Marine Research
of the National Academy of Marine Research
ISSN: 2709-6629 (Vol.3 Iss.2)
GPN: 2011200033

DOI: http://dx.doi.org/10.29677/MR.202312_3(2).0004
2023, 3(2), 48-59

Using the IPO Model to Develop a Competency Standard for Remotely Operated Vehicle Supervisors

Pei-Chi Chang [1*] Fu-Man Hsieh [2] Chian-Chi Huang [3]

[1] *Planning and Training Center, National Academy of Marine Research, Taiwan*
[2] *Department of Business Administration, Wenzao Ursuline University of Languages, Taiwan*
[3] *Department of Human Resource Development, National Kaohsiung University of Science and Technology, Taiwan*

ABSTRACT

Operations in the marine environment can be challenging. To mitigate potential hazards, substituting manual labor with a remotely operated vehicles (ROVs) has progressively emerged as a prevailing trend in maritime operations. ROVs have applications in marine industry sectors such as underwater search and surveys, marine ecological investigations, vessel inspections, underwater pipeline and cable installations, and other maritime engineering endeavors. Within the country, there have been extensive research efforts spanning several years dedicated to the technical development of ROVs. However, more attention should be given to the issue of cultivating the required human capital. Skilled professionals form the bedrock of any industry; therefore, it is imperative to address the industry's talent demands by establishing systematic frameworks. Consequently, this study focuses primarily on the establishment of the talent specifications required for the operation of ROVs in the marine environment.

This study is based on the IPO competency development model. It employs analysis methods such as interviews, secondary data analysis, and expert focus group discussions to study the competency analysis of supervisors engaged in ROV operations. Ultimately, it developed a set of competency standards for ROV supervisors. The competency standard includes fundamental occupational information, job content, and competency aspects. It outlines four primary job responsibilities, six work tasks, four work outcomes, 21 behavioral indicators, 16 knowledge items, 19 skills, and seven attitudes. This competency framework can act as a starting point for firms looking to hire the right people. Additionally, it can serve as a foundation for creating competency-based courses tailored to educational institutions or training organizations for the instruction of specialized professionals.

Keywords: Remote operated vehicle (ROV), input-process-output model (IPO), competency, competency standard.

* Corresponding author, e-mail: pamchang@namr.gov.tw

Received 5 September 2023, Accepted 26 September 2023.

1 INTRODUCTION

The seas surrounding Taiwan are rich in marine resources. However, the ocean remains an unpredictable environment for humans. The risks and costs associated with human-led development in oceans are excessively high. Therefore, in the face of the future needs of marine-related industries, such as offshore wind power and national defense, machines and tools will be used to replace labor. In this context, underwater robotics is emerging as the most effective solution.

According to the "Remote Operated Vehicle Market" report by "Transparency Market Research (TMR)" (2020), the global market for offshore autonomous underwater vehicles (AUVs) and remote operated vehicles (ROVs) is projected to witness a remarkable compound annual growth rate (CAGR) of 18.2% in terms of revenue from 2017 to 2025. By 2025, the market value is expected to reach a staggering $9.11701 billion. In Taiwan, ROVs have applications in diverse fields such as marine exploration, underwater energy development, and subsea inspection and maintenance. With the growth of marine-related industries and the government's emphasis on the marine economy, the ROV market is gaining prominence.

The "Estimation of Professional Talent Demand in the Offshore Wind Power Industry for 2021-2023" by the National Development Council (NDC) (2020) mentions that the cultivation of operation and maintenance talents, as well as the integration of intelligent technologies to foster interdisciplinary talents, is essential for the transformative development of the offshore wind power industry. In the current operational environment of offshore wind farms, there is a substantial demand for and emphasis on ROVs. In addition, the International Marine Contractors Association (IMCA), the leading authority in the offshore industry, has established guidelines for commonly used maritime functions in the offshore sector, including ROVs and dynamic positioning operations. However, domestic courses for maritime-related functional training have not been well developed and relevant functions have not yet been established to meet the needs of the industry.

