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USMC Landing Craft Case Study

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Abstract

This case study is written to produce an active learning environment to increase the capability of acquisition/program management professionals and senior leaders regarding program planning, decision-making, and affordability. The U.S. Marine Corps (USMC) Landing Ship Medium (LSM) program is a USMC priority acquisition program originating from USMC Force Design 2030 organizational changes and managed within the Naval Sea Systems Command (NAVSEA) Program Executive Office Ships acquisition portfolio. The USMC LSM procurement objective is 35 ships, and the initial cost estimate for each ship was between $100 million and $150 million. The U.S. Navy (USN) has expressed concern over the LSM's limited survivability requirements. To meet the USN's more stringent survivability requirements, the LSM cost would increase to more than $350 million per ship and threaten the program's affordability within the USN's shipbuilding budget. Moving forward, the USMC faces challenges addressing the best option to solve the medium-size amphibious ship capability gap as well as determining the optimal acquisition pathway and contracting strategy. The program must balance the following in determining the path forward: performance and security requirements; affordability/cost constraints; schedule need dates; program, technical, and manufacturing risks; and industrial base challenges.

Keywords: ship building, affordability, decision-making, critical thinking, project management

Introduction

The Landing Ship Medium (LSM) program is a U.S. Marine Corps (USMC) priority acquisition program with an acquisition objective of 35 ships originating from USMC Commandant General David Berger's (2023a) Force Design 2030 organizational and equipment changes. U.S. Navy (USN) leadership has expressed concern over initial LSM survivability requirements and potential increased cost estimates to over $350 million per ship to meet additional survivability requirements (O'Rourke, 2023b). Differences in ship capability requirements and Naval Sea Systems Command (NAVSEA) concerns with a limited shipbuilding budget have delayed procurement contract award to fiscal year (FY) 2025 (O'Rourke, 2023b).

The USMC's Force Design 2030 requirement identified a need for 35 additional amphibious connectors larger than a Landing Craft Air Cushion (LCAC) or Landing Craft Utility (LCU) and smaller than a Landing Platform Dock (LPD; Berger, 2023a). Figures 1, 2, and 3 depict an LCAC, LCU, and LPD, respectively, to show the vessel size differences and capability limitations between ship-to-shore LCU/LCAC connectors and larger amphibious LPD warships.

Figure 1. An LCAC Moving USMC Vehicles to Shore (Eckstein, 2023).

Figure 2. An LCU Transporting Marines to Shore (USN, 2019).

Figure 3. USS *New Orleans* (LPD 18) with an LCAC in the Background (Eckstein, 2022).

These additional vessels are needed because Marine Littoral Regiments (MLRs) operating as stand-in forces in the Pacific lack tactical mobility and maneuverability to move company-sized forces and equipment between Pacific islands (Berger, 2023a). The LSM will provide the USMC with a low-signature ship attached to the MLR that can deliver a Marine company to shore; it will also be larger and more effective than current smaller LCU and LCAC connectors assigned to Marine Expeditionary Units (MEUs; Oakley et al., 2023, p. 171). The LSMs will augment larger amphibious vessels assigned to support MEUs in the Pacific theater,

such as the LPD and Landing Helicopter Assault LHA; Berger, 2023b).

The initial cost estimate for each LSM was between $100 million and $150 million with an acquisition program and desired procurement contract award in FY2023 Quarter 1 (O'Rourke, 2023b). Currently, the program is behind the USMC's desired schedule, and the program could slip further due to issues solidifying the acquisition quantity and requirements (Oakley et al., 2023, p. 171). The USMC requirement outlines the need for additional medium amphibious connectors as a priority to meet increasing operational demand in the Indo-Pacific Command (INDOPACOM) and expects the first LSMs in the fleet by 2028 to meet Force Design 2030 implementation timelines (Feichart, 2023, p. 1). Given budgetary constraints, shipbuilding backlogs, limited industry participation, and other issues, the risk of further schedule slip is high (O'Rourke, 2023a).

