MARITIME RESEARCH CENTER

FOUNDATION FOR UNDERWATER DOMAIN AWARENESS

HANDBOOK

THE SKILLING MODULES FOR

UNDERWATER DOMAIN AWARENESS (UDA)

NIR DHWANI TECHNOLOGIES

INDO-SWISS CENTRE OF EXCELLENCE

https://mrc.foundationforuda.in/

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Foreword

In an era defined by unprecedented global connectivity and interdependence, the exploration and comprehension of our planet's underwater domain have taken on profound significance. The "Handbook on the Skilling Modules for Underwater Domain Awareness (UDA)" is a pioneering resource conceived to transcend geographical borders and contribute to a global understanding of underwater exploration and awareness.

The challenges and opportunities posed by the underwater domain extend beyond national boundaries, emphasizing the collective responsibility for nurturing a skilled and informed workforce in Underwater Domain Awareness. This handbook stands as a testament to collaborative initiatives aimed at equipping individuals worldwide with the indispensable skills and knowledge to navigate the intricacies of UDA.

Amidst the forefront of technological advancements, environmental stewardship, and international cooperation, the Skilling Modules delineated in this handbook function as a universal guide. Tailored to address the diverse needs and aspirations of individuals from different corners of the globe, they foster a collective comprehension of the pivotal role played by the underwater domain in global security, environmental sustainability, and scientific exploration.

In recognizing the interconnectedness of Earth's water resources, this handbook expands its scope to include insights into freshwater management. Understanding that responsible stewardship extends beyond oceans, the handbook delves into the challenges and opportunities presented by freshwater ecosystems. It underscores the importance of a holistic approach to water management, acknowledging that both saltwater and freshwater realms are integral components of our planet's ecological balance.

This handbook encapsulates not only the current state of UDA education but also lays the groundwork for a future wherein professionals, irrespective of their geographical origins, contribute to the responsible and sustainable exploration of our planet's underwater realms. The inclusion of freshwater management broadens the narrative, emphasizing the significance of a comprehensive approach to water ecosystems.

Appreciation is extended to the diverse team of contributors, educators, and experts whose collaborative endeavors have culminated in this comprehensive global resource. Their dedication to fostering a shared understanding of the underwater domain, encompassing both saltwater and freshwater ecosystems, is evident in the breadth and depth of the handbook's content.

May the insights and knowledge shared within these pages inspire a worldwide community of learners and practitioners committed to advancing the frontiers of Underwater Domain Awareness. May this handbook serve as an instrument for international collaboration, nurturing a shared commitment to the responsible and informed stewardship of our planet's invaluable underwater ecosystems, both ocean and freshwater alike. Together, let us explore, understand, and safeguard the richness of Earth's waters for generations to come.

Executive Summary

In this comprehensive handbook, the intricate web of the underwater commons and freshwater system unfolds, revealing the pivotal role it plays in global trade, serving as a linchpin for economic expansion. The exploration delves beyond surface understanding, extending to the uncharted potential of deep-sea resources, presenting economic and strategic opportunities on a global scale. The narrative navigates the tropical littoral waters of the Indo-Pacific, shedding light on the unique challenges faced by sonar systems in this diverse and crucial region.

Acknowledging the global significance of underwater security, the blue economy, environmental and disaster management, and science and technology, the concept of Underwater Domain Awareness (UDA) emerges. As the complexities of the Indian Ocean Region (IOR) come into focus, the imperative for home-grown initiatives becomes evident, aiming to safeguard underwater data against unauthorized access.

Global geopolitical shifts towards the Indo-Pacific underscore the critical importance of effective UDA. The socio-political and socio-economic intricacies of the IOR necessitate careful consideration, emphasizing the need for a regional underwater framework aligned with the long-term interests of nations across the globe. At the forefront of international concern lies the conservation and sustainable utilization of marine resources, highlighted by the 2023 ratification of the United Nations' High Seas Treaty. Environmental organizations express valid concerns about potential adverse effects of deep-sea mining, emphasizing the delicate balance required for sustainable development on a global scale.

The Underwater Domain Awareness (UDA) Framework, introduced by the Maritime Research Center (MRC), emerges as a nodal force. This collaborative approach, bridging policy and technology, stands ready to address challenges in tropical littoral waters on a global scale, offering a pathway to transparency and accountability in securing underwater data.

Recognizing the global implications, the handbook emphasizes the necessity of cultivating a globally competent workforce equipped with knowledge and skills for prosperous careers within the underwater sector. The skilling modules outlined in this program serve as beacons, guiding individuals globally towards a profound understanding and mastery of UDA in the IOR and beyond.

The Skilling Modules form the cornerstone of global Underwater Skill Development initiatives, injecting fresh energy and impetus into the sector. The program enhances education and training opportunities across expertise levels, aiming to create a dynamic and proficient global workforce capable of addressing the water resource challenges faced by nations worldwide.

Four Distinctive Programs:

1. **Corporate Training Program:** Tailor-made modules for UDA stakeholders addressing strategic security, blue economy, sustainability, climate change management, and digital transformation on an international scale.
2. **Diploma Program:** A two-year gateway to diverse UDA career opportunities, offering a combination of theoretical insights, practical immersion, and real-world applicability globally.
3. **Bachelor of Vocational Degree Courses (BVoc):** Three-year programs comprehensively addressing the expansive UDA framework, empowering participants globally across various stakeholder groups.
4. **Post Graduate Program:** A two-year program designed for UDA stakeholders worldwide, focusing on experiential learning through field experiments and hands-on problem-solving.

As nations navigate the uncharted waters of the underwater sector, these skilling modules serve as global compass points, guiding towards a future where a skilled and dynamic global workforce plays a pivotal role in the sustainable exploration of the profound depths of the underwater realm.

Enclosed within this dossier are strategic tools, including Curriculum Mapping, Stakeholder Mapping, Skill Mapping, Job Mapping, and Grade Mapping, offering blueprints for a future guided by global knowledge, skill, and purpose.

This exploration into the depths and expanses underscores the interconnectedness of our global ecosystem and the collective responsibility inherent in its stewardship. The investigation into both underwater and freshwater domains necessitates a concerted global endeavor, emphasizing the cultivation of collaboration and unwavering commitment.

As nations initiate this journey, it is anticipated that the Underwater Domain Awareness (UDA) Framework will serve as a guiding mechanism, directing global efforts toward a future characterized by sustainability and harmony for our oceans, freshwater and the broader ecological landscape. The handbook stands as an encouragement, illuminating the path towards responsible exploration, understanding, and preservation of Earth's invaluable underwater ecosystems.

2.1 Capacity and Capability Building for Underwater Domain Awareness (UDA):

In the contemporary global landscape, there is a growing recognition of the crucial role played by the underwater sphere and freshwater systems in driving economic expansion and maintaining climate equilibrium. These aquatic domains, particularly the underwater commons, have emerged as vital trade routes facilitating nearly 90% of global trade. The imperative for sustainable and efficient transportation infrastructure to support these routes is now at the forefront of international priorities. Furthermore, the untapped potential of deep-sea resources, spanning both biological and non-biological elements, demands focused exploration due to their substantial economic and strategic significance. Addressing global challenges such as food and energy security is increasingly linked to the responsible utilization of oceanic and freshwater resources. However, the pursuit of access and control over these resources may also raise concerns about potential competition and conflicts among coastal nations.

The heightened awareness of the strategic importance of underwater security has led to an increased naval presence in the underwater commons. Simultaneously, freshwater systems hold comparable significance, necessitating effective governance mechanisms built on a foundation of comprehensive situational awareness.

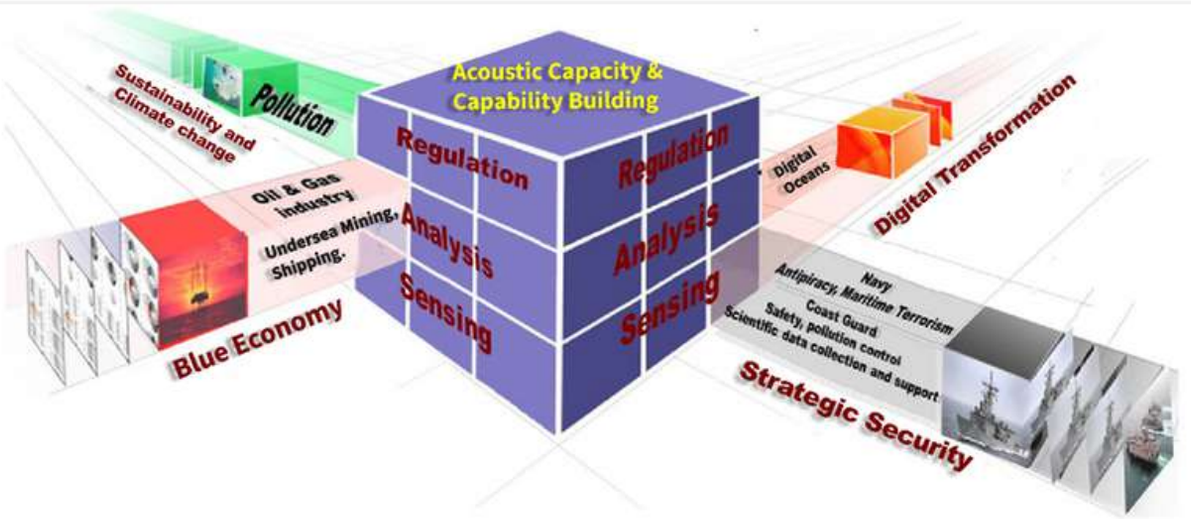
The Underwater Domain Awareness (UDA) emerges as a crucial framework for advancing our understanding and application of knowledge in this context. UDA encompasses four pivotal domains: underwater security, the blue economy, environmental and disaster management, and science and technology. The utilization of sonar-based acoustic surveys stands out as the primary tool for establishing effective UDA. However, the unique characteristics of the Indo-Pacific region's tropical waters pose significant challenges, impacting the optimal performance of sonar systems. Attempts to import technology and expertise from Western regions have proven largely unsuccessful in the Indian Ocean Region (IOR). Hence, there is a pressing need for home-grown initiatives to enhance acoustic capacity and capabilities, allowing for better navigation of the complexities and opportunities presented by the tropical littoral waters of the IOR, known for their abundant underwater resources. The participation of non-regional actors in UDA in these waters could potentially expose strategic vulnerabilities, necessitating a recognition of the security implications of underwater data and the implementation of measures to ensure its inaccessibility to unauthorized entities.

Recent geopolitical dynamics have witnessed strategic shifts towards the tropical coastal waters of the Indo-Pacific region, with non-regional powers positioning themselves strategically. This includes deploying military assets and research vessels to establish effective UDA. The Indian Ocean Region (IOR) is particularly susceptible due to its unique socio-political and socio-economic characteristics. Security concerns related to underwater terrorism and piracy are pervasive, with non-state actors operating in cooperation with local governments. Extra-regional powers deeply influence the region's domestic politics, potentially manipulating governance mechanisms as needed. The existing regional underwater framework demonstrates limited coherence with long-term national interests, posing challenges despite the IOR's high population density and rapidly growing population.

A landmark achievement in the collective global effort to protect and preserve the planet's oceans is the formal ratification of the United Nations' High Seas Treaty on March 4, 2023. This treaty commits nations to allocate 30% of the Earth's oceans as protected areas by 2030, with a primary focus on the conservation and revitalization of marine ecosystems. Within these designated protected zones, the treaty aims to establish a formidable bulwark against potential threats, particularly the contentious practice of deep-sea mining. The negotiations leading to this agreement were marked by debates and disagreements, especially regarding financial commitments and fishing rights.

Environmental organizations express concerns about potential adverse repercussions of deep-sea mining on marine environments. These apprehensions include disturbances to sediments, the introduction of disruptive noise pollution into vulnerable underwater ecosystems, and the detrimental impact on vital breeding grounds for various forms of marine life. The treaty is hailed as a watershed moment in the ongoing effort to safeguard the planet's biodiversity, promoting sustainable and responsible development for the benefit of humanity.

The Maritime Research Center (MRC) has developed the Underwater Domain Awareness (UDA) Framework, presenting a novel and comprehensive approach that combines policy and technological interventions with the enhancement of acoustic capabilities and capacity. What distinguishes this framework is its role as a unifying platform, bringing together stakeholders involved in strategic security, the blue economy, sustainability, climate change management, and digital transformation. In the complex democracy of India, where concerns about the fragmentation of stakeholders often arise, this collaborative approach encourages synergy among stakeholders. The structural framework of UDA holds the potential to facilitate a seamless transformation in governance processes, enhancing transparency and accountability. Most notably, the UDA framework is poised to effectively address the myriad challenges and opportunities presented by the unique tropical littoral waters within the ever-evolving geopolitical and geostrategic realities of the region.



Comprehensive Perspective of UDA Framework

2.2 Global Sector Skill Council on UDA:

The Maritime Research Center advocates for the establishment of a comprehensive global capacity and capability program focused on Underwater Domain Awareness (UDA). This initiative aims to equip individuals and organizations with the necessary knowledge, skills, and competencies for effective monitoring and governance of underwater activities. The primary goal is to meet the growing demand for proficient UDA specialists and contribute to the responsible and sustainable utilization of marine and freshwater environments on a global scale.

In recent governmental pronouncements, ambitious initiatives have been unveiled to support the SAGAR vision, including projects like Sagarmala, Bharatmala, and Inland Water Transport, all of which involve substantial financial allocations. The success of these projects hinges on the availability of well-trained human resources.

On a global perspective, countries, including India, grapple with significant challenges in aquaculture, water quality management, and blue biotechnology. Administrative complexities, lack of transparency in licensing procedures, constraints in securing adequate space and water resources, and stringent quality, health, and environmental standards contribute to these challenges. Proficient and knowledgeable professionals are essential to propel the growth of the blue economy.

However, many sectors face difficulties in recruiting the right talent, driven by factors such as the necessity for generational turnover, particularly in fields like fisheries. Additionally, the rapid advancement of innovative technologies has increased the demand for specialized workers, impacting sectors such as shipbuilding, freshwater management, and marine biotechnology.

The Maritime Research Center (MRC) proposes the establishment of a global sector skill council dedicated to the Underwater Domain Awareness (UDA) framework. This council will address the following concerns:

(i) **Identification of Skill Requirements:** The proposal involves identifying the necessary skill requirements to support the UDA framework, aligning with the holistic vision of SAGAR. The unique challenges and opportunities presented by marine and freshwater ecosystems must be effectively addressed to fully realize the SAGAR vision.

(ii) **Forward-looking Skill Requirements:** Skill requirements should be forward-looking, addressing future concerns and grounded in the realms of Science & Technology. An integrated approach aims to bring together UDA stakeholders from strategic security, blue economy, sustainability & climate change management, and digital transformation domains. MRC categorizes these requirements into three overarching domains: Acoustic Survey, Artificial Intelligence (AI) & Robotics, and Bio-technology & Bio-Sciences.

(iii) **Multidisciplinary Research:** Effective skilling must be complemented by multidisciplinary research to bridge the gap between theoretical knowledge and practical, context-specific insights. The sector skill council intends to establish a Center of Excellence (CoE) dedicated to managing emerging challenges and opportunities.

(iv) **Innovation and Entrepreneurship:** Innovation is crucial for realizing any concept on a widespread scale. An incubation center facilitating the integration of the startup ecosystem with novel ideas will serve as a vital catalyst. The sector skill council aims to nurture entrepreneurial spirit among youth, encouraging self-employment opportunities.

