime skills development has gained momentum over the past two to three years, with the UK and Scottish governments and industry stepping up efforts to address skills challenges and revitalise the sector in the UK, including on the Clyde. These efforts were particularly notable after the 2017 National Shipbuilding Strategy identified skills as a critical enabler. Following the creation of the NSO in 2021, the UK government issued the National Shipbuilding Strategy Refresh in 2022, setting out its ambitions for skills development, appreciative of the importance of a long-term and sustainable pipeline of skilled workforce.[22] The Strategy Refresh articulated a 30-year cross-government shipbuilding pipeline ambition and set out targets for setting up a skills foresight function in the sector to reduce skills shortage by 50% by 2030.[23] One interviewee noted that the strategy has already helped the sector better understand the nature of demand and potential implication for future skills requirements due to greater focus on skills foresights and closer coordination between government and industry.[24]

In response to the importance afforded to skills in the National Shipbuilding Strategy Refresh, the UK Shipbuilding Skills Taskforce (UKSST) was established by the Department for Education in July 2022 as an 18-month effort to develop a skills strategy for UK shipbuilding to support the development of a skilled shipbuilding workforce over the longer term.[25] The Taskforce, in collaboration with industry and the NSO, produced a report on the state of shipbuilding skills in the UK and an accompanying toolkit to help shipbuilding companies, and SMEs in particular, leverage the UK skills systems and access government-

[22] National Shipbuilding Office (2022).

[23] National Shipbuilding Office (2022).

[24] Interview with RAND Europe, 2024.

[25] City of Glasgow College (2022).

funded training and career promotion programmes.[26] The Taskforce closed in December 2023. To sustain momentum and oversee the implementation of the recommendations in the report, the NSO set up the Skills Delivery Group (SDG).[27] The objectives of this Group are to oversee the implementation of the recommendations and to address the skills challenge by maintaining a clear picture of the skills demand, engaging with government and industry, supporting NSO-led communications campaigns, and collecting and sharing good practice.[28]

2.2. Several skills challenges identified by the UKSST are prominent on the Clyde, especially low sector attractiveness and high competition

Despite the growing strategic coherence within the UK shipbuilding sector, the sector's ability to deliver against the articulated demand signal will be shaped by its ability to attract, retain and grow key skills both in terms of volume and skills type. The shipbuilding enterprise on the Clyde faces several challenges in sourcing and retaining a skilled workforce,[29] identified in the UKSST's report[30] and confirmed by the findings of this study. Building on literature review specifically focused on the Clyde and interviews with local stakeholders, our findings highlight the following challenges as the most prominent in the context of shipbuilding on the Clyde:

- Low attractiveness of the sector;
- Perceived deprioritisation of vocational training and further education;
- Insufficient coordination among stakeholders; and
- Competition with other sectors.

2.2.1. Low attractiveness of the sector

While shipbuilding has a strong legacy in the UK and in Scotland in particular, public awareness about it has diminished, as highlighted by several of our interviewees. Despite the large scale of shipbuilding and the maritime sector, the number of people working in the sector is not as high as it used to be, making shipbuilding less accessible through informal networks.[31] At the same time, a number of interviewees mentioned that shipbuilding is generally perceived as an outdated and declining sector, characterised by difficult and unattractive working conditions compared to both other sectors and shipbuilding industries abroad.[32] For workers desiring greater flexibility in terms of working hours and work location (particularly

[26] UK Shipbuilding Skills Taskforce (2023a).

[27] National Shipbuilding Office (n.d.); UK Government Department for Education (2024).

[28] National Shipbuilding Office (2024).

[29] Allison (2024a).

[30] The UKSST identified the following key skills challenges: 1) fluctuating demand; 2) attractiveness of the sector; 3) demand exceeding supply of skills; 4) competition with other sectors; 5) dropping interest in careers in shipbuilding; 6) siloed way of working with skills; 7) limited awareness about the sector; 8) challenges to sustaining experience at more senior levels; and 9) challenges posed by security clearance requirements.

[31] Interview with RAND Europe, 2024.

[32] Dean et al. (2023).

since the COVID-19 pandemic and increase in remote working), the geographic and site constraints inherent in many shipbuilding jobs can present further limitations. Also, decades of limited investment in facilities and low levels of modernisation have made for less appealing working conditions, while the location of shipyards in often socially and economically deprived areas can further contribute to negative perceptions of the industry, though modernisation efforts are growing.[33] Although these constraints do not seem to deter large numbers of apprenticeship applicants, as discussed in Chapter 4, retaining skills within the industry and recruiting mid-career professionals into the sector is more challenging.

Moreover, shipbuilding has historically been a volatile industry with fluctuating demand, with mass redundancies taking place in periods of low demand, for instance, in 2001, 2003 and 2013.[34] The cyclical nature of shipbuilding employment, exemplified by the layoff of 1,200 workers following the completion of the *Sir David Attenborough* research ship, further hinders shipbuilding's position vis-à-vis other industries.[35] Uncertainty around the pipeline of work can both deter people from pursuing a career in shipbuilding and cause them to leave for other sectors that compete for the same talent.[36] While shipbuilding in Scotland now has a much clearer demand picture for the coming decades, this stability may not translate into changes to the way the public perceives the industry based on decades of volatility. Yet, RAND Europe's previous work on UK shipbuilding shows that with improved planning and resourcing, this cyclicality can be reduced, creating a much smoother workload profile.[37]

Finally, naval shipbuilding, especially at BAE,[38] specifically faces additional recruitment challenges for roles requiring Developed Vetting security clearances due to the lengthy nature of these processes, during which applicants may get another job offer. Onboarding processes in defence are often slowed down by security clearance checks, potentially lasting up to six to twelve months after a conditional offer has been received. One interviewee noted that this can be particularly challenging for mid-career recruits, as they tend to bring much-needed specialised knowledge and experience, while it is less challenging for roles that require lower levels of security clearance.[39]

2.2.2. Perceived deprioritisation of vocational training and further education

Despite the recognition of the importance of skills for a healthy maritime enterprise, several interviewees perceived the scale of public investment for vocational and work-based skills in this area to be insufficient. The Department for Transport's 2019 report 'Maritime 2050' notes that without increased funding to education and close collaboration between the maritime sector, education providers and the government, the pace of change in the skills required by industry will outstrip the pace at which these skills can be developed by the education sector.[40] Two of our interviewees specifically noted a perceived deprioritisation

[33] Interview with RAND Europe, 2024.

[34] BBC News (2001a); BBC News (2001b); BBC News (2013); Rankin (2013).

[35] Interview with RAND Europe, 2024.

[36] UK Shipbuilding Skills Taskforce (2023a).

[37] Schank et al. (2005).

[38] Interview with RAND Europe, 2024.

[39] Interview with RAND Europe, 2024.

[40] Department for Transport (2019).

of vocational training and anticipated a decline in public funding for further education.[41] According to projections by the Scottish Funding Council, cuts to college staff are expected to reach 21 per cent by 2025–2026 compared to 2022–2023.[42] One interviewee noted that cuts to funding for colleges could lead to the loss of a quarter of skills development capacity in the maritime sector.[43] The same interviewee noted that apprentices in Scotland are awarded a lower contribution towards their training costs than apprentices in England, imposing limits on what training can be provided, when comparing between the two countries.[44]

In addition, interviewees noted that there are wider structural changes pertaining to the status of further education and the importance of technical college qualifications compared to university degrees, further hindering skills development through colleges and further education.[45] This poses a challenge for skills that are specific to the maritime sector and are not degree-related. Such skills categories include, for example, welding, fabrication, pipe fitting and shipbuilding planning.[46]

2.2.3. Limited coordination among stakeholders

Another challenge that was highlighted by interviewees is the perceived lack of structured cooperation mechanisms between and within national and local authorities, education providers, SMEs and industry.[47] While there is a momentum in the maritime sector in this regard, with valuable initiatives pursued over recent years including the establishment of the National Manufacturing Institute of Scotland (NMIS), the Movement to Work programme and efforts to attract more women to the sector,[48] there is room for a greater coordination. For instance, there are a number of skill academies being planned in Scotland, including the Manufacturing Skills Academy (NMIS & BAE),[49] BAE's Applied Shipbuilding Academy[50] and the Marine Industry Training Centre,[51] to complement existing groups and institutions, such as the Malin Group's John Tracey Specialist Welding Services,[52] Glasgow Clyde College, West College Scotland and City of Glasgow College.[53] However, maritime companies often coordinate their training needs with education providers informally and on an ad hoc basis,[54] and there is no centralised organisation responsible for monitoring long-term evolving skills demands that would regularly coordinate with education providers about the industry's future training needs.

[41] Interview with RAND Europe, 2024.
[42] Scottish Funding Council (2024).
[43] Interview with RAND Europe, 2024.
[44] Interview with RAND Europe, 2024.
[45] Interview with RAND Europe, 2024; House of Commons Scottish Affairs Committee (2022).
[46] Interview with RAND Europe, 2024.
[47] Interview with RAND Europe, 2024.
[48] Interview with RAND Europe, 2024.
[49] National Manufacturing Institute Scotland (n.d.).
[50] Allison (2024b).
[51] Argyll Bute Council (2019).
[52] Malin Group (n.d.).
[53] Interview with RAND Europe, 2024.
[54] Interview with RAND Europe, 2024.

2.2.4. Competition with other sectors

Competition from other sectors for the same skills is one of the key challenges that influences skills supply for the maritime industries on the Clyde, as highlighted by a number of our interviewees.[55] For skills that are not unique to defence or the maritime sector, companies often find themselves drawing from a talent pool shared among sectors such as renewable energy such as offshore wind projects, construction, rail, automotive, energy transition, aerospace, oil and gas, and nuclear energy.[56] The last few years have seen significant growth in skills required for the wind energy sector in particular due to the establishment of facilities like the Offshore Renewable Energy Catapult that helped to build up a strong skills base of engineers working on offshore wind.[57] Indeed, two interviewees noted that the skillsets developed for offshore wind projects are currently more appealing and marketable compared to traditional shipbuilding skills, evidenced by engineers increasingly being drawn more to the green energy sector over traditional maritime roles.[58] Furthermore, the Offshore Wind Industry Council's 'Skills Intelligence Report' (2023) suggests that the roles in greatest demand in the sector include welders, pipefitters, electrical technicians and crane drivers – utilising many of the same skills that are in high demand in shipbuilding as well.[59] Decommissioning of fossil fuel infrastructure will also require skills for several decades, drawing on many of the construction skills in Scotland that are also needed in shipbuilding.[60]

While competition with other sectors is strong in general, some skills are particularly challenging to recruit for and retain. These include engineering and technical skills, such as system, network and safety engineers, which are sought after in most sectors. The demand for green engineering roles is also on a rapid rise, already showing a 55 per cent increase from 2016–2017 to 2021–2022.[61] Interviewees also suggested that there is a shortage in construction workers, particularly in welding and fabrication, and the sector is struggling to find workers in traditional professions like naval, mechanical and electrical architects.[62] Design technicians and technical planning skills are also under resourced.[63]

Finally, in the geographic context of the Clyde, there will be an increased demand for talent for HMNB Clyde, which is expected to undergo a major expansion over the coming years, offering new long-term career opportunities in the maritime sector and attracting skilled workforce from the same pool.[64] Although it was beyond the scope of this study to assess the transferability of skills between the submarine and shipbuilding enterprises, the RAND Europe study team believes further competition will arise due to the surge in demand for submarine building and sustainment skills due to the volume of demand in Barrow-in-Furness.

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[55] Interview with RAND Europe, 2024.

[56] UK Shipbuilding Skills Taskforce (2023a).

[57] Interview with RAND Europe, 2024.

[58] Interviews with RAND Europe, 2024.

[59] Offshore Wind Industry Council (2023).

[60] Interview with RAND Europe, 2024.

[61] EDGE Foundation (2024).

[62] Interview with RAND Europe, 2024.

[63] Interviews with RAND Europe, 2024.

[64] Interview with RAND Europe, 2024.

2.3. Demographic challenges and limited space for facilities' expansion further limit skills supply on the Clyde

Many of the skills challenges relevant for the Clyde are common with those identified by the UKSST in its report 'A Step Change in UK Shipbuilding Skills'. In the context of the Clyde, there are also several trends that create unique constraints for skills relevant for the maritime and shipbuilding enterprise. These include:

- Demographic challenges in Scotland;
- Limited scope for facilities' expansion; and
- Supply shortages to meet immediate demand.

2.3.1. Demographic challenges in Scotland

A number of demographic trends are affecting workforce development on the Clyde and in Scotland more generally. While the population of Scotland is growing, it is growing at a slower pace (by 2.7 per cent) than in 2011, and its pace of growth is slower than that of the UK as a whole.[65] Furthermore, 20 per cent of Scotland's population is over the age of 65, higher than the UK average of 18.6 per cent.[66] Projections also indicate that around 22.9 per cent of Scotland's population will be retired by 2043, compared to 19 per cent in 2018, indicating that Scotland's working-age population is shrinking.[67] An ageing population means that the pool of talent from which the maritime industry on the Clyde is able to recruit is also shrinking. This is further exacerbated by labour and skills shortages in the port, coastal and island communities shipbuilders have historically recruited from.[68] Figure 2.1 illustrates the demographic challenge of Scotland's ageing population based on the 2022 census data.

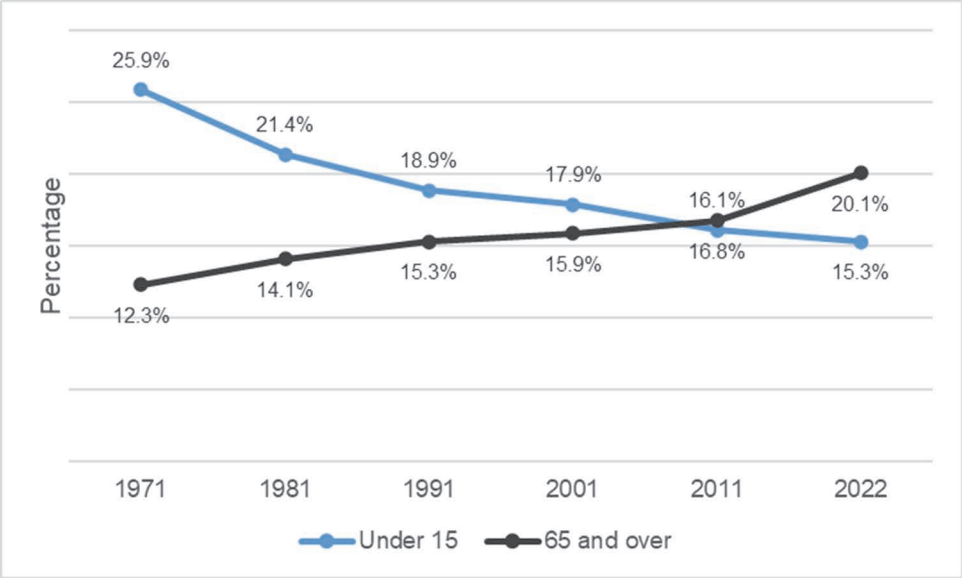
[65] Scotland's Census (2023a).

[66] Scotland's Census (2023b).

[67] Scottish Government (2021a).

[68] City of Glasgow College (2022).

Figure 2.1. Scotland's ageing population



Source: Scotland's census 2022 – rounded population estimates.[69]

In terms of qualifications, around 9.7 per cent of Scotland's and 13.7 per cent of Glasgow City Region's population aged 16–64 has low or no formal qualification, which is below the UK average of 18.2 per cent. This offers both opportunities and challenges for the maritime industrial base on the Clyde. On the challenging side, individuals with no qualification may not apply for open vacancies or may not be considered for positions. Viewing this as an opportunity, however, companies could choose to target those with low or no qualifications for recruitment and provide in-house training. Babcock, for instance, has created a 'Train to Fit' programme, a recruitment programme that targets those without qualifications but with the right skills for roles such as project controls or project management.[70] This programme has been highly successful in terms of recruitment, while the retention of employees recruited through this programme is also high.[71]

2.3.2. Limited scope for facilities' expansion

A further challenge highlighted by our interviewees is the limited space available for building new manufacturing facilities and expanding already existing docks and other facilities along the Clyde in and near Glasgow. Interviewees highlighted the difficulty of purchasing plots of lands for construction, with much of the land on the riverbank of the Clyde unavailable for industrial use.[72] On the other hand, this limitation complements the Green Belt initiative that is an essential element of Glasgow's planning policy, aiming to protect the countryside and its biodiversity and regenerate urban areas.[73]

[69] Scotland's Census (2023b).

[70] ManpowerGroup (2023).

[71] ManpowerGroup (2023).

[72] Interview with RAND Europe, 2024.

[73] Glasgow City Council (n.d.).

This inability to expand facilities also caps hiring, exacerbating challenges around skills growth. Interviewees and some online sources suggest that land on the riverbank close to Glasgow city centre is only available to purchase for housing and leisure, while land can be purchased for industrial use further down the river (e.g. around Clydebank and Port Glasgow) – locations less attractive to potential workforce due to the daily commute it would entail.[74] Yet, these areas further down the river are also marked by greater need for economic advancement, presenting opportunities to increase skills and generate local economic benefits. The Malin Group, for instance, has purchased 47 acres of vacant and derelict land at Old Kilpatrick to establish the Scottish Marine Technology Park (SMTP). Once the Malin Group completes the clean-up of the land and renovation of abandoned facilities, the SMTP is envisaged not only to house Malin Group manufacturing but also to provide dedicated space for non-profit purposes, ideally offering innovation facilities for use by other stakeholders in the maritime sector.[75] Such activities could create jobs in economically less active areas of Scotland while also providing alternative facilities for the sector to expand. Beyond collaboration on workforce and skills, Clyde maritime partners could also consider joint developments of brownfield land for maritime activities and sector growth.

Due to restrictions around building on the bank of the Clyde, local authorities and industry have indeed been pushing for the use of brownfield sites for industrial and other development projects over recent years. To facilitate this, the Scottish government created the Vacant and Derelict Land Investment Programme in 2021 to revitalise old industrial land and to incentivise the use of brownfield sites instead of the Green Belt.[76] The Govan Graving Docks, for instance, have been unused for the past 40 years, but the site is currently undergoing revitalisation, in the framework of which the dry dock was reopened in January 2024 with a five-year lease for the refurbishment of heritage maritime vessels, while other parts of the area will see new homes built.[77]

2.3.3. Supply shortages to meet immediate demand

While many of the challenges discussed so far are structural, there are also some immediate constraints that companies face in terms of their ability to meet current demand levels. The aftermath of Brexit, for example, resulted in companies being less able to employ EU nationals and having to look for workforce further afield and at higher costs due to visa requirements. Effectively, much of the EU-national workforce that previously supplemented the UK workforce is considerably more difficult to source, reducing the pool of skilled employees for which multiple sectors now compete.[78] According to a recent study, post-Brexit immigration policies have led to a shortfall of 460,000 EU workers, with the majority of this shortfall seen in blue-collar jobs such as manufacturing, construction and transport, among others.[79] Most skills gaps that previously used to be filled by EU nationals are now filled by workers from the Philippines, South Africa and other

[74] Scottish Construction Now (2019).

[75] Interview with RAND Europe, 2024.

[76] Scottish Government (2023b).

[77] Govan Graving Docks (n.d.).

[78] UK Shipbuilding Skills Taskforce (2023).

[79] Palmer (2024).

countries.[80] For instance, one of the companies included in this study has been recruiting extensively from the Philippines to plug the skills gap in welding.[81] One interviewee pointed out that this gap in the supply of cheap and accessible skills could drive industry to invest more in automation in the long term to avoid the costs of recruitment; the necessary modernisation of shipyards and reskilling of existing workforce could, however, take years.[82] It is also clear from the qualitative responses provided by several industries involved in this study that companies find it challenging to balance the need to meet short-term skills demand while ensuring they put in place robust long-term skills strategy and planning.[83]

2.4. A more effective collaboration of stakeholders at enterprise level and the modernisation of shipyards present opportunities for skills growth

The challenges discussed earlier in this chapter are not insurmountable. At company and local council level, several initiatives that creatively seek to encourage skills growth for the Clyde Maritime Enterprise, and from which others could learn, are already under way. Informally, there are ongoing discussions among companies and the Scottish government at local and national level about options for more collaborative working. In addition, Scotland is seeing an increase in Science, Technology, Engineering and Mathematics (STEM) graduates alongside increasing competition from technology-heavy sectors, such as renewable energy, prompting reflections on how to utilise technology growth for greatest benefit in the maritime sector.[84] Below we briefly discuss the high-level opportunities that arise from a more formal and more effective collaborative approach as well as opportunities related to technology and digitalisation in the shipbuilding workplace. More specific interventions are discussed in Chapter 5.

2.4.1. Greater stakeholder collaboration for better lessons sharing and minimising duplication

While forums such as the Clyde Maritime Enterprise create opportunities to informally share experiences, a more formalised cooperation between government, industry and the education sector in the region may be needed to maximise the efficiency and effectiveness of skills growth and utilisation. Formalising collaboration could ensure long-term robustness despite changes to leadership over time. Specifically, our interviewees noted that a more coordinated demand signal from industry (including the wider supply chain, not just primes) to the education sector would be beneficial to ensure that enough students go through the right training programmes to improve skills supply.[85] Two interviewees also highlighted the need for a closer collaboration with SMEs and the wider supply chain on skills, as smaller companies rarely have the resources to drive large recruitment campaigns or the staff to keep up to date with the latest available skills initiatives and programmes.[86] Specific opportunities to involve the wider supply chain include access to apprenticeship

[80] Interview with RAND Europe, 2024.

[81] Interview with RAND Europe, 2024.

[82] Interview with RAND Europe, 2024.

[83] RAND Europe engagement with companies involved in the survey.

[84] UK Shipbuilding Skills Taskforce (2023).

[85] Interview with RAND Europe, 2024.

[86] Interview with RAND Europe, 2024.

schemes, as is already the case with the BAE Systems apprenticeship scheme; access to innovative facilities by both primes and supply chain, as envisaged by the Malin Group, which is planning to transform an old oil terminal into the Scottish Marine Technology Innovation Hub[87]; and access to secondments and placements to gain specific expertise, such as the exchange scheme between BAE and Babcock.[88]

Through more formalised collaborative engagements, stakeholders could share lessons from their own individual initiatives and practices, or even consider scaling them up to include the wider enterprise. This could help minimise duplication and maximise effective learning from successful practices. Babcock on the Clyde, for example, is currently piloting a new retention programme that involves risk modellers tracking which employees are at greater risk of leaving the organisation, driving Babcock's intervention programme to prevent departures.[89] In addition, the Malin Group created a 'refer a friend' scheme that financially rewards employees who refer someone to a role, with the explicit ambition of raising awareness about opportunities within the sector.[90] The BAE Systems apprenticeship scheme has also seen significant numbers of early-career professionals entering the workforce, with applications often reported as oversubscribed by a factor of three or four.[91]

Finally, there are opportunities to work together as an enterprise to attract talent into the maritime sector, articulating clearly the career opportunities that exist in the sector and future prospects. As part of outreach, stakeholders on the Clyde should also consider proactively creating and encouraging career mobility across the sector, capitalising on the diversity of careers that can be pursued within the broader maritime programmes. Indeed, interviewees for this study highlighted that younger generations tend to follow shorter career cycles and look to explore opportunities in different sectors rather than pursuing a lifelong career within the same organisation or industry. Shipbuilding and maritime sectors could harness the benefits of exchanging experience and knowledge by encouraging movement within the enterprise and a 'zig-zag approach' to career development, ultimately also improving retention.[92] This should include movement not only between industries but also across the wider ecosystem, including, for example, HMNB Clyde, local education institutions and local government, for example through secondments, knowledge exchange placements and others.

2.4.2. Harnessing technology for more efficient and attractive work environments

The maritime industries on the Clyde must balance between short-term needs, such as recruitment to fill in immediate gaps in available skills, and long-term needs, such as embedding innovative approaches to manufacturing and servicing of ships using advanced robotics, data-driven approaches and other Industry 4.0 technologies. Advanced manufacturing, automation, robotics, AI and data analytics are already important elements of employment and increase the need for skilled talent while also presenting opportunities to save cost in the long term (e.g. due to reducing the need for re-work, streamlining testing

[87] Whyte (2024); Scottish Marine Technology Park (2024).

[88] Babcock International Group (2024).

[89] Survey response, 2024.

[90] Survey response, 2024.

[91] House of Commons Scottish Affairs Committee (2022).

[92] UK Shipbuilding Skills Taskforce (2023).

and approvals and increasing efficiency in in-service support).[93] The roll-out of Industry 4.0 also seeks to attract more female employees to the sector as greater automation changes the profile and physical demands of roles in maritime (and many other) industries. While companies like Babcock are already investing in modernisation through the adoption, for instance, of robotic welding technologies by PEMA welding and production lines, there are still opportunities to modernise faster and leverage advanced technology.[94] Although much of the implementation of Industry 4.0 technologies requires focused upskilling or reskilling programmes, these opportunities can help improve worker mobility and skills transferability within and beyond the sector. Three of the interviewees noted that by integrating advanced technologies, companies can start shifting the perception of the sector as outdated, increasing efficiency and potentially attracting a more diverse workforce.[95] One interviewee also suggested that cross-sectoral collaboration on manufacturing skills – one of the objectives of the cross-sectoral Strategic Leadership Group for Manufacturing – could also help advance generational change in shipbuilding skills, considering that many sectors require similar skills in STEM and operations.[96]

The UK-wide shortfall in STEM and data science skills is posing a barrier to the speed of modernisation.[97] In Scotland, however, STEM education is attracting an increasing number of students,[98] and the country sees a higher proportion of employees working in STEM than the UK average. In 2016, around 37 per cent of employees worked in STEM in Scotland, compared to the UK average of 32 per cent.[99] While this is a positive trend in general, it will be important for the Clyde maritime industry to ensure that they are able to secure a pipeline of both general STEM skills as well as specialised skills such as naval architecture, advanced electrical engineering, systems engineering and others, which may be needed only in smaller numbers. Digital skills, such as software engineering, cyber, AI and robotics are also facing high levels of competition as they are in growing demand in civil and defence sectors alike.

[93] Interview with RAND Europe, 2024.

[94] Interview with RAND Europe, 2024.

