



100 COASTAL WARRIORS INITIATIVE

PROJECT PROPOSAL

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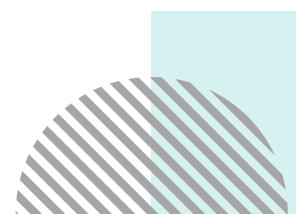
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Executive Summary

The global community is progressing quickly, and the maritime consciousness has gained significant attention. Many of our coastal communities are transitioning from their traditional practices to the so-called new age opportunities, and more often than not, they need to catch up to the skilling and knowledge benchmarks. As a result, they become the victims of such a development process. Mass migration and displacement from their native land become a curse. There is merit in formulating inclusive programs to map traditional knowledge and practices onto modern tools to drive new-age development processes. **This proposal outlines a strategy that leverages the Underwater Domain Awareness (UDA) Framework to promote sustainable models, empower coastal communities, and foster ecological conservation. By integrating strategic partnerships, technology innovations, and targeted interventions, our approach emphasizes tailored programs and collaborative efforts to uplift these communities and enhance their environmental stewardship.**



Introduction

The tropical waters present unique characteristics in terms of rich biodiversity, abundant and diverse mineral resources, and underwater acoustic propagation, all of which significantly impact local communities. This rich biodiversity not only provides a wealth of opportunities for coastal communities to harness commercial value through fisheries, aquaculture, pharmaceuticals, and tourism but also plays a crucial role in the blue economy. This will offer sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of marine and coastal ecosystems. By integrating blue economy principles, coastal communities can achieve a balance between economic development and environmental stewardship, ensuring that the rich marine resources contribute to long-term prosperity and ecological sustainability.

The mineral resources abundantly available in the region need to be identified and exploited through a pipeline of efficient and effective application-based value chains. However, the coastal fisherfolk communities face profound challenges due to climate change, resulting in increased economic vulnerability. Issues like declining fish stocks, erratic weather patterns, and rising sea levels continuously threaten these communities. **Our initiative addresses these issues by integrating skill development and sustainable fishing practices, thereby fortifying affected communities against pressing climate issues by empowering them with requisite skills and fostering ecological preservation.**

The Maritime Research Center (MRC) has been progressing the Underwater Domain Awareness (UDA) framework for safe, secure, sustainable growth for all in the tropical waters of the Indian Ocean Region (IOR) and beyond. The UDA Framework addresses the policy and technology interventions along with acoustic capacity & capability-building requirements. By aligning with the Underwater Domain Awareness Framework, we aim to foster innovation and inclusivity in sustaining traditional livelihoods whilst embracing modern practices. **This project envisions more than immediate outcomes. It strives to build resilience, preserve ecosystems, and empower the coastal and riverine communities for sustained progress. By collaborating with local stakeholders and leveraging targeted technology integrations, we aim to create sustainable models that empower beneficiaries while preserving the fragile ecological balance.**

Beneficiaries Involved

Coastal fisherfolk and riverine communities are the primary beneficiaries of this initiative. By offering tailored skill development programs and promoting sustainable fishing practices, this initiative empowers the coastal and riverine communities to adapt to climate change challenges while securing their livelihoods. Additionally, the focus on ecological conservation benefits not only the fisherfolk but also the wider community and ecosystem, safeguarding delicate marine ecosystems and supporting biodiversity. It will specifically empower the youth from the coastal community which will ultimately help them with economic empowerment and employment generation.

Key objectives and deliverables

The proposed project will be an end-to-end ground implementable pilot for the deployment of skilled coastal youth in their traditional livelihood for digital transformation. This project also intends to introduce new avenues of employment for the youth. The following will be the objectives and deliverables:

Policy Intervention:

- Based on interactions with policymakers and decision-makers across the government, social, and corporate sectors by way of one-on-one meetings, webinars etc., the policy gaps will be identified, and a firm way ahead will be suggested.
- The organizational structure with private-public partnerships will be drawn for institutionalization of the project through policy intervention.
- Standard Operating Procedures (SoPs) and Best Practices will be formalized and implemented across all entities.

Technology Intervention

- The technology gaps for digital transformation for Marine Spatial Planning (MSP) [36] realization will be identified through a detailed literature survey across the globe and then customized for the tropical waters.
- A Modelling & Simulation (M&S) based solution will be formalized for implementation in the coastal region as a pilot project.
- A complete 'to see' (sensors & platform), 'to understand' (data analytics) and 'to share' (customized display for providing actionable inputs) formulation will be demonstrated.
- The complete digital transformation for enhanced governance will be formalized for implementation across multiple other applications.

Acoustic Capacity & Capability Building

- Sensitization, skilling and knowledge building has to be taken up at multiple levels. Right from policy makers at the governance level, to decision makers at the corporate and societal level need to be sensitized on the nuances of ocean acoustics.
- Coastal warriors will have to be skilled and imparted knowledge to drive this initiative at multiple levels. Young people with multi-disciplinary skill sets will be prepared to undertake the pilot and these will be available to drive it across the country and beyond.
- Complete acoustic capacity & capability building framework will be prepared to be replicated across multiple locations going forward. It will include theoretical and field experimental based skilling and knowledge programs. An institutionalized framework will be prepared with extensive documentation. It will be a global standard program to be exported across the entire tropical nations.

Project details

The Coastal Warriors will follow a sequential procedure, where they first involve the coastal community's engagement to identify their needs and the challenges they face. Based on the identified problems, the scope of intervention for digital transformation needs to be understood. Our ground deployment warriors will be involved in building the desired infrastructure (deploying hardware sensors, etc) and engaging the community to implement the solutions, thereby empowering the coastal people.