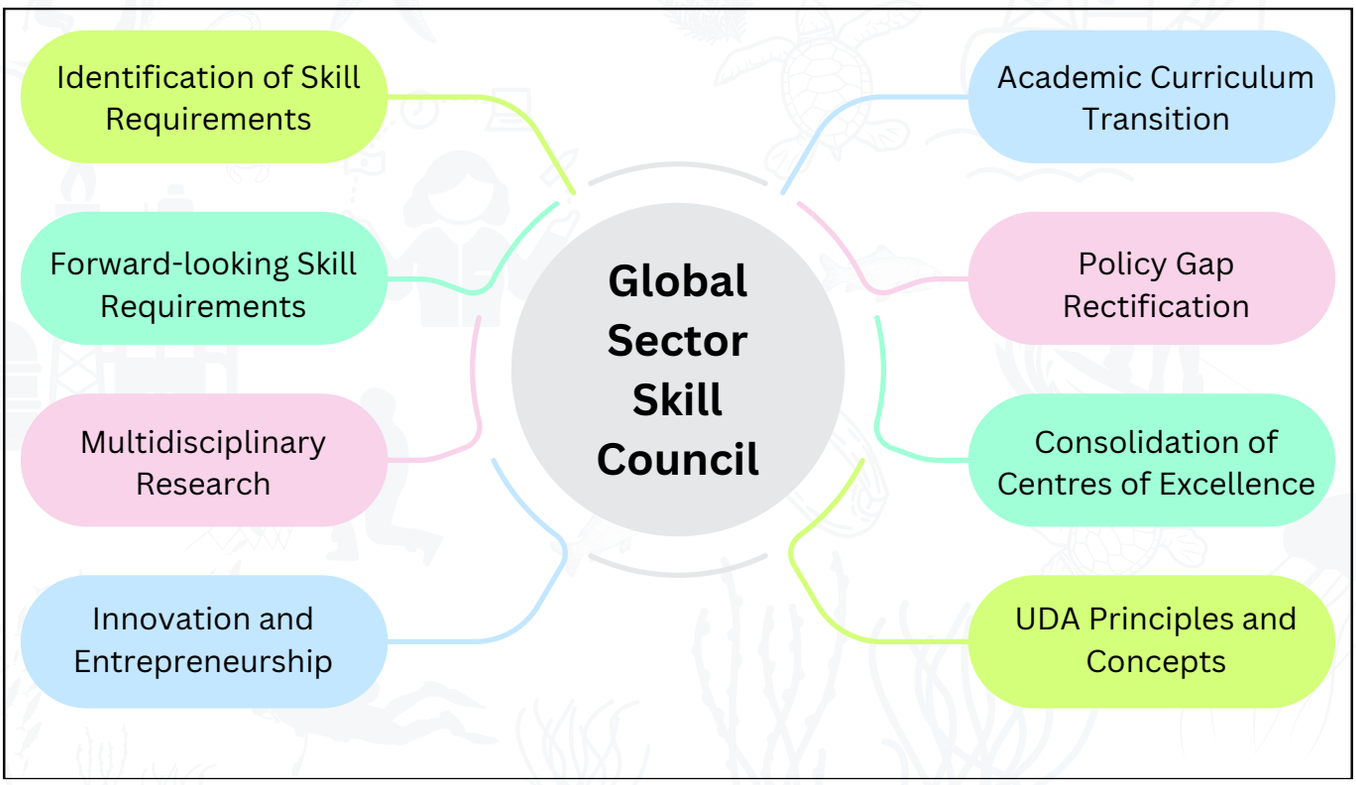
(v) **Academic Curriculum Transition:** Academia must adapt to the evolving global landscape and contemporary knowledge and skill deficits. The sector skill council will collaborate with educational institutions to address this skill gap in alignment with the New Education Policy (NEP).

(vi) **Policy Gap Rectification:** Comprehensive measures are needed to rectify policy gaps. The sector skill council should facilitate the convergence of industry, young talent, and the startup ecosystem to bridge policy gaps, significantly alleviating skill shortages and career opportunity disconnects for youth.

(vii) **Consolidation of Centres of Excellence:** Existing individual training centers should be consolidated to optimize efficiency and elevate quality standards. The sector skill council must establish regional centers that cater to specific stakeholder needs, developing practical skills in UDA technologies, including sonar systems, underwater sensors, and autonomous underwater vehicles (AUVs).

(viii) **UDA Principles and Concepts:** The primary objective is to furnish participants with a solid foundation in UDA principles and concepts, covering underwater surveillance techniques, data analysis, and situational awareness. Participants will gain a comprehensive understanding of regulatory frameworks, agreements, and best practices related to UDA.

The establishment of a global sector skill council for the UDA framework represents a significant step towards addressing the evolving challenges and opportunities presented by the unique tropical littoral waters, while aligning with the dynamic geopolitical and geostrategic realities on a global scale.



2.3 UDA Skilling Modules:

The Underwater Domain Awareness (UDA) framework requires massive skilling to support nuanced career opportunities and effective capacity & capability building across diverse stakeholders. The UDA framework is elaborated in enclosure-1 to this document. The entire UDA skilling modules have been divided into four categories:

(I) Corporate Training Programs
(II) Diploma Programs
(III) BVoc Programs
(IV) Post Graduate Programs

(I) Corporate Training Programs:

The Corporate Training Programs will comprise of customized modules specific to the stakeholder. These will be of one day, five day, three weeks, three months and six months duration. The stakeholders are enumerated below:

- Security Forces involved in Maritime and Waterfront Security
  - Indian Navy
  - Indian Coast Guard
  - Marine Police
  - Paramilitary Forces involved in Water front Security
- Blue Economy
  - Shipping Industry
  - Fisheries & Aquaculture
  - Deep Sea Mining
  - Oil & Gas Industry
  - Inland Water Transport
  - Tourism
- Sustainability & Climate Change Risk Management
  - Freshwater Resource Management
  - Water Quality Management
  - Environmental Regulators
  - Disaster Management Authorities
  - Climate Change Risk Assessment
  - ESG Managers
- Capacity & Capability Building
  - Research Scientists
  - Academia
  - Skilling Ecosystem
  - Innovation
  - Digital Transformation (Marine Spatial Planning)

(II) Diploma Programs:

The Diploma Programs are two-year duration programs that will cover the specific aspects of the UDA framework at the working level for varied stakeholders. These will enable the participants to acquire the required skills to be relevant to a specific aspect across stakeholders. The aspects that will get covered are:

- Technician who will operate, maintain and repair instrumentation for acoustic survey, bio-sample handling and data handling & robotics.
- Data logger and bio-sample collector to make sure the digital data and the bio-samples are collected properly to ensure minimal loss of their characteristics.
- Deployment specialist to make sure the equipment for data collection or bio-sample collection is undertaken properly.

The common subjects for all the six courses for the first semester will be as follows:

- Semester-1
  - Underwater Domain Awareness (UDA) Framework (42 hours)
  - Tropical Waters and their Unique Characteristics (42 hours)
  - Instrumentation and Robotics (42 hours)
  - Communication Skills (42 hours)
  - Sustainable Development Goals (42 hours)
  - Literature Review and Seminar (42 hours)

The five courses will be formalized as follows:

(a) Sonars Acoustic survey in the underwater domain is undertaken using sonars. Sonar is a generic term for any instrument that processes sound to extract information underwater.

- Semester-2
  - Types of Sonars (42 hours)
  - Basic Electronics (42 hours)
  - Circuit theory (42 hours)
  - Display Systems (42 hours)
  - Acoustic Transducers (42 hours)
  - Sonar System Engineering (42 hours)

- Semester-3
  - Electronic Circuit Design Practical (42 hours)
  - Electronic Fault Diagnosis Simulator Training (42 hours)
  - Sonar Systems Onboard Field Visit (42 hours)
  - Sonar Fault Diagnosis Simulator Training (42 hours)
  - Sonar System Practical Exposure (42 hours)
  - Visit to Sonar Manufacture Facility (42 hours)

- Semester-4
  - Project on One Type of Sonar (Complete understanding of design and operations) (84 hours)
  - Field Deployment and Data Collection (84 hours)
  - Case Study on Typical Defect Identification and Defect Rectification (DIDR) (84 hours)

(b) Marine Biotechnology .

- Semester-2
  - Analytical Techniques introduction (42 hours)
  - Microscopy, Centrifugation and Spectroscopy (42 hours)
  - Immunochemical and Chromatography techniques (42 hours)
  - Radioisotope techniques (42 hours)
  - GLP (Good laboratory practice) (84 hours)

- Semester-3
  - Introduction to Marine Biology (42 hours)
  - Marine resources assessment: Principal methods (42 hours)
  - Population study and Marine environment protection (42 hours)
  - Oceanography (42 hours)
  - Wet Lab Bioresources, Biodiversity & Oceanography (84 hours)

- Semester-4
  - Aquaculture Technology: Culture systems and Hatchery techniques. (42 hours)
  - Introduction to marine pharmacology (42 hours)
  - Manipulation techniques; Microbial techniques (42 hours)
  - Diseases diagnosis (42 hours)
  - Lab on Marine Microbiology & Aquaculture Technology (84 hours)

(c) Data Logger The acoustic data in the underwater domain needs to be collected in a manner to ensure minimal distortions. The data after recording needs to be stored in the appropriate format for easy access for processing.

- Semester-2
  - Types of Sonars (42 hours)
  - Data Formats (42 hours)
  - Data Acquisition Systems (42 hours)
  - Ambient Noise & Acoustic Propagation Characteristics (42 hours)
  - Acoustic Transducers (42 hours)
  - Sonar System Engineering (42 hours)

- Semester-3
  - Basic Digital Data Handling (42 hours)
  - Data Storage Devices (42 hours)
  - Sonar Systems Onboard Field Visit (42 hours)
  - Sonar Fault Diagnosis Simulator Training (42 hours)
  - Sonar System Practical Exposure (42 hours)
  - Visit to Sonar Manufacture Facility (42 hours)

- Semester-4
  - Project on One Type of Sonar (Complete understanding of Design and operations) (84 hours)
  - Field Deployment and Data Collection (84 hours)
  - Case Study on Data Handling in Sonar Systems (84 hours)

(d) Bioprospecting Bioprospecting in the underwater domain involves discovery and innovation, where the remarkable adaptability and unique features of marine life become reservoirs of inspiration for the creation of new and commercially valuable products. Through the synergistic collaboration of science, technology, and environmental stewardship, bioprospecting unfolds as a promising avenue for unlocking the untapped potential of the underwater world.

- Semester-2
  - Introduction to Marine Biology (42 hours)
  - Principles of Bioprospecting (42 hours)
  - Marine Microorganisms and Biotechnology (42 hours)
  - Underwater Flora and Fauna Identification (42 hours)
  - Underwater Conservation and Sustainable Use (42 hours)
  - Environmental Impact Assessment in Underwater Bioprospecting (42 hours)

- Semester-3
  - Bioactive Compounds in Marine Organisms (42 hours)
  - Marine Genetic Resources and Bioprospecting (42 hours)
  - Bioprospecting in Deep-Sea Environments (42 hours)
  - Advanced Bioprospecting Techniques (42 hours)
  - Industry Applications of Underwater Bioprospecting

- Semester-4
  - Collaboration with industry experts and site visits. (84 hours)
  - Independent research project in the underwater domain. (84 hours)
  - Analysis of case studies and real-world applications of bioprospecting. (84 hours)

(e) Deployment Specialist Waterfronts offer unique challenges, when we plan deployment of sonars or collection of Bio-samples. The platform that will be able to deploy the sensor or provide the means for bio-sample collection or even other abiotic samples will require specialized understanding of the local conditions.

- Semester-2
  - Surface & Sub-surface Platforms (42 hours)
  - Manned & Unmanned Platforms (42 hours)
  - Deployment Challenges (42 hours)
  - Maritime Safety Protocols (42 hours)
  - Seamanship Skills (42 hours)
  - Communication onboard Marine Platforms (42 hours)

- Semester-3
  - Seamanship Practical (42 hours)
  - Visit to a Seamanship Yard (42 hours)
  - Visit to Autonomous Underwater Vehicle (AUV) Facility (42 hours)
  - Sailing onboard Fishing Vessel (42 hours)
  - Visit to Offshore Support Vessel (42 hours)
  - Visit to Sonar Manufacture Facility (42 hours)

- Semester-4
  - Project on One Type of Deployment (Complete understanding of Deployment and Operations) (84 hours)
  - Field Deployment and Data Collection (84 hours)
  - Case Study on Typical Deployment Challenges and Customized Deployment (84 hours)

(III) BVoc Programs:

The BVoc Programs are three-year duration programs that will cover the larger UDA framework at multiple levels and for varied stakeholders. These will enable the participant to acquire the required skills to be relevant to cross section of stakeholders. The broad aspects that will get covered are digital transformation, acoustics, programming skills, signals & systems, instrumentation, sample handling, sustainable development goals, traditional knowledge, communication skills, etc. The common subjects for all the three courses for the first year will be as follows:

- Semester-1
  - Underwater Domain Awareness (UDA) Framework (42 hours)
  - Digital Transformation (42 hours)
  - Underwater Acoustics (42 hours)
  - Communication Skills (42 hours)
  - Sustainable Development Goals (42 hours)
  - Literature Survey & Seminar (42 hours)

- Semester-2
  - Tropical Waters and their Unique Characteristics (42 hours)
  - Climate Change Risk (42 hours)
  - Geopolitics and Geostrategy (42 hours)
  - Traditional Knowledge (42 hours)
  - Mini Project – Appreciation of the UDA and a specific application (84 hours)

Three broad courses will be formalized as follows:

(a) Acoustic Survey: Acoustic survey is the only means of visualizing the developments underwater. The acoustic survey will require hardware as well as software to undertake the actual operations in the water bodies. The tropical waters have their unique impact on the acoustic propagation in the underwater domain.

- Semester-3
  - Principles of Underwater Sound (42 hours)
  - Instruments for Underwater Measurements (42 hours)
  - Signals & Systems (42 hours)
  - Python Programming (42 hours)
  - Digital Signal Processing (42 hours)
  - Acoustic Propagation in the Tropical Waters (42 hours)

- Semester-4
  - Data Analytics (42 hours)
  - Field Experiment Planning (84 hours)
  - Actual Field Deployment (84 hours)
  - Analysis and Documentation (42 hours)

(b) Biotechnology & Biosciences: The biotic content underwater has tremendous value in terms of resources and if not protected can be a major cause of sustainability concern. The assessment of the underwater domain for biotic content and wellbeing will require specialized bio-technology & biosciences expertise. The biotic survey will require hardware as well as software to undertake the actual sample collection and testing in the water bodies. The tropical waters have their unique impact on the biodiversity in the underwater domain and even the way the components of the ecosystem interact with each other.

- Semester-3
  - Underwater ecosystems and biodiversity (42 hours)
  - Biotechnological Tools for Aquatic Environments (42 hours)
  - Hardware and Software for Biotic Survey (42 hours)
  - Advanced Biotic Survey Methods (42 hours)
  - Molecular Analysis of Underwater Organisms (42 hours)
  - Genetic Diversity and Adaptation in Underwater Species (42 hours)

- Semester-4
  - Sustainable Resource Management in Underwater Environments (42 hours)
  - Remote Sensing and Underwater Monitoring (42 hours)
  - Capstone Project: Integrated Biotic Survey and Conservation (84 hours)
  - Industry Internship (84 hours)

(c) Underwater Data Analytics: Data Analytics requires nuanced appreciation of the data, application and the site-specific local conditions. Acoustic data in the tropical waters require specialized signal processing and machine learning capabilities for effective data analysis.