[95] Interview with RAND Europe, 2024.

[96] Interview with RAND Europe, 2024.

[97] UK Shipbuilding Skills Taskforce (2023).

[98] Scottish Funding Council (2021); Scottish Government (2021b).

[99] Scottish Government (2017).

Box 2.1 Summary of key findings

- The maritime sector on the Clyde faces many of the skills challenges identified by the UK Shipbuilding Skills Taskforce, with the most prominent barriers to skills growth including: a) low attractiveness of the sector; b) perceived deprioritisation of vocational education; c) insufficient coordination among stakeholders; and d) intense competition with other sectors for talent.
- Further contextual factors present unique barriers to skills growth on the Clyde, including: a) the declining numbers of young people entering the workforce in Scotland more generally; b) physical and regulatory limitations to modernisation and expansion; and c) short-term skills supply shortages requiring resource allocation to ensure demand on current programmes can be met, with less focus on long-term strategic workforce planning.
- Finding ways to tackle skills challenges at a Clyde Maritime Enterprise level, with more formal involvement of government, industry and academia, has the potential to increase the effectiveness of individual initiatives as well as improving access to these for smaller companies.
- Embracing technology and innovation across the enterprise has the potential to improve the efficiency of both manufacturing and in-service support delivery and to create more attractive and appealing work environments. This could in turn improve the image of the sector, and ultimately recruitment and retention.

3. Demand outlook

This chapter provides an overview of open-source information on current and future shipbuilding and support demand for surface vessels in the UK. Where possible, we differentiate demand pertaining to the Clyde and draw out insights that are specific to this region. The purpose of this chapter is to contextualise the discussion on skills demographics and skills gaps presented in Chapter 4.

3.1. The UK government has issued clearer demand signals to boost shipbuilding, but its revival is building up from a reduced baseline

The release of the National Shipbuilding Strategy Refresh by the Conservative government in 2022 signalled the willingness of the UK government to provide support to the national shipbuilding industry and expand skills with the perspective of a steady stream of governmental orders. Against this background, the then Transport Secretary announced on 14 May 2024 a new 'Golden Age of shipbuilding' underpinned by the orders outlined in the strategy and an increased defence spending of 2.5 per cent of GDP by the end of the decade.[100] Orders include, for instance, the acquisition of six new amphibious or Multi-Role Support Ship (MRSS) vessels to replace the current amphibious fleet, as well as the procurement of up to five Type 32 frigates, in addition to the Type 26 and 31 models that are already being built in Scotland.[101] Part of the strategy to expand shipbuilding skills and capacity to meet this demand in the UK is the repurposing of the Type 23 frigate HMS *Argyll* as a training facility for apprentices at BAE Systems' Applied Shipbuilding Academy in Glasgow.[102]

3.1.1. Long-term shipbuilding demand in the context of reduced size of the sector

The UK's 'Golden Age' of shipbuilding is, however, starting from a low base considering the country's relatively small industrial footprint in shipbuilding overall (military and civil), representing less than 1 per cent of Europe's total by tonnage, as shown in Figure 3.1. In the last two decades or so, the UK has sustained its skills base mostly through naval shipbuilding and other small and medium vessels ordered by public authorities.[103] Shipbuilding skills in the UK have therefore been more reliant on domestic governmental

[100] UK Government (2024).

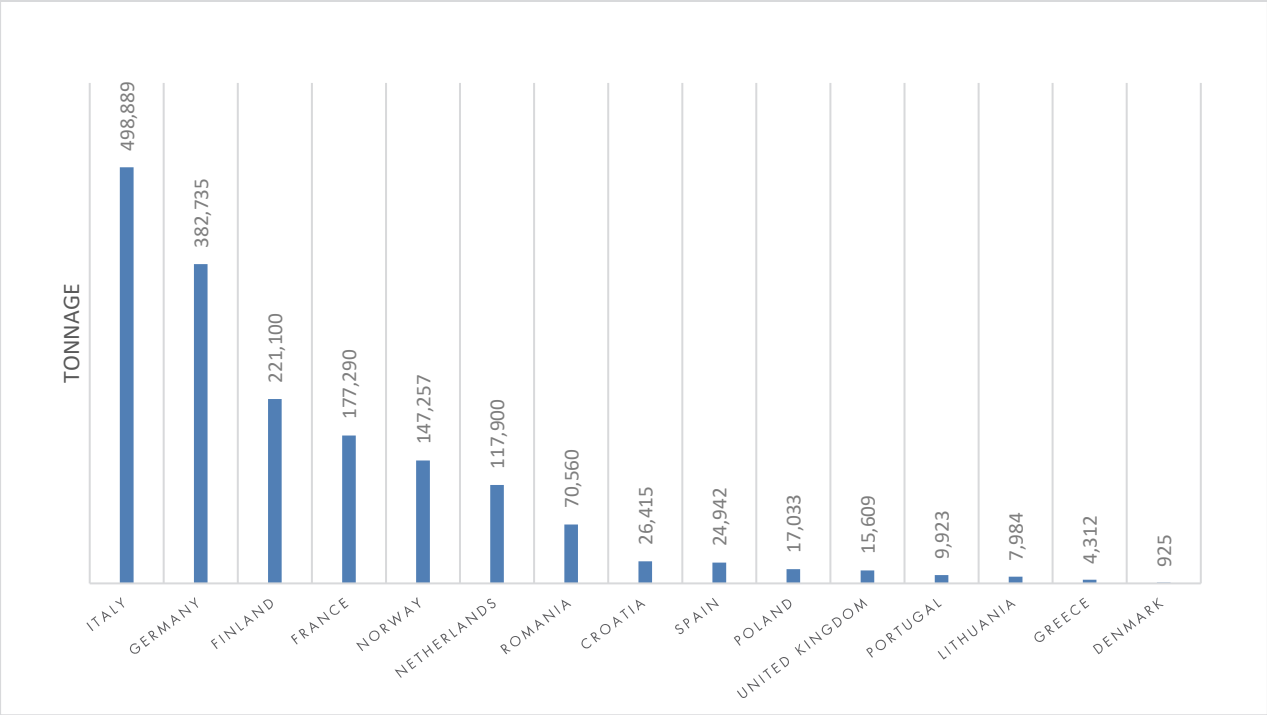
[101] Navy Lookout (2024); UK Government (2024); Allison (2024c).

[102] Allison (2024d); UK Government (2024).

[103] UN Trade and Development (2024).

orders for the use of the Royal Navy and other parts of the government relative to other countries of comparable scale such as Italy, Germany or France.

Figure 3.1. European shipbuilding by output (2021)



Source: UN Trade and Development (2023).[104]

3.1.2. Government-led demand signal for shipyards

Public demand for ships in the UK is decentralised across government, devolved administrations and local authorities, which all determine their own procurement strategies, processes and timelines, with the NSO having only limited authority to streamline these into a more coherent demand signal. These orders include warships, maintenance, patrol, search and rescue, research, transport and cargo ships, as summarised in Table 3.1.[105] It is also unclear which of these orders are intended for delivery by UK shipyards (or UK shipyards in collaboration with international partners) and which are to be sourced competitively from a wider pool of international suppliers. In the UK, to deliver against the demand signal, the shipbuilding industrial base comprises several shipyards owned by BAE Systems (Glasgow and Portsmouth), Babcock (Rosyth and Devonport), Dales Marine (Aberdeen, Leith, Greenock, Troon and Grangemouth), Ferguson Marine (Glasgow), Cammell Laird (near Liverpool), Harland & Wolff (Belfast and Appledore), A&P Tyne (near Newcastle), Wight Shipyard Co (on the Isle of Wight) and Parkol Marine Engineering (Whitby).[106] Wight Shipyard Co and Parkol Marine Engineering are specialised in small vessels. At the time of writing, there has not been a published analysis articulating the economic benefits and trade-offs of UK versus

[104] As of 13 December 2024: https://unctadstat.unctad.org/datacentre/dataviewer/US.ShipBuilding

[105] National Shipbuilding Office (2022).

[106] Trusted Docks (n.d.).

foreign delivery against the NSO demand. Without such analysis, the 30-year demand signal articulation falls short of a clear signal to UK industry, lacking a robust articulation of the wider prosperity, security and other benefits of UK industry involvement in its delivery.

Table 3.1. Shipbuilding demand over next 30 years by type

Type	Civil	Military	Total
National Flagship	1	0	1
Search and rescue	1	0	1
Maintenance	6	1	7
Cargo	2	8	10
Transport	41	6	47
Research	7	0	7
Patrol	19	0	19
Frigate	0	18	18
Support	0	9	9
Ice breaker	0	1	1
Pull tug	0	10	10
Pilot boat	0	2	2
Barge	0	14	14
Total	**77**	**69**	**146**

Source: National Shipbuilding Strategy Refresh (2022).

3.1.3. Persisting uncertainty around delivery against demand across the UK

The diversity of shipyards hides the fact that several of them have experienced high volatility in demand, and their capacity and capability is also varied. Cammell Laird, for example, has gone through multiple restructuring and lay-off plans over the past decade, partly due to a lack of orders since the completion of the RRS *Sir David Attenborough*.[107] As such, the capacity and experience of UK shipyards to deliver against the UK government's demand signal varies significantly by shipyard and type of vessel.

Finally, it is unclear which of the vessels in the 30-year pipeline will be built in UK shipyards, either alone or in collaboration with foreign shipbuilders. The order of four ferries by Scottish state-owned corporation Caledonian Maritime Assets Limited to Turkey's Cemre Shipyard in 2022 demonstrated the willingness of public authorities to offshore manufacturing if this is perceived to be more cost effective.[108] During interviews, stakeholders highlighted the perceived need for closer cooperation between the shipbuilding sector and the UK government to better align acquisitions processes and timelines with industry, for example engaging with industry early to understand potential design options to meet demand requirements.[109] Interviewees also highlighted the need for greater clarity around the trade-offs between

[107] BBC News (2018).

[108] Allison (2022).

[109] Interview with RAND Europe, 2024.

cost, capability and prosperity benefits, suggesting that decisions to procure ships from abroad instead of local shipbuilders can undermine skills development efforts.[110]

3.2. For successful delivery against the demand signal, timely access to the right volume and type of skills will be essential

One of the reasons why countries like Italy, Germany and France can stay competitive is due to their access to labour through advantageous EU agreements on freedom of movement for workers.[111] In the aftermath of Brexit, which imposed limitations on the sourcing of visa-free labour from the EU, UK shipyards are having to compete against many other labour-heavy sectors for a shrinking overall pool of workers. As a result, UK shipyards have shifted towards innovating domestic capabilities while outsourcing significant portions of manual labour activities overseas.

3.2.1. Access to labour

According to one interviewee, more than half of overall naval shipbuilding spending goes through globally competitive tenders where foreign shipbuilders can bid for a share of the work.[112] This trend has been more prominent for civil and commercial vessels, while the high-end construction and support of warships still tends to take place within the UK, not least due to the importance of sovereignty of industrial base and the national security constraints in terms of offloading labour to workers with appropriate security clearances.[113] Some interviewees expressed doubts about the feasibility of the naval shipbuilding pipeline and indicated that there have already been slippages in delivering on orders, some of which were driven by workforce shortages or mismatches.[114] To date, when demand for skills has outstripped supply – particularly for manufacturing jobs – UK shipyards have tended to recruit workers from the Philippines, Poland and wider Eastern Europe to fill in the gap. This has also been the case in shipyards on the Clyde.[115]

3.2.2. Competition for skills and workforce turnover

Although there have been successes in growing numbers of apprentices, there is a lead time before they achieve full productivity, which means new recruits cannot help immediately with closing urgent skills gaps.[116] Additionally, apprenticeship schemes have reportedly seen a relatively high turnover, as discussed in more detail in Chapter 4. The current skills demand in shipbuilding increasingly stands in direct competition with other industries requiring skills that are highly transferable in roles such as steel workers, welders and electricians.[117] Several interviewees emphasised that the short-term demand picture for skills in

[110] Interview with RAND Europe, 2024.
[111] Interview with RAND Europe, 2024; Simon (2023).
[112] Interview with RAND Europe, 2024.
[113] Interview with RAND Europe, 2024.
[114] Interview with RAND Europe, 2024.
[115] Interview with RAND Europe, 2024.
[116] Interview with RAND Europe, 2024.
[117] Interview with RAND Europe, 2024.

the area is clear, especially for trades jobs[118] and other operational or practical skills professionals,[119] but that there is not enough workforce growth in the shipbuilding sector to drive and sustain demand for the medium (five to ten years) to long term (10+ years).

3.3. The Type 26 programme has generated a large backlog, and its delivery will need effective utilisation of and growth in workforce

3.3.1. The UK naval shipbuilding backlog

The domestic backlog of the UK naval shipbuilding industry is currently at 16 major platforms, including surface combatants and support ships, as shown in Table 3.2.[120] This is not inclusive of commercial acquisitions and of public procurement of non-naval ships. More naval acquisition programmes have also been announced but are yet to be contracted with shipbuilders. These programmes include the construction of a new frigate class with the Type 32 (currently in design phase) and the MRSS.[121] Although diverse in platform types and capabilities, the overall backlog of the UK shipbuilding industry (including commercial shipbuilding) is in fact relatively small in terms of both tonnage and value compared to its European counterparts of similar economic and military size. France's domestic naval shipbuilding backlog, for example, currently includes only 13 major platforms and 12 light vessels, but most of its shipyards, including Chantiers de l'Atlantique and Socarenam, also have a strong commercial footprint (representing more than 10 per cent of Europe's total) that can support a broader skills base.[122] The civil–military dual nature of France's shipbuilding industry allows for a large output and more sustainable skills base, with 120,000 employees compared to 44,600 in the UK as of 2021.[123]

[118] Interview with RAND Europe, 2024.

[119] Interview with RAND Europe, 2024.

[120] IISS (2024).

[121] Allison (2024e); Mills (2024).

[122] UN Trade and Development (2024).

[123] Masson (2021); UK Shipbuilding Skills Taskforce (2023a).

Table 3.2. Current pipeline of UK naval procurements as of July 2024

Programme	Contractor(s)	Location(s)	Design work	Planned	Delivered
Type 31	Babcock	Rosyth (Scotland)	Completed	5	0
Type 26	BAE Systems	Govan and Scotstoun (Scotland)	Completed	8	0
Fleet Solid Support Ship	Navantia, Harland & Wolff and BMT	Belfast (Northern Ireland), Appledore (England) and Cádiz (Spain)	Ongoing	3	0
MRSS	*TBD*	*TBD*	*TBD*	*TBD*	*0*
Type 83	*TBD*	*TBD*	*TBD*	*TBD*	*0*
Type 32	*TBD*	*TBD*	*TBD*	*TBD*	*0*

Source: Miliary Balance +.

Not included in the table above but worth taking into account is also the demand for submarine delivery. Specifically, two out of the seven planned Astute boats are still to be delivered into service, as well as all four of the SSBN Dreadnought submarines and the SSN-AUKUS programme. To reach the required 17,000 workforce in Barrow-in-Furness, BAE Systems has ramped up investment in recruitment and training, including at its Academy for Skills and Knowledge.[124] The significant demand for workforce growth in Barrow-in-Furness creates further competition for skills in and around the Clyde, given the relative proximity of the two labour markets.

3.3.2. Naval shipbuilding backlog on the Clyde

Most of the work on the Clyde is being driven by Type 26, which has seen a sharp increase in labour demand since 2020.[125] This is because BAE Systems has been commissioned to build eight Type 26 vessels for the Royal Navy on top of further contracts with Canada and Australia.[126] While BAE's shipyard on the Clyde focuses on Type 26, Babcock's shipyard in Rosyth builds the Type 31 (see Figure 3.2).[127] Clyde's shipyards are set to be at full capacity without further infrastructure investment or strategic partnering until the delivery of the last Type 26 of the City class, HMS *London*, to the Royal Navy in 2033, with multiple overlapping build activities in place at the same time, as shown in Figure 3.2.[128] Shipbuilders on the Clyde have to compete with their counterparts in Rosyth (and to some degree in Barrow-in-Furness) for a similar pool of skills, both at the technical engineering level and for structure and outfitting skills.

[124] BAE Systems (2024).

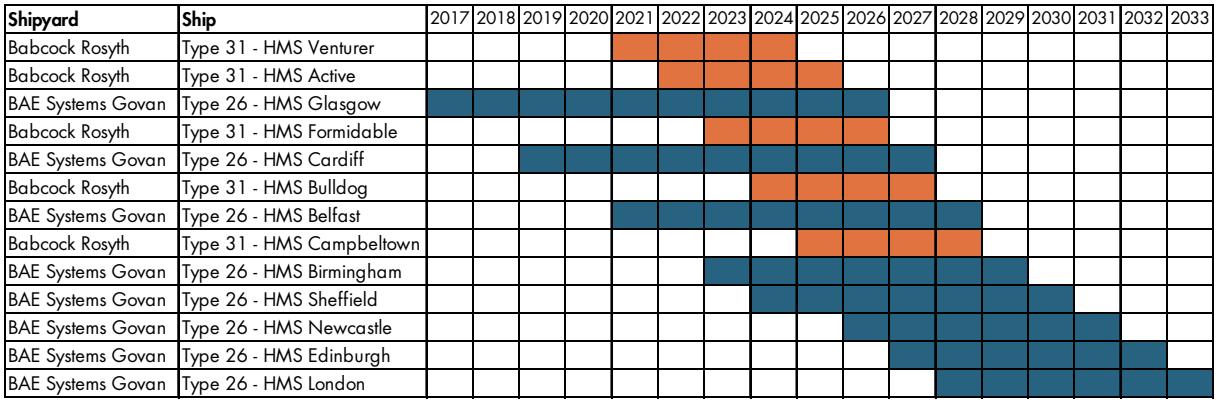
[125] Interview with RAND Europe, 2024.

[126] Interview with RAND Europe, 2024.

[127] Interview with RAND Europe, 2024.

[128] Navy Lookout (2024b).

Figure 3.2. Construction and delivery schedule of Royal Navy's Type 26 and Type 31 ships



Source: Navy Lookout (2024a, 2024b) and Naval Today (2022).

3.3.3. Maintenance and in-service support demand

In addition to the skills demand induced by the shipbuilding industry, the repair and refit industry also draws on similar skillsets. Compared to pure shipbuilding, the UK has a denser network of dry docks focusing on repair and refit that tend to be located in the same geographical areas. The main industrial players of ship maintenance and repair include BAE Systems Portsmouth (England), Babcock Plymouth (England), A&P Group Ltd (England), Cammell Laird (England), Dales Marine (Scotland), Dunston Ship Repairs (England), Babcock Rosyth (Scotland), UK Docks Marine Services (England), Harland & Wolff (multiple locations across the UK) and Ferguson Marine (Scotland).[129] Those with a presence on the Clyde include Dales Marine and Ferguson Marine. There is also a large submarine maintenance ecosystem that notably includes Babcock Plymouth (England) and HMNB Clyde (Scotland). These companies and organisations maintain a workforce with numerous skills transferable to shipbuilding, including welding, electrical engineering, interior design, glass and glazing solutions, and hydraulic systems.[130] The Royal Navy operates 62 surface platforms, of which 12 are currently undergoing repair or refit work.[131] The rest of the UK civilian and commercial fleet is too diverse to list precisely but is set to be significantly bigger than the navy, with, for instance, the state-owned Caledonian MacBrayne ferry company operating more than 30 ferries alone, posing further demand for refit and maintenance.[132] This extensive fleet of naval and civil ships ensures a steady demand for repair and refit work for UK dry docks, with a relatively steady utilisation of skills in servicing and support. However, the overall shift from traditional industries and the increased focus on renewables, electric transportation, autonomous vessels[133] and other future industrial priorities (e.g. 'secure-by-design' infrastructure[134]) also means a new demand landscape for ship design, construction, repair and refit.[135] The shipbuilding industry will need to proactively reskill, upskill and front skill workers to

[129] Trusted Docks (n.d.).

[130] Ship Technology (n.d.).

[131] Allison (2023b).

[132] CalMac (n.d.).

[133] Interview with RAND Europe, 2024.

[134] Interview with RAND Europe, 2024.

[135] Interview with RAND Europe, 2024.

match their capabilities with upcoming demand.[136] Retaining engineering and construction skills will also require better peaks-and-troughs management from government and industry to avoid laying off when demand declines.[137]

Box 3.1. Summary of key findings

- The UK's 'Golden Age' of shipbuilding must start from a low base considering the country's relatively small industrial footprint in shipbuilding overall (military and civil), representing less than 1 per cent of Europe's total by tonnage.
- The release of the National Shipbuilding Strategy Refresh in 2022 signalled the willingness of the UK government to signal its commitment to the shipbuilding sector, articulating a plan of a steady stream of governmental orders. This plan includes 146 ships to be ordered over the next 30 years. However, the national government as well as devolved administrations and local authorities continue to determine their own procurement strategies, processes and timelines, with limited centralised coherence.
- The domestic backlog of the UK naval shipbuilding industry currently stands at 16 major platforms, including surface combatants and support ships, many of which will be delivered at shipyards in close geographic proximity, competing for the same skills and talent. In addition, the increased demand for labour due to the SSN-A programme following the establishment of AUKUS already drives further competition for skills in the region.
- Industries on the Clyde further compete for talent with adjacent sectors, such as renewable energy, transport, autonomous vessels and others, presenting challenges for delivery against demand.
- Securing a steady stream of orders, as envisioned in the National Shipbuilding Strategy and the 30-year pipeline, is unlikely to be enough on its own to ensure the sustainment of skills on the Clyde, considering the competition coming from adjacent industries and other shipyards.

[136] Interview with RAND Europe, 2024.

[137] McDonough (2021).

4. Workforce demographics, demand and supply

This chapter summarises RAND Europe's analysis of industry-provided workforce data. It outlines key characteristics of the current maritime workforce on the Clyde and provides some insights on future workforce demand and supply.

4.1. The maritime workforce on the Clyde has a balanced age demographic, building on a successful recruitment of early careers

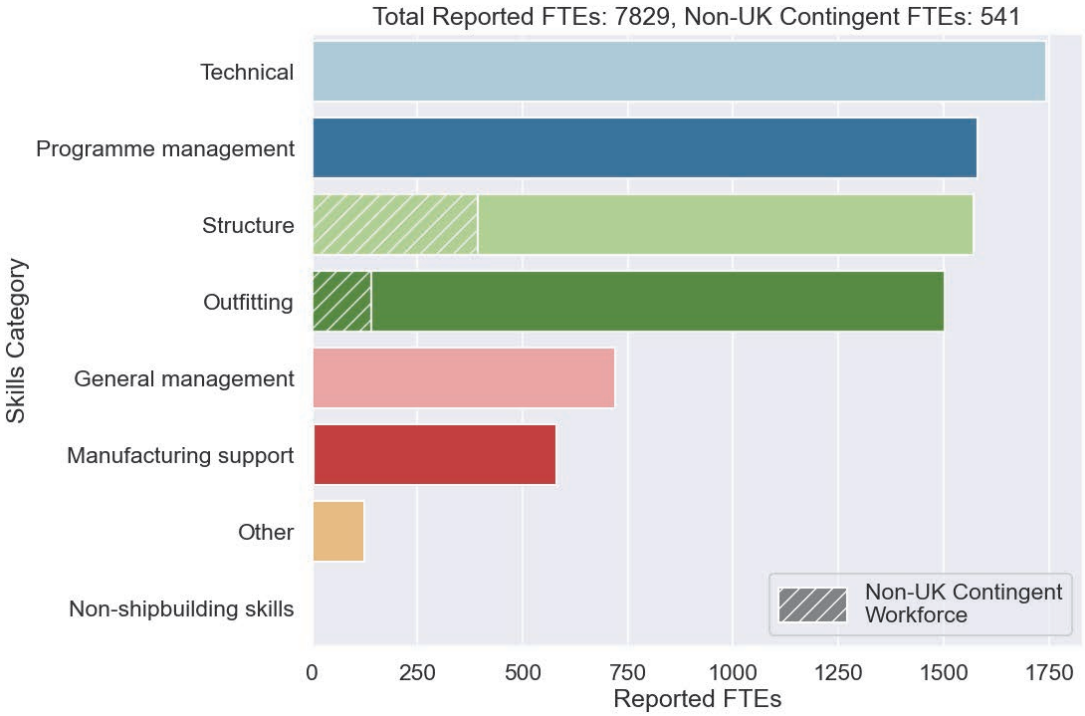
4.1.1. Workforce numbers and distribution of skills

Companies surveyed for this study employ nearly 8,000 full-time equivalent employees (FTEs), who are split evenly across skills categories: technical (primarily engineering skills), programme management, structure and outfitting, as shown in Figure 4.1. The overall number of FTEs is similar to the figure captured in RAND's 2003 industry survey for Scottish shipyards (*c.* 8,400), although that survey covered a slightly different workforce community. Specifically, the 2003 survey only included BAE Systems and Ferguson Marine on the Clyde and covered Rosyth as well, which this study did not.[138] A detailed breakdown of skills that fall under each overarching category is provided in Annex D.

To better understand the breakdown of the workforce, the RAND Europe study team also asked companies to provide a breakdown of their non-UK workforce, most of which represents contingent labour. As shown in Figure 4.1, non-UK workforce represents about seven per cent of the total workforce but is disproportionately higher in structure and outfitting. Indeed, nearly 99 per cent of non-UK workforce resides within structure and outfitting, which are composed of 25 per cent and nine per cent of non-UK workers respectively. These workers are often brought in to cover skills shortages arising from high levels of demand for build activities, particularly welders, steelworkers, platers and boilermakers, as shown in Figure 4.3. A more effective and coordinated local workload optimisation could help identify opportunities where peak demands could be met (or partially met) by local resources that may not be fully utilised across the wider industrial base. This is explored further in Chapter 5.

[138] Schank et al. (2005).

