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Indigenous Manufacture of Critical Technology Systems in Submarine Construction Program of Indian Navy

Cdr Alok Bhagwat, NM (Retd)
Research Scholar, Symbiosis International University, Pune (PRN-16029001037)

Dr. Pradnya Chitrao,
Associate Professor, SIMS, Pune
Symbiosis Institute of Management Studies, Pune, India

Abstract

Indian Navy has embarked upon an ambitious fleet expansion and modernisation program. The Indian Ocean region remains a key maritime policy driver for India. Indian Prime Minister Narendra Modi declared during the International Fleet Review at Visakhapatnam, India in February 2016, that the Indian Ocean Region remains his government's priority. Prime Minister Modi further underlined the need for a "modern and multi-dimensional Navy".

Indian Navy has already established itself as a 'Builders' Navy with a majority of its warships being built indigenously. The indigenous surface ship construction programme of Indian Navy is fairly mature. However, a submarine plays a vital role in sea denial and sea control roles of a nation. Therefore, in pursuance of the role laid down in the Maritime Security Strategy Document, published by the Indian Navy in year 2015, Indian Navy is also laying equal emphasis on indigenous submarine construction.

Indian Navy has planned an indigenous submarine construction programme, christened P75 (I). The MoD has issued EoI (Expression of Interest) document for this project to three selected foreign shipyards viz. ThyssenKrupp Marine Systems (TKMS), Germany, DCNS, France and Rubin, Russia. Indian Navy is driving towards achieving significant indigenous content in P75 (I), in line with the 'Make-in-India' initiative. Accordingly, it is mandatory for the foreign shipyards to forge a strategic partnership with a select Indian shipyard where the submarines will be built. With an outlay of about INR. 60000 Cr (USD 8 Billion), this programme is seen as a game changer in indigenous submarine construction.

The P75 (I) project throws open significant opportunities in indigenous development of submarine equipment. Today, a majority of submarine equipment are imported. The aim of this paper to suggest a roadmap for indigenous manufacture of equipment & systems for P75 (I). The research methodology will involve literature review as secondary methodology, interviews with stake holders and pilot studies as primary research methodology. It will be an exploratory and descriptive research. There is significant cost advantage for the country and Indian industry in indigenous manufacture of these equipment. Further, the indigenously developed equipment is expected to have export potential and applications in civil industry.

Keywords

Indigenous submarine construction, Propulsion System, Air Independent Propulsion (AIP)

Introduction

The first decade of the 21st century has witnessed sweeping changes and considerable turbulence in the Indian Ocean Region (IOR) in areas of India's national interest. India has made major strides in her developmental goals during this period and its role as a responsible player on the global stage towards promoting peace, stability and development, has been recognized in the international arena. Therefore, the Indian Navy has a key role to play in meeting the maritime components of these challenges, which have been increasing in both scale and scope in recent years. (IHQ MoD (N), 2015)).

The International Fleet Review (IFR) in February 2016, hosted by India's Eastern Naval Command at Visakhapatnam, underlined Indian Navy's growing ambitions and prowess. Indian Prime Minister Narendra Modi declared during the IFR that the Indian Ocean Region remains his government's priority. Prime Minister Modi further underlined the need for a "modern and multi-dimensional Navy". (Kennedy & Pant (2016)).

To fulfil the role entrusted to it of playing a strategic role in IOR, Indian Navy embarked upon an ambitious fleet expansion plans in the first decade of this century. The Indian Navy had moved from 'Buyers' Navy to 'Builders' Navy a long time ago when it established its indigenous warship design and construction capabilities way back in 1990s with the induction of Delhi Class Guided Missile Destroyers built at Mazagon Dock Ltd. (MDL), Mumbai. (Bhagwat & Chitrao (2016)). Around same time, Indian Navy set up a dedicated submarine design directorate and commenced preliminary design of a nuclear submarine with 'technology transfer model' from Russia. The first submarine 'INS Arihant', commissioned into Indian Navy in year August 2016, saw mostly the adaptation of Russian Design. However, Indian Navy laid due thrust on development of equipment and systems indigenously. A large number of systems going into this submarine are supplied by Indian manufacturers. Indian Navy has continued its drive of attaining self-reliance and increasing levels of indigenization are witnessed in the follow on submarines of this programme.

