THE PHILIPPINES

IN THE SHIPBUILDING GLOBAL VALUE CHAIN

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The Philippines in the Shipbuilding Global Value Chain

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Acronyms

Acronym	Name
AHTS	Anchor Handling Tug Supply
ANSI	American National Standards Institute
API	American Petroleum Institute
ASEAN	Association of Southeast Asian Nations
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
B2B	Business to Business
CGT	Compensated Gross Tonnage
CHED	Commission on Higher Education, Philippines
COGS	Cost of Goods Sold
DAB	Design and Build
DGPS	Differential Global Positioning System
DP	Dynamic Positioning
DSV	Dive Support Vessel
DWT	Dead Weight Tonnage
EPC	Engineering, Procurement and Construction
ERRV	Emergency Response and Rescue Vessel
ESWBS	Expanded Ship Work Breakdown Structure
EU	European Union
FLNG	Floating LNG Liquefaction Plant
FPSO	Floating Production, Storage and Offloading Vessel
FPSS	Floating Production Semi-Submersible
FPSU	Floating Production and Storage Unit
FPU	Floating Production (or Point) Unit
FSO	Floating Storage and Offloading Vessel (no production plant)
FSRU	Floating Storage and Regasification Unit
FTA	Free Trade Agreement
GT	Gross Ton/Gross Tonnage
GVC	Global Value Chain
HS	Harmonized System
HVAC	Heating, ventilation and air conditioning
IACS	International Association of Classification Societies
ILS	Integrated Logistical Support
IMO	International Maritime Organization
IRM	Inspection, Repair & Maintenance
ISS	In-Service Support
KSE	Korea Stock Exchange
LGC	Large Gas Carrier
LNG	Liquified Natural Gas
LPG	Liquified Petroleum Gas
LPH	Landing platform helicopter
LR2	Long Range 2
LSF	Landing ship fast
LST	Landing ship tanker

MARINA	Maritime Industry Authorities of the Philippines
MGC	Medium Gas Carrier
MMSAI	Metro Manila Shipyard Association Inc.
MNC	Multinational Corporation
MODU	Mobile Offshore Drilling Unit (drillships)
MPSV	Multi-Purpose Support Vessel
MR	Medium Range
MSV	Multi-Support Vessel
NPD	New Product Development
OBO	Ore-bulk-oil
ODM	Original Design Manufacturer
OEM	Original Equipment Manufacturer
OSV	Offshore Support Vessel
PEZA	Philippine Economic Zones Authority
PSV	Platform Supply Vessel
R&D	Research and Development
RoRo	Roll-on/Roll-off
SBSR	Shipbuilding and Ship Repair
SGC	Small Gas Carrier
SOLAS	International Convention for the Safety of Life at Sea
SPAR	Single Point Anchor Reservoir
STEM	Science, Technology, Engineering and Mathematics
SURF	Subsea, Umbilicals, Risers, Flowlines vessels
TEU	Twenty-foot Equivalent Unit
TLP	Tension Leg Platform
ULCC	Ultra Large Crude Carrier
US	United States
VLCC	Very Large Crude Carrier
VLGC	Very Large Gas Carrier
WTIV	Wind Turbine Installation Vessel

Executive Summary

This report uses the Duke CGGC global value chain (GVC) framework to examine the role of the Philippines in the global shipbuilding industry and identify opportunities for upgrading.

Global Shipbuilding Global Value Chain

In 2016, there were 1,664 ships delivered, with a total weight of approximately 66 million gross tons (GT), and a total value of $80.2 billion. Exports in 2015 were approximately $117 billion. There were approximately 730 active shipyards in 2015, however only 240 received an order in that year, and nearly 50% of output is consistently produced by the largest 20-24 yards. The global industry is currently in a state of overcapacity and the average age of the global fleet is young, however there will still be demand for newbuilds, as well as conversions and repairs, particularly due to increasing environmental regulations. There are four key aspects of the shipbuilding GVC that should be highlighted:

- **Final assembly is concentrated in a few countries and offshore production is uncommon:** A unique feature of the shipbuilding industry is that three countries (China, Korea and Japan) account for over 90% of production based on GTs. While some shipbuilders have set up shipyards in foreign countries, offshoring has not been a significant trend in this industry like many other GVCs.

- **There are two main segments:** commercial shipbuilding (focused on transporting) and the offshore segment (activities that occur at sea; primarily related to oil). Within each there is a wide mix of vessel types; all share some common materials and equipment, but several inputs depend on the intended purpose of the vessel. Global market share (in terms of producing countries and vessel types) also varies depending on the unit of measurement (volume/weight, value, number of vessels, and production versus exports). Furthermore, shipbuilders often specialize in one or a few ship types.

- **National/domestic support has, and continues to play, a key role in the development of the shipbuilding industry in a country:** Support is in the form of domestic demand (through government purchases, domestically-owned shipping companies or local content requirements) and in providing financial assistance through government-backed loans or state-ownership.

- **Safety and environmental standards are high and play a significant role for oceangoing vessels.** These standards are mandated for ships sailing in international waters, however vessels used in domestic waterways are only subject to national requirements. The ability to meet international standards can be a significant barrier to entry for new shipyards.

Philippines in the Shipbuilding Global Value Chain

The Philippines is in a unique position in the shipbuilding GVC as it has both demand for (smaller) vessels in the domestic market and it is an exporter of large, commercial ships for the international market. Furthermore, while completely different from the shipbuilding industry, a significant number of Filipinos work as seafarers on oceangoing vessels, and due to the use of similar terminology in both industries, this leads to confusion as to which segment resources and statistics are referring. While the focus of this report is on identifying opportunities in the export-oriented, commercial vessel segment, when possible it also identifies synergies and challenges created by also having strong domestic demand.

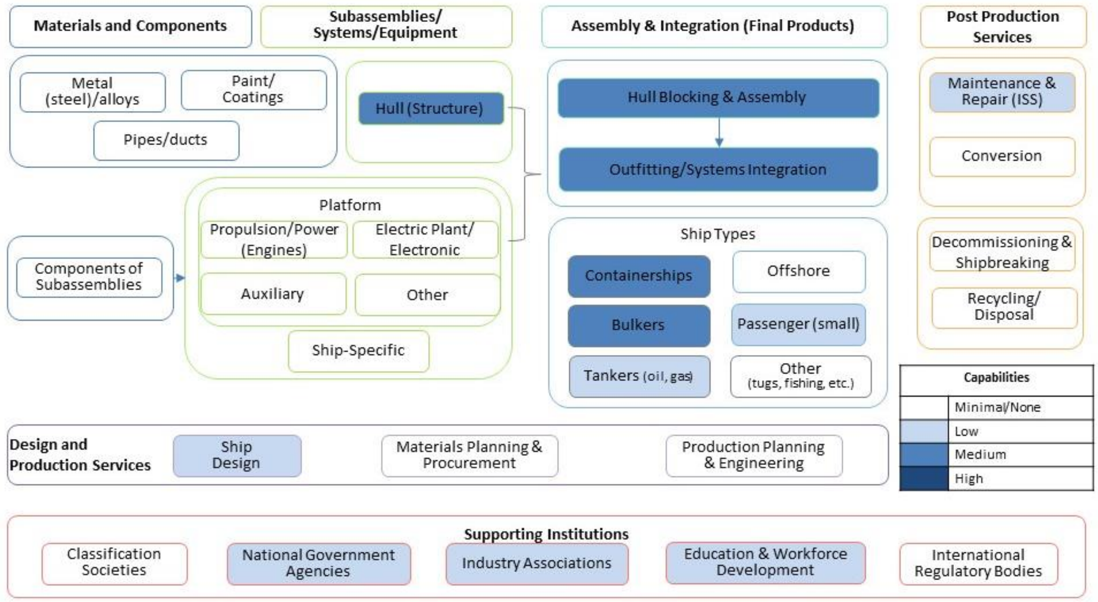
Export oriented shipbuilding has played a role in the Philippines economy since 1994. In 2015, it accounted for 2.6% of total exports from the Philippines at a value of US$1.5 billion. Total estimated revenue in shipbuilding and repair industry in was approximately $1.6 billion in 2015. From a global perspective, the Philippines has been the fourth largest ship producer (based on GT) since 2010. In 2015, the Philippines accounted for 2.8% of world ship completions (based on GT) and 1.3% of ship exports.

For export, the Philippines primarily produces bulk carriers and containerships as well as some tankers. Exports are driven by two large foreign-owned shipbuilders (Hanjin and Tsuneishi). Two other notable foreign owned firms are Austal (small aluminum passenger/mixed-use ships) and Keppel (mostly repair). Domestic shipyards primarily engage in ship repair for domestic ships, which accounts for 90% of domestic shipyard revenue. There are approximately 17 large or medium-sized domestic shipyards, 90+ smaller yards, as well as service and afloat contractors. Domestic yards that are engaged in shipbuilding build small vessels for domestic or internal demand (i.e., fishing, government, some passenger/cargo).

The industry employs 48,000 workers and is geographically concentrated in the greater Manila area and Cebu. While domestic firms account for the largest share of the industry based on the number yards (95%), the two largest foreign-owned exporters account for nearly all exports, 75% of employment, and 97% of revenue. In both segments, backward linkages to materials and equipment are nascent, and nearly all inputs are imported directly or via distributors.

A key advantage and constraint for the Philippines is related to the workforce. While abundant, cost competitive, and hard-working; top workers often go overseas to work in shipyards in the Middle East or Singapore to earn higher wages. Graduates of education and training programs for welders, the primary occupation in shipbuilding, often do not meet international standards. Investment in new shipyards has been stagnant over the last decade (mid-2000s). A positive sign however, has been the low exit rate. Builders that invested in the Philippines have stayed, with several operations dating back to the late 1970s and 1980s. These firms have continued to grow and expand due to the quality of the workforce and satisfaction with incentives. Moving forward, the Philippines is in a good position to expand global market share in the export-oriented segment by increasing global awareness and proactively targeting new foreign-owned shipbuilders and suppliers seeking more cost-effective locations.

Figure E-1. The Philippines in the Shipbuilding Global Value Chain



Source: Authors; based on Figure 1. Shading based on facilities in the Philippines for the international market. Boxes not filled are segments in which minimal activity is carried out in the Philippines.

Philippines Advantages for Upgrading

- **The workforce**, particularly at the operator level; specific strengths include English language skills, supply (availability), cost competitiveness, and work ethic. The merits of the workforce are not unique to shipbuilding as it has been a key contributing factor across all industries studied in this report series.
- **Geography and location:** inherent comparative advantages related to geography include abundant coastline providing necessary ocean access, adequate water depth, and near Cebu, an area suitable for conducting sea trials. Strategic location advantages stem from proximity to the center of global economic activity for shipbuilding and shipping. Shipbuilding is concentrated in three East Asian countries, and the Philippines is located along key Southeast Asian trade routes, making it a convenient location for repair.
- **Incentives** have historically been a key driver of foreign investment. These include tax and non-tax incentives for capital investments, and import duty exemptions.

Philippines Challenges for Upgrading

- **Local manufacturers of materials and equipment:** All equipment and materials used to construct export-oriented vessels must have IACS class approval. There are few providers in the Philippines (foreign or Filipino-owned), so inputs must be imported.
- **Service providers (subcontractors):** Subcontracting is common in shipbuilding, so a readily available supply of high quality service providers (i.e. painting, blasting, machining, and the like) able to meet international standards facilitates workflow. The lack of service providers is more apparent in the greater Manila areas.
- **Workforce** with skills certifiable to international standards and the ability to retain talented workers. Operators, particularly welders, are readily available, but most only

have a TESDA NC Level I/II certification, whereas Level III/IV are needed. Adding to the issue is the loss of top talent to the Middle East and Singapore.

- **Domestic facilities do not meet IACS standards or have ISO certifications.** Without these, domestic yards cannot participate in any segment of the global value chain (i.e., manufacturing, repair, contractors, or input suppliers).
- **Cooperation and leadership from the supporting environment:** there is not a well-defined division of labor among key supporting stakeholders. Separate policies and incentives (in most cases) are needed to meet domestic and export market objectives. The lack of clear leadership compiled with spatial dispersion has contributed to limited cooperation and communication among government, shipyards (domestic and foreign), associations, classification societies and education providers.
- **Limited global awareness**. The Philippines has several advantages as a location for shipbuilding and repair activities, but without marketing, opportunities will be missed.

The Philippines has opportunities to upgrade in the shipbuilding GVC via multiple pathways:

(1) FDI-led development to grow export-oriented, large commercial shipbuilding;
(2) FDI or JV-driven opportunities to enter the global market in post-production services;
(3) Domestic (Filipino-owned) firm opportunities to enter the industry to fill domestic market needs and eventually the GVC for smaller vessel types.

Table E-1. Potential Upgrading Trajectories for the Philippines

Time Frame	Upgrading Trajectory	Key Benefits	Philippines Challenges
Short	**Product upgrading: expand and diversify ship exports**	• Remain relevant & competitive as industry innovates • Increased product variety reduces risk to demand fluctuations. • Competencies in technology frontiers increases long-term viability of sector.	• Industry dominated by MNCs; strategy developed in HQs outside Philippines. • Competition with China. • Lack of workforce skills, materials and equipment suppliers • Limited global awareness
Short	**Backward linkages into parts and components**	• Increased local content increases domestic economic impact in terms of employment, revenue and value added • Future part/component export opportunities • Strengthen supply chain for automotive, aerospace, and construction	• Capability low or absent in essential materials and equipment • Little visibility into purchasing and coordination decisions of international shipbuilders. • Spatial dispersion of shipyards
Short to Medium	**Functional upgrading into repair services**	• ISS comprises approximately 30% of the value of a ship over its lifetime. • Repair and conversion services are likely to be of increased demand due to environmental regulations	• Existing shipyards do not meet international standards. • Existing/top talent goes abroad • Competition from other countries • Limited global awareness
Medium	**Entry into disassembly and recycling**	• Provides valuable steel scrap, which can be inputs for mini-mills with EAFs. • Steel inputs for construction or re-rolling	• No shipyards are dedicated to disassembly and scrapping • Philippines does not have a mini-mill
Medium to Long	**Entry and end market upgrading (domestic to export market)**	• Market opportunities for domestic shipbuilders to become lead firms • Leverage domestic and regional demand to drive economies of scale • Entry into GVC	• Few domestic shipbuilders • Limited market information on global demand for smaller ships for which domestic shipbuilders can produce
Medium to Long	**Functional upgrading in ship design**	• Cross-industry skillset • Skilled employment; higher wage positions • Expand service exports	• Minimal involvement in non-manufacturing segments of the chain

1. Introduction

Shipbuilding, the design and construction of ships, has a long history with the first known ship built by the Egyptians in 4000BC.[1] In the 20th century, shipbuilding was dominated by European nations and the U.S. until the mid-1960s, when Japan became the premier shipbuilding nation, followed by South Korea in 1999, and China in 2010 (Stopford, 2015). Today, commercial shipbuilding – the construction of seaborne vessels with the primary purpose of moving large quantities of goods, commodities, or people – is controlled by these three East Asian countries each completing about a third of the global commercial shipbuilding market, for a combined 90% of global commercial ship production (based on gross tons). This report is primarily about commercial shipbuilding, which is distinct from naval shipbuilding, used for national defense and other sovereign purposes, and recreational vessels, which are ships used for personal use.

Commercial shipbuilding is comprised of several vessel categories. Most production (80% based on GTs) occurs in three types of vessels: containerships, oil (crude) tankers, and dry bulkers. Containerships, making up about 15% of annual commercial ship production, are vessels optimized to carry containers (called TEUs, for Twenty-foot Equivalent Units) that hold components and final goods used in international commerce and production. Crude tankers, making up about 18%, carry crude oil from global production sites to national and regional refinery sites. Dry bulkers, making up approximately 48%, are designed to transport unpackaged bulk cargo, such as grains, coal, ore, and cement in large cargo holds. The balance of production (20%) within the commercial shipping category are general cargo ships used to transport refrigerated goods ("reefers") and cars ("RoRos"), gas tankers carrying compressed gasses (LPG/LNG carriers) used for energy production, passenger and fishing vessels, and "offshore" vessels used primarily to support oil extraction and undersea construction (see Box I).

This report analyzes commercial shipbuilding and the role of the Philippines in the industry. The report is structured as follows: First, it analyzes the shipbuilding value chain, including an extended discussion on market and competitiveness issues in the shipbuilding industry, followed by a description of the key segments of the chain, the countries that participate in each, and how key stakeholders in the chain interact. It then offers case studies to illustrate the opportunities and challenges faced by developing countries in similar positions in the global value chain. This is followed by an assessment of the industry in the Philippines before it concludes by offering possible upgrading strategies to boost the sector in the global market.

2. The Shipbuilding Global Value Chain

The purpose of this section is to describe the shipbuilding global value chain (GVC). We first discuss key market and competitiveness issues in the GVC, followed by a discussion of the major segments in the value chain.

2.1. Market and Competitiveness Issues

Four major trends shape the current commercial shipbuilding market. They are:

- overcapacity and lower prices

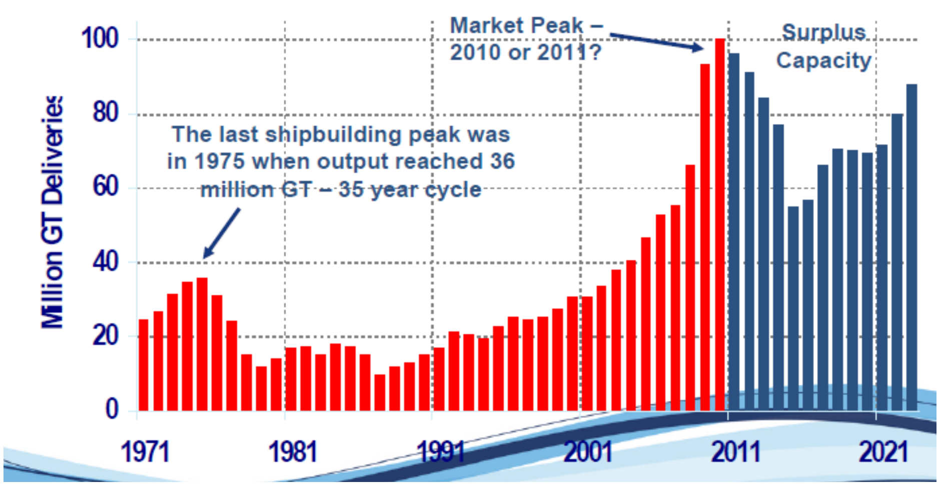
[1] https://www.britannica.com/technology/ship/History-of-ships

- lower order volumes and changing product mix
- financing new orders
- changing ship design and environmental regulations.

Overcapacity and lower prices: Overcapacity is a major trend affecting prices and profits in the shipbuilding industry. Persistent overcapacity in two (container and dry bulk) of the three major market segments (container, dry bulk, and tankers); a related stream of events has led to this including reduced transportation prices, reduced profits for shippers, cancelled ship orders, increased idling and demolition of existing ships, and market consolidation among shippers.

The global shipyard capacity utilization rate in 2016 is estimated at approximately 78%, down from 92% in 2008 (DSF, 2016). Within the three major shipbuilding countries, China utilized 68%, Japan 83%, and Korea 94%, of its shipyards in 2016. Major shipbuilders around the world are idling shipbuilding in active yards, and reducing the number of active yards through complete shutdowns and bankruptcies. The number of active yards is predicted to decline to 260 in 2017, down from 1,130 in 2010 and 780 in 2015. Newbuild prices for all major vessel categories have declined by at least 25% since their highs in 2009 (DSF, 2016).[2]

A major cause of overcapacity in the shipbuilding industry is weak demand for shipping and the existing stock of relatively young vessels in the three major shipbuilding market segments. As shipping demand declines, freight rates drop, ship prices decrease, newbuild demand decreases, demolitions increase, leading to an eventual recovery in freight rates and newbuild demand (OECD, 2015a). These long-term market cycles may be 30-40 years, with the current period indicative of a cycle which saw its last 2011 peak in 1975 (see figure below).



Source: *World Shipbuilding Scenario* from Clarksons (2013)

Reduced prices for transportation services have led to container and dry bulk shippers operating at or below operating costs, creating ripple effects throughout the shipbuilding market. Shippers have responded to excess supply by reducing demand (or cancelling orders) for newbuilds, and increasing the demolition rate of older ships. Increased demolition rates in

[2] Newbuild and secondhand prices for major vessel categories are provided by DSF (2016). Newbuild prices in 2015 declined by 2% for containerships, crude carriers, and gas carriers; 11% for bulk carriers.

containerships removed 201,000 TEUs of older ships from the global fleet (BRSGroup, 2016), but still accounted for 12% of newbuild deliveries over the same period. In the dry bulk segment, scrapping accounted for almost three-fourths (73%) of global scrapping activity, reducing fleet growth to its lowest level in 15 years (Clarksons, 2016; UNCTAD, 2016). Idling ships has also been used in the bulk market, accounting for a reduction of 5 million DWT (DSF, 2016; UNCTAD, 2016). However, these responses were still unable to balance supply and demand and return the container and dry bulk shipping sectors to profitability.[3]

To increase profitability, market consolidation among shippers has occurred. Japan's three biggest shippers, Nippon Yusen KK, Mitsui OSK Lines, and Kawasaki Kisen Kaisha, announced a merger in November 2016 as a way to remain competitive and avoid bankruptcy.[4] Additional consolidation among shippers is ongoing, both in Asia and Europe (Park, 2017). Insolvencies and liquidations among shipping companies, including those of Hanjin Shipping in August 2016, has led to greater concentration in the market, reducing the ability of smaller companies to operate, and which may result in an oligopolistic market (UNCTAD, 2016). Strategic partnerships also have occurred, with shipping alliances developing in both the container and dry bulk markets to coordinate chartering and transportation services. Capesize Chartering, for example, originated in the bulk carrier market during 2015 to share information and optimize fleet costs (Alix Partners, 2016; UNCTAD, 2016).

In addition to the cyclical decline in demand are structural and non-market causes for overcapacity in shipbuilding. Among structural causes of overcapacity are factors common in capital-intensive industries with long investment horizons. These include the long delivery times of vessels (approximately two years), long lead times in adding shipyard capacity, and push from buyers to add shipbuilding capacity during periods of tight capacity (OECD, 2015a). Non-market factors causing overcapacity in the shipbuilding sector are strategic capacity expansions to discourage new entrants, policies favoring new capacity investment or limiting restructuring, and protectionist policies, including cabotage polices (OECD, 2015a). In the current period, policies providing governmental financial support for maintaining capacity, including production subsidies, capital participation, tax benefits, and lax regulations on the use of lands and facilities are limiting the elimination of shipyard overcapacity (OECD, 2015a). Overcapacity in the shipbuilding and shipping industry will exist for the foreseeable future (Clarksons, 2013; DSF, 2016; UNCTAD, 2016), recovering only as existing in-service vessels are scrapped or retired after an average of 23 years of service (OECD, 2015a).

<u>Lower volumes and changing product mix:</u> Future vessel requirement estimates by OECD indicate that the major shipbuilding sectors – tankers, bulkers, and containers – will not return to levels seen in the last decade until the 2030's, if at all. Tanker completion volumes of 20 million GT in 2008 are not expected to return until 2028. Bulker deliveries of approximately 50 million GT seen in 2011 are not expected to return through the predictable future (2035). Containership volumes of approximately 15 million GT seen in 2008 and 2014 are not expected to return until 2033. Reduced vessel requirements are the result of the existing inventory of vessels, and longer-term trends reducing the linkage between GDP and trade growth

[3] Information about profitability levels across major market segments is provided in (DSF, 2016).
[4] Nippon Yusen president Tadaaki Naito stated "the aim of becoming one this time is so none of us become zero" as reported in (Chandran, 2016).

(UNCTAD, 2016). These longer-term trends include demographic shifts, shortened GVCs, and IT-related efficiency and productivity gains occurring as the result of the "4th industrial revolution," which could signal structural changes in the demand for shipborne transportation (DSF, 2016; UNCTAD, 2016). Although the majority of production in commercial shipbuilding has been in bulkers and oil tankers, growth will likely be in LNG/LPG gas carriers, RoRos and ferries, and the offshore market (Kent, 2016).[5] Although participation in the offshore market involves large risks (OECD, 2015a), it is an increasingly large share of shipyard production, and is composed of vessels that tend to have higher unit values.

Financing new orders: Access to finance has been a limiting factor in the shipbuilding industry since the economic crisis when Western commercial banks reduced their exposure to shipbuilding finance (Albertijn et al., 2011; Liu, 2016), in part due to capital requirements under the Basel III Accords (Liu, 2016). The Basel III Accords introduced new banking regulations at both the systemic and individual bank-level to enhance the sector's ability to absorb financial and economic shocks by improving risk management and governance practices, including additional transparency and disclosure measures (BIS, n.d.). Stepping into the breach have been Asian lenders, typically with state-backed funds (Aw et al., 2016; Liu, 2016) and shipbuilders seeking to secure orders in a buyer's market (DSF, 2016). Shipbuilders have provided generous payment terms to potential shipowners to maintain their orderbooks and shipyard activity. New terms reduce payments from the traditional 20% payments over five years to four 10% payments and one 60% payment at the end of five years, resulting in a "heavy tail" for ship finance (Hyun, 2013). However, these payment and financing arrangements have affected shipbuilders' profitability. Shipyards with limited ability to provide financing options, particularly refund guarantees and export credit guarantees, are at a disadvantage when compared to large, state-affiliated shipyards with better financing options.[6] Nevertheless, even shipyards in countries traditionally providing state-backing are experiencing financial challenges in the current environment. In South Korea, the "big three" shipyards - Samsung Heavy Industries (SHI), Hyundai Heavy Industries (HHI), Daewoo Shipbuilding and Marine Engineering (DSME) - and STX Offshore & Shipbuilding all announced the need to restructure. In China, five shipyard bankruptcies were announced in 2016 with another restructuring (Kent, 2016).