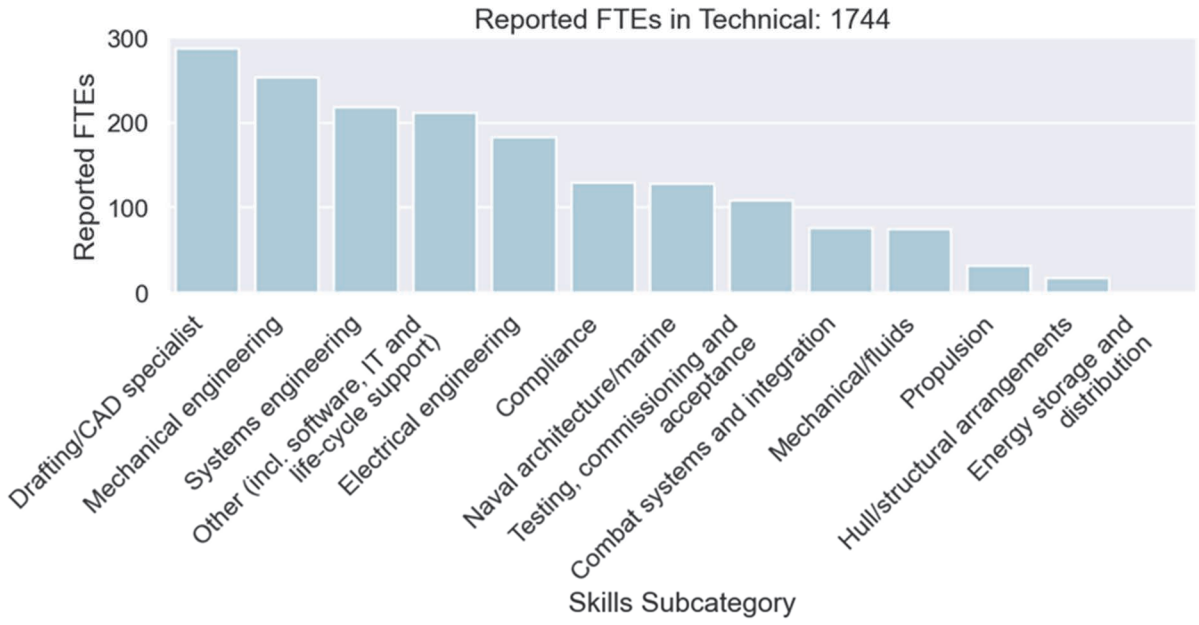
Figure 4.1. Overall FTE numbers for maritime industrial skills on the Clyde



Source: RAND Europe analysis of industry workforce survey data (2024).

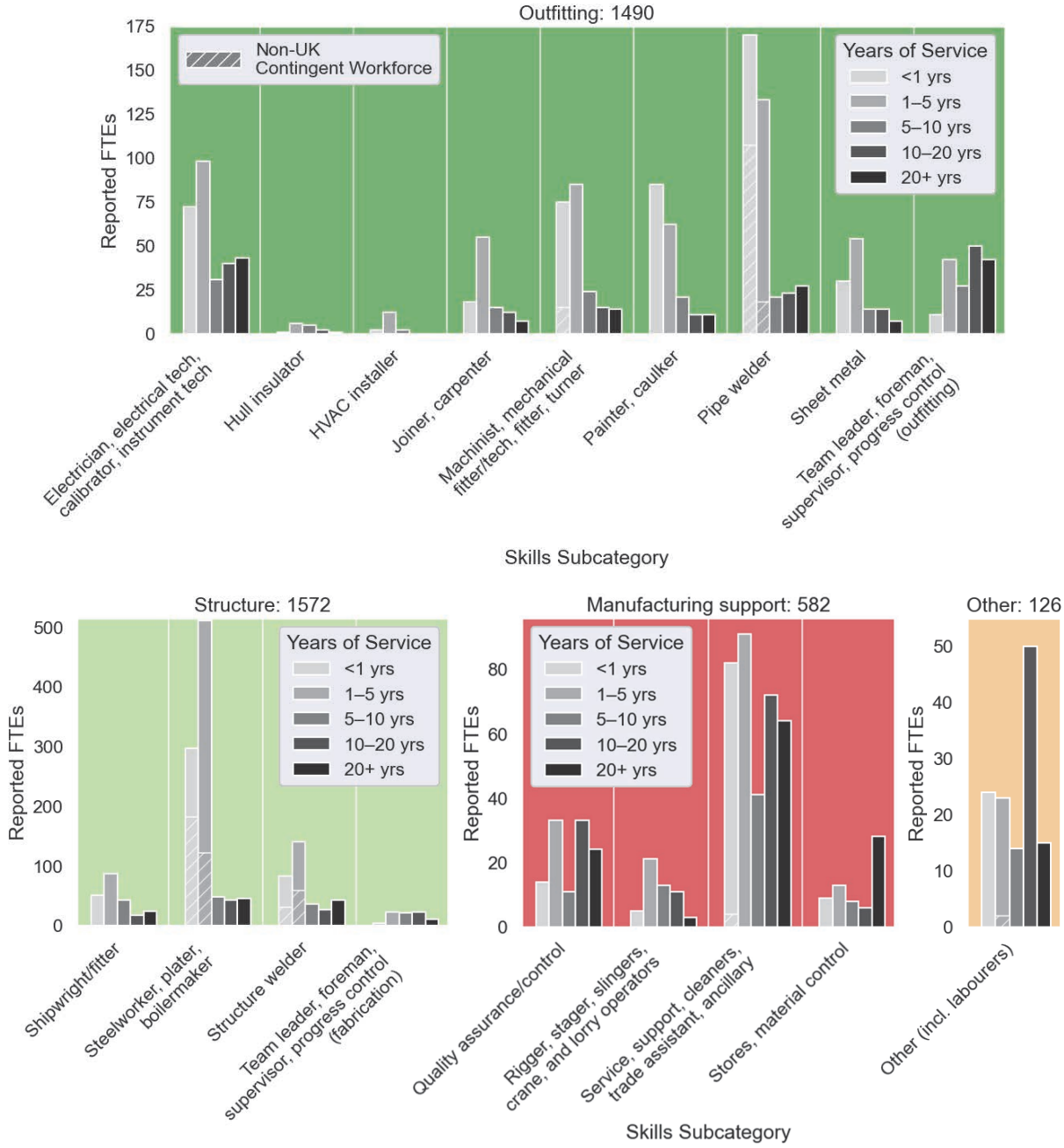
Aggregated across all the companies involved in this study (Babcock, BAE Systems, Dales Marine, Ferguson Marine and the Malin Group), there is a balanced coverage of all skills across the skills groups within structure, outfitting, technical and programme management, as shown in Figure 4.2 and 4.3.

Figure 4.2. Total FTE numbers per skills subcategory: Technical



Source: RAND Europe analysis of industry workforce survey data (2024).

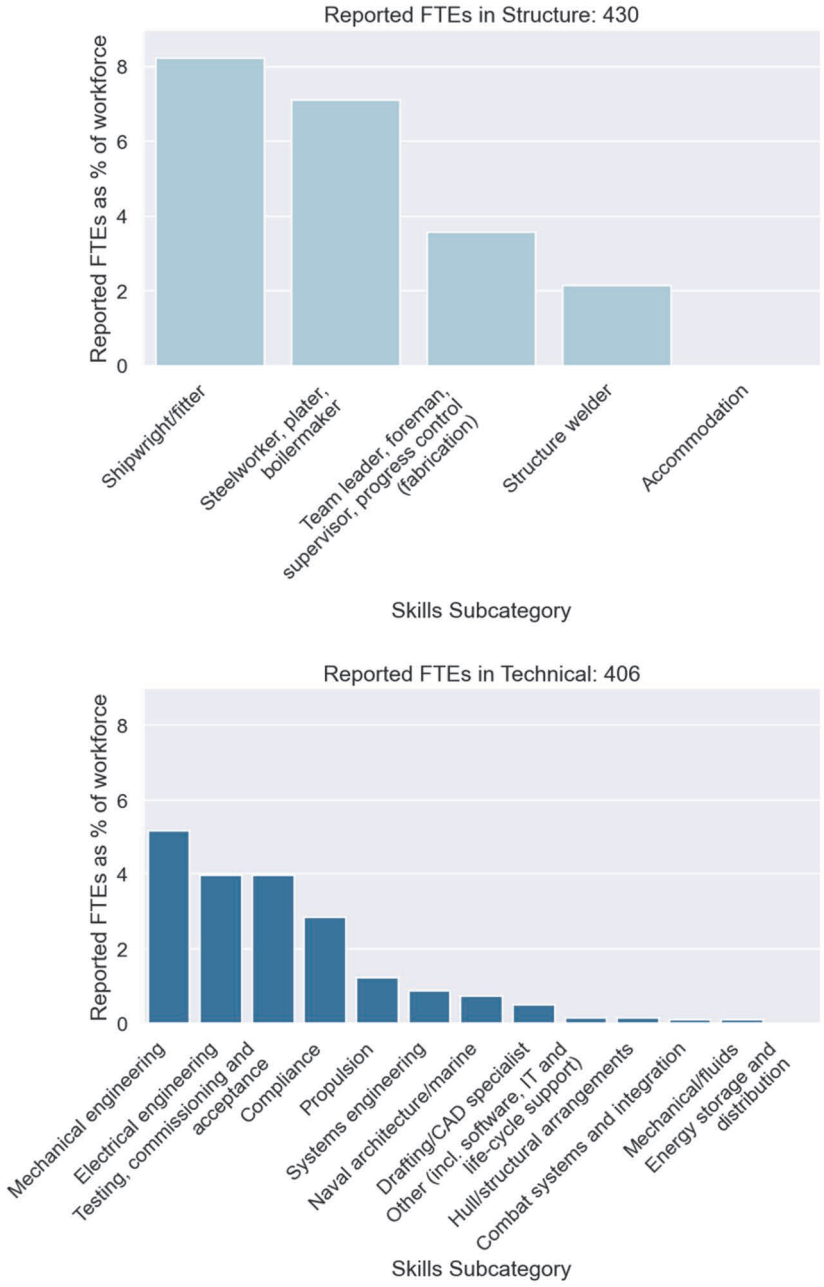
Figure 4.3 Total FTE numbers per skills subcategory: Outfitting, structure, manufacturing support



Source: RAND Europe analysis of industry workforce survey data (2024).

While at the aggregated level, the industries involved in this study have skills across the full skills taxonomy, within smaller companies, there might not be a full 'coverage' of skills as not all are needed for their business. Alternatively, some skills may represent a very small proportion of the workforce, as shown in Figure 4.4. While they are often needed in only small numbers in these companies, they may be at greater risk of loss, and companies may need specific retention or succession plans in place for these skills. In the structure category, these skills include welders and team leaders in particular, while in technical skills, there are low numbers of computer-aided design (CAD) specialists and naval architects.

Figure 4.4. Skills present in small numbers across smaller companies

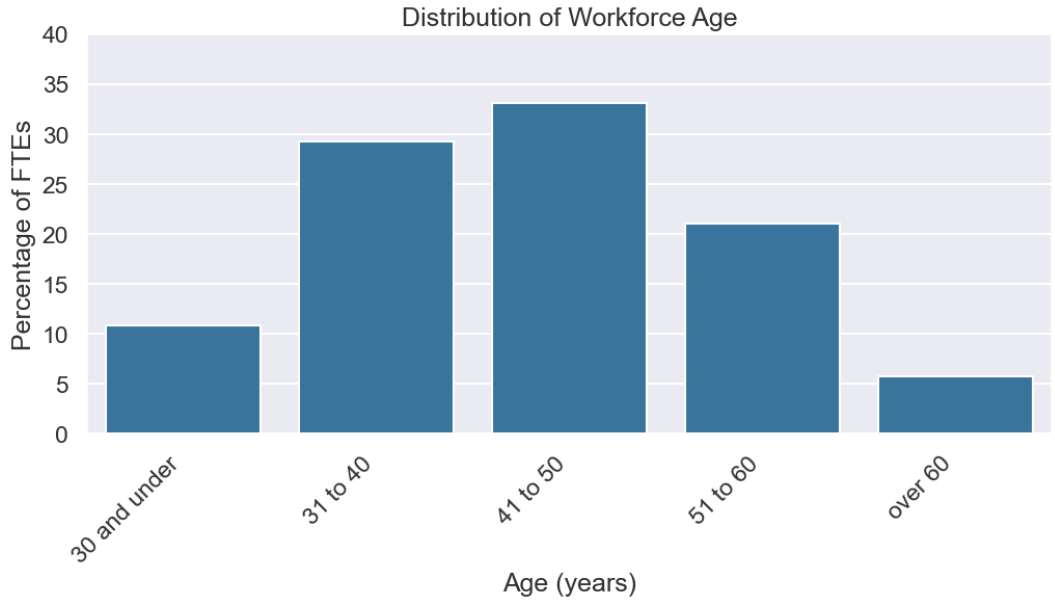


Source: RAND Europe analysis of industry workforce survey data (2024).

4.1.2. Age demographics

The current shipbuilding workforce on the Clyde displays a healthy age demographic profile, as shown in Figure 4.5, indicating success in companies' ability to recruit and retain younger workforce over the last few years. Importantly, about one third of employees are currently between 31 and 40 years old, with only about one fifth of employees being between 51 and 60 years old. About one third of employees are in between 41 and 50 years old, and just over one in ten are younger than 30 years of age.

Figure 4.5. Age demographics of the shipbuilding workforce on the Clyde



Source: RAND Europe analysis of industry workforce survey data (2024).

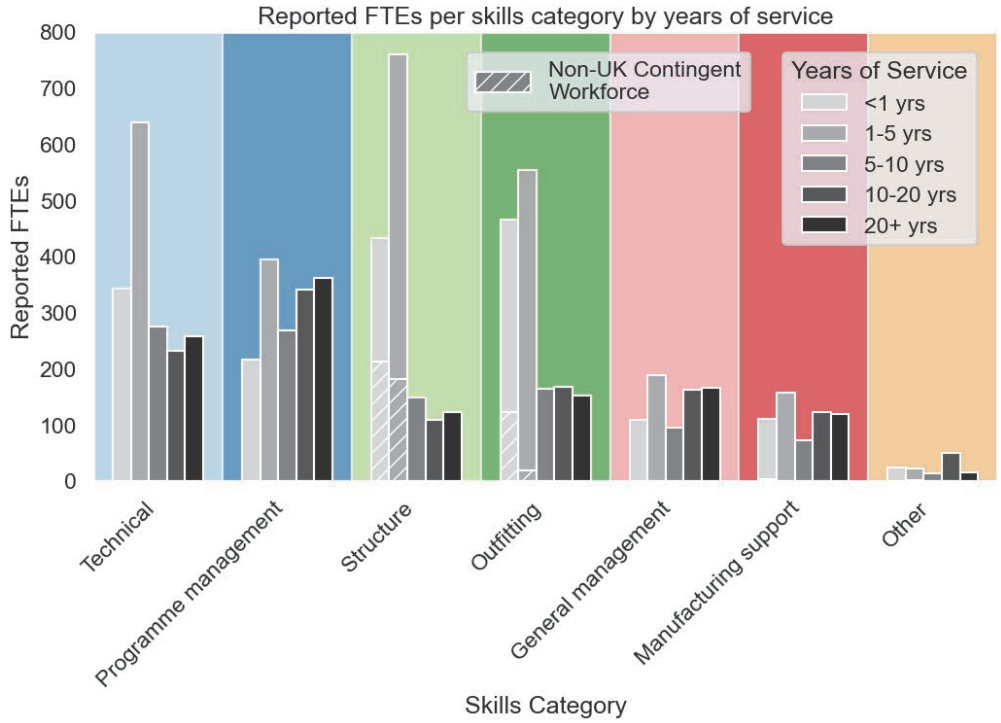
For comparison, RAND's 2003 industry survey of all UK shipbuilders showed roughly the same proportion of workers in the 41–50 age category (i.e. about one third), but there was a significantly higher proportion of employees in the 51–60 age category (about one quarter).[139] A more balanced age distribution means that there are more opportunities for peer-to-peer interaction and learning, as well as opportunities for knowledge transfer from more experienced (typically older) workers to those in early stages of their careers. This type of distribution also gives greater certainty and confidence to the stakeholders that a demographic 'cliff edge' – whereby a large proportion of the workforce would retire around the same time, leading to sudden loss of knowledge and expertise – will not occur. Finally, a more balanced age demographic helps to enable a smoother transition from earlier career stages through to more senior roles, backfilling posts as more experienced personnel leave or retire.

4.2. The majority of employees have been in their current company for five years or less, demonstrating the growing nature of this sector

In line with the balanced age demographics, workforce distribution by experience (estimated by number of years in service) also confirms a successful intake of less experienced professionals over the last five or so years, primarily as the Type 26 programme has been gathering pace. Indeed, as Figure 4.6 shows, there is now a peak of FTEs who have been in the company between one and five years, and this peak is present across most of the skills groups in structure and outfitting as well as technical roles. Non-UK workforce, almost without exception, falls into this category of less than five years' experience in the industry, indicating their relatively recent hire status. A detailed breakdown for individual skills is given in Figure 4.7.

[139] Schank et al. (2005).

Figure 4.6. Workforce by years of service in current company



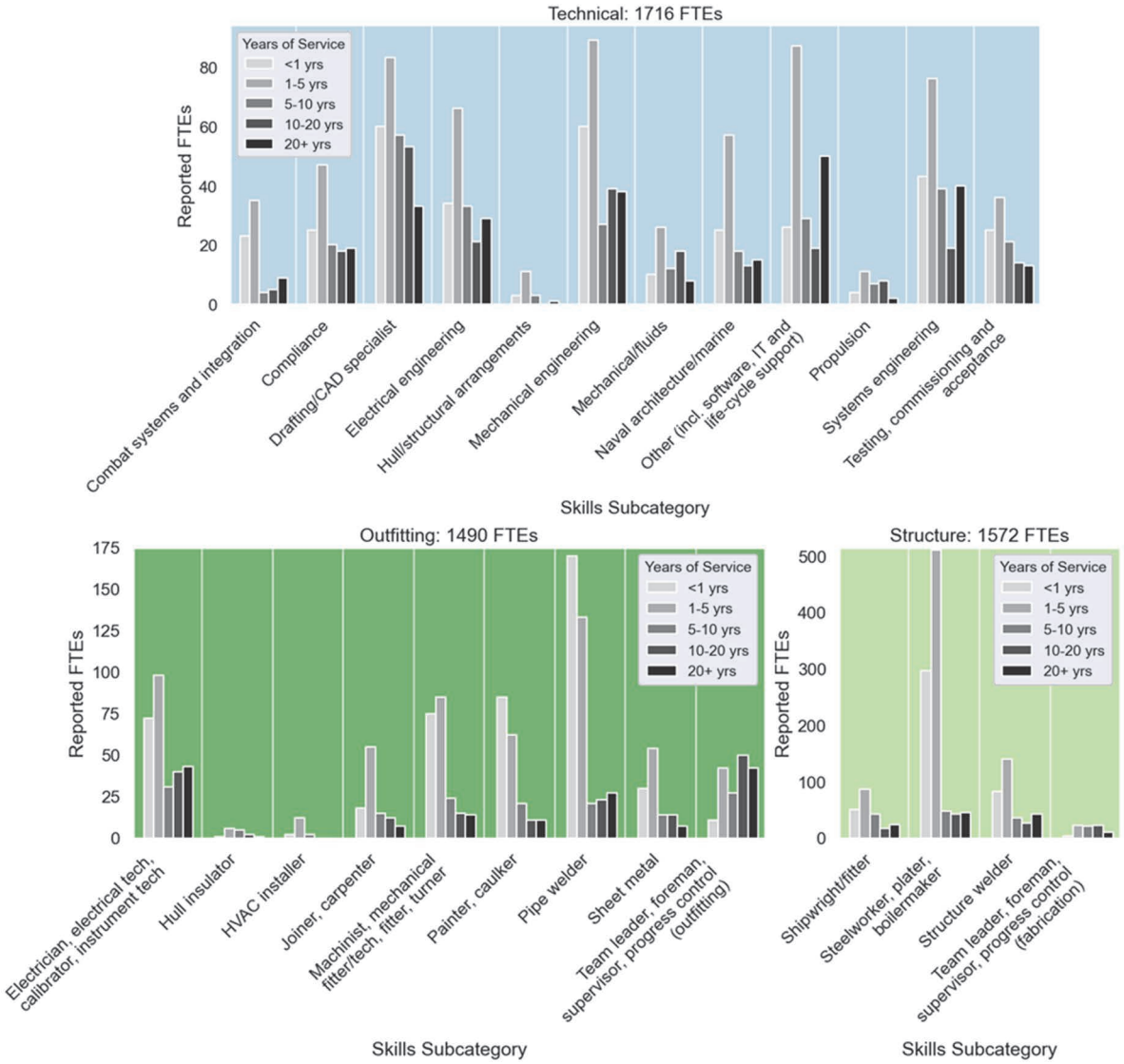
Source: RAND Europe analysis of industry workforce survey data (2024).

In addition to the high proportion of less experienced FTEs, there are also high numbers of very experienced professionals (with over 20 years of service in the company). This is particularly the case in programme and project management roles. In a sector where programmes typically last decades, from concept and design through to development, manufacture and in-service support, expertise is built up over years of engagement with the programme. At the more senior level, these roles also require significant contextual understanding of the wider policy and strategy landscape, stakeholder relationships and supply chain to effectively manage the complexity inherent in large shipbuilding and support programmes.

As our data only captures service within a particular company (rather than service within the sector as a whole), it is not possible to accurately determine the extent to which the recent growth of workforce has come from within the wider shipbuilding sector in the UK as opposed to from other sectors. Further qualitative information provided by companies surveyed in this study suggests, however, that most of the recruitment (in some cases close to 100 per cent) is from local areas, and therefore it is likely that the growth in workforce has come primarily from local companies and organisations rather than other UK shipyards around the country.

In general, large numbers of less experienced professionals are a positive sign of a growing sector that is facing a sustained or growing demand for work. This aligns with the projected demand outlook for the next decade and beyond, particularly as the Type 26 production continues out into the 2030s.

Figure 4.7. Workforce by years of service in current company: detailed breakdown by skills group



Source: RAND Europe analysis of industry workforce survey data (2024).

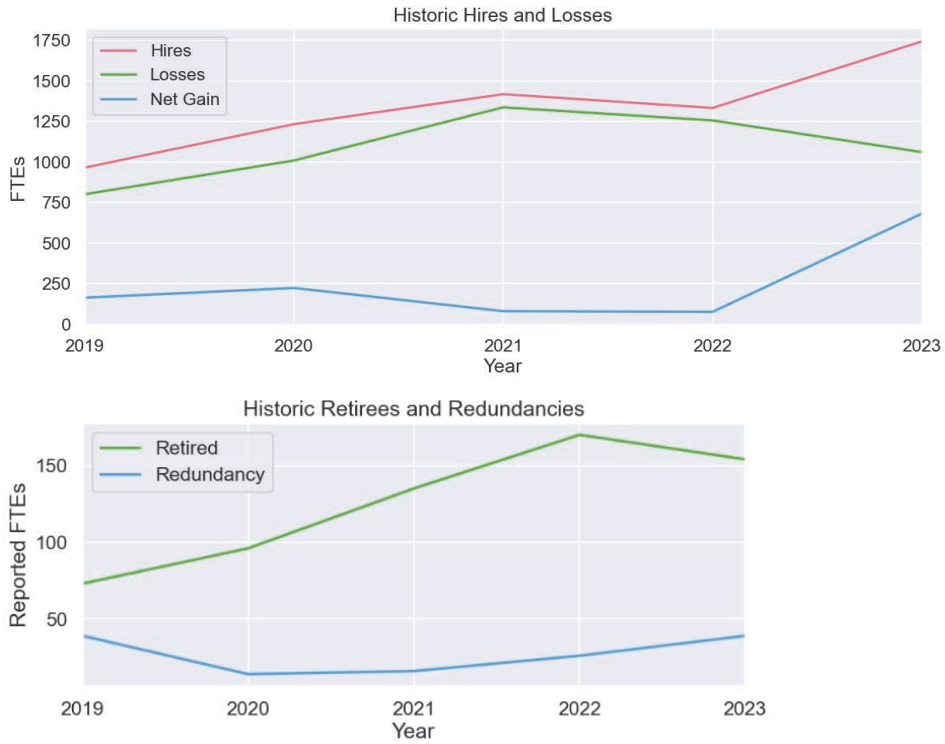
4.3. Despite successful recruitment, high turnover over the last five years places renewed emphasis on retention

The positive growth numbers discussed in the previous section need to be considered in the wider context of retention, workforce turnover and an overall balance of experience in the workforce. Similar to many other industrial and technology-heavy sectors, the aftermath of the COVID-19 pandemic has seen a significant churn of workforce, particularly in 2021 and 2022, intensified by low unemployment and growing demands among workers for greater flexibility, including remote working.[140] As Figure 4.8 shows, the companies on the Clyde have experienced both high hiring rates and high loss rates over the last five years, resulting in modest net growth of workforce until 2023 as companies effectively hired new staff to

[140] The Economist (2022).

offset the losses. The majority of the losses across all companies were due to retirement. When looking at smaller companies only, however, redundancies grew in 2022 and 2023 and were almost as high as retirements in 2023. High turnover within companies can lead to productivity losses, as experienced staff retire while new staff do not stay long enough to bring the desired return on training investment.

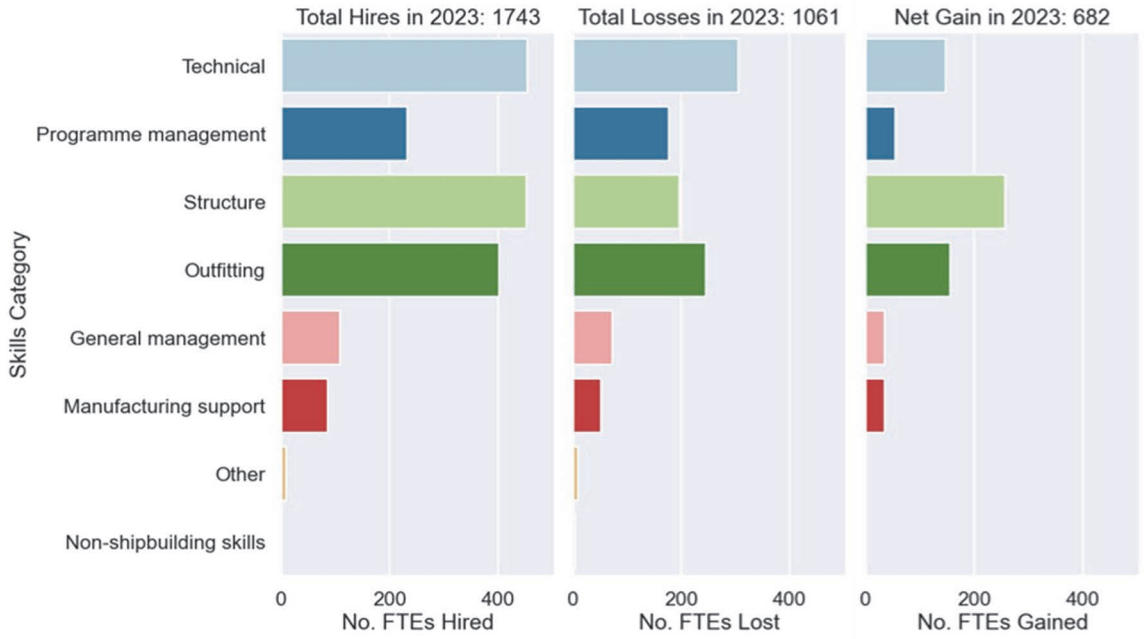
Figure 4.8. Historic hires, losses and net growth (2019–2023)



Source: RAND Europe analysis of industry workforce survey data (2024).