Parallelly, to bolster its ageing submarine fleet, Indian Navy concluded a contract with a French company, DCNS, to construct Scorpene class submarines. INS Kalvari (S50) is the first of the Indian Navy's six Kalvari-class submarines being built in India under Scorpene programme. It is a diesel-electric attack submarine which is designed by DCNS (French naval defence and energy company) and being manufactured at Mazagon Dock Limited in Mumbai. The construction of INS Kalvari started on 1st April 2009. The project encountered delays and the submarine, launched on 6th April 2015, was commissioned on 20th September 2017. The second submarine has commenced sea trials and is slated for commissioning in year 2018. The balance four submarines are planned for induction into service by year 2020.

Although the Scorpene class submarines are built within the country, its design as well as major equipment fit is French. Further, there is no concept of enhanced indigenization levels in follow on submarines of this class. It may be noted that there is a mandatory requirement of increasing indigenization in successive vessels of the same class in the shipbuilding programmes of the Indian Navy. Even the Arihant class submarines are witnessing increased indigenization levels with each follow on submarines. But, Indian Navy was not able to achieve significant indigenization levels in Scorpene programme due to certain performance and warranty/ guarantee related issues raised by French designers in indigenous equipment. Even though the issues were trivial, Indian Navy could not make the French Designers accept Indigenous equipment and systems.

The two submarine construction projects mentioned above, have given India the wherewithal to build submarines in a completely indigenous way, as has been followed for construction of warships. With this backdrop and driven by Prime minister Modi's 'Make in India' initiative, Indian Navy announced its intent of building six submarines christened P 75 (I) under Strategic Partnership model by a consortium of an Indian shipyard and a global technology partner The project has been allocated funds to the tune of Rs. 64,000 Crore. The project will be awarded to the consortium with the lowest bid. (GlobalSecurity.org (2016)).

Background - Submarine Building Technologies

A submarine is a lethal weapon with its ability to prowl undetected underwater. At the same time, a submarine is a sitting duck when on surface. Therefore, a submarine is designed to remain underwater for as long a duration as possible. Further, submarine should be capable of operating at deeper depths to avoid detection by shipborne underwater sensors 'SONAR'. Hence, a submarine is more effective if it can remain at deeper depths indefinitely. But there are technological limitations for a submarine to remain submerged for longer durations. The conventional propulsion systems using diesel engines need oxygen for operation. Therefore, a submarine uses large battery banks to run propulsion motors and other systems & equipment when underwater. The submarine surfaces only for charging battery as oxygen is required for running its generators, and in turn, charging the batteries. Once the batteries are charged, submarine dives again. Nuclear reactors do not need oxygen and, therefore, a nuclear submarine can remain underwater for longer durations. Second factor forcing a submarine to surface is human. Oxygen is needed continuously for submarine crew. When submerged, the air inside submarine is purified. But there is a limit to purifying the trapped air and periodically submarine is required to surface to refresh the air inside it.

World over, researchers are working on technologies that can enable submarine to remain deeper and stay underwater for longer durations. A nuclear submarine is not a preferred option due to prohibitive costs and Risks involved with nuclear power operating in confined spaces under tremendous pressures. Therefore, the natural choice lies in designing a conventional submarine that can operate at deeper depths and remain submerged for a longer time. The key technologies involved for such design are as follows: -

- Special Steel for the pressure hull to withstand higher pressures at higher depths
- A propulsion system capable of operating independent of Air (called Air Independent Propulsion (AIP)

Indian Navy's P75 (I) project specifications also lay down stringent requirements in these aspects of submarine operations. Indian Navy identified the above technologies and have formulated its requirements centered on these. The qualifying shipyards must acquire above technologies either indigenously or globally for technically qualifying for this project.

Another crucial challenging area for Indian industry is propulsion motors of a submarine. An Indian company capable of manufacturing submarine propulsion motors within the country will have a huge commercial advantage and will, therefore, be the preferred partner of the winning shipyard of P75 (I) project. Needless to state, this will give tremendous boost to 'Make in India' initiative of the country, in addition to having several technological offshoots in civilian industry. The option of ab-initio research into defence technologies is ruled out being time consuming. There is a strong case for a global collaborative approach for manufacturing the equipment in the country. Therefore, it is of vital importance that the Indian industry gear up to manufacture AIP and propulsion motor under a collaborative model. The Indian manufacturer will manufacture the equipment in India with hand holding by a global technology leader

Literature Review

Kennedy & Pant (2016) analyzed the Maritime Security Strategy Document and found out the desire on the part of Indian Navy to modernize and increase its warfighting capabilities across all aspects of naval capability. A large part of the maritime modernization policy has another domestic political aspect to it: the concept of the 'Indigenization of the Navy'. The authors also found out that the theme of Indigenization runs throughout the statement.

