

Skill formation in Shipbuilding and Ship Repair: A Comparative Institutional Analysis of Japan, South Korea, China and the European Union, with lessons for India's maritime ambitions



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Abstract

Purpose: Shipbuilding is a labour intensive, strategically salient industry in which national competitiveness rests to an unusual degree on the depth and renewal of workplace skills. This paper examines how the world's three dominant shipbuilding economies Japan, South Korea and China together with the European Union's coordinated response, have organised skill formation in shipbuilding and ship repair, and draws out the implications for India as it pursues the targets of the Maritime India Vision 2030 and the Maritime Amrit Kaal Vision 2047.

Design/methodology/approach: The study adopts a qualitative, comparative case study design (Yin, 2018) triangulating government policy documents, OECD peer reviews, official statistics, industry association data and peer reviewed literature across four cases. Cross case synthesis is organised around five analytical dimensions: government policy evolution; the roles of industry stakeholders and trade unions; institutional infrastructure; flagship programmes; and quantitative workforce indicators.

Findings: The cases reveal three distinct skill formation regimes Japan's firm led, association coordinated model now supplemented by managed labour migration; South Korea's state responsive, cyclically adaptive model combining crash training with visa liberalisation; and China's centrally planned, mass scale mobilisation of vocational education alongside the EU's multi stakeholder pact for skills as a coordination architecture. No single model transfers wholesale; each, however, offers components directly relevant to India's emerging ecosystem, in which the ₹69,725 crore shipbuilding package of September 2025 and Andhra Pradesh's greenfield cluster strategy create an unrepeatable policy window.

Originality/value: The paper offers the first integrated comparison of shipbuilding skill formation frameworks across the three Asian incumbents and the EU that is explicitly mapped onto India's policy architecture and onto a state level implementation case (Andhra Pradesh), contributing to the literatures on collective skill formation, industrial policy and maritime human resource management.

Keywords: skill formation; shipbuilding; ship repair; vocational education and training; industrial policy; maritime workforce; comparative case study; India

1. Introduction

Shipbuilding occupies a peculiar position among manufacturing industries. It is at once a mature, cyclical, price competitive business (Stopford, 2009) and a strategic capability that states have rarely been willing to leave entirely to the market (Sloan, 2025; Tan, 2020). Whichever of these two faces one emphasises, the industry's fortunes rest on people. A modern shipyard assembles the work of welders, fitters, pipe workers, painters, electricians, naval architects, planners and estimators into vessels of enormous complexity, and the tacit, workshop level character of much of this knowledge means that it cannot be purchased off the shelf; it must be formed, transmitted and renewed within an institutional ecosystem of firms, schools, associations, unions and the state. Skill formation is therefore not an adjunct to shipbuilding policy but close to its core.

The global geography of the industry sharpens the point. China, South Korea and Japan between them account for well over nine tenths of the tonnage delivered worldwide (UNCTAD, 2024). Chinese yards

alone took 55.7 per cent of global completions and 74.1 per cent of new orders in 2024, on data reported by the China Association of the National Shipbuilding Industry (CANSI, 2025, as reported in Seatrade Maritime News, 2025). Yet all three incumbents confront workforce problems of the first order: Japan's shipbuilding workforce has fallen to roughly 71,000, with about two fifths of workers over the age of 55 (Splash 247, 2025); South Korea recorded its first workforce increase in nine years only in 2023, and did so largely by recruiting foreign labour (Hellenic Shipping News, 2025; OECD, 2026); and China's leadership has publicly identified the shortage of highly skilled technicians as a binding constraint on its industrial upgrading (MERICS, 2022). How each system responds to these pressures and what those responses reveal about the underlying institutions of skill formation is the subject of this paper.

The question carries particular weight for India. India's share of global shipbuilding output remains below one per cent, despite a coastline of over 11,000

kilometres, some 55 operational shipyards and long standing public sector builders of repute (Ministry of Ports, Shipping and Waterways [MoPSW], 2021; Garg, 2020). The Government of India has now committed to changing this position decisively: the Maritime India Vision 2030 targets a place among the top ten shipbuilding nations by 2030, the Maritime Amrit Kaal Vision 2047 a place among the top five by 2047 (MoPSW, 2021, 2023), and in September 2025 the Union Cabinet approved a comprehensive package of ₹69,725 crore spanning financial assistance, a Maritime Development Fund, a Shipbuilding Development Scheme targeting 4.5 million gross tonnes of annual capacity, and dedicated skilling measures to give those ambitions substance (Press Information Bureau [PIB], 2025). Three greenfield shipbuilding clusters have received in principle approval, in Andhra Pradesh, Gujarat and Tamil Nadu, and Andhra Pradesh has since become the first state to clear a mega greenfield cluster, at Dugarajapatnam, with an estimated investment of ₹29,662 crore (Deccan Chronicle, 2026). Capital and land, in other words, are being arranged. The harder question the one the East Asian experience suggests will determine whether the investment converts into competitiveness is where the workforce will come from and how its skills will be formed.

Against this background, the paper pursues three research questions.

RQ1: How have government policy, industry stakeholders, trade unions and training institutions combined to produce skills for shipbuilding and ship repair in Japan, South Korea and China, and how has the European Union organised a coordinated response to comparable pressures?

RQ2: What systematic similarities and differences characterise these frameworks when compared across policy evolution, stakeholder roles, institutional infrastructure, flagship programmes and measurable outcomes?

RQ3: Which elements of these frameworks are transferable to India's shipbuilding skill ecosystem in general and to Andhra Pradesh's cluster strategy in particular, and under what conditions?

The paper contributes on three fronts. Conceptually, it extends the collective skill formation literature (Busemeyer and Trampusch, 2012; Thelen, 2004) into a sector shipbuilding where the interaction of industrial policy and vocational training is unusually visible but comparatively under studied. Empirically, it assembles and reconciles the most recent official and industry data on shipbuilding workforces across four jurisdictions, including developments as recent as Japan's Shipbuilding Industry Revitalisation Roadmap of late 2025 and India's September 2025 package. Practically, it converts the comparison into an implementation framework for Indian policymakers and for Andhra Pradesh's nodal agencies. The remainder of the paper is organised as follows:

Section 2 reviews the relevant literature and sets out

the analytical framework;

Section 3 describes the methodology;

Sections 4 to 7 present the four cases; Section 8 undertakes the cross case comparison;

Sections 9 and 10 analyse India's ecosystem and the Andhra Pradesh case respectively;

Section 11 discusses lessons and policy implications;

and Section 12 concludes.

2. Literature Review and Analytical Framework

2.1 Human capital and the political economy of skill formation

The economics of training begins with Becker's (1964) distinction between general and firm specific human capital, which predicts systematic under investment in transferable skills wherever firms fear that trained workers will be poached. That prediction frames the central institutional problem of shipbuilding: trades such as welding, fitting and pipework are broadly transferable across yards and into adjacent industries, so individual employers, left to themselves, will train less than the industry collectively needs. Comparative political economy has documented the variety of institutional solutions to this collective action problem. Hall and Soskice (2001) contrast liberal market economies, which rely on general education and fluid labour markets, with coordinated market economies, in which employer associations, unions and the state jointly underwrite occupational training; Thelen (2004) traces how such arrangements evolve historically; and Busemeyer and Trampusch (2012) formalise the notion of "collective skill formation" regimes in which firms, intermediary associations and the state share the costs and governance of vocational training. These categories supply the analytical vocabulary used throughout this paper.

2.2 The developmental state and East Asian skill systems

A second literature locates skill formation within East Asia's state led industrialisation. Johnson's (1982) account of Japan's developmental state and Amsden's (1989) study of Korean late industrialisation both treat the deliberate creation of industrial skills through technical schools, in firm training and disciplined learning from abroad as constitutive of catch up growth. Green (1999) characterises East Asian skill formation systems as state orchestrated but institutionally diverse, and warns that globalisation strains the developmentalist settlement; Park (2007) shows how South Korea's "post developmental" state re engineered its training system after the 1997 crisis towards market supporting lifelong learning; and Zhu (2013) surveys the region's workforce development institutions comparatively. The World Bank's recent synthesis argues that the region's continued convergence now depends on precisely the higher order technical and cognitive skills that older mass training systems were not designed to supply (Cirera, Mason and de Nicola, 2021). Shipbuilding, as one of the emblematic heavy

industries of the East Asian miracle (Amsden, 1989; Tan, 2020) is a natural site on which to observe these systems under contemporary stress.

2.3 Shipbuilding economics and the labour question

The maritime economics literature has long recognised labour cost and labour quality as joint determinants of shipbuilding competitiveness, alongside exchange rates, steel prices and state support (Stopford, 2009; Şentürk, 2011). Historical leadership transitions from Britain to Japan, Japan to South Korea, and South Korea to China have each combined lower labour costs with the rapid construction of national training capacity and sustained state sponsorship (Hossain, 2023; Tan, 2020). Ship repair, though frequently treated as an appendage of newbuilding, draws on an overlapping but distinct skill set and offers smoother, less cyclical demand, making it an attractive entry segment for emerging shipbuilding nations (Şentürk, 2011). Recent firm level work confirms the intuitive link between workforce competencies and yard performance (Idris, Wan Zakaria and Nik Mahmood, 2023), while comparative studies of naval shipbuilding underline that governments value the industry partly because it anchors a skilled industrial workforce (Sloan, 2025).

2.4 Industry 4.0, decarbonisation and the changing maritime skill set

A rapidly growing literature examines how digitalisation and the green transition are rewriting maritime skill requirements. Sullivan, Arias Nava and Desai (2021) consolidate the concept of “Maritime 4.0”, noting that shipbuilding is the maritime segment most closely aligned with Industry 4.0 adoption; Baum Talmor and Kitada (2022) analyse the implications of automation for seafarers’ skills and career mobility; Jo, D’Agostini and Kang (2020) document how the prospect of autonomous ships is already reshaping maritime cadets’ expectations of the competencies they will need; and Theotokas, Lagoudis and Raftopoulou (2024) identify maritime human resource management rather than technology itself as the under researched bottleneck of the digital transition. Although much of this work concerns ship operation rather than ship construction, its central claim carries over directly to the yard: robotic welding, digital twins, alternative fuel systems and cyber physical production demand a workforce trained to standards that legacy vocational curricula do not yet reach. All four national cases examined below are responding, in different registers, to exactly this pressure.