An outlier, 2023 was a successful year in terms of hiring, with a net gain of FTEs over 680, as shown in Figure 4.9, with the largest net growth seen in structure and outfitting, followed by technical workforce and a smaller growth in programme management and general management.

Figure 4.9. Net gain in FTEs (2023)



Source: RAND Europe analysis of industry workforce survey data (2024). Note: In 2023, 'non-shipbuilding skills' saw no hires, and lost 100 per cent of its workforce (corresponding to 3.8 FTEs). For ease of readability, this category has been omitted from Figure 4.9. Note that 'Other' saw a net loss of 0.16 per cent (0.2 FTEs) in 2023.

To understand workforce turnover on the Clyde in more detail, the RAND Europe study team also looked at the net gain of FTEs across the skills groups, shown in Figure 4.10, which depicts the skills groups with the highest turnover rates over the last five years. Technical skills have experienced the largest net losses over the last five years, with 2023 being the first year since 2019 where technical workforce has grown in net terms. Outfitting, too, experienced net losses prior to 2021, but this has been reversed in more recent years. Structure-related skills have seen a positive net growth since 2019, although the size of the growth has varied significantly, as shown in Figure 4.10, with a peak net growth experienced in 2020 and 2023.

At an even more granular level in technical skills, the industry data shows greatest net losses in drafting and CAD, software engineering, IT and life-cycle support and systems engineering roles up to 2023, though all negative growth has seen a reverse in 2023. For outfitting, the biggest turnover has been in pipe welding, seeing both the greatest losses and also the steepest hiring rate. In structure, a similar trend (greatest losses and greatest hiring rates) was seen in steelworker, plater and boilermaker roles, peaking in 2021 and achieving significant net growth in 2023.

Figure 4.10. Turnover over five years across skills groups

Source: RAND Europe analysis of industry workforce survey data (2024).

In addition to the high turnover of staff witnessed over the last five years, there are further challenges associated with a workforce demographic that is weighted towards the less experienced professionals. Specifically, less experienced individuals generally require more intense and purposeful upskilling, mentoring and on-the-job training, all of which place demands on the more experienced personnel. With large numbers of less experienced staff, proactive measures are needed to ensure learning and development are conducted efficiently and effectively. This is one of the reasons that BAE Systems has set up the Applied Shipbuilding Academy, with the aim of upskilling larger numbers of early career professionals more rapidly.

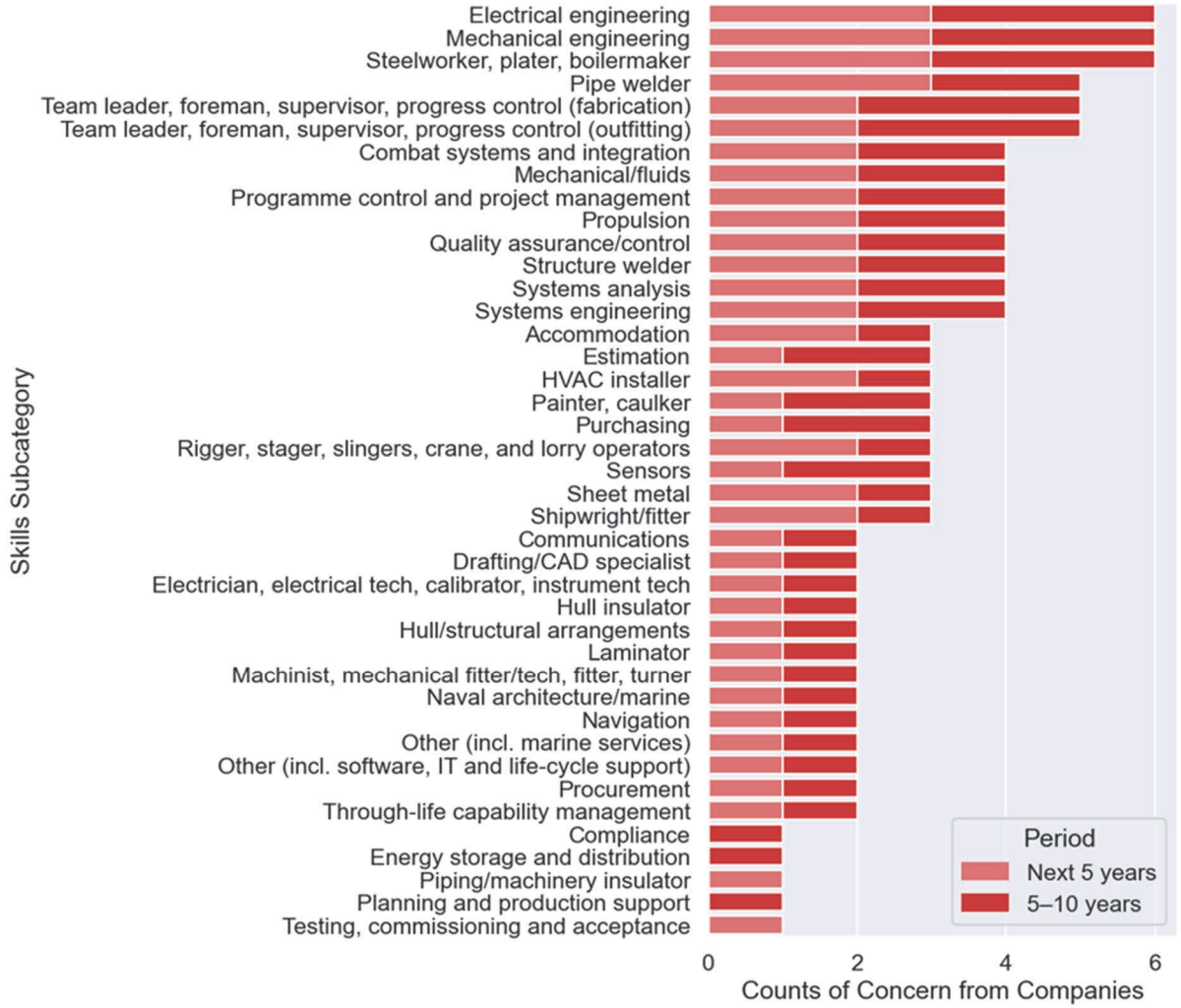
Finally, the large gap between more and less experienced workforce can pose a challenge for retention – not only of more experienced staff, who may now be required to provide significantly greater support to learning, development and upskilling, but also of early careers professionals, who may find themselves in a highly competitive environment in which promotions to more senior roles are relatively scarce. Dissatisfied individuals in both groups may decide to leave, exacerbating the high turnover described above.

4.4. Companies are concerned about the supply of transferable skills which are in high demand across a range of sectors

One of the questions in the RAND Europe industry workforce survey asked companies to indicate whether they had a high, medium or low level of concern regarding the future supply of different skills. This question was asked for the near term (five years) as well as for the medium term (five to ten years). Figure 4.11

summarises the number of times companies expressed high concern about future skills supply. Most companies are primarily concerned about sourcing sufficient numbers of electrical and mechanical engineers, as well as steelworkers, platers, boilermakers and welders – all of which are required in high numbers and all of which are skills for which companies have already been ramping up their recruitment, particularly since 2021 (following the COVID-19 pandemic). This confirms the insights gained from qualitative interviews and the study team's review of available literature, namely that maritime companies are competing with other sectors, such as construction, renewable energy and infrastructure, for the same transferable skills. It also highlights the challenge of high turnover, as these skills can be highly mobile, with a range of options available. Therefore, industries need robust strategies not only to attract engineers, steelworkers and welders but also to retain them and to secure the future pipeline, thus mitigating the risks of skills gaps.

Figure 4.11. Companies' concern about future supply



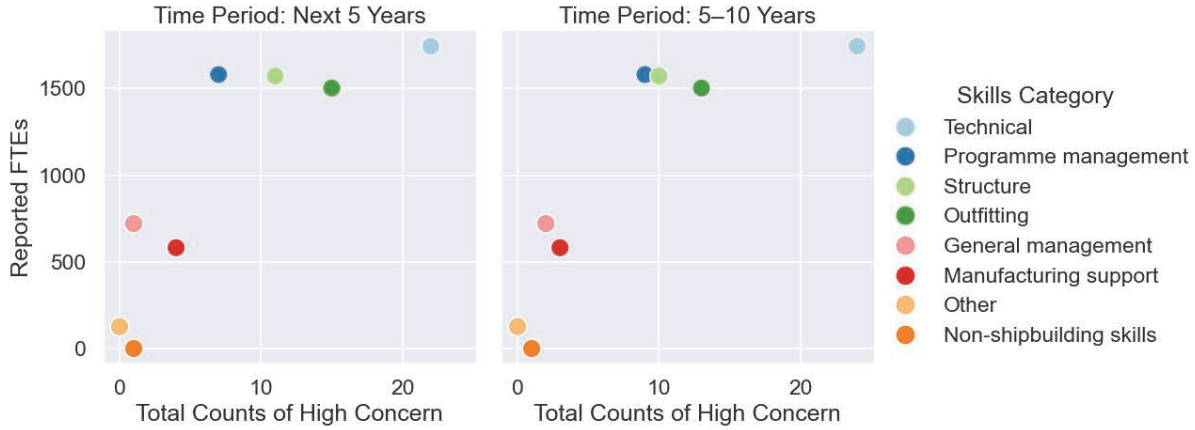
Source: RAND Europe analysis of industry workforce survey data (2024).

In addition, however, companies are also concerned about future supply of skills for roles that are only required in small numbers but require long-term expertise and experience on the job, specifically team leaders in fabrication and outfitting, programme control, quality assurance and control, as well as specialised skills such as combat system integration, systems engineering skills, systems analysis and structure welders.

For these skills, it is critical not only to have a sustained intake of new workers but also to ensure that they stay within the company in order to develop the level of expertise required for more senior, supervisory and sign-off roles. As such, robust retention strategies alongside upskilling and succession plans are especially important for these highly critical roles that are sensitive to fluctuations in supply.

Industry data analysed by RAND Europe also shows that there are many skills for which companies are more concerned about future supply beyond the next five years. Indeed, as Figure 4.12 shows, the frequency with which companies express concern about future skills supply increases for technical skills as well as for structure and general management skills. This suggests that companies perceive a growing risk of skills gaps emerging in the next five to ten years. For specific skills, such as welding, there may be concerns about the ability to source foreign labour if visa regimes change in the future,[141] while for others there are concerns about the sheer volume of skills required and whether the local labour market can support the demand (particularly given the competition from other growing sectors, such as renewable energy and infrastructure).

Figure 4.12. Concerns about future supply of skills mapped against FTE numbers



Source: RAND Europe analysis of industry workforce survey data (2024).

4.5. RAND Europe's system dynamics model suggests that skills gaps will likely emerge in scenarios that involve workforce demand growth

As part of the industry survey, the RAND Europe study team asked that industry respondents estimate their forward workload. The study team intended to use these forward-looking projections to develop demand profiles for future workload and skills utilisation. These demand profiles were intended to feed into a system dynamics model, developed for this study, that models demand and supply to identify potential skills gaps. As these data points were not provided as part of the survey, the study team instead developed our own forward estimation of demand. In doing so, we wanted to demonstrate, by means of practical examples, how industry may be able to dynamically plan future requirements. To underpin this modelling activity, the RAND Europe study team developed three basic demand scenarios against which we tested the companies' ability to meet future demand (drawing on workforce demographics data provided by the companies). The first scenario assumed that there was no growth in demand and that all demand for all

[141] Interview with RAND Europe, 2024.

skills would be held steady at 2023 levels. In addition, we modelled two 'growth' scenarios. The first was based on the assumption that future growth (by skill) can be estimated based on the net hiring projections provided by BAE Systems and Babcock. This results in differential growth between skills over the time period of the analysis. The second growth scenario relied on a uniform assumption of 15 per cent growth across all skills demand. This results in identical relative growth between skills.

These scenarios were tested with RAND Europe's internal shipbuilding experts, but they do not constitute future projections, nor do they provide accurate estimates for likely FTE numbers that may be needed, or how skills gaps will be distributed. As such, the analysis that follows is illustrative rather than predictive. Yet it seeks to demonstrate the value of conducting such scenario-based planning to better understand the impact of demand changes on current and future workforce. The three scenarios RAND Europe developed for this study are summarised in Box 4.1 below.

Box 4.1. Overview of workforce demand scenarios

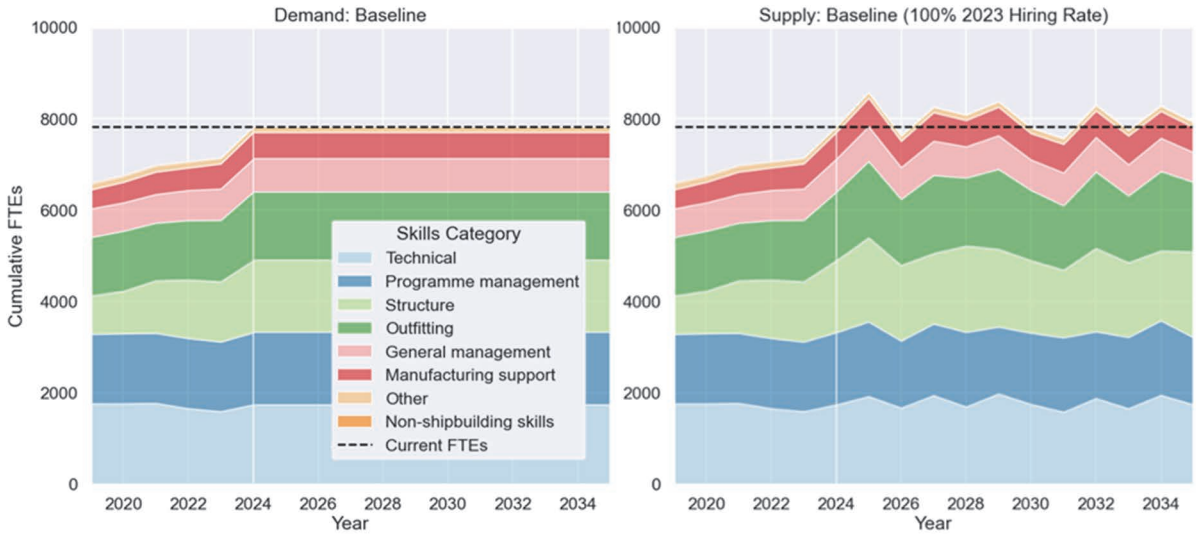
- Scenario 1 assumes that the size and structure of workforce evident in 2023 data is maintained for the next ten years (demand side) and that the hiring rate and loss rates of 2023 (underpinning the supply side of the model) are present consistently for the next ten years.
- Scenario 2 assumes that the current structure of workforce is maintained but the total growth follows the combined planned hires projections provided by BAE Systems and Babcock (as other companies did not provide this data). The supply of workforce is again modelled using the 2023 hiring and loss rates.
- Scenario 3 assumes that the workforce grows by 15 per cent by 2028 and is maintained at that level out to 2035. The structure of the workforce remains the same and the supply of workforce is modelled using the 2023 hiring and loss rates.

Source: RAND Europe assumptions.

4.5.1. Scenario 1: The shipbuilding companies on the Clyde could sustain their current size and structure with the hiring and loss rates experienced in 2023

As a baseline, the RAND Europe study team modelled a scenario in which the structure and size of the workforce of 2023 remains the same, as does the hiring rate and loss rate. If this scenario were to materialise, it is clear from our model that the shipbuilding companies on the Clyde would be able to sustain the same size of the workforce for the next decade, primarily due to the fact that 2023 saw a net growth of workforce across all skills categories. The demand and supply sides of the model's output are presented in Figure 4.13, with data prior to 2024 based on historical hiring and loss data provided by the companies as part of the industry workforce survey. While from a modelling perspective, companies could sustain their current levels based on growth achieved in 2023, it was beyond the scope of this study to assess whether the recent growth has been sustainable.

Figure 4.13. Demand and supply of workforce assuming static structure, size and hiring and loss rate of 2023

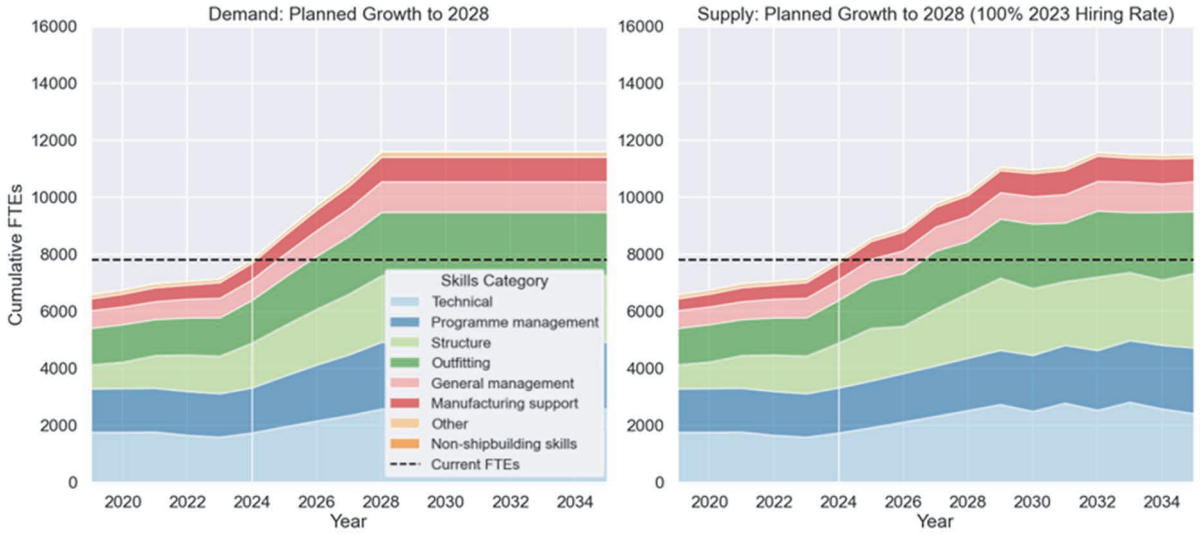


Source: RAND Europe analysis of workforce model outputs. Note: Workforce data underpinning the model has been aggregated across survey responses from Babcock, BAE Systems, Dales Marine, Ferguson Marine and the Malin Group. For supply modelling, if there is a skills gap at the end of the previous year, the model assumes both the hiring and loss rates of 2023; if there is no skills gap in the previous year, the model only assumes the loss rate. For 2025, the model assumes that both hiring and loss rates are in place.

4.5.2. Scenario 2: Assuming planned workforce numbers on the demand side, companies will likely face skills gaps unless they increase the net growth in workforce supply

A slightly more nuanced modelling by RAND Europe assumes that the current workforce structure is maintained with a total percentage growth in workforce defined by the planned hires projections provided by BAE Systems and Babcock and aggregated by RAND Europe. This means that on the demand side, there is a variable projected growth in workforce across the different skills categories, peaking in 2028 and maintained from then onwards. On the supply side, the model assumes the 2023 hiring and loss rates, given that this was the most successful year in terms of net growth in the last five years. Figure 4.14 depicts the output from the demand–supply model in terms of overall FTE numbers per skills group.

Figure 4.14. Demand and supply of workforce assuming planned growth out to 2028



Source: RAND Europe analysis of workforce model outputs. Note: Workforce data underpinning the model has been aggregated across survey responses from Babcock, BAE Systems, Dales Marine, Ferguson Marine and the Malin Group. For supply modelling, if there is a skills gap at the end of the previous year, the model assumes both the hiring and loss rates of 2023; if there is no skills gap in the previous year, the model only assumes the loss rate. For 2025, the model assumes that both hiring and loss rates are in place.

In this second scenario, the RAND Europe model suggests that skills gaps (i.e. gaps between demand and supply of FTEs) could persist for some skills groups well into the 2030s, as shown in Figure 4.15. In this figure, skills gaps are detected wherever the demand for skills outstrips supply and the percentage of workforce missing is positive, showing that skills gaps could be greatest in programme management, outfitting, general management and manufacturing support. On the other hand, the model shows that structure-related skills gaps could be relatively limited, most likely due to the recent success in hiring labour in this category.

Figure 4.15. Projected skills gaps across skills categories (Scenario 2)

Source: RAND Europe analysis of workforce model outputs. Note: When there is no bar for projected closure, this indicates that the skills gap is not projected to close by 2035 if current hiring rates are maintained.

In other words, unless the net growth rate in the future is higher than that of 2023, achieving the planned FTE recruitment targets could be difficult. The significant and persistent skills gap for 'other' skills is a consequence of the model's assumptions and constraints. Specifically, we applied the hiring and loss rates from 2023, which for 'other' skills equate to a net loss of 0.2 per year. As a result, the skills gap remains unbridgeable.

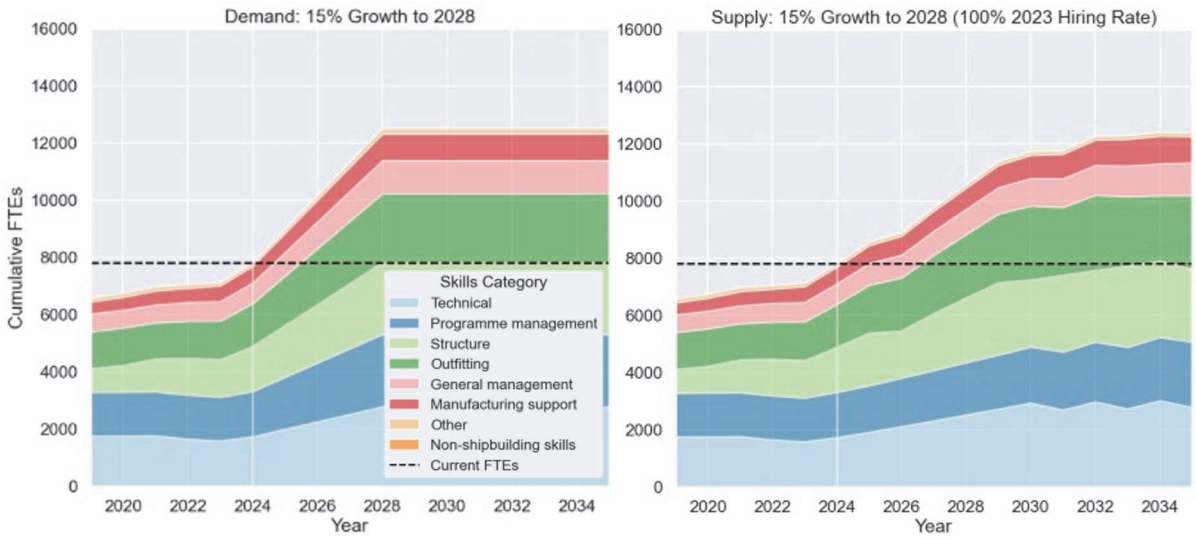
Additional sensitivity analysis conducted by the RAND Europe study team suggests that at least 125 per cent of the current hiring rate would be necessary to close skills gaps by 2025 across most skills categories, especially in the technical, outfitting and structure skills. Yet even this hiring rate would not be sufficient to close potential skills gaps in programme management, manufacturing support and general management.

While these findings are based on crude assumptions around planned hires and their distribution across different skills categories, it is nonetheless likely that meeting the planned hiring targets requires a more ambitious net growth than we had seen in 2023.

4.5.3. Scenario 3: A constant ramp up of 15 per cent relative to current workforce up to 2029 will result in larger skills gaps if the 2023 hiring and loss rates are maintained

The final scenario modelled by RAND Europe included a 15 per cent growth in current workforce for the next five years (up to 2029) annually, with the aim of building up the workforce levels to those of the early 1990s to support the scale and number of future shipbuilding orders. In this scenario, the size of the workforce increases, but its structure and distribution of skills remain unchanged. A simplified depiction of the demand and supply side for this scenario is included in Figure 4.16.

Figure 4.16. Demand and supply of workforce assuming 15 per cent annual growth out to 2029



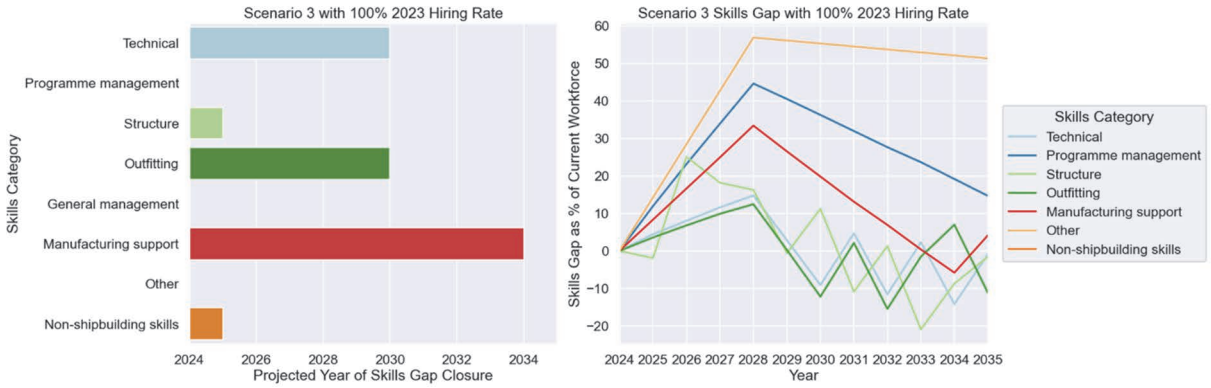
Source: RAND Europe analysis of workforce model outputs. Note: Workforce data underpinning the model has been aggregated across survey responses from Babcock, BAE Systems, Dales Marine, Ferguson Marine and the Malin Group. For supply modelling, if there is a skills gap at the end of the previous year, the model assumes both the hiring and loss rates of 2023; if there is no skills gap in the previous year, the model only assumes the loss rate. For 2025, the model assumes that both hiring and loss rates are in place.