Global Security.org (2016) talks about Modernisation plans of Indian Navy. It clearly brings out the opportunity for Indian Defence manufacturers. It states that The Indian Navy's efforts will supplement those of other government agencies, as also the private sector. The Science &Technology Roadmap (2015-2035) and Indian Naval Indigenization Plan (2015-2027) will steer the efforts to synergize overall Research & Development efforts in the maritime sector.

Singh (2016) takes a stock of the Scorpene and Arihant submarine construction programmes of the Indian Navy. He makes a case of the need for Indigenization in submarine building programmes of the Indian Navy.

Singh (2016): brings out the enthusiasm created globally by announcement of Rs. 64000 Cr indigenous submarine programme.

Indian Defence News (2016) has underlined the keenness of Russia to support Indigenous conventional submarine building programme of India.

Buckingham & Hodge (2008) found out about the merits of the conventional propulsion system of a submarine. They also found out the need of an AIP (Air Independent Propulsion) system for submarines. They analyzed the performance parameters of bit types of propulsion and found out that with AIP, a submarine is able to remain underwater for longer durations.

MoD (2016) **l**aid down rules and procedures for defence procurement.

Thomas & Mohanty (2016) found out India's ambitious journey to become a world class manufacturer of defence products under Prime Minister Narendra Modi's flagship 'Make in India' initiative. They have highlighted that over the next seven years, India plans to build a vibrant manufacturing industry that can cater not only to its armed forces but also begin exports.

DoI (2015) lists down the areas of indigenization where Indian Navy has desired import substitution by encouraging Indian industry to set up in-country manufacturing set-up.

Bhagwat & Chitrao (2016) have traced the history of naval shipbuilding and growing indigenous content in it. In the light of 'Make in India' initiative, there is significant scope for Indian Defence manufacturers in contributing towards this sector.

Research Gap

The literature review has clearly brought out a case for taking up indigenous manufacture of submarine equipment within the country. Today, the capability does not exist. Further, so far no estimate for life cycle cost of an imported equipment has been prepared to show the expenditure incurred by the country in full exploitation of the equipment. Therefore, the benefit of developing an in indigenous equipment and the life cycle cost that would be incurred for its exploitation has not been established. This is a major research gap.

Indian Navy, L&T, 'Make-in-India' and Global Cooperation

For Indian Navy, 'Make-in-India' with global cooperation has been the keyword in its fleet modernisation and expansion programmes.

The EAIC (Electrical & Automation Independent Company) Marine Business of Larsen & Toubro (L&T) has been associated with Indian Navy for more than decade in import substitution, The EAIC Marine Business has established indigenous capability for manufacturing equipment & systems within the country. Towards this goal, L&T adopted Make-in-India model with global cooperation and associated with technology leaders worldwide in acquiring the know-how to build the equipment indigenously. The partnership model ensured win-win commercial terms for all the stakeholders, viz. global partner, L&T and Indian Navy. L&T EAIC has indigenized a number of technologies for Indian Navy using this model [3].

Scope of the Study

- Identify Indian companies, organisations, research agencies and Academia having expertise in areas of submarine technologies. The areas are Propulsion Motor & associated control system and Air Independent Propulsion (AIP) system.
- Interact with Indian Navy and Ministry of Defence (MoD), being major stakeholders in the entire exercise, for modalities for undertaking development projects.
- Carry out a detailed feasibility study to elaborate upon the following steps: -
    - Market research in identifying global partners
    - Estimation of financial outgo and funding methodology. This is a crucial step.
    - Develop a financial model that will ensure profitability to all the stakeholders, the principal technology partner and Indian industry players
- Estimate Life Cycle Cost for the following two options: -
    - Outright import
    - Indigenous development with a global technology partner
- Carry out detailed study on impact of these technologies on Indian economy.
- Identify avenues for further research and employment generation as the technology areas are new and have a potential for skilled youth in areas of design, manufacturing as well as undertaking further and focused research.

Objectives of the Research Paper

- Elaborate upon the need for manufacturing submarine equipment for P75 (I) project within the country.
- Estimate Life Cycle Cost that would be incurred for these technologies. The Life Cycle Cost includes cost of execution and cost of utilization. Today, the decision to 'Make in India' or 'Import' is taken based on the acquisition cost. However, during the utilization of the

equipment, a heavy cost is incurred in spares and services. This element (utilization cost) is very high for an import as the services of a foreign supplier is much more costlier as compared to an indigenous supplier. Therefore, the objective is to prove that even if the acquisition cost of an import equipment is lower, the utilization cost will far outweigh this advantage. The life cycle cost will be estimated for the following two options: -

  - Outright import
  - Indigenous development with a global technology partner

- Prove that a Make in India option is always beneficial for the submarine technologies that are presently being imported,

Research Methodology

The research methodology will be exploratory and descriptive. The data will be collected using the following methodologies.

