

RATAN TATA MAHARASHTRA STATE SKILLS UNIVERSITY

offers

SHORT-TERM, EMPLOYABILITY-ORIENTED TRAINING

DURATION: 8 HRS / DAY



TRAINING OUTCOME REPORT

| | |
|--|--|
| Program Title | Skill Voucher-Based Training Program on Underwater Domain Awareness (UDA) |
| Funded Under | Raising and Accelerating MSME Performance (RAMP) Scheme |
| Work Order / Reference No | RTMSSU/2025-26/HO/MSSIDC/wo/1110 |
| Prepared & Submitted By (Implementing Agency) | Maritime Research Center, Pune |
| Submitted To | Ratan Tata Maharashtra State Skills University (RTMSSU) |
| Address | Maritime Research Center, Indo-Swiss Center of Excellence, Koregaon Bhima, Pune - 412216 |
| Date of Submission | 12/01/2026 |

1. Executive Summary

1.1 Program Summary

The "Skill Voucher-Based Training Program" is a specialized capability-building initiative mandated by the Ratan Tata Maharashtra State Skills University (RTMSSU) under the World Bank-assisted RAMP (Raising and Accelerating MSME Performance) scheme. The Maritime Research Center (MRC) served as the designated Training Partner and Conducting Body for this program, tasked with delivering niche technical expertise in the maritime domain.

This initiative successfully leveraged the administrative and certification framework of the University while utilizing the specific research-driven pedagogy of MRC to address the critical skills gap in the Indian Ocean Region (IOR). The curriculum was uniquely designed to merge biological, chemical, and engineering sciences with the proprietary Underwater Domain Awareness (UDA) Framework. It covered critical intersectional areas, including Aquaculture (Seaweed and Shrimp farming), Underwater Radiated Noise (URN), and Sediment Classification. By introducing concepts like Marine Spatial Planning (MSP) and Disaster Risk Assessment, the program successfully aimed to transform science and engineering graduates into employable professionals capable of understanding the complex interactions between marine biology, acoustic health, and policy frameworks.

1.2 Key Aggregate Statistics Snapshot

Across the six conducted batches (BJS College, MIT, MMCOE, NTTF, VIIT, and VIT), MRC successfully mobilized and trained a total of 300 candidates, fulfilling the target of 300 candidates outlined in the Work Order.

| Metric | Aggregate Details |
|-------------------------------------|--------------------------------------|
| Total Participants | 300 |
| Gender Diversity | Male: 172, Female: 128 |
| Completion Rate | 100% |
| Average Student Satisfaction | ~4.5 / 5.0 |
| Institutions Engaged | 6 (BJS, MIT, MMCOE, NTTF, VIIT, VIT) |

2. Program Context & RAMP Alignment

2.1 Background & Context The tropical waters of the Indian Ocean Region (IOR) present significant opportunities, including rich biodiversity for fisheries, underwater mineral deposits, and vast Inland Waterways for connectivity. Maharashtra alone has over 720 km of coastline with significant blue economy potential. However, traditional methods and technologies imported from the West often fail to perform adequately. Notably, sonars designed in temperate waters suffer up to a 60% degradation in performance when deployed in tropical waters. Thus, indigenous effort is extremely critical to customize these equipments. The Underwater Domain Awareness (UDA) framework, driving digital transformation and Marine Spatial Planning (MSP), is essential for inclusive, secure, and sustainable deployment across stakeholders.

2.2 Alignment with RAMP Objectives This training program is strictly aligned with the World Bank supported RAMP Central Sector Scheme. Specifically, it addresses:

- **RAMP Result Area 2 (Strengthening Firm Capabilities):** Creating a talent pipeline for MSMEs working in defense, shipping, and blue economy sectors.
- **Gender Inclusion:** Encouraging female participation in STEM fields related to maritime engineering.
- **Green Technology:** Promoting sustainable aquaculture and seaweed farming as eco-friendly MSME ventures.
- **Technology Upgradation:** Shifting from traditional fishing methods to data-driven Marine Spatial Planning.
- **Skill Development:** Creating a workforce ready for the "Blue Economy," identified as a high-growth sector by the Government of India.