As in Scenario 2, this scenario sees skills gaps emerging for a range of technical, outfitting and management skills. In contrast to Scenario 2, however, in Scenario 3 these gaps are larger in magnitude, as shown in Figure 4.17, and take even longer to close, assuming the 2023 hiring and loss rates are in place. RAND Europe's model output further suggests that even a 150 per cent hiring rate for skills in programme management, general management and manufacturing support would not be sufficient to close the skills gaps in these categories before about 2028. As such, if companies sought to achieve an ambitious growth of

workforce towards the 1990s levels over the next five years or so, their hiring rate would need to increase to over 150 per cent of the 2023 hiring rate (while keeping the loss rate of 2023 stable).

Of course, workforce demand can be filled not only through hiring of FTEs but also through temporary contracts and contingent labour, as has been the case (see the workforce demographics charts given earlier in this chapter). These options are often used by industry, particularly in times of peak workforce demand. However, there is also some volatility in the contingent labour pool's size and flexibility, which is often affected by wider trends such as unemployment levels and demand from other, labour-intensive sectors in the area. Contingent labour can also come at a cost premium as a trade-off for greater flexibility.

Figure 4.17. Projected year of skills gap closure (Scenario 3) and size of the skills gap



Source: RAND Europe analysis of workforce model outputs. Note: When there is no bar for projected closure, this indicates that the skills gap is not projected to close by 2035 if current hiring rates are maintained.

The significant and persistent skills gap for 'other' skills is a consequence of the model's assumptions and constraints. Specifically, we applied the hiring and loss rates from 2023, which for 'other' skills equate to a net loss of 0.2 per year. As a result, the skills gap remains unbridgeable.

Box 4.2. Summary of key findings

- The shipbuilding workforce on the Clyde displays a relatively healthy age demographic, shaped by successful early careers recruitment over the last five years and by Skills Development Scotland's increased investment in apprenticeships. However, the companies also have a large proportion of less experienced staff and challenges with workforce turnover, particularly in technical, structure and outfitting skills categories.
- The shipbuilding companies surveyed by the RAND Europe study team are concerned about sufficient supply of engineering skills as well as workforce that is sufficiently experienced to provide oversight, quality assurance and sign-off. Many transferable skills, such as electrical engineering, mechanical engineering and welding, are also highly coveted by other sectors, challenging shipbuilders' ability to grow the workforce in those areas sufficiently quickly to meet demand.
- The system dynamics model developed for this study shows that the continuation of the 2023 hiring and loss rates would be sufficient for the shipbuilding companies on the Clyde to maintain the size of their workforce. However, if their ambition is to grow the workforce, this will require greater net growth than was achieved in 2023, which in itself was the most successful year since 2019.

5. Options for interventions

The study has identified factors shaping the skills supply of the Clyde maritime sector. This chapter discusses potential options for enterprise-level interventions the RAND Europe study team has identified on the basis of international practice case studies and a gap analysis of initiatives already in place. The evidence base for this chapter relies on interviews, literature review and iterative engagement with SDS.

5.1. Many initiatives to support and grow skills are already ongoing, so this study sought to identify whether there may be gaps in focus

With shipbuilding gathering momentum over the past few years, in the aftermath of the National Shipbuilding Strategy and the establishment of the NSO, a number of initiatives have been launched to support maritime skills growth, both by local and national governments and industry. These are summarised in Table 5.1. Importantly, skills foresight has improved over recent years due to increased focus on future skills requirements, including foresight work carried out by the National Manufacturing Institute Scotland (NMIS).[142]

On the industry side, a range of initiatives aimed at maritime and shipbuilding skills development have been launched. These include, for example, the establishment of the Scottish Maritime Cluster website, which provides links to individual companies' job offerings. There has been significant growth in apprenticeship training and intake, with BAE Systems in particular successfully recruiting early careers professionals, reportedly receiving many times more applicants than the number of available vacancies. At the same time, Babcock and the Malin Group are leading modernisation efforts on the Clyde through the establishment of PEMA welding and production lines at Rosyth (Babcock) and the establishment of the Scottish Marine Technology Park in Glasgow (the Malin Group).[143]

Furthermore, local councils are increasingly investing in shipbuilding. For instance, Argyll and Bute Council, together with the Scottish and UK governments, has been investing in a new £8.1 million training centre, the Scottish Marine Industry Training Centre.[144] Inverclyde Council invested in the upgrade of Inchgreen Marine Park's facilities, new utility connections and roadways while also supporting the purchase

[142] NMIS led future workforce foresight workshops together with the Shipbuilding Skills Taskforce to better understand advanced manufacturing skills needs. UK Shipbuilding Skills Taskforce (2023b).

[143] Babcock (2020a); Scottish Marine Technology Park (2024).

[144] Argyll Bute Council (2019).

of land for the expansion.[145] Furthermore, Scottish Enterprise, a Scottish government agency, has provided funding for BAE Systems to support the company's training and skills development efforts.[146]

Although there are several ongoing initiatives at both national and regional level, there are also opportunities to align their objectives and activities to achieve greater coherence. Additionally, several new initiatives could complement the picture currently in place. These are discussed further in this chapter.

Table 5.1. Examples of skills development efforts and initiatives in Scotland and the UK

UK or Scottish initiative	Initiative	Objectives and activities
Scottish	Scottish Maritime Cluster (SMC)	SMC is an industry association that offers a platform for collaboration between stakeholders in the maritime sector to address future challenges.
Scottish	Skills Development Scotland (SDS)	SDS is the national skills agency of Scotland, a non-departmental body in the Scottish government. It supports skills and workforce development and offers career support to businesses and individuals, as well as supporting the Apprenticeship Programmes.
UK	Maritime Research and Innovation UK (MarRI-UK)	MarRI-UK is an industry-led membership organisation founded in the UK in 2019. It is a collaborative research organisation pursuing research and innovation for the UK maritime sector through collaboration between industry, academia and the non-profit sector.
UK	Maritime Skills Alliance (MSA)	MSA is a non-profit organisation, funded by its members. It offers maritime skills development opportunities through the design and promotion of qualifications and apprenticeships in the maritime sector.
UK	Maritime UK	Maritime UK is an umbrella organisation responsible for delivering industry recommendations in the UK government's Maritime 2050 strategy.
UK	Society of Maritime Industries (SMI)	SMI is a trade association for the maritime engineering and science and technology community, involving both industry and knowledge institutions.
Scottish	European Marine Science Park	The European Marine Science Park is a multipurpose facility for marine science research in Oban, established by Highlands and Islands Enterprise in partnership with Scottish Development International and the Scottish Association for Marine Science.
Scottish	Developing the Young Workforce (DYW)	DYW is an employer-led organisation that aims to connect employers with young people in schools and colleges across Scotland through close collaboration with educational institutions.
Company-led (Scotland)	Additive Manufacturing Facility (Rosyth, Babcock)	Set up and funded by Babcock International, the Additive Manufacturing Facility provides technical and engineering support and design and manufacture for a range of defence and civil specialist equipment.

[145] Inverclyde Council (2024).

[146] Allison (2024f).

UK or Scottish initiative	Initiative	Objectives and activities
Company-led (Scotland)	Scottish Marine Technology Park (SMTP, Malin Group)	The Malin Group is currently working towards establishing the Scottish Marine Technology Park, which will bring together world-leading innovators in the marine industry to collaborate.
Scottish	Marine Industry Training Centre (Argyll & Bute Council)	The Marine Industry Training Centre will be a hub for vocational training and academic study to support industry through continuing professional development and mandatory training.
Scottish	No One Left Behind (NOLB)	NOLB is an initiative funded by the Scottish government with the aim of updating Scotland's employability systems through collaboration with local governments. Its objective is to help people prepare for employment, training, education and/or volunteering and to tackle inequalities within the labour market.
UK	Shipbuilding Skills Delivery Group	Set up by the NSO, the Shipbuilding Skills Delivery Group engages with industry, governments and educators nationwide to support the development of shipbuilding skills and to oversee and drive the delivery of the recommendations of the UK Shipbuilding Skills Taskforce.
Company-led (Scotland)	BAE Applied Shipbuilding Academy, Glasgow	The BAE Applied Shipbuilding Academy in Glasgow, funded and run by BAE Systems, will provide training for BAE staff from apprentices to senior professionals.
UK	Maritime Skills Commission	Established by Maritime UK and the UK's Department for Transport in 2020, the Maritime Skills Commission aims to improve understanding of the skills of the sector, reduce the risk of skills shortages, and support career development.
UK	Movement to Work	Movement to Work is a voluntary collaboration of leading employers in the United Kingdom, including the Civil Service, to help young people aged 18 to 24 who are not in education, employment or training move closer to employment by providing quality work experience and learning opportunities, and to expose organisations to fresh, untapped talent.
UK	National Maritime Training Centre (NMTC)	The NMTC, located at North Kent College's Gravesend campus, is a provider of accredited maritime education and practical training. The Centre is managed through a partnership between North Kent College and Lloyd's Maritime Academy.
UK	UK Shipbuilding Skills Taskforce	Following the launch of the National Shipbuilding Strategy, the Taskforce was set up by the NSO to identify shipbuilding skills needs and provide solutions for skill shortages to ensure shipbuilders and the supply chain can access the skills needed. The Taskforce drew on experts from industry, academia and government and was dissolved in 2023 to pave the way for the Shipbuilding Skills Delivery Group.
Scottish	National Progression Award	The National Progression Award is a qualification provided in Scotland through partnership between schools, colleges and employers. The aim of the qualification is to assess a range of skills and knowledge in specific vocational areas to help provide access to employment, vocational and further education, and training.

UK or Scottish initiative	Initiative	Objectives and activities
UK	Maritime UK Roadshow for Girls	Organised by Maritime UK since 2023, the Roadshow for Girls aims to encourage girls to pursue STEM subjects by raising awareness about opportunities across the maritime industry.
UK	Women in Maritime	The Women in Maritime programme was established by Maritime UK in 2018. It aims to promote gender equality and inclusion within the maritime sector and to help identify practical steps to increase the number of women in the sector, and crucially within senior roles across shipping ports, marine and business service industries.
Scottish	Manufacturing Skills Academy	Funded by the Scottish government and run by NMIS, the Manufacturing Skills Academy offers advanced manufacturing training across Scotland.
Company-led	STEM outreach	BAE and Babcock are both delivering activities at schools to raise awareness about STEM career opportunities.
Company-led	Promotion of social values and sustainability	Babcock has been actively promoting the social value and sustainability aspects of shipbuilding to attract young talent.

Source: RAND Europe analysis of open-source information.

5.2. RAND Europe iteratively examined international case studies to identify insights for enterprise-wide skills interventions

As a next step, the RAND Europe study team identified a number of international practices in the maritime sector or adjacent sectors that seek to encourage skills growth and sustainment at an enterprise level (i.e. not merely at an individual company level). Following discussions with SDS, the study team shortlisted case studies for further detailed exploration. The prioritisation took place based on SDS's requirement that the case studies focus on initiatives and interventions relating to enterprise-level collaboration, upskilling, recruitment and retention. The case studies are summarised in Table 5.2 and described in more detail in Annex C.

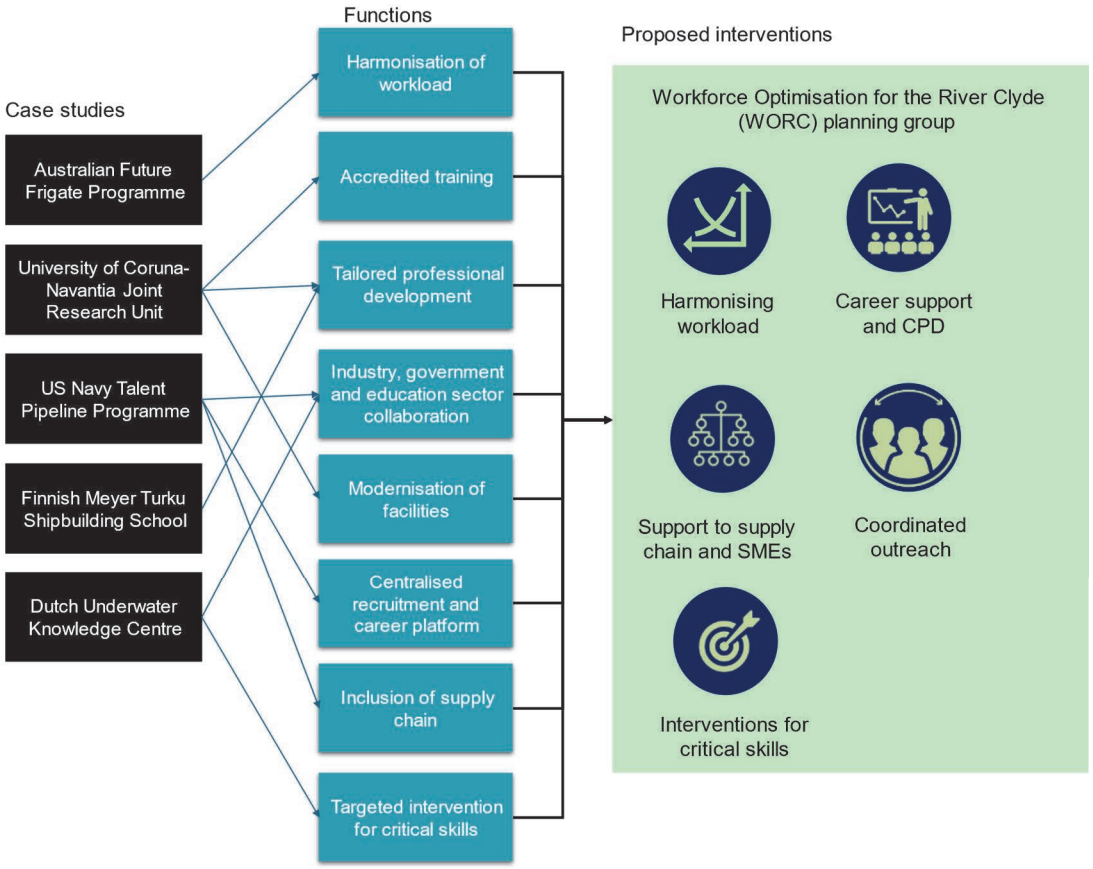
The sole purpose of the case studies was to distil a set of functions that can be delivered to help grow and sustain skills. The RAND Europe study team did not conduct an evaluation of the case studies but, rather, used them as tools to help articulate which features could be in place within enterprise-level skills interventions. Table 5.2 shows how case studies informed the list of key functions and how these, in turn, informed our proposed interventions.

Table 5.2. Shortlisted case studies of international practice

Case study	Objectives and actions
Australian Future Frigate Programme	**Strategic objective: To bridge the skills gap between acquisition programmes** Core activities: • Shifting programme schedule to avoid gaps in workforce utilisation • Ambition to drive down cost by ensuring continued utilisation. Implementation: • In 2018, Australian Department of Defence and industry started to transition the existing workforce from the Hobart-class destroyer programme to the Hunter class frigate programme, adopting a continuous build strategy. • In 2018, the Naval Shipbuilding College was set up to upskill the transitioning workforce and train the future cohort. • In 2020, the construction of two Offshore Patrol Vessels was begun in order to fill the gap before the launch of the Future Frigate programme, which was delayed.
University of Coruña – Navantia Joint Research Unit	**Strategic objective: To improve the competitiveness of the Spanish shipbuilding sector through innovation and digitalisation** Core activities: • The regional government and the Department of Economy, Employment and Industry funded the development of a joint research unit with Navantia focusing on embedding Industry 4.0 technologies in the 'Shipyard of the Future'. Implementation: • The research unit offers accredited courses (BSc, MSc) and double degrees in niche areas, such as naval and oceanic engineering and Industry 4.0 technologies. • The research unit also offers internships and placements at Navantia and its supply chain (c. 80 companies).
US Navy Talent Pipeline Programme	**Strategic objective: To match training demand with supply through regional marine centres** Core activities: • Regionally focused effort to build up submarine-related skills • Specific effort to help SMEs access training and opportunities for skills growth. Implementation: • US Department of Defense provides funding that is contracted through General Dynamics Electric Boat and delivered by a not-for-profit organisation. • The programme sets up regional centres (Maritime Centres of Gravity) that focus on 'match-making' between education providers and the submarine industrial base. • The programme set up a centralised career platform: buildsubmarines.com.
Finnish Meyer Turku Shipbuilding School	**Strategic objective: To provide on-the-job training** Core activities: • Training provided on a needs-basis, adjusted and adapted for company personnel. Implementation: • Meyer Turku set up the school, established next to the shipyard, to provide in-house training, with most training providers also being employees of the shipyard. • Strong focus on national workforce and strengthening of Finnish industry. • Variety of short and long courses provided based on workforce needs (e.g. short-term training in driving, forklift handling, SAP-Readiness reporting, etc.).
Dutch Underwater Knowledge Centre	**Strategic objective: To preserve minimum viable expertise in submarine operation** Core activities: • As a triple-helix organisation, the Underwater Knowledge Centre's aim is to sustain submarine skills through government–academia–industry collaboration. Implementation: • The Centre was established to consolidate expertise in submarine build and operations from the Walrus-class submarine programme. • It offers skills and expert support to international programmes through 'export' projects (e.g. Hai Lung class for the Chinese Navy).

Source: RAND Europe analysis of open-source information.

Figure 5.1. Analysis steps to derive proposed interventions



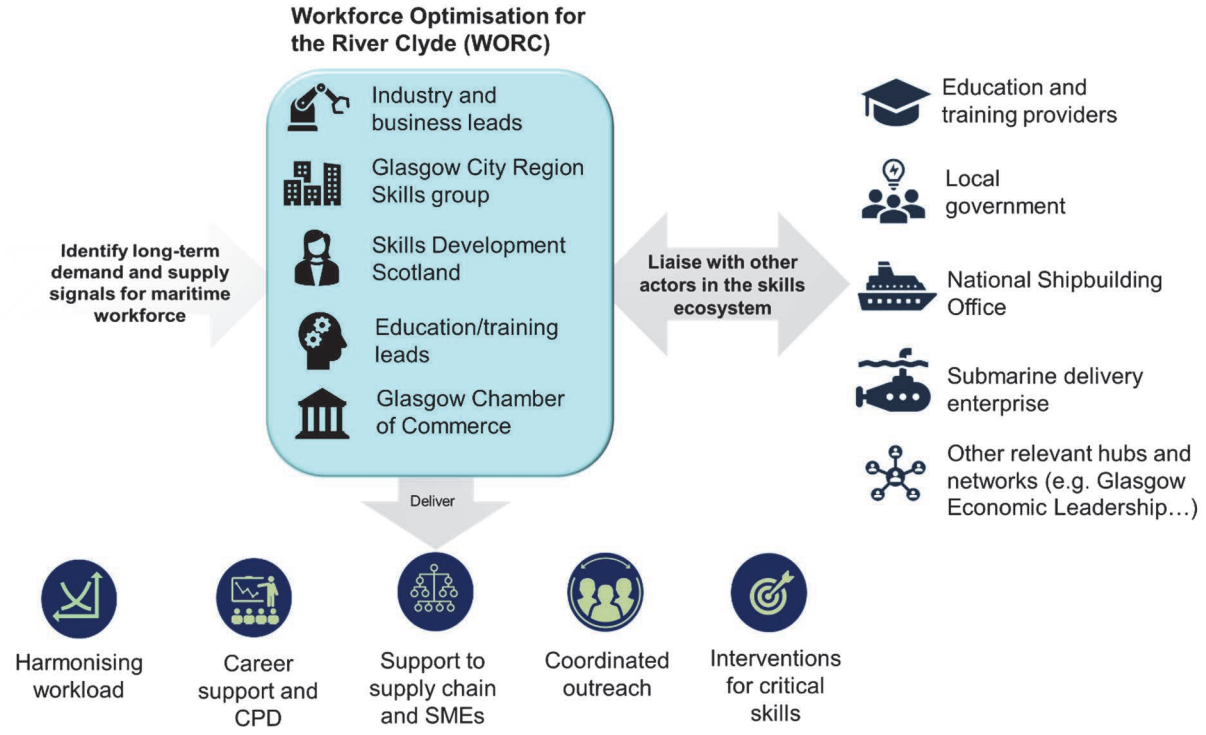
Source: RAND Europe analysis.

5.3. RAND Europe identified interventions that could help cohere and coordinate skills growth through a centralised strategic function

RAND Europe's engagement with stakeholders for this study made it clear that many of the industry stakeholders involved in maritime operations on the Clyde already work together and informally engage in learning lessons from each other. Local councils and SDS invest time and energy to engage with stakeholders to help facilitate access to funding for initiatives that seek to improve access to and growth of skills. Yet, there are opportunities for a more targeted and coordinated approach that can begin with a focus on skills and workforce and expand, as desired, to include other areas of potential collaboration.

As a starting point for a focused and targeted collaboration, the RAND Europe team proposes that a more centralised Workforce Optimisation for the River Clyde (WORC) planning group is set up to improve the coordination of different skills development initiatives under one organisation. The WORC planning group would involve, at a minimum, industry leads, the Glasgow Chamber of Commerce, SDS, and Glasgow City Region and education leads. This group's purpose would be: to identify long-term demand and supply signals for shipbuilding and maritime workforce on the Clyde; to act as a central liaison with other actors in the wider skills ecosystem (e.g. regional education providers, the NSO, local government and the submarine enterprise); and to deliver a number of enterprise-level activities to help grow and sustain skills. A simple schematic of the group's purpose and function is given in Figure 5.2.

Figure 5.2. Overview of key functions of the WORC planning group



Source: RAND Europe analysis.

The following sections present a brief overview of the proposed activities that could be delivered by the WORC. It is beyond the scope of this study to present detailed implementation plans or cost-benefit analyses. Therefore, the below should be understood as proposals, informed by RAND Europe's review of case studies of international practice and team expertise in skills.

5.3.1. Harmonisation of workload

As this study has shown (see Chapter 4), not all companies have a robust long-term view of their workload, and there continues to be uncertainty around how the 30-year shipbuilding demand articulated in the National Shipbuilding Strategy Refresh will be met, including which shipyards will be involved and when. Despite these uncertainties, there are opportunities for the WORC to act as a facilitator between companies that may experience short- or medium-term fluctuations in workload to more effectively transfer workforce. This presupposes setting up specific agreements and enabling contracts to allow such transfers, as well as a set of underpinning training and development courses to ensure staff are upskilled/trained for the new job they may need to perform. Harmonising workload on the supply side (i.e. industry) also presupposes a solid understanding of companies' future workload and related workforce demand. While primes like BAE Systems and Babcock have established systems in place to better forecast workforce demand over time, wider supply chain and SMEs in particular may not have the same level of capability.

With robust commitment from the Clyde maritime partners, the WORC could act as a vehicle for joint advocacy and programmes. For example, the WORC's understanding of the workload would enable the Clyde maritime partners to liaise more effectively with the NSO and make more informed decisions around potential bids for future procurement opportunities. If the need arises, it could also act as a liaison with other UK

shipyards to identify opportunities for workload optimisation. Finally, the WORC could provide a more informed picture to the wider client base, including the Ministry of Defence, Home Office, Department for Transport, Scottish government and others in terms of delivery capabilities and future outlook.

In practice, therefore, the WORC could help smooth the peaks and troughs of workload demand through industry-level optimisation, effectively helping to avoid the price premium that government clients have had to pay in the past due to the need to reconstitute workforce after long gaps between major acquisitions.[147] As explored by a previous study on UK shipbuilding by RAND, the benefits of more harmonised workload management could also include improved utilisation of workforce and facilities, more stable financial costs for acquisitions, and greater incentives for industry to invest in modernisation and innovation.[148] Subcontractors and suppliers would be fully involved in harmonising workload activities. Through this activity, maritime industries on the Clyde would be better able to evaluate their industrial capacity and potential strains on production capacities, in terms of both available facilities and skilled workforce, to pre-empt or anticipate delays to programmes.[149] A more coordinated workload harmonisation could also help to reduce reliance on contingent (often non-UK) labour, focusing on creating opportunities for local workforce to step in.

5.3.2. Career support and Continuous Professional Development (CPD)

While some companies already offer robust career support and CPD options, either internally or through collaboration with external providers, these opportunities are not equally accessible to the wider Clyde Maritime Enterprise. As the Clyde maritime stakeholders look to collaborate more formally to grow and sustain skills needed to deliver demand, there is an opportunity for the WORC to act as a central body to coordinate support for all career stages. The WORC could also act as a central 'match-maker' between industry and the education sector, identifying which training or education courses may be relevant as CPD or where there might be gaps in education provision that should be addressed through new courses or curriculum updates. Over time, the WORC could also explore options to develop a common curriculum tailored to the needs of its members and the wider Clyde Maritime Enterprise.

Our stakeholder engagement suggested that collaboration between education providers and industry on the Clyde is often informal. Formalising the cooperation between the education sector and wider industry stakeholders on the Clyde could help to create opportunities for industry to directly contribute to courses (e.g. through offering industry placements or specific challenges/competitions to students) and for education institutions to better understand and tailor their course provision to industry needs, where appropriate. There may also be opportunities for the WORC to act as a coordinator of internal training and course provision, facilitating linkages between companies who already run internal training and upskilling programmes like BAE's Applied Shipbuilding Academy.

Finally, the WORC could also run career support initiatives such as an early careers network, mentoring programmes, matching experts, secondments, industry placements or others. The WORC could either take

[147] Schank & DeLuca (2020).

[148] RAND Europe (2007).

[149] Schank et al. (2005).

on a coordinating role for existing schemes or develop new ones to enhance workforce mobility in the sector as well as upskilling. Acknowledging that people may not wish to join the maritime sector for life, it is important that any career support function also includes support to employees who want to move around within the sector or leave the sector entirely – these should be proactively included in and engaged with as part of alumni and ambassador networks.