Changing ship design and compliance with environmental regulations: Ships have become larger, more fuel efficient, and compliant with stricter environmental standards since the early 2000s. Larger vessels have become attractive to shipowners because they can achieve economies of scale in transportation, which have been made possible by the physical expansion of the Panama Canal and Suez Canal. Ship designers have also increasingly focused on fuel efficiency as an important factor affecting profitability, as ship fuel costs ("bunker prices") have become an increasingly large portion of operating costs, especially before the rapid decline in bunker costs from 2014 to the current period. As a result, vessels in the global fleet have become more fuel

[5] The fleet age for RoRos is higher than other product categories, with about half older than 20 years (p. 18).
[6] Refund guarantees provide for a return of pre-delivery payments made by the shipowner to the shipbuilder, typically as security against the insolvency of the shipbuilder (Heward, 2010). Export credit guarantees, typically provided by governments or quasi-governmental entities, ensure that an exporter receives payment for goods shipped overseas in the event the customer defaults, reducing the risk to the exporter's business (Davis, 2012).

efficient, while the use of alternative fuels, especially LNG, to power ships may also become increasingly common.[7]

Finally, the implementation of environmental regulations has affected shipbuilders. Most notable of these is the ballast water convention (2004 International Convention for the Control and Management of Ships' Ballast Water and Sediments) requiring the bilge to be free from fouling organisms by September 2017, and the International Maritime Organization's (IMO) adoption of enhanced environmental regulations, including reductions in the emission of air pollutants from ships. Marine pollution ("MARPOL") conventions, including the Energy Efficiency Design Index (EEDI), require reductions in carbon dioxide (CO_2) emissions. Specifically, the EEDI requires stepwise reductions in CO_2 emissions from 2000 levels, including 10% in 2015, 20% in 2020 and 30% in 2025.[8] Conventions under MARPOL Annex VI also establish emission control areas (ECAs) for sulphur oxide and nitrogen oxide emissions in specific geographic areas.[9]

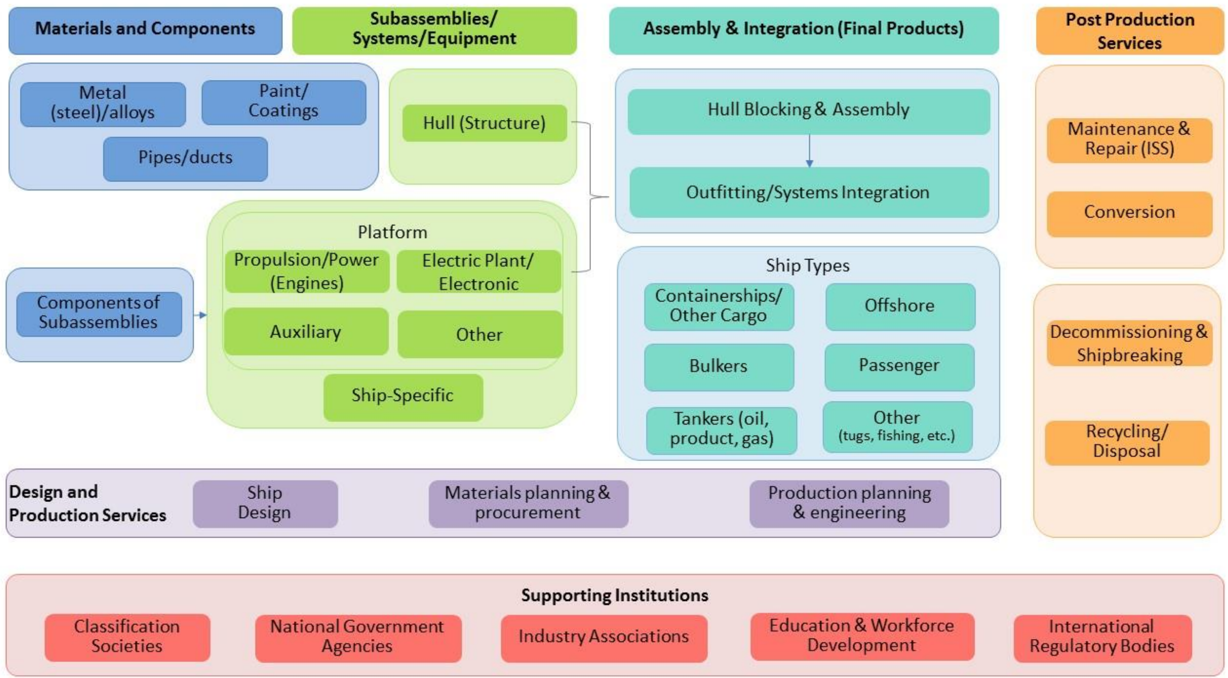
Construction trends: Dynamics in the shipbuilding industry since the 1980s have led to the adoption of a modular shipbuilding ("block construction") model developed in Asia. In modular shipbuilding, pieces of the hull of up to 300 tons are separately built and assembled in blocks on land before assembled in docks, dramatically increasing efficiency and reducing the costs of shipbuilding. South Korean firms, like HHI and SHI, rose to prominence by building large shipyards capable of block construction and vertically integrating the steps of the shipbuilding process, including the integration of major systems. Today, the efficiency of the block construction method has been enhanced by automated welding. Large ship blocks are quickly constructed by programmable robots made by ABB and Inrotech, among others. SHI's Geoje shipyard in South Korea is particularly well known for achieving efficiency gains in shipbuilding due to its adoption of these welding robots.[10]

2.2. Mapping the Shipbuilding Global Value Chain

Modern shipbuilding involves multiple actors to design, construct and maintain a ship. Figure 1 illustrates the complex set of design, production, and post-production activities involving multiple actors across the shipbuilding value chain. The purpose of this section is to illustrate the shipbuilding process using the value chain as an orienting framework.

[7] See www.marineinsight.com/future-shipping/shipbuilding-technologies
[8] The Ship Energy Efficiency Management Plan (SEEMP) is a complimentary convention regarding the energy efficient operation of ships.
[9] For more information, see www.imo.org/en/MediaCentre/hottopics/ghg/Pages/default.aspx
[10] See for example, www.kranendonk.com/shipbuilding/double-hull-welding-line

Figure 1. Shipbuilding Global Value Chain



Source: Authors

The shipbuilding value chain is comprised of three major phases: pre-production, production, and post-production. The *pre-production* phase of shipbuilding includes the phases of design and project management. The *production* phase includes hull construction and equipment/systems purchasing and integration. Hull construction components and activities are those required to build the structure of the ship. There is some need for every system on a ship, however the relative importance varies. *Standard* systems/equipment account for a similar share of equipment purchases on most types of ships. Ship-specific systems are those needed to make the vessel perform the tasks for which it is designed and account for a larger share of total equipment purchases Finally, *post-production* activities include in-service support (ISS) of the vessel after its final construction, customer support. ISS may be comprised of repair, conversion and maintenance activities. As a ship reaches the end of its service life, which for commercial vessels is about 25 years, ships can be left idle ("laid up") for several years before disassembly ("ship breaking") and recycling/disposal occurs. Next each major segment is described in turn.

Design: The major design phases, comprising of concept, preliminary, contract, and detailed designs, have different objectives and may be conducted by different firms. In the *concept phase*, the design process begins with a decision, usually by the ship owner, about the mission requirements of the vessel. A ship architect can then begin the process of defining the parameters and features of the ship. In the *preliminary design phase*, major equipment needed is determined, and the general arrangement of the hull and equipment is made. General arrangement plans give architects, builders and owners a chance to see the arrangement of passenger and crew spaces, machinery rooms, stores, holds, tanks and engineering before designs are finalized and shipyard work begins.

In the *contract design phase*, a single, preferred design is selected from several feasible designs in the previous phases. Specification of the hull form is conducted and initial selection of systems and major equipment suppliers is made. Prediction of drag on the hull of the ship is a challenging task for the naval architect. One of the major design tasks is to estimate the powering performance so that propulsion requirements can be determined. Estimates of resistance and power are developed using empirical data from similar ships to a more reliable approach to predict resistance, including scale-model testing.

An initial design and build strategy for the project may also be conducted at this phase. In the *detailed design phase*, the goal is to design the construction of the vessel. This design phase includes designing the details of compartment arrangements, specifications of equipment integration, shock specification and maintainability. For some vessels, a full engineering analysis may be conducted, including analysis of the ship's structure, noise and vibration, weight and stability. This phase also covers construction standards, including how factory automation, cutting of parts in the factory, and data management will be conducted in a specific shipyard as part of the construction (or "build") design.

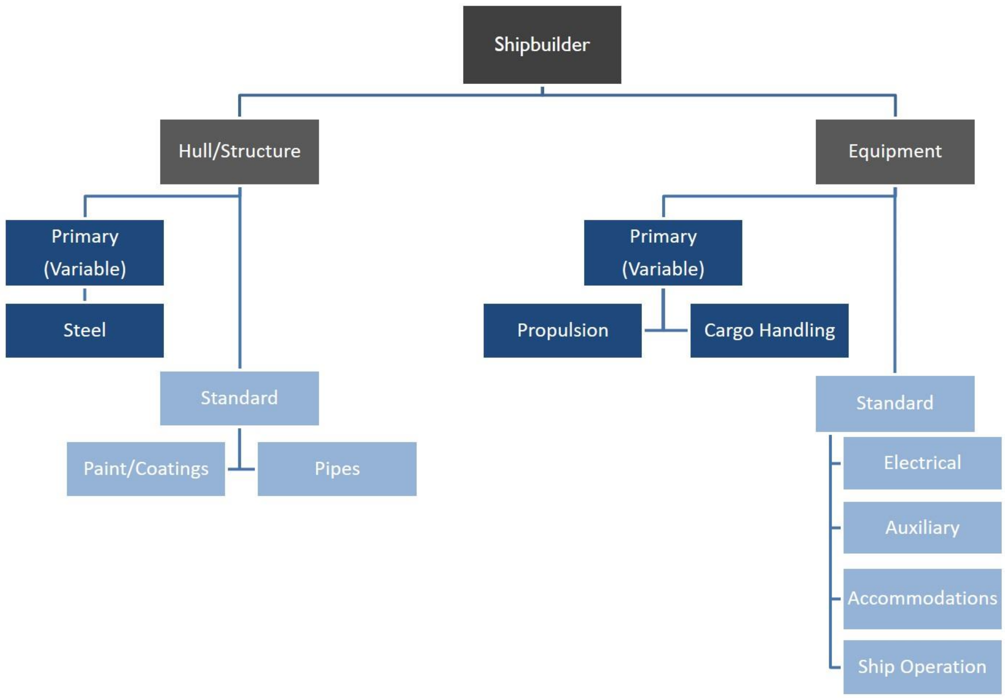
<u>Component production and subsystems assembly:</u> The main systems and subsystems for a ship are illustrated in

Figure **2**. The three main categories are[11]:

- **Hull**: Hulls are built in sections called blocks, primarily from steel. Hull fabrication is a labor-intensive process involving welding. Steel plates are cleaned, straightened, shaped, and cut by specialized plate-burning machines to build the ship's outer surface, or "skin". The framework, to which the skin is attached, consists of the ship's structural components, specifically the keel, girders, frames and beams.
- **Standard Systems**: These, for the most part, will be found on all ships. They are labeled here as 'standard' because they account for a lower, more stable share of equipment purchases across ship types. These include ship operation, basic accommodations, electrical systems/plant and electronic navigational and communication systems, and auxiliary systems, notably HVAC and environmental pollution control.
- **Ship-Specific Systems and Equipment:** These depend on the intended use and purpose of the vessel. In large commercial carriers, the propulsion system is the most important, because the purpose of the ship is to move as quickly and efficiently as possible for long distances. Alternatively, cargo handling equipment is more important on offshore production and drilling vessels as these primarily remain stationary. Accommodations (i.e., furniture) are more important in cruise ships and passenger vessels (Brodda, 2014). For research/survey vessels, advanced sensing, navigation and communication technologies are needed (radar apparatus, radio navigational aid devices, and radio remote control apparatus).

[11] Additional information on each of the assemblies and subassemblies may be found in Gereffi et al. (2013). An alternative categorization is offered in (EC, 2014). It divides materials, major systems and services into three segments: 1) external services and contractors; 2) materials (steel, pipes, ducts, paint/coatings); and 3) ship operation systems, cargo handling and processing equipment, accommodation systems/equipment, propulsion/power generation systems, auxiliary systems, electrical plants and electronic systems.

Figure 2. Ship Systems and Subsystems



Source: Authors

Shipbuilders purchase materials and components from distributors or directly from the manufacturer. This depends on the volume purchased and if the supplier has a manufacturing facility in-country. Each individual system is composed of several products and subsystems. Sometimes these are provided by the same firm and in others they must be purchased from multiple vendors. Manufacturers of equipment are often MNCs that make similar systems and equipment for other heavy industries and transportation. For key technologies such as engines, licensing is also common (see governance section).

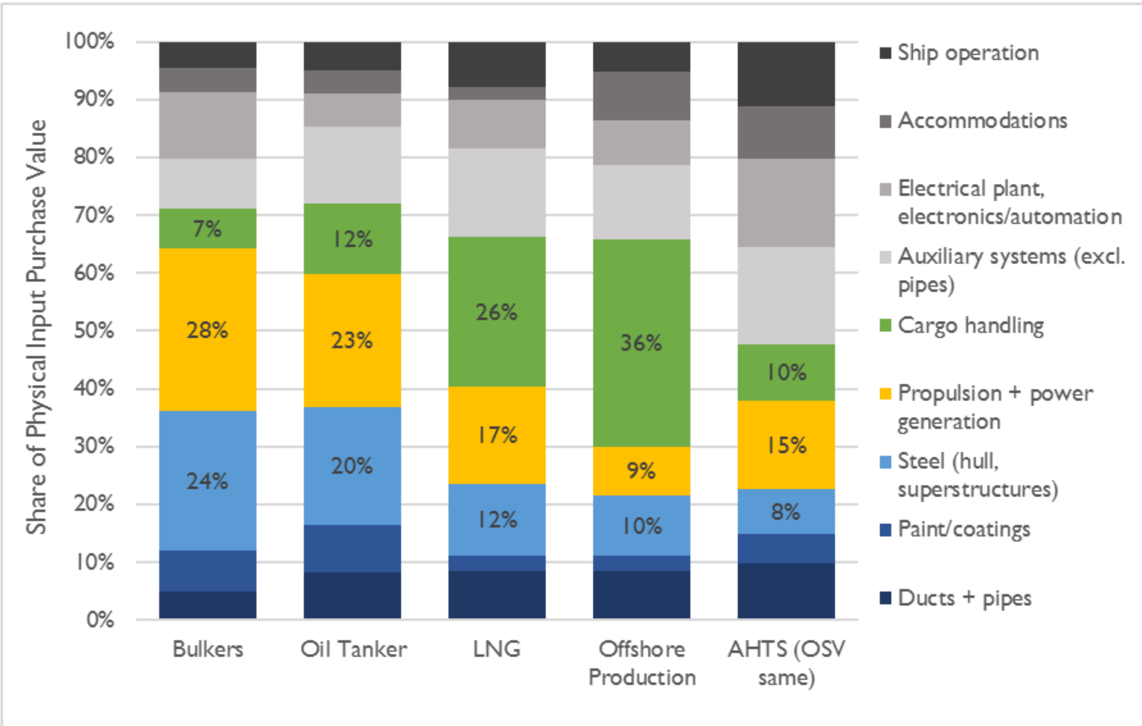
The distribution of physical input costs can be divided into two parts: materials (steel, pipes and ducts, paint and coatings) and systems and equipment. Materials account for approximately 25% of goods purchased and systems and equipment 75% (EC, 2014). These shares vary depending on the size, configuration and purpose of the ship.

Within materials, piping and paint make up relatively stable shares of input costs across all ship types, and in equipment/systems, all ships have similar shares for ship operation, accommodations[12], electrical plant and auxiliary systems. The main variations are in steel/structural components, propulsion and cargo handling. Steel and propulsion systems are the primary inputs for bulkers, containerships and oil tankers, whereas cargo handling equipment is significant for LNG and offshore production vessels. Smaller offshore vessels

[12] For passenger vessels, the share for accommodations is significantly higher, but these are not a particular focus in this report.

(AHTS and PSV) have the lowest share for material components, and the widest variety/most eventually distributed need for equipment (Figure 3).

Figure 3. Cost of Materials and Equipment by Ship Types



Source: Authors, calculated from (EC, 2014), which is based on purchase forecasts for 2013-17. Note: The "materials" category consists of steel, pipes + ducts, and painting/coating. The "systems" category consists of all other categories, except external services.

Ship assembly and integration: The main activities in assembly and integration are:

- **Hull blocking and assembly**: Hull subassemblies are coated with protectant or specialized marine coatings, welded together to form large prefabricated units, and welded into position to form the ship. Once assembled, the ship is ready for launch and outfitting.
- **Outfitting:** After launch, the ship is berthed for completion. The main machinery, piping systems, deck gear, lifeboats, accommodation equipment, insulation, rigging and deck coverings are installed. The tendency is to schedule the outfitting of a vessel in sections, to synchronize fitting work in the different sections and compartments.
    - **Systems integration:** Systems integrators install platform and ship-specific systems and ensure cross-functionality of subsystems. As subsystems become increasingly complex, the integrator's role becomes increasingly important.

Production support services: Production support consists of materials selection and procurement, and production planning and engineering.

- **Materials selection and procurement (sourcing)**: As the design for a ship develops, the shipbuilder identifies suitable suppliers or subcontractors to supply items the shipyard does not produce. Materials planning and procurement requires coordination between the design and procurement functions of the shipbuilding value chain. The design team provides the material needs and estimates for steel, pipes, and cables, subsystems, mechanical and electronic components, and optional equipment, while the procurement team gathers technical product information to create a database of potential suppliers. Selection of equipment in the design and build (DAB) phase has implications for post-production services. For example, propulsion systems made by two manufacturers may have similar prices, meet design specifications, yet have different maintenance costs and schedules. Evaluating systems based on total cost of ownership is one reason why coordination between the DAB team and ISS provider has become increasingly common. A second reason is the creation of the technical data package; this "owner's manual" lists the specifications and maintenance schedules for the ship's systems and subsystems.

- **Production planning and engineering**: Given the long build time for large commercial vessels, production planning is a critical and complex undertaking involving design, assembly, and installation. It ensures that individual parts and equipment are allocated to the appropriate stage in the production hierarchy of assemblies and subassemblies. Production planning and engineering includes assembly and production planning, cut and weld planning, and approval and release of designs. Specialized firms are often retained for production planning and engineering, though some shipbuilders maintain this capability in-house.

Post-production services and end-of-life: Post production services include in-service support (ISS), conversion, and technical training. ISS provides the maintenance, conversion and repair of the vessels, and generally occurs at planned intervals required by classification societies to ensure the ships remain seaworthy and in good condition. In-service support is the responsibility of the ship owner, and typically performed by the original shipbuilder or specialized service provider contracted to conduct maintenance and repair. Under normal operation, post production services in the commercial shipbuilding sector account for approximately 30% of the selling price of a ship. This percentage does not include significant conversions, for example, those required for LNG bunkering or for meeting MARPOL standards. Technical training is needed to teach personnel on the operation and maintenance of the vessels' systems. The operational expense of onboard training makes companies specialized in virtual reality and training simulation attractive alternatives.

Shipbreaking and recycling: At the end of ship's useful life, it is purchased by a shipbreaking or demolition shipyard where it is disassembled. Largely due to the high quality standards for materials used in shipbuilding, nearly all of a ship (estimated 95%) can be recycled or reused (SBC, 2008). Ships are recycled primarily to recover their steel, which makes-up approximately 75% to 85% of a ship's weight, or "lightweight."[13] Some steel plates and beams can be extracted and directly reused by the construction industry or they can be re-rolled and reused (without melting)[14], and irregular scrap pieces can be melted into crude steel and reprocessed using an electric arc furnace (EAF) method. Ship steel scrap is attractive for steelmaking because it is

[13] Lightweight (LDT) is the mass of the ship's structure, propulsion machinery, other machinery, outfit and constants. Another way of defining LDT is as the displacement of a ship when fully equipped and ready to proceed to sea but with no crew, passengers, stores, fuel, ballast, water or cargo on board.
[14] The re-rolling process is simpler and uses less energy compared to melting steel scrap.

high quality steel due to its high yield strength, ductility and impact strength. The annual average of 3.6 million tons of melting steel scrap from the global ship recycling industry (does not include steel that is reused or only rerolled) accounts for around 1.5% of the global steel making industry from old steel scrap (Mikelis, 2013). Other equipment still operational can be taken offboard and repurposed in another vessel.

Types of Ships/Vessels and Ship Owners/Buyers

There are several types of oceangoing vessels that can be described in terms of purpose or the type of cargo they are intended to carry (which relates to construction), size, and the main ship buyers or owners. Ships are typically designed to serve one of the following purposes: transport various types of cargo, conduct an activity at sea (extract oil or other resources, construction, research), and defense. In terms of cargo, ships are designed to transport dry goods (bulk raw materials, component/intermediate goods in containers, or large unpackaged general cargo), liquids/gases (oil, natural gas/petroleum, chemicals, beverages), and/or people.

Categories of ship owners/buyers are aligned with the different ships functions and types of cargo. Commercial shipping companies buy ships that transport dry goods (particularly containerships), oil and gas companies purchase liquid/gas carriers and offshore oil exploration units, and cruise lines purchase large passenger ships. Governments purchase a range of vessels used to conduct various duties and activities related to defense (warships, destroyers, frigates, corvettes, patrol vessels, fast attack crafts), research/survey (research vessels, icebreakers, and search and rescue), offshore oil exploration, and smaller passenger vessels for domestic transportation and shipping needs (see Table 1). In this research, the focus is on large, oceangoing vessels designed for use in international waters.

The scope and terminology used to describe the shipbuilding industry varies based on the data provider. For example, the term ‘tanker’ may refer to any ship carrying liquids/gas, including oil, gas, chemicals or other products. Similarly, the term ‘cargo ship’ may combine containerships and general cargo ships or even bulk carriers. Offshore vessels are often included in an ‘other’ category, however this also often includes large passenger ships, ferries, fishing boats or smaller, multipurpose cargo/passenger vessels. Some sources include recreational vessels and boats (or more generally smaller vessels less likely to be used to travel across the ocean), research vessels or government/military-related production (see Box 2).

Table 1. Ship Types and Characteristics

Type	Sub-Type/Alt. Names	Description	Type of Cargo	Size (Unit, Range, Terms)	Newbuild Price ($US, Mil, 2016)
Bulk Carriers	Bulkers	Unpackaged bulk cargo; separate areas if more than one product	Dry-grains, coal, ore	DWT: 10-100,000 Handysize, Handymax, Panamax, Capesize	$20-42
Container		Carry load in truck-size containers, in a technique called containerization.	Dry-containers	TEU: < 1-12,000 Feeder, Intermediate, Neo-	$12-$109

Type	Sub-Type/Alt. Names	Description	Type of Cargo	Size (Unit, Range, Terms)	Newbuild Price ($US, Mil, 2016)
				Panamax, Post-Panamax	
Tankers	Gas LPG, LNG, FSRU	LNG larger than LPG	Liquid/Gas	Cu.M/m3: < 5-160,000 SGC, MGC, LGC, VLGC	$42-71; $192
	Oil/Crude		Liquid/Gas	DWT: < 55-320,000 Handy, Panamax, Suezmax, VLCC, ULCC	$33-85
	Chemical/Product		Liquid/Gas	DWT: < 25-125,000 SR, SH, MR, LR1, LR2	--
General Cargo	Cargo; other dry cargo; barge; reefer (refrigerated); Pax/General/ RoRo; RoRo	Carry various forms of cargo or cargo and ≤ 12 fare paying passengers (Pax). Barges are non-propelled (must be towed or provide stationary support).	Dry/People	# of cars Reefer: cubic feet RoRo: Lane m.	RoRo: $45-58
Passenger	Ferries, Cruise ships	Carry passengers; for transport purposes only or where the voyage itself and the ship's amenities are part of the experience.	People	Cruise: # of berths	
Other	Fishing		N/A	Often below size threshold to be included. Small, 30 up to 100 meters	
	Tug	Designed for towing or pushing; increasing share used in the offshore segment.	N/A		
Offshore	See Box	Designed for exploration and extraction of natural gas and oil	N/A	Drillship: water depth AHTS: HP Dredger: GT	

Source: Authors. Newbuild Prices: 2016 (Dec) based on average of all sizes: Clarksons (2017b).

Newbuilding prices increased during the early 2000s, but have declined across ship types since 2009 (Clarksons, 2017a; UNCTAD, 2011). The decline has more significant for bulkers and mid-size containerships than tankers and LNG. LNG carriers are the most expensive ($192 million) and bulkers are the least expensive ($20-42 million). Oil tankers and LPG carriers have similar price ranges ($40-80 million), and containerships have the largest variation based on size ($12-$109). Bulkers and general cargo ships can be constructed in roughly 6-9 months and tankers in14-16 months. A large passenger ship or LNG/LPG carrier may take two years to complete.

In terms of complexity, bulkers and general cargo ships are the most basic, followed by tankers, then containerships, and lastly LNG/LPG carriers as the most complex (Collins & Grubb, 2008). Offshore vessels, particularly large platforms research vessels, can be quite complicated and would be on par with LNG/LPG. The level of complexity is reflected in average newbuild prices, time to complete, as well as the type and cost of materials. For instance, over half of the cost of materials in bulkers and oil tankers are steel and engines, whereas LNG/LPG and offshore have higher shares in ship-specific systems.

Box 1. Offshore Vessels

The offshore segment is different from the shipbuilding industry because the primary purpose of the vessels is not to transport long distances. These vessels are often stationary or their function takes precedent over efficient movement, of are designed to go shorter distances to supply stationary platforms. There is also a great deal of variation between vessels as described below.

The offshore segment appears insignificant in global statistics based on weight or carrying capacity, but much more important when evaluating market size based on value. It accounts for 31% by value, but only 5% by GT (EC, 2014), p. 67. The orderbook for offshore was $169 billion in 2013 (Clarksons, 2013), of which MODU accounted for the largest share (50%), followed by FPSU (20%), OSV (14%), construction (10%), and survey (3%).

The OSV segment is generally smaller, less complicated vessels. They account for the largest share of vessels in the offshore segment (at least half of total vessels), but a relatively small share by value (14%) and 23% by GT. Offshore production units are both physically large and high value vessels, however the overall number needed is much lower. Research/survey vessels are more of a niche market ship.