Background

> I woke up this morning, checked what's the readiness rate. It's 32 [percent]. We can't live with a 32 percent readiness rate. And over the last decade it's below 50 percent.
> —38th Marine Corps Commandant General David Berger (Kenney, 2023, p. 1)

During World War II, the rapid production and availability of Landing Ship Tanks (LSTs) played a pivotal role in transporting troops, equipment, and supplies in the European and Pacific theaters. These vessels were designed to carry heavy cargo, up to 431 troops, and 510 tons of vehicles, and conduct amphibious beach landings. After the war, the Department of Defense (DoD) recognized the naval utility value of these ships and kept the LST in service until 2002. However, after the Newport-class LST was decommissioned that year, a logistical void surfaced that could not be filled by smaller or less capable connectors or medium-sized vessels. Despite evolving warfare dynamics and technologies, there is still a need for modern multi-functional LSTs that provide the naval services with the ability to conduct amphibious operations, humanitarian missions, and evacuation operations. The LST's historical significance is amplified by its World War II production efficiency, which was due in part to its modular assembly and design. This unique feature enabled large-scale production at 18 shipyards that produced over 1,000 LSTs in only 3 years. Surprisingly, many of these vessels originated from inland shipyards located in Illinois, Indiana, and Pennsylvania because of the ship's smaller size, modular design, and ability to navigate inland rivers to reach the oceans (Phillips, 2023). The LST's historical significance is amplified by its World War II production efficiency, which was due in part to its modular assembly and design. This unique feature enabled large-scale production at 18 shipyards that produced over 1,000 LSTs in only 3 years.

Figure 4. World War II LSTs Onloading Equipment and Supplies in England in Preparation for Operation Overload (Ussery, 2008).

Amphibious Capability Gap and Requirements

USN amphibious L-class ships (e.g., LPD, LHA) are crewed by Navy sailors and used to transport Marines, weapons, equipment, and limited supplies to expeditionary operations in littoral areas (O'Rourke, 2023b, p. 5). Figure 5 depicts an LHA, which is the largest type of USN L-class ship and, unlike other amphibious vessels, does not possess a well deck.

Figure 5. USS *America* (LHA 6) Conducting a Replenishment-at-Sea (Defense Visual Information Distribution Service, 2020).

The FY2023 National Defense Authorization Act (NDAA) directs that the minimum necessary amphibious fleet shall consist of 10 amphibious assault ships (LHA/Landing Helicopter Dock [LHD]) and 21 LPDs (Berger, 2023b). The L-class ships are organized into Amphibious Readiness Groups and combine with MEUs to provide overseas naval deterrence and response capability to support combatant commanders. Kenney (2023) reported that the deployable USN amphibious fleet averaged 46% readiness over the past decade. In 2023, deployable L-class amphibious ship readiness reached its lowest recorded point, at 32%. The USN attributes these operational availability issues to a ship maintenance backlog, which is a fleet-wide problem. The lack of availability impacted the USMC's ability to respond quickly with an MEU in 2022 to the Russian invasion of Ukraine and provide humanitarian aid to Turkey and Syria earthquake victims (Kenney, 2023). Currently, the USN amphibious fleet is unable to meet the National Defense Strategy requirement to consistently provide 31 amphibious ships to ensure MEU forces for combatant commanders (Berger, 2023b, pp. 16–17).

Force Design 2030 introduced a new force structure by transforming two infantry and one artillery regiments into three MLRs possessing balanced infantry, fire support, low-altitude air defense, and logistics battalions organic to the new formation. These forces are designed to operate dispersed within the first island chain of the Pacific Islands, including Senkaku (Japan), Ryukyu (Okinawa), and the Philippines, providing land-based sea lane control and sea denial capabilities. The MLR structure promotes decentralized company-level operations within the area of operations to reduce detectability. USMC wargames identified that the MLR requires organic sea mobility to enable small company-size movements between the numerous Pacific first island chain nations. Sea mobility provides the MLR with the ability to blend into dense commercial shipping routes using comparably sized vessels, thus limiting detectability among similar commercial vessels, which increases the MLR's survivability during conflict. The LSM is envisioned to fulfill tactical sea mobility in politically and militarily contested Pacific environments while complementing L-class amphibious ships by offering a new remote island connector capability (Berger, 2023b, p. 13). This platform offers a lower risk of escalation when maneuvering in gray zone areas to facilitate security cooperation, humanitarian assistance, and

MLR logistics support mobility (Berger, 2023b, p. 13). According to General Berger (2023c),