To meet the demands of ocean exploration and sustainable maritime activities, underwater robotics has emerged as a pivotal tool for exploring the depths of the unknown sea, becoming a competitive research and development focus among advanced nations worldwide. In response to international development trends and the needs in the offshore wind power market, coupled with the complexity of underwater operations, this study aims to focus on cultivating interdisciplinary talents through the application of smart technology, with the primary objective of ensuring the safety of offshore operation personnel. Furthermore, the offshore wind power industry is more inclined to accept and frequently utilize ROVs to meet the operational needs of underwater inspections and maintenance nowadays. Therefore, this study primarily explores the competencies of ROVs and establishes a competency standard for ROV supervisors.

2 RESEARCH METHODS AND PROCESS

The "Guidelines for Competency Development and Application Promotion" (Workforce Development Agency, Ministry of Labor, 2022) point out that "Competency" refers to a combination of knowledge, skills, attitudes, or other traits required to accomplish a specific job task or to enhance an individual's and an organization's present and future performance. This study is based on the IPO competency development model (Workforce Development Agency, Ministry of Labor, 2022), divided into three dimensions: Input, Process, and Output. These dimensions are utilized to develop a competency model for supervisors engaged in ROV operations.

In terms of Input, this study is based on the document "Human Resource Demand Analysis for the Operations and Maintenance Phase of the Offshore Wind Power Industry" (2022) and supplemented by

Marine Research of the National Academy of Marine Research
DOI: 10.29677/MR.202312_3(2).0004

interviews with stakeholders in the ROV field. As a result of these sources, the primary focus for development was determined to be the role of "supervisor in ROV operations." The iCAP competency model was adopted as the principal framework throughout the developmental process.

In terms of Process, a competency analysis procedure was implemented, including the execution of competency validation, to produce the final competency model. As ROV operators constitute an emerging profession domestically, while procedural confidentiality is not a concern, the sample size is inherently limited. Coupled with time and budget constraints, this study opted for a combination of secondary data analysis, general interviews/competency interviews, and expert focus group discussions as suitable tools and methods for competency analysis. To enhance the validity of the verification, the triangulation method, involving cross-referencing of secondary data, expert focus group discussions, and expert interviews, was employed. The process of this study is illustrated in Figure 1.