Offshore Categories

Category	Abbreviations/ Sub-Types	Name/Types	Shares of Offshore		
			Orderbook ($Value, 2013)	Fleet (#, 2017)	Orderbook (GT, 2017)
Floating Production and Storage Units (FPSU)	FPU	Floating Production Unit	23%	4%	24%
	FPSO	Floating Production, Storage and Offloading Vessel			
	FSO	Floating Storage and Offloading Vessel (no production plant)			
	FPSS	Floating Production Semi-Submersible			
	SPAR	Single Point Anchor Reservoir			
	TLP	Tension Leg Platform			
Mobile Offshore Drilling Units (MODU)		Drillships (floating)	50%	1%	26%
		Semisubmersible (floating)			
		Jackups (non-floating)			
Offshore Support Vessels (OSV)	AHTS	Anchor Handling Tug Supply	14%	77%	>14%
	PSV	Platform Supply Vessel			
	ERRV	Emergency Response and Rescue Vessel (crewboats)			
Construction	MSV, MPSV, DSV	Subsea construction vessels	10%	11%	>4%

	SURF	Subsea, Umbilical, Risers, Flowlines Types: Pipe, reel, and flex lay			
	Offshore	Offshore and accommodation			
	WTIV	Wind Turbine Installation Vessel			
Survey/ Research			3%	7%	>0%

Sources: OECD (2015b); Clarksons (2013) (orderbook value data); OECD (2014); Clarksons (2017a) (Orderbook 2017-2019+, GT); Fleet based on current number of vessels in Clarkson's Offshore Intelligence Network database (March 2017); Notes: MODU and drillship are often used synonymously.

Offshore vessels accounted for around 10% of the total number of vessels completed in 2014, up from 4.5% in 2012. The offshore segment represented in 2012 more than half of investments in vessels and at least 20% of total investment each year between 2008 and 2014 (OECD, 2015b). By value, Korea accounted for 33% of the global offshore orderbook as of March 2017, followed by China (25%), Brazil (20%), Europe (8%) and Singapore (6%). Based on the number of vessels however, China accounts for 58%, Europe 13%, and Brazil, Korea and Singapore, 5%, 4% and 2% respectively (Clarksons, 2017b). This indicates China's position in OSV compared to Korea and Brazil, which are more active in FPSU and MODU. Based on exports, Korea is the dominate exporter and India is the main importing country.

Competitiveness factors

There are similarities between the offshore segment and commercial shipbuilding regarding materials and equipment, however there are several key differences. For large vessels, there is often more customization, thereby requiring a higher level of coordination among stakeholders, closer cooperation between designers and equipment manufacturers, more production flexibility, and often a more complicated and longer construction process. There are also strict safety regulations, and stringent environmental standards. Shipyards need both highly skilled experts who are difficult to find in the job market, as well as continuous investment in R&D (OECD, 2015b).

High levels of investment are needed in the short term requiring sophisticated project financing and the playing field is not always level when public support measures are accounted for. Similar to the commercial segment, finance is a key factor; financing by banks has declined compared to export credit agencies due to the tightening of banking regulation (Basel III)(OECD, 2015b). Local content requirements are also applied in various regions. They are present in Brazil; Indonesia requires all drilling vessels to be Indonesian-flagged. Malaysia's Petroleum Development Act requires suppliers and service providers to have a valid license by Petronas (national oil company) (OECD, 2015b).

2.3. Global Production and Trade in the Shipbuilding GVC

Most commercial shipbuilding and construction activity occurs in three countries. Japan, South Korea, and China routinely account for over 90% of annual commercial ship production, a competitive advantage resulting from the continued development of block construction techniques during the 1980s in which large pieces of a ship are constructed on land before assembly, and more recently, access to inexpensive inputs, including steel (China). Within the "big three" segments of commercial shipbuilding - containerships, bulkers, and oil tankers - Japan and China specialize in building containerships and bulkers, while Korea is especially competitive at building tankers. European shipbuilding nations are specialized in passenger ships, dredgers, and ice classed vessels, which are typically higher value vessels (per CGT) than other commercial vessels. Italy, and to a lesser extent Germany, is particularly strong in designing and building passenger cruise vessels, the Netherlands and Belgium are specialized in dredgers, while Norway has particular strengths in designing and building ice-classed vessels and offshore vessels (EC, 2014). Shipbreaking, the demolition and scrapping of vessels, occurs primarily in South Asian countries, especially Bangladesh, India, and Pakistan, and China.

Box 2. Unique Aspects of Shipbuilding Data

There are several caveats to measuring the size and scope of the global shipbuilding industry that are important to take into consideration when evaluating this GVC.

The first is related to data providers. The primary source of industry statistics related to production, trade, number of firms and employment is typically compiled by national statistical offices and customs (trade) based on international classification systems. While these are available for shipbuilding, the main source used is supplied by private, third parties (Clarkson, IHS, Lloyds, Dewry). Due to the strong regulatory requirements for oceangoing commercial vessels (see information on classes), detailed production, ownership and service information is required to be collected by international classification societies. This data is collected for safety purposes, but it also useful for market research purposes. As such, several of these societies have separate units that sell this information via a separate business unit. That data collected by these agencies covers the entire population of shipyards (as opposed to samples in national statistics), and the level of detail is much higher. All three types of data are used in this report, and efforts to point out differences are made when possible.

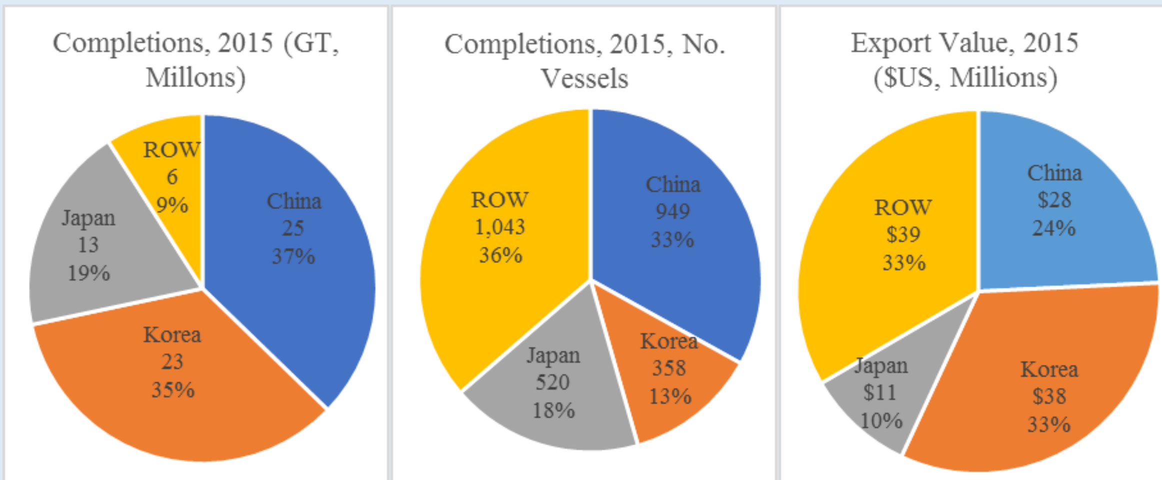
Second, the size of any segment also varies depending on the unit of measurement; the market is commonly described in terms of weight/carrying capacity of ships with common units including GT, CGT, DWT or TEUs. Market statistics are also produced based on orders, completions and deliveries (which can alter top categories and countries as well). The actual number of vessels produced and value are less commonly used, however the importance of the relative segments and top companies changes when using these indicators. Employment data also varies due to high use of temporary or contract workers (subcontractors).
IHS: 100GT+ (do not know original source of data, but matches Clarkson)
UNCTAD: propelled seagoing merchant vessels of 100GT or more (from Clarkson); excluding inland waterway vessels, fishing vessels, military vessels, yachts, and offshore fixed and mobile platforms and barges (except FPSO and drillships).
Clarkson: no definition, but IHS and UNCTAD generally match, so assume 100GT.

The third important feature is that (1) production is highly concentrated in a few countries, and (2) a significant share if purchased by domestic buyers. As such, production and trade data will provide different perspectives. Furthermore, ‘ship exports’ are convoluted by the fact that ships are often ‘flagged’ by a country that is not the ship owner/buyer, and the fact that ships are never ‘consumed’ in one country. Therefore, import statistics are not particularly pertinent.

Global Statistics on Shipbuilding

- Deliveries (2016): 1,664 vessels; 66.3 million GT; 34.7 million CGT; 100.5 million DWT; value: $80.2 billion (Clarksons, 2017b)
- Exports (2015): $117 billion (UNComtrade, 2016)
- Revenue (2016): $175 billion (IBIS, 2016)

- Production (Completions, 2015): 67.6 million GT; 2,870 ships (IHS, 2009-2016)
- Production (Deliveries, 2015): 64.1 million GT (UNCTAD, 2016); based on Clarkson (UNCTAD matches Clarkson in 2014; IHS matches in 2015)
- Contracted (2015): 38 million CGT (DSF, 2016)
- Active Shipyards (2015): 730 (DSF, 2016)
- Shipyards with new orders (2015): 240 (DSF, 2016)
- Korea: fewer, heavier vessels that are exported. China and Japan, similar weight/no. ratios, however China exports heavier vessels.

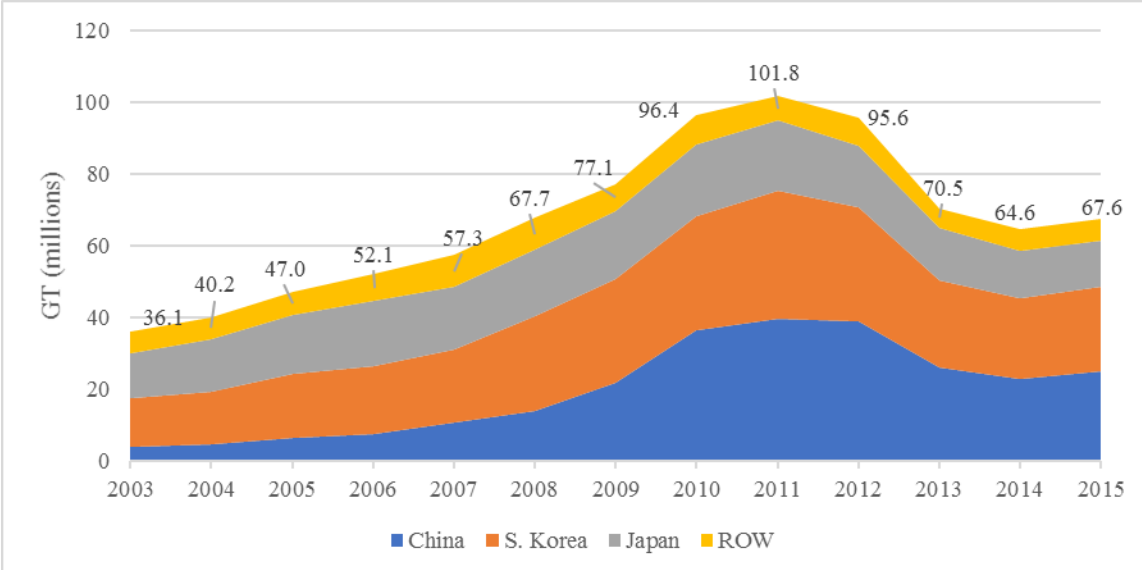


Completions from IHS (GT and #); Exports (UNComtrade)

The expansion of global new ship orders since the early 2000s was hit by the 2008-2009 economic crisis. New orders dropped from 170 million GT in 2007 to 34 million GT in 2009.[15] The economic recovery since 2010 has rekindled demand for new ships, raising new orders to 77 million GT in 2015.[16]

[15] Gross tonnage (GT), a measure of ship size, is calculated based on "the molded volume of all enclosed spaces of the ship" and is used to determine a ship's manning regulations, safety rules, registration fees and port dues.
[16] Based on IHS (formerly Lloyd's Register) *World Shipbuilding Statistics*, which only includes ships 100GT or over.

Figure 4. World Ship Completions by Country (GT, million), 2003-15



Sources: IHS (2009-2016); should be a new release in March 2017; for estimated shipments in 2016 and 2017.

In terms of vessels completed, China (37%), South Korea (34%), and Japan (19%) accounted for 91% of the world's approximately 68 million GT of ships completed in 2015 (see figure above). The Philippines completed 42 ships totaling approximately 1.9 million GT, roughly 2.8% of the world's total tonnage (see Table 2). The Philippines is also the only producer of larger ships to grow over the time frame (others with positive values, including Taiwan, Vietnam, USA and Brazil are producing ships lower weights).

Table 2. Top 10 Shipbuilding Countries (based on GT Completed), 2015

Rank	Country	No.	'000 GT	No. Share (%)	GT Share (%)	No. Change	GT Change	GT (000)/ Ship
		2015	2015	2015	2015	2010-15	2010-15	2015
	World Total	**2,870**	**67,566**			**-23%**	**-30%**	**24**
1	China	949	25,160	33.1	37.2	-33%	-31%	27
2	S. Korea	358	23,272	12.5	34.4	-32%	-27%	65
3	Japan	520	13,005	18.1	19.2	-10%	-36%	25
4	Philippines	42	1,865	1.5	2.8	24%	61%	44
5	Taiwan	56	749	2.0	1.1	167%	29%	13
6	Vietnam	90	591	3.1	0.9	-32%	6%	7
7	Romania	39	485	1.4	0.7	-9%	-21%	12
8	USA	75	427	2.6	0.6	-1%	79%	6
9	Germany	10	384	0.3	0.6	-72%	-59%	38
10	Brazil	32	361	1.1	0.5	52%	668%	11
Top 10 (based on GT) Share				76	98			

Source: IHS (2016); Note: No.=Number.

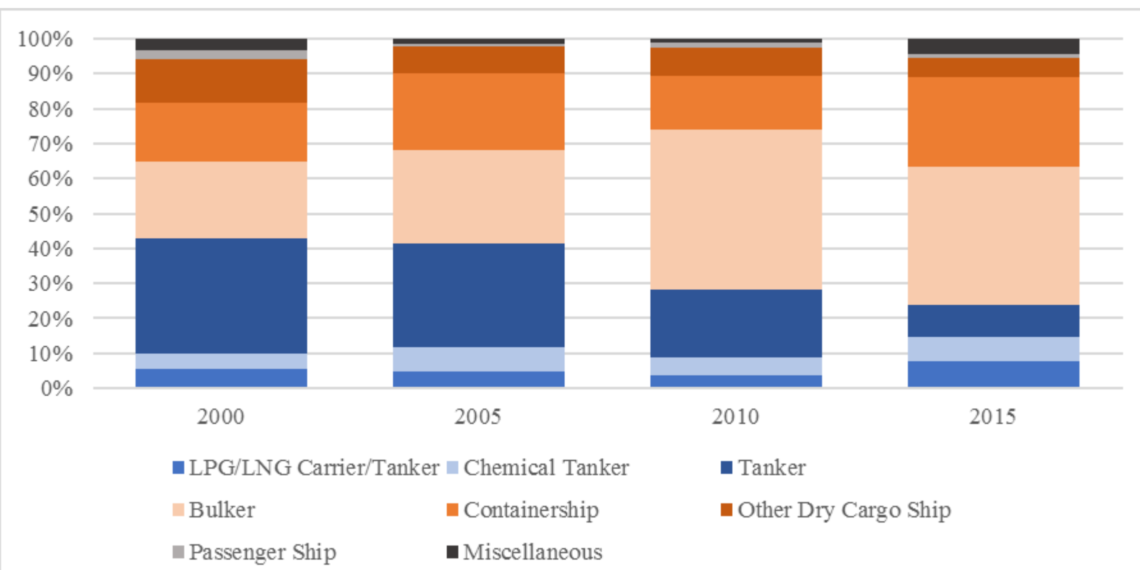
Regarding the type of vessels completed in 2015, product carriers dominated the market. Bulkers (39%), containerships (26%), and oil tankers (9%) are the top three vessel types in terms of world ship completions by gross tonnage (see Table and Figure). The share of LPG/LNG gas carriers has been rising in recent years (based on GT and numbers), indicating the growing markets for these vessel types. Offshore vessels account for less than 5% of GT, however they are much more important based on value.

Table 3. World Completions by Type (No. & GT), 2015

Rank	Type	No.	GT ('000)	No. Share (%)	GT Share (%)	No. Change	GT Change	GT (000)/ Ship	Countries
		2015	2015	2015	2015	2010-15	2010-15	2015	
	World Total	**2,870**	**67,566**			**-23%**	**-30%**	**24**	
1	Bulker	645	26,520	22%	39%	-35%	-39%	41	China, Japan
2	Containership	212	17,339	7%	26%	-18%	18%	82	Korea
3	Other Dry Cargo	332	3,876	12%	6%	-42%	-49%	12	China
4	Oil Tanker	130	6,384	5%	9%	-61%	-66%	49	Korea
5	LPG/LNG (Gas)	114	5,226	4%	8%	30%	42%	46	Korea
6	Chemical Tanker	208	4,588	7%	7%	-36%	1%	22	China
7	Miscellaneous	1,182	2,976	41%	4%	-54%	180%	3	
8	Passenger Ship	47	656	2%	1%	4%	-48%	14	
Bulker/Containership/Cargo				**41%**	**71%**				
Tankers (oil, gas, chemical)				**16%**	**24%**				
Offshore			*2,500*		**4%**		4%		

Source: IHS (2016); p. 7, p. 35 (for offshore). Offshore classified under 'miscellaneous' in IHS data, however Clarkson's includes offshore as a category.

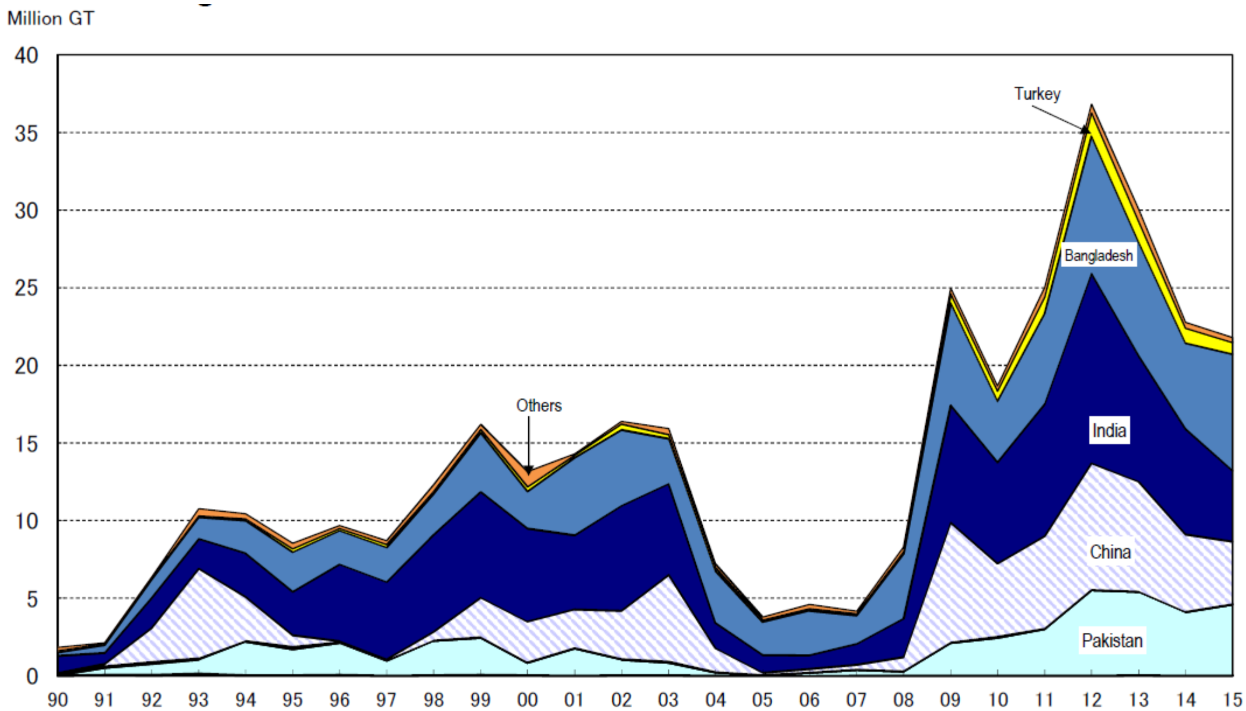
Figure 5. World Ship Completions, Shares by Type (GT), 2000-15



Source: IHS (2016)

A majority (63%) of the world's commercial shipping fleet, including oil tankers and bulk carriers, is under 10 years of age, 26% is between 10-19 years old, with the balance (11%) 20 years or older (IHS, 2016). The average in-service life for commercial vessels is 23 years, with sharp drop-offs in the probability of remaining in-service after year 25 (OECD, 2015a). World disposals peaked in 2012, with 38.4 million GT being scrapped. Bangladesh, India, China, Turkey and Pakistan are the leading countries for shipbreaking and disposal (Figure 6).

Figure 6. World Shipbreaking, by country (1990-2015)



Source: IHS (2016); Casualty Statistics, September 2016, Figure 9, PDF p. 20

Global ship exports

Global exports of ships were $117 billion in 2015.[17] The effect of the economic recession was noticed and disruptive to both trade in ships and in new orders. This difference is largely because ships delivered in 2008-10 were ordered before the recession began.[18]

Table 4. Top 10 Ship Exporters by Value & Year, 2007-2015

Exporter	Exports ($US, Billions)					Share of World Ship Exports (%)				
	2007	2010	2012	2014	2015	2007	2010	2012	2014	2015
Total	**88**	**156**	**140**	**123**	**117**					
Rep. of Korea	27	47	38	38	38	30%	30%	27%	31%	33%
China	12	40	39	25	28	14%	26%	28%	20%	24%
Japan	15	26	22	13	11	17%	17%	16%	10%	10%
Poland	3	3	4	5	5	4%	2%	3%	4%	4%
Germany	3	5	3	4	4	4%	3%	2%	3%	4%
India	1	4	4	5	4	1%	3%	3%	4%	3%
Saudi Arabia	1	1	2	2	2	1%	0%	1%	2%	2%

[17] These and following export figures were compiled from UN Comtrade, unless otherwise stated.
[18] The typical production time varies by the type of ship; a bulk cargo ship takes 6-9 months to build while a cruise or LNG ship takes up to 2 years or more for construction (European Commission, 2003, p. 11).

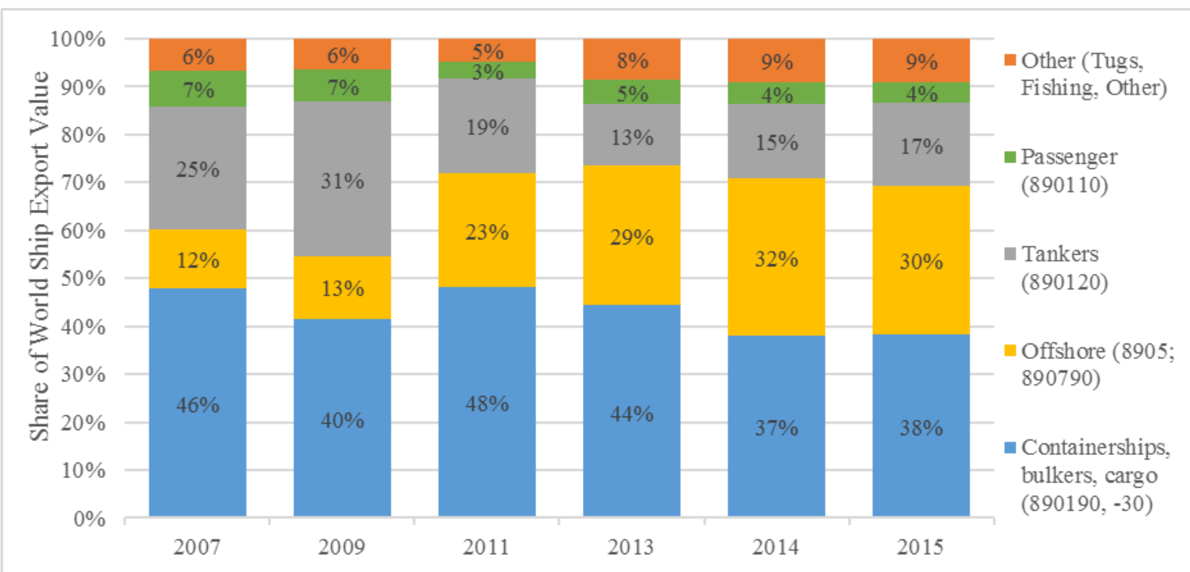
Exporter	**Exports ($US, Billions)**					**Share of World Ship Exports (%)**				
	2007	**2010**	**2012**	**2014**	**2015**	**2007**	**2010**	**2012**	**2014**	**2015**
Brazil	1	0	2	2	2	1%	0%	1%	2%	2%
Netherlands	1	1	1	2	2	2%	1%	1%	1%	2%
USA	1	1	2	1	2	1%	0%	1%	1%	1%
Top 10 (in 2015)	**80**	**140**	**124**	**104**	**107**	**75%**	**81%**	**83%**	**79%**	**85%**
Philippines	0	0	1	1	2	0%	0%	1%	1%	1%

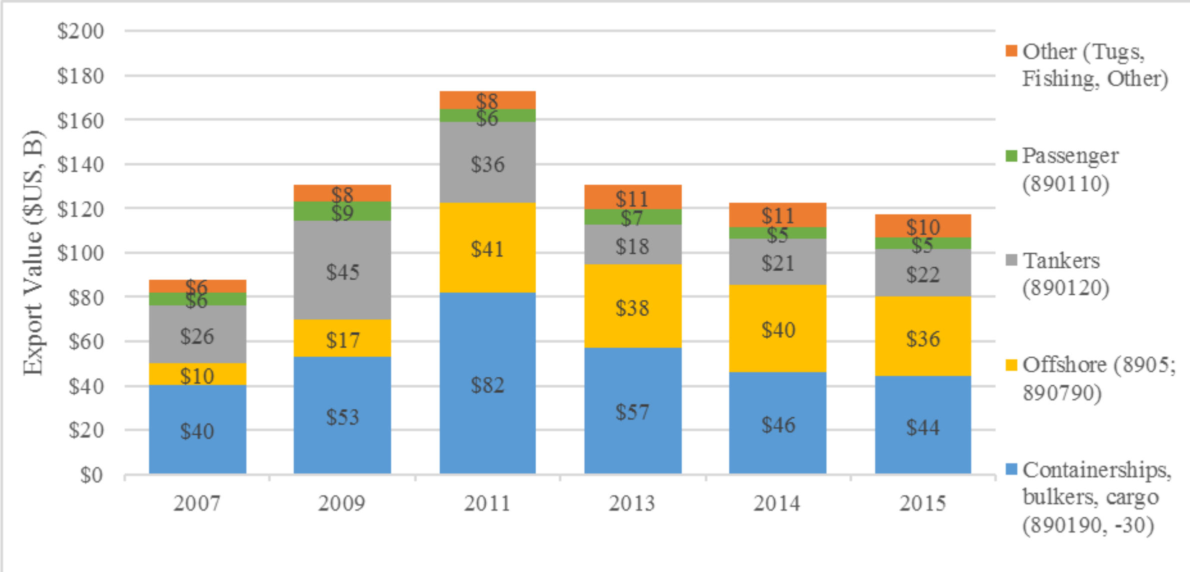
Source: UNComtrade (2016); updated 4/2/17

Korea is the top ship exporter whereas China is the top producer (based on GT) because at least one-third of China's production is for national buyers (see IHS Statistics appendix for sales for China, Korea & Japan by ship type and nationality). Korea is also a significant exporter of offshore vessels (lower tonnage).