5.3.3. Support to supply chain and SMEs

While all of the WORC's envisaged measures should include the wider supply chain, there is likely to be a need for specific interventions for SMEs and the wider supply chain. During interviews, the RAND Europe study team found that SMEs working in the maritime sector on the Clyde face a number of unique challenges, including their inability to compete for talent with primes due to the latter's ability to offer more generous salaries and benefit packages. The WORC's career support and CPD services, as well as its outreach and workload optimisation activities, should explicitly consider how they can be most effectively tailored to and inclusive of the supply chain. In practice, this could include offering talent management services to support SMEs' effective workforce utilisation, facilitating the upskilling and training of employees and offering secondments from larger shipbuilding companies to SMEs. Such secondments could help plug their skills gaps while also strengthening relationships and collaboration between shipbuilding companies and the supply chain.

Further tailored support could include access to innovation facilities to test specific technical solutions or to develop specific skills, for example in automation, robotics or specialist manufacturing. These could be provided by academia or institutions like NMIS. The WORC could facilitate such opportunities in a more structured and coherent way, acting as a repository of knowledge and networks of contacts to enable these linkages. The Malin Group's proposal to develop a brownfield site on the Clyde into an advanced manufacturing testing site with access to a range of industrial stakeholders already represents a concrete example of proactive consideration of SME and supply chain needs.

5.3.4. Coordinated outreach

While individual companies are often active in their efforts to raise awareness about the sector through engagements with schools, universities and the wider public, there is no unified outreach campaign explicitly focused on attracting talent to the maritime sector. Also, there are few outreach programmes that explicitly seek to engage individuals who would typically not consider a career in maritime industries. Based on the insights from the UKSST report as well as RAND Europe's own data from stakeholder engagement, it is clear that a lot of work remains to be done to promote the sector as inclusive, modern and vibrant. The WORC could lead on designing and delivering a public outreach campaign that would explicitly seek to raise awareness about the sector and the wide range of career opportunities it offers. This intervention would require a strong narrative about the importance of the sector in terms of national security and prosperity, as well as its opportunities for innovation and the development of interesting technical careers allowing for mobility and intellectual challenge. In brief, there are several angles that could be explored in a public outreach campaign:

- **Innovation**: The Clyde Maritime Enterprise could build a strong narrative around the sector's potential to be a high-tech, innovative and high-wage industry that drives innovation, for example,

through alternative fuels, automation, advanced manufacturing and AI. Underpinning this narrative would be modernisation efforts across Scotland's shipyards and maritime industries. Extending collaboration beyond skills, the WORC could also act as a catalyst for collaborative pursuit of Industry 4.0 and other technological innovations on the Clyde.

- **Environmental sustainability:** While some companies have been successfully incorporating sustainability into their outreach narratives (e.g. Babcock's projection of COP26 goals in their Rosyth facility), this aspect of the maritime sector is not explored widely.[150] The work undertaken by the sector can reduce emissions, including through green technology, alternative fuels and energy-efficient propulsion systems.[151] By strengthening this narrative, the maritime industry could strengthen its position vis-à-vis competing sectors.
- **Contributing to the national effort:** Both the central UK and Scottish governments could further build on the narrative of the 'Golden Age of shipbuilding' by linking it to the country's national endeavour to strengthen its strategic posture and resilience. Public outreach could emphasise the importance of defence, including shipbuilding, to national security and the economy.[152]

5.3.5. Interventions for critical skills

While interventions discussed earlier are broadly agnostic of skills they seek to target, the RAND Europe study team believes there is merit in implementing interventions that are explicitly focused on growing and/or sustaining specific critical skills. Based on the analysis of industry survey data and interviews, it is clear that welding, engineering and naval architecture skills are at greatest risk of skills gaps going forward. Therefore, concrete interventions for these skills should be put in place. For recruiting naval architects, it is essential to build an image of the maritime sector as a modern, innovative and sustainable sector to incentivise more students to pursue naval architecture degrees. The University of Strathclyde offers a world-class naval architecture degree, arguably at the doorstep of the Clyde Maritime Enterprise, with some companies, such as the Malin Group, taking in between four and six interns from the programme every year. To ensure a sustainable pipeline of talent, it will be important to both recruit and retain skilled naval architects, presenting an opportunity for more coordinated action under the umbrella of the WORC.

When it comes to skills shortages in welding, mechanical engineering and electrical engineering, short-term opportunities for skill growth include the promotion of vocational training and further education to ensure enough people are attracted to these trades. Interviewees suggested that there is a general preference for university degrees over vocational training as blue-collar jobs are often considered less attractive. This challenge could be addressed by a coordinated approach by industry and education providers to actively promote vocational training and associated career opportunities, including clear messaging about the financial rewards available when pursuing a trades career. Furthermore, the modernisation of shipyards to improve work environment and, as a result, attractiveness could also improve the supply of welding skills.

[150] Babcock (2020b); Babcock (2021).

[151] UK Shipbuilding Skills Taskforce (2023a).

[152] Interview with RAND Europe, 2024.

Finally, supporting supply chain with critical skills recruitment is also essential as SMEs often do not have the financial resources to compete with the salaries offered by primes and/or lack the sponsor licence to recruit from abroad.[153] Such support could take a number of forms, such as secondments of welders from primes to SMEs. In the longer term, however, the skill gap for welders could also be addressed through automation and robotics. To ensure that the workforce will be ready to adapt to these changes, modernisation efforts will have to take place in conjunction with the upskilling of existing workforce.

Box 5.1. Summary of key findings

- Significant progress in strengthening the Clyde's maritime skills base has been made over recent years. Some gaps remain, however, principally due to insufficient formal coordination of efforts by industry, the education sector, local government and the Scottish government.
- RAND Europe proposes the establishment of a Workforce Optimisation for the River Clyde (WORC) planning group as a central function representing industry, local and regional stakeholders. The WORC's purpose would be to identify long-term demand and supply signals for shipbuilding and maritime workforce on the Clyde; to act as a central liaison with other actors in the wider skills ecosystem; and to deliver a number of enterprise-level activities helping to grow and sustain skills.
- These activities include a) the harmonisation of workload; b) career support and continuous professional development; c) support to supply chain and SMEs; d) coordinated public outreach; and e) specific interventions for critical skills.

[153] Survey response, 2024.

6. Conclusions and recommendations

This chapter presents the RAND Europe study team's conclusions and recommendations, drawing on the findings and analysis presented throughout this report.

6.1. Recent revival of and investment in shipbuilding present opportunities on which Clyde companies can capitalise

The companies on the Clyde are finding themselves in an era of renewed focus on the maritime sector, with a long-term demand signal for build (and maintenance) of eight Type 26 frigates driving the need to grow the maritime workforce. Companies primarily focused on maintenance and support are seeing sustained throughput of vessels, with a projected demand for support services likely to increase as the 30-year pipeline of new vessels are delivered over the next decades, as articulated in the Conservative government's National Shipbuilding Strategy Refresh in 2022. Although there is some uncertainty about the exact demand and how much of it will be delivered in or through UK shipyards, there continues to be a stated commitment to shipbuilding under the newly elected national government led by the Labour Party.

Against this background, companies on the Clyde have already begun investing in initiatives and projects to revitalise the industrial base and attract workforce to the sector, including investments in automation, the establishment of a new shipbuilding academy and technology innovation hub accessible to SMEs as well as primes, and plans to promote secondments and placements to build specific expertise across the wider sector. These initiatives are taking place alongside numerous public-sector initiatives and funding streams, including the Glasgow City Deal.[154] Industry initiatives, however, are often pursued in siloes, and there is little formal coordination or opportunity to share lessons that could be adopted by the whole enterprise. In addition to local council initiatives, there are several national and Scottish government initiatives on which the Clyde companies could capitalise in a more coherent way. While primes may be better aware of the opportunities presented by the different programmes and initiatives, smaller companies and SMEs may lack the situation awareness or capacity to engage with broader initiatives.

[154] The Glasgow City Deal was agreed in 2014 between the UK and Scottish governments and eight local authorities to provide funding for major infrastructure projects in Glasgow and the surrounding areas, now totalling over £1 billion in investment. Glasgow City Region (n.d.).

6.2. Although the current workforce displays a healthy demographic profile, delivering on future demand signal will be challenging

Companies on the Clyde have seen successful intake of early careers, resulting in a marked shift of the workforce age demographic towards younger workforce over the last five years. While integrating large numbers of apprentices and early career professionals is challenging, this demographic should fill the enterprise partners with optimism that the sector is no longer facing a demographic 'cliff edge' whereby large proportions of the workforce would be close to retirement. In addition, there is now a large proportion of less experienced staff and, at an aggregate level, companies have experienced significant workforce turnover over the last five years. This turnover particularly affected technical, structure and outfitting skills, presenting challenges for growing workforce at speed. As a result of the high turnover rates, the net growth in workforce has been limited until 2023.

The National Shipbuilding Strategy Refresh in 2022 articulated a planned 30-year demand for 146 vessels (both civil and military) to be procured by UK public-sector and government clients. While it is not yet clear which of these vessels will be built in the UK, it is clear that sufficient shipbuilding and maintenance workforce will be required to meet this ambitious demand plan. Nationwide, maritime industries face challenges in sourcing and retaining a skilled workforce, and the industry partners on the Clyde are no exception.

As in the UK-wide analysis,[155] industries on the Clyde are faced with low attractiveness of the sector, perceived deprioritisation of vocational training, insufficient coordination among stakeholders and competition with other sectors. Added to these are further unique challenges on the Clyde, including a demographic decline of young people in the area vis-à-vis the rise of the ageing population, limited scope for expanding facilities and immediate worker supply challenges to meet short-term workload demands.

The industries on the Clyde are particularly concerned about sufficient supply of engineering skills as well as workforce that is sufficiently experienced to provide oversight, quality assurance and sign-off. Many transferable skills, such as electrical engineering, mechanical engineering and welding, are highly coveted by other sectors, challenging the maritime industries' ability to grow the workforce in those areas sufficiently quickly to meet demand. The system dynamics model developed for this study shows that if the companies wanted to maintain the same size as they have now, the 2023 hiring and loss rates would be sufficient. However, if their ambition was to grow the workforce, this would require greater net growth than was achieved in 2023; for example, if they wanted to grow the size of their workforce by 15 per cent every year for the next five years, their hiring rate would have to be 150 per cent of 2023's hiring rate across most skills categories. Effectively absorbing large numbers of new hires also requires proactive workforce management to ensure appropriate induction and mentoring processes are in place to minimise productivity losses.

[155] City of Glasgow College (n.d.).

6.3. Clyde maritime partners should work together as an enterprise and pursue shipyard modernisation to attract and grow workforce

The challenges discussed throughout this report are not insurmountable. As Chapter 5 shows, there are already several initiatives and programmes under way nationally, in Scotland and on the Clyde to encourage skills growth for the benefit of the local maritime sector. While there are few formal links and opportunities to learn lessons between these initiatives, informal discussions among companies and the Scottish government at a local and national level are common. These are often focused on linking up different stakeholders and facilitating funding access for initiatives that seek to improve skills in the local area more generally. Against this background, there are opportunities for a more targeted and coordinated approach specifically focused on attracting, retaining and upskilling workforce. As shipbuilding and ship maintenance companies face similar challenges in terms of attracting and retaining skilled workforce, there is merit in identifying activities and initiatives that benefit a wider enterprise, rather than competing with each other for the limited pool of skills available (and attracted) to work in the sector. SMEs in particular may not have the capacity to lead or engage with skills growth initiatives, but could benefit from having access to these (e.g. through secondments, placements or upskilling courses).

Finally, tackling the skills challenges will also rely on creating a robust employee value proposition. This entails not only remuneration but also many other benefits, including, for example, work in a modern, technologically advanced environment and a clear articulation of the broader value (e.g. contribution to a national endeavour). Investing in modernisation and use of technology for both production and maintenance/support activities should not only create working environments that are more attractive to younger generations used to interacting with technology and automation but also enhance efficiency and reduce re-work. While modernisation and technology roll-out across the maritime industries has already begun, these efforts can only be successful if they are accompanied by workforce upskilling or reskilling to effectively operate the new systems and maximise efficiencies. Attracting more local and regional workforce could also help reduce reliance on contingent labour and create jobs with benefits for the local economy.

6.4. A Workforce Optimisation for the River Clyde group could harness the momentum of collaboration and seize funding opportunities

Skills challenges faced by the shipbuilding and maritime companies on the Clyde cannot be tackled effectively by each individual company alone. This study shows that the Clyde Maritime Enterprise partners are willing to collaborate and share information where they see opportunities to find solutions to commonly faced challenges. At the same time, there is a timely opportunity to formalise collaboration to bring the needs and ambitions of the maritime industries together with the broader economic growth agenda of the Glasgow City Region. With the transfer of the Clyde Mission initiative from the Scottish government to Glasgow City Region,[156] maritime skills now fall within the Future Skills Programme under the 2021 Glasgow City Region's Economic Strategy,[157] presenting concrete opportunities for a robust regional

[156] Glasgow City Region (2023).

[157] Glasgow City Region (2021).

solution for workforce planning and skills. Indeed, a more regionalised approach to skills planning and delivery was recommended by a recent OECD review on local job creation in the Glasgow City Region[158] and also by the Withers review of the skills delivery landscape in Scotland.[159]

A coordinated, enterprise-level group could be set up to bring together stakeholders from across industry, SDS, the Glasgow Chamber of Commerce and the education sector. We propose that this Workforce Optimisation for the River Clyde (WORC) group has a central mission: to identify long-term demand and supply signals for workforce; to help facilitate strategic workforce planning and workload optimisation; and to deliver enterprise-level activities to grow and sustain skills. As such, it will require both a governing board and a delivery arm through which activities such as career support and public outreach can be delivered. The key objectives of the WORC are summarised in Box 6.1.

Box 6.1. Summary of objectives for the WORC

1) Support harmonisation of workload on the Clyde by utilising skills more effectively (e.g. through secondments or temporary placements where needed);
2) Provide career support and facilitate continuous professional development for existing staff to enhance retention;
3) Provide specific support to supply chain and SMEs in terms of access to initiatives for skills growth, career support and access to innovation opportunities;
4) Coordinate outreach to attract people into the sector (particularly focusing on those who may not typically consider maritime careers); and
5) Design specific interventions for critical skills or skills identified as those of greatest concern (including electrical engineering, mechanical engineering, naval architecture and others).

[158] OECD (2024).

[159] Scottish Government (2023a).

References

Allison, George. 2022. 'Turkish yard wins more work to build ferries for Scotland'. *UK Defence Journal*. As of 19 November 2024:
https://ukdefencejournal.org.uk/turkish-yard-wins-more-work-to-build-ferries-for-scotland/

Allison, George. 2023a. 'Labour pledges all naval ships to be UK built'. *UK Defence Journal*. As of 19 November 2024: https://ukdefencejournal.org.uk/labour-pledges-all-naval-ships-to-be-uk-built/

Allison, George. 2023b. 'The Status of the British Fleet'. *UK Defence Journal*. As of 19 November 2024: https://ukdefencejournal.org.uk/the-status-of-the-british-fleet/

Allison, George. 2024a. 'BAE Systems address national skills gap in shipbuilding'. *UK Defence Journal*. As of 19 November 2024:
https://ukdefencejournal.org.uk/bae-systems-address-national-skills-gap-in-shipbuilding/

Allison, George. 2024b. 'BAE shipbuilding academy takes shape in Glasgow'. *UK Defence Journal*. As of 19 November 2024: https://ukdefencejournal.org.uk/bae-shipbuilding-academy-takes-shape-in-glasgow/

Allison, George. 2024c. 'UK "remains committed" to Type 32 Frigate programme'. *UK Defence Journal*. As of 19 November 2024:
https://ukdefencejournal.org.uk/uk-remains-committed-to-type-32-frigate-programme/

Allison, George. 2024d. 'Frigate to be moored in Glasgow to teach shipbuilding skills'. *UK Defence Journal*. As of 19 November 2024:
https://ukdefencejournal.org.uk/frigate-to-be-moored-in-glasgow-to-teach-shipbuilding-skills/

Allison, George. 2024e. 'When will the Type 32 Frigate enter service?'. *UK Defence Journal*. As of 19 November 2024: https://ukdefencejournal.org.uk/when-will-the-type-32-frigate-enter-service/

Allison, George. 2024f. 'Scot Gov support to Clyde shipbuilders criticised by Greens'. *UK Defence Journal*. As of 19 November 2024:
https://ukdefencejournal.org.uk/scot-gov-support-to-clyde-shipbuilders-criticised-by-greens/

ANAO. 2020. *Project Data Summary Sheets*. ANAO 2019–20 Major Projects Reports. As of 19 November 2024:
https://www.anao.gov.au/sites/default/files/Auditor-General_Report_2020-2021_19_PDSS_air_warfare_destroyer_build.pdf

Argyll Bute Council. 2019. 'Scottish Marine Industry Training Centre plans get £100,000 boost'. As of 19 November 2024: https://www.argyll-bute.gov.uk/news/2019/aug/scottish-marine-industry-training-centre-plans-get-ps100000-boost

ATDM. 2023. 'Navy Tackling Workforce Development to Meet Submarine Goals'. As of 19 November 2024: https://atdm.org/navy-tackling-workforce-development-meet-submarine-goals

Australian Naval Infrastructure. 2024. 'Air Warfare Destroyers'. As of 12 April 2024: https://www.ani.com.au/osborne-naval-shipyard/shipbuilding-program/air-warfare-destroyers-awd/

Babcock. 2020a. 'Babcock invests in technically advanced shipbuilding facility'. As of 19 November 2024: https://www.babcockinternational.com/news/babcock-invests-in-technically-advanced-shipbuilding-facility/

Babcock. 2020b. 'Sustainable engineering centre stage for Babcock at Ballast Water Management conference'. As of 19 November 2024: https://www.babcockinternational.com/news/sustainable-engineering-centre-stage-for-babcock-at-ballast-water-management-conference/

Babcock. 2021. 'Babcock Highlighting Support of COP26 Goals'. As of 19 November 2024: https://www.babcockinternational.com/news/babcock-highlighting-support-of-cop26-goals/

Babcock International Group. 2024. 'Selected graduates from Babcock and BAE Systems are taking part in an exchange scheme to enhance their knowledge about UK submarines programmes…' LinkedIn. As of 19 November 2024: https://www.linkedin.com/posts/babcock-international-group_selected-graduates-from-babcock-and-bae-systems-activity-7165987814042492928-w612/

BAE Systems. 2023. 'Vickers-Shipbuilding'. As of 19 November 2024: https://www.baesystems.com/en-uk/heritage/vickers-shipbuilding

BBC News. 2001a. 'Bitter-sweet move for shipyards'. As of 19 November 2024: http://news.bbc.co.uk/1/hi/business/1470541.stm

BBC News. 2001b. 'Crunch meeting over Clyde jobs'. As of 19 November 2024: http://news.bbc.co.uk/1/hi/scotland/1442433.stm

BBC News. 2013. 'BAE to cut possibly more than 1,000 UK shipyard jobs'. As of 19 November 2024: https://www.bbc.co.uk/news/uk-scotland-24827221

BBC News. 2018. 'Cammell Laird: Shipyard workers walk out over job cuts'. As of 19 November 2024: https://www.bbc.co.uk/news/uk-england-merseyside-46304716

Birkler, John, John F. Schank, Mark V. Arena, Edward G. Keating, Joel B. Predd, James Black, Irina Elena Danescu, Dan Jenkins, James G. Kallimani, Gordon T. Lee, Roger Lough, Robert Murphy, David Nicholls, Giacomo Persi Paoli, Deborah Peetz, Brian Perkinson, Jerry M. Sollinger, Shane Tierney & Obaid Younossi. 2015. *Australia's Naval Shipbuilding Enterprise: Preparing for the 21st Century*. Santa Monica, Calif.: RAND Corporation. RR-1093-AUS. As of 19 November 2024: https://www.rand.org/pubs/research_reports/RR1093.html

Buildsubmarines.com. 2024. 'Homepage'. As of 19 November 2024: https://www.buildsubmarines.com/

Buitendijk, Mariska. 2021. 'DUKC: Dutch industry can play a major role in submarine replacement'. *SWZ Maritime*. As of 19 November 2024: https://swzmaritime.nl/news/2021/03/18/dukc-about-dutch-submarine-replacement-we-can-still-do-a-lot-ourselves-in-the-netherlands/

Buitendijk, Mariska. 2022. 'Royal IHC joins Dutch Underwater Knowledge Centre'. *SWZ Maritime*. As of 19 November 2024: https://swzmaritime.nl/news/2022/02/18/royal-ihc-joins-dutch-underwater-knowledge-centre/

CalMac. N.d. 'Fleet'. As of 19 November 2024: https://www.calmac.co.uk/fleet

Campus Industrial. 2024. 'The industrial campus of Ferrol hosts this Thursday the I Internship Day for students of the Master's Degree in Industrial Computing and Robotics'. As of 19 November 2024: https://campusindustrial.udc.es/en/the-industrial-campus-of-ferrol-hosts-this-thursday-the-i-internship-day-for-students-of-the-masters-degree-in-industrial-computing-and-robotics/

CITENI. 2024a. 'History'. As of 19 November 2024: https://cemi.udc.es/en/history/

CITENI. 2024b. 'Masters'. As of 19 November 2024: https://citeni.udc.es/en/masters/

CITENI. 2024c. 'UDC-Navantia Joint Research Centre (CEMI)'. As of 19 November 2024: https://citeni.udc.es/en/cemi/

City of Glasgow College. 2022. 'Written evidence submitted by City of Glasgow College (DIS0035)'. As of 19 November 2024: https://committees.parliament.uk/writtenevidence/113947/html/

City of Glasgow College. N.d. 'A Step Change in UK Shipbuilding Skills'. As of 19 November 2024: https://www.cityofglasgowcollege.ac.uk/uk-shipbuilding-skills-taskforce-report

Clyde Waterfront. N.d. 'Shipbuilding on the Clyde'. As of 19 November 2024: https://web.archive.org/web/20240607224337/http://www.clydewaterfront.com/clyde-heritage/river-clyde/shipbuilding-on-the-clyde

Damen. 2024. 'Masterclass Submarine Design door Nevesbu'. As of 29 August 2024: https://www.damen.com/companies/naval/royal-netherlands-navy/masterclass-submarine-design-door-nevesbu

Dean, Peter, Alice Nason, Sophie Mayo & Samuel Garrett. 2023. 'AUKUS inflection point: Building the ecosystem for workforce development'. United States Studies Centre. As of 19 November 2024: https://www.ussc.edu.au/aukus-inflection-point-building-the-ecosystem-for-workforce-development

Defence Nuclear Enterprise. 2024. *Delivering the UK's Nuclear Deterrent as a National Endeavour*. As of 19 November 2024: https://assets.publishing.service.gov.uk/media/6622702b49d7b8813ba7e576/Defence_Nuclear_Enterprise_Command_Paper_v6.pdf

Department for Business and Trade. 2024. 'Invest 2035: the UK's modern industrial strategy'. As of 19 November 2024: https://www.gov.uk/government/consultations/invest-2035-the-uks-modern-industrial-strategy/invest-2035-the-uks-modern-industrial-strategy

Department for Transport. 2019. *Maritime 2050: Navigating the Future*. As of 19 November 2024: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/872194/Maritime_2050_Report.pdf

EDGE Foundation. 2024. 'Skills shortages in the UK economy'. As of 19 November 2024: https://www.edge.co.uk/documents/480/DD1279_-_Skills_shortages_bulletin_summary_2024_FINAL.pdf

Errick, Kirsten. 2023. 'Navy continues to address submarine workforce challenges'. *Federal News Network*. As of 19 November 2024: https://federalnewsnetwork.com/navy/2023/11/navy-continues-to-address-submarine-workforce-challenges/

Glasgow City Council. N.d. *City Development Plan Background Paper 6: Green Belt and Green Network*. As of 19 November 2024: https://www.glasgow.gov.uk/media/650/Green-Belt-and-Green-Network/pdf/Background_Paper_6_-_Green_Belt_and_Green_Network.pdf?m=1663069743413

Glasgow City Region. 2021. 'Glasgow City Region Economic Strategy'. As of 19 November 2024: https://glasgowcityregion.co.uk/wp-content/uploads/2021/12/GCR-EconomicStrategy-Final.pdf

Glasgow City Region. 2023. 'Migration of Clyde Mission to Glasgow City Region'. As of 19 November 2024: https://glasgowcityregion.co.uk/migration-of-clyde-mission-to-glasgow-city-region/

Glasgow City Region. N.d. 'City Deal'. As of 19 November 2024: https://glasgowcityregion.co.uk/city-deal/

Global Defense Corp. 2020. 'The Royal Netherlands Navy's (RNLN) Submarine Replacement Programme'. Global Defense Corp. As of 19 November 2024: https://www.globaldefensecorp.com/2020/04/20/the-royal-netherlands-navys-submarine-replacement-programme/

Govan Graving Docks. N.d. 'Homepage'. As of 19 November 2024: https://govangravingdocks.com/

Henderson, David. 2023. 'Could Labour plans mean a sea change for shipbuilding in Scotland?'. *BBC News*. As of 19 November 2024: https://www.bbc.co.uk/news/uk-scotland-edinburgh-east-fife-67655480

HM Government. 2015. *Nuclear Sector Skills Strategy: Government and Industry in Partnership: Sustaining Our Nuclear Skills*. As of 19 November 2024: https://assets.publishing.service.gov.uk/media/5a74f2d6ed915d3c7d529339/Sustaining_Our_Nuclear_Skills_FINAL.PDF

House of Commons Scottish Affairs Committee. 2022. 'Oral evidence: Defence in Scotland: Military Shipbuilding, HC 81'. As of 19 November 2024: https://committees.parliament.uk/oralevidence/11984/html/

IISS. 2024. *The Military Balance 2024*. As of 21 November 2024: https://www.iiss.org/publications/the-military-balance/

Inverclyde Council. 2024. 'Inchgreen Marine Park upgraded as part of £11m investment'. As of 19 November 2024: https://www.inverclyde.gov.uk/news/2024/mar/inchgreen-marine-park-upgraded-as-part-of-11m-investment