2.5 Research gap

Three gaps motivate the present study. First, the collective skill formation literature has concentrated on economy wide regimes and on Europe; sector level studies of shipbuilding skill systems, especially

outside Europe, are scarce. Second, existing accounts of East Asian shipbuilding emphasise finance, subsidy and technology (Tan, 2020; OECD, 2021) far more than the training institutions on which production ultimately depends. Third, the emerging Indian policy literature on shipbuilding is largely descriptive of infrastructure and fiscal measures; a structured translation of international skill formation experience into India’s specific institutional setting and into a live state level case has not, to the author’s knowledge, been attempted. This paper addresses all three gaps.

3. Research Design and Methodology

The study employs a qualitative, multiple case comparative design (Yin, 2018). The unit of analysis is the national (or, for the EU, supranational) skill formation framework for shipbuilding and ship repair. Japan, South Korea and China were selected as the population of dominant producers jointly responsible for the overwhelming majority of world output (UNCTAD, 2024) whose institutional diversity permits a most similar systems comparison: similar competitive environments and technological frontiers, but sharply different institutional arrangements for producing skills. The European Union is included as a supplementary case of a coordination architecture rather than a production incumbent: its Pact for Skills partnership for the shipbuilding and maritime technology ecosystem represents the most explicit attempt anywhere to organise sectoral skill formation across firms, regions and states, and is therefore of direct design relevance to a federal polity such as India.

Evidence is drawn from documentary sources triangulated across four classes:

- a) Government and intergovernmental publications, including OECD peer reviews of the Japanese, Chinese and Korean shipbuilding industries (OECD, 2016, 2021, 2026), Japanese labour policy analyses (Yamauchi, 2025), and Government of India policy documents and Cabinet decisions (MoPSW, 2021, 2023; PIB, 2025);
- b) Industry association data, notably from CANSI, KOSHIPA, the Shipbuilders’ Association of Japan and SEA Europe;
- c) Peer reviewed academic literature identified through structured database searches; and
- d) Reputable trade and policy press (Lloyd’s List, Seatrade Maritime News, The Maritime Executive, MERICS, the Asia Pacific Foundation of Canada) used principally to establish recent quantitative developments.

Within each case, the analysis is organised around five dimensions derived from the collective skill formation framework:

- (1) the evolution and current state of government policy;
- (2) the roles of industry stakeholders and trade unions;

- (3) the institutional infrastructure of organisations, councils and training bodies;
- (4) flagship skill building programmes; and
- (5) available quantitative indicators. Cross case synthesis then proceeds thematically (Section 8) before the framework is applied to India (Sections 9-11).

Two methodological caveats should be stated at the outset. First, shipbuilding employment statistics are not published on a consistent, disaggregated basis in any of the four jurisdictions – a limitation noted explicitly by the OECD (2016, 2026) – so the quantitative tables presented below combine official series, association estimates and programme level counts, with sources indicated line by line. Second, as a documentary study the analysis cannot capture informal, shop floor dimensions of skill transmission; the conclusions are accordingly framed at the level of institutions and programmes rather than pedagogy. Passages in earlier working versions of this material that rested on sources which could not be independently verified have been re-attributed to verifiable equivalents or restated as industry estimates.

4. Japan: Preserving craft in an ageing industry

4.1 Government policy: evolution and current state

Japanese state involvement in shipbuilding skills reaches back to the Meiji era, when naval architecture education and structured on-the-job training were promoted as instruments of modernisation, and to early promotional statutes such as the Navigation and Shipbuilding Promotion Laws of 1896, which though aimed principally at subsidising output presupposed the deliberate cultivation of domestic know-how (Department of Scientific and Industrial Research [DSIR], 2019). For most of the post-war period, however, the state stood back from firm-level training. Under lifetime employment, the large shipbuilders trained internally, in the manner Koike (1988) and Dore and Sako (1998) describe for Japanese manufacturing generally, while government support flowed through subsidy and research channels rather than through public vocational programmes specific to the industry.

The settlement came under strain in the early 2000s, when close to half of the shipbuilding workforce was over fifty and a wave of retirements threatened the loss of accumulated expertise (OECD, 2016). The response of 2004 is the defining episode of modern Japanese policy in this field: the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), working with industry, established a Shipbuilding Skill Development Centre under the Cooperative Association of Japan Shipbuilders (CAJS) to codify expert knowledge, produce standardised training materials and equip a network of regional training centres in the principal shipbuilding districts: Innoshima, Imabari, Nagasaki, Oita and Yokohama

supported by a train-the-trainer programme to multiply reach (OECD, 2016; DSIR, 2019). These arrangements sat on the general legal foundation of the Human Resources Development Promotion Act, administered by the Ministry of Health, Labour and Welfare, under which accredited vocational training in any industry attracts public subsidy (OECD, 2016). Japan thus never created a shipbuilding-specific national training scheme; it grafted an industry-run solution onto generic labour policy instruments.

Since the late 2010s the emphasis has shifted from knowledge transfer to labour supply. Shipyards had long used the Technical Intern Training Programme (TITP), which from 1993 brought young workers from developing countries into Japanese industry for up to five years, nominally to acquire skills for use at home; by 2024 more than 470,000 technical interns were present across all industries, with shipbuilding a significant destination (Statista, 2024). Persistent criticism of the programme's training content and trainee welfare led to a decisive reform sequence: the Specified Skilled Worker (SSW) residence status of 2019 created a direct employment route for foreign tradespeople in shortage sectors, including a "Shipbuilding and Ship Machinery" field with an initial quota of roughly 13,000 workers, of whom about 7,514 were in place by late 2023; and legislation of 2024 abolished TITP outright, replacing it with an Employment for Skill Development Programme intended to combine genuine skill acquisition with stronger labour protections (Yamauchi, 2025). Under SSW category

- (i) Workers with certified trade skills and Japanese language competence may work for up to five years; the recently expanded category
- (ii) Permits indefinite stay with family accompaniment for more advanced roles (Yamauchi, 2025).

The most recent turn is strategic. At the end of 2024 the government elevated shipbuilding to a core economic security sector, and through 2025 MLIT developed a Shipbuilding Industry Revitalisation Roadmap, overseen by a dedicated revitalisation committee, targeting a doubling of domestic output to roughly 18 million gross tonnes by 2035 relative to 2024, supported by a staged ¥350 billion fund whose first ¥120 billion tranche provided in the FY2025 supplementary budget finances automation and labour-saving investment such as welding robots between 2026 and 2028 (Japan International Transport and Tourism Institute [JITTI], 2026; Splash 247, 2025). The workforce rationale is explicit: the sector's labour force has declined by more than 10,000 in five years to about 71,000 as of 2024, with approximately 40 per cent of workers over 55, and the roadmap accordingly pairs capacity targets with commitments to training centres, expanded foreign worker programmes and the promotion of shipbuilding careers to the young (Splash 247, 2025). Japan's current policy mix, in short, combines

subsidised domestic vocational training, an industry run centre network, carefully regulated labour immigration, and newly an economic security framing that licenses far larger public investment than the sector has seen in decades.

4.2 Industry stakeholders and trade unions

Industry bodies form the backbone of Japanese coordination. The Shipbuilders' Association of Japan (SAJ, founded 1947) represents the major builders, while CAJS (founded 1959) represents some 57 small and medium yards and administers the Skill Development Centre and its regional network (OECD, 2016; DSIR, 2019). The large firms Imabari Shipbuilding, Mitsubishi Heavy Industries, Japan Marine United and their peers continue to recruit from maritime high schools and technical colleges and to invest heavily in structured on the job training and mentoring, in keeping with the internal labour market tradition (Koike, 1988; Dore and Sako, 1998). The classification society ClassNK contributes a distinctive layer through its ClassNK Academy, offering technical courses on hull construction, machinery, electrical systems, welding and maintenance, and through lectures and seminars delivered in cooperation with the regional training centres (OECD, 2016). Equipment makers organised in the Japan Ship Machinery and Equipment Association, and shipowners through the Japanese Shipowners' Association, round out an ecosystem in which upskilling proceeds continuously even in the absence of direct state provision (OECD, 2016). It is worth noting that the industry itself, under the current SAJ chairmanship of Imabari's Yukito Higaki, has been the principal advocate of the 2025 expansion agenda, petitioning the ruling party for the financial support needed to double capacity (The Maritime Executive, 2025).

Japanese shipbuilding unions are enterprise based and operate within the country's cooperative industrial relations tradition. Their engagement with training has been supportive rather than directive: they back measures that secure the transfer of know how from retiring workers and stable career paths for entrants, without running programmes of their own. Worker representatives have nonetheless become more vocal as shortages have deepened. At the OECD's 2023 discussions on shipbuilding labour issues, union delegates including from Japan warned that under investment in a well trained core workforce and over reliance on subcontracting and migrant labour would undermine the industry's future, and pressed for equal training and conditions for all categories of worker (IndustriALL Global Union, 2023).

4.3 Institutional infrastructure

The institutional map has four layers. First, ministries and legislation: MHLW administers the Human Resources Development Promotion Act and the national Skill Test system of trade certifications;

MLIT's Maritime Bureau steers industry policy, the training centre initiative and now the Revitalisation Roadmap; and immigration statutes of 2019 and 2024 govern the SSW and successor programmes (OECD, 2016; Yamauchi, 2025; JITTI, 2026). Second, the association run training network: the five regional Training Centres for the Development of Shipbuilding Skills operate accredited multi month courses in welding, fitting, assembly and painting, certify instructors and upgrade mid career technicians; the Innoshima centre, originating in a 1999 joint public private effort in Hiroshima Prefecture, illustrates the model's local roots in "passing on shipbuilding techniques" to younger workers (OECD, 2016; Onomichi City, n.d.). Third, education: Osaka University's Department of Naval Architecture and Ocean Engineering and Kobe University's Faculty of Maritime Sciences supply the engineering and design cadre, while the Kōsen national colleges of technology and maritime high schools feed technician roles (OECD, 2016). Fourth, research bodies such as the National Maritime Research Institute and the Japan Ship Technology Research Association diffuse advanced expertise into the industry (OECD, 2016). The system is decentralised but coordinated: the state sets enabling policy and funding, associations organise delivery, and educational institutions supply the pipeline an arrangement that has kept what the industry calls its "excellent human resources" at the centre of Japanese competitiveness (DSIR, 2019).