- Semester-3
  - Signals & Systems (42 hours)
  - Python Programming (42 hours)
  - High Performance Computing (42 hours)
  - Machine Learning (42 hours)
  - Sonar Signal Processing (42 hours)
  - Acoustic Propagation in the Tropical Waters (42 hours)

- Semester-4
  - Data Analytics (42 hours)
  - Modelling & Simulation (M&S) (84 hours)
  - Field Experimental Validation (84 hours)
  - Analysis and Documentation (42 hours)

- Semester-5&6
  - Project Planning & Execution (Real World Problem Solving)
  - Four Seminars (every two months) for Evaluation of Progress
  - Final Project Presentation

(IV) Post Graduate Programs:

The Post Graduate Program are two-year duration programs that will cover the application specific requirements across multiple stakeholders. This will enable the participants to get deployed directly on the field for multiple stakeholders. The emphasis here will be field experimental learning and real-world problem solving. They will be fully ready for deployment for specific applications, relevant to multiple stakeholders. The first semester will common for all the ten programs as mentioned bellow:

(a) Digital Transformation in the Underwater Domain
(b) Sediment Management
(c) Freshwater Management
(d) Aquaculture & Fisheries Management
(e) Inland Water Transport (IWT) Management

(f) Strategic Security Management
(g) Underwater Archaeology
(h) Marine Spatial Planning
(i) Climate Change Risk Management
(j) Sustainable Development Goals

The first semester will be common to all and the subjects are as follows:

- Semester-1
  - Underwater Domain Awareness (UDA) Framework (42 hours)
  - Digital Transformation (42 hours)
  - Underwater Acoustics (42 hours)
  - Communication Skills (42 hours)
  - Literature Survey (42 hours)
  - Tropical Waters and their Unique Characteristics (42 hours)

- Semester-2
  - Traditional Knowledge (42 hours)
  - Four Course Specific Modules
  - One Slot will only be for Guest Lectures specific to the domain. Every week two to three, Guest Lectures will be arranged to expose the participants to domain experts, industry leaders and policy makers.

- Semester-3&4
  - Project Planning & Execution (Real World Problem Solving)
  - Four Seminars (every two months) for Evaluation of Progress
  - Final Project Presentation

(V) E-Learning Modules:

Additionally, E-Learning Modules have been developed to provide a nuanced exposure to the students and young professionals on varied aspects of the UDA framework. The modules have been developed in series of submodules that cover the varied dimensions of the topics. The series are mentioned below and the concept note for each is linked:

(a) Basic & Advance Level Modules for the UDA Framework. This has been uploaded in the IGOT platform of the Government of India, to expose the government officials across the Union Government and the States.
(b) Blue Economy.
(c) Climate Change Risk Management.
(d) Sediment Management across Marine & Freshwater Systems.
(e) Digital Transformation for Coastal & Riverine Communities.
(f) Tyranny of Small Decisions.

Corporate Training Programs	Security Forces involved in Maritime and Waterfront Security
	Blue Economy
	Sustainability & Climate Change Risk Management
	Capacity & Capability Building
Diploma Programs	Sonars Acoustic Survey
	Marine Biotechnology
	Data Logger
	Bioprospecting
	Deployment Specialist
BVoc Programs	Acoustic Survey
	Biotechnology & Biosciences
	Underwater Data Analytics
Post Graduate Programs	Digital Transformation in the Underwater Domain
	Sediment Management
	Freshwater Management
	Aquaculture & Fisheries Management
	Strategic Security Management
	Underwater Archaeology
	Marine Spatial Planning
	Climate Change Risk Management
	Sustainable Development Goals
E-Learning Modules	Basic & Advance Level Modules for the UDA Framework
	Blue Economy
	Climate Change Risk Management
	Sediment Management across Marine & Freshwater Systems
	Digital Transformation for Coastal & Riverine Communities
	Tyranny of Small Decisions

UDA Skilling Module

2.4 Way Ahead:

The UDA framework is positioned to make a substantial contribution to global digital transformation initiatives, thereby enhancing livelihoods and entrepreneurial prospects. In the dynamic landscape of strategic security, blue economy, sustainability & climate change management, and digital transformation, the imperative to sensitize stakeholders cannot be overstated. At the forefront of this effort lies the vital intersection of Underwater Domain Awareness (UDA) and skilling initiatives, forming a transformative synergy for global progress. To empower global stakeholders, a three-pronged approach is suggested:

2.4.1 Outreach: Sensitizing Stakeholders for Global Impact

Sensitizing stakeholders across strategic security, blue economy, sustainability & climate change management, and digital transformation domains, as well as engaging policymakers and practitioners, is deemed of paramount importance on a global scale. Overcoming resistance to change requires well-informed and gradual measures. Policies and technological interventions should be complemented by robust efforts to enhance capacity and capabilities. The awareness phase involves international seminars, workshops, and certificate courses, gradually instilling the concepts and intricacies. Government officers and employees engaged in ongoing professional development programs globally should integrate these initiatives into their existing curriculum.

- **The Significance of Sensitization:** Sensitizing stakeholders is not merely a task but a strategic imperative on a global scale. In the realms of strategic security, blue economy, sustainability, and digital transformation, the need for a collective understanding is paramount. Recognizing the intricate interdependencies among these domains is the first step towards fostering holistic and effective solutions.

- **Navigating Change with Informed Measures:** Change, especially in complex domains, is often met with resistance. To overcome this, their approach emphasizes well-informed and gradual measures. In the context of UDA and skilling initiatives, this means cultivating a profound understanding of the underlying principles and methodologies. Informed stakeholders are better positioned to champion and drive transformative change within their respective spheres.

- **Comprehensive Interventions for Sustainable Impact:** Policy and technological interventions play pivotal roles in shaping the future, but a truly impactful strategy extends beyond these domains. Their approach advocates for a comprehensive intervention strategy wherein policy and technological advancements are complemented by robust efforts to enhance capacity and capabilities. This ensures that stakeholders are not just recipients of change but active contributors to it.

- **Global Awareness Through Engaging Platforms:** The awareness phase of this initiative is dynamic and engaging, featuring international seminars, workshops, and certificate courses. These platforms serve as crucibles for the exchange of ideas, experiences, and best practices. More than disseminating information, they provide a collaborative space for stakeholders to collectively shape the future of these domains.

- **Integration into Professional Development:** Recognizing the pivotal role of government officers and employees in shaping policy and driving change, this initiative encourages the seamless integration of UDA and skilling initiatives into existing professional development programs. This integration ensures that ongoing programs globally equip participants with the latest insights and strategies to navigate the evolving landscape successfully.

- **UDA and Skilling Synergy:** Underwater Domain Awareness (UDA) is emerging as a linchpin in global security and environmental sustainability. Concurrently, skilling initiatives form the bedrock for developing a dynamic and proficient workforce capable of addressing the complexities of the underwater sector. The synergy between UDA and skilling initiatives creates a pathway for stakeholders to not only understand the intricacies but actively contribute to the advancement and sustainability of these domains.

- **A Call to Global Collaboration:** This initiative extends a global call to action, inviting policymakers, practitioners, and professionals from various sectors to join hands in this transformative journey. Together, they can break down silos, foster collaboration, and collectively address global challenges, thereby paving the way for sustainable and resilient futures.

The intersection of Underwater Domain Awareness and skilling initiatives marks a paradigm shift in global awareness and capability-building. By sensitizing stakeholders, navigating change with informed measures, and fostering a comprehensive intervention strategy, they are actively creating a future that is not only secure but also sustainable and prosperous.

2.4.2 Engagement: Bridging Knowledge Gaps for Global Transformation

The awareness phase should transition into identifying specific requirements for global stakeholders in various applications, spanning strategic security, blue economy, sustainability & climate change management, and digital transformation domains. Skill development and knowledge enhancement programs should address these identified gaps, benefiting both young job seekers and those already employed on a global scale. This engagement stage will enable international skill development missions and universities to adapt their curriculum based on input from stakeholders and policymakers globally. Necessary Memoranda of Understanding (MoUs) will be crafted to facilitate seamless interaction within the global ecosystem.

- **Understanding the Landscape:** The first step in this engagement stage is a meticulous analysis of the current landscape. This involves identifying specific challenges and opportunities within each domain, recognizing the unique needs and expectations of stakeholders on a global scale. The objective is to create a tailored approach that directly addresses the gaps in knowledge and skills.

- **Customized Skill Development Programs:** With a clear understanding of the requirements, the focus shifts to skill development and knowledge enhancement programs. These programs are designed to cater to the identified gaps, benefiting both young job seekers entering the workforce and those already employed. The aim is to offer relevant and cutting-edge training that aligns with the demands of strategic security, blue economy, sustainability, climate change management, and digital transformation.

- **Global Scale Impact:** This engagement stage goes beyond individual aspirations, aiming for a global impact. International skill development missions become a key component, fostering collaboration and knowledge exchange among nations. Universities, as key players in shaping future talent, are encouraged to adapt their curriculum based on insights garnered from stakeholders and policymakers worldwide.

- **Adaptive Curriculum Development:** To ensure that education remains responsive to the evolving needs of global industries, the engagement stage facilitates a continuous feedback loop. This involves universities adapting their curriculum based on real-time input from stakeholders, practitioners, and policymakers. The goal is to create a dynamic and relevant educational framework that prepares individuals to excel in their respective domains.

- **Facilitating Global Interaction:** The creation of Necessary Memoranda of Understanding (MoUs) becomes instrumental in facilitating seamless interaction within the global ecosystem. These agreements serve as formal expressions of commitment and collaboration between entities, ensuring that the exchange of knowledge, resources, and expertise is conducted efficiently and with a shared purpose.

- **Fostering a Collaborative Ecosystem:** The engagement stage is not just about meeting immediate needs; it's about fostering a collaborative ecosystem. By bringing together stakeholders from various corners of the globe, the initiative encourages the sharing of best practices, innovative ideas, and successful strategies. This collaborative approach ensures that the collective intelligence of the global community is harnessed for the greater good.

The engagement phase is a pivotal step in the journey towards global transformation. It goes beyond raising awareness; it dives deep into the specific needs of stakeholders and crafts tailored solutions. Through international skill development missions, adaptive curriculum development, and collaborative agreements, this stage sets the foundation for a future where knowledge knows no borders, and individuals worldwide are equipped to initiate positive transformations in their respective domain.

2.4.3 Sustainability: Forging a Global Path Towards Inclusive Education

The awareness and engagement efforts will lead to the establishment of a sustainable and viable global program. This stage will address international academic approvals, faculty and infrastructure requirements, placement opportunities, global stakeholder integration, and policy support. These efforts will enable the development of comprehensive and inclusive global programs.

Building upon the foundations laid during the awareness and engagement phases, the initiative is now poised to establish a sustainable and viable global program. This critical stage is designed to ensure that the impact of the efforts extends far beyond immediate gains, addressing key facets such as international academic approvals, faculty and infrastructure requirements, placement opportunities, global stakeholder integration, and policy support.

- **International Academic Approvals:** One of the cornerstones of sustainability is obtaining international academic approvals. This involves aligning the program with global educational standards and securing accreditation from relevant bodies. By adhering to recognized academic criteria, the initiative aims to ensure that the educational offerings are universally acknowledged, fostering credibility and trust among students, educators, and employers worldwide.

- **Faculty and Infrastructure Requirements:** The sustainability of the program hinges on the availability of skilled faculty and adequate infrastructure. Efforts will be directed towards recruiting qualified educators with diverse expertise, ensuring a robust and dynamic learning environment. Simultaneously, infrastructure requirements, both physical and technological, will be addressed to facilitate seamless and effective program delivery.

- **Placement Opportunities:** Sustainable education goes hand in hand with meaningful employment opportunities. The program will actively collaborate with global industries to create placement avenues for the program's participants. Establishing partnerships with corporations, research institutions, and other relevant entities will ensure that graduates are not only equipped with knowledge but also have tangible pathways to apply their skills in real-world scenarios.

- **Global Stakeholder Integration:** The sustainability of the program is contingent upon the continuous involvement of global stakeholders. Ongoing efforts will be made to foster collaboration and engagement with stakeholders from various sectors, ensuring that the program remains relevant, responsive, and aligned with the evolving needs of industries worldwide. Regular feedback mechanisms will be established to incorporate insights from stakeholders into program enhancements.

- **Policy Support:** For long-term viability, the program will actively seek and advocate for policy support at both national and international levels. This involves engaging with policymakers to create an enabling environment that encourages the growth and sustainability of global education initiatives. Policy advocacy will focus on promoting inclusivity, flexibility, and innovation in education frameworks.

- **Comprehensive and Inclusive Global Programs:** The ultimate goal of the sustainability stage is to develop comprehensive and inclusive global programs. This entails crafting curricula that not only cover the breadth of knowledge required in strategic security, blue economy, sustainability, climate change management, and digital transformation but also incorporate diverse perspectives and approaches. The programs should be designed to cater to a wide range of learners, fostering inclusivity and accessibility.

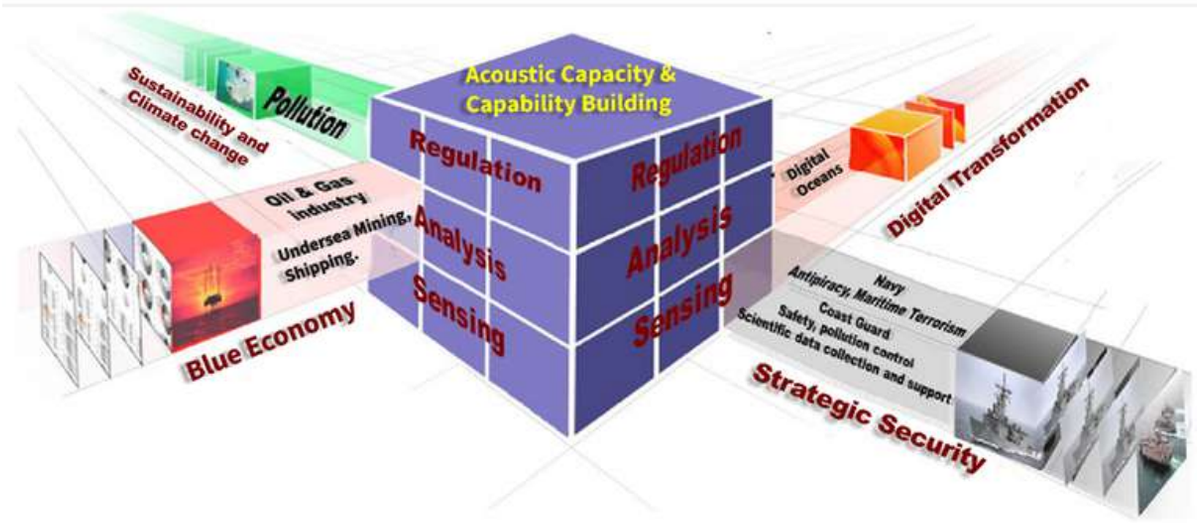
As the sustainability stage unfolds, the initiative envisions a future where education transcends geographical boundaries, providing learners worldwide with equitable access to high-quality, relevant, and sustainable programs. By addressing the intricacies of international academic approvals, faculty and infrastructure requirements, placement opportunities, global stakeholder integration, and policy support, the program aims to be a beacon of transformative education on a global scale.

ENCLOSURES

Enclosure 1: Underwater Domain Awareness Framework

Underwater Awareness Framework (UDA)

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 underwater areas. This keenness for underwater awareness from the security perspective means defending our Sea Lines of Communication (SLOC), coastal waters, and varied underwater assets against the proliferation of submarines and mining capacity aimed at limiting access to the sea and coastal waters. However, a mere military requirement may not be the only motivation for creating underwater awareness. The earth's underwater geophysical activities have a lot of relevance to the well-being of humankind and monitoring such activities could provide vital clues to minimize the impact of devastating natural calamities. Commercial activities in the underwater realm need precise inputs on the availability of resources to be able to explore and exploit them for economic gains effectively and efficiently. On the other hand, regulators need to know the usage model to manage a sustainable plan. With so much of activities, commercial and military, there is a significant impact on the environment. All conservation measures must accurately assess habitat degradation and species vulnerability as a result of these activities, as well as the state of the ecosystem. The scientific and research community needs to engage and continuously update our knowledge and access to the multiple aspects of the underwater domain. Fig. 1, 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 of these developments and then respond effectively and efficiently to them before they take the shape of an event.