The entire UDA Framework will require a three-step implementation as follows:

- **To See:** This will include the sensors and the platform that deploys the sensor at the appropriate location. These sensors will be largely acoustic sensors. However, this is not limited to them alone. The platforms could be static, like moored buoys, or dynamic, like Autonomous or manual, Surface or subsurface vehicles. Appropriate design and development or selection of the sensors and platforms will be the key to deploying these assets in the water bodies.
- **To Understand:** This will translate to pre-processing, processing and post-processing of the recorded data. The tropical challenges have to be mitigated with enhanced modelling & simulation of the ambient noise and the underwater channel. The application-specific processing will provide us the actionable inputs critical for effectively utilizing these assets. The errors during the processing and pre-processing can be compensated in the post-processing stage. This data analytics will employ massive amounts of AI-based tools and large sets of data from multiple sources to build an intelligent system.
- **To Share:** Once the actionable inputs are available with the processing unit, it has to be shared in real-time with the user. The users could be diverse, starting from the deployment specialist on the ground involved in operations to procurement experts or even policy makers at the top level. Each one of these users will require inputs in specific formats and customized details. The displays in a static war room environment for field specialists with limited resources have to be customized based on user requirements.

Project Formulation & Execution

The '100 Coastal Warriors' will be an intense program which will have multiple activities and diverse projects being managed seamlessly to achieve the program goals. The objectives of outreach, engage, and sustain will be interconnected, working together to efficiently achieve the program goals.

The outreach will be structured with specific objectives, ensuring each event is unique while consolidating acoustic capacity and capability building.

- **Webinars:** The webinars will address multiple aspects of the UDA framework, including Science & Technology (S&T), Communities, Sustainable Blue Economy, Riverine aspects, Sediment Management, Acoustic Habitat Degradation, Geopolitics, Underwater Archaeology, Sustainable Development Goals, Disaster Management and more. One webinar will be conducted monthly, and experts and domain specialists will be invited to share their inputs. The audience will comprise students, young professionals, strategists, practitioners, researchers and more. MRC will conduct the webinars however, they will partner with various stakeholders and entities to on-board them. These webinars will be for a duration of two hours and a detailed report will be generated post the webinar to be communicated to all concerned.
- **Seminars:** The seminars will allow participants to meet one-on-one, exchange ideas, and build partnerships. The larger aim of these seminars will be to consolidate the gains of the webinars and reach out to policymakers and decision-makers regarding specific areas of concern. The seminars will be held once every six months, and the webinar outcomes will feed into the seminar agenda. The seminar will be a full-day or two-day event. MRC will partner with a specific government entity to host the seminar. Seminars will be conducted every six months.
- **Executive Training Program:** Stakeholders with diverse requirements will require customized training programs specific to their interest. Five-day executive training programs will be undertaken across the sectors to build on the appreciation of these stakeholders. Focussed brainstorming will also be included to ensure actionable outcomes of these webinars. Such programs will allow closer engagement with these stakeholders in the long term. Such programs will be conducted every quarter. MRC will conduct these programs on the premises of the stakeholder
- **Workshops:** The workshops will be field experimental based with hands-on skilling and data analytics oriented. The specific water body will be chosen and sonar equipment will be hired for undertaking the workshop. Four weeks of workshops will be planned, with the first week for sensitization, the second week for problem formulation, the third week for field data collection and the final week for data analytics and interpretation. One workshop will be undertaken every year. MRC will jointly collaborate with the stakeholders and policymakers for the conduct of these workshops.
- **UDA Summer School:** This will be a six-week project-based internship program. Each participant will undertake a project on topics of relevance to the UDA framework. These have to be real-world problem-solving aspects. The participants will include students, faculty and young professionals. The engage will be an ongoing process. Three levels of UDA fellows will be engaged in building on the human resource. It will be open to both students and young professionals.

The 'engage' will be an ongoing process. Three levels of UDA fellows will be engaged in building on the human resource. It will be open to both students and young professionals.

- **UDA Project Fellowship:** This will be a five-month, part-time fellowship for undertaking small projects. The participants could take up their graduation project with MRC and build on their knowledge and skills. Specific deliverables will be formalized, and the fellow will be required to deliver them accordingly. The fellow will be paid a sum of Rs. 20,000/- month as a stipend for his contribution. Even Undergraduate (UG) students from reputed institutes could apply. Ten UDA project fellowships will be given every six months.
- **UDA Theme Fellowship:** This will be a one-year full-time fellowship, and the fellow will be required to work on a specific project or core specialization. Specific deliverables will be formalized, and the fellow will be required to work on those aspects. The fellow will be paid a stipend of Rs. 25,000/—per month based on specific deliverables. The fellowship could be renewed based on the candidate's performance. Five UDA theme fellowships will be awarded every year.
- **UDA Research Fellowship:** This will be a full-time research fellowship with specific deliverables for coming up with a monograph or serious technical report with associated research outputs. A total sum of Rs. 4 lakhs will be paid to the fellow based on the timelines and specific deliverables. Even PhD students and Postdoctoral fellows could apply for these positions. Any project-related travel and research expenses will be supported additionally. One conference trip will be supported. Ten UDA Research Fellows will be supported for the entire duration of the program. The fellows will pertain to:
 - (i) Underwater Signal Processing.
 - (ii) Freshwater Management.
 - (iii) Underwater Channel Modelling in the Tropical Littoral Waters.
 - (iv) Underwater data analytics framework for UDA.
 - (v) Artificial Intelligence (AI).
 - (vi) Underwater Robotics, Sediment Management.
 - (vii) Acoustic Sensors and Data Acquisition.
 - (viii) Underwater Deployments.
 - (ix) Sustainable Development Goals.

The 'sustain' component will be undertaken as a follow-up of the 'outreach' and 'engage' component. The project execution will be undertaken based on the objectives stated in the beginning.

Dr. (Cdr) Arnab Das, Founder and Director of the Maritime Research Center (MRC), will lead a multidisciplinary team of five fellows in Project Management, Science & Technology, and Science Communication. The S&T team will include experts in signal processing, data analytics, and civil engineering, hired per government norms. The project, requiring strategic understanding of national and regional dynamics, will involve continuous engagement with authorities to align outcomes with national priorities.