3. Implementation Methodology & Curriculum

3.1 The 8-Hour Training Model In compliance with the work order mandating a minimum of 8 training hours, the program was structured to deliver highly specialized, interdisciplinary modules. The daily schedule included:

- Basics of Underwater Domain Awareness (UDA) Framework (90 Minutes)
- AI and Data Analytics (60 Minutes)
- Sustainable Blue Economy and Marine Spatial Planning (MSP) (60 Minutes)
- Sediment Management for Connectivity and Flood/Erosion Management (60 Minutes)
- Digital Transformation for Fisheries & Aquaculture (60 Minutes)
- Career and Skill Mapping (90 Minutes)
- Evaluation & Feedback Session (60 Minutes), with assessments containing 10 MCQs on each topic.

3.2 Faculty & Experts

The sessions were delivered by leading maritime and acoustic domain experts, including:

- Dr. (Cdr.) Arnab Das
- Mr. Shridhar Prabhuraman
- Mrs. Catherine J
- Mr. Romit Kaware
- Mr. Shlok Nemani

3.3 Skills & Competency Framework

The curriculum was designed to impart niche technical competencies that are currently scarce in the Indian maritime sector. Participants gained a foundational understanding of Acoustic Capacity Building, learning to analyze how sound propagation changes based on the specific sound velocity profiles of tropical waters. Significant emphasis was placed on Sediment Management, a critical skill for flood control, erosion management, and maintaining connectivity in inland waterways. Furthermore, the students were introduced to the 'UDA Framework' model, for mapping maritime challenges across stakeholders (policy makers, practitioners) and drivers (security, sustainability), enabling them to approach Marine Spatial Planning (MSP) problems with a structured, data-driven mindset.

Comprehensive UDA Skill Matrix: The training program was rigorously structured around the proprietary **Underwater Domain Awareness (UDA) Framework**. To ensure the B.Sc.

Science, Engineering graduates and diploma holders could transition into the maritime sector, the curriculum decomposed the UDA framework into the following fourteen core competency areas:

1. **Basics of Acoustics** Participants were introduced to the fundamental physics of sound in underwater environments. The curriculum covered the principles of sound propagation, reflection, and refraction, providing the necessary scientific baseline for students to understand how acoustic waves interact with the marine medium.
2. **Acoustic Capacity and Capability Building** A major focus was placed on the "Tropical Littoral Challenge," teaching students why standard sonar technologies imported from the West often suffer up to **60% performance degradation** in Indian waters. The session emphasized the critical need for indigenous capacity building to customize acoustic equipment for local temperature and salinity profiles.
3. **Strategic Security and UDA** This module covered the strategic dimensions of the maritime domain, including the detection of sub-surface threats like submarines and underwater vehicles. Students learned how **Sonar Signal Processing** is used for surveillance and how the unique acoustic characteristics of tropical waters impact national security operations.
4. **Sustainable Blue Economy** The training highlighted the economic potential of the ocean while prioritizing ecological balance. Participants learned about the sustainable management of marine resources, including minerals and biological assets, while ensuring the economic activities do not lead to environmental degradation.
5. **Aquaculture Technologies** Tailored to the Zoology and Chemistry background of the cohort; this section focused on high-growth entrepreneurial sectors such as **Shrimp Farming** and **Seaweed Cultivation**. The curriculum covered the biological and chemical parameters required for sustainable yield, presenting aquaculture as a viable livelihood opportunity.
6. **Marine Spatial Planning (MSP)** Students were trained in the **Marine Spatial Planning** framework, a key governance tool for allocating marine space to competing stakeholders. The skill involved learning how to use data to balance economic activities, conservation efforts, and security requirements to prevent conflict and

ensure sustainable resource utilization.

7. **Sediment Management** Addressing environmental risks, this module taught students to classify and manage sediment accumulation. The training linked sediment analysis to flood control and erosion management, providing a practical application for the students' understanding of chemical and physical properties of substrates.
8. **Freshwater Systems (Inland Water Transport)** The curriculum extended UDA concepts to freshwater systems, focusing on the maintenance of **Inland Waterways** for effective connectivity. Students learned about the challenges of siltation and depth maintenance required for efficient movement of goods and people via river systems.
9. **Underwater Radiated Noise (URN) & Bioacoustics** Bridging physics and biology, this competency focused on the impact of noise on marine life. Students learned to analyze how **Underwater Radiated Noise (URN)** affects the communication and migration of marine species, a vital skill for conducting Environmental Impact Assessments (EIA), and monitoring ecosystem health.
10. **Underwater Radiated Noise (URN) & Shipping Radiated Noise Management** This section focused on the **anthropogenic** (man-made) sources of noise, specifically from shipping and industrial activities. Participants were taught methodologies to measure, monitor, and mitigate shipping noise to comply with emerging international environmental standards.
11. **Digital Transformation & AI in Marine Science** Participants were introduced to the application of **Artificial Intelligence (AI)** and **Data Analytics** in the maritime domain. The training emphasized moving beyond manual methods to using automated data processing for identifying acoustic signatures and monitoring marine environments.
12. **Disaster Risk Management (DRM) & Climate Resilience** The training covered the use of UDA for predicting and mitigating geological and climatic disasters. Students learned how acoustic monitoring can serve as an early warning system for events like tsunamis and landslides, contributing to climate-resilient coastal planning.
13. **ESG Integration & Environmental Impact Assessment (EIA)** : A unique aspect of this training was the integration of the ESG (Environmental, Social, and Governance)