Figure 7 shows the world's ship exports by vessel type. As with production, containerships/bulkers and tankers are two of the leading categories in exports. However, offshore ships account for a much larger share of the market based on value than by GT as these are smaller, higher value vessels (IBIS, 2016). They also account for a larger share because more are produced for external customers than domestic buyers.

Figure 7. World Ship Exports, by Type & Value, (US$ billions), 2007-2015





Source: UNComtrade (2016); updated 4/2/17

The table below lists the leading exporting countries in the major traded ship categories: (1) containerships, bulkers, cargo, (2) offshore, (3) tankers, (4) passenger ships. Collectively these categories accounted for 89% of exports in 2015. Korea, China and Japan are driving global exports in containerships, bulkers, and general cargo. Korea dominates the offshore category and in tankers. Passenger ships are primary from European countries.

Table 5. Top World Ship Exporters by Type & Value, 2015

	Overall	Container, Bulkers, Cargo	Offshore	Tankers	Passenger ships
Total Exports	$117 billion	$44 billion	$36 billion	$22 billion	$5 billion
Top 5 (by type)	Korea (33%)	China (37%)	Korea (47%)	Korea (58%)	Germany (38%)
	China (24%)	Japan (21%)	China (18%)	China (18%)	Italy (23%)
	Japan (10%)	Korea (20%)	India (8%)	Japan (8%)	Finland (10%)
	Poland (4%)	Poland (6%)	Brazil (5%)	Poland (7%)	Philippines (7%)
	Germany (4%)	Germany (3%)	Netherlands (4%)	Germany (3%)	Poland (4%)
Philip.	1.3%, 13th	2%, 6th	0%, 76th	0.2%, 15th	7%, 4th
Korea	33%, 1st	20%, 3rd	47%, 1st	58%, 1st	1%, 14th
HS02	89	890190, 890130	8905, 890790	890120	890110

Source: UNComtrade (2016); See Appendix table for codes, world and Philippines values. Other not shown (8902, 8904, 890690), but incl. in overall total. Philippines UNComtrade exports are not accurate. Updated 4/2/17.

Demand for large commercial shipbuilding is driven by trends in seaborne trade and vessel age (except offshore vessels and passenger vessels). Trade, measured in tons, has steadily increased since the 1990s reaching 10.5 billion tons in 2014.

2.4. Lead Firms and Governance Structure of the Shipbuilding GVC

Assembly and integration activities are organized as a tiered production system. The shipbuilder holds the contractual relationship with the ship owner. In commercial shipbuilding, the shipbuilder generally is responsible for hull fabrication, outfitting, and a range of service activities related to ship production, including procurement, sub-contracting, risk management, and scheduling, collectively known as Engineering, Procurement and Construction (EPC). The shipbuilder may also have design capabilities in-house. As EPC, the shipbuilder typically develops a list of system and subsystem suppliers appropriate to the vessel specifications. Although the ship owner may add additional suppliers, the final procurement decision is made by the EPC to optimize cost and performance. For example, a shipbuilder may provide two propulsion manufacturers in a list supplied to the ship owner, who after review may add one additional propulsion manufacturer. The shipbuilder will then select the propulsion provider from among the combined list. Thus, the shipbuilder and ship owner collaborate in selecting the system and subsystem suppliers.

Shipbuilders are responsible for hull construction and, typically, the outfit and furnishings on a ship. Depending on the capability of the shipbuilder and the complexity of the ship, major systems may be supplied either internally by the shipbuilding firm or by external firms. Some large shipbuilders are vertically integrated enough to use internally sourced propulsion systems to place on their ships; Hyundai Heavy Industries in Korea is a notable example. However, as the complexity of the ship increases, the more likely it is that systems are sourced externally from specialized firms. Below the shipbuilder are tier 1 companies, providing major systems for the ship. Additional tiers to this system supply subassemblies, components, and raw materials to the shipbuilder and tier 1 suppliers.

The organization of production in the shipbuilding sector is characterized by major systems, subsystems and service suppliers co-located at major shipyards, typically with branch offices (Woo, 2003). However, component suppliers are not "captive" in the sense that they only have one outlet for their products and services. Many component suppliers have multiple clients within the domestic and international shipbuilding sector. The degree of coordination and information exchange between buyer and supplier (i.e., value chain governance) depends on the level of product value and supply chain risk to the shipbuilder (EC, 2014). General products, defined as off-the-shelf standardized products, are characterized by low product value and low supply chain risk. The critical factors in general products are the acquisition costs and ease of ordering for the buyer, and quick response and delivery by the supplier. Pumps are an example of a general product in the shipbuilding sector because they have general specifications, are readily available in large quantities, and are manufactured by several suppliers. In GVC terms, general products are characterized by "market" governance.

Strategic products, defined as products that provide product differentiation competitive advantages to the shipbuilder, are characterized by high product values and high supply chain risk. The critical factors for strategic products are long-term sourcing, long-delivery lead times, and long-term contractual agreements between the supplier and shipbuilder. Engines and complex integrated bridge systems are examples of strategic products in the shipbuilding sector because they have special-to-type specifications, are developed cooperatively with the shipbuilder, and few manufacturers exist to provide the systems. Strategic partnerships are characteristic and value chain governance approximates a "captive" relationship between buyer and supplier.

Price critical products are high value (i.e., relatively expensive to produce and purchase) but with low supply chain risk due to their general availability in the market. These are standard catalog products such as diesel generators and deck cranes, that are available from several suppliers. Differentiation among suppliers is based on price and consistent product quality; suppliers are managed by the shipbuilder through supplier audits and individual price negotiations. Value chain governance approximates a "modular" relationship.

Finally, bottleneck products have relatively low value but are critical for the final product. Suppliers are differentiated by their ability to deliver on time with consistent product quality; they closely coordinate their activities with the shipyards to ensure timely delivery at a reasonable price. Examples are ship propellers and fire doors; value chain governance approximates a "relational" relationship between buyer and supplier (EC, 2014).

Shipbuilding is becoming increasingly concentrated; in 2015, only 240 shipyards received an order (although 730 were active), with 47% of orders going to 20 large shipyards (annual max capacity above 500,000 CGT) and another 47% to medium shipyards. Small shipyards only accounted for 6% of orders (annual maximum capacity of less than 80,000 CGT). Typical shipyard size also varies by country; Korea's orders are dominated by large shipyards (91% of new orders in 2015) whereas medium yards dominate in Japan (large was only 20% of new orders). China is composed of a fairly even split between large and medium firms (DSF, 2016). Based on this definition, there are no large shipyards in the Philippines. All large shipyards are in China, Korea, and Japan (DSF, 2016).

The number of large yards has remained constant, from 20 to 24, on average attracting 46% of annual contracting over the five-year period; 20 of the large yards have existed since at least 2011 (i.e., new large yards are uncommon).

Country	**2011 (Active)**	**2015 (Active)**	**2015 w/new orders**
China	191	200	75
Korea	22	30	13
Japan	48	70	55
Philippines	4		
Other		430	97
World		730	240

Source: 2011, Clarksons (2013); 2015, (DSF, 2016), p. 29-33. DSF data based on CGT, an international unit of measure that facilitates a comparison of different shipyards' production regardless of the types of vessel produced.

Offshoring production is uncommon in shipbuilding. Lead firms (with a few exceptions) primarily only own shipyards in their home country. This is at least partially tied to naval shipbuilding (countries want to keep the skills/technology to produce ships close to home for national defense reasons).

Table 6. Top Global Shipbuilders

OB Value*	Name	Revenue $US, B*	Emp. ('000)	Year Est.	Own.	Segments/Types (CGT, 2016)	Linkages/ Locations/	Yards
$24.4	Hyundai Heavy Industries (HHI)	$40.9 $16.4	27	1972	Korea, Ulsan KSE: 009540		Engines; steel; shipping HSHI: Mokpo, 2002 (acq.); $3.3B	3
$19.9	Daewoo (DSME)[19]	$13.3 $12.6	13	1973	Korea, Seoul KSE: 042660	Container (32%), LNG/LPG (32%), Oil Tankers (29%) Offshore (7%)		1-2
$10.5	Samsung Heavy Industries (SHI)	$8.6 $3.9	14	1974	Korea, Seoul KSE: 010140	Container (52%), LNG (36%), Offshore (13%)	China	2
	Hyundai Mipo Dockyard (HMD)[20]	$3.3		1975	Korea, Ulsan	Chemical tankers, containerships	Vietnam	2
	Tsuneishi				Japan	Bulkers (100%)	Philippines, China	3
	Yangzijiang Shipbuilding (Holding Co.)	$2.6	.9	2005	China Singapore SE: BS6	Bulkers, containerships	China (Jiangsu New YZJ), Singapore, USA	3
$9.9	Imabari Shipbuilding			1942	Japan Private	Bulkers, containerships, tankers, others		9
$15.1	China State Shipbuilding Corp. (CSSC)			1999	China, Beijing SOE		Shanghai Waigaoqiao SB (SWS)	3?
	China COSCO Shipping (COSCOCS)[21]		150	1999	China, Beijing SOE SSE: 601989	Dalian Shipyard largest. CSSC spin-off.	Backward: yes	7
	Hanjin Heavy Industries & Construction (HHIC)	$2.8 $1.5?	2.6	1937	Korea, Busan KSE: 097230	Container, bulkers, gas	Philippines	2
	Fujian Shipbuilding				China			4+
	Oshima Shipbuilding				Japan Private	Bulkers (100%)		1

Sources: Generally based on Clarkson's 2016 ranks by CGT, GT, DWT and number of ships completed. Other sources: WMN (2016)(orderbook value in $US billions as of March 2016; same data provided in Statista), IBIS (2016), Clarksons (2011), Worldyard Statistics (2011). For Korean companies: MarketLine Company Reports; KOSHIPA members; OneSource. Notes: Revenue column (*): first number is total revenue and second is shipbuilding-specific revenue for most recent year available.

[19] Recently had a yard in Romania, but sold: www.reuters.com/article/us-daewoo-restructuring-idUSKBN17K0KX
[20] HMD claims to have the largest global ship repair facility.
[21] Formed by Government of China in July 1999 from companies spun-off from CSSC, and is 100% owned by SASAC. CSIC handles shipbuilding activities in the north and west of China, while CSSC deals with those in the east and the south of the country (Wikipedia). Think is the same as China Shipbuilding Industry Corp (CSIC).

Table 7. Global Lead System Suppliers

System	Global Lead Firms
Propulsion/ Electric Power Generation	MAN Diesel (Germany), Wartsila (Finland) *Licensees of one or both of above companies:* HHI (Korea), Doosan (HSD) (Korea), Mitsui (Japan), Mitsubishi (Japan), Hitachi Zosen (Japan), Diesel United (Japan) *Others:* Caterpillar Marine Power Systems (US), GE (US), Rolls Royce (UK/US), TECO Westinghouse (US), ABB (Switz), Sulzer (Switz), Stadt (Norway), Schottel (Germany), Volvo Penta (Sweden)
Navigation & Electronics	Kongsberg Maritime (Norway); Siemens (Germany); ABB (Finland/Norway/Switz.); Wartsila/SAM Electronics (Netherlands); Imtech Marine (Netherlands); SperryMarine/Northrup Grumman (UK)
Communication	L-3 Communications (US); Inmarsat (UK); EADS/Astrium (France); Telenor Satellite Broadcasting (Norway); Cobham SATCOM (UK)
Cargo Handling	Cargotec (Finland); Liebherr (Switz); TTS Group (Norway); Scana Industrier (Norway)
Auxiliary Systems & Outfitting	HVAC: Bronswerk Marine (Canada); Ballast water treatment/emission control: Alpha Laval (Denmark), Wartsila Hamworthy (UK); Autronica Fire & Security (Norway); Winches: Bosch Rexroth (Germany) Electrical systems: Schneider Electric (France) Life-saving equipment: Survitec Group (UK)
Coatings/Paint	AkzoNobel (Brand: International Paint) (Netherlands), Hempel (Denmark) Chogoku Marine Paints (Japan), Jotun Paints (Norway), PPG Coatings (Belgium), Sigma Samsung Coatings (Korea), Subsea Industries (Belgium)
Other	Offshore Engineering & Construction: Saipem (Italy), Tyco Marine (UK); Technip (France); Aker Solutions (Norway)

Source: Authors; see also (EC, 2014)

Table 8. World Exports of Ship Subassemblies/Components, 2015

System/VC Stage	Specific	Item	Main Exporters	World Exports 2015 ($US, B)
Platform: Propulsion	Ship-Specific	Turbines for marine propulsion	Japan (42%), India (15%)	< $1
		-Spark-ignition reciprocating or rotary internal combustion piston engines -Outboard motors/Other	Japan (58%), USA (16%)	$3
		Compression-ignition internal combustion piston engines (diesel or semi-diesel engines)	Korea (23%) Germany (21%)	$4
	Not Ship-Specific	Nuclear reactors, boilers, machinery and mechanical appliances/Other engines and motors/Hydraulic power/Other	Germany (16%) USA (16%) UK (8%)	$3
		Parts for use with engines of heading 84.07 or 84.08 /Other/for use with spark-ignition internal combustion piston engines	Germany (19%) Japan (15%), USA (12%), Mexico (10%)	$30
		Parts/applies to ships and auto for engines other than internal combustion	Germany (24%) China (7%), US (7%)	$33
Mechanical	Ship-Specific	Propeller & blades	Japan (21%), Germany (14%) China (12%)	$1
	Not S.-Specific	"Other machinery self-propelled, other", 4D code lists ship derricks (crane)	Germany (24%) Japan (19%)	$3
	Not Ship-Specific	Radar apparatus, radio navigational aid apparatus and radio remote control	China (16%) Germany (14%)	$18

Navigation & Comm-unication		Surveying, hydrographic, oceanographic, hydrological, meteorological or geophysical instruments and appliances	USA (22%) UK/Germany (17%)	$9
		Navigation-related	USA (20%), France/ UK/Germany (30%)	$3
Hull/ Raw Materials	Not Ship-Specific	Steel	China (10%) Japan (9%) Korea (9%) Germany (7%)	$160
		Tubes & pipes & fitting (steel products)	China (19%) Germany/Italy (18%)	$71

Source: see Table A-2. Shipbuilding Subassemblies, Components & Raw Materials, HS02 Codes.

2.5. Standards and Institutions

The shipbuilding industry has several classification and certifications relevant to the design, production, and post-production phases of shipbuilding. "Classification" establishes that a ship[22] or offshore structure conforms to class rules developed by national classification societies during construction and time in-service, which are verified through periodic inspections called "surveys". Ship class rules are standards for the structural strength, integrity, and functioning of various parts of a ship, including the hull, propulsion, steering, power and essential service-related auxiliary systems (IACS, 2016). "Certifications" establish conformity with safety, health, and environmental statutory requirements found in international conventions or national legislation, including SOLAS and MARPOL (Table 9). Certification is a "provision by an independent body of written assurance (a certificate) that the product, service or system in question meets specific requirements" (ISO, 2017). Certifications in the marine industry are applicable to ships, offshore units and installations, marine equipment, training and management systems and thus are relevant to marine products and their components, services, people and systems (BV, 2017). We discuss classifications and certifications in turn below.

Table 9. Standard Setting Organizations and Agreements in the Shipbuilding GVC

Organization	Description	Reference
IACS	International Association of Classification Societies: Umbrella organization for the major twelve national classification societies, which comprise more than 90% of in-service cargo ships. The twelve members are listed in the box below.	www.iacs.org.uk/default.aspx
National classification societies	Classification societies set technical rules, confirm that designs and calculations meet these rules, inspect ("survey") ships and structures during construction and commissioning, and survey vessels to ensure that they continue to meet the rules during in-service	USA: American Bureau of Shipping (ABS) UK: Lloyd's Register (LR) Russia: Russian Maritime Register of Shipping Poland: Polish Register of Shipping (PRS) Korea: Korean Register of Shipping (KRS) Japan: ClassNK Italy: Registro Italiano Navale (RINA) India: Indian Register of Shipping (IRS)

[22] According to (IACS, 2016), "'ships' are defined as any ship subject to SOLAS safety certification and capable of unrestricted navigation" (footnote 2, p. 15).

Organization	Description	Reference
		Germany/Norway: Det Norske Veritas (DNV) Germanischer Lloyd (GL) (DNV-GL) France: Bureau Veritas (BV) Croatia: Croatian Register of Shipping (CRS) China: China Classification Society (CCS)
IMO	International Maritime Organization: United Nations agency founded in 1948; establishes standards on maritime safety, health and environmental protection.	www.imo.org/en/About/Pages/Default.aspx List of IMO conventions: www.imo.org/en/About/Conventions/ListOfConventions/Pages/Default.aspx
SOLAS	International Convention for the Safety of Life at Sea (1974): IMO convention that governs safety regulations for ships.	www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-%28SOLAS%29%2c-1974.aspx
MARPOL	International Convention for the Prevention of Pollution from Ships (1973, modified 1978, 1997): IMO convention that governs air and water pollution released from marine sources. **Annex VI,** limits sulphur oxide and nitrogen oxide emissions from ship exhausts and mandatory technical and operational energy efficiency measures aimed at reducing greenhouse gas emissions from ships.	www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-%28MARPOL%29.aspx

Sources: references in table.

Classification: The International Association of Classification Societies (IACS) is the umbrella organization for twelve of the world's major classification societies, including those of the U.S. (American Bureau of Shipping [ABS]), Korea (Korean Register of Shipping [KR]), China (China Classification Society [CCS]), and Japan (ClassNK). More than 90% of the world's cargo carrying ships' tonnage is covered by the classification standards set by the twelve member societies of IACS (IACS, 2016). The IACS also holds special status with the International Maritime Organization (IMO) with regards to the development and application of rules applicable to the shipbuilding industry, including those related to the International Convention for the Safety of Life at Sea (SOLAS) and MARPOL (marine pollution). While classification represents the level of compliance of a ship or offshore structure to rules set up by classification societies and verified by periodic surveys, they are not a warranty of the ship's safety, the seaworthiness of the ship, or that the ship is being operated in a manner consistent with its purpose, because classification societies have no control over how a vessel is manned, operated, and maintained between the periodic surveys (IACS, 2016).

Classification societies set technical rules, confirm that designs and calculations meet these rules, survey ships and structures during construction and commissioning, and survey (inspect) vessels while in-service to ensure that they continue to meet class rules.[23] In general, the

[23] The IACS (p.4) notes that more than "50 organizations worldwide define their activities as providing some form of marine classification service; however not all meet the definition given in Appendix 1" required for membership in IACS. The IACS requirements for membership are that the classification society: (i) publishes its own classification Rules (including technical requirements) in relation to the design, construction and survey of ships, and has the capacity to (a) apply, (b) maintain and (c) update those Rules and Regulations with its own resources on a regular basis; (ii) verifies compliance with these Rules during construction and periodically during a classed ship's service life; (iii) publishes a register of classed ships; (iv) is not controlled by, and does not have interests in,

construction, materials, structural strength ("scantlings") and workmanship of a ship's hull, equipment, and machinery are inspected to ensure compliance with classification society rules (KRS, 2017b).[24] During pre-production, designs are certified by the classification society, who must confirm that the design and calculations meet its technical rules. Details of the construction, materials, scantlings and the dimensions the ship's hull, equipment and machinery are submitted and approved before work on ship construction begins. Modification of certified plans must be re-approved before work begins (KRS, 2017b).

During production, classification societies certify that the vessels are constructed according to the approved design and are being built according to standards. Materials, equipment, auxiliary systems (i.e., cargo handling) and workmanship are inspected. Materials used on board must comply with manufacturing methods approved by classification societies. Equipment, including main engines, shafting, boilers, and electrical equipment, undergo shop trials simulating operating conditions to ensure that systems are functioning properly. Once installed on the ship, the machinery undergoes inspection to ensure that they are "in-class." Auxiliary systems, including cargo handling, must be manufactured and certified as compliant with safety regulations and given appropriate certifications. For cargo handling systems, this includes a safe working load certificate. Workmanship is examined by the classification society inspector (KRS, 2017b). For example, welds must be certified as being completed by a certified welder and following approved welding procedure specifications (WPS).[25] The specific qualifications of certified welders are determined by the classification society, but generally, certification requires the welder to produce test welds of acceptable quality, which are then subjected to visual examination, non-destructive testing (NDT), and mechanical testing. IACS and DNV (FR) require that welders are qualified to society recognized standards, specifically ISO 9606, ASME Section IX, ANSI/AWS D1.1.[26] Lloyd's Register (UK) requires that shipbuilders test the welders and weld operators as able to meet national standards, but is not specific as to what the standard is. ABS (USA) details its own program of welder qualification in its *Rules for Materials and Welding (Part 2)*. Welders qualified for more difficult welds are also approved for easier welds. As welding in shipbuilding has become more automated and mechanized, welding operators of mechanized or automated processes do not need to pass approval testing as long as they maintain records exhibiting their proficiency in programming and operating the equipment (Moore, 2009).

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ship-owners, shipbuilders or others engaged commercially in the manufacture, equipping, repair or operation of ships; and (v) is authorized by a Flag Administration as defined in SOLAS Chapter XI-1, Regulation 1 and listed accordingly in the IMO database, Global Integrated Shipping Information System (GISIS) (IACS, 2016).

[24] IACS notes that "Class Rules do not cover every piece of structure or item of equipment on board a vessel, nor do they cover operational elements. Activities which generally fall outside the scope of classification include such items as: design and manufacturing processes; choice of type and power of machinery and certain equipment (e.g. winches); number and qualification of crew or operating personnel; form and cargo carrying capacity of the ship and maneuvering performance; hull vibrations; spare parts; life-saving appliances and maintenance equipment" (IACS, 2016) (p.7).

[25] WPS is a document providing in detail the required variables for specific application to assure repeatability by properly trained welders

[26] EN 287 (standard for welding steel) has been replaced with ISO 9606 covering a variety of metals as of October 2015 and is now more like ASME Section IX. (www.twi-global.com/technical-knowledge/job-knowledge/a-comparison-of-bs-en-287-part-12011-with-bs-en-iso-9606-part-1-130/) ASME IX (arc welds) and AWS D1.1 (laser welds) cover different types of welds. A good description of Section IX and ANSI/DWS D1.1 is offered by www.thefabricator.com/article/shopmanagement/asme-and-aws-welding-codes-similarities-and-differences

Welders of IACS vessels are required to pass welding tests to demonstrate their ability to properly use the equipment and satisfactorily perform the operation per the WPS. Welders are certified by their employer or a third party, and the employer maintains a written document called a welder qualification test record (WQTR) stating the welder passed the test. The shipbuilder must maintain these records in the event the classification society audits the builder asks for the documents during an inspection. The WQTR may be for a specified amount of time, the duration of a specific project, or indefinitely if the procedure is not changed. Even though the welder is certified to his ability, the WPS is typically quite specific to the ship, shipbuilder and classification society requirements. As such, a welder should keep records of their qualifications, but if he were to change jobs, he'd likely be required to be tested by the new employer.

After assembly, classification societies ensure that the ship performs according to its rating, and passes relevant tests, stability experiments and trials before given a Certificate of Classification. The Certificate notes the ship's class, construction mark (procedure under which the ship and main equipment have been inspected), limitations regarding service, navigation, and operating conditions, and additional class notations designating compliance with additional voluntary criteria specific to the vessel type that exceed standard classification standards (IACS, 2016).

After delivery, classification societies ensure that vessels are being maintained according to the class rule requirements. Surveys are conducted annually, every three years ("intermediate surveys"), and every five years (class renewal or "special survey"), with class renewal being the most stringent survey. Other surveys required to maintain class are "bottom" surveys (examination of the ship's hull every 36 months), tailshaft (examination of screwshafts and tube shafts), and boiler surveys. Non-periodic surveys are carried out when the ship is damaged, repaired, sold, renamed, or required to undergo inspection by a State's port control inspection authority (IACS, 2016). A Certificate of Classification is issued if the vessel is found to be "in-class". If the ship is found to be out of class during a survey, a temporary certificate may be issued until minor repairs are completed ("suspension of class"), or the certificate may with withdrawn or invalidated ("withdrawal of class"). If defects or damage occurs between relevant surveys, the ship owner is required under IACS rules to immediately notify its classifications society (IACS, 2016). Damage and repair surveys are considered "non-periodical surveys" by IACS and must follow specific rules for vessels to remain in class. For older vessels, the construction rules in force during original construction are applicable, although the materials used and certificates required for repair must meet newbuild class requirements (GL, 2011).

Table 10. IACS Required Inspections ("Surveys")

Survey Name	Description	Frequency
Assignment of Class	Class is assigned to a vessel upon the completion of satisfactory review of the design and surveys during construction undertaken to verify compliance with the Rules of the Society.	**on completion of the new building**, after satisfactory surveys have been performed **ship transfer** between IACS members **on completion of a satisfactory specific class survey** of an existing

Survey Name	Description	Frequency
		ship not classed with an IACS society, or not classed at all.
Annual survey	The ship is generally examined. The survey includes an inspection of the hull, equipment and machinery and some witnessing of tests, so far as is necessary and practical to verify that, in the opinion of the surveyor(s) the ship is in a general condition which satisfies the rule requirements.	Annually (three months before to three months after anniversary date)
Intermediate survey	includes examinations and checks on the structure as specified in the Rules to verify the vessel complies with the applicable Rule requirements. Rule criteria become more stringent with age. According to the type and age of the ship the examinations of the hull may be supplemented by thickness measurements as specified in the Rules and where deemed necessary by the attending surveyor.	Every three years (three months before second to three months after third anniversary date)
Class renewal or "special" survey	Include extensive examinations to verify that the structure, main and essential auxiliary machinery, systems and equipment are in a condition which satisfies the relevant Rules. Examinations of the hull are supplemented by thickness measurements and witnessing of tests as specified in the Rules, and as deemed necessary by the surveyor, to assess that the structural condition remains effective and to help identify substantial corrosion, significant deformation, fractures, damages or other structural deterioration	Five-year intervals
Bottom or "Docking" survey	A bottom/docking survey is the examination of the outside of the ship's hull and related items. This examination may be carried out with the ship either in dry dock (or on a slipway) or afloat: in the former case the survey will be referred to as dry-docking survey, while in the latter case as in-water survey. The conditions for acceptance of an in-water survey in lieu of a dry-docking survey will depend on the type and age of the ship and the previous history	Hull and related items are examined on two occasions in the five-year period of the certificate of class with a maximum of 36 months between surveys. One of the two bottom/docking surveys to be performed in the five-year period is to be concurrent with the class renewal/special survey
Tailshaft survey	A tailshaft survey is the survey of screwshafts and tube shafts (hereafter referred to as tailshafts) and the stern bearing. Three different types of tailshaft surveys exist: **partial, modified, and complete**. "Complete" means that the shaft is drawn up for examination or that other equivalent means of examination are provided. Partial and modified are more limited examinations.	**Partial**: permits the postponement of the complete survey, having a periodicity of 5 years, for 2.5 years. **Modified**: alternate five-yearly surveys for tailshafts provided the shaft arrangement is in accordance with specific requirements. **Complete:** based on the type of shaft and its design.
Boiler survey	Steam boilers, superheaters and economizers are examined internally and externally. Boilers are drained and prepared for the examination of the water-steam side and the fire side. External surfaces must be accessible for inspection by removal of insulation and lining when necessary.	Boilers and thermal oil heaters are to be surveyed twice in every five-year period. The periodicity of the boiler survey is normally 2.5 years.
Non-periodical survey	• to update classification documents (e.g. change of owner, name of the ship, change of flag); • to deal with damage or suspected damage, repair or renewal work, alterations or conversion, postponement of surveys or outstanding conditions of class; • At the time of port State control inspections.	Earliest opportunity and without delay

Source: IACS (2016)

Certifications: Certifications establish compliance with international and national statutory (legal) requirements regarding the safe and sustainable operation of ships. Certifications cover ships, marine equipment, people and management processes.