A brief presentation will be held every six months, with the entire project spanning three years and a review after six months.

Impact Assessment

By employing quantitative data and qualitative feedback, our impact assessment strategy aims to comprehensively measure the direct effects on beneficiaries, the ecological impact, and the efficacy of collaborative partnerships, ensuring a holistic evaluation of the initiative's success.

- **Skill Development Outcomes:** Evaluate skill enhancement and socio-economic impact on communities. Quantitative assessments can include tracking improved resource management practices among participating communities. Qualitative assessments encompass gauging their feedback, assessing the adoption of sustainable practices, and observing changes in their livelihoods. Surveys and interviews will serve as valuable tools to collect this data, providing insights into the tangible impact of skill development.
- **Ecosystem Conservation Metrics:** Assessing the success of conservation initiatives involves monitoring various ecological indicators. This includes tracking the health of marine habitats, changes in biodiversity, and the presence of key indicator species. Quantifying the reduction in harmful practices and the adoption of sustainable fishing methods among participating fisherfolk becomes crucial. Additionally, evaluating community participation in coastal clean-ups or conservation efforts will help provide qualitative data on the ecological impact of our initiatives.
- **Collaborative Partnership Outcomes:** Evaluating the outcomes of collaborative partnerships entails assessing the effectiveness of technology integrations and the impact on community development. Metrics include tracking the adoption of technological tools by fisherfolk, observing changes in fishing practices after technology integration, and assessing the scalability of these interventions. Qualitatively, feedback from stakeholders on the usefulness and adaptability of the integrated technology will be essential in gauging its impact.

Long Term Impact Projection

The long-term impact of this initiative is envisaged as a sustainable and thriving ecosystem for coastal fisherfolk and riverine communities. The initiative aims to create resilient communities capable of navigating climate change challenges by imparting essential skills and promoting sustainable practices. Through strategic collaborations and technology integrations, it seeks to establish sustainable models that ensure these communities' livelihoods and contribute to preserving marine ecosystems. The envisioned long-term impact is a harmonious coexistence between human activities and nature, fostering sustainable livelihoods, economic stability and ecological conservation for future generations.

Budget Allocation

Basic Team and Backend Management

The budget has been divided into five categories: equipment, manpower, logistics, consumables, and overheads and formulated for 3 years.

Sr No	Deliverable	Amount
1	Equipment (Hardware and Software) Basic Office Automation for Study & Documentation	Rs.50 Lakhs
2	Manpower (@ Rs. 75,000/- per month for five people for three years)	Rs.135 Lakhs
3	Logistics (travel for project - related interactions) (one domestic travel every month @ Rs. 1,00,000/-)	Rs.36 Lakhs
4	Consumables & Miscellaneous (@ Rs. 10 lakhs per year)	Rs. 30 Lakhs
5	MRC Overheads for Management Support	Rs 50 Lakhs
	Total	Rs 301 Lakhs

Outreach Program

Each of the five activities has been categorized into its own budget requirements.

Sr No	Deliverable	Amount
1	Webinar (@ Rs. 1 lakh for each webinar for one every month)	Rs. 36 Lakhs
2	Seminar (@ Rs. 10 lakhs for each seminar for one every six months)	Rs. 60 Lakhs
3	Executive Training Program (@ Rs. 5 lakhs for each program for one every quarter)	Rs. 60 Lakhs
4	Workshop (@ Rs. 100 lakhs for each workshop for one every year)	Rs. 300 Lakhs
5	UDA Summer School (@ Rs. 50 lakhs for each program for one every year)	Rs. 150 Lakhs
	Total	Rs. 606 Lakhs

Engage Program

Each of the three activities has been categorized into their budget requirements

Sr No	Deliverable	Amount
1	UDA Project Fellowship (@ Rs. 1.5 lakh for twenty fellows every six months)	Rs. 180 Lakhs
2	UDA Theme Fellowship (@ Rs. 4 lakhs for twenty fellows every year)	Rs. 240 Lakhs
3	UDA Research Fellowship (@ Rs. 8 lakhs for forty fellows for the entire program)	Rs. 320 Lakhs
	Total	Rs. 740 Lakhs

Sustain Program

The manpower and deployment costs for both projects have been covered in the 'outreach' and 'engage' budget. Only some specialized equipment and computational infrastructure will have to be covered in the 'sustain' budget. A broad budget of Rs. 5 Cr (**500 Lakhs**) is added in this section, and a more detailed expense sheet will be submitted during the execution phase.

Grand Total	Rs 2147 Lakhs
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Payment Schedules & Timelines

The total project duration is 03 years. The proposed payment terms for this program are based on the work progress during the various phases.

Sr No	Deliverable	Amount
1	Start of the Project	30 % of the total cost.
2	Submission of the detailed project plan(End of six months from the start)	20 % of the total cost.
3	Detailed Progress Review(End of first year)	20 % of the total cost.
4	Detailed Progress Review(End of second year)	20 % of the total cost.
5	End of the Program	10 % of the total cost.

The project will be deemed to be started upon receipt of the first payment installment.

Conclusion

The '100 Coastal Warriors' initiative is dedicated to enhancing skills and ensuring sustainable livelihoods. It also holds a firm commitment to preserving our delicate ecosystems, fostering diversified opportunities, and aligning with the principles of the blue economy.

By empowering coastal warriors with tailored skill development programmes, we strive to ensure their economic stability and resilience to environmental shifts and uphold the integrity of our marine and freshwater ecosystems. This commitment to ecosystem conservation aligns with our vision for a sustainable future where reliant communities thrive in harmony with their environment, contributing significantly to the Blue Economy's sustainable and responsible marine resource utilization principles.