JobMarket Finland. N.d. 'Meeting place for people and jobs'. As of 19 November 2024: https://tyomarkkinatori.fi/en

Katz, Justin. 2023. 'Navy pushes annual talent pipeline initiative amid submarine base workforce concerns'. *Breaking Defense*. As of 19 November 2024: https://breakingdefense.com/2023/11/navy-pushes-annual-talent-pipeline-initiative-amid-submarine-base-workforce-concerns/

La Moncloa. 2023. 'Pedro Sánchez highlights the Navantia shipyard…'. As of 19 November 2024: https://www.lamoncloa.gob.es/lang/en/presidente/news/Paginas/2023/20231216_visit-to-navantia.aspx

Malin Group. N.d. 'Training at John Tracey Specialist Welding'. As of 19 November 2024: https://malingroup.com/jtsw/training-at-john-tracey-specialist-welding/

ManpowerGroup. 2023. 'Building Talent Outside the Box in 6 Simple Steps'. As of 19 November 2024: https://www.manpowergroup.co.uk/b_building-talent-outside-the-box-in-6-simple-steps/

Maritime Skills Commission. 2023. *Maritime Skills Commission Annual Report*. As of 21 November 2024: https://www.maritimeuk.org/priorities/people/skills-commission/reports/

Masson, Nicolas. 2021. 'French Marine Industry overview'. Masson International. As of 19 November 2024: https://www.massoninternational.com/blog/french-marine-industry-overview

McDonough, Tony. 2021. '"Inefficient" Cammell Laird to lay off 178 workers'. *Liverpool Business News*. As of 19 November 2024: https://lbndaily.co.uk/inefficient-cammell-laird-lay-off-178-workers/

Meyer Turku. 2021. 'Sustainable Shipbuilding- Sustainability Report'. As of 19 November 2024: https://www.meyerturku.fi/en/sustainability/index.jsp

Meyer Turku. N.d.-a. 'Training'. As of 19 November 2024: https://rekry.meyerturku.fi/en/training/

Meyer Turku. N.d.-b. 'Shipbuilding School'. As of 19 November 2024: https://rekry.meyerturku.fi/en/training/shipbuilding-school/

Meyer Turku. N.d.-c. 'Personnel training'. As of 19 November 2024: https://rekry.meyerturku.fi/en/training/personnel-training/

Mills, Claire. 2024. 'AUKUS submarine (SSN-A) programme'. UK Parliament: House of Commons Library- Research Briefing. As of 19 November 2024: https://commonslibrary.parliament.uk/research-briefings/cbp-9843/

Ministry of Economic Affairs and Employment of Finland. N.d. 'TE Services help to boost employment and growth'. As of 19 November 2024: https://tem.fi/en/public-employment-and-business-services

National Manufacturing Institute Scotland (NMIS). N.d. 'Manufacturing Skills Academy'. As of 19 November 2024: https://www.nmis.scot/what-we-do/manufacturing-skills-academy/

National Shipbuilding Office (NSO). 2022. *National Shipbuilding Strategy: A refreshed strategy for a globally successful, innovative and sustainable shipbuilding enterprise.* As of 19 November 2024: https://assets.publishing.service.gov.uk/media/6231b9e2e90e070ed32f18ce/_CP_605___National_Shipbuilding_Strategy_Refresh.pdf

National Shipbuilding Office (NSO). N.d. 'Skills Delivery Group'. As of 21 November 2024: https://assets.publishing.service.gov.uk/media/66e408a80d913026165c3e14/20240829_SSDG_Terms_of_Reference_FINAL.odt

Naval News Staff. 2023. 'Navantia Lays Keel of Spain's First F110 Frigate'. *Naval News*. As of 19 November 2024: https://www.navalnews.com/naval-news/2023/08/navantia-lays-keel-of-spains-first-f110-frigate/

Naval Seas Systems Command. 2024. 'Navy Launches Talent Pipeline Expansion in Southern California'. As of 2 May 2024: https://www.navsea.navy.mil/Media/News/Article-View/Article/3760371/navy-launches-talent-pipeline-expansion-in-southern-california/

Naval Technology. 2018. 'Hobart-Class Air Warfare Destroyers'. *Naval Technology*. As of 19 November 2024: https://www.naval-technology.com/projects/hobart-class-air-warfarre-destroyers/?cf-view

Navy Lookout. 2024a. 'Royal Navy's Multi Role Support Ship programme to go ahead'. As of 19 November 2024: https://www.navylookout.com/royal-navys-multi-role-support-ship-programme-to-go-ahead/#

Navy Lookout. 2024b. 'Type 26 frigate construction and shipyard investment – progress update'. As of 19 November 2024: https://www.navylookout.com/type-26-frigate-construction-and-shipyard-investment-progress-update/

Nevesbu. 2024a. 'Naval Architects since 1935'. As of 19 November 2024: https://www.nevesbu.com/

Nevesbu. 2024b. 'Submarine & naval platform design and engineering'. As of 19 November 2024: https://www.nevesbu.com/markets/submarines/

NIDV Difensive & Veiligheid. 2024. 'Dutch Underwater Knowledge Centre – DUKC'. As of 29 August 2024:
https://www.nidv.eu/platform/nidv-marinebouw-cluster/dutch-underwater-knowledge-center/

OECD. 2024. *Future-Proofing the Skills System in the Glasgow City Region (Scotland, United Kingdom)*. OECD Publishing, Paris. As of 19 November 2024: https://doi.org/10.1787/5f36b5db-en

Offshore Wind Industry Council. 2023. *Offshore Wind Skills Intelligence Report – Executive Summary*. As of 21 November 2024:
https://www.renewableuk.com/media/hgzfsc2r/owic-offshore-wind-skills-intelligence-report-2023-executive-summary.pdf

Optimat & Scottish Maritime Cluster. 2021. *Clyde Mission Maritime Opportunities*. Final Report Scottish Enterprise. As of 19 November 2024:
https://www.scottish-enterprise.com/media/thva1swp/clyde-mission-maritime-opportunities.pdf

Palmer, Nadine. 2024. 'Post-Brexit UK migration trends and record highs'. Brunel University. As of 19 November 2024:
https://www.brunel.ac.uk/news-and-events/news/articles/Post-Brexit-UK-migration-trends-and-the-all-time-highs

Pittaway, Nigel. 2023. 'Australia's anti-submarine frigate program sails rough seas'. *DefenseNews*. As of 19 November 2024:
https://www.defensenews.com/naval/2023/12/21/australias-anti-submarine-frigate-program-sails-rough-seas/

Project Scotland. 2024. 'Work begins on £12m academy tipped to modernise Glasgow's shipbuilding industry'. As of 19 November 2024:
https://projectscot.com/2024/01/work-begins-on-12m-academy-tipped-to-modernise-glasgows-shipbuilding-industry/

Pyne, Christopher. 2018. 'Statement on ASC'. As of 19 November 2024: https://www.minister.defence.gov.au/statements/2018-04-24/statement-asc

RAND Corporation. 2007. *Naval Shipbuilding in the United Kingdom: RAND Europe research summary*. Santa Monica, Calif.: RAND Corporation. RB-9205-MOD. As of 19 November 2024: https://www.rand.org/pubs/research_briefs/RB9205.html

Rankin, Jennifer. 2013. 'BAE ends shipbuilding in Portsmouth and axes 1800 jobs'. *The Guardian*. As of 19 November 2024:
https://www.theguardian.com/business/2013/nov/06/bae-closure-portsmouth-shipyard-jobs

RH Marine. 2024. 'Maximising your performance'. As of 19 November 2024: https://rhmarine.com/

Schank, John F. & Paul DeLuca. 2020. *RAND's Insights on Australia's Naval Shipbuilding Capability*. 12 November. Santa Monica, Calif.: RAND Corporation. CT-A1030-1. As of 19 November 2024: https://www.rand.org/pubs/testimonies/CTA1030-1.html

Schank, John F., Hans Pung, Gordon T. Lee, Mark V. Arena & John Birkler. 2005. *Outsourcing and Outfitting Practices: Implications for the Ministry of Defence Shipbuilding Programmes*. Santa Monica, Calif.: RAND Corporation. MG-198-MOD. As of 19 November 2024: https://www.rand.org/pubs/monographs/MG198.html

Scotland's Census. 2023a. 'Scotland's Census first results'. As of 19 November 2024: https://www.scotlandscensus.gov.uk/news-and-events/scotland-s-census-first-results/

Scotland's Census. 2023b. 'Scotland's Census 2022 – Rounded population estimates'. As of 19 November 2024: https://www.scotlandscensus.gov.uk/2022-results/scotland-s-census-2022-rounded-population-estimates/

Scottish Construction Now. 2019. 'Malin Group gains consent for first phase of Clyde marine industry park'. As of 19 November 2024: https://www.scottishconstructionnow.com/articles/malin-group-gains-consent-for-first-phase-of-clyde-marine-industry-park

Scottish Funding Council. 2021. 'New figures show growth for STEM subjects'. As of 19 November 2024: https://www.sfc.ac.uk/?news=news-83074

Scottish Funding Council. 2024. 'Financial Sustainability of Colleges in Scotland: 2020–21 to 2025–26'. As of 19 November 2024: https://www.sfc.ac.uk/wp-content/uploads/2024/01/202312_FinancialSustainbability_College.pdf

Scottish Government. 2017. 'Science, Technology, Engineering and Mathematics (STEM) Evidence Base'. As of 19 November 2024: https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2017/10/science-technology-engineering-mathematics-education-training-strategy-scotland/documents/00526537-pdf/00526537-pdf/govscot%3Adocument/00526537.pdf

Scottish Government. 2021a. 'A Scotland for the future: opportunities and challenges of Scotland's changing population'. As of 19 November 2024: https://www.gov.scot/publications/scotland-future-opportunities-challenges-scotlands-changing-population/pages/4/

Scottish Government. 2021b. *STEM: Strategy for Education and Training in Scotland*. Third Annual Report. As of 19 November 2024: https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2021/05/stem-strategy-education-training-scotland-third-annual-report2/documents/stem-strategy-education-training-scotland-third-annual-report/stem-strategy-education-training-scotland-third-annual-report/govscot%3Adocument/stem-strategy-education-training-scotland-third-annual-report.pdf

Scottish Government. 2023a. 'Fit for the Future: developing a post-school learning system to fuel economic transformation'. As of 19 November 2024:

https://www.gov.scot/publications/fit-future-developing-post-school-learning-system-fuel-economic-transformation/pages/7/

Scottish Government. 2023b. 'Vacant and Derelict Land Investment Programme (VDLIP): application form'. As of 19 November 2024: https://www.gov.scot/publications/vacant-and-derelict-land-investment-programme/pages/aims-and-objectives/

Scottish Marine Technology Park. 2024. 'The Scottish Marine Technology Park: A unique environment for world-leading innovators to co-locate and collaborate'. As of 19 November 2024: https://malingroup.com/wp-content/uploads/2024/03/SMTP-Overview-brochure-2024.pdf

SeaWaves Magazine. 2023. 'US Navy SIB's 2023–2024 Talent Pipeline Program'. As of 19 November 2024: https://seawaves.com/us-navy-sibs-2023-2024-talent-pipeline-program/

Ship Technology. N.d. 'Ship Repair and Maintenance for the Shipping Industry: Shipbuilding, MRO & Conversion Services'. As of 19 November 2024: https://www.ship-technology.com/buyers-guide/shipbuilding-conversion-repair-and-mro/

Simon, Bartolomé. 2023. 'Métiers en tension : à Saint-Nazaire, le port ne peut pas se passer des ouvriers étrangers'. *Le Point*. As of 19 November 2024: https://www.lepoint.fr/societe/metiers-en-tension-a-saint-nazaire-le-port-ne-peut-pas-se-passer-des-ouvriers-etrangers-03-11-2023-2541855_23.php

SWZ Maritime. 2021. 'DUKC: Dutch industry can play a major role in submarine replacement'. As of 18 December 2024: https://swzmaritime.nl/news/2021/03/18/dukc-about-dutch-submarine-replacement-we-can-still-do-a-lot-ourselves-in-the-netherlands/

Talent Pipeline Program. 2024. '2023–2024 Executive Overview'. As of 19 November 2024: https://static1.squarespace.com/static/60da212207734e325a393350/t/64ffaf5a93c8d03731f6e4fb/1694478171700/2023-2024+Talent+Pipeline+Program+EXSUM+September+2023.pdf

Talent Pipeline Program. N.d. 'Homepage'. As of 19 November 2024: https://dibtalentpipeline.com/

Team Submarine Public Affairs. 2022a. 'The Pennsylvania Talent Pipeline Project Expands to Pittsburgh'. Naval Sea Systems Command. As of 19 November 2024: https://www.navsea.navy.mil/Media/News/Article/2995486/the-pennsylvania-talent-pipeline-project-expands-to-pittsburgh/

Team Submarine Public Affairs. 2022b. 'U.S. Navy Leaders Celebrate 1 Year Milestone of the Pennsylvania Talent Pipeline Project'. America's Navy. As of 19 November 2024: https://www.navy.mil/Press-Office/News-Stories/Article/3046513/us-navy-leaders-celebrate-1-year-milestone-of-the-pennsylvania-talent-pipeline/

The Economist. 2022. 'Britain's labour market is straining to recover from the pandemic: The disappearance of older workers explains a lot'. As of 19 November 2024: https://www.economist.com/britain/2022/07/07/britains-labour-market-is-straining-to-recover-from-the-pandemic

Trusted Docks. N.d. 'All shipyards, shipbuilders & docks in United Kingdom'. As of 19 November 2024: https://www.trusteddocks.com/catalog/country/226-united-kingdom

UK Government. 2022. 'Apprenticeships and traineeships'. As of 19 November 2024: https://explore-education-statistics.service.gov.uk/find-statistics/apprenticeships-and-traineeships/2021-22

UK Government. 2024. 'New Golden Age of shipbuilding as new UK-built warships boost Navy building programme to up to 28 ships and submarines'. As of 19 November 2024: https://www.gov.uk/government/news/new-golden-age-of-shipbuilding-as-new-uk-built-warships-boost-navy-building-programme-to-up-to-28-ships-and-submarines

UK Government. N.d.-a. 'National Shipbuilding Office'. As of 19 November 2024: https://www.gov.uk/government/groups/national-shipbuilding-office

UK Government. N.d.-b. 'UK shipbuilding skills taskforce (UKSST)'. As of 19 November 2024: https://www.gov.uk/government/groups/uk-shipbuilding-skills-taskforce-uksst

UK Government Department for Education. 2024. 'UK shipbuilding skills taskforce report: government response'. As of 19 November 2024: https://www.gov.uk/government/publications/shipbuilding-skills-in-the-uk/uk-shipbuilding-skills-taskforce-report-government-response

UK Shipbuilding Skills Taskforce (UKSST). 2023a. 'A Step Change in UK Shipbuilding Skills'. As of 19 November 2024: https://www.cityofglasgowcollege.ac.uk/sites/default/files/A%20Step%20Change%20UK%20ShipSkills_Digital.pdf

UK Shipbuilding Skills Taskforce (UKSST). 2023b. 'UK Shipbuilding Skills Taskforce: Our vision and call to action'. As of 19 November 2024: https://www.investni.com/sites/default/files/2023-12/eddie-corbett-uksst-engagement.pdf

UN Trade and Development. 2024. 'Ships built by country of building, annual'. As of 19 November 2024: https://unctadstat.unctad.org/datacentre/dataviewer/US.ShipBuilding

Universidade da Coruña. 2024a. 'Grado en ingeniería naval y oceánica'. Universidade da Coruña. As of 19 November 2024 : https://estudos.udc.es/es/study/start/730G05V02?_gl=1*10t64lg*_ga*NDM2OTgwMjMxLjE3MTI4NDk5NDk.*_ga_PKZEC02YMQ*MTcxNDEyNDkwOS4yLjEuMTcxNDEyNTA5NS4wLjAuMA

Universidade da Coruña. 2024b. 'Máster universitario en informática industrial y robótica'. As of 19 November 2024: https://estudos.udc.es/es/study/start//4538V01/2023?_gl=1*17nc4fo*_ga*NDM2OTgwMjMxLjE3MTI4NDk5NDk.*_ga_PKZEC02YMQ*MTcxNDEyODUxNi4zLjEuMTcxNDEyODc3NS4wLjAuMA

Universidade da Coruña. 2024c. 'Máster universitario en ingeniería naval y oceánica'. As of 19 November 2024: https://estudos.udc.es/es/study/start//4496V02/2023?_gl=1*bgsqeg*_ga*NDM2OTgwMjMxLjE3MTI4NDk5NDk.*_ga_PKZEC02YMQ*MTcxNDEyODUxNi4zLjAuMTcxNDEyODUxNi4wLjAuMA

Universidade da Coruña. 2024d. 'Master universitario erasmus mundus en sostenibilidad e industria 4.0 aplicada al sector marítimo'. As of 19 November 2024:
https://estudos.udc.es/es/study/start//4542V01/2023?_gl=1*1a9qjyu*_ga*NDM2OTgwMjMxLjE3MTI4NDk5NDk.*_ga_PKZEC02YMQ*MTcxNDEyODUxNi4zLjEuMTcxNDEyODU5Ny4wLjAuMA

Universidade da Coruña. 2024e. 'Programa de simultaneidad del grado en ingeniería mecánica y el grado en ingeniería naval y oceánica'. As of 19 November 2024:
https://estudos.udc.es/es/study/start//730G06V02/2023?_gl=1*1i3jlfw*_ga*NDM2OTgwMjMxLjE3MTI4NDk5NDk.*_ga_PKZEC02YMQ*MTcxNDEyODUxNi4zLjEuMTcxNDEyODU5Ny4wLjAuMA

Université Paris Cité. 2024. 'Master Physique fondamentale et applications (M2) parcours Physics of Soft Matter'. As of 19 November 2024:
https://odf.u-paris.fr/fr/offre-de-formation/master-lmd-XB/sciences-technologies-sante-STS/physique-fondamentale-et-applications-K2VO0C50//master-physique-fondamentale-et-applications-m2-parcours-physics-of-soft-matter-JS1YTYX4.html?search-keywords=physique

U.S. Fleet Forces Command. 2023. 'Adm. Daryl Caudle, New York, Commander, U.S. Fleet Forces Command'. As of 19 November 2024:
https://www.usff.navy.mil/Press-Room/Speeches/Article/3421661/submarine-industrial-base-keynote-remarks/

Watt, David. 2014. *The Air Warfare Destroyer Program*. Parliamentary Library. As of 19 November 2024:
https://parlinfo.aph.gov.au/parlInfo/download/library/prspub/3497967/upload_binary/3497967.pdf;fileType=application/pdf

Whyte, Ava. 2024. 'Former oil terminal in Old Kilpatrick to be regenerated'. *Clydebank Post*. As of 19 November 2024:
https://www.clydebankpost.co.uk/news/24288374.former-oil-terminal-old-kilpatrick-regenerated/

Annex A. Qualitative data collection protocols

This annex includes the data collection protocols that were used for collecting qualitative data through interviews and a bespoke industry survey.

A.1. Interview protocol

Introduction

RAND was commissioned by Skills Development Scotland in partnership with the Glasgow Chamber of Commerce to conduct a study on how resources could be better managed to help address shipbuilding capacity issues related to peaks and troughs in activity on the Clyde. The study will look at existing synergies and opportunities to manage skills collaboratively across industry.

RAND Europe is an independent not-for-profit research institute, whose mission is to help improve policy and decision making through objective research and analysis. RAND previously conducted similar skills and workforce assessment studies on UK defence aerospace and combat air sectors in 2010, 2011 and 2015, as well as on key skills in the UK's naval industry.

The interview should last approximately 60 minutes. It will be semi-structured, which means that we will combine a core set of questions with the flexibility to ask follow-up questions based on your answers. We will be taking notes during the interview and if you consent, we will record the interview for note-taking purposes. We will not attribute any information to interviewees. The final report of this study will not be publicly available. Do you have any questions before we begin?

Interview questions

Please provide a brief introduction of yourself, your current role and your experience.

Current state of skills health

1. From your perspective, how would you characterise the health of the shipbuilding and maritime skills base on the Clyde specifically and in Scotland more generally?
    a. Where do you see areas of positive growth/sustainment?
    b. Which skills do you consider to be at greatest risk of atrophy or loss? Why?
    c. Which of these do you consider to be critical for the future?
2. In your view, how important are the following factors in shaping the supply of shipbuilding and maritime skills?

a. Perception of the sector and career opportunities in it
b. Restrictions on work (e.g. security clearances, salary thresholds for visas…)
c. Pipeline of work
d. Competition by other sectors
e. Staff turnover
f. Other

Sourcing labour

3. Where do companies source their early career professionals? Mid-career professionals? Senior supervisors?
4. There are numerous ongoing initiatives (e.g. the NMIS, Workforce Foresighting Hub, UK Shipbuilding Skills Taskforce, etc.). What would you say is working well and what could be improved?
5. How easy is it for companies to hire labour from overseas? What are the main opportunities/challenges?

Adapting to new technologies

6. What do you consider to be the new and emerging design and industrial technologies that will in future be applicable for shipbuilding companies (e.g. in terms of design, manufacture, maintenance processes and tools)?

7. How, in your view (if at all), are shipbuilders looking to exploit these, and what are the barriers (financial, organisational, cultural etc.) to doing so?

Opportunities

8. What would you consider to be the 'quick fix' type measures that could help grow and nurture shipbuilding skills?
9. What would you consider to be the medium- to long-term opportunities?

Good practice

10. Do you have any specific examples of good practice you would like to share with us?

Thank you very much for your participation.

A.2. Qualitative industry questionnaire

To complement the quantitative analysis, we would like to establish a more robust understanding of wider strategic issues, concerns and opportunities in relation to workforce and skills planning in your company.

For these qualitative questions, **we envisage answers to be provided by strategic programme directors, functional heads, HR and skills development professionals through a collaborative effort**.

Please feel free to provide your answers as bullet points.

Your answers will serve as a starting point for discussion with the RAND team during the clarification call/workshop with each company separately (see introduction to this survey for detail).

Questions

1. What is the average **retirement age** in your company? Does it significantly differ for different skills categories?
2. What is the company strategy for workforce planning when **demand for labour increases**?
3. Which factors **constrain the workforce ramp-up rate**?
4. In periods of low demand for labour, in which skills areas does the company have the **fastest rates of skill atrophy** (i.e. how quickly does the industrial skills base degrade over a sustained period without a demand signal), due to:
   a) Loss of skill/productivity due to lack of ongoing work to practice and maintain relevance;
   b) Reduction of headcount, due to lack of internal business case to sustain workforce in this functional competence area during a period of low demand (e.g. certain manufacturing functions)
   c) Other reasons (please elaborate)
5. Do you have any concerns regarding relative proportion of your workforce by seniority (senior management/supervisor/team leader)? If so, in which areas?
6. From which **sources** do you typically **recruit your new technical workforce**?
7. Do you have specific collaboration programmes with local education institutions? If so, can you please list them? (e.g. apprenticeship schemes, training schemes, work placements)
8. From which **sources or organisations do you draw** your **experienced technical workforce**?

   If you are able to draw skills from other parts of your company/group (e.g. overseas business units), which skills are these and how easily and quickly are you able to leverage this source of supply? What are the barriers to doing so, if any?
9. What do you experience as the main challenges and barriers when **recruiting** new employees?
10. What do you experience as the main challenges and barriers when **retaining** experienced employees?
11. What do you consider to be the new and emerging design and industrial technologies that will in future be applicable for your company (e.g. in terms of design, manufacture, maintenance processes and tools)? How (if at all) is your company looking to exploit these, and what are the barriers (financial, organisational, cultural etc.) to doing so?

Annex B. List of interviewees

This annex provides a list of experts and stakeholders consulted as part of the data gathering for this study.

Table B.1. Interviewees consulted in this study

Institution	Stakeholder
Strathclyde University	Graham Wren
Glasgow City Council	Michael McNally
BAE Applied Shipbuilding Academy	Paul Feely
City of Glasgow College	Paul Little
Glasgow Clyde College	Jennifer Brickwood
Scottish Enterprise	Gillian Cay
MarRI-UK	Wenjuan Wang, Simon Reid, John Hudson
Naval Base Command (NBCC)	Hamish Tetlow
HMNB Clyde	Anne McKinley, Laura Wellington, Andrew Bower
Argyll & Bute Council	Fergus Murray
Babcock at Faslane	Coralina Smith, Andrew Currie, Dale Smith
Malin Group (development site)	John MacSween
Society of Maritime Industries	Tom Chant
National Shipbuilding Office (NSO)	Paul Sheerin, Rod Paterson, Rue McIlmoyle
Intermarine	Nick Mansell
Babcock	Anthony McCrory
Ferguson Marine	Linzi McKinnon
Malin Group	John MacSween, Jennifer Cowan
BAE Systems	Stuart Gallacher, Steven Kelly, Cameron Dick
Dales Marine	Kevin Paterson, Elizabeth Kennedy

Annex C. Case studies

This annex provides a detailed summary of international case studies of skills growth programmes implemented at an enterprise level. These case studies provided evidence base for the development of RAND Europe's options and recommendation for the Clyde shipbuilding sector's skills development.

C.1. US Navy Talent Pipeline Programme

Organisation and purpose

Launched in 2021, the US Navy Talent Pipeline Programme is a strategic initiative aimed at developing workforce solutions for the US Submarine Industrial Base (SIB).[160] Funded by the Department of Defense through the Pentagon's Program Executive Office Submarines and established by the US Navy's SIB programme team, the programme aims to create and sustain a 'maritime and defence industrial base-focused talent pipeline' that enables SIB employers to re-capitalise their workforce by addressing critical skills gaps, recruiting, training and retaining a skilled workforce with critical trade skills, including key technical trades and engineering.[161] This includes, but is not limited to, welders, machinists, electricians, ship fitters, metal fabricators and quality assurance.[162] Supporting the workforce requirements of the wider defence industrial base, the ultimate goal of the programme is to improve the production capacity of the SIB.[163]

To address workforce shortages, 100,000 new skilled trade workers will have to be hired into the SIB over the next ten years (by 2033).[164] The talent pipeline programme is one of many initiatives that are part of a wider effort by the US Navy to bolster the SIB.[165] It has partnered with non-profit organisation BlueForge Alliance, contracted through shipbuilder General Dynamics Electric Boat, to address hiring and retention challenges and support the implementation of SIB workforce development initiatives.[166] In 2023, the company received over $200 million in government funding to implement such initiatives.[167] The Alliance's work aims to provide a 'unified industrial base development strategy across shipbuilders, suppliers, and

[160] Dean et al. (2023).

