Sustainable Manufacturing in the US Shipbuilding Industry through Outsourcing

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Abstract

This paper discusses the issues facing global outsourcing in the US shipbuilding industry. These issues include the benefits and risks that accompany outsourcing in general and global outsourcing, or offshoring, in particular. Shipbuilding in the United States has historically been considered a strategic industry, supporting both military and commercial interests. Even though the US shipbuilding enjoys competitiveness in market share and high-tech capability but most often it suffers cost overruns. The opportunity to reduce costs by taking advantage of lower labor rates around the globe is the primary reason for shipyards to consider offshoring. Both outsourcing and offshoring can be used to help offset fluctuations in labor requirements and maintain a stable workforce. Currently, outsourcing activities are in place at most shipyards around the globe, but larger shipyards tend to be vertically integrated to a point where significant outsourcing is unnecessary.

For offshoring of shipbuilding activities in the United States, the risks and barriers sometimes outweigh the benefits. A loss of control over production processes can lead to quality and schedule problems if not closely monitored. The stability of the country in which the subcontractor is located is a major factor in the outsourcing decision. Changes in labor and exchange rates can cause significant increases to the cost of the outsourced product. Technology transfer issue is another impediment to global offshoring. The absence of a static design and the needs of national security prevent the outsourcing of naval warship construction. However, for commercial ships, offshoring can be a viable option for producing higher quality ships at a lower cost. One of the few areas that may be a candidate for offshoring of U.S. warships is habitability spaces. This paper discusses unique factors affecting the shipbuilding industry and proposes possible solutions.

Keywords: Global Outsourcing, Sustainable Shipbuilding, Technology Transfer, Cost Overruns

1. Introduction

The US shipbuilding and repair industry includes about 600 companies with combined annual revenue of about $17 billion in 2010 [1]. Major companies include the shipbuilding divisions of General Dynamics and Northrop Grumman, both of which are US military contractors. Other top companies include BAE Systems Ship Repair, Bollinger Shipyards, the inland barge division of Trinity Industries, and VT Halter Marine (a subsidiary of Singapore Technologies Engineering). The industry is highly concentrated: the largest 50 companies account for about 90 percent of revenue [1].

The shipyards on the Eastern and Gulf Coasts account for over 80 percent of the revenues for the entire industry. The six largest shipbuilders, commonly referred to as the Big Six, account for two-thirds of the industry’s total revenue and perform nearly 90 percent of all military work [2]. Ninety-five percent of the revenues of these yards are defense-related. The Big Six accounted for about 11 percent of the industry's commercial revenues during the 1996-2000 periods [2]. Corporately, the Big Six are structured as follows: Bath Iron Works (Maine), Electric Boat (Connecticut and Rhode Island), and NASSCO (San Diego) are part of General Dynamics’ Marine Systems; Avondale (New Orleans) and Ingalls Shipbuilding (Mississippi) are part of Northrop Grumman Ship Systems; and Newport News Shipbuilding (also part of Northrop Grumman Ship Systems), the largest of the Big Six, remains independent to date. All of these big six shipbuilders are located on the US coasts shown in Figure 1.
Defense ships in the US are acknowledged to be the best in the world. Construction of these ships has advanced naval technology. Advancements include the integration of nuclear power and gas turbine propulsion, advanced weapons systems, state-of-the-art electronic communications, and stealth technologies. Advanced research and development at the Navy’s laboratories, acquisition commands, and certain shipbuilders and universities have resulted in state-of-the-art hull, mechanical, electrical, power projection, air defense, and undersea warfare capabilities that are operational today [2]. With reduced research and development budgets, some of that capability is now becoming fragmented. The shipbuilding industry’s principal roles in the development process have been in the application of technology, detailed design, and manufacturing and system integration.

The U.S. commercial shipbuilding industry is generally not internationally competitive; particularly in the construction of vessels over 1,000 gross tons. Various sources report several reasons for this lack of competitiveness, including foreign government subsidies and other unfair trade practices, exchange rates, and lagging U.S. productivity. In some niches, however, the United States currently has a significant world market share based mostly on domestic sales.