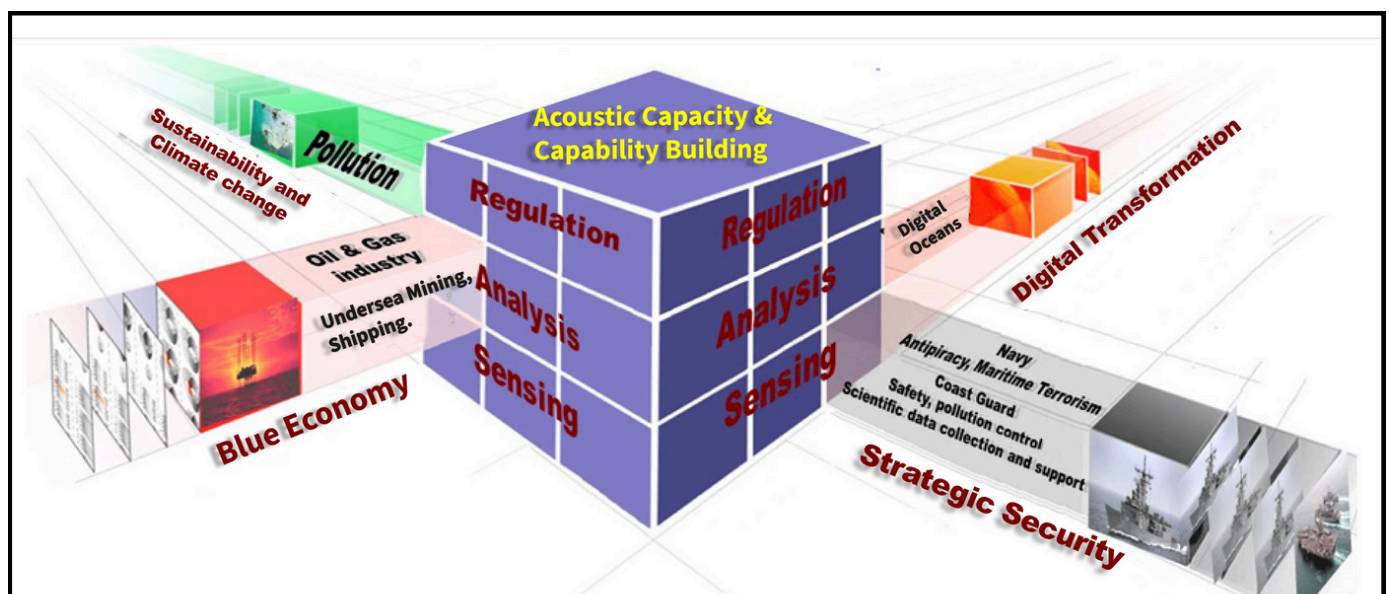
Moreover, our emphasis on diversifying livelihood opportunities beyond traditional fishing practices expands economic prospects and serves as a crucial safety net. Enabling coastal communities to explore alternative income avenues positions them for a more secure future, reducing reliance solely on fishing and contributing to greater economic stability, a key tenet of the blue economy. Through a holistic approach encompassing skill development, ecosystem conservation, diversified livelihoods, and alignment with the blue economy's objectives, our initiative aims to uplift coastal and riverine communities and nurture the environments they depend upon sustainably.



Enclosures

Underwater Domain Awareness (UDA) Framework

The concept of Underwater Domain Awareness (UDA) in a more specific sense will translate to our eagerness to know what is happening in the underwater realm of our maritime areas and the freshwater systems. This keenness for underwater awareness from the security perspective, means defending our Sea Lines of Communication (SLOC), coastal waters and varied maritime assets against the proliferation of submarines and mine capabilities intended to limit the access to the seas and littoral waters. The freshwater systems particularly the transboundary Rivers, are not defended by the Navy & the Coast Guard, but these waters are equally vulnerable and more complex to manage. However, just the military requirement may not be the only motivation to generate underwater domain awareness. The earth's underwater geophysical activities have a lot of relevance to the wellbeing of the human kind and monitoring of such activities could provide vital clues to minimize the impact of devastating natural calamities. The commercial activities in the underwater realm need precise inputs on the availability of resources to be able to effectively and efficiently explore and exploit them for economic gains. Underwater resources include fisheries, aquaculture, seaweeds, pharma ingredients, minerals and more, that have significant market value. The regulators on the other hand need to know the pattern of exploitation to manage a sustainable plan. The connectivity through the water bodies has been recognized as the most effective and efficient mode of transportation, however ensuring navigability in these water bodies requires massive amount of UDA. With so many activities, commercial as well as military, there is significant impact on the environment. Any conservation initiative needs to precisely estimate the habitat degradation and species vulnerability caused by these activities and assess the ecosystem status and climate change risk. The scientific and the research community need to engage and continuously update our knowledge and access of the multiple aspects of the underwater domain. The figure below, presents a comprehensive perspective of the UDA. The underlying requirement for all the stakeholders is to know the developments in the underwater domain, make sense out of these developments and then respond effectively and efficiently to them before they take shape of an event.



The UDA on a comprehensive scale, needs to be understood in its horizontal and vertical construct. The horizontal construct would be the resource availability in terms of technology, infrastructure, capability and capacity specific to the stakeholders or otherwise. The stakeholders represented by the four faces of the cube will have their specific requirements, however the core will remain the acoustic capacity and capability. The vertical construct is the hierarchy of establishing a comprehensive UDA. The first level or the ground level would be the sensing of the underwater domain for threats, resources and activities. The second level would be making sense of the data generated to plan security strategies, conservation plans and resource utilization plans. The next level would be to formulate and monitor regulatory framework at the local, national and global level.