[161] Talent Pipeline Program (n.d.); ATDM (2023).

[162] Team Submarine Public Affairs (2022a).

[163] U.S. Fleet Forces Command (2023).

[164] Katz (2023).

[165] Errick (2023).

[166] Errick (2023); ATDM (2023).

[167] ATDM (2023).

other businesses', and has been leading the way in developing recruitment platforms, including the website buildsubmarines.com, and advertising campaigns.[168]

Matching demand and supply of training and careers

The programme's objectives are achieved by connecting SIB employers with Career and Technical Education providers (CTE) and career-seeking students.[169] Employers are paired with CTE suppliers whose programmes will enrol and train skilled candidates for primarily entry-level positions as part of a one-year programme, allowing employers to recruit and retain workers with necessary skills.[170] The programme targets a network of companies that are involved in contracts with the Navy and career-seeking students, as well as small to medium defence industrial base suppliers.[171]

The programme organises events, including orientation events in 'maritime centres of gravity' where participants can learn more about the Navy's mission and workforce needs from senior leaders, career fairs connecting students and employers, welding competitions to foster practical skills, and signing days that recognise students embarking on SIB careers.[172] By building relationships and talent pipelines at CTE centres, regional high schools and community colleges, employers in the critical maritime defence supply chain are educated about talent acquisition and retention to commit to hire and retain programme graduates.[173]

Nationwide programme with regional hubs

In April 2024, the programme expanded along the US East Coast to include two new regional flag locations in Boston, Massachusetts, and Long Island, New York, and launched in Newport Beach, California.[174] Active nationwide, the programme is also present in Philadelphia and Pittsburgh (Pennsylvania) and Hampton Roads (Virginia).[175] In these locations, regional flags represent a commitment to build a talent pipeline in the region and to help suppliers find employees with the right skillsets.[176] The project is customised to meet the different regions' specific circumstances, to enable the development of another pipeline of talent to add to the SIB skilled workforce.[177] Since the programme's 2021 launch in Pennsylvania, the pipeline projects have supported more than 300 SME maritime suppliers and facilitated 'the employment of more than 2,700 individuals'.[178] The 2022–2023 year saw a participation of 104 employers in the programme, resulting in 872 starts, averaging eight per employer.[179] The 2023–2024 target is to hire more than 3,500 individuals over 400 companies as part of the six regional pipeline projects.[180]

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[168] ATDM (2023); Buildsubmarines.com (2024).

[169] Talent Pipeline Program (n.d.).

[170] Dean et al. (2023); SeaWaves Magazine (2023).

[171] U.S. Fleet Forces Command (2023).

[172] SeaWaves Magazine (2023).

[173] Team Submarine Public Affairs (2022b).

[174] SeaWaves Magazine (2023).

[175] Talent Pipeline Program (2024).

[176] Talent Pipeline Program (2024).

[177] Team Submarine Public Affairs (2022a).

[178] Naval Sea Systems Command (2024).

[179] Talent Pipeline Program (2024).

[180] Naval Sea Systems Command (2024).

Key takeaways

- To launch the Talent Pipeline Programme, the US Navy's SIB programme team partnered up with a critical network of suppliers. Establishing strong partnerships with suppliers was instrumental in launching the programme and creating a sustainable talent pipeline.
- By aligning personnel training and development with the Navy's critical skills needs, the programme helps ensure personnel are equipped to contribute effectively to the Navy's objectives and fulfil its requirements as the ultimate employer.
- Public outreach and awareness-raising efforts can provide insight into the defence sector's activities and career opportunities. By collaborating on targeted communications and outreach campaigns, government and industry can shape the narrative. Effective campaigns can help to increase the sector's accessibility and promote a diverse and attractive image of the sector.
- A 'one-stop shop' or centralised career and recruitment platform (buildsubmarines.com) offers one way to increase visibility and ease access to the defence enterprise at large. The platform serves as a convenient hub for individuals seeking information on careers and recruitment opportunities in the sector. By consolidating resources and information in one location, the platform simplifies access and promotes engagement with potential candidates.

C.2. Transition from the Air Warfare Destroyer programme to the Future Frigate programme

Organisation and purpose

The Australian Department of Defence's Hobart-class destroyer acquisition programme, also called the Air Warfare Destroyer (AWD) programme, was an $8 billion (A$9.1bn) project that aimed to generate 3,000 jobs in Australia.[181] The programme was coordinated by the Air Warfare Destroyer Alliance. Its main partners were shipbuilding company ASC Shipbuilding (currently BAE Systems Maritime Australia), responsible for shipbuilding, Navantia, responsible for design and ship build management, and Raytheon Australia, responsible for combat systems engineering.[182] A key objective of the Alliance was to provide long-term training for employees to support the Australian government's continuous build strategy.

Skill transition from the Air Warfare Destroyer programme to other future programmes

As a cornerstone of the Australian government's continuous build strategy, the Alliance focused heavily on workforce development and retention. Efforts to bolster skills retention among ASC employees started in 2018 with several measures by the Australian government, including, for instance, a targeted retention strategy to create up to 200 positions within ASC Submarines for current shipbuilders from the AWD programme,[183] and the provision of upskilling opportunities in operations management, CAD, engineering and supply chain fields.[184] Additionally, the Naval Shipbuilding College was established to grow the

[181] Naval Technology (2018).

[182] Australian Naval Infrastructure (2024).

[183] Pyne (2018).

[184] Pyne (2018).

shipbuilding workforce to meet the skills demand.[185] The Alliance has also implemented an apprentice training system to further boost skills supply to the sector.

Following the AWD programme, the Alliance aimed to ensure the smooth transition of workforce to the Future Frigate programme to limit peaks and troughs in activity, emphasising the benefits of maintaining continuity in work and retaining associated knowledge and skills.[186] Relatedly, the Department of Defence aimed to adjust its acquisition schedule to align with skills development programmes between the Hobart-class destroyer and the Future Frigates to decrease costs. As new production workforce needed to be developed to support the shipbuilding enterprise in Australia, costs for the programmes were already estimated at 30–40 per cent more than similar programmes overseas.[187]

In 2020, two Offshore Patrol Vessels were commissioned, to be constructed immediately after the conclusion of the AWD programme, to avoid a potential 'cliff edge' for skills prior to the commencement of the Future Frigates programme that eventually cut steel in June 2024.[188] To address the concern over the loss of skills and expertise at the conclusion of the AWD programme, the AWD programme office staff were transitioned to new roles in the Naval Construction Branch, and efforts were made to expand the Branch's resources, ensuring the retention of knowledge and skills.[189] The focus was on upskilling workforce in operations management, CAD, engineering and supply chain fields to ensure readiness for the Future Frigate programme.[190]

Key takeaways

- The programme to transition workforce was led by the Alliance, based on contractual arrangements between the Australian government and industry. This contractual basis facilitated close collaboration between government and industry.
- A key element of this case study is the harmonisation of the government's procurement schedules with industry's production schedule, with the intention to avoid peaks and troughs in activity, supporting cost reduction, retention and the smooth transitioning of workforce from one programme to another.[191]
- This case study also highlights that the upskilling of the existing workforce is as important as retention, to ensure their skills remain up to date for new design work.

[185] Pyne (2018).

[186] Watt (2014).

[187] Schank & DeLuca (2020).

[188] Pittaway (2023).

[189] ANAO (2020).

[190] Pyne (2018).

[191] Birkler et al. (2015).

C.3. University of Coruña – Navantia Joint Research Centre

Organisation and purpose

The University of Coruña – Navantia Joint Research Centre is a collaboration in Research, Development and Innovation (R&D+I) between Spanish shipbuilding company Navantia, the Spanish government and the University of Coruña, aimed at the modernisation of the Spanish shipbuilding sector to support the Spanish Navy's F-110 programme.[192] The Centre was established in 2022 from the consolidation of the UDC–Navantia Mixed Research Unit, which dates back to 2015. The Steering Committee, which oversees the research and strategies, is chaired by Navantia.[193] The programme is funded by the Galician Innovation Agency of the regional government of Galicia, with support from the Department of Economy, Employment and Industry.[194]

Modernising Spain's maritime sector

The Centre aims to enhance the competitiveness of the Spanish maritime industry through modernisation and the establishment of the 'Shipyard of the Future'.[195] The Centre's five overarching objectives are: 1) the digital transformation of shipyards; 2) the optimisation of production processes; 3) the planning and development of a new block factory; 4) the introduction and use of enabling and disruptive technologies; and 5) the implementation of the digital twins of plant and product.[196]

Through innovation, the Centre is contributing to Spain's F-110 programme, started in 2019, for the construction of five technologically advanced frigates by 2032, maximising the utility of using digital twins in the process.[197] The Centre also helped to establish the new digital block factory of Navantia-Ferrol in 2024, representing a €100 million investment[198] focusing on digital transformation, production process optimisation and the implementation of enabling technologies.[199]

The University of Coruña plays a significant role in supporting the upskilling and reskilling of the workforce. Close collaboration between Navantia and the University supports the development of key naval skills in the shipbuilding and maritime sectors through sponsored project work and specialised, hands-on and high-quality university courses in the maritime sector, also offering pan-European double degree programmes.[200] The University offers a wide range of Bachelor's and Master's degree programmes in naval, oceanic and industrial engineering, as well as in energy efficiency, complex materials, robotics and additive manufacturing.[201] In addition to the Centre's activities, the University also offers internship opportunities

[192] CITENI (2024c).

[193] CITENI (2024c).

[194] CITENI (2024a).

[195] CITENI (2024c).

[196] CITENI (2024c).

[197] La Moncloa (2023); Naval News Staff (2023).

[198] La Moncloa (2023).

[199] CITENI (2024c).

[200] CITENI (2024b); Université Paris Cité (2024); Campus Industrial (2024).

[201] CITENI (2024b); Universidade da Coruña (2024a); Universidade da Coruña (2024b); Universidade da Coruña (2024c); Universidade da Coruña (2024d); Universidade da Coruña (2024e).

for students pursuing a degree in maritime fields. These internship opportunities are offered with at least 80 companies operating in the shipbuilding and maritime sectors.[202]

Key takeaways

- The Centre is an illustrative example of a triple-helix public–private sector collaboration between industry, the education sector and the government, with the Spanish and regional governments providing funding, and Navantia and the University of Coruña implementing the initiative to modernise the Spanish shipbuilding and maritime sector.
- By supporting the modernisation of the shipbuilding sector and through the adoption of advanced technologies, the Centre also helps to improve the attractiveness of the sector as well as its image as a high-tech field, supporting recruitment and retention.

C.4. Dutch Underwater Knowledge Centre

Organisation and purpose

The Dutch Underwater Knowledge Centre is a specialist working group established in 2004 as part of the non-profit Dutch Marine Construction Cluster.[203] It was cofounded by the government and industry, including through its involvement in strategic defence projects such as the Royal Netherlands Navy's submarine replacement program.[204] It is responsible for supporting skills retention and development in the Dutch maritime, and especially submarine, sector and supporting the life extension of Walrus-class submarines in the Netherlands.[205] The working group is also focused on maintaining and fostering innovation in underwater technology in the Dutch industry and its associated research bodies.[206] The Centre builds on close collaboration between industry, government and knowledge institutions.

Preserving submarine skills

The Centre is a triple-helix organisation involving government, industry and research entities to ensure the success of the 2007 Life Extension Program of Walrus-class submarines (operatable until at least 2025).[207] The working group actively engages with education providers to ensure the continuity of expertise in submarine design, construction and maintenance. Given its centrality in the Dutch underwater industry, the Centre aims to provide skills development opportunities for early career professionals, current employees and mid-career professionals, raising awareness about advanced education programmes in the industry while also fostering recruitment for industry partners at all levels. For instance, the Centre organises submarine design masterclasses led by the naval architect and engineering company Nevesbu.[208] These masterclasses have two main objectives: to refresh or teach basic submarine design principles and requirements, and to

[202] CITENI (2024a).
[203] NIDV Difensive & Veiligheid (2024).
[204] Global Defense Corp (2020).
[205] NIDV Difensive & Veiligheid (2024).
[206] Buitendijk (2022).
[207] Nevesbu (2024b).
[208] Nevesbu (2024b).

facilitate knowledge sharing among relevant parties.[209] The training is delivered by former submarine officers and experts from Nevesbu and marine technology leaders from RH Marine, providing insights into submarine design principles and workshops.[210] The Centre has also been involved in several studies for submarine replacement projects, such as the Zwaardvis class, export projects (Hai Lung class) and recent designs and deliveries for foreign submarine programmes, and provides lifetime support at affordable and competitive cost.[211]

The Centre's role is to cultivate a skilled workforce to guarantee the maintenance, sustainability and operability of the Walrus-class submarines.[212] The Centre's mission is driven by the understanding that a well-trained workforce with operational experience is an asset that would be expensive, or even impossible, to replace if lost.[213] The expert capabilities that the Centre preserves include, for instance, pressure hull design, platform system architecture, combat management systems (CMS) integration, signature management, sensors, updated hydraulic systems and refined torpedo capabilities.[214] The skills capabilities sustained through the Centre are intended to be utilised for the Walrus-class replacement programme, the Orka-class submarine programme.[215]

Key takeaways

- The non-profit Centre, set up as a triple-helix organisation, facilitated close collaboration between government, industry and knowledge institutes and education providers, ensuring that the Netherlands' underwater skills base remains up to date and internationally competitive. This is particularly important for critical skills that cannot be transferred from other sectors and have to be grown within the submarine skills and knowledge community.

C.5. Meyer Turku's Shipbuilding School

Objective and purpose

Meyer Turku Oy is a Finnish cruise ship construction company that specialises in cruise ships, ferries and special vessels, with a 15 per cent share in the world's cruise ship construction market.[216] The company provides needs-based training to its employees through its shipyard-based Meyer Turku Shipbuilding School.[217] The school has trained shipbuilding industry professionals in Finland since 1962 and is responsible for company personnel's 'know-how' based on current and future needs at the shipyard as well as required up-to-date competences.[218]

[209] Damen (2024).
[210] RH Marine (2024); Damen (2024).
[211] NIDV Difensive & Veiligheid (2018).
[212] NIDV Difensive & Veiligheid (2018).
[213] NIDV Difensive & Veiligheid (2018).
[214] NIDV Difensive & Veiligheid (2018).
[215] Buitendijk (2021).
[216] Meyer Turku (2021).
[217] Meyer Turku (n.d.-a).
[218] Meyer Turku (n.d.-b); Meyer Turku (2021).

In-house training to ensure the development and retention of skills

Operating at the company's own shipyard helps ensure that the personnel designing and building the ships are knowledgeable and well-trained.[219] Further, to ensure that the training provided meets demand, there is close cooperation with company department supervisors.[220] Training needs are identified during employee discussions, after which training can be arranged internally or externally. Teachers and lecturers provide training in addition to their work undertaken at the shipyard, where hands-on experience ensures knowledge transfer and that the training offered is at the cutting-edge of competence.[221] The company collaborates extensively with regional training institutions, universities, institutes and vocational schools.[222]

The school offers centralised, demand-based training and courses for company personnel and subsidiaries, with many events open to companies that are part of the Meyer Turku Oy network.[223] In 2021, despite COVID-19 restrictions, over 3,600 people attended short-term training programme, of which 40 per cent were personnel from network companies.[224] Most of the training offered is online, and in addition to professional training, management training is also provided. Finnish-language skills are required to participate, as most of the training is provided in Finnish.[225] Training delivered in 2024 includes, but is not limited to, forklift handling, driving testing, SAP-Readiness reporting and others.[226]

Recruitment training is also recognised as an important part of the school's activities, to increase the shipyard workforce. Training events are arranged based on need, to allow for individuals to gain the relevant qualification, including, but not limited to, naval architects, sheet metal welders or pipe or engine fitters.[227] The recruitment training consists of theoretical and work phase as well as on-the-job learning and is organised in cooperation with Finland's Ministry of Economic Affairs and Employment.[228]

Key takeaways

- The establishment of the shipbuilding school at the shipyard facilitates in-house training aligned with the evolving skill needs of Meyer Turku.
- A flexible approach to curriculum design helps to ensure that needs-based training can be provided for company personnel in a timely manner. Close cooperation with vocational schools and universities also helps to address training needs as and when they arise.
- Meyer Turku offers training for partner companies, ensuring that necessary skills are also present in its supply chain.

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[219] Meyer Turku (2021).

[220] Meyer Turku (n.d.-c).

[221] Meyer Turku (n.d.-b); Meyer Turku (2021).

[222] Meyer Turku (n.d.-c).

[223] Meyer Turku (n.d.-c).

[224] Meyer Turku (2021).

[225] Meyer Turku (n.d.-b).

[226] Meyer Turku (n.d.-c).

[227] Meyer Turku (n.d.-b).

[228] Meyer Turku (n.d.-a); JobMarket Finland (n.d.); Ministry of Economic Affairs and Employment of Finland (n.d).

Annex D. Quantitative data collection

This annex explains the quantitative industry survey data collection and includes the skills taxonomy.

D.1. Quantitative survey data collection

The quantitative survey administered to the companies involved in the study consists of two components: current workforce supply and future workforce demand. The current workforce component of the survey collected detailed data on the existing workforce, broken down by experience level. The skills categories follow the RAND Europe taxonomy (as in Section D.3 below). The survey gathered information on the number of FTEs in each skill category, their experience level and their age range (minimum, maximum and average). Additionally, it collected data on historic hires, leavers, redundancies and retirees from 2019 to 2023, alongside projected hire rates up to 2028 (where available). For the future workforce demand section of the survey, few companies were able to provide data due to uncertainty around future work. This structured approach to data collection was designed to provide a comprehensive understanding of the current workforce in order to better understand future workforce requirements.

The survey also included a focused section that assessed industry's concerns regarding the future availability of specific skills. This evaluation was structured to capture the companies' level of concern over three distinct future time periods: the next five years, the next five to ten years, and the next ten to twenty years. Respondents were asked to rate their level of concern regarding each of these periods using a three-point scale: low, medium or high. This detailed approach allowed companies to express concern not only for the skills currently utilised within their workforce, but also for those skills not presently covered by their FTEs. This method enabled the capture of data on emerging skills that companies anticipate being critical in the future, thereby providing valuable insights into potential skills shortages and areas requiring proactive workforce planning and development.

D.2. Data analysis

Before analysis, we aggregated the data across the survey responses from the shipbuilding companies, anonymising the data across all survey aspects. For survey sections on the current number of FTEs, hires, losses and demand profiles, we aggregated the data by simply summing the responses from across the companies. However, we calculated the minimum and maximum FTE age ranges from the extremes of the four supplied age ranges, and the average age as the FTE-weighted mean across the four companies. When aggregating the hire data, we adjusted the hire rates to include both external hires and internal transfers.

To aggregate companies' responses regarding concern for future availability of skills, we tallied the number of companies that expressed low, medium and high levels of concern over the next five years, five to ten years, and ten to twenty years.

Once we had aggregated the data, we analysed it and visualised key findings in figures created using Python. We analysed workforce demographics to understand the distribution of age across the entire workforce, and across the different skills categories and experience levels. Since the minimum, maximum and average age of workers in each category experience level was provided in the aggregated survey responses, we simulated the age of the workforce by drawing random samples from a beta distribution. To address the inherent randomness in the sampling process, we used a Monte Carlo simulation technique. Specifically, we generated 1,000 random samples of FTE ages for each subcategory experience level, and averaged these samples to provide a comprehensive representation of the entire workforce's age distribution.

The Monte Carlo sampling technique involves generating multiple sets of random samples to estimate the data distribution and assess the uncertainty associated with the results. By averaging the results over multiple simulation runs, a more robust estimate of the demographic characteristics of the workforce can be obtained. Taking multiple samples helps to reduce the impact of outliers or extreme values that may occur in a single random sample. Using Monte Carlo sampling with multiple iterations enhances the reliability and accuracy of the analysis by capturing data variability and providing a more robust basis for drawing conclusions about workforce demographics across different skills categories.

D.3. Skills taxonomy

Category	Subcategory
General management	Management
	Administration
	Marketing
	Purchasing
Programme management	Programme control/project management (e.g. performance management, cost management, risk management, contract management)
	Logistics and material resource control (parts control, logistics buyer)
	Estimation (e.g. cost estimation)
	Planning and production support (e.g. component support, purchasing support)
	Procurement (market research, financial management)
	Through-life capability management (infrastructure requirements, logistics requirements, information requirements)
	Systems analysis (operational effectiveness analysis, system technical capabilities and interfaces)
Technical	Drafting/CAD specialist
	Mechanical /fluids (e.g. HVAC design engineers, piping design, hydraulic system design)
	Mechanical engineering (configuration control, mechanical architecture, design definition)
	Systems engineering (systems integration, decision and risk analysis, prototyping, tools and processes for design optimisation)
	Electrical engineering (architecture, generation, distribution, conversion)
	Naval architecture/marine (e.g. marine engineer, weights analysis)
	Hull/structural arrangements (e.g. structural design and engineering)
	Propulsion (e.g. shafting and gear design, prime mover analysis, engine health monitoring)
	Energy storage and distribution (power generation, architecture)

Category	Subcategory
	Navigation (GPS, GPS assurance)
	Testing, commissioning and acceptance
	Sensors (sensor protection measures, sensor management)
	Communications (SATCOM systems, electro-optical systems, antenna integration)
	Compliance (safety and environment, regulatory, recycling)
	Combat systems and integration
	Other (e.g. software engineering, IT support, life-cycle support)
Structure	Steelworker, plater, boilermaker
	Structure welder
	Accommodation
	Shipwright/fitter
	Team leader, foreman, supervisor, progress control (fabrication)
Outfitting	Electrician, electrical tech, calibrator, instrument tech
	HVAC installer
	Hull insulator
	Joiner, carpenter
	Laminator
	Machinist, mechanical fitter/tech, fitter, turner
	Painter, caulker
	Pipe welder
	Piping/machinery insulator
	Sheet metal
	Team leader, foreman, supervisor, progress control (outfitting)
Manufacturing support	Rigger, stager, slinger, crane and lorry operators
	Service, support, cleaners, trade assistant, ancillary
	Stores, material control
	Quality assurance/control
Non-shipbuilding skills	E.g. marine services

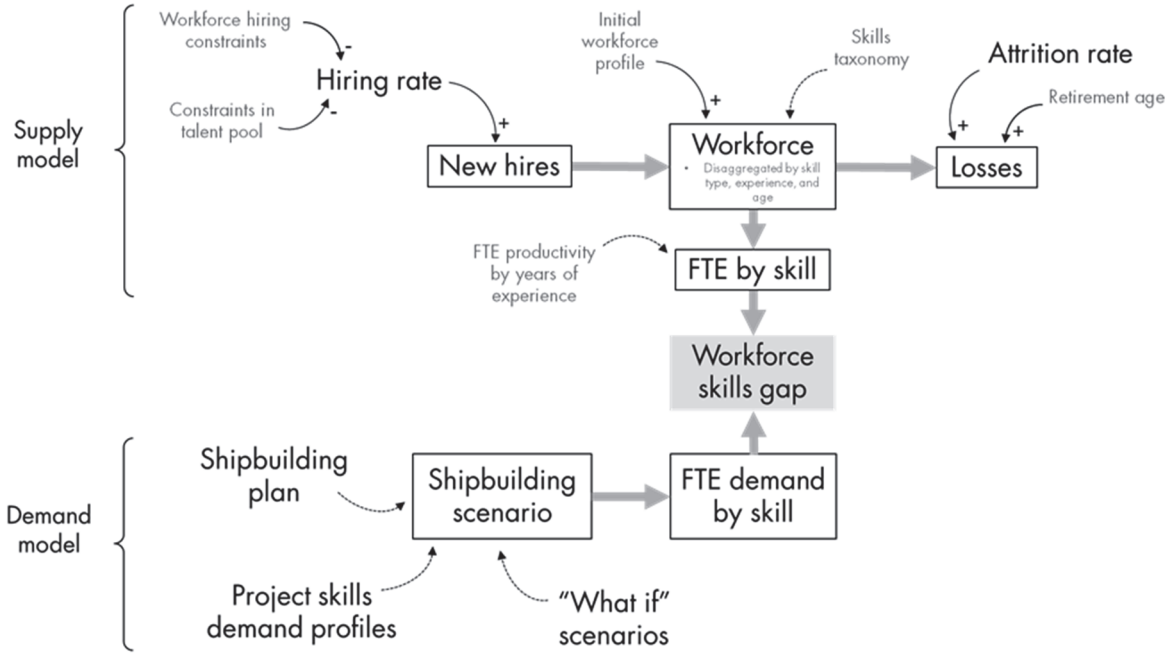
D.4. Workforce demand and supply model

Responses to the Shipbuilding Industry Workforce Survey were used anonymously to parameterise a bespoke model designed to provide insight into potential workforce skills gaps under different future shipbuilding scenarios. The model was developed by the RAND Europe study team for the purposes of this study and is based on systems dynamics and agent-based modelling principles. The model aims to capture how both workforce supply and demand drive skills gap dynamics. A high-level view of the model is illustrated in Figure D.1, showing separate submodels for workforce supply and demand.

In the absence of industry-provided future demand scenarios, the RAND Europe team developed three basic scenarios for future demand, to include:

- Static demand (no growth; workforce levels stay at 2023 levels)
- Differential growth across skills using BAE and Babcock forward-looking hiring projections
- 15 per cent growth applied across all skills groups.

Figure D.1. Overview of RAND Europe's supply–demand model



Within the workforce supply submodel, survey responses were used to establish a detailed profile of the current workforce, including counts of workers by skills type, age and experience level. Age profiles, along with projected retirement ages, allowed estimates of how worker retirement may affect overall workforce attrition rates over time. Historical hire rates and workforce losses (including redundancies) helped establish bounds on how rapidly the workforce can reasonably be expected to grow and contract over time.

The workforce demand submodel adopts a scenario-based approach to reflect the uncertainty in future shipbuilding projects. These scenarios were developed by RAND Europe to demonstrate the utility of dynamic forward workload modelling.