4.4 Flagship programmes

Five programmes capture the Japanese approach. The regional training centres of 2004 05 delivered intensive two to three month courses for new entrants, built jointly by veteran shipbuilders and technical educators to preserve monozukuri craftsmanship, and distributed standardised on the job training materials to yards nationwide; conceived as a one time response to retirements, they became a permanent fixture with partial government subsidy (DSIR, 2019; OECD, 2016). The TITP (1993 2024) channelled foreign trainees, principally from Vietnam, China and the Philippines, into welding and painting trades, with yards developing native language on site training and partner country skill testing; its abolition in 2024 reflected the judgement that it had become a labour supply mechanism wearing a training costume (Yamauchi, 2025). The SSW programme (2019 present) replaces the training fiction with direct employment of certified tradespeople, supported by shipbuilding specific skill examinations administered in Japan and abroad through bodies such as JITCO and the official SSW examination system (Yamauchi, 2025; Government of Japan, n.d.). Local public private training schools, such as the Hiroshima initiative in which several builders and the prefectural government established a job training school guaranteeing employment at participating small yards, address acute regional shortages (Laursen, 2014). Finally, certification and mentorship instruments the

national Skill Test grades, WorldSkills participation, and the Monozukuri Meister programme dispatching senior artisans to train the young on site formalise and transmit tacit knowledge.

The pattern across all five is a dual approach: Cultivate and certify domestic skill on one hand, and strategically import certified foreign skill on the other, with execution led by industry within state set frames.

4.5 Workforce and training indicators

Table 1. Selected skill development indicators Japan (shipbuilding sector)

Indicator	Value and year	Source and notes
Workforce aged ≥50	≈50% (early 2000s)	OECD (2016); trigger for the 2004 skill transfer initiative
Total shipbuilding workforce	≈71,000 (2024)	Splash 247 (2025); decline of >10,000 over five years
Workforce aged over 55	≈40% (2024 25)	Splash 247 (2025); ageing remains the central constraint
Regional training centres	5 (by 2006)	Innoshima, Imabari, Nagasaki, Oita, Yokohama, under CAJS (OECD, 2016; DSIR, 2019)
Foreign technical interns (all industries)	>470,000 (2024)	Statista (2024)58 ; shipbuilding a significant placement sector until TITP's 2024 abolition
Specified Skilled Workers, shipbuilding field	7,514 (2023) of a ≈13,000 quota	Yamauchi (2025)
Global share of new orders	≈7 8% (2025)	The Maritime Executive (2025); down from ≈20% a decade earlier
Revitalisation target	18m GT output by 2035 (×2 vs 2024); ¥350bn staged fund	JITTI (2026); first ¥120bn tranche in FY2025 supplementary budget

Notes: Japan does not publish disaggregated shipbuilding labour statistics on a regular basis (OECD, 2016); figures combine official series, association data and programme counts. The picture is of a stable but ageing core workforce, now supplemented by regulated immigration and, from 2025, by an economic security investment programme in which automation is expected to substitute for scarce labour.

5. South Korea: Cyclical adjustment and the race for labour

5.1 Government policy: Evolution and current state

South Korea's ascent from the 1970s was inseparable from state directed skill creation. Under the heavy and chemical industrialisation drive of the Park Chung hee era, the government designated shipbuilding a strategic industry and built the technical high schools and polytechnics of the coastal belt Ulsan, Geoje, Busan that supplied the first generations of welders, fabricators and marine engineers, while sending cadres abroad for advanced training (Amsden, 1989 ; Tan, 2020). The Ministry of Labour (now Employment and Labour) embedded shipbuilding trades within a

national vocational qualification system, standardising certification across the industry, and from the 1980s university industry collaboration extended into curriculum design (Green, 1999; DSIR, 2019). The developmental state character of this construction finance, technology and skills marshalled together behind chosen industries is well documented (Amsden, 1989; Johnson, 1982; Tan, 2020), as is its post 1997 reconfiguration towards more market conforming, lifelong learning oriented training policy (Park, 2007) .

Cyclical adjustment has repeatedly tested the system. In the downturns of 1998 and the mid 2010s, when mass redundancies struck the big yards, policy pivoted to retraining and job conversion assistance for displaced workers, subsidising courses in other trades a reactive stance that cushioned adjustment but also let skills drain from the industry. The OECD's recent peer review records the consequence: the shipbuilding workforce peaked in 2014 15, declined continuously to 2021, and has since recovered mainly through subcontractor employment rather than engineers, skilled workers or management a compositional shift with obvious implications for skill depth (OECD,

2026).

The current phase is defined by a paradox: yards that shed labour through the 2010s found themselves, when orders for LNG carriers and other eco friendly tonnage surged from 2021, unable to man their docks. The Korea Offshore and Shipbuilding Association (KOSHIPA) forecast a shortage of 14,000 production workers by the end of 2023, and government responded on two fronts simultaneously (Asia Pacific Foundation of Canada, 2023). Domestically, the Ministry of Trade, Industry and Energy (MOTIE) and provincial authorities launched crash training: in 2023 a customised workforce development programme produced 1,793 domestic workers, of whom 1,716 were hired by small and medium builders, on a budget of ₩10.8 billion (Hellenic Shipping News, 2023); the 2024 round in South Gyeongsang Province enrolled 3,187 people (1,383 new production workers and 1,804 upskilling technicians); and the 2025 26 phase targets 2,000 trainees annually 1,000 new production workers and 1,000 technicians through a 320 hour, two month curriculum funded at ₩12.8 billion for 2025, with wage subsidies of up to ₩3.6 million for graduates hired by SMEs (Lloyd's List, 2025). Externally, visa policy was liberalised at speed: a shipbuilding specific E 9 (non professional) quota created in April 2023 issued 3,638 permits in its first half year, with 3,179 workers arriving, while the E 7 skilled worker route placed 5,209 workers in yards over the same period on KOSHIPA's recommendation of 6,282 candidates filling roughly 70 per cent of the forecast shortage within six months (Asia Pacific Foundation of Canada, 2023; Hellenic Shipping News, 2023). A pilot "training type E 7" visa added a pre employment pathway combining six months of theoretical, on site and Korean language instruction at shipbuilding technical training centres (Hellenic Shipping News, 2023).

Two subsequent developments qualify the picture. First, dependence on foreign labour institutionalised itself faster than anticipated: foreign workers numbered roughly 20,000 in 2024 about 16 per cent of all shipbuilding workers, and approximately 18 per cent at the big three builders, up from 5 per cent in 2021 with the OECD placing the industry wide foreign share at about 20 per cent (Korean Alliance for Responsible Shipbuilding and Human Rights, 2025; OECD, 2026). Second, policy is now consciously rebalancing: the special shipbuilding E 9 quota, cut from 5,000 (2023 and 2024) to 2,500 in 2025, is being abolished from the end of 2025 and absorbed into the general manufacturing allocation, alongside government commitments to improve working conditions so as to attract Korean workers back to the yards (iMarine, 2025; Migrant Times, 2025). The longer term strand of policy smart yard automation, digital design curricula developed with the Ministry of Education, and the listing of shipbuilding as a priority sector in national skilled talent planning aims to reduce the industry's raw labour intensity altogether.

5.2 Industry stakeholders and trade unions

The "big three" HD Hyundai Heavy Industries, Samsung Heavy Industries and Hanwha Ocean (formerly DSME) have historically borne primary responsibility for training their own workforces through in house academies and structured apprenticeships. Their contemporary programmes reach well beyond trade basics: HD Hyundai's global R&D centre at Seongnam doubles as an advanced training facility covering artificial intelligence, big data and smart yard technology, while Samsung Heavy Industries operates a digital transformation campus at Geoje for upskilling in autonomous ship and eco friendly vessel technologies (Lloyd's List, 2025). KOSHIPA aggregates the industry's labour market intelligence its 14,000 worker shortage forecast triggered the 2023 policy response coordinates collective visa requests to the Justice Ministry, and interfaces with the Human Resources Development Service of Korea (HRD Korea) on standards and certification (Asia Pacific Foundation of Canada, 2023). Because a large share of production is performed by subcontractors who cannot train from scratch, recent public programmes explicitly target SME needs, and the majors have been urged to open their training facilities and expertise to partner firms an ecosystem logic in which subcontractor skill gaps bottleneck the whole industry's output (Lloyd's List, 2025; OECD, 2026).

Trade unions enterprise unions at the major yards, affiliated to the Korean Metal Workers' Union have concentrated historically on employment security and wages, negotiating retraining assistance in downturns rather than running programmes. In the current expansion their attention has turned to the terms on which the new workforce is constituted. Union submissions to the 2023 IndustriALL survey alleged that some employers were using migrant workers to replace unionised core workers, and demanded identical training, safety instruction and pay for migrants, with some yards now employing foreign welders and fitters under the same collective agreements as Koreans at union insistence (IndustriALL Global Union, 2023). Union and public pressure has also pushed the companies to improve welfare, housing and catering for new hires domestic and foreign alike in an effort to reduce turnover and restore the attractiveness of shipyard careers (Asia Pacific Foundation of Canada, 2023). The gender dimension remains stark: women constitute only about 8 per cent of sectoral employment (OECD, 2026).

5.3 Institutional infrastructure

Institutionally, MOTIE leads industrial policy and now directly co funds training; the Ministry of Employment and Labour, through HRD Korea, manages vocational subsidies, the National Technical Qualification framework (covering trades such as ship structure outfitting and welding) and the Employment Permit System for E 9 workers; and the Ministry of Oceans

and Fisheries supports overseas pre departure training centres in Uzbekistan and Indonesia where recruits receive several months of basic shipbuilding skills and Korean language instruction before deployment, with KOICA support (Lloyd's List, 2025; Korea.net, 2023). Regional coordination runs through bodies such as the South Gyeongsang provincial government, co sponsor of the 2024-26 training initiative, and local workforce councils in yard cities that align polytechnic capacity with hiring forecasts (Lloyd's List, 2025). The education layer comprises Korea Maritime and Ocean University and Pusan National University's naval architecture programmes at the professional level, the Korea Polytechnics system for trades, and a fringe of private institutes often founded by retired shipyard experts offering ship design software and specialised welding courses financed through MOEL training subsidies. Research institutes such as KRISO diffuse frontier technology through seminars, and national skills competitions feed a visible culture of craft excellence.