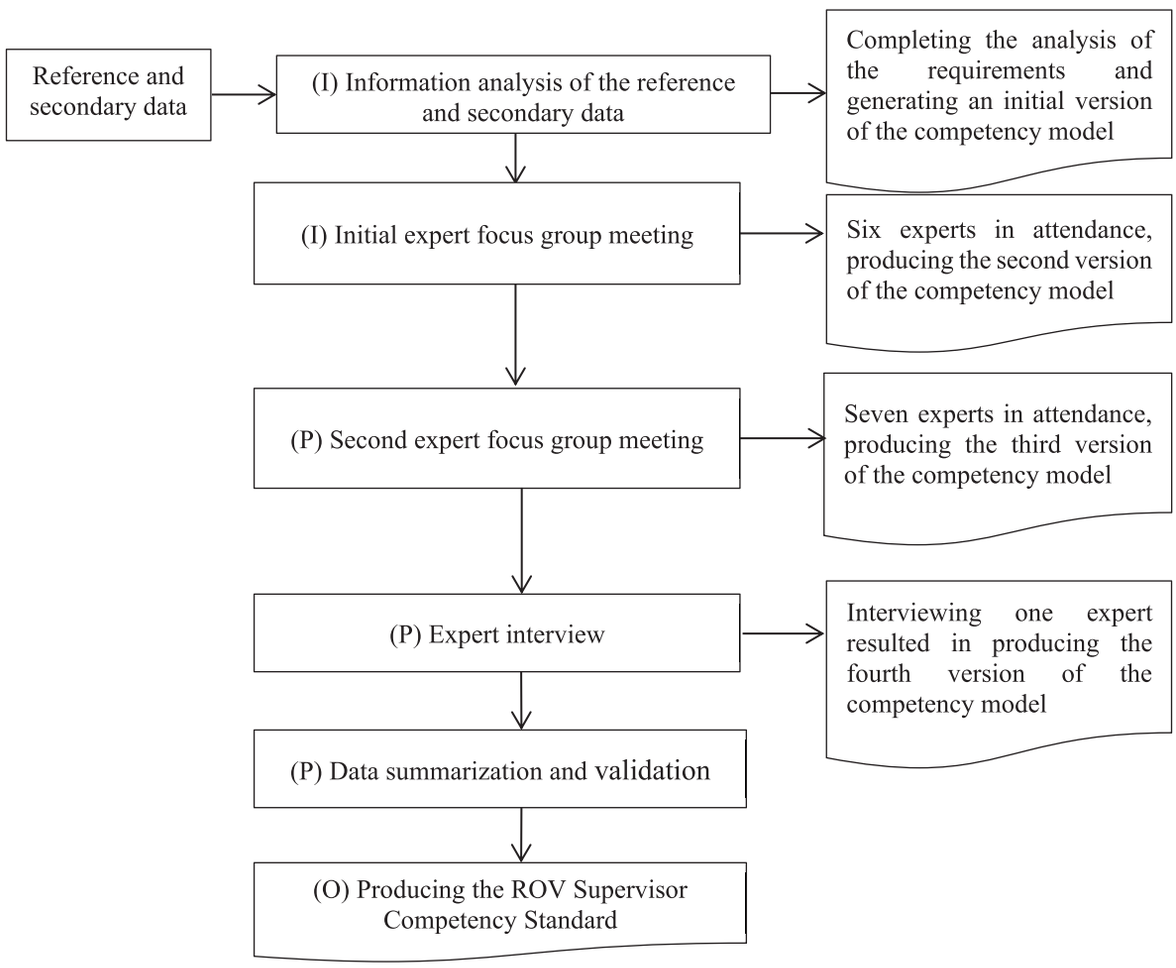

Figure 1. Flowchart of the Study

This study follows the output dimension's competency development and application promotion guidelines. This content specifies that the competency framework for a particular occupation or role should encompass the primary work tasks, behavioral indicators, work outcomes, corresponding knowledges, skills, attitudes, and competency levels. As a result, this study ultimately completed the "ROV Supervisor Competency Standard."

DOI: 10.29677/MR.202312_3(2).0004

3 COMPETENCY ANALYSIS

3.1 Interview Method

In this study's initial phase of competency analysis, open-ended questions were employed for inquiry to comprehend the domestic and international overview of this profession. These questions encompassed various aspects such as the general operation and personnel allocation related to ROV in companies, the tasks that ROV personnel need to carry out, and the essential capabilities required to become an ROV operator. This was to ensure that no details regarding the intended occupation were overlooked. Subsequently, secondary data analysis was conducted based on interview records, information obtained during the interview process, and pertinent reference resources.

This study conducted interviews with a total of three stakeholders. These included the general manager of a parent company based in the UK with 170 years of experience in shipbuilding and relevant operations, providing operation, maintenance, installation, and testing services, among others. Additionally, the chairman of a company, who has long been engaged in the offshore wind power industry, and a director from the first underwater electromechanical equipment and vehicle manufacturer in Taiwan were also interviewed. The summaries of these expert interviews are as follows:

1. Offshore operations incur incredibly high costs for each voyage, and underwater operations are complex. The investment of time and resources in talent cultivation is relatively high. Using ROVs to fulfill underwater inspection, maintenance, and other operational needs is currently an accepted approach in the industry.

2. Compared to AUVs, ROVs offer greater versatility. They can perform light-load operations, such as biological sampling and waste removal, as well as heavy-load operations, including pipeline component replacement, valve switching, and cable arrangement. Under Taiwan's current offshore wind power policies, ROVs are more suitable for underwater operations.