> After extensive research and wargaming, we calculated a need for nine LSMs to support a single regimental sized unit. The DON's Amphibious Force Requirements Study over the last two years validated this number, articulating a requirement of no fewer than 18 LSMs to support littoral maneuver. Given that current force structure plans call for three MLRs, we require 35 LSMs to account for operational availability and mobility for those units. We anticipate an initial request for 18 of the 35 LSMs we seek will be a step toward enabling us to more effectively counter adversaries' strategies, support and reinforce alliances and partnerships, and do so at a relatively low cost. (pp. 13–14)

In 2020, the LSM ship requirements were simple and inexpensive, and could be based on commercial ship design (O'Rourke, 2023b). Figure 6 depicts an LSM concept design based on the following vessel requirements and specifications outlined in the System for Award Management's (2020a, 2020b) LSM Circular of Requirements and Industry Day brief, which were consolidated by O'Rourke (2023b):

- length of 200–400 feet
- maximum draft of 12 feet
- displacement of up to 4,000 tons
- ship's crew of no more than 40 USN sailors
- ability to embark at least 75 Marines
- 4,000–8,000 square feet of cargo area for the Marines' weapons, equipment, and supplies
- stern or bow landing ramp for moving the Marines and their weapons, equipment, and supplies from the ship to shore (and vice versa) across a beach
- modest suite of C4I equipment
- 30mm gun system and .50 caliber machine guns for self-defense
- transit speed of at least 14 knots, and preferably 15 knots
- minimum unrefueled transit range of 3,500 nautical miles
- tier 2+ level of survivability (i.e., ruggedness for withstanding battle damage), a level broadly comparable to that of a smaller USN surface combatant (e.g., a corvette or frigate), that would permit the ship to absorb a hit from an enemy weapon and keep the crew safe until they and their equipment and supplies can be transferred to another LSM
- ability to operate within fleet groups or deploy independently
- 10-year minimum and 20-year expected service life

Figure 6. An LSM Concept Design (Grady, 2023).

Key to the LSM design and survivability is mobility to hide within commercial shipping lanes and surrounding Pacific Islands. The capability to move forces, equipment, and supplies between small commercial ports and remote island beaches is crucial to fill the MLR amphibious vessel gap. The LSM is a fraction of the size of L-class ships, and initial requirements described a desire for it to resemble commercial shipping vessels navigating the same maritime arena. Hubbard (2023) described the LSM as a "transport vessel in the tradition of vessels like the Landing Ship, Tank (LST) of World War II [WWII] vintage. LSTs were designed to bring materiel from American factories at home across oceans and deposit this equipment on a foreign and often hostile shore" (p. 68). The LSM, like the LST, was initially envisioned as an inexpensive vessel able to deploy dispersed surface forces across the INDOPACOM theater. Like the LST, the LSM provides intra-theater tactical lift able to fulfill multiple transportation requirements in conjunction with larger L-class ships. The LSM is required to be less detectable than L-class amphibious ships and able to operate in a channel distribution system to move people and things between vessel platforms to dispersed remote island end points (Hubbard, 2023).

The LSM capability forecasts a vessel able to support a "dispersed, agile, constantly relocating force" (Apte et al., 2021, p. 305) operating in accordance with the Expeditionary Advanced Base Operations concept. As a medium-sized ship, the LSM is required to conduct amphibious landings on beaches to offload Marines, equipment, and supplies while also possessing greater carrying capacity, range, and survivability in comparison to LCUs and LCACs. Apte et al. (2021) described the LSM requirement as a "risk-worthy vessel (defensible enough that risks are not excessive or cheap enough that we can afford to lose it) with priority for personnel survivability" (p. 306), which is a different employment concept from L-class ships.

The Deputy Commandant of Marine Corps Combat Development and Integration (CD&I), Lieutenant General Karsten Heckl, described the LSM as a shore-to-shore connector not requiring a pier or another ship (Easley, 2022). CD&I is the USMC's requirements generation, experimentation, and wargaming command responsible for defining what the USMC needs from the LSM to be effective in the INDOPACOM region. LtGen Heckl described the LSM as a priority for modernization efforts despite budget constraints delaying production and USN leadership concerns about survivability in a conflict. In 2022, CD&I leased a commercial stern vessel to deploy with 3rd MLR for experimentation in the INDOPACOM area of operations to reaffirm minimum viable product LSM requirements and demonstrate urgency of need (Easley, 2022).