Statutory certification of ships: The United Nations Convention on the Law of the Sea (UNCLOS) in 1948 established the International Maritime Organization (IMO) which sets out uniform safety, security, pollution mitigation, and sustainability requirements to promote commerce by ensuring that a ship registered in one country is accepted by the waters and ports of another (IACS, 2016). Statutory certifications of ships required by IMO are in four broad areas: (1) the ship's design and structural integrity; (2) pollution control during normal ship operation (see below); (3) accident prevention; and (4) accident mitigation, including accident containment and accident escape. The statutory certification of the ship's design and structural integrity may be fulfilled by the results of the classification survey conducted by classification societies; in other words, the classification survey may be given the status of the required statutory survey if the classification society is designated by a country as the recognized organization to perform this function under UNCLOS (IACS, 2016).[27]

Pollution control during normal ship operation must comply with several statutory and treaty obligations. Most notable among these are the ballast water convention (2004 International Convention for the Control and Management of Ships' Ballast Water and Sediments) requiring the bilge to be free from fouling organisms by September 2017, and the International Maritime Organization's adoption of enhanced environmental regulations, including reductions in the emission of marine air pollutants ("MARPOL") from ships. MARPOL Annex VI, first adopted in 1997, limits the main air pollutants contained in ships exhaust gas, including sulphur oxides (SOx) and nitrous oxides (NOx), and prohibits the deliberate emission of ozone depleting substances (ODS). MARPOL Annex VI also regulates shipboard incineration, and the emissions of volatile organic compounds (VOC) from tankers. Conventions under the revised MARPOL Annex VI, entered into force in July 2010, also establish emission caps and special emissions control areas (ECAs) for sulphur oxide and nitrogen oxide emissions in specific geographic areas (IMO, 2017a). The global sulphur cap is 3.50% m/m (mass/mass), falling to 0.50% m/m on January 1, 2020. Inside ECAs, the sulphur cap is 0.10% m/m (IMO, 2017b). The revised MARPOL Annex VI also include the Energy Efficiency Design Index (EEDI), requiring stepwise reductions in CO_2 emissions from 2000 levels, including 10% in 2015, 20% in 2020 and 30% in 2025 (IMO, 2017b).

Marine equipment certification: Classification societies also establish procedures to approve marine equipment suppliers. For example, since 1999, EU's Marine Equipment Directive (MED) requires certain categories of marine equipment placed on European ships to have an EU marine equipment "conformity mark." The categories of equipment include lifesaving appliances (i.e., lifeboats and lifejackets), marine pollution prevention equipment, fire protection equipment, navigation and radio communication equipment (BV, 2017). Korea's Classification Society (KRS) identifies radio equipment, fire extinguishing equipment, lifesaving equipment,

[27] For offshore units, the American Petroleum Institute (API) maintains standards. Additional information here.

voyage recorders and low location lighting (LLL) systems as among the marine equipment requiring certification to be compliant with KRS rules and national legislation (KRS, 2017a).

Management processes: Various standard management system process standards are relevant to the shipbuilding industry. Among the most common are ISO 9001, 14001, 28000, 28007, 50001 and OHSAS 18001. ISO certifications are typically valid for three years (see table below for description).

Table 11. Management System Certifications in Shipbuilding

Standard	Description	Source
ISO 9001	Quality management certification	https://www.iso.org/obp/ui/#iso:std:iso:9001:ed-5:v1:en
ISO 14001	Environmental management system certification	https://www.iso.org/obp/ui/#iso:std:iso:14001:ed-3:v1:en
ISO 28000	Supply chain security management certification	https://www.iso.org/obp/ui/#iso:std:iso:28000:ed-1:v1:en
ISO 28007	Guidelines for Private Maritime Security Companies (PMSC) providing privately contracted armed security personnel (PCASP) on board ships	https://www.iso.org/obp/ui/#iso:std:iso:28007:-1:ed-1:v1:en
ISO 50001	Energy efficiency management system certification	https://www.iso.org/obp/ui/#iso:std:iso:50001:ed-1:v1:en
OHSAS 18001	Occupation health and safety management system certification	http://www.osha-bs8800-ohsas-18001-health-and-safety.com/ohsas-18001.htm

National legislation on inland and nearshore commercial vessels: Many countries designate coastal and inland waterways as closed to international vessels. The limitations are variously defended as required on national security and national capability grounds. For example, in Japan the limitations on foreign vessels in these waters is defended as protecting the domestic shipping industry from foreign competition, preserving domestically owned shipping infrastructure for national security purposes, and ensuring safety in congested territorial waters (JFCSA, 2011). The restrictions also may guarantee work for domestic shipyards if ships built in the country are required (UNCTAD, 2016). Known as "cabotage" restrictions, the laws require vessels operating in coastal and inland waters to be flagged by the country and manned by sailors with citizenship or permanent residence in the country. In the U.S., the Jones Act (Merchant Marine Act of 1920) requires all goods transported by water between U.S. ports to be carried on U.S.-flag ships, which must be constructed and owned by U.S citizens, and crewed by either U.S. citizens or permanent residents.[28] Other countries with cabotage laws include Argentina, India, and Malaysia (UNCTAD, 2016).

2.6. Human Capital and Workforce Development

Shipbuilding is highly labor intensive, with the largest shipyard employing tens of thousands of workers. Workers tend to be skilled labor, ranging from welders to marine engineers. In countries with low labor costs, labor intensity tends to be higher as operators take advantage of lower wages. There were approximately 1 million employed by the ship and boat building

[28] http://www.maritimelawcenter.com/html/the_jones_act.html

industry globally in 2016 (IBIS, 2016). A report by the OECD estimated global employment in 2010 to be 1.875 million (OECD, 2016a).

Given the project-based nature of shipbuilding, subcontracting is common. Subcontracting occurs in two ways. The primary shipbuilder hires subcontracted laborers (instead of regular workers) for shipyard workers (i.e., welders, fitters, operators, etc.). Although they receive temporary contracts, given the time to build a ship, they are often for a year and tend to be renewed given work at the shipyard is steady. Alternatively, primary shipbuilders will issue a subcontract (i.e., outsource) a portion of the assembly process to a nearby shipyard. In many cases these subcontracted firms locate in the same facility as the primary shipyard and operate as if they were a part of the main company.

Like materials and equipment purchases, the relative share of labor costs varies based on ship type and country, but fall in the range of 15-30% (IBIS, 2016; Korean Shipbuilding Stakeholders, 2017; Philippines Shipbuilding Stakeholders, 2016). Generally, ships with a higher share of material versus equipment costs will require more labor (i.e., bulkers, containerships).

Table 12. Employee Profile for the Shipbuilding Value Chain

Position	Share	Median Hourly Wage ($)	Education	Job Characteristics
Production/ Assembly	71%	$22	High school and technical college	Production, Construction, and Maintenance, including Welders, Crane Operators, Steel Cutters, Outfitters, Painters
Technical/ Engineers	11%	$34	Technical, college, and/or post-graduate education	Engineers (electrical, mechanical, marine, naval architects; design (CAD))
Administrative	13%	$25	Technical, college, and/or post-graduate education	Business and financial operations, office and administrative support, sales & marketing
Managerial	4%	$53	Post-graduate	Management occupations
Subcontractors	46%			Approx. share of employment; primarily from production workers

Source: wage and share data based on BLS (2015). Occupational breakdown is similar for Korea based on data from KOSHIPA (2001-2015)(also OECD data). Subcontractor share based on Japanese data from IHS (2009-2016).

Shipyard workers are needed to perform a variety of different tasks including welding (blocks and pipes), fitting (pipe fitting/ship outfitting), painting, masonry/carpentry, electrical work, and plumbing. The types of workers needed to build a ship are like those in the construction industry, and to a lesser extent other transportation equipment such as automobiles, airplanes, or trains. Given the importance of regulations and safety in shipbuilding and all transportation industries, workers must demonstrate their ability to perform to standard operating procedures for specific tasks (i.e., welding) and employers are required to maintain documents proving their capabilities. As such, training and workforce development are important for shipyards building and repairing IACS vessels.

In Singapore, a quality workforce is hallmarked by a strong training culture in the industry. Major shipyards and marine companies have invested in training infrastructure and resources in-house to ensure that workers are trained and reskilled continuously to keep up with changing requirements to execute work safely. The key industry players worked with the Association of Singapore Marine Industries (ASMI) to set competency standards, develop generic curriculum for training of marine workers and supervisors as well as certify workers' skill competency.

In recent years, academic courses on marine and offshore technology have been introduced at the technical, diploma and degree levels to ensure a continuous pipeline of trained manpower to support the specialized manpower needs of the industry. ASMI continues to partner key industry players to offer scholarships to students enrolled in relevant courses at the technical institutes, polytechnics and universities. This collective offering of scholarships is aimed at attracting more talents to join the industry as well as to groom competent leaders for the industry (ASMI, 2014).

2.7. Upgrading Trajectories in the Shipbuilding GVC

Upgrading in the shipbuilding industry can be analyzed in two ways. The first approach is to define the level of sophistication and capability of a company within a segment of the value chain as low, medium, or high, and to find pathways to increase the level of sophistication of the firm. In pre-production segments, upgrading of capabilities requires improvements in research, design and purchasing. Within design, the challenge is moving from the design of relatively simple components, to the design of systems with multiple components, to the design of ships with multiple systems, and from there to the design of increasingly more sophisticated vessels. Bulkers are considered relatively simple commercial vessels, while passenger vessels and icebreakers are some of the most sophisticated. In the research segment, firms with low levels of capability in research modify existing products and add simple customization to existing products, for example redesigning existing ships for conversion and refitting. Firms with a medium level of sophistication in research could design a new hull with increased efficiency or sturdiness, for example STX Canada Marine's (now Vard Marine) design of Canada's Icebreaker procured under the National Shipbuilding Procurement Strategy (NSPS). Firms with high levels of research capabilities invest in basic research to create new products. For example, Akzo Nobel/International Paints (NL) developed new antifouling paints that are biocide-free due to their extremely slippery surface, which limits the ability of fouling organisms to grow on the hull while also increasing fuel efficiency.[29] The purchasing capabilities of companies can also be tracked along a continuum of less to more sophisticated supply chain management practices. Companies with a high level of sophistication search for global component suppliers and evaluate them using balanced score cards to determine ongoing suitability for inclusion in their supply chain.

Within the production segment of the value chain, firms can be evaluated based on the type of commercial vessel they produce. Fincanteiri (IT) is a well-known cruise ship designer and shipbuilder, constructing some of the newest and most sophisticated class of passenger vessels around the world for Carnival and Norwegian Cruise Lines. Each ship requires sophisticated design and engineering, in part customized for the intended passengers and ship owner. In

[29] http://www.international-marine.com/foulrelease/foul-release-home.aspx

contrast, China's Yangzhou Guoyu Shipbuilding Company produces relatively simple cargo vessels and bulk carriers that contain few modifications from each ship produced by the shipyard. These vessels are much simpler to produce, requiring little innovative design or sophisticated integration of components. A third category of vessels, offshore vessels, can range from the very simple (supply vessels) to the complex (drill ships). Due to their broad range of sophistication, shipbuilders of a variety of capabilities can participate in this segment of the market, eventually increasing the range of products provided by increasing their capability in the market segment.

In the post-production segment, companies provide a range of maintenance, repair and overhaul (MRO) services to in-service vessels to ensure that they remain compliant with classification society requirements. Shipyards and service providers within this market segment can be distinguished by the types of vessels and systems they are qualified to work on. Highly capable companies work on complex systems and vessels, while less capable companies work on less sophisticated systems and vessels. As noted in the standards and institutions section, shipyards specializing in ISS and MRO must be capable of meeting classification society requirements for the ship class, which generally requires the ability to meet new construction welding processes. In addition to post-production services are ship breaking services, which scrap vessels after their useful life. Interestingly, many of the South Asian countries with extensive experience in shipbreaking are now developing their own shipbuilding industries (Johari, 2011). Thus, shipbreaking can be a pathway into shipbuilding. Figure 8 describes how companies in the shipbuilding industry can upgrade capabilities within each segment of the shipbuilding value chain.

Figure 8. Capability Upgrading in the Shipbuilding GVC

Stage	Value Chain Segment	Capability Level	Activity	Example
Pre-production	Research & Design	Low	Product design modification and customization	Re-designing ships for conversion and refitting
		Medium	Applied research and new product design	Developing a new hull design with advanced capability or efficiency
		High	Basic nautical research	Conducting scientific research to develop new anti-fouling coatings
	Purchasing	Low	Local search for supply chain partners	Shipbuilder identifies outfitting contractors within 20 km of plant
		Medium	Local and regional search for supply chain partners + practice of simple supply chain management practices	Shipbuilder scans for regional outfitting contractors and maintains informal quality assessments of suppliers
		High	Regional and/or global search for supply chain partners + sophisticated supply chain management practices	Shipbuilder seeks "best in class" component producers and evaluates suppliers with balanced scorecards
Producti on	Production	Low	Construction + assembly of simple vessels	Cargo vessels and bulk carriers
		Medium	Block construction + assembly for moderately complex vessels	Producing moderately sophisticated ships (oil tankers; Ro-Ros)

		High	Fully integrated block construction + assembly for complex vessels	Producing sophisticated passenger ships (cruise ships) or military vessels (frigates; aircraft carriers)
Post-production	Marketing, distribution and post-production services	Low	Domestic distribution + MRO	Domestic distribution and MRO repair network for locally owned and operated commercial vessels
		Medium	Domestic + regional distribution and MRO	Regional distribution of assembled vessels and providing MRO for regionally-owned and operated commercial + passenger vessels
		High	Domestic + regional + international distribution and MRO activities + advanced post-production services, such as consulting & training	Global export of assembled vessels; providing MRO for globally-owned and operated commercial/passenger or sophisticated military vessels; providing post-production services for commercial/passenger + military vessels

Source: adapted from Brun et al. (2012)

A second path to upgrading is to distinguish between product, process, functional, and inter-sectoral upgrading.

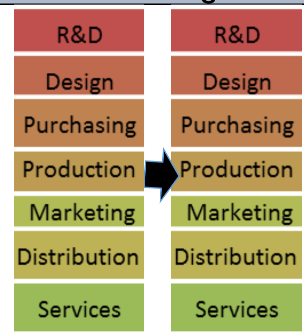
- **Entry** into the value chain is a necessary precondition to upgrading and exemplified by a firm entering the shipbuilding segment and offering a simple product or service within the shipbuilding industry. Examples could include companies producing a simple boat placed on a larger seagoing vessel, or offering welding subcontractor services. In either case, the firm has a narrow focus to provide a product or service to a specific customer or end-market in the shipbuilding industry.
- In **process upgrading**, a firm produces a product or service more efficiently. For example, some shipbuilders have adopted robotic plasma steel plate-cutting to improve cutting quality, speed, and waste reduction. In-sourcing and outsourcing decisions are also process upgrading practices used in the shipbuilding industry.
- The purpose of **product upgrading** is to increase the value of the good or service produced by a firm. For example, a firm could produce a more durable product or provide a service requiring advanced engineering capabilities more valued in the marketplace.
- Upgrading can also be achieved by establishing additional **backward linkages** in the production-related segments of the chain. This concept is most often used to describe a country's position in the GVC. An example would be if a ship assembly facility or country imports all inputs establishes a local engine, steel or propeller manufacturing operation (typically via FDI).
- In **functional upgrading**, a firm enters new segments of the value chain. Examples include adding maintenance services to existing product offerings. For example, a company may start in ship repair or as a contract manufacturer, but over time takes on additional responsibilities such as input purchasing, logistics, NPD, or marketing.
- Finally, **end market upgrading** allows companies from one sector to enter another sector (this is particularly relevant for component and subassembly suppliers). For example, ClearView (PL) manufacturers and repairs glass for both ship portholes and airplane windows due to their need for similar performance and maintenance

requirements.[30] End market upgrading or diversification can also occur from a geographic perspective; in developing countries, this is often a shift from the domestic to foreign export markets.

Figure 9. Types of Upgrading in the Shipbuilding Value Chain

	Value Chain Segments	Description	Example
Entry	Production / Services	• Firm offers basic shipbuilding services. • Focus of the company may be relatively narrow to focus on a specific customer, product, service or end-market.	• Company provides welding services for block construction. • Company provides design services for simple commercial ships.
Increasing productivity (Process Upgrading)	Purchasing / Production / Marketing / Distribution	• Company focuses on increasing the productivity of value chain segments. • Reconfigures production processes, pre- and post-production activities to become more efficient. • Outsourcing and in-sourcing are considered as options for increasing productivity.	• Company reconfigures production line to be more efficient. • Company streamlines distribution network to focus on getting products to market faster. • Company outsources product design to specialized firm, or chooses to purchase vital component product supplier.
Better products or	Production / Services	• Company offers better, higher quality products and/or services. • Focus of the company is to increase unit value of products or services offered.	• Company produces more durable or better designed products. • Company offers services requiring advanced engineering capabilities.
Expansion across value chain segments	R&D / Design / Production / Services	• Firm adds services to existing product manufacturing or adds product manufacturing to services. • Focus of the company expands to an increasing number of value chain segments, products, or services. • Company may carry out pre-production processes, such as design or product development with a major customer or research partner.	• Shipbuilder offers design or MRO services

[30] http://www.europages.co.uk/CLEAR-VIEW/00000004523449-001.html

	Value Chain Segments	Description	Example
Selling across end markets (End Market Upgrading)		• Company finds new product markets for existing products, or modifies existing products for customers in new end-markets.	• Company uses experience in ship design to enter underwater vehicles market • Shipbuilder enters oil & gas platform or underwater construction market

Source: modified from (Brun et al., 2012)

While listed separately above, the various types of upgrading often occur in combination. For example, Hawboldt Industries (CAN) traditionally only produced winches for shipboard use; however, due to the interest of one of its customers, International Submarine Engineering (ISE), it now designs and builds the Launch and Recovery System (LARS) for ISE's autonomous underwater vehicle (AUV).[31] In this case, Hawboldt engaged product upgrading (making a more sophisticated product) and functional upgrading (participating in design with manufacturing).

3. Lessons from Other Countries

To help define the potential upgrading of the Philippines in the shipbuilding value chain, the upgrading experiences of other countries, Korea and Brazil were examined. Singapore's involvement was also considered given the added focus on ship repair. The case of Brazil is particularly relevant for its innovations in workforce development, while Korea provides examples of strong government commitment with a focus on backward linkages.

3.1. Republic of Korea

Development

Both international and national level factors led to Korea's rapid emergence as a commercial shipbuilding powerhouse (Bruno & Tenold, 2011). Internationally, the oil crises of the early 1970s led to a rapid decline in demand for shipbuilding, which affected high cost shipyards in Europe more than the lower-cost shipyards in Japan and Korea. Europe's main shipbuilding nations could not keep up with productivity improvements necessary to maintain their global leadership despite attempts to use public funding to improve shipyard productivity (Bruno & Tenold, 2011). Domestically, Korea established key national policies targeting the development of heavy industries, including shipbuilding. The Third Five Year Development Plan (1972-1976) targeted heavy and chemical industrialization (HCI), which included shipbuilding, as a key objective for economic growth in Korea. Korea selected HCI development as important for sustained economic growth due to what it saw as an eventual reduction in its competitive advantage in light manufacturing exports resulting from inevitable increased labor costs and greater international competition (Bruno & Tenold, 2011). In addition, national security concerns resulting from the announced desire of the US in 1969 to reduce its presence in Asian

[31] http://hawboldtind.com/project/launch-recovery-system-for-autonomous-underwater-vehicle-auv/

countries (the "Nixon Doctrine") and the eventual one-third reduction of US troops in Korea in 1971, made the development of shipbuilding for defense purposes a national priority.

In March 1973, the Korean Ministry of Trade and Industry (MTI) announced the Shipbuilding Development Plan which had several objectives. South Korea would be self-sufficient in vessels by 1980 and shipbuilding exports should reach 1 billion US$ (3.2 million GT) by 1980 and 2 billion US$ (6.2 million GT) by 1985. The plan designated that nine shipyards should be constructed by 1980 and another five by 1985. To help achieve these goals, Korea provided capital incentives, infrastructure and steel industry investments, trade incentives and tax holidays. The capital incentives included low nominal rates from state-owned banks, which made real interest rates for preferred sectors negative for most of the 1970s, and government guarantees for foreign loans. Complementary investments included large infrastructure programs for new facilities in both the shipbuilding and steel industry (Bruno & Tenold, 2011). Hyundai Heavy Industries (HHI) was designated by the Korean government as leading shipbuilding production (Bruno & Tenold, 2011). As a *chaebol*, HHI was supported by the government to achieve a competitive level of efficiency in production, and was managed in a hierarchical, top-down, and centralized manner in close cooperation with the national government in return for the support (Hassink & Shin, 2005). HHI was established in March 1972 and began constructing its shipyard in Ulsan at the same time as it was (famously) building two oil carriers for Greek shipowners. Both the shipyard and ships were completed in 1974. It became the largest shipbuilder in the world in 1983, a position it still holds in 2017.

The Fourth Five Year Development Plan (1977–81) included several objectives for the shipbuilding sector. The Development Plan emphasized the goal of producing ship components domestically and the use of government purchasing to increase demand for shipbuilding. Additional financing came from the National Investment Fund and foreign loans. Due to overcapacity and low international shipping rates in the shipbuilding industry during the period, the number of planned shipyards was reduced in the Development Plan from nine to two (Bruno & Tenold, 2011). Two other chaebols, Daewoo and Samsung, entered the shipbuilding market in the late 1970's. In December 1978, Daewoo purchased the KSEC shipyards at Okp'o and completed it in January 1981. Samsung purchased the Geoje Shipyard and began shipbuilding operations in September 1979. Daewoo and Samsung also received state support in the form of preferential access to financing and lending guarantees (ibid).

To develop shipbuilding technological capacity in the country, Korean shipbuilders used technological assistance and license agreements with foreign shipbuilders and component suppliers. HHI received dockyard designs from A&P Appledore (UK), ship designs and shipyard operation instructions from a second UK company, Scott Lithgow, and production knowledge from Kawasaki Shipbuilding (JP) (Bruno & Tenold, 2011). Samsung, Daewoo, and smaller shipbuilders in Korea developed 159 license agreements and spent $117 million from 1962-1987 to develop shipbuilding productive capacity (Gomes-Casseres & Lee, 1989). Bruno and Tenold (2011) argue that a critical element for upgrading the Korean shipyards was due to European shipbuilders who, during the shipping crises of the 1970s and early 1980s, were unable to secure new shipbuilding orders and as a result were willing to sell technology and services to the Korean yards. The agreements included access to European engineers who, as expatriates, worked at HHI's Ulsan Shipyard for the first three years of its operation, and overseas training in shipbuilding technology and management by Appledore and Scott Lithgow.

Similarly, during the 1970s and early 1980s, most shipbuilding components were imported, yet by the end of the 1990s, between 70-80% of components were supplied domestically (Bruno & Tenold, 2011). To achieve this level of domestic production, companies either created the capability to produce components themselves or used Korean manufacturers. Hyundai developed, with technical assistance, licensing, and overseas training, the ability to make engines and other ship components (Amsden, 1989). Samsung used its electronics division to develop and purchase electronic component systems for its shipbuilding unit. During the 1980s, R&D in shipbuilding components were developed in partnership with the Korean government, shipbuilders and component suppliers. Hyundai Mipo developed a research center in Ulsan; Samsung established a research center in Daejon, and governmental research institutes have also been active in adopting and developing increased capability in ship component systems. The Korean Institute of Machinery and Materials (Daejon and Changwon), Pusan University's Advanced Ship Engineering Research Center, and the Korea Electronics and Telecommunications Research Institute (ETRI) have been important in developing ship systems, with ETRI leading the development of electronic devices for shipbuilding, including semiconductors, telecommunications and information technology (Shin & Hassink, 2011).

Leading technological development in both shipbuilding and shipbuilding component production have allowed Korea to remain globally competitive in terms of productivity, exports, and improving the types of ships it produces. Prior to the 1970's, Korean shipbuilding was primarily concentrated in wooden ship and small fishing vessel construction; today it is a global leader in VLCCS, LNG/LPG ships, FPSOs and drillships and entering into higher cost and technologically sophisticated ice-classed and passenger vessels. It could only have achieved this level of success by continually investing in its production facilities to make them more efficient, able to meet global demand, and be at the forefront of technology development and adoption (Sung-hyuk, 2010). Interestingly, while Brazil, Taiwan, and South Korea all tried to enter the shipbuilding market during the 1970s using similar state-led development approaches and a focus on price competitiveness, only Korea was able to flourish due to its ability to maintain shipbuilding activity that was not only based on low wages but improved productivity and backward linkages (Bruno & Tenold, 2011).

Policies of the Korean government revolve around three aspects: upgrading and maintenance of facilities, technology development, and "localization" of equipment and machineries (Mendoza, 1994). The Korean case provides an example of a well-developed 'cluster-type' strategy that focused on developing backward linkages to key inputs, investment in R&D and public-private research and training institutions, as well as developing horizontal linkage to similar industries in the country at the same time (i.e., heavy industries including automotive and construction).