![Figure 1. Big Six Shipbuilder’s location in the USA](image)

The US shipbuilding is facing many challenges like other shipbuilders around the world. Some of these challenges are cost and schedule overruns, lack of expert workers, quality problems, and technology transfer issues [2]. Some of these challenges can be dealt very well and make the US shipbuilding sustainable if outsourcing is managed effectively. The purpose of this paper is to help understand the issues facing global outsourcing in the US shipbuilding industry. These issues include the benefits and risks that accompany outsourcing in general and global outsourcing, or offshoring, in particular. In the following sections, this paper first discusses about the challenges of US shipbuilding and then how outsourcing can help to be sustainable.

2. Current challenges at the US shipbuilding industry

Shipbuilding in the US is facing many challenges such as falling behind schedule, cost overruns, lack of available skilled workers, quality problems, technology transfers, etc. Current economic situation puts additional pressure on the shipbuilding industry. A summary of the findings in the GAO reveals the problems of Navy programs in the US and abroad. Cost and schedule overruns are representative of naval shipbuilding and stem from a lack of certainty and risk mitigation during the initial procurement stages of a program. This lack of certainty comes from a desire to develop new technologies in concert with design and construction of the ship hulls, as well as from external political
factors. Table 1 illustrates the cost overruns on recent Navy programs which have spurred the generation of the GAO report [3].

<table>
<thead>
<tr>
<th>Navy Ship Models</th>
<th>Initial Budget Request</th>
<th>Updated Budget request</th>
<th>Cost Overruns from Initial Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSN 774</td>
<td>$3,260 million</td>
<td>$3,752 million</td>
<td>15%</td>
</tr>
<tr>
<td>SSN 775</td>
<td>$2,192 million</td>
<td>$2,740 million</td>
<td>25%</td>
</tr>
<tr>
<td>T-AKE 1</td>
<td>$489 million</td>
<td>$538 million</td>
<td>10%</td>
</tr>
<tr>
<td>LPD 17</td>
<td>$954 million</td>
<td>$1,758 million</td>
<td>84%</td>
</tr>
<tr>
<td>LHD 8</td>
<td>$1,893 million</td>
<td>$2,196 million</td>
<td>16%</td>
</tr>
<tr>
<td>LCS 1</td>
<td>$215 million</td>
<td>$631 million</td>
<td>193%</td>
</tr>
<tr>
<td>LCS 2</td>
<td>$257 million</td>
<td>$636 million</td>
<td>147%</td>
</tr>
<tr>
<td>CVN 77</td>
<td>$4,975 million</td>
<td>$5,843 million</td>
<td>17%</td>
</tr>
</tbody>
</table>

To avoid cost overruns in the shipbuilding, the US shipbuilding industry will need to be lean and agile by deploying all cost saving measures including outsourcing. Many of the changes that should be made to ensure that the required fleet is built in a financially responsible manner require the introduction of tried and true practices from the commercial shipbuilding industry. The end goals of a Navy shipbuilding program are primarily ones of performance and capability. As the end goals of the commercial shipbuilders are centered on profitability and schedule, there are certain behaviors they exhibit that can be introduced into naval shipbuilding to reduce cost and avoid schedule delays [3].

Financial crisis is forcing government agencies to spend less and less in the defense sector. In 1988, US government spent $27 billion on shipbuilding while it has requested only $12 billion for 2009 shown in Figure 2). US Navy believes that 12 ships per year will sustain them in the future. If the US slows its ship building, China will surpass the USA in Navy ships by 2014 shown in Figure 3). Demand for military shipbuilding is largely determined by the US military budget, and to a much lesser extent, the military spending of foreign governments allied with the US. Commercial shipbuilding demand is determined by international and domestic trade, the health of the global economy, and rate of fleet replacement due to age or obsolescence. This shrink of demand is further challenging the US shipbuilding industry to be more efficient.

Department of Labor stated that the productivity in the US shipbuilding industry has not significantly improved since the mid-1980s, although gains have occurred since 1995 (up 12%). Compared to productivity increases in aircraft manufacturing (up 84%), for example, shipbuilding productivity has not kept pace [3]. The skill base of the US shipbuilding industry is eroding, notably for welders, pipe fitters, and ship fitters. Shipyards also cited shortages of machinists, electricians and

Figure 2. US spending on Navy ships [4]
marine engineers [3]. Shipyards compete with other industries and with each other for skilled labor. A common response to acute labor shortages by some U.S. shipyards is to hire and train unskilled workers. Training unskilled workers imposes additional costs with no guarantee the workers will stay long enough for the yard to recoup its investment. Some commercial yards reported that worker morale, substance abuse, and work-related accidents due to inexperience posed additional challenges.