The figure above gives a comprehensive way forward for the stakeholders to engage and interact. There is significant fragmentation among all the four stakeholders, namely the Strategic Security, Blue Economy, Sustainability & Climate Change Risk Management and Science & Technology (Digital Transformation). The individual cubes represent specific aspects that need to be addressed. The User-Academia/Industry partnership can be seamlessly formulated based on the user requirement, academic inputs and the industry interface represented by the specific cube. It will enable a more focused approach and a well-defined interactive framework. Given the appropriate impetus, the UDA framework can address multiple challenges being faced by the global community today. Meaningful engagement of Young and Aspirational population, probably is the most critical aspect that deserves attention. Multidisciplinary and multi-functional entities can interact and contribute to seamlessly synergize their efforts towards a larger goal.

The global community is looking at the Indo-Pacific strategic space for their power play. The Indo-Pacific region by definition is the tropical waters of the Indian and the Pacific Ocean. The tropical waters present unique challenges and opportunities in terms of rich biodiversity and resource availability. However, the biggest issue is the sub-optimal sonar performance, limiting the UDA in these regions. It may be noted that the sonars that were designed for the temperate & polar waters of the Greenland, Iceland, United Kingdom (GIUK) gap, during the Cold War era, suffer 60% degradation when deployed in the tropical waters. The developing nations in the tropical waters need to customize these technologies to suit their conditions. The western nations, who are pushing these hardware, do not have the manpower to deploy, whereas the tropical nations, lack the appreciation of the technology and the knowhow. The proposed UDA framework can optimize resource deployment and provide nuanced policy and technology intervention, along with acoustic capacity & capability building to manage the tropical challenges and opportunities.

The UDA Framework as proposed above has been formulated by the author, Dr(Cdr) Arnab Das, who is the founder of the Maritime Research Centre (MRC), Pune and M/S NirDhwani Technology Pvt Ltd (NDT).

100 Coastal Warriors Initiative - Explained

India's 8000 km (approx.) of coastline provides rich fishing grounds, feeding millions and supporting livelihoods. Approximately 30 million people [1] in India depend on marine fisheries and aquaculture for their livelihood. Bustling ports facilitate trade, boosting the economy, and in significance of IOR where 95% of trade (in terms of volume) happens through the water [2]. Breathtaking beaches draw tourists, generating income [3] which is significant considering the EU's coastal tourism contribution of 26% to the Blue Economy GVA [4]. Coastal communities have lived in harmony with the sea for centuries, harnessing natural resources for their sustenance. Their well-being is intricately linked to the health of the marine environment.

The Government of India, launched the flagship *Pradhan Mantri Matsya Sampada Yojana (PMMSY)* program, in 2020. This government initiative aims to achieve a "Blue Revolution" by promoting sustainable and responsible development in India's fisheries sector. The PMMSY promises to double fishery export earnings to Rs. 1,00,000 crore and create roughly 55 lakh direct and indirect jobs within the fisheries sector over the next five years [5].

A thriving coastline with flourishing communities is vital for a prosperous and sustainable future for India. We believe in continuously improving coastal infrastructure to empower communities, strengthen economies, and protect the natural environment. This should be achieved while respecting traditions, cultural heritage, and ensuring equitable access for all.

Our plan of action with the deployed coastal warriors revolves around revitalizing coastal communities through practical solutions. The aim is to strengthen the pillars of social, economic and ecological sustainability [6]. These warriors will follow a sequential procedure, where firstly they involve the engagement of coastal community to **identify their needs and the challenges** they face. Based on the identified problems, scope of **intervention of Digital Transformation** in the space needs to be understood. Our ground deployment warriors will be involved in building the desired infrastructure (deploying hardware sensors, etc) and engaging community to carry out the implementation of the solutions, thereby empowering the coastal people.

Digital Transformation of coastal infrastructure, fisheries and aquaculture is currently a futuristic vision, and embracing this potential future offers a clear path towards a world free from hunger, with thriving ecosystems, and strong economies that provide decent work & livelihood opportunities for all. While talking about the **Digital Transformation**, the key concern is its adaptability and reach to the local communities in the remote coastal areas. The *inclusivity of tech* is another important aspect because it is significant to make sure no marginalised community is left out because of their past lives, access to education, and knowledge. [7]

We identify the need for 100 such brilliant and innovative candidates with enthusiasm to connect to the ground reality of the coastal lives and a strong desire to improvise the same.

These are the areas of responsibility for the chosen candidates:

Policy Intervention (20): These warriors with their critical thinking on policy implementation are responsible for initiating talks with the stakeholders to determine:

- Problem identification and analysis: Thoroughly investigating and defining the problems hindering growth and potential in coastal infrastructure
- Stakeholder engagement: Initiating and maintaining dialogues with relevant stakeholders, including community members, industry experts, and policymakers, to get their perspectives and build consensus among local communities (especially marginalised groups) and people from the governance.
- Monitoring and evaluation: Continuously assessing the effectiveness of existing policies and interventions to ensure they meet the desired outcomes.

Based on the identified challenges plaguing the growth and potential along coastal infrastructure, they need to curate documentations along the lines of policy building that identify the limitations of existing policies, and current problems in the enforcement of such policies.

These candidates are expected to offer what is called a policy brief [8] to address all the concerns they have noticed and can be brought up to the policymakers. The points in the policy brief should broadly encompass the following ideas:

- Lives of coastal communities, presented as specific case studies: Presenting case studies that illustrate the real-world impacts of policy issues on these communities.
- Required policy developments: Identifying necessary changes or additions to current policies to better support coastal infrastructure growth.
- Effective policy formulation strategy: Proposing strategies for creating and implementing policies that are both effective and sustainable, ensuring long-term benefits for coastal regions.

People, Economy, and Nature (10): The project will be developed along the lines of People, Economy, and Nature elaborated in the multi-faceted Underwater Domain awareness framework developed by Dr. (Cdr.) Arnab Das [9].

The people should identify the threats to people (any short-term or long-term consequences of their actions and/or marginalization), the economy (growth plagued due to any certain personal benefits), and nature (environmental impacts).

The warriors should be keen in framing what is known as an EIA or Environmental Impact Assessment that would holistically look at the impacts on the environment while also considering the socio-economic factors. The EIA provides systematic process used to evaluate the potential environmental effects of a proposed project or development before it is undertaken.