UDA Framework

A comprehensive UDA must be understood in its horizontal and vertical structure. Horizontal structure would be the availability of resources in terms of technology, infrastructure, capacity and capability specific to stakeholders or otherwise. The stakeholders represented by the four faces of the cube will have their specific requirements; however, the core will retain the acoustic capacity and capability. The vertical structure is the hierarchy for creating a complete UDA. The first level, or ground level, should identify the underwater area for threats, resources and activities. The second level would be the rationalization of the data generated to prepare security strategies, defense plans and resource use plans. The next level would be to formulate and monitor regulatory frameworks at the local, national, and global levels.

The image above provides a comprehensive way to continue to engage and communicate with stakeholders. Individual cubes represent specific aspects that need to be addressed. User-academia-industry partnerships can be seamlessly designed based on user requirements, academic input, and the industry user interface represented by a specific cube. This allows for a more targeted approach and a well-defined interactive framework. With proper impetus, the UDA framework can address many of the challenges the country is currently facing. Young India's significant commitment to nation building is probably the most critical aspect that deserves attention. Multidisciplinary and cross-functional units can communicate and seamlessly foster synergy in their efforts toward a greater goal.
The UDA Framework as proposed above has been formulated jointly by the Maritime Research Center (MRC), Pune, and M/S Nir Dhwani Technology Pvt Ltd (NDT). The focus is on all three aspects namely Policy, Technology & Innovation, and Human Resource Development. More details are available on the MRC website https://mrc.foundationforuda.in/.

Enclosure 2: Curriculum Mapping

The UDA Skilling Modules are meticulously designed to not only impart essential knowledge but also align participants with diverse opportunities within the burgeoning field of Underwater Domain Awareness (UDA). The curriculum spans Corporate Training Programs, Diploma Programs, BVoc Programs, and Post Graduate Programs, each catering to distinct levels of expertise and roles within the underwater sector.

(a) Corporate Training Programs: Bridging Expertise to Opportunity:

- **Curriculum Overview:**

The Corporate Training Programs within the UDA Skilling Modules are meticulously crafted to cater to diverse stakeholders, including Security Forces, Blue Economy entities, Sustainability & Climate Change Management professionals, and Science & Technology Providers. The curriculum is designed as a bespoke offering, presenting customized modules that delve into crucial aspects of Underwater Domain Awareness (UDA). Topics span maritime safety, acoustic survey techniques, climate change risk assessment, and digital transformation strategies for marine spatial planning.

- **Key Modules:**

1. Maritime Safety: Essential for Security Forces and Marine Police, covering protocols, risk assessment, and emergency response.
2. Acoustic Survey Techniques: Equipping professionals with skills to conduct underwater surveys using sonars, vital for UDA practitioners.
3. Climate Change Risk Assessment: Delving into the impact of climate change on underwater ecosystems and developing risk mitigation strategies.
4. Digital Transformation for Marine Spatial Planning: Navigating the integration of digital technologies for effective marine spatial planning.

- **Potential Opportunities:**

Graduates from these programs are strategically positioned to explore a plethora of impactful roles within the UDA landscape. Opportunities include:

1. UDA Consultants: Offering expertise in comprehensive UDA strategies for diverse stakeholders.
2. Maritime Security Analysts: Analyzing and enhancing security measures in maritime and underwater domains.
3. Environmental Compliance Specialists: Contributing to sustainable practices and ensuring adherence to environmental regulations.
4. Digital Transformation Experts: Spearheading technological advancements for efficient marine spatial planning and data management.

- **Further Avenues:**

1. Policy Shapers: Opportunities abound in influencing policies related to UDA, maritime safety, and environmental conservation.
2. Blue Economy Contributors: Playing a pivotal role in sustainable practices within the Blue Economy, such as fisheries, tourism, and shipping.
3. Research for Climate Change Resilience: Engaging in vital research to understand and mitigate the impact of climate change on underwater ecosystems.

The Corporate Training Programs not only impart specialized skills but also serve as gateways to a multitude of career paths. Graduates emerge as versatile professionals, contributing significantly to UDA and related fields, thereby fostering a resilient and sustainable underwater future.

(b) Diploma Programs: Nurturing Specialized Expertise for UDA Professions:

- **Curriculum Overview:**

The Diploma Programs, spanning two years, are meticulously tailored to hone participants into specialized roles-UDA Technicians, Data Loggers, Bio-prospecting Instrumentation experts, or Deployment Specialists. The curriculum begins with a foundational semester covering essential aspects of the UDA Framework, Tropical Waters, Instrumentation, Communication Skills, Sustainable Development Goals, and Literature Review.

- **Foundational Semester Modules:**

1. UDA Framework: Providing a comprehensive understanding of the principles and components of Underwater Domain Awareness.
2. Tropical Waters: Analyzing the unique characteristics of tropical waters and their impact on UDA operations.
3. Instrumentation: Equipping participants with the skills to operate and maintain instrumentation for underwater activities.
4. Communication Skills: Enhancing communication abilities crucial for effective collaboration in the underwater sector.
5. Sustainable Development Goals: Integrating sustainability principles within the context of UDA practices.
6. Literature Review: Cultivating research skills through the exploration of existing literature in the field.

- **Specialized Tracks:**

Participants then delve into specialized tracks tailored to their chosen roles:
1. UDA Technicians: Focused on operating, maintaining, and repairing instrumentation for acoustic survey, bio-sample handling, and data management.
2. Data Loggers: Specializing in the proper collection, formatting, and storage of digital data in underwater environments.
3. Bio-prospecting Instrumentation Experts: Acquiring expertise in the instrumentation used for bio-sample collection and analysis in underwater ecosystems.
4. Deployment Specialists: Gaining insights into the challenges and protocols associated with deploying equipment for data collection and bio-sample collection.

- **Potential Opportunities:**

Diploma holders emerge with a range of potential career opportunities:
1. UDA Technicians: Undertaking critical roles in the operation and maintenance of UDA-related instrumentation.
2. Marine Instrumentation Specialists: Contributing expertise in instrumentation for acoustic survey and data handling.
3. Data Management Professionals: Handling and organizing digital data collected in underwater environments.
4. Deployment Planning and Execution: Contributing to the strategic planning and execution of underwater deployments.

- **Further Opportunities:**

1. Research and Development: Opportunities exist to contribute to R&D endeavors focused on specific aspects of UDA, enhancing the field's knowledge base.

The Diploma Programs not only equip participants with specialized skills but also open doors to dynamic career paths within the underwater domain, ensuring a well-prepared workforce for the evolving challenges and opportunities in UDA.

(c) BVoc Programs: A Deep Dive into Specialized UDA Fields

- **Curriculum Overview:**

The BVoc Programs, spanning three years, provide a comprehensive exploration of three specialized fields within Underwater Domain Awareness (UDA): Acoustic Survey, Biotechnology & Biosciences, and Underwater Data Analytics. The curriculum is designed to equip participants with advanced knowledge and skills crucial for thriving in these specialized domains. Key modules include Principles of Underwater Sound, Python Programming, Data Analytics, Machine Learning, and Field Experiment Planning.

- **Core Modules:**

1. Principles of Underwater Sound: Delving into the fundamental principles governing sound in underwater environments, a critical aspect of UDA operations.
2. Python Programming: Developing proficiency in a key programming language essential for data analysis and processing in UDA.
3. Data Analytics: Gaining advanced skills in analyzing and interpreting data collected in underwater domains.
4. Machine Learning: Exploring the application of machine learning techniques for enhanced data analysis and pattern recognition.
5. Field Experiment Planning: Acquiring practical skills in planning and executing field experiments in underwater settings.

- **Specialized Tracks:**

Participants specialize in one of the three tracks:
1. Acoustic Survey: Focused on techniques, technologies, and methodologies for conducting acoustic surveys in underwater environments.
2. Biotechnology & Biosciences: Exploring the application of biotechnological and bioscience principles in the context of marine ecosystems.
3. Underwater Data Analytics: Specializing in advanced data analytics techniques tailored to underwater data, including real-time processing and interpretation.

- **Potential Opportunities:**

Graduates from BVoc Programs emerge with a diverse set of potential career opportunities within the realm of UDA:
1. Acoustic Survey Specialists: Undertaking crucial roles in planning and executing acoustic surveys for UDA purposes.
2. Biotechnology Analysts: Contributing expertise in applying biotechnological principles to analyze and understand marine ecosystems.
3. Underwater Data Analysts: Specializing in the analysis of data collected from underwater environments, contributing to informed decision-making.

- **Further Opportunities:**

1. Research Institutions: Opportunities to engage in cutting-edge research within institutions focused on underwater domains.
2. Marine Conservation Projects: Contributing to projects aimed at the conservation and sustainable management of marine ecosystems.
3. Data-Driven Decision-Making Roles: Opportunities in sectors where data-driven decision-making is crucial, such as environmental monitoring and policy formulation.

The BVoc Programs not only provide specialized knowledge but also open avenues for graduates to contribute meaningfully to the evolving landscape of UDA, ensuring a workforce adept at tackling the complexities of underwater awareness.

(d) Post Graduate Programs: Nurturing Specialized UDA Leaders:

- **Curriculum Overview:**

The two-year Post Graduate Programs in Underwater Domain Awareness (UDA) are designed to provide participants with a deep understanding of application-specific requirements within the underwater sector. The curriculum combines foundational knowledge with specialized modules, allowing participants to tailor their learning to specific areas of interest. The first semester covers essential subjects, while subsequent semesters offer modules such as Digital Transformation, Sediment Management, Freshwater Management, and Climate Change Risk Management.

- **Core Modules:**

1. Foundational Subjects (Semester 1):
   - Underwater Domain Awareness (UDA) Framework: An introduction to the fundamental principles and frameworks governing UDA.
   - Digital Transformation: Exploring the integration of digital technologies in underwater domains.
   - Underwater Acoustics: Delving into the principles and applications of underwater sound.

- **Specialized Tracks (Semester 2 and 3):**

Participants can choose from a range of specialized tracks, including:

1. Digital Transformation in the Underwater Domain: Focused on underwater data collection, monitoring, robotics, automation, mapping, and imaging.
2. Sediment Management: Covering aspects such as sediment transport modeling, dredging, sediment removal, and bathymetry.
3. Freshwater Management: Exploring desalination technologies, rainwater harvesting, water quality, and siltation and flooding.
4. Aquaculture & Fisheries Management: Covering ecosystem-based fisheries management, aquaculture techniques, fisheries biology, and aquaculture policy.
5. Inland Water Transport (IWT) Management: Including modules on inland waterway infrastructure, IWT policy, vessel operations, and technological advancements.
6. Strategic Security Management: Focusing on underwater security, geopolitical dynamics, threat assessment, and underwater diplomacy.
7. Underwater Archaeology: Covering techniques, archaeological registration, survey and mapping, underwater history, and diving skills.
8. Marine Spatial Planning: Addressing policy and technology interventions, environmental impact assessment, real-time digital transformation, and spatiotemporal ambient noise mapping.
9. Climate Change Risk Management: Covering climate data and monitoring systems, climate change and shipping, climate science and oceanography, and climate risks in underwater sectors.
10. Sustainable Development Goals: Introduction to sustainable development goals, with a focus on sustainable fisheries management, aquaculture, coastal planning, and sustainable coastal tourism.

- **Potential Opportunities:**

Postgraduates from these programs are prepared for leadership roles in the UDA landscape and related fields. Potential career opportunities include:

1. UDA Project Managers: Leading projects focused on enhancing underwater awareness and domain-specific applications.
2. Sediment Management Experts: Contributing expertise to projects addressing sediment-related challenges in underwater environments.
3. Climate Change Analysts: Analyzing climate data and assessing its impact on underwater ecosystems and activities.
4. Specialists in Various UDA Fields: Opportunities in academia, policy-making, and roles aligned with specific UDA tracks chosen during the program.

These Post Graduate Programs not only empower participants with specialized knowledge but also position them as leaders capable of navigating the complex and evolving challenges within the underwater domain. Graduates are poised for impactful careers and contributions to the advancement of UDA.

(e) E-Learning Modules: Empowering Professionals in the Underwater Domain:

- **Curriculum Overview:**

The E-Learning Modules in Underwater Domain Awareness (UDA) provide a flexible and accessible platform for professionals seeking to enhance their skills in the underwater sector. The comprehensive curriculum covers a range of critical topics, including Basic & Advanced UDA Framework, Blue Economy, Climate Change Risk Management, Sediment Management, Digital Transformation, and the Tyranny of Small Decisions.

- **Key Modules:**

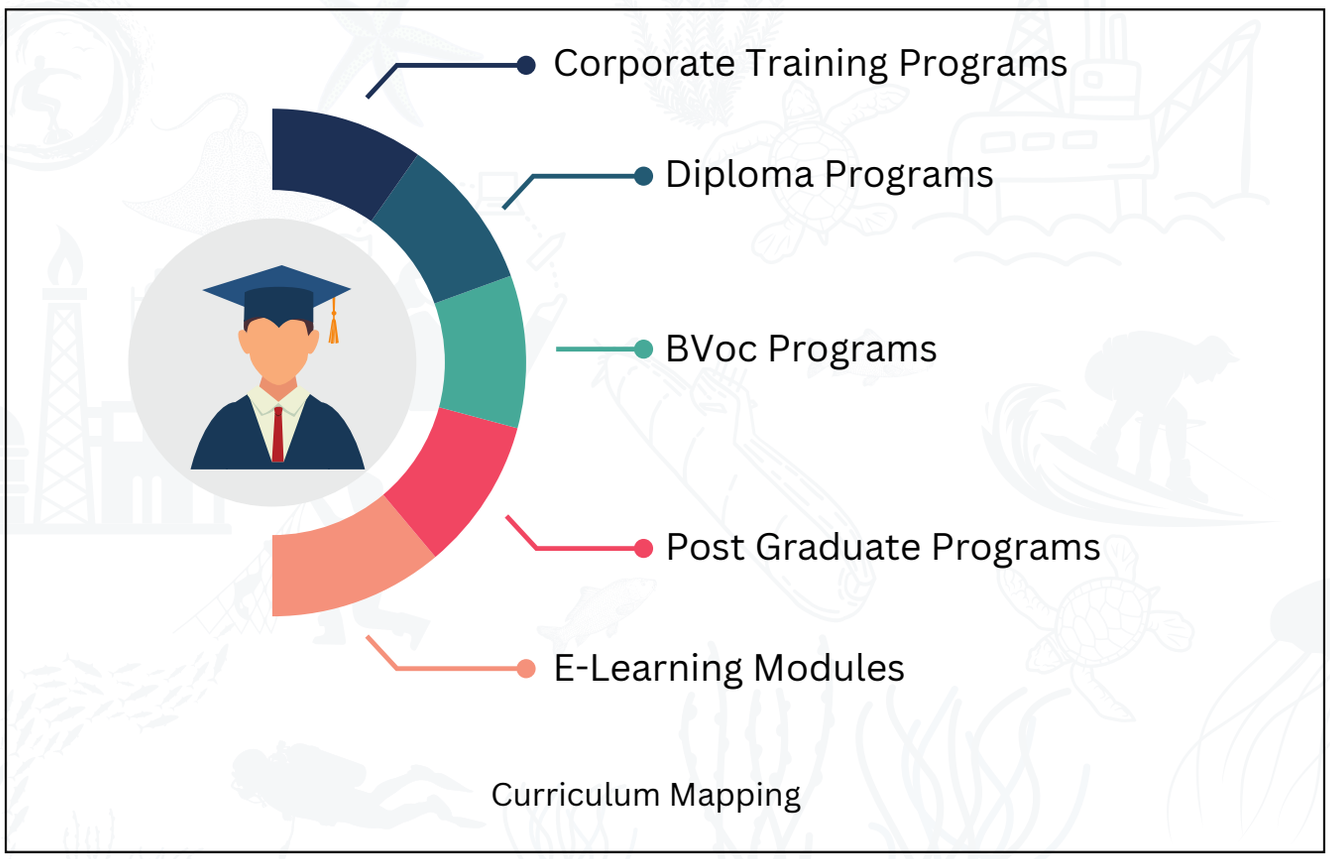
1. Basic & Advanced UDA Framework: A foundational module providing insights into the principles and frameworks governing UDA, catering to both entry-level and advanced learners.
2. Blue Economy: Exploring the sustainable utilization of marine resources, encompassing shipping, fisheries, aquaculture, deep-sea mining, and more.
3. Climate Change Risk Management: Addressing the impact of climate change on underwater ecosystems and activities, with a focus on risk assessment and mitigation.
4. Sediment Management: Covering techniques and strategies for managing sediments in marine and freshwater systems to ensure environmental sustainability.
5. Digital Transformation: Examining the integration of digital technologies for efficient data collection, monitoring, and decision-making in underwater environments.
6. Tyranny of Small Decisions: Understanding the cumulative impact of small decisions on underwater ecosystems and the importance of strategic planning.