3. Sustainability in the shipbuilding

In order to develop a sustainable shipbuilding industry, the US government will need to offer guidance to ensure a standard approach is followed across the industry. In terms of production efficiency and modern shipbuilding practice, many of the same principles can be applied regardless of whether the shipyard in question is building naval or commercial vessels. On the navy side there are a number of challenges that must be overcome to ensure a sustainable, competitive industry can be built that will ensure accountability to the US taxpayer during the procurement process. Despite technological advantage in the US shipbuilding industry, it is not competitive in the world market because of labor costs. Due to the relatively high labor costs in US compared to those in the emerging shipbuilding markets, it will be necessary to be highly efficient in order to compete on the international stage [5]. The US has some key indicators that will allow being successful in a bid to be commercially competitive at an international level. The first of these is a proven track record in other industries, usually accomplished via innovation and technology. The second is a number of shipbuilding industry leaders already operating in the shipbuilding industry in US.

A sustainable workforce is the backbone of a sustainable industry. Currently US lacks a sufficiently large and sufficiently educated workforce of naval architects, ship designers, marine engineers, welders, fitters, and many other occupations required to sustain the type of shipbuilding industry that has been envisioned by the US government. Either US has to train a large number of people in a diverse set of skills for shipbuilding or go for outsourcing. The following sections discuss the potential benefits and risk of outsourcing for US shipbuilding industries.

4. Outsourcing in the shipbuilding industry

Outsourcing is the practice of contracting out business functions or services to external firms that can perform these functions at a lower cost [6]. This may involve specific tasks such as accounting, IT services, and janitorial services, or it may involve broader tasks such as manufacturing [7]. Many firms perform design functions in house, but contract the manufacturing process to specialized external firms. An example would be an architectural firm that designs a building, but contracts with a
construction company to build it. A specific type of outsourcing is offshoring, an outsourcing effort that is contracted with a foreign firm to occur outside the borders of the home country.

Offshoring is much more complicated than outsourcing within a firm’s own country. Many additional factors affect the decision to outsource. Some of these factors are exchange rates, labor rates, cultural differences, political stability, and distance. A firm should take considerable care before deciding to outsource offshore to avoid unforeseen consequences associated with business transactions involving foreign companies.

The accelerating trend of globalization over the past few decades has had an impact on firms’ ability to compete in both the domestic and global marketplace. Firms can now move capital quickly and easily between and among companies and nations making it easier to select the lowest cost provider of processes and services, regardless of location. As companies struggle to compete in the global marketplace, the ability to control costs is vital to remaining competitive. Outsourcing is one option to help reduce the costs associated with manufacturing a product. There are many reasons why a firm would choose to outsource: cost reduction, lack of qualified labor, insufficient in-house capacity, improved processes or technology and a desire to devote resources to core competencies. Many times, a subcontractor has specialized equipment and highly trained personnel that can perform a certain task that the contracting firm requires only occasionally. It would not be cost effective to tie up capital in equipment and personnel if they are not used often enough to realize a return on the investment [8].

Offshore outsourcing is increasing at a significant rate. Estimates for global outsourcing in 2006 are $5.1 trillion [7]. Although these figures include outsourcing activities such as information technology, accounting services, customer support, and other back-office functions, manufacturing represents a significant portion of the total. Lower labor rates, less stringent environmental laws, and favorable business climates make offshoring an attractive option for manufacturing operations. In the end, as with most business decisions, the primary reason companies outsource is to reduce costs. The shipbuilding industry involves very complex and labor-intensive activities. Ships are the largest machines produced on the planet and require years to design and manufacture. Ships are divided into two main classes, commercial and military. Trends in labor rates and capital investment over the last several decades have shifted the construction of commercial ships away from developed countries and their high labor rates and toward developing countries. Fifty years ago, the United States was one of the largest commercial shipbuilding countries in the world, but now represents only one percent of the construction volume [9]. High labor rates, stringent regulations, and lack of capital investment to improve productivity have combined to make commercial shipbuilding unprofitable in the United States on a large scale.

Military shipbuilding represents the majority of shipbuilding activity in the United States in terms of revenue. A similar situation exists in Great Britain and other developed countries. The bulk of this paper will discuss outsourcing and offshoring options available to shipyards constructing military vessels. Following the end of the Cold War, Congress trimmed defense budgets and reduced shipbuilding programs. In 1977, Litton’s Ingalls Shipbuilding Division (now Northrop Grumman Shipbuilding Gulf Coast) employed almost 25,000 workers [10]. By 2001, the employment level had decreased to slightly over 10,000 [11].