Technology Intervention (40): As per my understanding, these people should ideate the possibility of digital technology to help and improvise the state of the current coastal activities:

- **Identify problems where technology can be a solution:** This can be understood as scoping, or filtering, where the problems with feasible technological solutions are chosen. Conducting thorough assessments to pinpoint specific issues within coastal activities that can be effectively addressed through technological solutions. This involves understanding the unique challenges faced by coastal communities and industries.
- **Integrate technology into existing systems:** Ensuring that new technological solutions are seamlessly incorporated into current systems and practices. This includes upgrading existing infrastructure, training personnel, and creating interoperability between old and new technologies.
- **Develop or implement technology solutions:** Ensuring that new technological solutions are seamlessly incorporated into current systems and practices. This includes upgrading existing infrastructure, training personnel, and creating interoperability between old and new technologies.
- **Promotion of the Marine Spatial Planning schemes for data-driven policy making:** Ensuring that new technological solutions are seamlessly incorporated into current systems and practices. This includes upgrading existing infrastructure, training personnel, and creating interoperability between old and new technologies.

These warriors have the required domain expertise and high-end data analytics understanding for required data processing to carry out predictive analysis, recommendation analysis, classification, and other modeling aspects.

Capacity and Capability Building (20): They are involved in the groundwork and curation of action programmes for Skill training and knowledge transfer to the farmers. Promoting existing material on the blue economy, government policy and schemes and making communities more responsible towards the use of technology for their good.

- **Skill Training and Knowledge Transfer:** Designing and delivering targeted training programs that equip aquaculture farmers with the necessary skills and knowledge to enhance productivity, sustainability, and profitability in their operations. This involves imparting practical skills in areas such as aquaculture techniques, resource management, market access, and financial literacy.
- **Promotion of Blue Economy Principles:** Advocating for the principles of the blue economy, which emphasize sustainable resource use, ecosystem conservation, and equitable economic development. This includes disseminating information on best practices, innovative technologies, and market opportunities that align with the principles of the blue economy.
- **Government Policy and Scheme Promotion:** Facilitating access to government policies, programs, and schemes that support the development of the aquaculture sector. This involves educating farmers about available incentives, subsidies, and regulatory frameworks that can help them improve their operations and access financial support.
- **Community Empowerment through Technology Adoption:** Empowering communities to embrace technology as a tool for their advancement and well-being. This entails promoting the adoption of appropriate technologies, such as digital platforms for market access, weather forecasting tools, aquaculture management software, and sustainable farming practices enabled by IoT devices and sensors.

To See, To Understand, To Share (10): These people will work along the lines of To See, To Understand, and To Share as described by Dr. (Cdr.) Arnab Das [10]. These people will mainly be employed to work with the communities towards the deployment of any hardware infrastructure that supports the study for the researchers towards the development of any tech infrastructure.

- The **“To SEE”** candidates or our **deployment team** while focusing on the ground deployment, will be crucial for making sure that all the data is securely transmitted to the *data analytics* team.
- The data analytics team or our **processing team**, consisting of mathematicians and machine learning engineers, is the crux of **“To Understand”** where they are responsible for carrying out required data cleaning, transformation, and processing. These engineers, with their domain of expertise in Linear algebra, statistics, and Machine learning, work with data to train *mathematical models, and machine learning* to build models that draw important inferences from the data.
- The drawn inferences act as input for **“To Share”** where the **development team** will carry out application development (android app development, and web development) to disseminate necessary information to the masses.

The table below describes key challenges associated with coastal communities and methods of overcoming these challenges.