Competitive Strengths

The Korean shipyards' market share of containership newbuilding orders is driven by their (1) efficient yard management, and (2) ability to retain skilled manpower, particularly for welding work. Korean yards have robust R&D and integrated business structures that enhance the quality of the vessels built in terms of ship operating performance, fuel efficiency and technically-strong designs to meet the customized requirements of different ship owners.

Technical competitiveness will keep Korean yards at the top of the containership building game in view of the adoption of enhanced environmental regulations. Each of the big Korean yards has thousands of in-house designers and engineers. This has made them world leaders in the new generation of fuel-efficient, cheap-to-run "eco ships". Prior to regulations, owners demanded ships able to perform at their maximum speeds but, now owners focus on fuel-efficient ships optimized for lower speeds, handing over competitive advantage to the technically-advanced Korean yards. Newly-designed commercial ships by Korean yards for delivery from 2012 onwards are known to have 10-30% better fuel efficiency than existing ships (CIMB, 2013).

3.2. Brazil

The "triple helix" model (Etzkowitz (1993); Etzkowitz and Leydesdorff (1995)) for developing national and regional innovation systems is a well-known analogy for technology development. In the model, government, higher education, and private sector firms work collaboratively to provide the needed human, financial, and infrastructure resources to develop increased innovation capacity and competitiveness in a region. In an analogous framework, Guinn (Guinn, 2011) describes a model for effective workforce development in Brazil's shipbuilding sector at the Suape Port Complex region of Pernambuco State in Northeast Brazil. Investments by both national and local governments and the private sector facilitated the development of vocational training institutions needed to develop a competitive shipbuilding workforce in a historically low-wage, low-skilled region. The local government provided funding guarantees and operational support to the vocational training organizations. The national government facilitated the development of vocational training organizations by creating national level industrial policy targeting the shipbuilding industry in the region, and establishing social responsibility conditions to loans that required investment in the local education system. A large private shipbuilder, stimulated by demand from Petrobras (the national petroleum company), needed capital to build the ships, while Petrobras, as a recipient of national public funding, was required to procure ships produced in Brazil using 70% domestic inputs. To round out the equation, social responsibility clauses in the loan led to the shipbuilder investing in renovating local schools and developing the educational curriculum needed to create a competitive workforce.[32]

Thus, argues Guinn, the vocational training institutions were nested within guarantees of funding and operational support that played to each partner's strengths. The shipbuilder helped develop human capital in the local labor market without long-term and costly investments outside its core competencies, yet established vocational goals for the workforce and the physical infrastructure it required to be competitive. The local government provided constituents with expanded educational resources and services, which it likely could not afford if the large capital investments in physical infrastructure were not provided by the shipbuilder. The national government achieved its goal of developing the industrial shipbuilding capacity in

[32] Readers interested in a more general history and condition of Brazil's shipbuilding industry should consult (Paschoa, 2014).

the region by providing access to finance without micromanaging the development of workforce capabilities.

In sum, the case demonstrates how "inclusionary state activism without statism" (Arbix & Martin, 2009) can be used to selectively intervene in otherwise free markets to ensure that populations with little or no skills or experience in formal employment can participate in the gains of a region's economic development. In the summary of Guinn's paper presented below, additional details are provided regarding the model as practiced in Suape, Brazil, how actors in the region recruited Brazilian expatriates working in Japan's shipyards to enhance skills development, and how private and public actors developed worker loyalty, which served to protect investments in enhanced skills formation in individuals and reduced the threat of job "poaching" by other companies. The combination of these practices helped develop, in a remarkably short period, a globally competitive shipbuilding sector in the region.

Case Overview

Brazil anticipated in 2011 that 430 new vessels would have to be built by 2015 to meet demand from its growing domestic petrochemical and oil industries, doubling the construction industry from 50,000 to 100,000 workers. To help meet this challenge, Estaleiro Atlântico Sul (EAS)[33] oversaw a trained workforce of 4,800 individuals within five years of incorporation, most of whom previously had no ties to a formal labor market or to industrial work in general. The firm managed to achieve ambitious production goals despite being in a region characterized by a long-standing deficit in skilled industrial workers. How was this impressive level of human capital formation achieved in such a short period of time? Guinn argues that the outcome was possible on an institutional level because of the way in which training institutions were "sandwiched" between guarantees at both the national and local levels, which, in turn, opened a space within which training institutions could flourish. The outcome was also facilitated by the adoption of an innovative recruitment strategy of skilled workers who served as trainers and mentors to the entry-level workforce in the region historically lacking relevant technical expertise and ensuring worker loyalty through the provision of direct and indirect benefits to workers and their communities.

The 'sandwich model' of workforce development

Between 2005 and 2010, new workforce development institutions arose in the Suape Port Complex region, which expanded the supply of shipbuilding relevant skills to the local labor market. The increased availability of workforce skills was a function of both national and local policies and investments. At the national level, policies targeting the development of the petrochemical and shipbuilding industries in the region, provided the initial stimulus for industrial development. In addition, the $26 million BNDES loan required social responsibility actions by the recipient (EAS), which allowed the local education department and the shipbuilder to develop new workforce development curricula. Furthermore, Petrobras and Sistema-S facilitated the development of a leadership training course within EAS. At the local level, the shipyard helped construct and renovate schools, assisted with the development of curricula, while the local government administered the ongoing operations required to offer the

[33] EAS was etablished as a private firm in 2005 through a partnership between the private Brazilian investment groups Carmargo Corrêa and Quiroz Galvão and the Brazilian equity holding and ventures management company PJMR Empreendimentos.

skills development curriculum and provided financing for educational facilities. The partnership allowed each actor to focus on core strengths and objectives: the firm helped develop workforce skills it needed to be competitive without long-term and expensive investments, while the local government received guidance on the workforce skills required by a major employer, yet could provide enhanced educational services to its constituents through the funding received. The case demonstrates how appropriate sequencing and investments by both national and local governments, in partnership with private actors, can help build workforce development institutions important to industrial competitiveness.

For the workforce investment policy to be effective, two additional components were necessary. First, workers had to be persuaded to remain in the area despite higher wages offered by companies in other regions. Second, Brazilian workers living offshore with advanced skills in the shipbuilding industry had to be persuaded to return.

Reducing job poaching through increased worker loyalty

Strategic behavior by companies and workers, specifically, companies in higher wage areas poaching trained workers, was avoided by developing worker loyalty through various mechanisms. These mechanisms included investing in the skills of the workforce through vocational training, the provision of individualized benefits to workers, including formal employment, pensions, career services, and above-median regional wages tied to an employment contract. Worker loyalty was also increased though more diffuse social investments, notably improved housing, education, and bus transportation, which served to increase the quality of life in the region. These "place-making investments" worked to build loyalty of community members and workers to the firm, and enmeshed workers into the social fabric of the community, thus reducing the potential of moving to other, higher paying regions.

To help build loyalty, the firm made direct investments in the skills of its workforce through vocational training, and provided other direct benefits to workers, including formal employment, pensions, career services and above-median wages. In addition, EAS also made several social investments that helped build the loyalty and commitment of its workforce. These included investments in housing, the local bus transportation network and a municipal education system. These actions by the company served to build worker loyalty because workers became embedded in the community, reducing the threat that they might leave. However, as the Suape region continues to develop, loyalty to the company will play an increasingly important role. The location of additional employers in the region, including two new shipyards, may undermine the temporary advantage received by EAS as the first mover. Worker loyalty (and maintaining locally competitive wage rates) will become increasingly important as EAS seeks to make investments in the transferable skills of its employees without the serious threat of poaching. In the EAS case, this was accomplished at the national level through BNDES loan conditionality requiring social investments and through local government officials' openness to coordinating with the shipyard on education strategy and lobbying efforts.

An innovative workforce recruitment strategy

EAS faced a basic operational barrier in building a competitive workforce in Suape as the region lacked trainers needed to teach the entry-level workforce. Welding is a key operational process in the shipbuilding industry, which was especially problematic for EAS because Brazil faced a generalized shortage of welders. Recruiting domestically was difficult, as it would have been very expensive to recruit workers from the Southeast. Furthermore, paying wages competitive with Southeastern employers would potentially create conflicts with the local workforce, because of the large wage differences between team leaders and entry-level workers.

EAS overcame this obstacle in an innovative way by recruiting and repatriating Brazilians working abroad in the Japanese shipbuilding industry. The company advertised its need for skilled welders on Japanese television, which turned out to be a much more successful strategy than its failed attempt at recruiting Korean welders. Brazilians communicated in Portuguese with their teams and successfully transferred knowledge and tacit skills they learned in Japan to entry-level workers at EAS. The lack of opportunity for leadership training in Japan was an influential factor for some experienced Brazilian welders to return to Brazil and work at EAS.

Conclusion
In the case presented, the state's investments in the shipbuilding sector of the Suape Port Complex used the private investments of EAS shareholders to create thousands of skill-intensive jobs. Under this model of economic development policy, the state's interventions enabled markets to work while also ensuring that unskilled workers could participate in the opportunities presented by new industries. The state's approach was not one of "command and control" but rather to influence the investment decisions of local private and public actors by selectively intervening in the market by establishing social investment lending conditions.

The EAS case provides insights into debates regarding active labor market policy and social policy implementation. The vocational training institutions, which were supported by state investments, produced positive effects on both labor market policy and social policy implementation. The existence of opportunities for upward mobility within the firm through training made employment with EAS attractive and increased perceptions of job quality. Second, integrating the training provided by Sistema-S with the internal training and career ladder strategies provided by EAS facilitated job matching for workers. These integrated internal and external training systems were critical to the rapid development of both workforce development and production capacity by EAS.

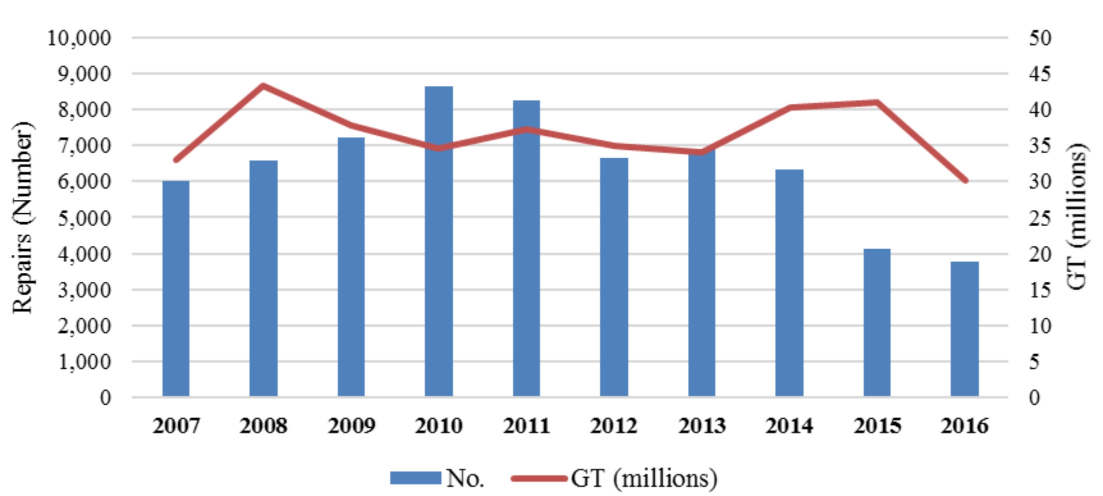
A key lesson from the Brazil case is that when vocational training institutions are well integrated with the workforce development strategies of firms, both job quality and job matching outcomes can be improved to benefit both workers and firms. As the EAS case demonstrates, the government can play a significant and positive role by ensuring the provision of well-performing training institutions provided by the firm and local workforce development organizations.

3.3. Singapore

The shipbuilding and repair industry in Singapore has being a significant part of its economy making up 7% of the country's GDP and providing about 170,000 jobs (MPA Annual Report, 2015). Port Singapore was named the second top container port in the world with a total volume of 30.92 TEU in 2015 (WSC, 2015). Singapore is connected to about 600 ports globally and it is known as the world's busiest transshipment hub with about 85% of the containers that arrive in Singapore prepared for transshipment to another port or its destination.[34]

Singapore's strategic location makes it viable for ship repair services due to its connections to many global ports, and the high level of transshipment activities in the country. As shown in the figure below, the total number of vessels repaired in Singapore grew between 2007 and 2010 from 5,995 to 8,631, however it has declined since 2010 (ASMI, 2013). While total GT fluctuates from year to year, it has generally held steady or increased. Even though the number of vessels has generally declined since 2010, the average size (based on GT) has increased overall, indicating larger vessels repaired in more recent years. Larger vessels are calling at Singapore for repairs with the additions of bigger VLCC-sized docks. Most of the repair and upgrading works were carried out on tankers, bulk carriers, containerships, LNG carriers, FPSO vessels, passenger ships and dredgers (ASMI, 2014).

Figure 10. Singapore: Ship Repairs, based on Number and GT, 2007-2016



Source: based on data from Marine Port Authority (MPA)

Amid the uncertainties in the global economy, in 2014, the Singapore marine industry recorded a turnover of $17.2 billion. Rig building, ship repair and shipbuilding make up the major sectors of the marine industry in Singapore. Ship repair is the second largest contributor and accounts for 32% of the revenue generated for the industry while rig building contributes 65% and shipbuilding accounts for 3% of the generated revenue from the marine industry in Singapore (ASMI, 2014). Leading companies such as Evergreen Marine Corp. (Taiwan) Ltd., Hanjin Shipping Co., Ltd., (MarketLine, 2016) Singapore Technologies (ST) Marine Ltd. and Keppel Subic Shipyard (Manila Bulletin, 2013) offer ship repair in Singapore among other services.

Government Support and Workforce Development

[34] PSA. Core business: Transshipment. Retrieved April 8, 2017 www.singaporepsa.com/about-us/core-business.

Singapore focuses on optimizing and enhancing skills training, application of mechanized technology to shipyard operations, closer cooperation between specialized tertiary institutions and shipyards, and continued government investment in research and development (R&D) infrastructure (Mendoza, 1994). The government of Singapore through the Maritime and Port Authority of Singapore (MPA) provides several incentives to enhance the competitiveness of the industry. Singapore offers tax exemptions for several shipping activities. For instance, Singapore ships that adopt both energy-efficient ship designs and approved SOx scrubber technology that exceeds IMO requirements enjoy a 75% reduction of their initial registration fees and a 50% rebate on their annual tonnage tax (E&Y, 2016).

MPA has incentive programs geared towards workforce development, business development and increasing productivity within the domestic maritime industry. Some of these include the Maritime Cluster Fund (MCF) which has three key areas: (1) *Manpower Development* co-funds maritime companies in the development of manpower, training initiatives and capabilities[35], (2) *Business Development* supports eligible expenses incurred in the initial development of new maritime companies and organizations setting up in Singapore, or existing maritime companies and organizations expanding into new lines of maritime businesses, and (3) *Productivity* supports initiatives by the maritime industry that will lead to productivity gains (MPA, n.d.). They also sponsor talented students who want to join the maritime industry through scholarship schemes. The maritime career page also lists several other courses and scholarship opportunities for students.

In Singapore, technical education falls under the authority of the Institute of Technical Education (ITE), which has three locations in the country. The School of Engineering offers a Higher NITEC (National Institute of Technical Education Certificate) two-year program in Marine & Offshore Technology. The program trains students to support and supervise fabrication, repair and refurbishing of vessels. Students must meet an entry-level grade requirement in English language, mathematics and one other approved science and technology subject to enroll (ITE, n.d.). The program teaches students to:

- Interpret general arrangement drawings, pipe and instrument drawings, welding procedure specifications, and test procedures.
- Perform preliminary design of pipe routing plan.
- Perform non-destructive tests on weld metals.
- Perform inspection on brazed joints, pre- and post-welding, and alignment of pumps.
- Assist in system testing and commissioning marine auxiliary system and drilling system.
- Perform planning of work activities such as lifting, erection of supports for assembly works, manpower deployment and work schedule.
- Perform supervision on fabrication and welding.
- Perform quality control checks of welding, painting and blasting, insulation, and machinery and electrical installations.

Graduates with a GPA of 2.0 and above can apply to a polytechnic (there are five in Singapore, and this adds one additional year of school) through the Joint Polytechnic Admissions Exercise

[35] MCF-approved courses

(JPAE). Or if graduates also have at least 1.5 years of work experience, they can apply for a technical diploma at ITE.

The MPA Academy (n.d.) offers leadership programs for local and global partners in over 80 countries in Africa, Americas, Caribbean, Middle East and Pacific Islands; some include:

- Advance Maritime Leadership Program (Chief and Deputy Chief Executives)
- IMO Third Country Training Program (TCTP)[36]
- Maritime Public Leadership Program (MPLP).

4. The Philippines and the Shipbuilding Global Value Chain

4.1. The Development of the Shipbuilding Industry in the Philippines

As a nation composed of over 7,000 islands, the development of a shipbuilding and repair industry was a necessity to move people and goods from place to place. Many of the small domestic shipyards have been in operation since the early to mid-1900s. Medium and larger yards have existed since the 1970s, however ownership has changed in a few over the years.

Prior to the mid-1990s most of the ship-related activity in the Philippines was limited to repair. Between 1994 and 2006, JVs and foreign investors started to develop in the Philippines for shipbuilding. There have been no new major investors since 2006, however there have been some input and service suppliers in the PEZA zones over the last decade.

Since the 1970s, local shipping companies received incentives like building and repair companies in the Philippines, and as such purchased used vessels from foreign countries, primarily Japan, creating demand for repair only in the Philippines. Incentives to import vessels were made on the grounds on needing to replace an old domestic fleet. More incentives were released in 1986 and shipbuilding activity in the Philippines further declined. In 1991, only eight ships were constructed (2,500 GT), and the number of large shipyards (200+ employees), went from nine to six between 1983 and 1988 while the number of small increased (indicating shift to repair from building) (Mendoza, 1994).

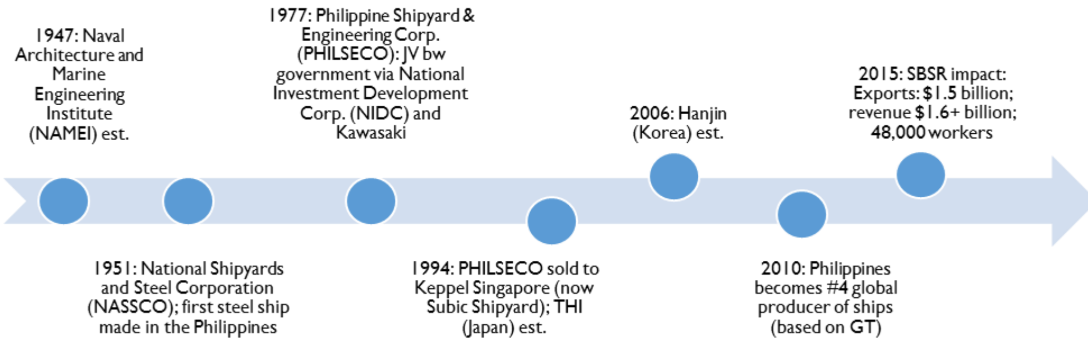
Many of the shipyards in the Philippines have been in operation since the 1970s; of the six established in that decade, half are still under the same ownership. The next wave came in the 1990s and 2000s, with few new yards established over the last decade. Suppliers, on the other hand, have been more concentrated in the last two decades. Of the 24 identified in PEZA zones, 17 have come in the last 12 years, while only seven came in the 1990s.

Table 13. Evolution of Shipbuilding & Repair and Suppliers in the Philippines

Year/Decade	Building or Building/Repair	Shipyards: Medium/Large	Emp.	Entry: Shipyards	Entry: Suppliers in PEZA
1970s	56		4,100	6	
1980s	35	12	5,100	3	1
1990s	60		9,900	5	6

[36] Trained over 1,700 participants in 80 countries since 1998.

2000s	69			5	7
2010s	117	23	48,000	2-3	10



Sources: 1985-1992 (Mendoza, 1994); licensed companies from MARINA annual reports and Census; Medium and large yards currently operational (data not available for two of the 23); based on year the shipyard was operational; five of the yards have changed ownership.

4.2. Philippines Current Participation in the Shipbuilding Global Value Chain

This section provides an overview of the Philippines current footprint in the GVC, describing the main firms by segment (origin, size, entry year, etc.), employment/workforce characteristics, export destinations, and backward linkages inputs (origin, cost).

Geography

There are 11 MARINA regional offices with SBSR locations (Dec. 2016); nine of these have a medium or large shipyard. Only two of the regional offices has export-oriented activity (Central and Cebu). The Central office has two main areas: Navotas, which is in the Metro Manila region is primarily ship/boat repair, and the Subic area where the larger shipbuilders are located. The Subic area (closer to Manila) is known for calm waters/moderate winds, deep sea, and adequate water space. The Cebu area has favorable sea channels for sea trials. In addition to the above areas, three others have some activity and are marketed as future areas: Mindoro, Occidental; Phividec Industrial Estate, Misamis Oriental and Port Irene, Cagayan Valley (labeled with flags in the map).

Figure 11. Shipbuilding in the Philippines

Name/Office	SBSR (Dec. 2016)
Central Office	45
Batangas MRO 4	4
Legaspi MRO 5	1
Iloilo MRO 6	8
Cebu MRO 7	20
Tacloban MRO 8	1
Zamboang MRO 9	12
Cagayan MRO 10	1
Davao MRO 11	2
General Santos MRO 12	20
Surigao MRO 13	3
Total*	**117**

Country total is 118; one shipyard is not under the purview of MARINA.

Sources: MARINA (2014, 2015, N/A); Map; not pictured: Golden Seacraft Marine Corporation, Megaship Builders Inc., DMCI Shipbuilders and SL Mariveles Drydocking & Shipyard Corporation

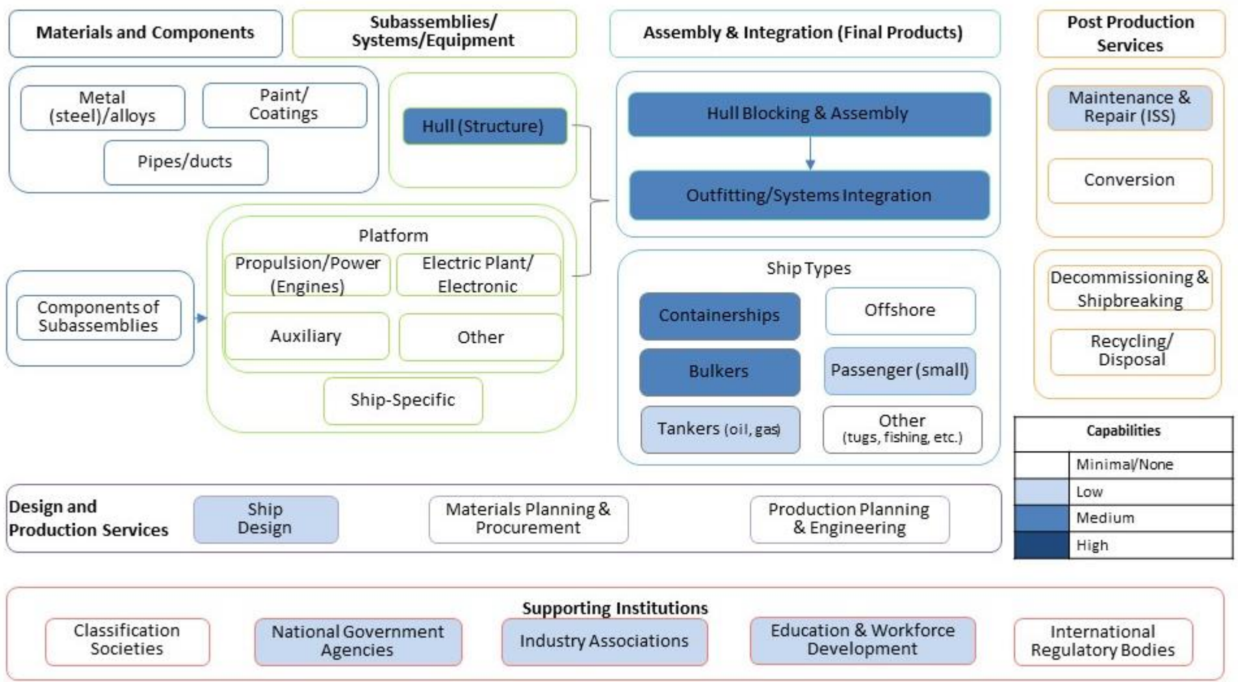
Firm Profile

According to MARINA, there are eight large, 15 medium and approximately 95 small shipyards in the Philippines, for a total of approximately 118 shipyards as of Dec. 2016. Employment is approximately 48,000 and annual output is approximately 2 million GT (ShAP, 2016). There are also many service providers that are not labeled as shipyards by MARINA in the Philippines, but are listed as contractors or afloat repair. Most yards are Filipino-owned however the largest employers, exporters, and revenue generators are foreign-owned.

Based on firm interviews and data provided by MARINA, SBSR sales for 2014/15 were at least $1.64 billion. Of this, the top two firms account for 97%, and about 98% is exported. Revenue of medium-large domestic shipyards range from approximately US$50,000 to $8.8 million (median: $610,000, avg. $2 million)(MARINA, 2017; Philippines Shipbuilding Stakeholders, 2016). Income of domestic shipyards primarily comes from ship repair (90%) rather than building (ShAP, 2016).

ASPBI results for 2010 indicate there were 15 ship manufacturers and 54 engaged in ship repair. Of the 15 manufacturers, three manufactured metal sections of ships (all Filipino), with the remaining building ships (six Filipino, two Japanese, one Korean and one Singaporean; two did not report). Of the 12 shipbuilders, seven had over 20 employees, with an average number of 3,105 per firm. Ship repair operations are much smaller on average with 73 employees per firm. Only 28 reported ownership, of which 26 were Filipino. Depreciation of fixed assets accounted for a significant share of costs for shipbuilders; 51% compared to an average of 5% for manufacturing overall in the Philippines. Intermediates accounted for 41% of cost (compared to 81% for all manufacturing), of which electricity and water were 15%. Shipbuilding revenue was from direct exports, except for the three metal section manufacturers for which revenue was attributable to interplant transfers.

Figure 12. The Philippines in the Shipbuilding Global Value Chain



Source: Authors; based on Figure 1. Shading based on facilities in the Philippines for the international market. Boxes not filled are segments in which minimal activity is carried out in the Philippines.