- **Potential Opportunities:**

Professionals engaging with these E-Learning Modules gain valuable skills and knowledge, positioning them for diverse opportunities within the underwater domain. Potential career pathways include:

1. Digital Transformation Experts: Leveraging skills in digital technologies to enhance data collection, analysis, and decision-making processes in the underwater sector.
2. Climate Change Mitigation Specialists: Contributing to efforts in mitigating climate change impacts on underwater ecosystems through informed decision-making.
3. Policy Advisory Roles: Providing expertise in advising on policies related to underwater conservation, climate change resilience, and sustainable practices.
4. Environmental Consulting: Offering specialized consultancy services in environmental management, sustainability, and UDA strategies.
5. Contributors to Sustainable Practices: Playing an active role in promoting and implementing sustainable practices within the underwater domain.

As the underwater domain continues to gain significance globally, professionals equipped with the knowledge from these E-Learning Modules are well-positioned to navigate challenges and contribute to the sustainable and responsible development of underwater resources. The modular and accessible nature of these programs allows professionals to tailor their learning journey, ensuring relevance and impact in their chosen field. The UDA Skilling Modules not only offer a comprehensive curriculum but also open doors to a spectrum of opportunities within the underwater domain. Graduates and professionals can find fulfilling careers in various sectors, contributing to sustainable practices, marine conservation, and technological advancements in UDA. As the field continues to evolve, skilled professionals are poised to play pivotal roles in shaping the future of Underwater Domain Awareness.



Curriculum Mapping

Enclosure 3: Stakeholder Mapping

The primary stakeholders involved in Underwater Domain Awareness (UDA) may vary depending on the specific circumstances. Nonetheless, they broadly fall into Strategic Security, Blue Economy, Sustainability & Climate Change Management and Digital Transformation Sectors. Following are some of the typical stakeholders poised to gain from UDA:

Government Agencies, Spanning Environmental Ministries, Water Resource Management Bodies, Fisheries Departments, and Underwater Authorities, play a crucial role in overseeing underwater domain awareness at various levels. Their responsibilities include policy formulation, regulation enforcement, and the management of India's underwater security and environmental issues. Key competencies and infrastructure required for their effective functioning include surveillance and monitoring capabilities to address illegal activities like contraband trafficking and piracy, instantaneous vessel tracking for rule enforcement and national security, ecological surveillance to detect pollution and oil spills, and rapid alert systems for natural disasters such as tsunamis and hurricanes.

The participation of **Naval and Coastal Defense** units in Underwater Domain Awareness (UDA) holds significant importance as they play a crucial role in ensuring underwater security, conducting surveillance, and managing responsive measures in the underwater domain. These units allocate resources and personnel to oversee underwater actions, utilizing advanced technologies such as sonar systems, submarines, and naval vessels to monitor and protect India's underwater interests. Key skills and systems essential for their effective operation include augmented situational awareness through consolidated sensor networks for identifying submarines, subaquatic risks, and suspicious activities, tools for collecting and analyzing intelligence to discern potential hazards and adversaries, and swift response capacities to thwart subaquatic threats and assert underwater supremacy.

Educational and Research Institutions, including entities like the National Institute of Oceanography (NIO) and the Indian Institute of Technology (IIT), play a vital role in Underwater Domain Awareness (UDA) by contributing to scientific research, technology development, and expertise in areas such as oceanography, marine biology, and underwater sensing. Crucial skills and systems for their effective operation include ensuring the availability of UDA data for scientific exploration, modeling, and analytical purposes, establishing collaboration platforms and mechanisms for information exchange to encourage cross-disciplinary research and creativity, and offering educational programs designed to nurture a proficient workforce in underwater technologies and UDA-related domains.

Underwater Business and Commercial Operators, encompassing shipping companies, offshore energy firms, and fishing companies, hold a substantial stake in Underwater Domain Awareness (UDA). They heavily rely on accurate underwater data for safe navigation, resource exploration, and environmental compliance. Key skills and systems crucial for their efficient functioning include the need for robust and secure navigation systems to prevent collisions and navigate underwater hazards, access to real-time environmental and oceanographic data for optimizing route planning and informed operational decisions, and the implementation of security measures to deter unauthorized access to offshore assets and prevent underwater piracy.

Marine Conservation and Environmental Non-governmental Organizations (NGOs) play an active role in supporting Underwater Domain Awareness (UDA) efforts focused on marine ecosystem protection, pollution mitigation, and biodiversity conservation. Critical proficiencies and mechanisms essential for their optimal functioning involve the surveillance and assessment of marine biodiversity and ecosystem well-being, encompassing activities like monitoring species variety, tracking population dynamics, and evaluating habitat conditions. Swift recognition and response to environmental threats, including coral bleaching and the management of invasive species, are paramount. Additionally, the integration of UDA data into conservation approaches and policy formulation is crucial, enabling data-driven strategies for effective marine ecosystem protection and preservation.

The **Fishing and Aquaculture Sector**, heavily reliant on both marine and freshwater environments, deems these ecosystems vital for their livelihoods and economic activities. Ensuring the sustainability of fishing practices, averting overfishing, and protecting aquatic habitats necessitate collaborative efforts with relevant stakeholders. Key skills and systems for effective operation include access to real-time data on fish stocks and environmental conditions, forming the basis for sustainable fishing practices and resource preservation. The implementation of monitoring systems for tracking fishing vessels ensures adherence to regulations and enhances the safety and security of fishermen in oceanic environments. Access to critical information about vulnerable habitats, like coral reefs and marine protected areas, is essential for mitigating the ecological impact of fishing activities and promoting responsible practices. Additionally, deploying early detection systems for aquatic diseases and harmful algal blooms, along with strategies to prevent their transmission to aquaculture facilities, is imperative for responsible and sustainable fishing practices.

The Tourism and Recreation Industry, encompassing coastal tourism, water sports, and wildlife watching, relies on accurate underwater data to ensure the safety of tourists while minimizing ecological impacts. Collaboration with this sector is crucial to endorse sustainable tourism methods, mitigate environmental consequences, and safeguard the long-term sustainability of ecosystems for leisure and recreational purposes. The expertise and systems essential for effective operation involve utilizing Underwater Domain Awareness (UDA) tools and services for real-time information on weather patterns, ocean currents, and potential risks to ensure the safety of participants in activities like scuba diving, snorkeling, and boating. Additionally, accessing data on marine biodiversity, migratory routes, and opportunities for sustainable wildlife observation is key. Collaborating with UDA partners is vital for designing educational initiatives and interpretative materials that enhance awareness about marine preservation, the significance of sustainable tourism, and responsible conduct within fragile marine environments.

Global Entities, including international institutions like the United Nations (UN) and UNESCO, as well as regional bodies such as RFMOs and IORA, play a crucial role in advancing international coordination, setting standards, and promoting cooperation for the sustainable administration of Underwater Domain Awareness (UDA). Skills and infrastructure vital for effective functioning involve global collaboration to facilitate data sharing, standardize UDA practices, and establish common protocols for monitoring transboundary marine areas. Additionally, supporting developing nations in enhancing their UDA capabilities through technology transfer, training initiatives, and knowledge exchange is essential to bolster underwater security, combat illegal fishing, and safeguard marine resources. The gathering of data is emphasized as critical for advancing scientific comprehension of the marine environment, understanding the impacts of climate change, and shaping international policies and conservation approaches.

Technology and Service Providers in the Underwater Domain Awareness (UDA) sector play a pivotal role by developing and supplying tools and systems for underwater monitoring and surveillance. Their effective operation requires technical expertise in designing and maintaining underwater technologies, sensor systems, and data analysis tools. Proficiency in engineering skills, including mechanical, electrical, and software engineering, is essential for creating reliable UDA solutions. Competence in data analytics, remote sensing technologies, sensor integration, and quality assurance procedures is crucial for extracting meaningful insights from UDA data and ensuring system reliability. Furthermore, a culture of innovation, regulatory compliance, customer engagement, training and support, environmental awareness, market awareness, and a global perspective are vital aspects for technology and service providers to stay competitive and contribute to the sustainable development of the UDA sector.

Interdisciplinary Collaborations are indispensable for addressing complex Underwater Domain Awareness (UDA) challenges comprehensively, involving stakeholders from strategic security, blue economy, sustainability and climate change management, and digital transformation. Skills and infrastructure vital for effective functioning encompass information integration, data literacy, project management, cultural sensitivity, technical proficiency, conflict resolution, ethical awareness, innovation, resource management, continuous learning, policy advocacy, and stakeholder engagement. These collaborations require the ability to synthesize information from diverse disciplines, interpret data, and manage projects efficiently, while also fostering cultural understanding and resolving conflicts constructively. Ethical decision-making, innovation, and resource management are crucial, along with a commitment to continuous learning and effective communication of findings to policymakers and stakeholders across various domains. Engaging diverse stakeholders and maintaining their support are also pivotal aspects of successful interdisciplinary collaborations.

Below are Some of the typical stakeholders poised to gain from UDA

Government Agencies	Underwater Business and Commercial Operators
Spanning Environmental Ministries	Marine Conservation and Environmental NGO's
Water Resource Management Bodies	Fishing and Aquaculture Sector
Fisheries Departments	Tourism and Recreation Industry
Underwater Authorities	Global Entities
Naval and Coastal Defense	Technology and Service Providers
Educational and Research Institutions	Interdisciplinary Collaborations

Stakeholder Mapping

Enclosure 4: UDA Skill Gaps and Skill Mapping

On a global scale, nations, including India, grapple with substantial challenges in aquaculture and blue biotechnology. Administrative complexities, opaque licensing procedures, limited access to space and water resources, and stringent quality standards contribute to these issues. To foster the blue economy, there is a critical need for proficient professionals. However, sectors face hurdles in recruiting suitable talent due to generational turnover, especially in fisheries, and the rapid evolution of technology, intensifying the demand for specialized workers in areas like aquaculture, shipbuilding, and marine biotechnology. This section provides an overview of key initiatives by the Indian Government across diverse schemes, highlighting prevailing skill gaps within each project, with a specific focus on the Blue Economy sector.

The Sagarmala Project, focusing on port-led development and coastal community growth, requires a diverse set of skills. These include proficiency in port management encompassing cargo handling, logistics, security, vessel operations, and maintenance. Additionally, expertise in the underwater domain is crucial, covering shipbuilding, marine engineering, equipment maintenance, and fabrication to support the expansion of shipyards and related industries. Furthermore, skills in underwater safety and security, such as search and rescue operations, navigation, firefighting, and disaster management, are essential to ensure the safety and security of port operations, along with effective response capabilities during emergencies.

The GatiShakti Initiative, focused on establishing a multi-modal infrastructure grid for seamless transportation, demands a diverse set of skills. These include expertise in inland waterway navigation, encompassing the ability to navigate vessels and operate them on inland water routes, understanding navigational charts, and employing specific maneuvering techniques. Proficiency in vessel operations and maintenance is crucial to ensure the efficient and secure movement of cargo along waterways, especially operating specialized vessels designed for inland water transport. Infrastructure management skills are necessary for overseeing and maintaining waterway infrastructure, including locks, dams, jetties, and navigation channels, with a focus on inspection, maintenance, and ensuring navigational safety. Additionally, cargo handling and logistics skills are vital for activities such as loading, unloading, stowage planning, warehousing, and inventory management, contributing to the smooth flow of goods within the multi-modal transportation system.

Project Mausam, initiated by the Ministry of Culture, Government of India, requires a diverse skill set for its focus on documenting underwater cultural heritage and researching underwater interactions in the Indian Ocean region. Key skills include competence in historical research methods and archival study to collect and analyze historical documents, manuscripts, and records related to underwater cultural heritage. Preservation and museum curation knowledge are essential for ensuring the protection, conservation, and display of underwater cultural artifacts. Understanding heritage policy frameworks and community engagement strategies is crucial for actively involving local communities in safeguarding and promoting underwater cultural heritage. Proficiency in underwater archaeology methods and techniques is necessary to explore and document submerged cultural heritage sites and artifacts.

Additionally, expertise in using Geographic Information Systems (GIS) software and spatial analysis is vital for visualizing data, identifying patterns, and establishing connections related to underwater cultural heritage and interactions in the Indian Ocean region.

The National Offshore Sensor System (NOSS), an underwater surveillance project, demands a diverse skill set for its effective implementation. Understanding and developing advanced sensor technologies, such as hydrophones and sonar systems, is crucial for individuals involved in NOSS, requiring skills to design, build, and maintain these sensors. Skilled data analysts and scientists are needed to process, analyze, and interpret the vast amount of data collected by NOSS sensors to identify potential threats. Additionally, expertise in remote sensing technologies is necessary for operating and maintaining sensors deployed in remote underwater locations. Professionals with skills in communication and networking are essential to design robust infrastructure for transmitting data from underwater sensors to a central command center. Marine engineering expertise is crucial for the installation and maintenance of underwater sensors, ensuring they withstand harsh underwater conditions. Skilled environmental scientists are required to assess and mitigate the environmental impact of NOSS operations, while experts in underwater law and regulatory compliance are essential to ensure the project operates within legal boundaries.

The National Command Control Communication and Intelligence Network (NC3I Network) aims to enhance underwater domain awareness by integrating various surveillance systems. Key skills for personnel involved in this project include knowledge of underwater communication protocols and standards, such as the Global Underwater Distress and Safety System (GMDSS) and the Automatic Identification System (AIS), to facilitate effective communication. System integration expertise is crucial for integrating diverse surveillance systems like radars and sonars seamlessly. Developing and maintaining underwater domain awareness requires skills in surveillance systems, tracking technologies, and real-time monitoring tools for data analysis and threat identification. Proficiency in vessel tracking systems, underwater traffic management, and collision avoidance technologies is essential for ensuring safety and security. Skilled individuals are needed for data analysis and interpretation, as the NC3I Network collects vast amounts of data from multiple sources. Training programs are crucial to equip personnel with the necessary skills for operating and maintaining the NC3I Network, covering system operation, troubleshooting, and emergency response procedures.