3. In practical ROV operations, domestic and international institutions reference the IMCA standards.

4. Typical offshore wind power ROV teams consist of three main categories of personnel: ROV supervisors, submersible engineers, and pilot technicians. Among these roles, ROV supervisors and pilot technicians are indispensable for ROV observation system operations.

Based on expert recommendations and considering the demand for ROV professionals in Taiwan's current marine industry, the role of the ROV supervisor primarily involves commanding and leading teams. ROV supervisors are a pivotal team figure, so this study focuses on developing the "ROV Supervisor Competency Standard."

3.2 Secondary Data Analysis Method

During the interviews, experts indicated that domestic and international institutions reference the IMCA standards in practical ROV operations. Therefore, in developing competencies for this study, significant emphasis was placed on collecting and compiling competency content using this pivotal secondary data source.

In the "Guidance on Competence Assurance and Assessment-Remote Systems & ROV Division" (IMCA, 2020), nine categories of roles within the ROV domain are identified. These include (1) ROV superintendent, (2) ROV supervisor, (3) ROV tooling supervisor, (4) ROV senior pilot/technician, (5) ROV senior tooling technician, (6) ROV pilot/technician Grade I, (7) ROV tooling technician Grade I, (8) ROV pilot/technician Grade II, and (9) ROV tooling technician Grade II.

Marine Research of the National Academy of Marine Research
DOI: 10.29677/MR.202312_3(2).0004

ROV supervisors play a pivotal role within ROV work teams, shouldering responsibilities such as team leadership, performance management, and overseeing project activities. From the IMCA, an ROV supervisor's competencies encompass five main tasks: (T1) safety, (T2) emergency response, (T3) performance management, (T4) supervisory skills, and (T5) project activities. Additionally, the qualifications required for an ROV supervisor include possession of offshore medical capabilities, completion of an offshore survival course suitable for the geographical area of work, competence equivalent to that of an ROV senior pilot/technician, and a minimum of three months' offshore experience as an ROV senior pilot/technician, accompanied by satisfactory completion of company-assigned tasks (nominal 180 days' offshore expertise).

In addition to consolidating IMCA standards, this study gathered information from the Norwegian Standardization Association (Standard Norway, SN), which establishes standards based on national draft standards, as well as European and international standards, notably the NORSOK standards (NORSOK, 2020). The NORSOK standards are developed based on the national draft, and European and international standards, with over 17,000 active standard specifications. The U-series pertains to subsea standards, and it includes the Remotely Operated Vehicle (ROV) Service (U-120:2020) Standard (NORSOK, 2020). Chapter seven of this standard outlines the competency requirements for ROV-related personnel.

Furthermore, this study also gathered information from the training courses periodically conducted by SubNet Service Ltd., a UK-based competency training institution, regarding ROV training programs. This study also organized the content of the ROV Supervisor Course offered by SubNet (Subnet Service Ltd., 2023). Information regarding ROV supervisor job responsibilities and related details was collated from job postings on the recruitment platform of Subsea7 Maritime Engineering Services Company (Subsea7, 2023). Moreover, guidance on underwater monitoring using ROVs from the Joint Nature Conservation Committee (JNCC, 2018) was consulted to understand the differences in ROV levels used in different water depths.

This study obtained competency requirements for ROV supervisors and relevant information about their required knowledge and skills from the sources. Additionally, the study referenced the content related to competencies and attitudes in the iCAP Competency Development Platform in the country. This information synthesized the primary responsibilities, job tasks, outputs, behavioral indicators, and competency content (knowledge, skills) of the "ROV supervisor" competency model. After confirmation by the study team's decision-making panel, the first version of the competency model was produced.