Table 14. Major Shipbuilding Companies in the Philippines

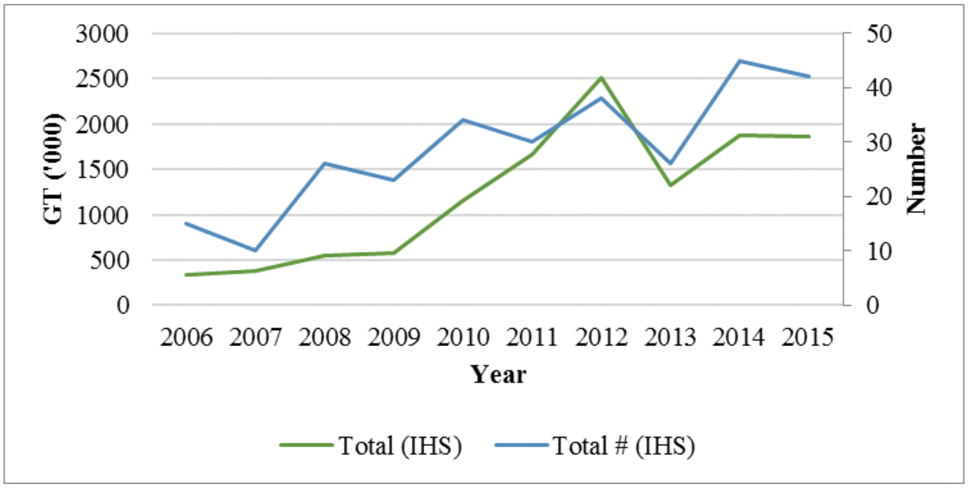
Size	Firm	Year Est.	Ownership	Location/ EPZ	Emp.	Type	Export
Large Shipyards (8; 7 under MARINA)	**Hanjin Heavy Industries (HHIC)**	2006	Korea	Subic Bay FZ /Yes	33,000	Container	Yes
	Tsuneishi Heavy Industries (THICI)	1994	Japan	Cebu/Yes	8,800	Bulk carriers	Yes
	Keppel Subic (acquisition)	1978/ 1994	Singapore	Subic	-- 1,520	Repair (most) Build-Tug, offshore	Yes (minimal)
	Keppel Batangas	1975	Singapore	Batangas	432	Repair	Yes
	Subic Drydock Corp. SUBICDOCK	< 1999 2007?	USA	Subic	41	Repair/ Military	No
	Herma Shipyard (HIS)*	2000	Philippines	Bataan	290	Repair; Build (2007) Tankers	No
	Philippine Iron Construction & Marine Works (PICMAW)*	1970	Philippines	Misami, Oriental	450	Repair	No
	F.F Cruz & Co.	1994	Philippines	Iloilo City, Lapaz	78	Repair (internal)	No
Medium Shipyards (15)	**Mactan Shipyard Corp.***	2011/ 1972	Philippines	Cebu	460	Repair	No
	Colorado Shipyard Corporation (CSC)*	1972	Philippines	Cebu	175	Repair; Build (2010) Cargo ship	Yes (once)
	Santiago Shipyard & Shipbuilding Corp.	1986	Philippines	Cebu	41		No
	Gensan Shipyard and Machine Works, Inc.*	1999	Philippines	General Santos	272	Repair (fishing); Larger ships (2011)	No
	Signal Marine Shipyard	2008	Philippines	General Santos	27	Repair	No
	Elfa Shipyard	1992	Philippines	Navotas	43	Repair	No
	Dansyco	2006	Philippines	Navotas	53	Repair (fishing)	No
	Frabelle Shipyard	1982	Philippines	Navotas	36	Repair (fishing)	No
	Josefa Slipways	2005	Philippines	Navotas	237	Repair	No
	R & LT Shipyard & Realty Development	1989	Philippines	Navotas	79	Repair	No
	Seafront Shipyard and Marine Services*	2004	Philippines	Bataan	35	Repair	No
	SL Mariveles Drydocking & Shipyard	n/a	Philippines	Bataan	39	Repair	No
	Megaship Builders	2015	Philippines	Ormoc City, Tacloban	35	Repair	No
	DMCI Shipbuilders	n/a	Philippines	Zamboanga City, Zam.	35	Repair (internal)	No
	Golden Seacraft Marine	2014	Philippines	Butuan City, Surigao	19	Repair	No
Small	**Austal**	2011	Australia	Cebu/Yes	230	Aluminum passenger vessels	Yes
	Nagasaka Shipyard	2002	Japan	Cebu/No		Repair	No

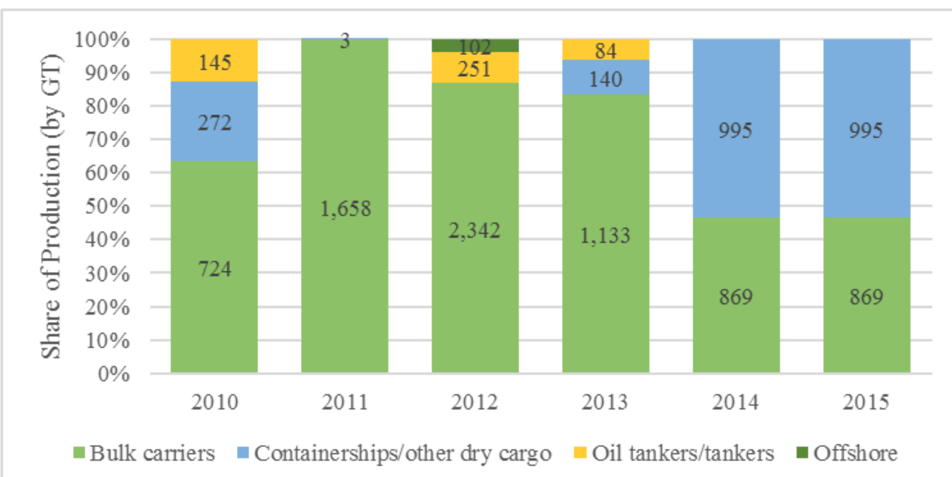
Sources: Authors. Note (*): believed to be larger or have higher sales among domestic facilities.

Product Profile

The Philippines has been capturing global ship production market share since the global recession. Shipbuilding completions in the Philippines has grown from 15 ships in 2006, accounting for 335 GT or .6% of the world's tonnage, to 42 ships in 2015, accounting for 1,865 GT, or 2.8% of the world's GT (see Figure)(IHS, 2009-2016). Based on GT, the Philippines has been the 4th largest producer of ships since 2010 and has maintained this position through 2015 (they were 6th in 2009).

Figure 13. Philippines Ship Production, 2006-2015





Source: UNCTAD (2016) (and earlier years)

The Philippines manufacturers medium-sized bulk carriers and containerships, as well as some smaller vessels for export. Exports in 2015 were $1.5 billion; up from $1.1 billion in 2012 and $0.4 billion in 2010 (UNComtrade, 2016). At most there have been seven companies accounting for exports from the Philippines since 2007. One firm has accounted for over 50% of the Philippines exports since at least 2009, with the top two accounting for over 97% since 2009. In 2014, the two ship exporters from the Philippines were the 14th and 15th largest exporters from the country, accounting for 1.4% and 1.3% respectively of total exports from the Philippines PSA (2007-2014).

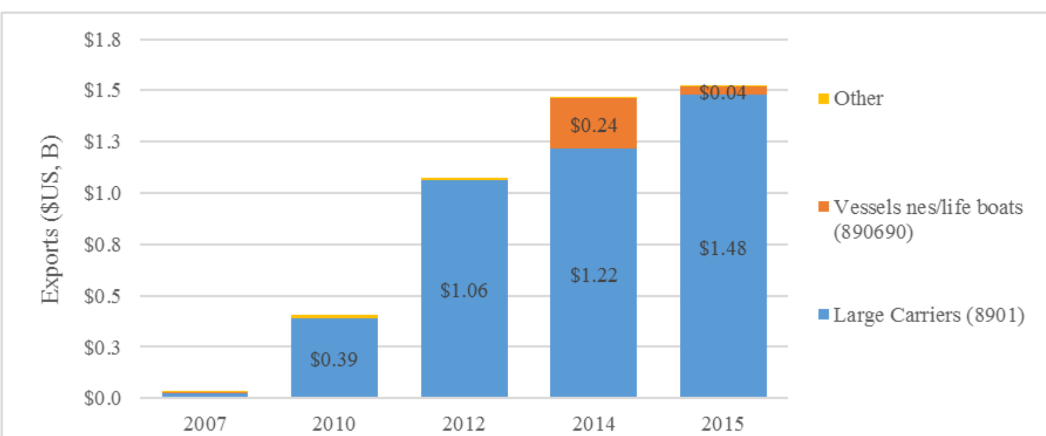
The export-oriented shipbuilders in the Philippines have minimal interaction with the small, medium and large domestic shipyards. At least one of the large shipbuilders uses the services of domestically-owned service contractors, but these are labeled as 'shipyards' by MARINA.

Exporters
Hanjin has upgraded in terms of the type and variety of ships produced in the Philippines. In the beginning, only containerships, then a few tankers, then bulkers, then gas carriers. Within product categories Hanjin has also expanded the size of ships produced in the Philippines, particularly in oil tankers, but also containerships and bulkers.

THI has had minimal changes in terms of the type and size of ship produced. They have always produced bulkers that are smaller than the ones produced by Hanjin. From 2010-2016 they had a relatively stable output of 20 ships per year, which is scheduled to continue through 2018. Whereas THI has not engaged in product upgrading in the Philippines, they do carry out some of their higher value activities in the Philippines at least for design via TTSI, located in the same EPZ as THI. While not necessarily upgrading, the way THI has set up their supply chain has led to capacity building in the Philippines. Instead of conducting all assembly (service) work in-house in terms of block product, painting, outfitting, etc. the company outsources to domestic subcontractors. This creates the opportunity for these companies to potentially work for other shipbuilders and leads to management capabilities in terms of operating a business. The difference in Hanjin and THI's strategy is reflected in employment numbers; THI only employs around 7,000 directly whereas Hanjin is closer to 20,000 (however interview had 33,000 listed). THI also has similar facilities in China, and plans to set-up a recycling facility in the Philippines.

Neither company has expanded in terms of backward supply chain linkages, but both have engaged in process upgrading (i.e., expanded facility size/space over time).

Figure 14. Philippines: Ship Exports, by Type, 2007-2015



Source: UNComtrade; One exporter is (likely) not included in data prior to 2014 because sales were to the parent company abroad, but in 2014 started exporting directly to customers from the Philippines. PSA data does not match UNComtrade at six-digit level.

Suppliers
Suppliers to shipbuilders are limited. There are 24 supplier firms involved in shipbuilding in PEZA zones, of which 16 are Japanese, six are Filipino, and one each from Singapore and Norway. Those that do exist are mostly came to the country around the same time as THI (at least 12 of the 24). These companies primarily provide **services** such as hull block fabrication, beam construction, painting, and outfitting (14). There are four companies that likely support Keppel. There are four firms that claim to do metal parts machining, at least two engaged in ship design (CAD), and one export-oriented manufacturer of ship furniture. There is one company that mentioned engines and two for business processing outsourcing for ship activities (see Appendix for known suppliers). There has been some evidence of upgrading by PEZA supplier firms; 10 new projects, seven amendments and two expansions (suppliers from 1978-2016) PEZA (2015). Outside PEZA, there are many other small firms exist in the Cebu area to support THI. They are listed as Service Contracting or Afloat Ship Repair.

The primary import of the top two ship exporters is steel (HS7208), which accounted for at least 90% of imports of the main exporting company in 2014. For the second, steel (46%) and aluminum (6%) were over half, followed by engine/parts (20%), and electrical (7%). There are no approved steel manufacturers in the Philippines (as of October 2016)(Lloyd's, 2016). Material and equipment purchased locally are from distributors rather than local manufacturers. While these firms could not be identified, there may be up to three engine manufacturers. Based on ASPBI data for 2010, there were three manufacturers of engines and turbines for marine propulsion (two Filipino and one Japanese). These firms had 273 employees and revenue of US$15 million, of which 99% was directly exported.

Supporting Environment[37]
There is one 'official' industry association in the Philippines (SHAP), however there are two regional associations (Cebu and Manila).

In 2014, the Philippines started hosting an annual trade show for the shipbuilding industry called Philippines Marine (PHILMARINE), co-located with "Shipbuild Philippines" and "Offshore Philippines." The organizer, AsiaFireworks, is a Singaporean company that organizes shows in the ASEAN region for a few industries as well as other maritime shows in Vietnam (Marine Vietnam) and Thailand (Marine & Offshore Expo).

According to the 2016 post report, there were 220 exhibiting brands from Philippines, Singapore, China, Norway, Japan, Korea, Australia, Taiwan, U.S., Canada, Germany, Malaysia, UK and 4,230 visitors. MARINA is the main entity involved in planning; BOI is a participant. In 2016, the show was co-located with Oil & Gas Philippines, which claims to be a separate event in 2017, but is at the same time and place as PHILMARINE (Manila, July 12-14, 2017).

Classification Societies
MARINA mandates all ships (imported vessels or vessels to be constructed locally) are classed by Government recognized classification societies. Likewise, Government lending institutions

[37] See Table A-5. Supporting Shipbuilding-Specific Stakeholders by Focus Area for details.

such as the Development Bank of the Philippines (DBP), require vessels acquired through their Lease and Financing Programs to be classed by a recognized classification society.

Philippine Register of Shipping, Inc. (PRS) is the first Filipino Ship Classification Society established and registered with the Securities and Exchange Commission on June 26, 1989. It is a non-governmental, non-stock, non-profit independent technical organization established to assist the Government to enhance and promote the safety of life and property at sea and the protection of the marine environment. Since 2012, PRS (a non-member of IACS) embedded the "Unified Requirements" and "Common Structural Rules" into its own rules. As of Dec. 2012, PRS had 904 vessels under its classification and survey with a total GT of 788,024. These cover a broad spectrum from passenger vessels to cargo, tanker, tugboats, training ships etc. There are also five other classification societies in the Philippines that do not adhere to IACS standards, but are accredited by MARINA.

Foreign and export-oriented ships are classed by internationally-recognized societies. There are 11 international classification societies with an existing Memorandum of Agreement with MARINA, of which eight are among the 12 IACS member societies. The IACS include ABS, DNV, NKK, BV (mentioned by companies), as well as CCS, KR, LR, and RINA; the other three are HRS (Greece), GL (Germany) and IRS (USA).

Government Policies and Incentives

MARINA, established in 1974 (PD666) is responsible for regulating all affairs related to oceangoing vessels in the Philippines (in terms of operating, building and repair). All domestic shipyards are required to obtain a license from MARINA, subject to annual renewal. MARINA's mandate also includes industry development, however in practice this is pursued more by the Board of Investments (BOI). The following are the key regulations and incentive programs put in place in the Philippines (current and historical).

In 2015, the Philippines lifted restrictions on foreign shipping companies to transport domestic waterways ("Republic Act No. 10668," 2015). This policy does not impact where the ship itself is constructed. To our knowledge, the Philippines does not (and never has had) have cabotage laws seeking to protect the domestic shipbuilding industry. Rather, the country has done the opposite by removing or reducing import duties on imported vessels. These incentives have historically been extended to shipping companies (i.e., ship owners) which led to dominance of imported, largely used vessels. While this created demand for ship repair services, it has deterred growth of shipbuilding activities in the Philippines.

While shipbuilding and ship repair have been listed as priority industries for the Philippines since 1967, ship-related legislation in the Philippines has favored shipping companies rather than builders. Since the early 1970s, incentives have been extended to domestic shipping companies enabling them to import vessels (new and used) duty-free.

RoRo shipping was enacted in 2003 and RoRo routes were introduced to replace existing means of transportation (LoLo), which required cargo handling (Basilio, 2011). EO No. 170 was issued to promote the RoRo shipping mode, backed by strong support from the market (shippers, business, and logistics providers). When this policy was enacted, the domestic shipping industry was dominated by five shipping companies accounting for 90% of passenger and cargo and almost all the primary and secondary shipping routes (Llanto et al., 2005).

Table 15. Policies Pertaining to Shipping, Building and Repair

Name	Years	Focus	Implementing Agency
PD 215[38]	1973, June	First incentives for importing vessels (extended finance for imports). Exemption on duties of imports and compensating tax.	BOC, BIR
Investment Incentives Act: RA 5186	1967	Omnibus Investments Code of 1967: first IPP, shipbuilding included.	BOI
IPP	1970, May	4th IPP: SBSR granted pioneer/non-pioneer based on facility size.	BOI
PD 666[1]	1975, March	MARINA established. 100% foreign equity allowed. Extended incentives to small shipyards not under BOI.	MARINA BOI
PD 1221[1]	1977, October	Required Philippine-registered oceangoing ships to undergo drydock/repairs in MARINA registered shipyard.	MARINA
Omnibus Investments Code: EO 226[1]	1987, August 1989	Omnibus Investments Code of 1987 Implementation of IPP: exempt from duties/taxes on imports of ship spare parts. A new IPP issued every three years; reviewed annually. Shift in incentive structure from all yards to effectively only large shipyards (10,000 DWT+); perhaps 7 shipyards	BOI
National Emergency Memo No. 8	1990, January	Reduced import tariffs on inputs.	BOI
Domestic Shipping Development Act: RA 9295 [1]	2004, May-2014, May	Exempt from VAT (expired 2014); allows shipyards to be fully owned by foreign investors. See details below.	MARINA
RA 9337	2005, July	Amendment to1997 tax code; pertains to VAT transactions incl. import and sale of vessels incl. locally built vessels. Sales to domestic market VAT free	BIR
IPP 2011-2013 Memorandum Circular 2015-1: IPP 2014-16	2011-2016 2015, April	General policies and specific guidelines to implement 2014 IPP. See details below.	BOI
RA 10668	2015, July	Opened inland waterways for foreign shipping companies	GOVPH

Sources: (1) (Mendoza, 1994; Reyes, 2013); Notes: Republic Act (RA); Executive Order (EO); BIR BOC. Note: Two other initiatives may be in development: Grant of pioneering status and protection of investments through the issuance of MARINA Circular 2015-04 implementing EO 909 "Encourage Investments in Newly Constructed IACS-classed Ships or New Vessels in the Domestic Shipping Industry by Providing Incentives."

Policies enacted at the time the RoRo network was established continued to promote imports over domestic sources in terms of vessels, parts, and the development of backward linkages to inputs need for building and repair. As outlined in the following, essentially no entities had to pay taxes to import (ships or parts), and if local manufacturers existed, they were entitled to get a refund on taxes and import duties paid.

[38] www.lawphil.net/statutes/presdecs/pd1973/pd_215_1973.html

Details of RA9295 Incentives (May 2004-May 2014): The Domestic Shipping Development Act (RA 9295) provided incentives to encourage modernization of the industry. It required the "retirement of old vessels, including wooden-hulled ships" and had provisions on ship safety standards, move towards ship classification by Classification Societies and compulsory insurance coverage of passengers and cargo (Llanto et al., 2005). Even though the Philippines had seven classification societies when RA9295 was issued, there was still a need for MARINA to establish and strictly enforce rules on safety and procedures for vessel inspection to reduce the high rate of maritime accidents (Llanto et al., 2005).

RA 9295 primarily provided a VAT exemption on imports of supplies by ship owners, builders or repairers, effective from 2004-2014. The VAT exemption provision was time bound and expired on May 2014. At present, there is a pending bill in congress to reinstate this (Philippines Shipbuilding Stakeholders, 2016). Domestic ship owners/operators, builders and repair operations were exempt from paying VAT on the import, sale, transfer or disposition of:

- Passenger and cargo ships ≥150 tons including engine spare parts of the imported ship
- Lifesaving equipment, firefighting systems, safety and rescue equipment and cargo-handling equipment.
- (Llanto et al., 2005) mentions VAT exemption of materials for the construction and repair of ships and "restrictions on vessel importation to promote local shipbuilding."

Philippine shipping companies operating oceangoing vessels registered under the Philippine flag were also exempt from import duties and taxes. Spare parts for the repair and/or overhaul of vessels were also exempt, if the items were destined for or consigned to either: (a) a drydock or repair facility accredited by MARINA and registered as a customs-bonded warehouse that will undertake the work, or (b) the vessel in which the items are to be installed. Local manufacturers or dealers who sell machinery, equipment, materials and spare parts to a Philippine shipping enterprise are entitled to tax credits for the full amount of import duties and taxes paid (E&Y, 2012, 2016).

IPP incentives target large shipyards. At present, only three shipyards (THI, Hanjin and Keppel) are large enough to qualify for these incentives (based on berthing). The following are the requirements for BOI incentives under 2011 and 2014 IPP for shipbuilding, which covers the construction and repair of ships or boats and includes breaking or recycling. Any of the following may qualify for pioneer status:

- Shipbuilding or repair facilities with a minimum lifting capacity of 20,000 DWT;
- Shipbuilding or ship repair facilities with a minimum berthing capacity of 7,500 DWT
- (2011 only): Projects that cost at least US$100 million may be granted pioneer status but with non-pioneer incentives (E&Y, 2012, 2016).

The IPP incentives granted by BOI for shipbuilding (2011 and 2014) promote domestic shipbuilding, but do not incentivize developing backward linkages to key inputs. IPP fiscal incentives include:

- Income tax holidays: New projects with pioneer status, and new or expansion projects in less-developed areas (six years); New projects with non-pioneer status (four years); Expansion or modernization projects (three years).
- Exemption from taxes and duties on imported spare parts

- Exemption from wharfage dues and export tax, duty, impost and fee
- Tax credits and additional deductions from taxable income.

Non-fiscal incentives include: Employment of foreign nationals, simplification of customs procedures, importation of consigned equipment for a period of 10 years, and the right to operate a bonded manufacturing/trading warehouse.

Documents have mentioned a Manpower Development Program for training and workforce development for shipbuilding and repair (Dion Global Solutions, 2014) by the government in coordination with TESDA due to increasing number of workers required to be employed in the shipyards. However, we have not been able to find any details on this program.

Human Capital

According to MARINA, the SBSR industry employed approximately 48,000 workers in 2016. In 1988, employment was approximately 4,800. The increase in employment is almost entirely tied to the arrival/expansion of the three foreign-owned shipyards.

A significant share of workers in commercial shipbuilding are welders. Welding processes vary and include traditional welding rod method as well as Shielded Metal Arc Welding (SMAW), Gas Tungsten Arc Welding (GTAW), Flux-cored Arc Welding (FCAW) and Submerged Arc Welding (SAW) (Philippines Shipbuilding Stakeholders, 2016). Other positions include scaffolding, pipe welding, pipe fitting, and ship fitting.

TESDA programs appear to typically range between 120 and 270 hours to complete. To take the next course level, a student must have satisfactorily completed the previous National Certificate (for example, SMAW II was be taken prior to taking SMAW III). National Certificate levels I and II can be completed while a student is completing grades 11 and 12 in school. As such, completion of Level IV would be a more comparable proxy for receiving a two-year Associates degree in the United States. NC's are valid for five years and must be renewed. Outside of a formal education program each certification level could be completed in approximately six months.

For the welding programs with data available on the number of people certified, most (75%) certifications are level II, whereas less than 2% have a level III or IV certification. Based on feedback from stakeholders, welders are needed with at least this level of competency. For example, a welding program in the United States would take approximately three years to complete, whereas even a level III in the Philippines is under a year.

Feedback from stakeholders suggest that the standards of shipyards are much higher than what is someone with a TESDA NC Level I in welding would have. Beyond welding, there is also a need for technical institutes to offer other trades such as scaffolding, pipe welding, pipe fitting, ship fitting and the like (Philippines Shipbuilding Stakeholders, 2016). These issues contribute to efficiency and productivity. One source suggests that on average, domestic shipyards take 20% more time to build ships compared with international competitors due to operational inefficiencies and technology levels (Dion Global Solutions, 2014).

Another issue is the loss of top talent to foreign countries, particularly the Middle East and Singapore. This pertains to the engineering level or the equivalent of NC IV status. This is not a new program (or one unique to shipbuilding). Even in the 1990s, shipyards indicated a growing shortage of qualified workers because of more lucrative job opportunities in the Middle East (Mendoza, 1994). Wages for engineers appear to be low. While results from the previous study did not specify education levels for these tiers, interview results indicate that wages for engineers (college graduates) are low and not much higher than those received by production workers. Administrative and managerial positions tended to be higher than those in the 2013 report. These wage levels are likely a prime contributor to top talent taking positions overseas. Based on data from ASPBI for 2010, workers in the ship repair sector make higher wages than those in manufacturing (see appendix table).

According to SONAME (2016), since 2008 there have been approximately 32 new naval architects that graduate each year in the Philippines (B.S. Naval Architecture and Marine Engineering). These graduates would predominately come from the Marine Architecture and Naval Engineering Institute (NAMEi). Technical, administrative and management tend to come from regional universities.

Table 16. Employee Profile for the Shipbuilding Value Chain

Position	Share	Workers (2012)	Salary Range (PHP/Month)	Job Characteristics	Education
Production Workers	70%	31,527	15-25,000 $350-600 (paid daily)	Welders, Crane Operators, Steel Cutters, Outfitters, Painters, Electricians	TESDA
Technical/Engineers	13%	5,855	25-35,000 $600-825*	Naval Architects; Engineers (electrical, mechanical, marine, software/CAD)	NAMEi; Regional University
Engineers *Supervisors*			15-25,000 32-34,000	Interview results	
Administrative	11%	4,954	10-15,000 $235-350		Regional University
Administrative			14-22,000	Interview results	
Managerial	6%	2,702	25-45,000 $600-1,060		Regional University
Management			42-84,000	Interview results	
Total		**45,038**			

Source: Reyes (2013); The salary scale of workers in Philippine shipyards is about 50% lower than those working in Korea and Singapore according to Hanjin and Keppel. Sources of data: MARINA and BOI; Jobstreet salary range report. Note: converted to $USD based on 2013 exchange rates.

4.3. Advantages and Constraints for Upgrading

This section provides an overview of the status of shipbuilding in the Philippines based on interviews with stakeholders in the country and a review of secondary materials.