Sr	Key Challenges			
	Problem Statement	Description		
1	Mangrove Destruction	<p>Mangroves are highly efficient carbon sequesters and are among the most carbon-rich ecosystems. These underwater forests serve as nurseries for fish, filtering water and storing carbon. However, human activities like development and shrimp farming destroy these vital ecosystems, jeopardising coastal communities and the health of our oceans.</p> <p>The issue of mangrove destruction is getting more visibility over time, with initiatives like the Blue Carbon Initiative (coordinated by IUCN, CI, and IOC-UNESCO) coming up [11]. Most of the loss of mangrove forests has been attributed to the rapid expansion of coastal infrastructure [12, 13, 14]. With the engagement of coastal communities, we aim to promote sustainable techniques like Integrated Mangrove Aquaculture [15] that allow a combined culture of shrimp aquaculture and mangrove forests. Digital Transformation techniques like satellite imagery and image processing must be in place to keep a check on the constant balance of aquaculture farms and mangrove plantations. Enhanced productivity from a single pond can reduce the demand for farm expansions.</p> <table border="1" data-bbox="427 952 1485 1196"> <tr> <td data-bbox="427 952 916 1196"> <i>Promotion of Silvoaquaculture (Integrated mangrove systems) and Silviculture (rehabilitation of the mangroves) on the abandoned land from rhizophoras</i> </td> <td data-bbox="916 952 1485 1196"> <ul style="list-style-type: none"> • Policy Intervention: 5 warriors • Technological intervention: 8 warriors • To See, To Understand, and To Share: 2 warriors • People, Economy, and Nature: 1 warrior </td> </tr> </table>	<i>Promotion of Silvoaquaculture (Integrated mangrove systems) and Silviculture (rehabilitation of the mangroves) on the abandoned land from rhizophoras</i>	<ul style="list-style-type: none"> • Policy Intervention: 5 warriors • Technological intervention: 8 warriors • To See, To Understand, and To Share: 2 warriors • People, Economy, and Nature: 1 warrior
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2	Coastal Environment Impact Assessment (CIA)	<p><i>Coastal environments are delicate. Anthropogenic activities and climate change are the main attributes to how marine life has been degraded [16]. These activities include mangrove destruction for land expansion, saline water discharge into freshwater resources, and groundwater, which can create scarcity in freshwater resources [17]. Conducting an effective CIA (Coastal impact assessment) can clearly outline these ecological problems along with the challenges faced by farmers in traditional fisheries. The saltwater intrusion leading to groundwater availability along the southwest coast is also covered in [18].</i></p> <table border="1" data-bbox="427 1554 1485 2024"> <tr> <td data-bbox="427 1554 916 2024"> <i>Understanding the guidelines by the NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT (MOEFCC) for Coastal Environment Impact Assessment (CIA) and initiating a strict enforceable policy framework for the same. [17] E.g., Identification of areas of saltwater intrusion in coastal aquifers and those areas need to be prevented from further harm and/or remediated</i> </td> <td data-bbox="916 1554 1485 2024"> <ul style="list-style-type: none"> • 4 warriors from the People, Economy, and Nature to lead this Task. The task should be performed in terms of a committee formation to carry out an understanding of the problem, carry out documentation, and share relevant details with our researchers. • 1 warrior can head the committee. </td> </tr> </table>	<i>Understanding the guidelines by the NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT (MOEFCC) for Coastal Environment Impact Assessment (CIA) and initiating a strict enforceable policy framework for the same. [17] E.g., Identification of areas of saltwater intrusion in coastal aquifers and those areas need to be prevented from further harm and/or remediated</i>	<ul style="list-style-type: none"> • 4 warriors from the People, Economy, and Nature to lead this Task. The task should be performed in terms of a committee formation to carry out an understanding of the problem, carry out documentation, and share relevant details with our researchers. • 1 warrior can head the committee.
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	Problem	Description
3	Social Conflicts	<p>Coastal land is a battleground. Aquaculture, agriculture, and salt production all crave this precious real estate. Allocating land to one industry limits what's available for others, sparking competition over resources like water [19]. The economic benefits are also uneven. Aquaculture can be profitable, but agriculture often supports more families. This disparity, along with environmental concerns like pollution from shrimp farms harming fisheries, creates tension and social conflict.</p> <p><i>As highlighted in [20], the over-intensification of coastal farming can hamper the growth of other industries, which is the main cause of increased conflicts. Similarly, [21, 22] showcases that a justified allocation of land and water resources for Agriculture & Aquaculture will often allow combined economic prosperity and reduce the chances of conflicts.</i></p> <ul style="list-style-type: none"> • Policy intervention: 5 warriors to understand how the communities engaged in different sectors can exist together supporting the economic and social needs of each other. • Technological Intervention: 5 warriors to ideate technological solutions that can enhance productivity in the region so dependence on land is reduced
4	Digital Transformation	<p><i>With India boosting coastal aquaculture, Marine Spatial Planning (MSP) is vital. MSP maps suitable areas for fish farms, minimizing conflicts with traditional fishing, sensitive ecosystems, and tourism. This ensures sustainable growth, protecting marine resources and fostering a thriving blue economy. MSP is a holistic framework for conducting Socioeconomic, oceanographic, biological, and habitat analysis. This MSP is aimed to drive the data-driven policy framework scheme (for effective management of the marine resources to minimize conflicts) for enhancing the fisheries and aquaculture sector in the country.</i></p> <p><i>Includes an array of technologies:</i></p> <ul style="list-style-type: none"> • <i>Real-time understanding of characteristics of coastal waters like SST, salinity & pH</i> • <i>Aquaculture and agriculture (and salt plains) open-pond mapping using GIS and remote sensing</i> • <i>Shrimp and Seaweed Growth modeling and APY analysis of farms</i> • <i>Integrating all these technologies as a part of MSP</i> <ul style="list-style-type: none"> • Technological intervention: 10 warriors for working on MSP as a tool • To See To Understand To Share: 8 warriors. The team deployment on the team for receiving ground data, analytics team obtains models by capturing relations from the data. Share team develops required applications to disseminate information to the end user. • Policy Intervention: 5 warriors can introduce these interventions to include them as a part of the policy framework and promote faster implementation of them

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5	Water quality management	<p>The Water quality management here refers to the Water quality management for the aquaculture farms and the discharge of the water quality. As highlighted in [22] there are a lot of chemicals involved like bicarbonates (liming), nitrite and nitrate buildup, phosphates, and sludge formation. The discharge from aquaculture can cause rampant eutrophication, in the adjacent areas. The saltwater (carbonates, phosphates) intrusion from the ponds into the groundwater also needs to be checked. Proper discharge treatment facilities should be looked upon. [23]</p> <p><i>RAS (Recirculating Aquaculture systems) and seaweed cultivation are the programmes that needs a strong promotion and significant boost in India's coastal region. These enhance the sustainability of the practices but also offer less usage wastage of water, and water treatment is an inherent plus in IMTA leading to better growth results [24].</i></p> <ul style="list-style-type: none"> • Capability building: 6 warriors for Knowledge transfer of the APY analysis to the farmers. Conducting regular workshops for better farm practices and inputs for APY tool development are key responsibilities.
6	Inequality between small-scale and large-scale fisheries and farms	<p>Small-scale operators in the aquaculture and fisheries sectors worldwide face numerous obstacles that hinder their ability to engage in responsible and sustainable value chains, ultimately threatening their livelihoods. These challenges include inefficient supply chain processes, inadequate environmental management practices, lax food safety and nutritional standards, and overall weak planning [25]. The suboptimal value chains, coupled with poor waste management and lack of stringent quality controls, prevent these smallholders from fully participating in and benefiting from responsible and sustainable value chain activities, consequently putting their livelihoods at risk. [26]</p> <p><i>In [27] it is clearly highlighted how economies at scale, as well as productivity, favor large-scale farmers. Also [28] showed how small-scale fisheries operate differently than large-scale ones.</i></p> <p>Human factor and coherence between the thoughts of large-scale and small-scale farmers. The idea of sustainable cooperation between small-scale and large-scale farmers needs to be ingrained within the communities. To allow small-scale farmers to participate equally, Increasing the funding for small-scale value chain participants engaged in aquaculture and fishery, as well as more equitable access to financing is an important aspect.</p> <p>Capability and Capacity building: 4 warriors to lead the task of planning the roadmap to achieve the listed aspects and also curate other opportunities to bring small-scale farmers to the forefront of policy-making.</p>