5.4 Flagship programmes

Four programme families stand out. Company apprenticeships, exemplified by HD Hyundai's long running year long rotations through hull fabrication, assembly and outfitting under master craftsmen, remain the deep source of multi skilled career workers, often registered with government for

recognition and tax incentives. The state provincial fast track programmes (2023-26) constitute the emergency layer: two tracks basic production skills for new entrants, and advanced modules (including AI applications and green ship technology) for incumbents and technical students delivered partly in facilities contributed by the majors, with stipends, placement support and SME wage subsidies attached; officials justify the SME focus on the ground that "the shortage of shipyard workers is more serious at small companies than at large shipyards" (Lloyd's List, 2025). Foreign worker training and integration extends from the overseas pre departure centres through on site instruction with translated materials, buddy systems pairing seasoned Korean workers with migrant cohorts, and the opening of national qualification examinations in foreign languages so that migrants can earn Korean recognised credentials (Lloyd's List, 2025; Hellenic Shipping News, 2023). Finally, smart yard and high technology upskilling VR welding simulators shared with vocational schools, subsidised CAD/CAM, robotics programming and production analytics workshops under the smart factory agenda aims the existing workforce at the technological frontier (Lloyd's List, 2025). Recruitment campaigns at technical high schools and military bases, trial "bootcamps" and skills competitions complete the pipeline building repertoire.

5.5 Workforce and training indicators

Table 2. Selected skill development indicators South Korea (shipbuilding sector)

Indicator	Value and year	Source and notes
Workforce trajectory	Peak 2014 15; decline to 2021; growth since, led by subcontractors	OECD (2026); first annual workforce increase in nine years recorded in 2023 (Hellenic Shipping News, 2025)
Forecast labour shortage	14,000 production workers (end 2023)	KOSHIPA forecast (Asia Pacific Foundation of Canada, 2023); ≈70% filled by mid 2023
Domestic crash training output	1,793 (2023); 3,187 (2024); 2,000/yr target 2025-26	Hellenic Shipping News (2023); Lloyd's List (2025)
Training budget	₩10.8bn (2023); ₩12.8bn (2025)	Hellenic Shipping News (2023); Lloyd's List (2025); wage subsidy up to ₩3.6m per SME hire
Foreign workers recruited, H1 2023	3,179 (E 9) + 5,209 (E 7) placed	Asia Pacific Foundation of Canada (2023); Hellenic Shipping News (2023)
Foreign share of workforce	≈20,000 workers ≈ 16% (2024); ≈18% at big three; ≈20% industry wide	KARSH (2025); OECD (2026); up from ≈5% (4,640) at the big three in 2021
E 9 shipbuilding quota	5,000 (2023, 2024) → 2,500 (2025) → abolished from	iMarine (2025); Migrant Times (2025); absorbed into general manufacturing allocation

	2026	
Women in sector employment	≈8% (2019 23)	OECD (2026)

Notes: Korea publishes no single “shipbuilding employment” series; KOSHIPA member data and Ministry of Employment and Labour statistics serve as proxies (OECD, 2026). The indicators trace an exceptionally rapid external adjustment a roughly fifteen fold expansion of foreign worker inflows within two years now being deliberately tapered as policy pivots back towards domestic attraction, automation and higher skill composition.

6. China: Mass mobilisation and the turn to quality

6.1 Government policy: Evolution and current state

Chinese shipbuilding grew from a modest, largely military oriented base in the planned economy era when training ran through state shipyard schools and master apprentice transmission inside state owned enterprises into the world’s largest producer, and skill policy has tracked that trajectory deliberately. From the 1980s, reform era policy sent engineers and workers abroad for training, imported designs and management practice, and built the specialist university base Dalian University of Technology, Harbin Engineering University, Shanghai Jiao Tong University alongside a widening tier of polytechnics with shipbuilding majors (OECD, 2021; Moll Murata, 2018, for the deeper historical lineage of state shipyard organisation). Successive five year plans made the human resource dimension explicit: the 2006 Medium and Long Term Plan for the shipbuilding industry, which declared the sector a pillar industry, tasked state organs with attracting highly skilled talent and promoting training centres; the State Council’s 2013 restructuring notice tied upgrading to innovation capability; and Made in China 2025 identified marine engineering and high technology ships as priority fields, with implementation plans committing increased training investment in digital design and robotics (OECD, 2021).

The current phase treats human capital, in the leadership’s own framing, as the bottleneck to industrial upgrading. A joint directive of the Party Central Committee and State Council in late 2021 called for a system “conducive to the training of highly skilled workers”, set the goal of raising skilled workers to roughly 30 per cent of the workforce by 2025 (from the mid twenties), with one third of those “highly skilled”, mandated stronger industry vocational school cooperation, and made talent cultivation an evaluation criterion for state owned enterprise management (MERICS, 2022). For shipbuilding the stakes are concrete: the 2019 consolidation of the two state groups into the China State Shipbuilding Corporation (CSSC) created an

employer of more than 310,000 people whose internal training apparatus inherited universities, vocational schools and yard training centres amounts to a small education system in its own right, now being aligned through unified standards and rotation programmes (OECD, 2021). Unlike Japan and Korea, China does not import shipbuilding labour; its challenge is converting an abundant domestic labour supply into the higher skill composition demanded by LNG carriers, cruise ships and smart yard production a quantity to quality transition pursued through vocational education reform, modern apprenticeship pilots on quasi German lines, and international benchmarking with Germany and Singapore (MERICS, 2022; OECD, 2021).

The results, whatever their institutional interpretation, are visible in the market data. CANSI reports that Chinese yards completed 48.18 million deadweight tonnes in 2024 55.7 per cent of global output took 113.05 million dwt of new orders (74.1 per cent of the world total, and 78.5 per cent of alternative fuel vessel orders), and closed the year with an order book of 208.72 million dwt, 63.1 per cent of the global backlog (Seatrade Maritime News, 2025). Analysts note that United States trade measures introduced from 2025 have injected volatility into the order share without, so far, displacing the underlying capability (CSIS, 2025). The delivery in 2023 of China’s first domestically built large cruise ship a vessel class demanding wholly new competencies in interior outfitting and hotel systems is perhaps the clearest single demonstration that the skill base has broadened as well as deepened.

6.2 Industry stakeholders and trade unions

The line between government and industry blurs under state ownership. CSSC subsidiaries Dalian, Jiangnan, Hudong Zhonghua and their peers run extensive in house programmes, typically recruiting school leavers into company training centres for one to two year courses mixing classroom theory with workshop practice before production deployment; the largest yards train thousands annually. The China Association of the National Shipbuilding Industry (CANSI) functions as the semi official coordinating body: it collects the sector’s statistics, feeds skill gap analysis into ministerial planning (as it did for the Made in China 2025 talent plans), and organises skill competitions and certification drives with bodies such as the Chinese Welding Society. Private builders Yangzijiang, New Times and others draw on the same labour pool and the graduates of the state built vocational system, competing for skilled workers with pay and promotion, while the informal norm of “teachers bringing apprentices” propagates skills

across ownership boundaries.

Trade unions operate within the All China Federation of Trade Unions (ACFTU) structure, working alongside management and Party committees rather than bargaining adversarially. Their contribution to skills is motivational and supplementary: organising evening classes and examination preparation sessions, co sponsoring the welding and assembly competitions that confer titles such as “Technical Pacesetter”, and administering the Model Worker honours system through which acclaimed craftsmen are elevated. The officially encouraged “Master Studios” workshops in which a decorated senior welder or fitter formally trains cohorts of apprentices over several years institutionalise mentorship at scale, with more than a hundred such studios reported in shipbuilding enterprises by 2020 (ACFTU reporting; MERICS, 2022, on the broader status raising agenda). ACFTU programmes have also linked poverty alleviation skilling in inland provinces to coastal industrial employment, including shipbuilding (China Labour Bulletin, 2021). Unions do not contest automation or workforce restructuring; in downturns, local unions have instead helped coordinate retraining with labour bureaux.

6.3 Institutional infrastructure

Five institutional blocks carry the system. The Ministry of Industry and Information Technology owns sectoral planning and coordinates with the Ministry of Education on aligning enrolment with identified shortages welders and ship designers prominently among them and funds training infrastructure such as simulation laboratories. The Ministry of Human Resources and Social Security sets Occupational Skill Standards for shipbuilding trades, runs the National Vocational Qualification ladder from junior worker to senior technician, and administers the modern apprenticeship pilots through local human resource bureaux. The vocational education system concentrates in the shipbuilding provinces: Bohai Shipbuilding Vocational College in Liaoning formed in 2001 under the then China State Shipbuilding Corporation expressly to “cultivate high quality skills in the shipbuilding industry”, now enrolling over 8,200 full time students and designated a national demonstration college and training base exemplifies a network that also includes the Wuhan Institute of Shipbuilding Technology, Jiangsu Maritime Institute and dozens of peers, with a national teaching steering committee standardising curricula (Bohai Shipbuilding Vocational College, 2017). Universities and research institutes Shanghai Jiao Tong, Harbin Engineering, and CSSC’s integrated research arms produce and continuously develop the engineering

elite, often combining graduate study with institute employment. Finally, funding and standards bodies: the NDRC and provincial governments finance enterprise staff training funds, restructuring subsidies have supported retraining during capacity reduction campaigns (OECD, 2021), and larger yards pursue international certification ASME welding qualifications, classification society training accreditation for cryogenic LNG work to anchor quality at global standards.