The U.S. Army possesses a large fleet of aging watercraft capable of transporting soldiers and equipment short distances and conducting beach landings. Under the U.S. Army's Maneuver Support Vessel initiative, two new watercraft variants are being developed for operations in the Indo-Pacific region. The Army Program Executive Office for Combat Support and Combat Service Support (PEO CS&CSS) launched the Maneuver Support Vessel-Light (MSV-L) prototype at Vigor LLC's Vancouver, WA, facility, which marked the introduction of a new and improved class of Army watercraft (Higgins, 2022). Vigor was awarded a 10-year contract in 2017 to produce up to 36 of these MSV-L craft that are intended to replace the Vietnam-era Landing Craft Mechanized-8, which is like the USN LCU vessel. The MSV-L is 117 feet long, is crewed by eight soldiers, has a top speed of 21 knots fully loaded with soldiers and equipment, and has a maximum range of 360 nautical miles (Higgins, 2022). Further, the MSV-L is designed to transport either an M1 Abrams tank, two Stryker combat vehicles, or four Joint Light Tactical Vehicles (Luckenbaugh, 2023). After initial testing, the Army determined the MSV-L baseline requirements necessitated modification to address design changes and cost increases, with projections for initial operational capability in 2028 (Roque, 2023). Notably, the MSV-L design lacks the defensive systems and survivability features the USN desires to incorporate in the LSM design, which increase the LSM's cost per ship (The Maritime Executive,

2023). Figure 7 shows the MSV-L concept design and resemblance to USN LCUs in service.

Figure 7. U.S. Army MSV-L Concept Design (Vigor, n.d.).

Brigadier General Samuel Peterson, U.S. Army PEO CS&CSS, highlighted collaboration with the USN and USMC in defining the larger Maneuver Support Vessel (Heavy; MSV-H) requirements (Roque, 2023). The MSV-H is planned to be up to 400 feet in length, have a top speed of 18 knots, carry as many as 175 soldiers and their equipment, possess a crew of approximately 30, and be capable of beach landings (Luckenbaugh, 2023). The Army plans to select multiple shipyards to develop virtual prototypes with a planned low-rate initial production (LRIP) decision in 2028 and the first delivery in 2030. The MSV-H design specifications resemble the USN LSM vessel requirements; however, the MSV-H provides slightly greater speed and carrying capacity. The similarities between the two programs in meeting INDOPACOM warfighter requirements create the possibility for a joint solution that would provide reduced life-cycle operations and sustainment operation and costs as well as Army/USN/USMC collaboration opportunities for budgetary resources allocation.

Program Development

The LSM program, previously named the Light Amphibious Warship (LAW) program, received a Material Development Decision and entered the Materiel Solution Analysis phase of the major capability acquisition (MCA) process with a procurement goal of 18–35 LSMs and the awarding of initial production contracts in FY2025 (O'Rourke, 2023b). The initial capabilities document outlined the validated threshold requirements for the ships (System for Award Management, 2020a, 2020b), which supported the completion of a draft Analysis of Alternatives (AoA; Oakley et al., 2023, p. 171). As of 2023, the DoD had not approved the AoA (Oakley et al., 2023, p. 171). According to DoD Instruction 5000.85, without AoA approval, the acquisition program is unable to proceed to the MCA Milestone A decision to develop the system further in the Technological Maturation and Risk Reduction (TMRR) phase (Office of the Under Secretary of Defense for Acquisition and Sustainment, 2020). Figure 8 displays the LSM program schedule (as of 2023) from concept to system development and through production.

Figure 8. LSM Acquisition Timeline as of June 2023 (Oakley et al., 2023, p. 171).

The LSM AoA studies the necessity to proceed in developing and producing a new amphibious ship design over repurposing existing USN, Maritime Sealift Command, or U.S. Army watercraft to meet the sea transportation requirement. According to O'Rourke (2023b), the DoD has not yet approved the AoA because the "key requirements of the new vessels are very similar to the capabilities of vessels operated by U.S. Army Transportation Command" (p. 22). Further, O'Rourke (2023b) recommended that "the Navy and Marine Corps should delay any new construction and immediately acquire some of these existing vessels to drive experimentation and better inform their requirements for the LAW program" (p. 22). O'Rourke's (2023b) recommendation to delay production and further explore opportunities to leverage existing Army Transportation Command watercraft systems could benefit the USN and USMC to reduce their operational capability gap risk.