Likewise, the British shipbuilding industry employed 11,000 production employees in 1992 and only 7,000 in 2002 [8]. The reduction of Northrop Grumman’s and Britain’s workforce is typical of the shipbuilding industry in the United States and Europe in general. This has created a situation where manufacturing capacity may not be able to handle projected shipbuilding programs proposed by the U.S. and British navies.

The British government commissioned the RAND Corporation to conduct an analysis of shipbuilding outsourcing practices used by shipyards in the United Kingdom, the United States, Asia, and the European Union (EU). Although reasons varied somewhat by country or region, the top drivers for outsourcing were cost savings, corporate directives, lack of necessary skills, labor shortages, and capacity constraints. Also noted were reasons why outsourcing was not used, including in-house capability, security concerns of military shipbuilding, and lack of an adequate supplier base [8].
5. Potential benefits of outsourcing in the US shipbuilding industry

The benefits of outsourcing include cheaper labor, ability to adjust to fluctuations in demand, improved quality when subcontracting to specialized firms, avoidance of recapitalization, and a desire to concentrate on core competencies [12], [13], and [14]. Risk associated with outsourcing include rising global wage rates, failure to link outsourcing plans to business strategy, loss of control, and poor quality [14], [15], and [16]. The key to successfully incorporating outsourcing practices into shipbuilding is to identify and mitigate risks. This will insure that expected benefits are realized.

5.1 Labor Savings

Currently, a large gap exists between labor rates paid in the shipbuilding industries located in the United States and Britain and the developing world. By sending outsourced portions of the construction process offshore to companies located in nations that enjoy a low labor rate, shipyards can realize significant savings. A substantial portion of the total ship cost is labor, and outsourcing provides one means of reducing this cost. Estimates of labor savings by offshoring can range from 30% to 80%, but the costs associated with managing offshore operations need to be included in the total costs [13].

Much of the problems associated with high labor costs in the United States are tied to the benefits that manufacturing workers receive. Overall, productivity in the manufacturing sector has increased 109% from 1977 to 2002. Much of this productivity is attributable to increase use of automation and applied technology. Although prices in the U.S. economy during this period have risen 140%, manufacturing prices have only risen 60% [17]. The high costs of insurance, retirement benefits, and vacation inflate U.S. wage rates when compared to developing countries that do not offer these benefits to their workers.

Even though U.S. workers are increasing their productivity, they are not receiving a corresponding increase in their take home salary. Productivity has increased 85% from 1973 to 2005, but when adjusted for inflation, wages have decreased 8% [18]. This phenomenon is sure to continue and will place more pressure to offshore manufacturing jobs to lower wage countries. As technology continues to increase productivity worldwide, the opportunity to reduce manufacturing costs by offshoring will increase. Computers are beginning to be ubiquitous in modern shipyards around the globe as recapitalization efforts are transforming foreign shipyards into formidable competitors. In 2004, the U.S. Maritime Administration inserted wording into its request for proposal changing the definition of U.S. construction to mean that 10% of the hull and superstructure could be manufactured in foreign shipyards [9]. This brought immediate reaction from both the U.S. shipbuilding industry and congress to prevent the offshoring of shipbuilding for the U.S. government. However, this event does highlight the growing pressures U.S. shipyards are facing to reduce the costs associated with building ships.

5.2 Fluctuations in Labor Requirements

The cyclic nature of the shipbuilding industry coupled with the length of the construction process creates significant fluctuations in the labor mix required to support the shipbuilding industry. Much of these fluctuations within the U.S. are currently being handled by outsourcing to subcontractors as production demands exceed workforce capability. Subcontracted labor normally performs this peak work at a shipbuilder’s facility alongside permanent workers. U.S. shipbuilders have been slow to outsource actual steel fabrication work offsite to other companies and have avoided offshoring this work almost entirely.