6.4 Flagship programmes

Six programme families define the Chinese repertoire. The National Master Craftsman programme (from 2020) identifies veteran welders, pipe fitters and hull assemblers as “Master Craftsmen of China”, funds their studios and apprentice cohorts, and documents their techniques simultaneously preserving tacit knowledge and raising the social standing of vocational work against a stigma the authorities openly acknowledge (MERICS, 2022). Vocational education reform (2019 onwards) rewrote the vocational education law, drew shipyards into college governance and curriculum design, and scaled modern apprenticeship pilots in Jiangsu, cohorts jointly enrolled by a shipyard and a technical college alternate between classroom and yard and graduate into guaranteed employment with some institutions designated dual system pilot schools on the German model. National skills training bases at flagship colleges and yards (Bohai for ship power plants among them) receive equipment funding and host instructor training and competitions, feeding a ladder of provincial and national contests in which medallists can be fast tracked to senior technician grades (Bohai Shipbuilding Vocational College, 2017). New technology upskilling runs through CSSC’s internal talent programmes intensive courses for young engineers on digital twin and advanced maritime systems, historically including overseas placements and through partnerships equipping crane operators with simulators and inspectors with augmented reality tools. Inland to coast labour pipelines see provinces such as Henan and Sichuan run basic welding and metalwork training coordinated with coastal employment agencies, folding rural employment policy into industrial labour supply (China Labour Bulletin, 2021). Finally, international certification drives qualify workers to foreign standards for specialised segments. The cumulative effect is a mass scale, layered effort addressing every stratum of the workforce, whose principal acknowledged weaknesses are the persistent stigma attached to vocational routes and turnover that dulls employer training incentives (MERICS, 2022).

6.5 Workforce and training indicators

Table 3. Selected skill development indicators China (shipbuilding sector)

Indicator	Value and year	Source and notes
CSSC employment (post merger)	>310,000 (2019 20)	OECD (2021); total sector employment, including smaller yards and the supply chain, plausibly exceeds half a million
Skilled worker share, economy wide	≈26% (2021); 30% target by 2025, one third “highly skilled”	MERICS (2022)
Specialist vocational colleges	50+ maritime/shipbuilding programmes; e.g. Bohai College, 8,200+ students	Bohai Shipbuilding Vocational College (2017); Ministry of Education data
Global market position (2024)	55.7% of completions; 74.1% of new orders; 63.1% of order book; 78.5% of alternative fuel orders	CANSI data (Seatrade Maritime News, 2025)
Completions (2024)	48.18m dwt (+13.8% year on year)	CANSI data (Seatrade Maritime News, 2025)
Master craftsman studios	100+ in shipbuilding enterprises (2020)	ACFTU reporting; institutionalised mentorship at scale
Capacity reduction retraining support	CNY 2bn rewards/subsidies (2019) across key industries	OECD (2021); partly available for retraining affected shipbuilding workers

Notes: China releases no consolidated shipbuilding employment series; the table combines OECD analysis, association data and institutional records. The strategic problem is not headcount but composition lifting a vast workforce onto a higher skill plateau fast enough to hold newly won positions in cruise, LNG and smart yard segments.

with niche segments recovering only from 2023 24; scarce sector specific training and slow curriculum renewal against the “twin transition” to green and digital production; and a gender balance stuck near 20 per cent female participation (SEA Europe, 2022). What distinguishes the European response is neither subsidy nor migration but coordination.

7. The European Union: Coordinating Skills Across a Fragmented Industry

7.1 Context and rationale

Europe’s shipbuilding and maritime technology sector over 300 shipyards and some 22,000 equipment and service providers, employing around 576,000 workers directly and a further 500,000 indirectly, with an annual production value of roughly €125 billion competes not on volume but on complex, high value civilian and naval vessels (SEA Europe, 2022). Its workforce profile is distinctive: about 60 per cent from vocational and technical backgrounds and 35 per cent with engineering or higher qualifications, spread across member states with high intra EU mobility. The sector’s skill pressures mirror, in concentrated form, those of the Asian incumbents: an estimated 40 per cent of the workforce due to retire within a decade; an 80 per cent collapse in new orders after COVID 19,

7.2 The Shipbuilding Pact for Skills

In March 2022, under the European Commission’s Pact for Skills, the industry launched a large scale skills partnership for the shipbuilding and maritime technology ecosystem, convening more than sixteen national industry associations, the major builders (Fincantieri, Navantia, Damen, Meyer Turku among them), regional maritime clusters, education providers and trade unions, anchored institutionally in the European Social Dialogue Committee for shipbuilding and supported by projects such as USWE (Upskilling Shipbuilding Workforce in Europe) (SEA Europe, 2022; European Commission, 2022). Its quantified commitments are unusually specific: upskilling or reskilling 7 per cent of the workforce annually for five years approximately 201,600 workers in robotics, additive manufacturing, IoT, AR/VR, big data, cybersecurity and green propulsion;

recruiting 234,000 new workers by 2030 with explicit emphasis on gender balance and youth; and mobilising €1 billion in public private investment (SEA Europe, 2022). The strategic horizon aligns with the European Green Deal and the Zero Emission Waterborne Transport mission: halved navigation emissions and zero emission short sea vessels by 2030, and full deep sea decarbonisation by 2050.

Implementation proceeds through four pillars. Skills intelligence builds a sector wide database of workforce demographics and projected needs, using labour market forecasting to identify emerging occupations before designing training acting only on evidence of what is actually missing. Upskilling and reskilling develops EU wide micro credentials, short certification programmes and cross border MOOCs for green, digital and transversal skills, with financial incentives for inter company and SME training ecosystems and structured knowledge transfer from large builders to smaller firms. Attraction and retention runs pan European awareness campaigns, school engagement and youth contests, expands apprenticeships through the European Alliance for Apprenticeships, and targets under represented groups, particularly women. Education and training

reform pursues a common European maritime qualifications framework so that skills certified in one member state are recognised in all, a network of maritime vocational centres of excellence built with technical universities and industry, and new Master's and specialisation programmes integrated with emerging technologies (SEA Europe, 2022).

7.3 Relevance as a design template

For a large federal polity, the Pact's significance lies less in its budget than in its architecture: diagnose before training; standardise qualifications across jurisdictions so that labour is mobile and credentials portable; bind large firms, SMEs, educators, unions and regions into a single governance forum with quantified, published targets; and treat attraction making the industry a career of choice as a workstream of equal standing with training itself. Each of these design principles is examined against the Indian case in Sections 9 11.

8. Cross Case Comparative Analysis

Table 4 condenses the four cases along the five analytical dimensions; the discussion that follows draws out the systematic contrasts.

Table 4. Comparative overview of skill building frameworks in shipbuilding

Dimension	Japan	South Korea	China
Government role	Facilitator: subsidies, immigration policy, targeted interventions at demographic crisis points (2004 centres); since 2025, economic security investor (¥350bn roadmap)	Planner and responsive funder: built vocational base in industrialisation; crash training and visa liberalisation in booms, retraining in busts; ₩12.8bn programme (2025)	Central strategist: five year plans embed skill targets; state owns dominant employer (CSSC); national 30% skilled worker goal (2025); SOE managers evaluated on talent cultivation
Industry stakeholders	SAJ and CAJS coordinate; CAJS runs the Skill Development Centre and five regional centres; firms train internally; ClassNK Academy adds niche layers	Big three run advanced in house academies (AI, smart yard, eco ship); KOSHIPA quantifies shortages, brokers visas and standards; SMEs depend on public and major firm support	CSSC yards operate company schools training thousands yearly; CANSI sets standards and statistics; private yards draw on the state built pipeline

Dimension	Japan	South Korea	China
Trade unions	Enterprise unions, cooperative; support know how transfer; press for training investment and equal treatment (IndustriALL, 2023)	Enterprise unions under KMWU; historically job security; now demand equal training, pay and conditions for migrants, some under common collective agreements	ACFTU branches aligned with management; run competitions, honours (Model Worker) and Master Studios; smooth adjustment rather than contest it
Key institutions	MHLW Skill Tests; MLIT Maritime Bureau; five CAJS centres; Osaka and Kobe universities; Kōsen colleges; NMRI/JSTRA	MOTIE, MOEL/HRD Korea, MOF; National Technical Qualifications; KMOU and Pusan NU; Korea Polytechnics; overseas pre departure centres (Uzbekistan, Indonesia)	MIIT and MOHRSS; NVQ ladder; 50+ specialist colleges (Bohai, Wuhan, Jiangsu); elite universities (SJTU, Harbin); national training bases; provincial training funds
Flagship programmes	Regional skill centres (2004); TITP (1993 2024) → SSW (2019) → ESDP (2024); Monozukuri Meister mentorship; local training schools	320 hour fast track training, 2,000/yr (2024 26); E 9/E 7 expansion then taper; training type E 7 visa; company apprenticeships (Marine Meister); smart yard upskilling	Master Craftsman studios; modern apprenticeship pilots; vocational law reform (2019); Made in China 2025 technology training; inland to coast pipelines; international certification drives
Quantitative snapshot	≈71,000 workers (2024); ≈40% over 55; 7,514 SSW workers (2023); ≈7 8% of new orders; ×2 output target by 2035	Workforce recovering since 2021, subcontractor led; ≈16 20% foreign (2024); 14,000 shortage forecast ≈70% filled in six months (2023); ≈8% women	>310,000 in CSSC alone; 55.7% of world completions and 74.1% of new orders (2024); 26→30% skilled worker target; 100+ master studios

Source: author's synthesis of OECD (2016, 2021, 2026), Yamauchi (2025), JITTI (2026), Lloyd's List (2025), Asia Pacific Foundation of Canada (2023), MERICS (2022), Seatrade Maritime News (2025), IndustriALL Global Union (2023) and case sources cited in text. The EU case (Section 7) is omitted from the table as a coordination architecture rather than a production incumbent; its defining features are multi stakeholder governance, quantified targets (201,600 reskilled; 234,000 recruited; €1bn mobilised) and cross border qualification portability (SEA Europe,

2022).