The National Automatic Identification System (NAIS), implemented by the Indian Coast Guard for vessel tracking and monitoring, requires various skills for effective operation. This includes expertise in AIS system design to plan and implement the necessary infrastructure for comprehensive coverage. Skilled personnel are essential for analyzing and interpreting AIS data, extracting meaningful information for underwater situational awareness. The management and maintenance of the AIS network demand skills in network management, hardware and software maintenance, and effective troubleshooting. Regulatory compliance with international and national AIS regulations, such as those outlined by the International Maritime Organization (IMO), requires skilled individuals. Integrating AIS data with other underwater surveillance systems calls for expertise in system integration and data fusion. Skilled personnel are crucial for emergency response and search and rescue operations, utilizing AIS data to identify distressed vessels and coordinate rescue efforts.

Data analysts with the necessary skills are required for efficient processing of AIS data, generating reports, and identifying anomalies and potential threats. Training programs and education for personnel involved in AIS operations are crucial for ensuring effective equipment use and accurate data interpretation. Quality assurance measures and regular audits, overseen by skilled individuals, are essential for maintaining the reliability and accuracy of the AIS network.

The success of the "Make in India" initiative in the underwater sector relies on a diverse set of skills. Skilled shipbuilders and repair technicians are crucial for vessel construction and maintenance, including expertise in ship design, welding, and mechanical and electrical systems. Naval architects play a pivotal role, requiring skills in structural engineering, hydrodynamics, and computer-aided design. Safety and quality assurance skills are paramount, encompassing compliance with international underwater regulations and risk assessment. Effective supply chain management skills, including logistics and procurement, are vital for optimizing material flow. Project management skills are essential for overseeing large-scale manufacturing projects, ensuring they stay on schedule and within budget. International trade skills, including knowledge of regulations and finance, are crucial for global engagement. Environmental sustainability skills, embracing eco-friendly practices, are increasingly important. Technology integration skills, focusing on automation and IoT, are essential for modernizing manufacturing processes. Workforce development through training and education programs is critical. Market research, business development, regulatory compliance, and financial management skills round out the key competencies needed for the initiative's success.

The Digital India initiative aims to digitally empower the blue economy and underwater sectors, necessitating a focus on various digital literacy and technological skills. Training programs are essential to impart basic digital literacy skills to individuals involved in these sectors, enabling them to use digital devices and navigate specialized underwater software. Effective communication and collaboration skills using digital platforms are crucial for efficient teamwork in underwater operations. Data analytics skills, including data collection, cleansing, and interpretation, are vital for deriving valuable insights from the vast amounts of data generated in the blue economy. The integration of IoT and sensor technologies in underwater affairs requires skills in deployment, maintenance, and data analysis from underwater IoT devices. Proficiency in digital navigation systems, including GPS and ECDIS, is crucial for safe underwater navigation, while skills in underwater data management, remote sensing, satellite technology, and environmental monitoring contribute to responsible and sustainable underwater practices. Understanding and adhering to underwater regulations related to digitalization is imperative, with skilled individuals needed to ensure compliance with legal frameworks and standards.

The following is a compilation of several skills that constitute the focal points within the UDA skilling modules:

Sediment Management:

Professionals in sediment management require a diverse skill set encompassing sediment analysis techniques, dredging expertise, and hydrographic surveying skills to understand and manage underwater sediments effectively. They assess the environmental impact of dredging activities, utilizing preventive measures and siltation processes understanding to propose mitigation strategies. Expertise in regulatory compliance, GIS and mapping, project management, data interpretation, and communication is crucial for executing sediment-related projects while adhering to local, national, and international regulations. Additionally, a commitment to environmental sustainability, adaptability to changing conditions, and incorporating innovative technologies are essential for safeguarding aquatic ecosystems and ensuring responsible sediment management practices.

Port Management:

Professionals in port management and underwater domain activities require a comprehensive skill set across various domains. In underwater security, expertise in security protocols, threat assessment, and emergency response planning is essential to prevent intrusion and manage crises effectively. Marine environmental monitoring demands proficiency in collecting and analyzing environmental data, ensuring regulatory compliance in port activities. Navigational safety skills include knowledge of navigation aids, hydrography, and risk assessment to manage vessel traffic safely. Marine ecosystem monitoring necessitates expertise in assessing ecosystem health, biodiversity monitoring, and integrating data into sustainable port management strategies. Regulatory knowledge involves familiarity with port regulations and effective compliance management. Technology utilization proficiency includes using technology for security surveillance, environmental monitoring, and communication within the port. Emergency preparedness involves developing and implementing plans for various scenarios. Collaboration and communication skills are crucial for working with diverse stakeholders, and sustainability advocacy emphasizes promoting environmentally responsible port management practices for economic growth.

Oil & Gas Industry:

Professionals in the oil and gas industry require a diverse skill set spanning multiple domains. In seismic surveying, expertise in geophysical data collection, survey equipment operation, data processing, and seismic safety is crucial for assessing subsurface structures and planning drilling operations safely. Ensuring the security of offshore assets demands skills in asset protection, security protocol development, and risk assessment against threats like piracy. Environmental impact assessment skills involve navigating environmental regulations, assessing the impact of operations, and devising mitigation strategies for oil spills and habitat protection. Supporting research and development entails skills in aiding R&D initiatives, evaluating emerging technologies, and fostering collaboration for innovation.

Regulatory knowledge includes understanding oil and gas regulations and managing compliance with safety and environmental standards. Emergency preparedness involves planning for various scenarios and conducting drills, emphasizing a strong safety culture within the industry to protect workers and prevent environmental harm.

Inland Water Transport:

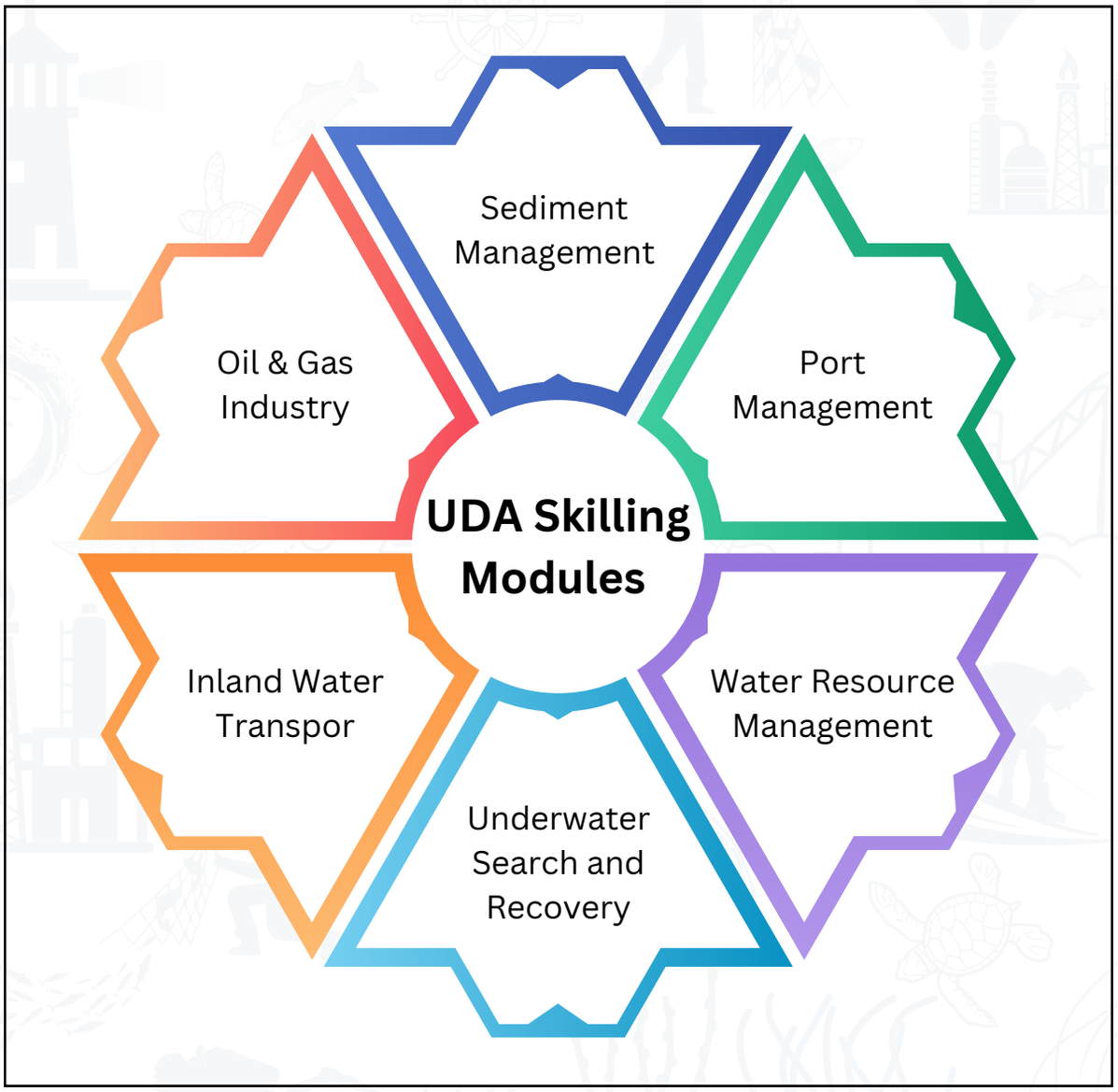
Professionals in inland water transport must possess a multifaceted skill set to ensure safe, efficient, and environmentally responsible operations. Navigational safety demands proficiency in underwater navigation techniques, utilization of navigation equipment, and collision avoidance strategies. Environmental impact assessment skills involve navigating environmental regulations, assessing the impact on water quality and ecosystems, and implementing mitigation plans. Security aspects require expertise in developing protocols, threat assessment, and providing security training to personnel. Planning and optimizing the use of inland waterways for various activities, including cargo and passenger transportation, necessitate skills in multimodal transportation, resource allocation, and infrastructure planning. Regulatory knowledge includes understanding and managing compliance with inland water transport regulations. Emergency preparedness involves developing response plans and conducting drills for accidents, environmental incidents, and security threats. Additionally, data analysis and planning skills are essential for collecting and analyzing data, optimizing transportation routes, and ensuring overall efficiency.

Water Resource Management:

Water resource management requires a comprehensive skill set spanning various domains. Capacity building for storage dams necessitates expertise in dam engineering principles, safety protocols, and the implementation of monitoring systems. Ensuring the effectiveness of recharge systems demands an understanding of groundwater recharge techniques, hydrogeology, and sustainable recharge strategies. Implementing an effective de-siltation plan involves managing sedimentation, proficiency in dredging techniques, and conducting environmental impact assessments. Prevention of siltation requires knowledge of erosion control methods, land use planning, and watershed management. Regulatory compliance involves familiarity with water laws, permitting processes, and adherence to regulatory requirements. Environmental conservation requires the ability to assess ecological impacts, develop conservation plans, and engage in community outreach. Lastly, data analysis and monitoring skills are crucial for collecting and analyzing data on sedimentation rates, groundwater levels, and dam performance, facilitating informed decision-making in water resource management initiatives.

Underwater Search and Recovery:

Underwater Search and Recovery demands a multifaceted skill set across diverse applications. Proficiency in sonar technology is essential for navigation, collision avoidance, and mapping in the shipping industry, with expertise in data analysis for emergency response scenarios. Acoustic surveys for underwater mining require knowledge of mineral resource assessment, mining equipment operation guided by surveys, and environmental impact assessment. Hydrographic surveys involve expertise in charting, harbor maintenance, and infrastructure planning using multibeam sonar, GIS, and data management. Acoustic habitat degradation monitoring necessitates skills in ecosystem monitoring, compliance with environmental policies, and the development of mitigation strategies. Cross-cutting skills include adherence to safety protocols, effective communication, staying updated on technology advancements, and knowledge of legal and regulatory compliance in underwater activities and acoustic surveys. These skills collectively ensure effective underwater search and recovery operations while prioritizing safety, environmental conservation, and compliance with regulations.



Enclosure 5: Job Mapping

As technology continues to advance, the demand for skilled professionals in these fields is likely to grow, making UDA a promising area for career development. It is essential to delineate the roles and responsibilities within the workforce dedicated to underwater operations.

Firstly, technicians play a pivotal role in the management of various instrumentation. Their core responsibilities encompass the operation, maintenance, and repair of crucial equipment like sonars utilized in acoustic surveys, as well as other instrumental devices employed for data collection and sample retrieval. These skilled individuals ensure the proper functioning and upkeep of these intricate tools, contributing significantly to the overall success of Maritime Research and activities.

Secondly, the role of data and sample loggers is of paramount importance in the seamless handling and storage of collected data and samples. These professionals are tasked with the meticulous collection of data and samples, thereafter organizing and storing them in a format that ensures both accessibility and efficiency during subsequent processing phases. Their diligent efforts contribute to the optimization of data analysis and research outcomes.

Lastly, deployment specialists play a unique and critical role in the underwater sector. Their primary responsibility revolves around the strategic deployment of instrumentation and sample collection platforms within water bodies, each of which presents distinct challenges and safety concerns. Given the complexities and hazards inherent to underwater environments, these specialists are often skilled divers with specialized training. Their expertise is indispensable in ensuring the safe and effective deployment of instrumentation and platforms, thereby facilitating comprehensive data collection and sample retrieval in marine and aquatic contexts.

The underwater sector's workforce can indeed be divided into two broad categories to ensure effective operations and community involvement:

(a) Young Professionals with Higher Education:

1. Data Analysts and Scientists: Professionals with degrees in marine biology, environmental science, geology, oceanography, or related fields who can conduct research, analyze data, and contribute to the sector's scientific knowledge.

2. Engineers and Technologists: Individuals with engineering degrees (e.g., marine engineering, mechanical engineering) who can design and maintain specialized equipment used in underwater activities.

3. Regulatory and Policy Experts: Those with legal and policy backgrounds who can ensure compliance with underwater regulations and contribute to the development of policies that promote sustainable practices.

4. Environmental Impact Assessment Specialists: Experts in assessing the environmental effects of underwater activities, ensuring compliance with environmental regulations, and suggesting mitigation measures.

5. IT and Data Management Professionals: IT experts who can manage data collection, analysis, and storage systems, ensuring the secure and efficient handling of underwater data.

6. Underwater Security Personnel: Trained security professionals responsible for safeguarding underwater assets and ensuring the safety of underwater operations.

(b) Local Community Youth:

1. Instrumentation and Sample Collection Technicians: Local community members can be trained to operate specialized equipment and collect samples from water bodies. Their familiarity with the local environment is a valuable asset.

2. Traditional Knowledge Keepers: Indigenous and local knowledge holders can play a crucial role in preserving traditional practices and sharing insights that enhance the sustainability of underwater activities.

3. Community Liaison Officers: Individuals who bridge the gap between the local community and underwater organizations, facilitating cooperation and addressing community concerns.

4. Environmental Stewards: Local youth can be engaged in environmental conservation efforts, including beach cleanup initiatives and biodiversity monitoring, contributing to both socio-economic development and ecological preservation.

5. Tourism and Hospitality Professionals: In regions with a significant underwater tourism industry, local youth can work in tourism-related roles, such as tour guides, hospitality staff, and boat operators.

6. Skilled Tradespeople: Local communities may benefit from training programs that equip youth with skills in welding, shipbuilding, or other trades relevant to the underwater sector.

Efforts to involve the local community not only enhance socio-economic development but also foster a sense of ownership and responsibility for the sustainable use of underwater resources. This dual workforce approach can lead to a more inclusive and sustainable underwater sector.