Recent trends in U.S. naval construction contracts have begun to change this practice. As the number of ships procured by the U.S. Navy has continued to fall, collaborative efforts among competing shipyards have emerged. There are not enough ships being produced each year to employ fully the required workforce at all shipyards that are involved in production of naval vessels. For a number of years, Electric Boat, a subsidiary of General Dynamic, and Newport News Shipbuilding, a subsidiary of Northrop Grumman, have shared the design and construction of the Virginia class submarines to keep engineering design capabilities at both shipyards.
The new DDG 1000 destroyer contract also splits design and construction tasks between General Dynamic’s Bath Iron Works and Northrop Grumman Shipbuilding Gulf Coast (NGSB-GC) operations. Each shipyard will build their respective sections of the hull and superstructure and ship them to the other shipyard for integration of the final ship. For strategic purposes, all four of these shipyards must be kept open to retain a manufacturing base, but there is not enough work for each to perform independently.

Finally, in an effort to keep as much U.S. production capacity as possible, modules of various ships are being subcontracted among Bath Iron Works (BIW), Newport News, and NGSB-GC. Units for aircraft carriers under construction at Newport News are being fabricated at NGSB-GC. Units for amphibious ships under construction at NGSB-GC are being built at BIW and Newport News. Barges transport these assemblies to the shipyard where final assembly takes place. A similar situation exists in Great Britain where a new class of aircraft carrier is being planned, the Future Aircraft Carrier (CVF). No single shipyard in Great Britain has the capability or capacity to build these aircraft carriers independently. The solution is to contract out large portions of the ship to individual shipyards for complete fabrication and transport these super blocks to a shipyard for final assembly [8]. Even with this strategy, production capacity at existing shipyards will be seriously strained.

Another method of outsourcing used by shipyards involves entire tasks such as painting. This method is very common in the EU, but is relatively rare in the United States or Great Britain. The major reason for this difference is that U.S., U.K., and major Japanese shipyards have extensive vertical integration and perform virtually all shipbuilding tasks within house labor. This practice aggravates fluctuations in labor levels in the U.S. and U.K., but Japanese shipyards manage to avoid this problem with a flexible workforce and high production levels.

By contrast, EU shipyards focus on steel fabrication and outsource all other construction activities. This allows these shipyards to maintain constant permanent workforce levels and avoid legal and financial consequences associated with terminating workers. Mid-sized Japanese shipyards also use a high level of outsourcing to help reduce costs [8].

5.3 Increased Quality

It is generally perceived that by outsourcing tasks to companies that specialize in those tasks, a higher quality product will be produced. For some shipyards, certain tasks such as special paint and coating applications do not generate enough work to justify investing capital for in house capability. Other tasks occur so infrequently or are so new to shipbuilding that existing capability does not exist. In these cases, avoidance of capital expenditures may be the primary reason to outsource and not an effort to increase quality.

U.S. and U.K. shipyards report that the primary reason they chose outsourcing as an option is to reduce costs. However, neither of these groups performs much outsourcing, relying instead on vertically integrated infrastructures to perform all necessary tasks associated with shipbuilding. Asian shipyards depend on peak outsourcing to address fluctuations in workloads rather than an attempt to increase quality.

European shipyards make heavy use of outsourcing during the construction cycle of a ship. Although maintaining a constant labor force is a large part of the outsourcing decision, increased quality is also a factor [8]. Quality is very much a reason for outsourcing on commercial vessel such as cruise ships where quality construction of staterooms, cabins, and dining and entertainment facilities is very important. It is much cheaper to achieve a high quality product through outsourcing these functions to specialized contractor with highly skilled craftspeople.

5.4 Core Competencies

A final reason to outsource is to allow a shipyard to focus on its core competencies. During the construction of modern warships, outsourcing is performed during contract negotiation and award. Various contractors combine talents to build a warship with a shipyard producing the vessel, weapons manufacturers producing guns and missile systems, and electronic integration firms creating the software that allows all of these systems to interact.
When a shipyard does receive a contract for the entire ship, it usually subcontracts those portions outside of its core competencies. This allows the shipyard to focus its capital and workforce on building the hull and superstructure. Specialized facilities and people are required to build and test weapons systems and their associated software and control systems. Since it is not necessary for these functions to be performed at the shipyard itself, there is little incentive for shipyards to develop these capabilities.

6. Potential risks and barriers of outsourcing in the shipbuilding industry

6.1 Reduced Control over Processes

Transferring activities outside the shipyard by outsourcing also transfers the control and accountability of daily activities. This increases the risk that substandard work performed at an early stage of construction has to be reworked at a later stage. The further along in the construction process a particular task is performed, the higher the cost of that activity. A task that requires one hour to complete at the lowest unit of construction may take as much as ten hours to complete on an assembled ship [8]. This requires a substantial quality inspection effort throughout the construction of the outsourced portion of the ship.