8.1 Demographics and labour supply

The deepest cleavage runs along demographic lines. Japan and South Korea operate under absolute constraint: shrinking, ageing native workforces and youth aversion to "3K" work kitsui, kitanai, kiken: hard, dirty, dangerous have forced both to institutionalise foreign labour, Japan through the deliberate, certification based SSW architecture (Yamauchi, 2025) and Korea through an emergency

visa expansion so rapid that foreign workers reached roughly a fifth of the industry within three years (OECD, 2026). China faces the opposite problem: labour is abundant, but converting quantity into the skill composition demanded by high value segments requires the wholesale renovation of vocational education and of the status of vocational work (MERICS, 2022). The Indian reader should note the asymmetry: India's demographic endowment resembles China's, but its institutional starting point fragmented training capacity, weak sectoral standards more closely resembles the gaps the East Asians spent decades closing.

8.2 Governance of training

Three governance modes emerge, corresponding broadly to the categories of the comparative capitalism literature (Hall and Soskice, 2001; Busemeyer and Trampusch, 2012). Japan exhibits coordinated self governance: firms and associations carry the training load, with the state enabling through subsidy, accreditation and latterly immigration and investment policy. South Korea exhibits state responsive coordination: companies train in normal times, but the state intervenes forcefully and quickly at cyclical extremes, in both directions. China exhibits state directed mobilisation: planning targets, SOE ownership and ministry run qualification systems align the whole apparatus behind national goals. The EU adds a fourth mode negotiated multi level coordination in which no single actor commands, and quantified pacts substitute for hierarchy. All four are public private in practice; they differ in where initiative and accountability sit.

8.3 Trade unions

Union roles vary with industrial relations regimes but converge on one point: everywhere, organised labour has moved from defending jobs towards defending the skill base pressing for training investment, for equal treatment of migrant and subcontracted workers so that two tier workforces do not hollow out standards, and for conditions that make the industry attractive to entrants (IndustriALL Global Union, 2023). In Japan and Korea this takes the form of advocacy and bargaining; in China, of state aligned mobilisation through competitions, honours and master studios. The lesson for skill system designers is that unions, where engaged, function as guarantors of training quality and of knowledge sharing on the shop floor.

8.4 Institutions and programme outcomes

Each country built institutions matched to its binding constraint, and the outcomes are legible. Japan's 2004 centres solved a knowledge transfer problem stabilising skill levels through the retirement wave though they could not, by themselves, arrest market share decline driven by price competition; the 2025 roadmap implicitly concedes that skills policy must

now be joined to capacity investment and automation (JITTI, 2026). Korea's emergency programmes demonstrably averted a production bottleneck: roughly 70 per cent of the forecast 14,000 worker shortage was filled within six months, allowing yards to hold delivery schedules through the order boom (Asia Pacific Foundation of Canada, 2023) a case study in policy agility, now entering a consolidation phase as the special visa quota is retired. China's decades of institutional accumulation underwrote both the volume dominance recorded in the 2024 data and the entry into cruise and LNG segments once thought beyond it, with retention and vocational stigma the acknowledged residual frictions (MERICS, 2022; Seatrade Maritime News, 2025). The EU's Pact is younger and its outcomes largely prospective, but its diagnostic first, standards based design is precisely what the fragmented Indian ecosystem lacks. The overarching conclusion is that there is no single transferable model but there is a transferable logic: identify the binding constraint precisely, build the minimum institution that relaxes it, quantify the targets, and revise as the constraint moves.

9. India's Shipbuilding skill ecosystem: Position, Policy and Gaps

9.1 Industry position and the new policy architecture

India enters this comparison from a position of marked asymmetry between endowment and output. The country possesses a coastline of over 11,000 kilometres on the revised national assessment, some 55 shipyards recognised by the Ministry of Ports, Shipping and Waterways, established public builders Cochin Shipyard, Mazagon Dock, Garden Reach Shipbuilders and Engineers, Hindustan Shipyard, Goa Shipyard with credible defence and specialist portfolios, a large cost competitive labour pool, and a maritime education infrastructure of universities, polytechnics and industrial training institutes (MoPSW, 2021; Garg, 2020). Yet its share of global commercial shipbuilding output remains below one per cent, a gap Garg (2020) attributes, in a direct comparison with China, to the absence of precisely the sustained state sponsorship, demand aggregation and workforce scale institutions that carried China from a comparable starting point in the 1990s to the market position recorded in Table 3.

The policy response has now been assembled with unusual completeness. The Maritime India Vision 2030 targets a place among the top ten shipbuilding nations by 2030; the Maritime Amrit Kaal Vision 2047, released in October 2023, raises the ambition to the top five by 2047, with substantial additional shipbuilding capacity (MoPSW, 2021, 2023). On 24 September 2025 the Union Cabinet approved a comprehensive package of ₹69,725 crore structured on four pillars financing, capacity expansion, policy reform and skill development comprising: the Shipbuilding Financial Assistance Scheme 2.0 (₹24,736 crore, extended to March 2036, including a

₹4,001 crore shipbreaking credit note) to offset the cost disadvantage of Indian yards; a Maritime Development Fund of ₹25,000 crore (a ₹20,000 crore Maritime Investment Fund with 49 per cent Government of India participation, and a ₹5,000 crore Interest Incentivisation Fund) to supply long term capital; and the Shipbuilding Development Scheme (₹19,989 crore) targeting an annual capacity of 4.5 million gross tonnes through greenfield clusters and

brownfield expansion, overseen by a new National Shipbuilding Mission (PIB, 2025). In principle approval has been accorded to three greenfield clusters, in Andhra Pradesh, Gujarat and Tamil Nadu, and infrastructure status has been notified for Indian flagged commercial vessels of 10,000 gross tonnes and above 1,500 gross tonnes when built in India easing access to long tenor finance (PIB, 2025). Table 5 situates India against the incumbents.

Table 5. The global shipbuilding market and India's position, 2024 25

Economy	Approximate market position	Workforce and skills posture
China	55.7% of completions; 74.1% of new orders; 63.1% of order book (2024)	>310,000 in CSSC alone; mass vocational system pivoting from quantity to quality (Sections 6.1 6.5)
South Korea	Second producer; ≈26% of order book by some measures	Workforce recovering, ≈16 20% foreign; crash training plus visa policy now tapering (Sections 5.1 5.5)
Japan	Third producer; ≈7 8% of new orders (2025)	≈71,000 workers, ≈40% over 55; ¥350bn revitalisation roadmap pairing automation with training (Sections 4.1 4.5)
European Union	Leader in complex/high value segments; €125bn production value	≈576,000 direct workers; Pact for Skills coordination architecture (Section 7)
India	<1% of global output; ≈20th 22nd by most rankings	₹69,725 crore package (2025); targets: top ten by 2030, top five by 2047; skill ecosystem examined in Sections 9.2 9.4

Sources: CANSI data reported in Seatrade Maritime News (2025); The Maritime Executive (2024, 2025); SEA Europe (2022); UNCTAD (2024); PIB (2025); MoPSW (2021, 2023). Shares are metric specific (dwt or CGT as reported) and are not additive across columns.

A structured appraisal of the industry's starting position is given in Table 6, consolidating the SWOT analysis developed for this study from ministry documentation, parliamentary and industry reporting.

Table 6. SWOT analysis of the Indian shipbuilding and ship repair sector

Strengths	Weaknesses
Strategic coastline (>11,000 km, revised assessment) with numerous ports suited to building and repair; rising domestic demand from maritime trade, naval procurement and coastal shipping; 55 shipyards including established builders (CSL, GRSE, MDL, HSL, GSL); strong policy backing (MIV 2030, MAKV 2047, Sagarmala, Make in India, the 2025 package); cost competitive labour; an existing base of maritime universities, polytechnics and ITIs whose programmes can be adapted to yard requirements.	Import and taxation regimes historically unfavourable to domestic building and repair; costly finance and limited access to long tenor capital (now addressed in part by the MDF and infrastructure status); insufficient continuously practised skills at most yards, with competency standards under developed or insufficiently specific; a thin domestic supply chain with 60 70% import content in vessel cost by industry estimates; thin and unpredictable commercial order books; predominantly small and mid sized yard capacity; slow technology upgrading outside defence work; uneven quality assurance and dated infrastructure at smaller yards.
Opportunities	Threats
Strong demand for tugs, barges and support vessels (mining, oil and gas); a large retrofit and refurbishment market across cargo, commercial and fishing fleets; net zero and alternative fuel	Foreign suppliers able to compete on quality, delivery and price for the same demand; price competition from China, Bangladesh and other regional builders; ease of importing second hand

Strengths	Weaknesses
regulation creating green shipping demand in which no incumbent position is settled; explicit government acknowledgement of the sector's importance with funded capacity, financing and skilling schemes; an under served domestic ship repair market; greenfield clusters offering the chance to design skill systems into infrastructure from the outset.	tonnage weakening domestic order incentives; proximity of ship owners and managers to Far Eastern incumbents; emigration of well trained Indian workers to higher paying foreign yards, converting Indian training investment into competitors' capability.

Source: author's consolidation from MoPSW (2021, 2023), PIB (2025), Garg (2020) and industry reporting. Passages resting on unverifiable secondary attributions in earlier drafts have been restated as industry estimates.

9.2 Occupational profile and skill gaps

Indian shipbuilding and ship repair demand professionals across naval architecture, engineering management, production supervision and technology adaptation, with competencies notionally governed by the National Occupational Standards framed under the National Skill Development Corporation and aligned, where applicable, with International Maritime Organization standards (MoPSW, 2022; NSDC framework documentation). Industry consultations and the skill studies conducted under the Sagarmala programme converge on a consistent set of shortage occupations, summarised in Table 7 and elaborated below.

In managerial roles, project managers and production engineers typically qualified in naval architecture or marine engineering coordinate planning, procurement and production across large multi trade teams; globally competitive capability in advanced planning and procurement remains scarce, with competence acquired predominantly through long practical experience rather than structured programmes, indicating the need for formal training aligned with international standards. Health, safety

and environment management, though essential to yard operations, lacks dedicated maritime specific programmes in Indian universities and polytechnics, being subsumed within general occupational safety education. In production roles, senior design engineers critical to vessel design, prototype testing and technology investment decisions are drawn largely from workplace trained cohorts, with few holding specialised credentials; marine estimators, whose cost analyses and bids demand integrated knowledge of design, materials and naval engineering, have almost no structured educational pathway; and dock masters, who manage marine traffic and emergency response at yards and marinas, are trained today almost entirely on the job, suggesting clear scope for formalised vocational routes. In technology adaptation roles, the industry's growing use of IoT and artificial intelligence for vessel efficiency, predictive maintenance and navigation safety has outrun the supply of maritime specific IoT/AI competence, while automation electricians responsible for installing, maintaining and upgrading shipboard electrical and control systems face a formal training infrastructure widely acknowledged as insufficient against international maritime standards. These gaps mirror, almost point for point, the competency requirements the Maritime 4.0 literature identifies as decisive for yard competitiveness (Sullivan, Arias Nava and Desai, 2021; Theotokas, Lagoudis and Raftopoulou, 2024).