framework, teaching students how UDA enables compliance in the Blue Economy. The "**Environmental**" aspect was emphasized by explaining how acoustic data is used to monitor ecological risks like Underwater Radiated Noise (URN) and sediment dispersion. The "**Social**" aspect addressed sustaining coastal livelihoods through aquaculture, while "**Governance**" covered regulatory alignment with UNCLOS. This strengthened participants to conduct specialized EIA beyond traditional methods and include acoustic impact analysis.

14. Maritime Policy, Legal & Governance Frameworks Finally, the curriculum tied technical skills to the regulatory landscape. Students were sensitized to the legal frameworks governing the ocean, including the **Law of the Sea (UNCLOS)**, ensuring they understand the policy environment required to implement UDA projects effectively.

4. Consolidated Participant Demographics

4.1 Aggregate Batch Profile The training program successfully mobilized and trained a total of 300 candidates across six distinct batches, encompassing a diverse range of academic levels from undergraduate science and engineering degrees to technical diplomas.

| Institute Name | Academic Level | Total Students | Male | Female |
|--|------------------------|----------------|------|--------|
| Bharatiya Jain Sanghatana's (BJS) College | Undergraduate (B.Sc) | 61 | 09 | 52 |
| MIT ADT University | Undergraduate (B.Tech) | 46 | 39 | 07 |
| Marathwada Mitra Mandal's College of Engineering (MMCOE) | Undergraduate (B.Tech) | 54 | 27 | 27 |
| Nettur Technical Training Foundation (NTTF) | Diploma | 64 | 44 | 20 |
| Vishwakarma Institute of Information Technology (VIIT) | Undergraduate (B.Tech) | 32 | 26 | 06 |

| | | | | |
|---|------------------------|------------|------------|------------|
| Vishwakarma Institute of Technology (VIT) | Undergraduate (B.Tech) | 43 | 27 | 16 |
| Total Aggregate | | 300 | 172 | 128 |

4.2 Academic Diversity and Background Analysis

The cohorts represented a highly interdisciplinary mix of academic backgrounds, allowing the UDA framework to be applied across multiple domains:

- **Pure Sciences (BJS):** Students specialized in Zoology, Botany, and Chemistry. They possessed a foundational understanding of water chemistry and marine biodiversity.
- **Core Engineering & AI (MIT, MMCOE, VIIT, VIT):** Students specialized in Electronics & Communication (ECE), Artificial Intelligence & Data Science (AIDS), Mechanical Engineering, Civil Engineering, Computer Science, and Instrumentation. They brought foundational knowledge in Digital Signal Processing (DSP), structural integrity, and Machine Learning.
- **Technical Diplomas (NTTF):** Students specialized in Mechatronics, Smart Factory Systems, and Electronics Engineering. They brought expertise in automation, hardware interfacing, and control systems.

5. Batch-wise Execution & Interventions

To effectively deliver the UDA framework, specific pedagogical interventions were tailored to the unique academic backgrounds of each cohort:

5.1 BJS College (Science Cohort)

- **The Challenge:** Students initially viewed marine biology and acoustic technology as separate silos.
- **The Intervention:** Instructors bridged this gap by emphasizing that sound is the only effective medium for communication underwater, as light cannot penetrate deep water. They highlighted the conflict where anthropogenic shipping noise occupies the exact same low-frequency bands used by marine species.
- **The Outcome:** This provided a "Eureka" moment. Zoology students realized that man-made noise is a communication blocker that blinds marine life, transforming acoustic monitoring into an essential tool for marine conservation.