Though the AoA study plan is still pending approval, the LSM program office awarded concept design contracts to five production-capable shipbuilders with the option to award a follow-on Preliminary Design Review (PDR) contract (Shelbourne, 2021). These five finalist shipbuilders, tasked with creating digital prototypes, could be viable manufacturers during the production phase even though they are not all traditional Navy amphibious shipbuilders (Quigley, 2022). These shipbuilders and engineering design firms included Fincantieri, Austal USA, VT Halter Marine, Bollinger, and TAI Engineers. In total, 11 industry teams worked with NAVSEA to understand the vessel requirements and competed for the design contract award (Eckstein, 2021). One of the 11 firms was SeaTransport; Figure 9 displays its LSM concept design.

Figure 9. SeaTransport's Proposed LSM Concept Design (Shelbourne, 2021).

The contract winners will use the requirements to produce ship designs, which will include engineering analyses and trade-off studies to assist in the TMRR phase (Royal Institution of Naval Architects, 2021). The winning concept will receive a follow-on preliminary design contract to refine technology maturation in preparation to enter the Engineering and Manufacturing Development (EMD) phase post–Milestone B. The five concept design awards amounted to less than $7.5 million (Shelbourne, 2021). Additionally, in the FY2024 budget, the USN programmed $14.7 million for research and development to refine the five awarded design review contracts through prototyping.

Originally, the USN and USMC requirements and acquisition team projected enthusiasm and willingness to begin initial production as early as FY2022 (Eckstein, 2021). However, capability requirements differences delayed initial production. Shelbourne (2021) described LSM planning, programming, budgeting, and execution funding as an issue, for the "Navy only sought the research and development funding in the recent FY2022 request" (p. 1). The USMC's aggressive acquisition requirement timeline did not match the USN's desire to refine the concept studies and did not program procurement appropriation funding to meet the expected FY2022 initial production goal.

Rear Admiral John Gumbleton, deputy assistant secretary of the USN for budget, commented on the LSM development as part of the USN's FY2023 budget by stating, "The Marine Corps and the Department are getting the requirements tight on that ship before we choose to put it in our [shipbuilding appropriations account]. So, there is funding in R&D for LAW" (O'Rourke, 2023b, p. 17). While RAML Gumbleton argued that USN shipbuilding leadership preferred to reduce the risk through research and development funding, Major General Tracy King, former director of expeditionary warfare for the Office of the Chief of Naval Operations (OPNAV 95), proclaimed that the LSM acquisition schedule was "aiming at lead ship construction in FY '22, it's going to be late in FY '22, but I still consider that pretty fast" (Eckstein, 2021, p. 1). O'Rourke (2023b) outlined the developing program schedule risk, stating that "another issue for Congress concerns the date for procuring the first LAW. As noted earlier, previous USN plans envisioned starting procurement of LAWs in FY2023. Compared to this, the USN's FY2023 five-year shipbuilding plan in effect defers the start of LAW procurement two years, to FY2025" (pp. 16–17). O'Rourke (2023b) highlighted the LSM program schedule delays and increased per-ship procurement costs, opining the need for further cost–benefit analysis and enhanced congressional oversight.

Currently, the USN is planning for LRIP beginning with procurement contract award in 2025, with the first LSM estimated to cost $187.9 million (O'Rourke, 2023b). Using a single shipbuilder, the follow-on manufacturing contract award for the second LSM would occur in FY2026 and cost $149.2 million, while the third and fourth ships would be procured in FY2027 and cost a combined $297 million, or $148.5 million per ship. The LRIP fifth and sixth LSM procurement contract awards are scheduled for FY2028, costing an estimated combined total of $296.2 million, or around $148.1 million per ship. Included in the cost estimate for the lead ship are the detailed design and nonrecurring engineering costs, which are traditionally how the USN generates ship cost estimates for the first procurement (O'Rourke, 2023b).