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7	Climate Change Impact and Global Warming Effects	<p>Extreme climate events and climate variability have been increasing over India (and evidently over most parts of the world). Fisheries and aquaculture are also significantly affected by climate change impacts. Rise in SST can lead to Sea level rise (Satabhaya village story [29]) which poses challenges for the coastal communities like loss of livelihood, and displacement, migration issues. This leads to the loss of their true identity. Fisheries are affected due to changing potential fishing zones with changing temperatures (which in turn also affects salinity, alkalinity, conductivity, chlorophyll, and photosynthesis rate).</p> <p><i>Increasing information dissemination to fisheries to switch to mariculture and aquaculture to increase their productivity. This will involve teaching aquaculture as a way to adapt to changing climate and Sea surface Temperature rise. This should be assisted by having a policy that ensures effective Disaster Management techniques are in place.</i></p> <ul style="list-style-type: none"> • Policy Intervention: 5 warriors to curate policy developments that can safeguard coastal communities from migration due to natural calamities. • Technological Intervention: 5 warriors for Effective Alert Systems and Advance Dissemination of Information Using Predictive Systems • Capability building: 5 warriors making sure all systems are in place, effective, and in working condition.
8	Skill Training	<p>Coastal communities rely on healthy oceans and skilled people. Training residents in sustainable fishing, tourism, or maritime industries creates jobs, boosts the local economy, and fosters a connection between people and the precious environment they live by. Farmers needs to be taught about IUU regulations and laws they need to abide by, and productive farming by following best aquaculture practices. Farmers need to adopt seaweed farming and IMTA for better returns. Farmers also need to be made technologically friendly to intervene in digital technologies in fisheries and aquaculture. [30]</p> <p><i>Skill, either it is the knowledge of how to stock the culture, or knowledge of the feed quality (and quantity), the breeding period, or the water quality parameters, as well as the wastewater treatment, is an invaluable part of farm operations. This way the farmer can make sound decisions to enhance productivity and revenue, while also being able to understand all the policy aspects that are enforced by the state to support the aquaculture sector. The idea of Skill Farmer is a huge objective of the Capacity and capability building programme.</i></p> <ul style="list-style-type: none"> • Capability Building: 9 warriors. The major responsibility of the capability-building initiative is on the warriors who will work along the lines of Engage, sustain, Outreach. This holistic overview encompasses how the warriors engage the major stakeholders of aquaculture in India (i.e. farmers) and develop their interests in policy and technological aspects. The aim is to make aquaculture as a sustainable source of income for the marginalized coastal communities. These warriors will have the responsibility to also record the challenges and barriers the coastal communities need to face in their day-to-day operations.

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9	Overfishing	<p>To deal with overfishing concerns, the Food and Agricultural Organization (FAO) initiated combating the IUU (Illegal, Unregulated, and Unreported fishing) fishing by bringing into effect, what is known as IPOA-IUU (International Plan of Action – IUU). European Commission stance on this is very strong with the introduction of IUU Regulations and Catch Certificate scheme. This scheme makes sure all the imports of seafood are duly certified and defers any practice that involves over-exploitation of habitat or indulges in practices marked as IUU. Similarly, the USA SIMP (State Import Management Programme), JCDS scheme by Japan, India’s Blue Economy Policy draft 2020, ASEAN Blue Economy Framework 2023 (Indonesia chair) all highlight the need to combat IUU Fishing.</p> <p>Despite this, as [31] states very recently, that stocks of commercially important fishes have been on the decline on the India’s Southwest coast. India very recently at WTO negotiation session [32], remarked that current approaches at addressing the overfishing are flawed. This is attributed to ‘Distant Water Fishing nations’ providing subsidies to fisheries to fish beyond their EEZ boundaries.</p> <p><i>Making farmers aware about existing policies in action and why they should abide by it. Making them understand the idea of Nature, and how personal benefits in the short term can harm the community in the future.</i></p> <p><i>Helping fishers switch to aquaculture for higher productivity and better returns on investments. This is in sync with India’s Blue economic vision to be driven through aquaculture [33] to help combat the overfishing issue.</i></p> <ul style="list-style-type: none"> • People, Economy and Nature: 5 warriors to be deployed to check what is working and what is not. How much are farmers aware of what are the regulations set for them? What are the challenges they are facing due to these regulations or if there are any long-term threats to their livelihood for the same
10	Seaweed cultivation and Integrated Multi-trophic Farming	<p>Integrated Multi Trophic Aquaculture, interleaves the organisms from different trophic levels in the same aquaculture ecosystem. The ones at the lower trophic levels act as feeders that feed on the waste organic and inorganic compounds (sludge) and thus make the water cleaner. On the other hand, these feeders can be considered as they feed themselves to the main organism thus supporting the growth. For example, fishes with worms and shrimp with Sea urchins and seaweeds are examples of Integrated Multi Trophic Aquaculture. [34]</p> <p><i>Realizing India’s Push to Mariculture, Seaweed Farming. The Kori Creek project started by the former union minister of fisheries, P. Rupala Ji is a game changer in this regard. In the project specifications, it was mentioned that despite having a rough environment in the Kori Creek region in the Rann of Kutch, India possesses specialized and robust floating rafts that can be deployed to withstand those conditions. [35] This is in alignment with India’s set target of harnessing the potential of 9.7 Million metric Tonnes of seaweed. [33]</i></p> <ul style="list-style-type: none"> • Technology Intervention: 10 Warriors to lead the task of formalizing the methodology to obtain higher yields. Demarcating the regions for the most optimum growth patterns in the seaweed.

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