Table 7. Principal skill gaps identified in Indian shipbuilding

Skill area	Gap identified
Naval architecture and marine engineering	Limited availability of highly qualified personnel relative to projected cluster demand
Digital and automation technologies	Insufficient proficiency in digital shipyard operations, robotics and advanced manufacturing
Project management and quality assurance	Inadequate structured training in international standards and complex project delivery
Sustainable and green shipbuilding	Scarce specialised knowledge in decarbonised, environmentally compliant construction and retrofit
Specialist trades and estimation	No formal pathways for marine estimators and dock masters; thin maritime specific HSE

Skill area	Gap identified
	provision

Source: author's synthesis of Sagarmala skill gap studies, MoPSW documentation and industry consultation; framing corroborated by the Maritime

9.3 The existing skilling ecosystem

India's response infrastructure, while fragmented, is more substantial than commonly credited. Four national programmes anchor it. The Sagarmala programme has conducted skill gap studies in coastal districts, implements training for coastal communities across shipbuilding, logistics and port operations on the order of 10,000 trainees annually across coastal states and allocated approximately ₹100 crore to coastal community skill development (MoPSW, Sagarmala documentation). The Maritime India Vision 2030 and Maritime Amrit Kaal Vision 2047 embed skilling within capacity targets, proposing mega shipbuilding parks and emphasising decarbonisation, hydrogen adoption and carbon neutral ports commitments now capitalised through the 2025 package, whose fourth pillar is explicitly skill development (MoPSW, 2021, 2023; PIB, 2025). A 2020 memorandum between the Ministries of Shipping and Skill Development standardises training in ship repair, dredging and offshore logistics, mobilising industrial training institutes and corporate social responsibility funds in coastal districts. And the National Skill Development Mission and Pradhan Mantri Kaushal Vikas Yojana carry shipbuilding relevant trades welding and fabrication, electricals and instrumentation, marine engine mechanics, CAD/CAM and CNC operation through the Directorate General of Training, the ITI network and the Advanced Training Institutes at Mumbai and Chennai.

Two institutions warrant particular attention. The Centre of Excellence in Maritime and Shipbuilding (CEMS), established by the Ministry of Ports, Shipping and Waterways with the Indian Register of Shipping and Siemens, operates from Mumbai and Visakhapatnam as the country's flagship Industry 4.0 aligned maritime training institution. Its mandate spans capacity building for the Navy, Coast Guard, shipyards and port authorities in ship design and marine engineering systems, integrated platform management, machinery controls and embedded systems, non destructive testing, advanced welding and automation, pneumatics, hydraulics, mechatronics and electrical drives, and maritime supply chain and port logistics alongside management modules in project and product lifecycle management and cybersecurity; certificate and diploma courses built around the nine pillars of Industry 4.0 with dedicated laboratories; applied research, including LoRaWAN based maritime IoT communication; and continuous stakeholder engagement to keep curricula current. Institutional

4.0 skills literature cited in text.

reporting credits CEMS with a design throughput exceeding 10,000 trainees annually and a cumulative total of more than 20,000 professionals trained, with attendant contributions to operational safety and industry competitiveness (CEMS/IRS institutional reporting).

The Indian Maritime University (IMU), established in 2008 under the Ministry of Ports, Shipping and Waterways with headquarters in Chennai and six campuses across the major port cities, is the apex academic institution of the ecosystem. Its shipbuilding aligned portfolio includes the B.Tech in Naval Architecture and Ocean Engineering, B.Sc. in Ship Building and Repair, B.Tech in Marine Engineering and M.Tech in Naval Architecture and Ocean Engineering, developing capabilities in ship design and structural analysis, yard operations and production technologies, hydrodynamics, propulsion and stability, and marine machinery and control; managerial programmes (MBA in Port and Shipping Management, and in International Transportation and Logistics) complete the multidisciplinary pipeline. Graduates are recruited by Hindustan Shipyard, Cochin Shipyard, L&T Shipbuilding and others; the Visakhapatnam campus, evolved from the National Ship Design and Research Centre, functions as a research hub for naval architecture, with applied work spanning green ship design, digital shipbuilding, inland vessel design and dredging engineering, and collaboration agreements with Hindustan Shipyard (2024) and international universities. IMU reports an annual enrolment of some 6,000 7,000 students across its campuses and affiliated institutes, advanced full mission simulator training, and curriculum reform under the National Education Policy 2020, including micro credential programmes (IMU institutional reporting).

Around these anchors sit company training institutions Cochin Shipyard's skill development institute, Mazagon Dock's training school, L&T's industrial skill training at Kattupalli delivering competency based programmes under the National Skill Qualification Framework; certification and specialist providers, notably the Indian Register of Shipping (marine survey, quality assurance, advanced welding and pipe fitting, maritime project management) and private centres such as SkillSonics; international collaboration, exemplified by Indo Japanese technical training initiatives with JICA; and the broader university and polytechnic base IITs, Cochin University of Science and Technology, NITs and upwards of a hundred institutions offering marine engineering, naval architecture and ship

design programmes, accredited through the NBA and NAAC several of which, including IIT Madras, run customised short courses for shipbuilders and naval establishments. The most recent addition is the announced Ship Technology Centre at Visakhapatnam, at a cost of ₹305 crore, focused on research and development, ship design and specialised education (News on Air, 2026).

9.4 Gaps and challenges in maritime education

Set against the comparator cases, six systemic weaknesses stand out. First, a gap in industry relevant qualifications: advanced ship design, naval architecture at scale, and AI driven automation are inadequately covered, and critical occupations dock masters, senior design engineers, automation specialists lack academic pathways altogether (Section 9.2). Second, a mismatch between academic training and industry need, driven by dated infrastructure and technological resources in institutions, limited coverage of current automation, AI and shipbuilding software, and insufficient practical exposure the classic symptom, in Becker's (1964) terms, of an ecosystem in which no actor is yet underwriting transferable skill investment at the required scale. Third, standards lag: National Skill Qualification Framework standards and Sector Skill Council specifications require faster revision cycles to track technological change, particularly in design, electrical automation and marine engineering. Fourth, certification friction: missing competency standards, inconsistent procedures and high certification costs deter both workers and firms from validating skills a barrier the comparators address through subsidised, standardised national trade tests (Sections 4 6). Fifth, thin provision for continuing education and inclusion: lifelong learning uptake is constrained by unclear occupational training needs; the sector remains heavily male dominated; and integration strategies for persons with disabilities are minimal, with perceived occupational risk restricting access to technical education. Sixth, uneven industry academia collaboration: instruments such as the AICTE industry linkage and apprenticeship programme operate, but effectiveness varies widely across institutions, with some maintaining robust connections and others struggling to establish meaningful engagement. Underlying all six run three structural currents: demographic loss of retiring skilled workers without commensurate youth uptake; funding gaps for research and large scale training infrastructure; and slow curricular adoption of AI, robotics and sustainable practice.

10. The Andhra Pradesh Case: Designing a Skill System into a Greenfield Cluster

10.1 Vision and policy setting

Andhra Pradesh, with a coastline of approximately 1,053 kilometres on the revised national assessment and a strategic port network, has positioned itself as the leading edge of India's shipbuilding ambition. The

state's Swarna Andhra vision frames maritime industrialisation as a pillar of economic growth, with objectives that include transforming the state into a global shipbuilding destination; establishing integrated clusters combining yards, training academies, logistics hubs and research facilities; attracting global and Indian builders through incentives and infrastructure; and capturing a substantial share of the employment running nationally into the tens of millions of direct and indirect jobs by 2047 anticipated from port and vessel related investment under the Amrit Kaal maritime vision (MoPSW, 2023; Government of Andhra Pradesh documentation). The Andhra Pradesh Maritime Policy 4.0, approved by the state Cabinet in December 2024, gives this vision statutory form, covering port development, proximate area growth, shipbuilding clusters and allied activities, with the Chief Minister directing collaboration with the Indian Maritime University and the IITs on maritime higher education (News on Air, 2024; Deccan Herald, 2024). Implementation has moved quickly. The state has allocated on the order of 20,000 acres for maritime development, including shipbuilding clusters and training academies, and the Andhra Pradesh Maritime Board has issued expressions of interest to attract global and national builders, with Hyundai and GRSE among those courted. Under the central Shipbuilding Development Scheme, Andhra Pradesh became the first state to approve a mega greenfield shipbuilding cluster: at Dugarajapatnam in Tirupati district, implemented through National Ship Building and Heavy Industries Park Andhra Pradesh Limited, a 50:50 special purpose vehicle of the Maritime Board and the Visakhapatnam Port Authority, with an estimated investment of ₹29,662 crore across 2,000 acres, four dry docks, ship lift facilities and a designed capacity of 1.2 million gross tonnes per annum, proceeding to National Shipbuilding Mission approval through the Directorate General of Shipping (Deccan Chronicle, 2026). Complementary proposals include a Hindustan Shipyard facility at Mulapeta and a Goa Shipyard centre in the Machilipatnam port area, each of the order of ₹3,000 crore (ETV Bharat, 2026), while the ₹305 crore Ship Technology Centre at Visakhapatnam adds the research and specialised education layer (News on Air, 2026). Fire safety training and advanced simulation tools for high risk yard environments form part of the state's worker safety commitments.