Compared to larger LPD and LHA amphibious ships, the LSM's reduced size enables a greater number of shipyards and shipbuilders to manufacture it. O'Rourke (2023b) stated, "The Navy's baseline preference is to have a single shipyard build all the ships, but the Navy is open to having them built in multiple yards to the same design if doing so could permit the program to be implemented more quickly and/or less expensively" (p. 2). The LSM concept is a modified commercially produced stern landing vessel design that can be built at many U.S. shipyards, creating greater production capacity beyond the limited larger L-class shipyard producers (Royal Institution of Naval Architects, 2021). With the USN's proposed LRIP acquisition strategy, the time between procurement contract award and delivery is estimated at 3.5 years for the first ship, so a FY2025 contract award will deliver the lead ship to the fleet in FY2028. Former Commandant of the Marine Corps Gen Berger (2023b) described the current problem set in congressional testimony by stating,

> We have adapted to this challenge and are developing bridging solutions to experiment with LCU-1700s and leased Expeditionary Fast Transports (T-EPF) and Stern Landing Vessels. While these platforms will inform the eventual employment of the LSM, they will fall short of desired capabilities if called upon in an operational setting. Our modernized expeditionary forces need a comparably modern mobility platform to bring the full weight of their capability to bear on competitors or adversaries, particularly in littoral regions. (p. 14)

Optimistically, the first LSM will complete production in 2028, and the fleet will not be

fully operational and capable of effectively supporting MLRs until at least a decade later. In the interim, pressure to achieve the USMC's high priority need for additional amphibious ships can only be fulfilled by commercial vessel leasing options and existing alternative legacy Army Transportation Command watercraft. These will be the only solutions available in the near term to meet an increasing need for light sea transportation in INDOPACOM.

Program Challenges

With the LSM, the USN aims to provide a modern adaptation of the World War II–era LST for transporting Marines and equipment throughout INDOPACOM. In a major war, LSMs would be susceptible and slow targets, just like World War II LSTs were, though the LST's versatility outweighed its vulnerability (Hooper, 2023). Additionally, the modest 40-person LSM crews led by junior officers conflict with current naval personnel shortfalls. A 35-LSM fleet would require 280 junior naval officers, further challenging recruitment, and would deviate those officers from traditional surface warfare officer career pathways (Hooper, 2023). Contrary to common sense, commanding an LSM as a USN lieutenant (O-3) could put junior officers at a disadvantage in terms of remaining competitive for promotion due to their peer group gaining greater warship systems experience while serving aboard actual warships (e.g., destroyers; Hooper, 2023).

O'Rourke (2023b) described that the LSM program experienced significant delays, with the detail design and construction contract award pushed from FY2023 to FY2025. O'Rourke (2023b) opined that the 19-month slippage stems from ongoing engagement with industry to refine requirements and delays approving the program's AoA. O'Rourke (2023b) detailed that the LSM program continues working toward a contract award in 2025 and aims to shorten development time by modifying an existing commercial ship design rather than creating a new design. The LSM program seeks to streamline the schedule by eliminating certain oversight reviews, which risks senior leaders lacking information necessary for making sound decisions (O'Rourke, 2023b). The USN has engaged industry on LSM concepts since 2020 through multiple rounds of studies with numerous participating designers and shipbuilders. The USN aims to rapidly iterate designs to meet evolving requirements and provide feedback on requirement impacts.

Key LSM program elements, including survivability requirements and procurement quantity, remain undefined. The USMC proposed acquiring 35 LSMs, but the USN supports only 18. Without a clearly defined acquisition objective and concurrence on commercial ship design modification requirements, the LSM vessel procurement cost ranges from $150 million per ship to produce the minimum viable product the Marines desire to $350 million per ship to add the Navy's desired survivability requirements comparable to L-class amphibious ship survivability and systems technology (O'Rourke, 2023b). At its core, the disagreement over LSM capability systems and survivability reflects the USN and USMC's differing attitudes toward risk tolerance. The USN is extremely reluctant for its vessels to suffer catastrophic battle damage, whereas the USMC acknowledges that losses of Marines and equipment, while regrettable, are an unavoidable hazard during combat operations (Larson, 2022).