Job Mapping
Young Professionals with Higher Education
Data Analysts and Scientists
Engineers and Technologists
Regulatory and Policy Experts
Environmental Impact Assessment Specialists
IT and Data Management Professionals
Underwater Security Personnel
Local Community Youth
Instrumentation & Sample Collection Technicians
Traditional Knowledge Keepers
Community Liaison Officers
Environmental Stewards
Tourism and Hospitality Professionals
Skilled Tradespeople

BVoc Programs in Underwater Specializations:

(a) Acoustic Survey:

Job opportunities for individuals with a Bachelor of Vocation (BVoc) in Acoustic Survey:

Professionals in the field of underwater acoustics take on various roles, such as Underwater Acoustic Surveyors who conduct surveys using acoustic technologies to create detailed maps and reports. Marine Environmental Consultants assess the impact of human activities on marine ecosystems, offering recommendations for sustainable practices. Hydrographic Surveyors map the seafloor and underwater structures, collaborating with government agencies or research institutions. Oceanographers explore and analyze underwater acoustics to understand ocean currents and marine life. Marine Geophysicists study the geological characteristics of the seafloor. Underwater Archaeologists use acoustic survey techniques to locate and map underwater archaeological sites. Remote Sensing Specialists use acoustic remote sensing technologies for monitoring underwater environments. Fisheries Acoustic Scientists study fish populations for sustainable fisheries management. Underwater Robotics Technicians operate and maintain underwater robotic systems equipped with acoustic sensors. Marine Resource Management Officers monitor acoustic data related to biodiversity and collaborate with government agencies or environmental organizations for effective resource management.

(b) Underwater Biotechnology:

Individuals with a Bachelor of Vocation (Bvoc) in Underwater Biotechnology have diverse career opportunities in this innovative field. As Underwater Biotechnologists, they research and apply biotechnological techniques for underwater environments, developing methods for marine organism cultivation and bioprospecting. Marine Biotechnology Researchers investigate marine organisms for potential applications, contributing to the development of new products. Aquatic Biotechnology Technicians operate and maintain equipment, assisting in experiments related to underwater biotechnology. Bioprospecting Specialists identify and study marine organisms for genetic and biochemical potential, exploring applications in pharmaceuticals and other industries. Marine Geneticists study the genetic makeup of marine organisms, contributing to understanding biodiversity. Aquaculture Technologists apply biotechnological methods to improve practices for sustainable production. Environmental Biotechnicians address challenges in underwater ecosystems using biotechnological solutions, focusing on pollution remediation and restoration. Underwater Bioprocessing Engineers design techniques for biofiltration, bioremediation, and waste treatment. Marine Conservation Scientists use biotechnological tools for biodiversity conservation and sustainable resource management. Biological Oceanographers study interactions between marine organisms and their environment, employing biotechnological methods to explore microbial communities. Underwater Biotechnology Educators teach principles and applications, working in academic institutions or outreach programs. Biotechnology Product Development Specialists contribute to developing products for underwater industries, collaborating with companies involved in technology and exploration.

(c) AI and Robotics:

Individuals with a Bachelor of Vocation (Bvoc) in Artificial Intelligence (AI) and Robotics in the maritime sector have a wide array of career paths. They can become Maritime Robotics Engineers, designing and maintaining robotic systems for applications like autonomous underwater vehicles and remotely operated vehicles. Autonomous Systems Specialists focus on implementing AI algorithms to enhance unmanned maritime vehicles' intelligence and decision-making capabilities. Marine Data Analysts use AI and machine learning to extract valuable insights from large datasets collected during maritime operations. Robotics Technicians troubleshoot and maintain AI-driven robotic systems in maritime environments. Maritime AI Researchers engage in projects to advance AI applications in navigation, communication, and decision support. Underwater AI Specialists develop AI models tailored for underwater environments, improving the capabilities of underwater robots. Maritime System Integrators integrate AI and robotics technologies into existing maritime systems, ensuring seamless communication. Remote Sensing Analysts use AI to interpret remote sensing data for maritime monitoring, covering environmental changes and security issues. Maritime Cybersecurity Analysts focus on securing AI-driven maritime systems from cyber threats. AI Consultants for Maritime Companies provide insights and guidance on adopting AI and robotics in operations. Maritime Automation Specialists work on automating processes within the industry for increased efficiency. AI and Robotics Instructors/Trainers educate and train individuals in the maritime sector on applications through workshops and training sessions.

PG Programs in Underwater Specializations:

(a) Digital Transformation in the Underwater Domain: This module delves into the integration of digital technologies within underwater operations, equipping students with the tools to navigate and harness the power of digital transformation in underwater contexts.

A Postgraduate (PG) degree in Digital Transformation in the Underwater Domain offers a range of career opportunities at the intersection of digital technologies and underwater applications. Graduates can become Digital Transformation Specialists, leading and implementing initiatives to advance technology and processes. Underwater Data Scientists apply data analytics and machine learning to derive insights from underwater data, enhancing decision-making. Marine Technology Consultants provide expertise on digital strategies to improve efficiency in underwater technology companies. Underwater Communication Systems Engineers design and optimize communication systems using digital technologies. Digital Innovation Managers (Underwater) spearhead projects driving technological advancements in underwater operations. Underwater Cybersecurity Analysts specialize in securing digital systems within the underwater domain. Underwater IoT Specialists develop and implement Internet of Things solutions for underwater applications. Underwater GIS Analysts use GIS technology for mapping and analyzing underwater environments. Digital Twin Engineers (Underwater Systems) create digital replicas for simulation and analysis. Underwater Robotics Programmers control robotic systems using digital solutions. Underwater Infrastructure Managers oversee digital infrastructure for underwater facilities. Underwater Remote Sensing Specialists use digital tools for monitoring underwater ecosystems. Underwater Digital Archivists manage digital archives related to underwater research and exploration.

Underwater Project Managers (Digital Initiatives) coordinate and oversee digital transformation projects. Underwater Environmental Data Analysts analyze digital data for marine conservation and sustainability initiatives. These roles encompass a diverse range of responsibilities, combining digital expertise with a focus on advancing underwater technologies and practices.

(b) Sediment Management: Students explore the intricacies of sediment control and management in aquatic environments, focusing on strategies to preserve water quality and ecological balance.

Individuals with a Postgraduate (PG) degree in Sediment Management, particularly in the maritime sector, have a range of career opportunities. They can become Port Environmental Managers overseeing sediment management in ports for safe navigation and water quality. Marine Environmental Consultants provide expert advice on sediment-related environmental issues and conduct impact assessments. Dredging Operations Managers manage dredging activities and sediment disposal in compliance with regulations. Coastal Zone Managers focus on sediment dynamics along coastlines, addressing erosion and sedimentation. Maritime Geoscientists study sedimentary processes in marine environments for geological assessments. Marine Surveyors (Sediment Analysis) conduct surveys to assess sediment composition and distribution, ensuring regulatory compliance. Marine Environmental Scientists research sediment impacts on marine ecosystems and develop preservation strategies. Harbor Masters monitor sedimentation, coordinate dredging, and ensure safe navigation. Marine Infrastructure Engineers design sediment control measures for maritime projects. Offshore Sediment Management Specialists address sediment challenges around offshore oil and gas platforms. Maritime Policy Analysts (Environmental Compliance) analyze policies related to sediment management and ensure compliance with environmental standards. Marine Conservation Planners develop conservation plans considering sediment impacts on habitats. Hydrographic Surveyors map the seafloor and assess sediment characteristics for navigation safety. Marine GIS Specialists (Sediment Mapping) use GIS technology for mapping and analyzing sediment distribution. Marine Research Scientists (Sediment Dynamics) conduct scientific research on sediment movement in marine ecosystems, contributing to marine science advancements. These roles cover a broad spectrum, from managing sediment in ports to conducting scientific research on sediment dynamics, highlighting the diverse career paths available in sediment management within the maritime sector.

(c) Freshwater Management: This module offers expertise in the management of freshwater resources, emphasizing sustainable practices and the conservation of freshwater ecosystems.

Individuals with a Postgraduate (PG) degree in Freshwater Management have a diverse array of rewarding career opportunities. They can become Water Resource Managers, overseeing the sustainable use and management of freshwater resources and developing strategies to address water scarcity. Hydrologists study the distribution and movement of freshwater, contributing to projects related to water availability and watershed management. Water Quality Analysts monitor and assess the quality of freshwater sources, implementing measures for improvement. Environmental Consultants with a freshwater focus provide expertise on ecosystems and advise on sustainable practices. Wetland Conservation Specialists focus on preserving and restoring wetland ecosystems. Aquatic Ecologists study freshwater ecosystems, contributing to conservation and restoration projects. Water Policy Analysts analyze and develop policies related to freshwater management.

Irrigation Specialists design efficient irrigation systems for agriculture. Groundwater Specialists study and manage groundwater resources for sustainability. River Basin Planners develop integrated management plans addressing flood control, water supply, and ecosystem health. Water Conservation Officers promote water-saving initiatives in communities. Freshwater Biologists conduct research on organisms and contribute to biodiversity conservation. Urban Water Management Specialists plan and implement water strategies in urban areas. Dam Safety Engineers monitor and assess the safety of dams and reservoirs. Environmental Educators (Water Conservation) raise awareness and develop educational programs. Water Infrastructure Planners design projects for sustainable water supply. Limnologists study freshwater lakes and ponds, contributing to freshwater ecosystem research. GIS Specialists (Water Mapping) use GIS for analyzing freshwater resources. Water Treatment Plant Managers oversee the operation of treatment facilities. Research Scientists (Freshwater Dynamics) conduct scientific research, contributing to advancements in freshwater science. These roles cover a wide spectrum, from managing water resources to conducting scientific research, highlighting the diverse and impactful career paths in freshwater management.

(d) Aquaculture & Fisheries Management: With a focus on aquaculture and fisheries, this module covers sustainable practices, production management, and the responsible stewardship of aquatic resources.

Individuals with a Postgraduate (PG) degree in Aquaculture & Fisheries Management have diverse career opportunities in the aquaculture and fisheries sectors. They can become Aquaculture Farm Managers, overseeing daily operations and managing fish and shellfish production. Fisheries Biologists conduct research on fish populations, contributing to sustainable fisheries management. Aquaculture Research Scientists engage in scientific research to improve practices and explore innovative technologies. Fish Health Specialists monitor and maintain fish health, implementing disease prevention measures. Fisheries Officers enforce regulations related to fishing and aquaculture for sustainable practices. Aquaculture Extension Officers provide education and outreach to farmers, disseminating information on best practices. Hatchery Managers oversee fish hatcheries for breeding and raising fish larvae. Fisheries Economists analyze economic aspects and contribute to policy recommendations. Aquaculture Nutritionists formulate nutrition plans for farmed fish, optimizing feed formulations. Fisheries Ecologists study ecological relationships within fish populations for conservation efforts. Aquaculture Consultants offer expert advice and assistance to businesses. Sustainable Fisheries Managers develop and implement strategies for sustainable fisheries. Seafood Quality Assurance Managers ensure the quality and safety of seafood products. Fish Processing Plant Managers oversee processing and compliance with standards. Aquaculture Technology Developers research and innovate technologies for improved practices. Fisheries Extension Specialists provide services and facilitate training programs for fishing communities. Aquaculture Operations Analysts analyze data for improving operational processes. Marine Biologists (Aquatic Ecology) study aquatic environments, contributing to conservation and habitat restoration. Aquaponics Specialists develop integrated aquaculture and hydroponics systems. Fisheries Policy Analysts analyze and develop policies related to fisheries management. These roles encompass a broad spectrum, reflecting the diverse and impactful career paths available in aquaculture and fisheries management.

(e) Inland Water Transport (IWT) Management: Centered on inland waterways, this module delves into transportation logistics, infrastructure management, and regulatory aspects specific to inland water transport.

Individuals with a Postgraduate (PG) degree in Inland Water Transport (IWT) Management have diverse career opportunities in the field. They can become IWT Operations Managers, overseeing day-to-day operations for efficient and safe transportation. Port Managers manage inland water ports, coordinating logistics activities. IWT Infrastructure Planners contribute to infrastructure projects and the development of waterway routes. Waterway Maintenance Engineers supervise maintenance and dredging activities to ensure navigability. IWT Safety Inspectors conduct safety inspections and enforce regulations. Logistics Coordinators optimize the movement of goods through inland water transport. Environmental Compliance Specialists ensure compliance with environmental regulations and implement impact-reducing measures. IWT Project Managers manage and coordinate infrastructure development projects. Water Resources Planners manage water resources for sustainability. IWT Research Analysts provide insights for policy development and strategic planning. IWT Policy Advisors contribute expertise to policy matters and regulations. Freight Brokers facilitate goods transportation through inland water routes. IWT Marketing Specialists develop strategies to promote waterway transportation. Training and Development Managers create training programs for IWT professionals. Community Engagement Coordinators address community concerns related to IWT projects. IWT Technology Integration Specialists explore and implement technology solutions for efficiency. IWT Financial Analysts analyze financial aspects of projects and operations. IWT Legal Advisors provide legal counsel and ensure compliance with maritime laws. IWT Data Analysts analyze data for optimization and decision-making. Government Affairs Specialists engage with government agencies to advocate for IWT policies and monitor regulatory developments. These roles showcase the diverse and impactful career paths available in the Inland Water Transport sector.

(f) Strategic Security Management: Students explore underwater security strategies and practices, preparing for roles involving the safeguarding of underwater assets and operations.

Individuals with a Postgraduate (PG) degree in Strategic Security Management can explore diverse career opportunities across various sectors. They can become Security Analysts, analyzing threats and developing strategies to enhance organizational security. Security Managers oversee the implementation of security measures and manage personnel and resources. Cybersecurity Consultants provide expertise in protecting digital assets and develop cybersecurity policies. Security Risk Assessors evaluate risks and recommend mitigation strategies. Intelligence Analysts collect and interpret intelligence data to support decision-making. Emergency Management Specialists plan and coordinate responses to security emergencies. Physical Security Specialists design and implement physical security systems. Corporate Security Managers manage security programs in corporate settings. Security Consultants offer specialized advice and conduct security audits. Counterterrorism Analysts assess threats related to terrorism and work with law enforcement. Security Operations Center (SOC) Managers oversee SOC operations and respond to incidents. Information Security Managers manage an organization's information security program and ensure compliance with regulations. National Security Policy Analysts analyze and contribute to national security policies. Security Clearance Investigators conduct background investigations for clearances.

Critical Infrastructure Protection Specialists assess and enhance infrastructure security. Security Education and Training Coordinators develop and deliver training programs for security personnel. Security Technology Analysts evaluate and implement security technologies. Government Security Officers work within government agencies to ensure security and develop policies. Security Compliance Managers ensure compliance with regulations and standards. Disaster Recovery Specialists plan and implement strategies for business continuity. Security Information and Event Management (SIEM) Analysts monitor and analyze security events using SIEM tools. These roles demonstrate the diverse and crucial career paths available in the field of Strategic Security Management.

(g) Underwater Archaeology: This captivating module introduces students to the world of underwater archaeology, equipping them with the skills to investigate and preserve underwater historical sites and artifacts.