5.2 MIT ADT University (Electronics & Communication Cohort)

- **The Challenge:** Students approached communication with a "Terrestrial Mindset," assuming standard wireless protocols like GPS or Wi-Fi could simply be adapted for underwater use.
- **The Intervention:** Instructors demonstrated the massive attenuation of electromagnetic waves in water and contrasted the stable air channel with the highly volatile underwater acoustic channel. They explained how Sound Speed Profiles (SSP) cause severe signal refraction and multipath fading.
- **The Outcome:** ECE students realized that UDA is a complex Signal Processing and Data Analytics challenge. This shifted their perspective from seeing the ocean as a "hardware problem" to seeing it as a "software and algorithmic challenge".

5.3 NTTF (Mechatronics & Smart Factory Diploma Cohort)

- **The Challenge:** Diploma students entered the program with absolutely no prior understanding of the underwater world or geopolitical sense regarding the Indian Ocean Region (IOR).
- **The Intervention:** Instructors built awareness systematically from the ground up: starting with the absolute physical fundamentals of the marine environment, moving to the geopolitics of the IOR, and finally introducing specific UDA terminology and mechatronic technology.
- **The Outcome:** Students experienced a massive paradigm shift. They understood how their specific skills in Mechatronics and automation fit into the massive geopolitical puzzle of developing indigenous underwater hardware and sensors.

5.4 MMCOE, VIIT, and VIT (Multi-Disciplinary Engineering Cohorts)

- **The Challenge:** Across these engineering colleges, students initially viewed Sonar purely as an off-the-shelf hardware component, completely unaware of the strategic vulnerabilities associated with its deployment in the IOR.
- **The Intervention:** Instructors shifted the focus from basic physics to technology customization and geopolitical realities. They highlighted the critical technical oversight that imported sonars are calibrated for cold, temperate waters and suffer up to 60% degradation in performance in warm, tropical waters.
- **The Outcome:** Engineering students realized that achieving effective UDA requires rigorous indigenous technological adaptation. They recognized a massive entrepreneurial opportunity, learning that their skills are desperately needed to customize, tune, and optimize technologies for local waters to support national security and the Blue Economy.

6. Aggregate Outcome & Impact Analysis (Quarterly Impact Report)

6.1 Learning Outcomes and Perspective Shifts

Post-training assessments across all institutions indicated a profound shift in perspective regarding the application of science and engineering principles in the maritime domain for the 300 candidates:

- **Integration of Disciplines:** Students successfully grasped the critical links between their core subjects—whether Zoology, Mechatronics, or Digital Signal Processing (DSP)—and Underwater Acoustics. They gained an understanding of how signal-to-noise ratios (SNR) are compromised in tropical waters.
- **Practical Application:** Participants demonstrated the ability to conceptualize AI and data-driven models for sediment classification, recognizing the severe limitations of standard terrestrial sensors in shallow water environments.
- **Strategic Awareness:** 100% of the participants reported a newly acquired understanding of the "Tropical Littoral Challenge" and the geopolitical reasons why Western hardware and algorithms frequently fail to perform accurately in the Indian Ocean Region (IOR).

6.2 Industry Relevance & Future Pathways The training program explicitly bridged the critical skills gap in the maritime sector, transforming science and engineering graduates into industry-ready professionals for the emerging Blue Economy and Strategic Security domains. The curriculum directly mapped their existing skills to high-demand job roles such as Underwater Data Scientist, Acoustic Signal Processing Engineer, and Marine Spatial Planning Consultant. Participants have been made aware of immediate employment pathways with defense organizations like DRDO-NSTL and the Indian Coast Guard, infrastructure majors such as L&T Defense and Adani Ports, and research bodies including INCOIS and NIOT.

7. Consolidated Feedback & Satisfaction

7.1 Aggregate Quantitative Feedback Based on the feedback forms collected, the program achieved exceptional satisfaction ratings. Students highly valued the interdisciplinary technical approach and the exposure to niche core engineering and scientific careers beyond standard IT, software, or laboratory roles.

- **Content Relevance:** Achieved scores ranging from 4.4/5 to 4.6/5.

- **Trainer Knowledge:** Achieved scores ranging from 4.5/5 to 4.9/5.
- **Venue & Logistics:** Achieved scores ranging from 4.3/5 to 4.6/5.