Critics of the LSM program stress that the USMC values ship procurement and delivery speed by requesting appropriation funding before the final requirement is determined, which is reminiscent of the flawed LCS program (Baird et al., 2022). Deviating from major capability acquisition processes and milestones increases program risk and can lead to requirements creep. LCS construction began before prototype testing did, which led to cost overruns and unmet operational needs after 20 years of design and program management failures, resulting in terminating future production and retiring ships early (Baird et al., 2022). Currently, the FY2024 shipbuilding budget supports the first LSM construction contract being awarded in

2025.

Also, the USN prefers a single shipyard that manufactures all LSMs but would allow a multi-yard approach if it accelerated schedule or reduced costs (O'Rourke, 2023b). Key design considerations reflect these trade-offs, including a maximum 12-foot draft, which facilitates transit in shallow waters and beach landings, and ample cargo space, as open deck storage differs from most current amphibious ships. The modest speed of about 15 knots, compared to 22 knots for larger amphibious ships, allows for a less expensive and more fuel-efficient propulsion system (O'Rourke, 2023b). The 20-year service life is less than the 30–45 years that is typical for bigger amphibious ships but enables a lower cost for this smaller ship class. The services are working to strike the right balance between affordability gained through simplified designs and survivability requirements aimed at enhancing fleet capabilities.

The LSM survivability is questionable due to its slow speed and limited maneuverability, which makes it susceptible to enemy detection when transiting contested seas and vulnerable to missile strikes (Jenkins, 2022). Further, any direct hit on the lightly defended ship would result in unrecoverable catastrophic damage. Adding enhanced survivability features increases the per-unit procurement cost and the operations and maintenance cost, resulting in the necessity to trade off other features or reduce the number of ships procured. It is inevitable that the final cost of building the new ship will be far higher than initial estimates, as more unforeseen expenses and requirements will emerge during the long construction process. Additionally, given the new naval ship class's record of cost overruns and delays, there is considerable uncertainty about when this capability will be delivered to the fleet (Jenkins, 2022).

In April 2023, the USN and USMC communicated that they were close to reaching agreement on the requirements and costs for the LSM program (O'Rourke, 2023b). BGen Marcus Annibale, the director of expeditionary warfare on the chief of naval operations staff, indicated there was progress in drafting the capability development document (O'Rourke, 2023b). The author further reported Vice Admiral Scott Conn, the deputy chief of naval operations for warfighting requirements and capabilities, recognized the importance of procuring these smaller ships. Additionally, LtGen Heckl, deputy commandant of CD&I, explained that he, VADM Conn, and BGen Annibale were able to work together to find common ground on survivability and vulnerability features to incorporate into the LSM design (O'Rourke, 2023b). LtGen Heckl also noted that the original concept emphasized low cost, larger quantities, and a commercial-style design (O'Rourke, 2023b). However, discussions between the USN and USMC led to the USN and the Office of the Secretary of Defense demanding greater capability and survivability requirements—and, therefore, greater costs—and now the program is returning to its initial size and cost (O'Rourke, 2023b). On May 17, 2023, the USN issued a request for information to shipbuilders about the LSM program and asked interested firms to provide responses on several production capacity and investment topics. According to O'Rourke (2023a), those questions included the following:

- Do you have the resources and production capacity available to be awarded 4 LSM ships per fiscal year?
- If so, how can your shipyard support production of 4 LSM hulls per year?
- If not, what is the maximum number of LSM ships that can begin production each year?
- If not, are there investment or shipyard improvements that can be done to enable increasing production capacity to 4 LSM hulls per year? (p. 5)

This request for information showed the USN's interest in manufacturing multiple LSMs per year, and, given the USN's previously stated acquisition strategy to produce 18 LSMs, this four-ships-per-year rate would complete production within 5 years of accelerated production. This is a key insight into the USN's goals and willingness to accept increased risk to achieve

greater production speed for the warfighter.