Material shortages and interruptions, labor disputes, and production engineering issues can all contribute to slippage of schedules that affects the final delivery of the outsourced assembly. These issues are extremely difficult to control in the prime shipyard and would be much harder to control at a subcontractor’s facility. When portions of the ship are outsourced overseas, these issues become even more difficult to identify and control. The probability of poor quality increases as control over construction process decreases.

Shipyards must approach outsourcing with care and ensure contractual stipulations are in place that clearly define critical quality indicators. These indicators should identify specific activities and events that need monitoring to prevent poor quality work from occurring. The contracting shipyard needs to have their quality personnel embedded in the subcontractor’s facility from the start of construction to final delivery. This will insure that problems are identified early, corrective action taken, and changes to processes are implemented to prevent repeated mistakes.

The cost of these added quality inspections, onsite quality inspectors, and a robust system for tracking the construction process remotely must be factored into the cost benefit analysis when deciding to outsource. Failure to do so may result in unexpected cost increases. A study conducted by AMR Research showed over 50% of manufacturers outsourcing production, experienced cost over runs [12].

6.2 Changes in Global Competitiveness

Trends show that manufacturing costs are rising globally. As developing countries prosper, wages rise and competition increases. The more outsourcing projects that flow into a country, the greater the demand for labor. This eventually leads to an imbalance in the supply and demand for skilled workers and wages have to increase. This in turn will cause a decrease in outsourced work entering the country and a new equilibrium will be reached, but at a higher wage level. Since shipbuilding is a lengthy process, prices need to be negotiated and locked in to prevent spiraling labor costs from eroding any anticipated savings from outsourcing. The recent rise in oil prices underscores how quickly global commodity markets can affect costs associated with manufacturing ships and other long-term projects.

6.3 Transportation

Transportation costs associated with building portions of a ship in another country are high. Not only does the finished product have to be shipped back to the parent shipyard, all material that goes into the construction has to be shipped to the subcontractor’s facility. Most of the material used in the construction of ships is tightly controlled by specifications and are obtained from a few select vendors. Hazards during the transportation of the assembled units from the subcontractor’s facility to the shipyard are very real. Storms have sunk many vessels and caused much cargo to be lost. Barges used
in the transportation of large ship assemblies are not very seaworthy and heavy lift seagoing vessels are very expensive to lease. While insurance may cover the loss or damage to an assembly, the delay in constructing and delivering the ship would be prohibitively expensive. A single day delay in delivering a modern warship can amount to over $1 million in costs.

This requires delivery schedules to be coordinated with seasonal weather patterns over the course the delivery ship will sail. For an Atlantic crossing, two or three weeks of fair weather would be required to insure a safe delivery. If an East Coast shipyard in the U.S. outsourced the units to Asia, more than a month would be needed to insure a safe delivery. The cost of this risk has to be factored into the decision to outsource and extensive mitigations steps put in place.

6.4 Human Capital

The decision to outsource has to take into account the impact to the shipyard’s workforce. Long-term outsourcing will lead to lost jobs and decreased opportunities for remaining employees. Morale and motivation may decline if workers fear their jobs are headed overseas where labor is cheaper. Efforts need to be taken to retrain displaced workers and incorporate them into the remaining workforce.

If outsourcing becomes commonplace for major assemblies or entire tasks such as piping or outfitting, the opportunity to train young workers entering the workforce decreases significantly. Many of the skills needed to build ships take years to learn under apprenticeship programs and mentoring with skilled craftspeople. If the workforce is allowed to fall to a lower level through attrition, the opportunity to continually hire and train new employees diminishes. This can have the effect of placing the shipyard in jeopardy of not being able to field a trained workforce to build a ship. For this reason, outsourcing decisions need to be closely linked to the shipyard’s business strategy. Once knowledge of core activities are lost or severely diminished through attrition due to outsourcing, it is unlikely it will ever be regained. If a shipyard becomes dependent on a subcontractor for a part of its core business, the shipyard loses bargaining power [16].

6.5 Static Design

One of the most important aspects of subcontracting out work on a ship is the necessity of a completed and mature design. Both the shipyard and the subcontractor need to know the final configuration of the ship to price the construction process in an accurate manner and to ensure the lowest construction costs throughout the build process. This situation may exist for commercial ships, but military vessels are rarely designed in advance and the design is never static.