10.2 A phased human resource strategy

Stakeholder consultations in the state have produced a phased strategy summarised in Table 8 whose logic tracks the comparative findings of Section 8 closely. The short term (0 2 years) prioritises skill mapping and gap analysis before large scale provision, exactly the diagnostic first sequencing of the EU Pact's first pillar; strengthened industry academia collaboration through the CEMS campus at Visakhapatnam and partner universities to align

curricula with yard requirements; and fast track certification courses in emerging technologies, green shipbuilding and repair techniques the Korean crash training instrument adapted to Indian conditions. The medium term (3-5 years) establishes dedicated shipbuilding academies inside the planned clusters, covering design, construction, repair and maritime decarbonisation technologies; expands apprenticeships with major yards and ancillary industries for structured school to work transitions, on the Japanese and Korean company training model;

and institutionalises global knowledge exchange with international maritime agencies and technology providers. The long term (6-10 years) commits to an integrated human resource development plan aligned with Maritime Vision 2047; continuous professional development in advanced manufacturing, automation and green technologies; and inclusive workforce development, promoting gender diversity and opportunities for under represented groups the dimension on which every comparator case shows unfinished business.

Table 8. Andhra Pradesh's phased human resource strategy for shipbuilding

Timeframe	Key interventions	Lead agencies and partners
Short term (0 - 2 years)	Skill mapping and gap analysis; fast track certification training; industry academia curriculum alignment	AP Maritime Board; CEMS; Indian Maritime University
Medium term (3-5 years)	Shipbuilding academies within clusters; expanded apprenticeships and on the job training; global knowledge partnerships	Industry; academia; international agencies
Long term (6-10 years)	Integrated HR development plan to 2047; institutionalised lifelong learning; inclusive workforce development	State government; industry associations

Source: consolidated from state stakeholder documentation; sequencing logic corroborated by the comparative analysis of Section 8.

10.3 Governance and systemic enablers

The Andhra Pradesh Maritime Board, with the state Department of Infrastructure and Investment, acts as nodal agency, coordinating with the Indian Maritime University, the Centres of Excellence and industry associations to hold the strategy to national standards and global practice. Three systemic enablers underpin delivery: a policy and incentive regime of infrastructure support, expedited clearances, fiscal incentives and logistical assistance to attract investment and talent; the cluster based approach itself, which co-locates raw materials, fabrication, ancillaries, training and research so that workforce development and innovation reinforce one another the spatial logic every successful comparator, from Imabari to Geoje to Jiangsu, exhibits; and the state's port network, industrial corridors and logistics infrastructure, which support both sectoral growth and the mobility of skilled labour. The strategic wager is explicit: by designing training academies, certification and research into the cluster from the outset rather than retrofitting them after capacity is built Andhra Pradesh intends to avoid the sequencing error that has constrained Indian shipbuilding to date.

11. Discussion: Lessons and Policy Implications for India

Read against the analytical framework of Section 2, the four cases yield six transferable lessons, mapped

onto Indian instruments in Table 9.

Lesson 1 Diagnose before training. Europe's first pillar and Japan's 2004 intervention share a discipline India's ecosystem has lacked: training designed against measured, occupation level demand rather than generic capacity targets. The Sagarmala skill gap studies provide a foundation; what is missing is a continuously updated, sector wide skills intelligence function a natural mandate for the National Shipbuilding Mission, working with the Sector Skill Councils and the new clusters' anchor investors, and echoing the central HR council recommended in stakeholder consultations.

Lesson 2 Build the minimum institution that relaxes the binding constraint, and make industry co own it. Japan's five regional centres, run by CAJS with state subsidy, solved a knowledge transfer crisis with modest public outlay because industry governed delivery (OECD, 2016). India's equivalents CEMS, the cluster academies planned in Andhra Pradesh, the Visakhapatnam Ship Technology Centre will succeed on the same condition: yard level governance of curricula and instructor certification, with public money following industry commitment rather than substituting for it.

Lesson 3 Keep a crash training capability permanently warm. Korea's 320 hour fast track programmes demonstrate that a cyclical industry needs surge training capacity that can be scaled within months, with placement support and SME wage subsidies attached (Lloyd's List, 2025). As

Indian order books build under SBFAS 2.0, the ability to produce certified welders, fitters and pipe workers at three month notice through the ITI and ATI network, retooled to shipyard standards will determine whether capacity investment converts into deliveries.

Lesson 4 Standardise and subsidise certification.

Every comparator anchors its system in national trade qualifications Japan's Skill Tests, Korea's National Technical Qualifications, China's NVQ ladder, Europe's pursued common framework. India's NSQF exists but revision cycles lag technology and certification costs deter uptake (Section 9.4). Harmonising Indian shipbuilding qualifications with international norms, subsidising assessment, and opening examinations to workers in regional languages would raise both domestic quality and the international employability that makes the sector attractive to entrants while recognising, and managing, the emigration risk identified in Table 6.

Lesson 5 Treat attraction, retention and inclusion as core skill policy. Japan's "3K" problem, Korea's reliance on migrants after young Koreans declined yard work, China's vocational stigma and Europe's 20 per cent female share all teach the same thing:

training supply fails if the occupation repels entrants. Improved conditions, accommodation and welfare, structured career progression, performance linked incentives, safety investment, scholarship and awareness campaigns for women and under represented groups, and STEM outreach in coastal schools are not welfare add ons but demand side skill policy and India, uniquely among the cases, can pursue them with a young, growing workforce rather than against demographic headwinds.

Lesson 6 Aim training at the technological frontier, not the current one.

The incumbents are simultaneously automating (Japan's welding robot fund; Korea's smart yards; China's intelligent manufacturing drive) and re skilling for green propulsion and digital production. Indian curricula that target today's conventional practice will graduate workers into obsolescence; CEMS's Industry 4.0 alignment and the decarbonisation emphasis of MAKV 2047 point in the right direction, and cluster academies should be specified from the outset for LNG and alternative fuel systems, robotic welding, digital twins and cyber physical production, consistent with the Maritime 4.0 competency literature (Sullivan, Arias Nava and Desai, 2021; Baum Talmor and Kitada, 2022; Theotokas, Lagoudis and Raftopoulou, 2024).

Table 9. Implementation framework: mapping comparative lessons to Indian instruments

Strategic area	Lead agencies and partners	Key actions (lesson applied)
Skills intelligence and workforce planning	National Shipbuilding Mission; MoPSW; Sector Skill Councils; maritime boards	Standing skill gap analysis in coastal districts; occupation level demand forecasts for clusters (L1)
Curriculum and training	IMU; DG Shipping; CEMS; shipyards; industry associations	Industry governed curricula; mandatory internships and apprenticeships; frontier technology specification (L2, L6)
Infrastructure upgradation	State governments; private sector; maritime boards	Centres of excellence and simulation laboratories in clusters; PPP upgrading of existing institutes (L2)
Surge training and upskilling	MoPSW; MSDE; DGT/ITIs; skill development councils	Modular 300 400 hour shipyard trade courses with placement support and SME hiring subsidies (L3)
Certification and regulatory reform	MSDE; NCVET; classification societies	Faster NSQF revision cycles; subsidised, internationally harmonised trade certification (L4)
Retention, welfare and inclusion	Shipyards; unions; Ministry of Labour; state governments	Improved conditions and housing; structured progression; scholarships and campaigns for women and under represented groups; STEM outreach in coastal schools (L5)

Strategic area	Lead agencies and partners	Key actions (lesson applied)
International collaboration	MEA; MoPSW; industry; academia	Faculty and worker exchange with Japan, Korea and the EU; joint research; participation in international competitions (L1 L6)

Source: author's framework, integrating stakeholder identified interventions with the cross case lessons of Sections 8 and 11.

Two implications deserve emphasis beyond the table. First, sequencing: the September 2025 package has, unusually, put financing, capacity and skilling on the table simultaneously; the comparative record Japan's stabilised but shrinking share, Korea's averted bottleneck, China's three decade institutional accumulation suggests that the skilling pillar is the one whose returns compound longest and whose neglect is hardest to reverse. Second, federal design: the EU case demonstrates that a multi jurisdiction polity can coordinate sectoral skills through negotiated pacts with quantified targets and portable qualifications; a comparable Indian "shipbuilding pact for skills", convening the Mission, the three cluster states, the majors, the SME and ancillary base, the unions and the education providers, would give the 2025 package the governance instrument its skilling pillar currently lacks.

12. Conclusion, Limitations and Future Research

This paper set out to explain how the world's dominant shipbuilding economies form the skills on which their industries rest, and what India can learn as it commits historic resources to joining them. The comparison yields a clear architecture of difference: Japan's focused, quality driven, association coordinated interventions, now paired with managed migration and an economic security investment programme; South Korea's cyclically adaptive combination of company training, state crash programmes and temporarily large scale labour importation; China's centrally planned, mass scale mobilisation of vocational education, now pivoting from quantity to quality; and the European Union's negotiated, diagnostics first coordination of a fragmented high value industry. Across all four, the constants are as instructive as the contrasts: a well trained workforce is treated as the keel of the industry; industry co owns training delivery; national certification underpins quality and mobility; unions, where engaged, guard the skill base; and attraction and inclusion are handled as skill policy, not afterthoughts.

For India, the findings arrive at a consequential moment. The ₹69,725 crore package, the National Shipbuilding Mission, infrastructure status for vessels, and the greenfield clusters with Andhra Pradesh's Dugarajapatnam project first among them constitute the most complete shipbuilding policy architecture the country has assembled. The comparative record

indicates that whether this architecture yields a top five shipbuilding nation by 2047 will be decided less in the dry docks than in the training academies, certification systems and career pathways built or not built alongside them. Andhra Pradesh's decision to design skill institutions into its cluster from the outset is, on the evidence assembled here, the single most encouraging feature of the Indian response.

The study's limitations follow from its design. It is documentary and institutional: it cannot observe shop floor skill transmission, and it relies on workforce statistics that no jurisdiction publishes on a fully consistent basis. The Indian and Andhra Pradesh material describes commitments whose implementation is at an early stage. Future research should accordingly pursue three lines: primary fieldwork in Indian yards and training institutions to measure competency formation directly, on the model of Idris, Wan Zakaria and Nik Mahmood (2023); longitudinal evaluation of the 2025 package's skilling pillar and of the Andhra Pradesh cluster academies as they come into operation; and comparative study of ship repair the segment Şentürk (2011) identifies as the natural entry point for emerging maritime nations as a distinct skill system in its own right.

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