Primary Data Collection

A survey will be conducted amongst stakeholders viz. Indian Navy, FICCI (Federation of Indian Chambers of Commerce and Industry), CII (Confederation of Indian Industry), Indian Shipyards (aspiring to build the submarines), equipment suppliers in the country to gather relevant data. Structured and semi-structured questionnaire will be utilized to conduct personal interviews with senior defence officials and industry players. Subsequently, a financial model will be created for a pilot study and this will be validated by the stake holders. This study will be utilized to validate the financial model for life cycle costing. Thereafter a dummy project will be identified and life cycle costs for the two options will be estimated. This model will also get validated by the stake holders through focused group discussions. Eventually, the selected technologies will be evaluated for life cycle costs for the two options and a recommendation will be arrived at.

Secondary Data Collection

This will be carried out by studying the available literature as follows: -

- Defence Procurement Policy (DPP) – 2017
- Indian Maritime Doctrine
- Indian Maritime Perspective Plan
- Indian Naval Indigenization Plan 2015-2030
- Submarine Construction Plan P75 (I)
- Research Papers from IDSA (Institute of Defence Studies), New Delhi
- Life Cycle Costing techniques
- Research Papers on Life Cycle Costing

The research methodology will involve mix of Exploratory and Descriptive Research. The steps involved are as follows: -

- Carry out a thorough literature survey in associated technical and financial areas of submarine motors
- Carry out survey of Indian industry with an aim to identify established high power motor manufacturing set-up
- Identify global technology leaders and interact for collaboration in areas of propulsion motors and AIP
- Interact with CII, MoD (Ministry of Defence) and Indian Navy in identifying potential collaboration partners, within the country as well as globally
- Evolve a financial model for technology transfer from global technology leader
- Evolve a roadmap for indigenous manufacture of propulsion motors and equipment of AIP within India

Discussion points and Findings

- Relevance of indigenous development of following complex technologies critical in submarine construction programme of Indian Navy: -
    - Motor technology with induction of new technologies viz. permanent magnet motors, linear motors, use of super conductors in motors, motors operating at higher voltage (up to 6.6 Kilo-Volts), high power motors up to 15 Mega-Watts and associated power management systems. These technologies are mature in civil industry in India. There is a need for adaptation for naval applications. A tie-up with a global technology leader may be essential.
    - AIP technologies and possibility of global association for manufacturing within India
    - High strength steel and forging/ welding technologies for manufacturing pressure hull of a deep water submarine in India
- Concepts and elements of Life Cycle Costing, the models followed world wide and its relevance in procurement for Indian Navy.
- Broad aspects of Life Cycle Costing for two options; Make in India and import

Limitations

- Significant funding requirement in establishing naval high power motor manufacturing set-up.
- Support needed from Ministry of Defence and Indian Navy in forging collaboration between Indian Industry and foreign technology leader
- Sensitive nature of information about nuclear submarine construction programe of Indian Navy

Conclusion

Indian Navy has achieved indigenous design and warshipbuilding capability catapulting the country in a league of select few nations capable of building aircraft carrier and nuclear submarine. However, a lot is to be achieved in in-country manufacturing of submarine equipment. Make-in-Indian initiative has evoked enthusiastic response in taking up indigenous manufacturing of high technology equipment within the country. DPP-2017 has laid emphasis on providing level playing field to the private sector in defence manufacturing. The logical step now is in achieving global collaboration for creating capability within the country in critical defence technology areas so as to help achieving Life Cycle Support from within the country. It makes financial sense as well. Collaborative approach is the only way forward in this direction as has been demonstrated by the EAIC Marine Business of L&T in indigenization of ship control system and magnetic stealth equipment for the Indian Navy. Indigenous development of submarine technologies in consonance with the built schedule of the P75 (I) project following globalization model is the need of the hour. It will help the country in achieving total indigenization in the critical technologies of submarine building. The technological off shoots of the research study will have impact in a number of technology areas. Last, but not the least, the developed technologies have significant export potential.

Recommendations

Indian Industry should undertake urgent capability building in areas of technologies for supporting P75 (I) programme indigenously. It may need establishing a consortium of Indian Industry, Research agencies and Academia, duly supported by a Global Technology Leader. The technologies should be developed in line with the build schedule of P75 (I) submarine programme. It has significant export potential and will give the country a strategic edge in naval warfare and establishing Sea Control and Sea Denial capability across not only Indian Ocean but also Pacific Ocean.

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