Table 17. The Philippines in the Shipbuilding GVC SWOT Analysis

Advantages	**Constraints**
• Workforce; available, English-speaking, loyal • Geography/location; natural advantages and proximity to shipbuilding countries and shipping routes • Incentives	• Availability of local suppliers (material, equipment, and service providers) • Workforce skills levels and retaining talent • Domestic shipyards with international standards • Clear and coordinated leadership • Marketing/global awareness
Opportunities	**Threats**
• Commitment of foreign shipyards • Increasing cost competitiveness in shipbuilding • Domestic and regional demand • Potential to leverage develop opportunities in tandem with other 'heavy' industries in the country	• Loss of welding and engineering talent to other countries (Saudi Arabia, Singapore) • Consolidation and overcapacity of global ship industry • Domestic and foreign shipyards operate in isolation

Source: Authors

Advantages

- *Workforce: readily available, English speaking, cost competitive, and strong work ethic.* Undoubtedly, a key competitive factor of the Philippines is human capital. This applies to the workforce at all levels, but, particularly for operators. The country has a readily available, trainable workforce, with good work ethic and generally lower wages compared to competing nations (Japan, Korea, Singapore and increasingly China). The merits of the workforce are not unique to shipbuilding as it has been a key contributing factor across all industries studied in this report series.
- *Location: ideal geography.* The Philippines benefits from both inherent comparative advantages related to geography as well as indirect location benefits based on the center of gravity in the shipbuilding and shipping GVC. Given the Philippines is composed of islands, it has abundant coastlines providing ocean access, a necessary feature for setting up a shipyard. Furthermore, there is enough water depth to build large ships in multiple areas and enough coastline to enable multiple yards to set up in one location. In the Cebu area, there is a canyon strait where sea trials can be conducted, which also provides protection from typhoons, or rough seas and strong winds. The Philippines also has strategic location advantages for building and repair. Shipbuilding is concentrated in three East Asian countries in proximity to the Philippines. Second, the country is located along key Southeast Asian trade routes. As such, a lot of ships pass nearby, making it a convenient location for repairs.
- *Incentives* have historically been a key driver of foreign investment. These include tax and non-tax incentives for capital investments and raw material import duty exemptions.

Constraints

- *Local manufacturers of materials and equipment:* Marine grade materials and equipment with IACS class approval are not produced in the Philippines (by foreign or Filipino-owned companies). These must be imported directly by the shipyard or purchased from a distributor who imported the products. All materials being used to construct export-oriented vessels must qualify to the standards of IACS. It would be beneficial to shipbuilders to have local suppliers, but there are few domestic manufacturers, and those that do exist are not qualified to pass the standards of the classification societies.

- *Lack of service providers (subcontractors)* near shipyards (specifically in the greater Manila area) to support the industry. There should be a readily available supply of high quality machinery, equipment, spare parts and service providers (i.e. painting, blasting, machining, and the like). Subcontractors need to be reliable and able to meet the international standards of export-oriented shipyards. Even though service providers have a time-based contract with the prime shipbuilder, these function as long-term business relationships unlike a civil construction project which is usually a one-off contract. Shipyards strive to have a steady flow of projects and prefer to use the same subcontractors, however the duration and tasks required to build a ship are specific to each ship (and builders are only paid at timed intervals or after completing the work), so they must also have contract based relationships with suppliers.
- *Workforce: efficiency, skill levels, and ability to retain talent*
    - Graduates from TESDA programs have the skills needed to weld for domestic repair needs, but a more advanced level of the program, or more graduates from NC Level IV when available, is needed to meet international standards. Most graduates only have Level I or II national certifications. This requires knowledge of properties of the materials (i.e., steel) beyond just the operation of the machinery (i.e., why materials behave a certain way). Furthermore, there is a need for graduates at these levels in skills other than welding.
    - A second issue relates to the loss of top talent Middle East and Singapore. This contributes to the lack of available workers at the operator stage, but is also an issue at the engineering and management levels. The latter limits upgrading opportunities into higher value products and new markets.
- *Domestic facilities do not meet IACS standards or have ISO certifications*. Without these, domestic yards cannot participate in any segment of the global value chain. This includes exporting new ships, repairing or converting ships used in international commerce, or producing materials or equipment used on ships in another country.)
- *Lack of cooperation and leadership from the supporting environment:* The shipbuilding and repair industry in the Philippines lacks a unified supporting infrastructure and voice. At the government level, MARINA is tasked with regulating domestic shipping and building activities while the Board of Investment engages in investment promotion. PEZA is responsible for export processing zones, but does not appear to be actively involved in shipbuilding activities. To develop an effective ecosystem for building and repair, these organizations must work together so that domestic regulations create an environment that promotes the needs of building sector. For example, if regulations and policies incentivize importing ships rather than building them, this makes it difficult to build up a domestic workforce. At the industry level, there is a push to establish one association, but in practice this is difficult due to geographic distance. At the education level, there appears to be little or no interaction between TESDA and universities. Furthermore, there are no interactions among these three groups. For example, there are no government or firm-supported education/research institutions, limited or no presence of educational institutions involved in industry associations, and minimal interaction between government agencies and industries associations. Industry associations are also mainly driven by domestic shipyards with minimal involvement by foreign shipyards.

- *Global (or regional) awareness:* information on the potential or existing capabilities of the Philippines in the SBSR industry are limited. The industry association does not have a website, and information provided by educational institutions related to the "maritime" sector is focused on seafarers. Furthermore, over half of the companies identified as participants in the industry do not have websites or other advertising presence with reliable information on the Internet. The trade show is a positive development in this regard, but there are very few domestic participants. Marketing is needed to increase global awareness.

5. Opportunities for Upgrading

Upgrading opportunities for the Philippines are divided into three categories:
(1) FDI-led development to grow export-oriented, large commercial shipbuilding;
(2) FDI or JV-driven opportunities to enter the global market in post-production services;
(3) Domestic (Filipino-owned) firm opportunities to enter the GVC via smaller vessels.

Given the structure of the shipbuilding GVC, the current depressed demand conditions for newbuilds, the likelihood of a new, Filipino company successfully entering the global commercial shipbuilding industry as a prime contractor or top tier supplier are low. However, due to workforce and geographic advantages, there is significant potential for the country to grow its global footprint in shipbuilding and through building a local supply base. This will provide employment opportunities and opportunities for domestic service providers to provide outsourcing/subcontract work to nearby MNCs.

1. **Product upgrading: expand and diversify ship exports:** the Philippines is one of few countries to have sizeable foreign-invested shipyards, with presence in the country for over two decades. Given these companies have continued to expand production in the country suggests they are satisfied with their investment. There has not been a new investor in the industry in the last decade, but this is not due to a lack of space or advantageous conditions. Rather it stems from a lack of marketing backed by a coordinated national effort to attract new companies. Given the industry is globally facing overcapacity and newbuild prices have gone down, foreign shipbuilders, particularly those in Japan directly competing with Chinese builders, will be looking for ways to reduce costs. This is an opportunity for the Philippines to increase market share because shipbuilding is labor-intensive and a key advantage of the country is the abundant, affordable workforce. A challenge will be in retaining talent and raising the skill level of workers to meet international standards. When possible, new investments should seek to expand the portfolio of ships produced in the Philippines to reduce risks associated with cyclical demand in the industry. Increasing the number of large foreign shipbuilders also leads to opportunities for domestic shipyards to enter the value chain as subcontractors.

2. **Establish backward linkages:** At present, nearly all physical inputs required to build (and repair) ships in the Philippines are imported. Given the Philippines proximity to key supplying countries (China, Korea, and Japan) and the relatively long lead times to build a commercial vessel, this is not a deal breaker for the Philippines, however having a

supply base for some key inputs would benefit existing (and new) shipbuilders and would diversity and grow the capabilities of the country. The most expensive components for the types of ships currently produced for export in the Philippines are steel and engines, which also tend to be the bulkier/heavier parts that benefit from local production in terms of shipping costs. More generic inputs, such as coatings and paint, should also be considered because these are needed for both building and repair. Suggestions mentioned in (Stürzebecher, 2014) include: steel products, paint, panels and furniture, electric cables and pumps. A domestic supply base would shorten lead times, provide shipyards with a guaranteed supply, and create additional jobs.

The second set of upgrading opportunities relate to entering the GVC in post-production services in ship repair, breaking and recycling. While repair activities take place now, these are primarily for domestic customers. Entry into these segments for the global market will initially be driven by foreign-investors, but the potential for joint-ventures in repair is much higher given there are firms that have the skills to perform these activities. Foreign firms can assist by providing access to global customers and assistance in understanding the complex nature of standards and certifications required to do business for international customers.

3. **Functional upgrading: ship repair or conversion for international clients:** Given the current overcapacity/decline in demand in the industry, ship repair, conversion or ship breaking/recycling offer more immediate opportunities. In fact, the loss of welding and engineering talent to other countries, one of the main threats to the industry in the Philippines, also presents and opportunity in terms of developing the technical expertise needed to initiative a domestically or jointly owned ship repair industry in the Philippines. While the Philippines does not have the same advantages as Singapore in terms of port activity, it is located along major trading routes and has available space to build shipyards. Due to new environmental standards, there is also an increasing market for conversions/retrofitting. Conversions needed include those to meet ballast water management standards, and the SOx, NOx, and ECA requirements under MARPOL VI. The ability of existing domestic shipyards to move into conversion activities may be limited due to their size. Domestic yards tend to be small as many have been in existence since the 1970s and the average size of vessels has increased. However, several yards are located next to one other (at least in the Cebu area), so one option could be combining space to build a larger facility.

Box 3. Opportunities in Ship Repair

Ship repair work is more labor intensive and less prone to automation than shipbuilding and conversion. This provides an advantage to developing economies that have an abundant supply of low-cost labor. Facilities that have access to ample relatively skilled, low-cost labor have an advantage for routine repair/maintenance work over competitors in higher-cost centers, even if they cannot match them in terms of technology. Repair work is also more suitable for the large number of small yards. Dedicated repair yards must keep a relatively high inventory of spare parts and components to minimize down time for ship owners who use their facilities (Senturk, 2010). On average 70% of ship repair work can be done when the ship is in the water and only 30% of the work requires drydocking (Senturk, 2010).

Repeated ship repairs include: steel, painting, line shaft (underneath the boat), propellers, and piping work when piping has been eroded and needs replacement. Electrical work is less common. Margins on repair are 35-50%; Higher than margins on building (10%). As such, ship repair work has advantages over building for smaller yards without economies of scale due to higher margins and quicker turnaround. Building takes longer and ties up all manpower (Philippines Shipbuilding Stakeholders, 2016).

One source estimates that maintenance and repair of the world merchant fleet is approximately $18.5 billion annually, composed equally of labor and materials/equipment (EC, 2014). Furthermore, the market for welding in ship repair, particularly in Asia, is experiencing high growth (F&S, 2011).

Ship owners choose repair facilities based on price, location, specialization, and due to increasing safety regulations, quality as well. It is also dependent on whether it is scheduled/routine maintenance or an unforeseen problem. While yards that specialize in newbuilds or major conversions are less sensitive to location; yards that specialize in repair have a distinct advantage if they are located close to major sea lanes or key loading/discharge points. This is because such strategic locations will minimize the amount of vessel downtime experienced by ship owners, and would make those repair facilities more attractive than those that are situated in less convenient locations. Examples of such strategic locations are Singapore, the Arabian Gulf and the Mediterranean (Senturk, 2010). Singapore, Dubai and Bahrain have emerged as ship repair centers.

Case for the Philippines

While the Philippines is not a ship repair hub, it is the country leading countries look to for labor. Singapore has sought to maintain its leading role in ship repair by entering into alliance agreements with major ship owners and operators, and attempting to retain its long-standing reputation as a relatively low-cost center by hiring labor from lower cost sources such as China, Malaysia, India and the Philippines. Dubai has also looked to the Philippines as a primary source for labor in its ship repair yards (Senturk, 2010). **This indicates there should be Filipinos with the skills needed to do repairs that could open facilities in the Philippines.**

Keppel's shipyards in the Philippines started by providing ship repair and building barges and tugboats for the domestic market. Over time, activities have expanded to include servicing foreign vessels and shipbuilding activities complex and specialized vessels such as oil carriers, custom-built barges, tugboats for foreign ports (Singapore and Oman). They have also ventured into offshore structures. As a component supplier, the shipyard fabricates the lower pontoon structure that will form part of the semi-submersible oil rig structure, which is integrated and completed in Keppel's Singapore yards.

4. **Entry into breaking and recycling:** Given the lack of domestic inputs available in the Philippines, a ship breaking and recycling facility could be a viable option. Reports

indicate that Tsuneishi has been looking for a location to build a new green recycling facility in Asia since 2014, and has decided on a 1.2km2 plot of land on Negros Island in the Philippines for a PHP 5.2bn ($103m) investment (Clarksons, 2017b). The merits of such a facility were mentioned in previous reports on development opportunities for the Philippines (Stürzebecher, 2014), noting that such a facility should comply with rules for green recycling and could create at least 5,000 jobs. "Green" in this context means the operation meets the environmental and health/safety regulations acceptable to European shipowners as compared to the current shipbreaking countries that have received negative attention from the NGO community about their treatment of workers' safety and the disposal of environmentally sensitive materials (e.g., asbestos). While the shipbreaking industry has been centered in South Asia and China over the last two decades, scrapping Japanese and European flagged ships could be a profitable niche for the Philippines if they can market themselves as providing a unique end of life service different from the South Asian yards. Such a facility would provide a source of employment and revenue, but also a needed domestic supply of inputs. Equipment can be refurbished and reused and steel can be reused or recycled. Recovered steel can be used as feedstock into mini-mill steel production, while recovered structural beams and plates can either be directly used in the construction industry without further processing, or heated and re-rolled into bars and rods in re-rolling mills without melting into crude steel and producing new steel products using the electric arc furnace (EAF) method. While the average age of the global fleet is young, ship breaking may increase because ship owners with 'middle-aged fleets' (~12 years) may choose to break and rebuild instead of convert to meet the new environmental regulations. Shipbreaking may also increase for ships prior to the end of their useful life (~25 years) to reduce global overcapacity.

The third set of opportunities pertain to opportunities for domestic firms to develop building and design capabilities to initially satisfy demand for the domestic market that can lead to opportunities for entering the regional and global value chain in more niche markets.

At the time of writing, two proposals were being circulated to expand the domestic SBSR industry in the Philippines. Both primarily focus on the domestic market, and therefore do not fall within the purview of this report.[39] However, the Philippines is in a unique position due to significant domestic demand for ships for inter-island transportation and there is not a well-defined international market for these ships (thus creating the opportunity for the Philippines to establish such a position). Both provide pathways for the Philippines to enter the global SBSR value chain. These export-oriented objectives should be built into the development programs from the onset rather than be viewed as afterthoughts. Furthermore, while presented as conflicting or competing strategies, they are complimentary and can be pursued in tandem.

The first proposal focuses on reforming domestic ship regulations related to the useable life of a ship while simultaneously providing incentives and support to develop a new SBSR cluster in the Mindanao area. The objective of this plan is to create a full domestic supply chain for RoRo

[39] Domestic ships for domestic shipping is not 'global' or export-oriented. Furthermore, domestic shipping is not legally subject to the same standards and regulations as oceangoing vessels on international waters (although there are benefits of adopting these standards as discussed below).

vessels to initially serve inter-island transportation and shipping needs, with the objective of expanding to exports and other types of vessels.

- *Pros:* builds full supply chain and in one location; provides a solution to a potential safety issue in the Philippines. Would introduce a design standard for a new type of vessel that does not exist that could potentially be used in other locations.
- *Cons:* will take a long time to get off the ground and the location for development is on the security watch list of several developed countries.

5. **Entry and end market upgrading (domestic to export market):** There is a potential opportunity for the Philippines to enter the regional and global value chain for smaller vessels such as RoRos and AHTS/OSV offshore vessels. This was selected as a target because: (1) while small, the average age of the global RoRo fleet is among the oldest, and thus will go through a 'build' cycle in the near future; (2) increasing trade within Asia will require new types of vessels specifically designed to navigate waterways in this part of the world and for smaller loads than global shipments; (3) one of the leading global suppliers of small offshore vessels has a long-term presence in the Philippines and could serve as an entry way for the country into this market; (4) these are physically smaller vessels that may not require expansion of existing facilities, and (5) there is domestic demand for these vessels.

The second proposal also focuses on reforming existing regulation for domestic shipping, but promotes converting vessels for domestic use rather than newbuilds. This would change the useful life of a vessel by ensuring the vessel is safe to operate and would require new technology to test the stability of existing vessels. Recommendations related to ship repair and design capabilities have similarities to the objectives of this proposal.

- *Pros:* can be implemented without extensive capital investment in facilities, so ramp up time is short. Skillset exists in the Philippines.
- *Cons:* does not increase export-oriented opportunities for larger vessels.

6. **Functional upgrading: ship design (smaller regional/domestic vessels):** Shipbuilding activities extend beyond those performed in shipyards to ship design (for both new builds and conversions). These activities require workers with skills in engineering, and offer intersectoral upgrading opportunities to other transportation and construction industries. This requires college-educated workers with knowledge of software (CAD, etc.). There could be overlap in educational programs that train students in this area that could be applicable for multiple end markets. The Philippines already has at least two companies engaged in ship design (TTSI and Dash Engineering).

Appendix

Table A-1. Shipbuilding Final Products, HS02 Codes & Export Statistics, 2015

Category	HS Codes	World Exports (US$, B)	Philippines Exports (US$, B)	Phil. World Share
Total		**$117**	**$1.5**	**1.3%**
Containerships, bulkers, cargo		**$44**		
Other goods carriers (e.g., containerships)	890190	$44	--	--
Refrigerated vessels (reefers)	890130	$0.1	--	--
Tankers	890120	$22	--	--
Passenger ships	890110	$5	--	--
Carriers	*8901*	*$71*	*$1.5*	*2.1%*
Offshore		**$36**	**$0.0001**	**0%**
Floating structures: rafts, tanks, coffer-dams, landing-stages, buoys, beacons	890790	$1	--	--
Construction: dredgers	890510	$1	--	--
Drilling/production platforms	890520	$11	--	--
Light-vessels, fire-floats, floating cranes; other vessels of which navigability is subsidiary to their main function; floating docks	890590	$22	--	--
Other		**$10**	**$0.04**	**0.4%**
Tugs and pusher craft	8904	$5	--	--
Fishing	8902	$2	--	--
Other vessels (life boats)	890690	$4	$0.04	1.0%
Share of Philippines' Total Exports			**2.6%**	

Source: Authors. At the six-digit level, the Philippines exports from HS8901 are not reflective of the ships exported from the country. As such, all codes beginning with HS8901 have been grouped together. These are considered carrier ships. See Mapping the Shipbuilding Global Value Chain for context.

Table A-2. Shipbuilding Subassemblies, Components & Raw Materials, HS02 Codes

System/VC Stage	Specific	Item	HS Codes
Platform: Propulsion	Ship-Specific	Turbines for marine propulsion	840610*
		Marine propulsion engines -Spark-ignition reciprocating or rotary internal combustion piston engines -Outboard motors/Other	840721 840729
		Compression-ignition internal combustion piston engines (diesel or semi-diesel engines)/Marine propulsion engines	840810
	Not Ship-Specific	Nuclear reactors, boilers, machinery and mechanical appliances/Other engines and motors/Hydraulic power/Other Hydro-jet engines for marine propulsion code ended in .40	841229
		Parts for use with engines of heading 84.07 or 84.08 /Other/for use with spark-ignition internal combustion piston engines	840991
		Parts/applies to ships and auto for engines other than internal combustion	840999
Mechanical	Ship-Specific	Propeller & blades 848710 (HS07-12)	848510 (HS02)
	Not Ship-Specific	"Other machinery self-propelled, other", 4D code lists ship derricks (crane)	842649*
Navigation & Communication	Not Ship-Specific	Radar apparatus, radio navigational aid apparatus and radio remote control	8526
		Surveying, hydrographic, oceanographic, hydrological, meteorological or geophysical instruments and appliances	9015
		Navigation-related	901480* 901490*
Hull/ Raw Materials	Not Ship-Specific	Steel (iron & non-alloy steel)	7206-7217
		Tubes & pipes & fitting	7303-7307

Source: Authors; see Gereffi et al. (2012) for an earlier version (*) code was not included in it, but added here. See Table 8. World Exports of Ship Subassemblies/Components, 2015.

Table A-3. Delivery of Newbuilds by Vessel Type and Country of Build, 2015

Type	Gross Tons (millions)						Country's Share of World (%)					Vessel Type Share of Country's GT (%)					
	China	Japan	Korea	Phil	ROW	Total	China	Japan	Korea	Phil.	ROW	China	Japan	Korea	Phil.	ROW	Total
Total	**23.1**	**13.4**	**22.0**	**1.9**	**3.8**	**64.1**	**36**	**21**	**34**	**3**	**6**						
Bulk carriers	13.3	10.8	1.6	0.9	0.2	26.8	50	40	6	3	1	58	81	7	47	6	42
Containerships	5.0	0.2	9.3	1.0	0.6	16.1	31	1	58	6	4	22	1	42	53	17	25
General cargo	0.7	0.2	0.3	0.0	0.4	1.6	43	12	20	0	24	3	1	1	0	10	3
Oil tankers	2.9	0.9	4.8	0.0	0.4	9.0	32	10	53	0	5	12	7	22	0	11	14
Other ships (if looking at UNCTAD vessel groupings data, all below are under "other")																	
Gas carriers	0.1	0.7	3.4	0.0	0.0	4.2	3	16	81	0	0	1	5	16	0	0	7
Chemical tankers	0.2	0.2	0.2	0.0	0.1	0.6	23	30	29	0	18	1	1	1	0	3	1
Offshore	0.9	0.0	1.5	0.0	1.0	3.4	25	1	44	0	29	4	0	7	0	26	5
Ferries and Passenger	0.1	0.0	0.0	0.0	0.8	0.9	11	3	1	0	85	0	0	0	0	21	1
Other	0.0	0.4	0.8	0.0	0.2	1.5	3	27	57	0	13	0	3	4	0	5	2
Containership, bulkers, cargo	19.0	11.2	11.2	1.9	1.3	44.5	43	25	25	4	3	82	83	51	100	33	69
Tankers	3.1	1.8	8.4	0.0	0.6	13.8	23	13	61	0	4	14	13	38	0	15	22

Source: UNCTAD (2016); UNCTAD secretariat calculations, based on data from Clarkson. Note: covers propelled seagoing merchant vessels of 100GT+.

Table A-4. Key Indicators of the Shipbuilding Industry in the Philippines

Indicator	Philippines Values					Ship Share of Philippines				
	1999	2010	2012	2014	2015	1999	2010	2012	2014	2015
Ship Manufacturing										
Employment		22,238	19,509	15,910		0.9%	2.3%	1.9%	1.3%	
Establishments		15	13	19		1.1%	0.1%	0.2%	0.1%	
Firm Size (# and share of firms, ≥ 20 emp.)		10 67%	--							
Value, Output $US, Mil		$1,617	$1,874	$1,526		1.0%	2.0%	1.8%	1.5%	
Value Added ($US, Mil)			$582	$304		0.8%		2.2%	1.2%	
Wages/Employee ($US)		$2,414	$4,665	$1,819					Lower	
Exports (US$, Billion)		$0.4	$1.1		$1.5		0.8%	2.1%		2.6%
Ship Repair										
Employment		3,927		6,269			0.4%		0.5%	
Establishments		54		67			0.3%		0.3%	
Firm Size (# and share of firms, ≥ 20 emp.)		24 44%								
Value, Output $US, Mil		$101		$189			0.1%		0.2%	
Wages/Emp. ($US)		$3,341		$9,571					Higher	
Mfg. + Repair										
Employment	9,900	26,165		22,179	48,000		2.7%		1.8%	
Establishments	79	69		86			0.4%		0.3%	
Firm Size (# and share of firms, ≥ 20 emp.)	-- --	34 49%					0.7%			
Value, Output $US, Mil	$432	$1,718		$1,716			2.2%		1.7%	
Value Added ($US, Mil)	$142			$396					1.5%	
Wages/Emp. ($US)	$2,727	$2,553		$3,912					Lower	

Sources: 2014: Philippines NSO (2017); 2010: Philippines NSO (2013): ASPBI results for all establishments; ship manufacturing represented by ISICRev4 3011 and PSIC2009 codes C30111: Building of ships and boats other than sports and pleasure boats and C30114: Manufacture of metal sections for ships and barges. Ship repair represented by ISICRev4 3315 and PSIC09 C3315: Repair on ships and boats. Notes: C30113: Manufacture of inflatable rafts

(ISIC4, 3011) and C30121: Manufacture of inflatable boats (ISIC4, 3012) in ASPBI 2010, but listed as (S). These are same codes in ISIC, Rev. 4; in ISIC Rev. 3.1, within 351 (building and repairing of ships and boats).

Data for 1999 and 2012 from INDSTAT. Represents establishments with ≥ 20 emp.; employment based on paid employees (always within 1% of total employment). Data for 2015 from other sources cited within the document.

See section on the Philippines Current Participation in the Shipbuilding Global Value Chain for details.

Table A-5. Supporting Shipbuilding-Specific Stakeholders by Focus Area

Name	Abbrev.	Focus	Location	Year Est.
Maritime Industry Authorities of the Philippines	MARINA	Government Agency	Manila	1974
Association of Shipyards in the Philippines/ Shipyard Association of Cebu	SHAP	Association	Cebu	2015
Metro Manila Shipyard Association Inc.	MMSAI	Association	Navotas	
Society of Naval Architects and Marine Engineers, Inc.	SONAME	Association	Manila	1950/ 2008
Board of Investments	BOI	Government Agency	Manila	
Department of Environmental and Natural Resources	DENR	Government Agency	Quezon City	
Philippine Register of Shipping	PRS	Classification Society	Manila	1989

Source: compiled by Authors

Table A-6. Shipbuilding Suppliers in the Philippines

Firm	Year Est.	Ownership	Location	Service/ Product
Confidence Marine Industries	2011	Japan- THICI Supplier	Cebu	Hull
Asian Craft (Cebu), Inc.	1999	Japan-THICI Affiliate	Cebu	Hull, Painting, Steel Blocks
Bisyou Industry Cebu	2012	Japan- THICI Supplier	Cebu	Painting
Metaphil International	2007	Philippines	Cebu	Ship blocks Components
Nakanishi Paint Cebu	2012	Japan- THICI Supplier	Cebu	Painting
Tsuneishi Accommodation Cebu	2002	Japan- THICI Affiliate	Cebu	Outfitting, furniture, accommodation blocks, repair
Kambara Empresa Philippines	2015	Japan	Cebu	Outfitting
Karumona Nagano Seiko	2005	Japan		Engine parts
GRT (Cebu)	2011	Japan	Cebu	Outfitting, Steel
Dynacast/ Dynapower	1968		Cebu	Propellers/ Engine repair
Navnautics	2007		Manila	Repair; Small switchboards
Propmech	1991		Manila	Boatbuilder Engine repair
Cebu Furnishings			Cebu	Furniture (Export)

Source: PEZA (2015)(primary source)

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