One of the reasons for the high cost of warships is the constant change that occurs to the design as the ship is built. Construction usually starts on the lead ship of a class before the design is completely finished. This allows a head start on a very lengthy process but adds tremendous risk to the program in the form of potentially added costs to change items that have already been built. In addition, changes to the design are constantly being incorporated as the ship is being built. A truism in U.S. warship manufacturing is that no two ships are ever exactly alike. Each one will incorporate different changes with the latest ship built being the most updated with equipment and capability.

All of these changes present obstacles to outsourcing for cost savings. Changes to the design after the award of a construction contract with an offshore subcontractor can quickly drive up the delivered cost of the product. This factor alone may be sufficient to prevent the offshoring of portions of military ships.

6.6 Security and technology transfer

Finally, the need for national security and the desire to prevent foreign nationals seeing how a U.S. warship is constructed prevents outsourcing of major components. However, crew habitability modules, and other parts of a ship may be outsourced offshore without security concerns. These are the areas that shipyards can explore to determine if outsourcing is an option.
7. SWOT analysis

7.1 Strengths

The primary strengths of a shipyard are its integration capability, business strategy, and trained workforce. Most shipyards excel in hull fabrication and have an excellent engineering staff capable of creating new ship designs. U.S. shipyards are equal to international yards in outfitting and storage, and very close in their organization and operating systems [19].

Suppliers of outsourcing services, as a group, have the ability to adjust workforce levels to the demand of current work. Together, subcontractors have an extremely large workforce with a high degree of skill and specialization. This gives the subcontractors a lot of flexibility in adjusting to changing work demands and can increase the quality of the finished product.

7.2 Weaknesses

Ironically, U.S. shipyards lag behind international yards in steelwork and pre-erection activities [19]. They could benefit from offshoring these activities, but the cost would be prohibitive. U.S. shipyards need to concentrate and improve these skills to compete better with foreign yards.

Weaknesses of foreign suppliers are very similar to the risks associated with offshoring. Distance from the shipyard makes transportation difficult and expensive. Inability to work on military ships disqualifies foreign subcontractors from working on the vast majority of U.S. ships. Finally, stability of governments, quality of the labor pool, language, culture, currency volatility, and intellectual property rights all combine to present obstacles and risks to performing outsourcing functions for U.S. shipyards [6].

8. Conclusion

The nation needs a unified strategy for developing and maintaining an infrastructure to produce world-class ships at more competitive prices. The US Navy and the Maritime Administration can play an important role in developing such a strategy. In addition to its economic and military benefits, this strategy could help exploit the energy savings and environmentally friendly aspects of waterborne transportation.

The opportunity to reduce costs by taking advantage of lower labor rates around the globe is the primary reason for shipyards to consider offshoring. Both outsourcing and offshoring can be used to help offset fluctuations in labor requirements and maintain a stable workforce. Currently, outsourcing activities are in place at most shipyards around the globe, but larger shipyards tend to be vertically integrated to a point where significant outsourcing is unnecessary.

Although increased quality is often given as a reason to outsource, most shipyards did not consider this as a prime factor in the decision to outsource, but rather viewed it as an added benefit. The most common reason for outsourcing seems to be in an effort to stabilize workforce levels, especially in Europe.

For offshoring of shipbuilding activities in the United States, the risks and barriers outweigh the benefits. A loss of control over production processes can lead to quality and schedule problems if not closely monitored. The stability of the country in which the subcontractor is located is a major factor in the outsourcing decision. Changes in labor and exchange rates can cause significant increases to the cost of the outsourced product.

For U.S. shipyards, isolation from other shipbuilding nations is a cost driver due to transportation costs. For shipyards in Europe and Asia, close proximity to other shipyards may make offshoring a feasible option. The impact of moving shipbuilding jobs overseas has the potential to weaken the workforce and not provide enough jobs to attract young workers. In this manner, outsourcing can lead shipyards down a spiral path where an insufficient workforce causes more outsourcing, leading to further degradation of jobs.

The absence of a static design and the needs of national security prevent the outsourcing of naval warship construction. However, for commercial ships, offshoring can be a viable option.
for producing higher quality ships at a lower cost. One of the few areas that may be a candidate for offshoring of U.S. warships is habitability spaces. U.S. shipyards should explore this option.

9. References