In the Government Accountability Office's 2023 annual weapons system report, Oakley et al. (2023) described the current LSM (referred to as the LAW) program status by stating,

> Since our last review, the Navy delayed the detail design and construction contract award for LAW from fiscal year 2023 to fiscal year 2025. According to Navy officials, this change was due to ongoing efforts to engage with industry and refine program requirements, as well as delays in gaining approval of the program's analysis of alternatives (AOA)—a key document to help DOD and the Navy decide if a new ship class is needed. As of January 2023, the Office of the Secretary of Defense had yet to approve the AOA, which is at least a 19-month delay in the planned approval since our last review.
>
> Although an approved AOA has yet to confirm the need for LAW, the program continues to work toward a detail design and construction contract award and is looking for opportunities to shorten LAW's development time. For example, the program plans to modify an existing parent ship design, instead of creating a new one, and has been assessing potential designs with five companies since 2021. The program also plans to seek approval to streamline its schedule by eliminating certain early acquisition oversight reviews. We previously found that eliminating such reviews can increase the risk that senior acquisition and warfighting leaders lack information needed for sound investment decisions.
>
> Currently, several key program elements remain undefined. In particular, the Navy is still determining LAW's requirements. In alignment with leading principles for iterative development, the Navy is making changes to draft requirements based on industry feedback and ongoing AOA efforts. DOD has also yet to determine LAW's total procurement quantities. The Marine Corps suggested 35 ships, but the Navy proposed acquiring only 18. The Navy cannot estimate LAW's costs until it defines requirements and quantities. (p. 171)

Oakley et al. (2023) received the following summarized comments from the LSM/LAW Program Office:

> It stated that the Navy is following a deliberate requirements process to determine its needs for the LAW program. It noted that the Navy endorsed the AOA in March 2022 and is awaiting the sufficiency review by the Office of the Secretary of Defense. It added that it is incorporating the analysis results and feedback from the five industry preliminary designs into the upcoming Capabilities Development Document. (p. 171)

Path Forward

The LSM program faces acquisition options and decision points that include finalizing the vessel requirements and procurement quantity and maturing the commercially modified

design (Oakley et al., 2023, p. 171). The program must also determine whether the design and construction contract will be awarded to a sole shipbuilder or multiple concurrent shipbuilders. The shipbuilding industrial base's capability and capacity to produce four LSMs per year to meet the USMC's operational need dates remain key constraints. Finally, the program must determine the best acquisition path forward to manage cost, schedule, performance, and manufacturing risk. In an attempt to shorten development timelines and streamline oversight reviews, the program plans to modify an existing commercial ship design rather than develop a completely new design.

In summary, the LSM program faces decisions on balancing performance capability, schedule, costs, and manufacturing risks as it proceeds toward a production contract award. Careful oversight is necessary to avoid past shipbuilding program pitfalls. The acquisition team's challenge is to tailor, combine, and transition between acquisition pathways to deliver the LSM to the warfighter before 2030 while also reducing per-unit costs through capability trade-offs to meet shipbuilding budget constraints. The team must maximize value for the warfighter by creating a realistic program baseline despite cost overruns, budget limits, and a need for faster shipbuilding.

Recommendations for the path forward must address the following questions and key decisions:

- What is the best option to solve the warfighter's medium-size amphibious ship capability gap?
- Assuming the doctrine, organization, training, materiel, leadership and education, personnel, and facilities assessment justifies a materiel solution and the LSM AoA is approved, what is the best acquisition pathway to follow?
- What is the best LSM contract award strategy?

Options to address the warfighting capability gap include using current amphibious ships, pursuing a joint acquisition program with the Army's MSV-H program, acquiring commercially available vessels (commercial off-the-shelf), or pursuing an LSM development program. If the USMC decides that the LSM program is best path forward, then the appropriate acquisition approach can leverage multiple Adaptive Acquisition pathways based on the urgency of need, available resources, and technical/manufacturing readiness levels. Acquisition approaches to consider include continuing in the major capability acquisition (MCA) pathway toward an MS B, using the MCA pathway but going directly to MS C, using the middle tier acquisition (MTA) pathway with both rapid prototyping and rapid fielding, using the MTA pathway with rapid prototyping followed by entry to MCA at MS B, and using the MTA pathway with rapid prototyping followed by entry to MCA at MS C. Finally, the LSM contracting strategy to engage with shipbuilders can include contracts with a single domestic shipbuilder, multiple domestic shipbuilders, or multiple domestic shipbuilders and international shipbuilders. Decision criteria used to compare these options could include performance (meeting more USMC requirements is better), cost (lowering total life-cycle costs is better), schedule (meeting the USMC operational need dates is better), technical and manufacturing risk (leveraging high TRLs and MRLs is better), defense industrial base considerations (supporting the capacity and capability of shipbuilding industrial base is better), and security considerations (lowering the risk with use of international shipyards is better).

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