7.2 Selected Student Testimonials

The following testimonials represent the cross-disciplinary impact of the UDA training:

- *"This course has opened my mind and gave me a broader vision of underwater marine science. It connected Physics, Chemistry, Zoology, and Biology with AI and machine learning... It showed me the opportunities in this field and the coordination of all sciences."* – Kajal Premchandra Jha, B.Sc
- *"The sessions were very informative. I learned about how underwater domain awareness is important for our country... It was a great experience to learn about the new technologies used in the underwater domain."* – Sakshi Santosh Kadam, B.Tech
- *"Gained a strong understanding of maritime research methodologies and data analysis techniques... Understood the importance of sustainable maritime practices and ocean resource management."* – Saburi Yeola, B.Tech Undergraduate
- *"Understanding underwater environment challenges: Learned how high pressure, limited visibility, corrosion, and biofouling significantly affect underwater systems and design choices."* – Paras Chinchwade, Mechanical Engineering
- *"We should all be more aware of our oceans. An effort should be made in solving problems that are locally existing. We should start manufacturing things in India instead of buying them from other countries."* – Shravani Divate, B.Tech TY CS AIML

8. Challenges, Lessons Learned & Conclusion

8.1 Core Pedagogical Challenges

Across the batches, the primary instructional challenge was overcoming pre-existing academic conditioning:

- **The "Terrestrial Mindset":** Engineering students consistently assumed that standard electromagnetic (EM) wireless protocols could be adapted for underwater use, requiring instructors to aggressively establish that sound is the only viable medium for long-range data transmission.
- **The Geopolitical Blindspot:** Students across disciplines initially viewed sonar as an off-the-shelf hardware component, completely unaware of the strategic vulnerabilities and the 60% degradation in performance of Western sonars deployed in the IOR.

- **Building Baseline Context:** For diploma students, instructors had to build an understanding of the maritime environment and IOR geopolitics completely from scratch before any technical mapping could occur.

8.2 Conclusion

The Skill Voucher-Based Training Program successfully met all defined RAMP objectives. By equipping science, engineering, and diploma graduates with the proprietary UDA Framework, the program has created a unique cadre of professionals capable of addressing Inland Waterways challenges, managing Underwater Noise, and driving Blue Economy entrepreneurship. This cohort is now prepared to contribute to the nation's vision of 'Science-led Development' in the maritime sector.

9. Mandatory Administrative & Financial Compliance

- **Target Fulfillment:** In accordance with the Work Order, the skilling target of 300 candidates has been successfully achieved.
- **Project Cost Alignment:** The training execution complies with the prescribed cost head of Rs. 1,800 per candidate, which encompasses Rs. 500 for candidate mobilization and Rs. 1300 for training, mapped to the candidates.
- **Anti-Corruption Adherence:** The program successfully adhered to the World Bank's Anti-Corruption Guidelines throughout candidate mobilization and program execution, fulfilling the complaints handling reporting requirements.

10. Annexures & Evidence

The following mandatory documents are submitted concurrently with this consolidated report for final review and invoice processing:

- **Annexure A:** Geo-Tagged photographs corresponding to each of the training batches.
- **Annexure B:** Batch-wise Detailed Reports including Student details, Feedback and comments

Annexure A:

Geo-Tagged photographs corresponding to each of the training batches

Batch ID: 118





Batch ID: 117





Batch ID: 196





Batch ID: 197





Batch ID: 198





Batch ID: 304





Annexure B:

Batch-wise Detailed Reports including Student details, Feedback and comments

| Batch ID | User Report | Training Report |
|------------|---|--|
| 117 | <u>RTMSSU - User Portal 117.pdf</u> | <u>MIT Batch 117 - Training Report .pdf</u> |
| 118 | <u>RTMSSU - User Portal 118.pdf</u> | <u>BJS Batch 118 - Training Report.pdf</u> |
| 196 | <u>RTMSSU - User Portal 196.pdf</u> | <u>MMCOE Batch 196 - Training Report.pdf</u> |
| 197 | <u>RTMSSU - User Portal 197.pdf</u> | <u>VIIT Batch 197 - Training Report.pdf</u> |
| 198 | <u>RTMSSU - User Portal 198.pdf</u> | <u>NTTF Batch 198 - Training Report.pdf</u> |
| 304 | <u>RTMSSU - User Portal 304.pdf</u> | <u>VIT Batch 304 - Training Report.pdf</u> |

SCAN ME



www.maritimeresearchcenter.com

Dr. (Cdr) Arnab Das
Founder and Director, MRC

+91-96650-33463

UDA Framework Page

director@maritimeresearchcenter.com

**Address: Maritime Research Center, Koregaon Bhima,
Pune, Maharashtra – 412216**