Individuals with a Postgraduate (PG) degree in Underwater Archaeology have diverse and exciting career opportunities combining history, archaeology, and underwater exploration. They can become Maritime Archaeologists, conducting underwater surveys and excavations. Underwater Cultural Heritage Specialists assess and manage submerged cultural heritage sites, contributing to conservation projects. Museum Curators (Maritime Collections) curate and manage artifact collections, developing exhibitions related to underwater archaeology. Historical Divers engage in underwater exploration to discover artifacts, participating in archaeological dives and surveys. Researchers in Maritime History conduct academic research, publishing findings and presenting at conferences. Heritage Consultants provide expertise on underwater heritage preservation and collaborate with various organizations. Educators/Professors in Archaeology teach underwater archaeology courses and mentor students in research projects. Archaeological Project Managers coordinate and oversee underwater archaeological projects, including fieldwork and budgeting. Dive Archaeologists conduct excavations while diving and recover artifacts from underwater sites. Cultural Resource Managers work with government agencies to manage cultural resources and ensure compliance with preservation laws. Conservators (Maritime Artifacts) preserve and restore underwater artifacts using specialized techniques. Archaeological Illustrators create visual representations of underwater finds for research publications. Environmental Impact Assessment Specialists assess the impact of development projects on underwater cultural heritage and provide preservation recommendations. Archaeological Site Managers oversee logistics and operations at underwater archaeological sites, coordinating with divers and researchers. Remote Sensing Specialists use technologies to identify and map underwater archaeological sites, analyzing data for potential excavation sites. GIS Specialists (Geographic Information Systems) use GIS tools to map and analyze underwater archaeological data. Underwater Surveyors conduct surveys of underwater landscapes and archaeological sites using advanced equipment. Documentary Filmmakers (Maritime Archaeology) create documentaries showcasing underwater discoveries and collaborate with production teams. Archaeological Outreach Coordinators engage with the public through outreach programs, organizing events and exhibitions. Archaeological Technicians assist in fieldwork, artifact recovery, and documentation under the supervision of senior archaeologists. These roles highlight the diverse and fascinating career paths available in the field of Underwater Archaeology.

(h) Marine Spatial Planning: This module imparts knowledge and techniques related to the planning and management of marine spaces, encompassing aspects such as conservation, resource utilization, and spatial optimization.

Individuals with a Postgraduate (PG) degree in Marine Spatial Planning have diverse and rewarding career opportunities. They can work as Marine Spatial Planners, developing and implementing plans to optimize marine resource use while considering ecological, economic, and social factors. Environmental Consultants assess the environmental impact of maritime projects and provide recommendations for sustainable development. GIS Specialists (Geographic Information Systems) analyze and map marine spatial data, contributing to decision-making for coastal and marine management. Coastal Zone Managers oversee activities in coastal areas, focusing on land use, conservation, and sustainable development. Policy Analysts (Marine Affairs) analyze and develop policies for marine spatial planning and regulatory frameworks. Research Scientists in Marine Ecology contribute to understanding ecological patterns in marine environments through research on ecosystems and biodiversity. Oceanographers study physical, chemical, and biological aspects of oceans, informing marine spatial planning and conservation efforts. Urban Planners (Coastal Development) integrate sustainable practices into the planning and design of coastal urban areas. Aquaculture Planners manage areas for sustainable aquaculture development, ensuring compliance with marine spatial plans. Fisheries Management Specialists develop strategies for sustainable fisheries management and collaborate with stakeholders to balance fishing activities and conservation. Marine Resource Economists assess the economic value of marine resources, providing insights for decision-makers. Maritime Infrastructure Planners design and implement projects in alignment with marine spatial plans and environmental considerations. Coastal Engineers plan engineering projects along coastlines, minimizing environmental impact in line with marine spatial plans. Climate Change Analysts (Marine) analyze climate change impacts on marine ecosystems and contribute to adaptation and mitigation strategies. Tourism Development Planners (Coastal Areas) plan sustainable tourism development, considering marine spatial plans to minimize negative impacts. Remote Sensing Specialists (Marine) use technologies to collect and analyze marine spatial data for mapping and monitoring. Marine Conservation Officers develop and implement conservation programs for marine habitats, promoting sustainable practices. Port and Harbor Planners design ports and harbors considering marine spatial plans for efficient and sustainable use. Environmental Impact Assessment (EIA) Specialists assess project impacts, ensuring compliance with marine spatial plans. Marine Education and Outreach Coordinators engage communities, raise awareness about marine spatial planning, and organize educational programs. These roles highlight the diverse opportunities for individuals with expertise in Marine Spatial Planning.

(i) Climate Change Risk Management: Students delve into the impact of climate change on underwater environments and gain insights into risk mitigation strategies and adaptation measures.

Individuals with a Postgraduate (PG) degree in Climate Change Risk Management have diverse career opportunities. They can work as Climate Change Analysts, assessing climate change data and providing recommendations for mitigation and adaptation strategies. Sustainability Consultants advise organizations on sustainable practices and assist in developing sustainability plans. Environmental Policy Analysts contribute to policy development related to climate change and environmental protection.

Climate Resilience Planners develop and implement strategies to enhance community and infrastructure resilience. Renewable Energy Analysts assess the impact of climate change on renewable energy projects and contribute to sustainable energy solutions. Climate Change Adaptation Specialists work on adaptation plans for ecosystems and communities. Risk Management Analysts assess climate-related risks and develop strategies for businesses and communities. Environmental Impact Assessment (EIA) Specialists evaluate project impacts in the context of climate change. Natural Resource Managers conserve resources considering climate change impacts and develop sustainable use strategies. Climate Data Scientists analyze large sets of climate data to identify patterns and trends, developing models for climate change projections. Corporate Sustainability Managers oversee sustainability initiatives in a corporate setting, addressing climate-related risks. Community Engagement Coordinators work with communities to raise awareness of climate change risks and facilitate resilience projects. Disaster Risk Reduction Specialists develop strategies to reduce the impact of climate-related disasters. Climate Finance Analysts analyze financial risks and opportunities associated with climate change, contributing to climate financing mechanisms. Urban Climate Planners integrate climate resilience into urban development projects. Biodiversity Conservation Officers develop conservation plans considering climate change effects on biodiversity.

Renewable Energy Policy Analysts contribute to policies supporting renewable energy adoption and consider climate change impacts on energy policy. Climate Change Education Coordinators develop educational programs on climate change and coordinate outreach initiatives. Climate Communication Specialists develop strategies to convey climate change risks to the public. Research Scientists in Climate Change conduct scientific research on climate change processes, contributing to the understanding of climate science. These roles showcase the varied opportunities available for individuals with expertise in Climate Change Risk Management.

(j) Sustainable Development Goals: Engaging with global sustainability goals, students learn how to apply these principles to underwater practices, contributing to a more sustainable underwater domain.

Individuals holding a Postgraduate (PG) degree in Sustainable Development Goals (SDGs) can discover opportunities within the maritime sector that closely align with principles of sustainability, environmental management, and international maritime regulations. Although the sector may lack explicitly labeled SDGs positions, potential roles include Environmental Compliance Specialist, Marine Environmental Scientist, Sustainability Analyst for Shipping Companies, Maritime Policy Analyst (Sustainability), Marine Conservation Coordinator, Port Sustainability Manager, Climate Change and Resilience Planner, Maritime Risk and Compliance Officer, Maritime Education and Training Coordinator (Sustainability Focus), Maritime NGO Program Manager, Sustainable Fisheries Manager, Maritime Renewable Energy Specialist, Maritime Environmental Impact Assessor, International Maritime Regulation Analyst, and Maritime Corporate Social Responsibility (CSR) Coordinator. These positions involve ensuring compliance with environmental standards, conducting research on environmental impacts, promoting sustainability in shipping, analyzing policies for sustainability, coordinating marine conservation projects, overseeing sustainability at ports, planning for climate resilience, managing risks and compliance, providing education on sustainability, contributing to NGOs focused on maritime sustainability, managing sustainable fisheries, exploring renewable energy solutions, assessing environmental impacts, analyzing international regulations, and implementing CSR programs aligned with social and environmental sustainability goals.

Enclosure 6: Grade Mapping

Generally, employees are classified into different grades based on their experience and expertise in various roles within the organization. Starting at the Associate level (AS1 to AS3), individuals undergo training and progressively take on more responsibilities as Trainees, Assistants, and eventually become full-fledged Technicians, Data Analysts, or Research Staff. Moving up the hierarchy, Senior Associates (SA1 and SA2) take on senior roles with supervisory responsibilities, overseeing operations and leading teams of Data Analysts and Research Fellows. Middle Management (MM1 and MM2) positions involve managerial roles, with individuals responsible for operations, data science, and scientific research. Finally, in the top-tier Management (SM) level, Senior Managers oversee high-level operations and research centers, while Principal Data Scientists and Senior Managers in Research Centers lead the organization's data science and research initiatives. This structured categorization system allows for career progression and specialization within the organization. (Table (1))

Category	Grade	Technician	Data Analyst	Research Staff
Associate	AS1	Trainee Technician / Trainee Data Storage / Trainee Field Deployment	Trainee - Data Engineer	Trainee Research Fellow
	AS2	Assistant Technician / Assistant Data Storage / Assistant Field Deployment	Assistant - Data Engineer	Assistant-Research Fellow
	AS3	Technician / Data Storage Executive / Field Deployment Executive	Data Analyst	Research Fellow
Senior Associate	SA1	Senior Technician / Senior Data Storage Executive / Senior Field Deployment Executive	Senior Data Analyst	Senior Research Fellow
	SA2	Technical Supervisor / Data Storage Supervisor / Field Deployment Supervisor	Lead Data Analyst	Lead Research Fellow
Middle Management	MM1	Deputy Manager-Operations	Data Scientist	Research Scientist
	MM2	Manager-Operations	Senior Data Scientist	Senior Research Scientist
Management	SM	Senior Manager-Operations	Principal Data Scientist	Senior Manager-Research Center

Table (1) Different Grades for Career Progression Based on Skills and Experience

The organization's career progression framework offers both vertical and horizontal pathways for employees in different educational programs. In the Vertical Progression map, entry-level designations upon completing various courses range from AS1 to AS3. Advancement criteria for vertical progression include a minimum of 3 years of experience after completing a diploma, subject to satisfactory performance records, and successful completion of a Bvoc degree for AS1 to AS3 progression. For higher roles, such as SA1, SA2, and MM1, more experience and additional corporate courses are required. (Table (2))

On the other hand, the Horizontal Progression Map offers opportunities for lateral movement within the organization. Entry-level designations for horizontal progression start at AS1, AS2, or AS3, depending on the candidate's qualifications and experience. The criteria for horizontal progression include a minimum of 3 years of experience after completing a diploma, excellent performance records, successful completion of Bvoc or Bachelor's degree, and selection through an interview process by the department head of the relevant specialization, be it Data Analyst or Research Practice. In case of horizontal movement, the entry grade offered is AS3, ensuring that employees maintain a certain level of expertise and experience as they transition between roles. (Table (2))

	Corporate Programs	Diploma Programs	Bvoc Programs	PG Programs
Vertical Progression Map				
Entry Level Grade / Designation after completing the course		AS1	AS2	AS3
Criteria for Vertical Progression		Min 3 years' experience after diploma+ Subject to satisfactory performance records+ Successful completion of Bvoc Degree	Min 3 years' experience after Bachelor's degree+ Subject to satisfactory performance records+ Successful completion of PG	Min 5 years' experience after Bachelor's degree+ Subject to satisfactory performance records+ Successfully completion of 4 corporate courses
Progression after completing each of the course		SA1	SA2	MM1
Horizontal Progression Map				
Entry Level Grade / Designation after completing the course		AS1	AS2	AS3
Criteria Horizontal Progression		Min 3 years' experience after diploma + Subject to excellent performance records + Successful completion of Bvoc Degree + Selection through Interview process by department head of Data analyst / Research practice	Min 3 years' experience after diploma+ Subject to excellent performance records+ Successful completion of Bvoc/Bachelor Degree+ Selection through Interview process by department head of Research practice	Min 3 years' experience after diploma+ Subject to excellent performance records+ Successful completion of Bvoc / Bachelor Degree+ Selection through Interview process by department head of data analyst practice
Entry Grade offered in case of Horizontal Movement		AS3	AS3	AS3

Table (2) Horizontal and Vertical Career Progression Based on Skills and Experience

Reference

- Profile of Dr. Das in Moving Waters Film Festival, mentioning that he was working on UDA.
- Article by Dr. Arnab Das, in ‘Geopolitics’ mentioning UDA
- Article by Mrs Scharda Dubey on ‘The Wire’ mentioning Dr. Arnab Das and his work on Underwater Domain Awareness
- Underwater Domain Awareness: A New Paradigm for The Indian Ocean Region, Article On Salute
- The Underwater Domain Awareness Framework: Infinite Possibilities in the New Global Era – India Foundation
- Arnab Das and D.S.P Varma, “Ocean Governance in the Indian Ocean Region- An Alternate Perspective”, Underwater Affairs, 2015
- SagarMala - Coastal Community Development Ministry of Shipping, GOI, Government of India
- PM Gati Shakti - National Master Plan for Multi-modal Connectivity| National Portal of India
- Project Mausam | Ministry of Culture, Government of India (indiaculture.gov.in)
- Indian Navy's National Command Control Communication and Intelligence (NC3I) Network | Pakistan Defence
- National AIS implemented in India - Digital Ship - The world leader in underwater IT news (thedigitalship.com)
- National Underwater Domain Awareness Plan (ise.gov)
- Digital India: For digitally empowered society and knowledge economy| National Portal of India
- Indian_Underwater_Security_Strategy_Document_25Jan16.pdf (indiannavy.nic.in)
- Underwater radiated noise: A new perspective in the Indian Ocean region: Underwater Affairs: Journal of the National Underwater Foundation of India: Vol 15, No 1 (tandfonline.com)
- The geopolitical dimension of underwater security, The geopolitical dimension of underwater security - ScienceDirect
- Remote sensing of tropical riverine water quality using sentinel-2 MSI and field observations - ScienceDirect
- (PDF) Tropical Environment (researchgate.net)
- https://mrc.foundationforuda.in/sediment-management-for-uda-framework/
- “INLAND WATER TRANSPORT | Ministry of Ministry of Ports||Shipping and Waterways.” Ministry of Ports and Waterways, shipmin.gov.in/division/iwt-1. Accessed 7 June 2021.

- Freshwater Management. - Maritime Research Center (foundationforuda.in)
- Minnich, Sam. “SEDIMENT REMOVAL 101: WHAT IS DREDGING?” Geo Form International, 27 Sept. 2019, geoforminternational.com/sediment-removal-101.
- ICZM – NCSCM
- Freshwater Resource - an overview | ScienceDirect Topics
- Seawater Desalination | Climate Technology Centre & Network (ctc-n.org)
- Report No. 4 of 2022_CCE_English_PDF-A.pdf (cag.gov.in)
- Fisheries and aquaculture management March 2021 Edition: 1stPublisher: Today and Tomorrow’s Printers and Publishers, New Delhi - 110 002 (India)ISBN: 81-7019-687-3
- https://mrc.foundationforuda.in/collision-avoidance-in-inland-waterways-by-using-ais-data/
- https://mrc.foundationforuda.in/inland-waterways-aids-to-navigation-using-sediment-predicition/
- https://journals.sagepub.com/doi/full/10.1155/2016/2834616
- A network underwater security approach to intelligence sharing in the IOR, Jamal Barnes &Daniel Baldino
- Skilling in India and beyond – A New Perspective Based on the Underwater Domain Awareness (UDA) Framework - UDA Digest (foundationforuda.in)
- Underwater Domain Awareness (UDA) Framework: A New Perspective for Young India - UDA Digest (foundationforuda.in)
- https://mrc.foundationforuda.in/marine-spatial-planning-a-new-perspective-based-on-the-underwater-domain-awareness-uda-framework/
- https://mrc.foundationforuda.in/sdgs-and-the-freshwater-ecosystem/
- “Automatic Identification System (AIS) Data Analysis”

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The Maritime Research Center (MRC) is a think tank dedicated to Underwater Domain Awareness* (UDA).

Focused on acoustic capacity and capability building for the tropical and littoral waters in the Indian Ocean Region, MRC collaborates with stakeholders from Blue Economy, National Security, Marine Environment to Science and Technology.

MRC's Centers of Underwater Excellence molds tangible products, policies and human skills. Towards this, MRC is guided by its holistic UDA framework which has been embraced by stakeholders nationally and globally.

Join us to contribute in making our blue planet more safe, secure, sustainable and effectively explored.

Let’s Collaborate !!

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