3.3 Expert Focus Group Method

This study developed an initial version of the competency model by compiling relevant competency data from domestic and international sources. Six representative experts were invited to participate in the first expert focus group meeting to refine this competency model. Using the initial version of the competency model as the basis, the primary purpose of this meeting was to revise the contents of the model, including primary responsibilities, work tasks, work outputs, behavioral indicators, and competency content (knowledge, skills), as well as to confirm attitudes towards competencies and other competency conditions. Based on the discussion outcomes of the meeting and after being approved by the decision-making panel, the second version of the competency model was produced.

The verification meeting that followed invited a total of seven representative experts, mainly from well-known benchmark companies in this industry. As both the ROV market and offshore wind power industry are emerging industries, there are few experts with extensive practical experience in this field domestically. There are also only a few representative companies. In order to focus the discussion on specific topics, there is a high degree of overlap in the representative experts invited to the two meetings. The attending experts and their representativeness are shown in Table 1. All representative experts have more than 10 years of working

DOI: 10.29677/MR.202312_3(2).0004

experience, and their work is related to underwater operations or underwater instruments. They are also employed in companies related to underwater operations in the offshore wind power industry chain.

Table 1. Representative Attendees at the Expert Focus Meeting.

Expert Number	Company/Unit Position	Representation
E01	Detection Technology Co., Ltd. Chairman	Formerly served as the director of the Underwater Search and Ship Traffic Resource Center at the university, and has provided technical assistance to the Instrumentation Company since 2009.
E02	Marine Services (Corp.) Ltd. General manager	Eleven years of experience in the offshore wind power industry. The parent company is a listed company in the UK with 170 years of experience in ship operations, providing operation, maintenance, installation, and testing services, among others, having experience from more than 50 multinational wind farms.
E03	Marine Instrumentation (Corp.) Ltd. Director of business development	Eleven years of experience in the offshore wind power industry. Involved in underwater equipment since 2008. The first manufacturer of underwater electro-mechanical equipment and vehicles in Taiwan, specializing in the development of underwater ROVs and related components.
E04	Energy Co., Ltd. Chairman	Seventeen years of experience in the offshore wind power industry. Formerly worked in the Operations and Maintenance Department of ◯ New Energy (Corp.) Ltd.
E05	Wind Energy Technology Co., Ltd. CEO	The company was established in 2019. Its parent company owns a large-scale engineering fleet, responsible for both nearshore and offshore development of wind farms.
E06	Corporation Ltd. Chairman	Former general manager of Taiwan International ◯ Corporation Ltd. The current company is investing in Taiwan's first large cable-laying ship, scheduled to be put into operation in 2024 for offshore wind power cable-laying operations.
E07	Foreign Company Asia-Pacific Region, Chemical Building Materials Division Manager of offshore project logistics	Diver with extensive hands-on underwater experience.
E08	Detection Technology Company Deputy general manager	Specializes in seabed exploration and offshore operations. Formerly worked at ◯ Instrumentation Company and is currently a director at Taiwan Maritime Engineering Corporation Ltd.

During the second meeting, the attending experts evaluated the options of the competency validation questionnaire, thus collecting data on the importance, urgency, and difficulty of job tasks through the questionnaire. Moreover, the expert group helped review the completeness of the competency model, including primary responsibilities, work tasks, work outputs, behavioral indicators, knowledge, skills, and attitudes. The third version of the competency model was produced following the discussion outcomes in these meetings and after being confirmed by the decision-making panel.

To ensure the validity of the competency model, the study further invited an expert from a prominent domestic underwater instrument equipment company for an expert interview. This interview aimed to refine the job responsibilities, job tasks, behavioral indicators, and competency content (knowledge, skills, attitudes) within the competency model. After the decision-making panel confirmed the revisions, the competency

Marine Research of the National Academy of Marine Research
DOI: 10.29677/MR.202312_3(2).0004

model's final version (fourth version) was completed, concluding the final stage of the IPO competency development model.

4 COMPETENCY OUTCOMES

Competency standards serve as specifications for industry talent capabilities and follow a standardized format (Workforce Development Agency, Ministry of Labor, 2022). The content should encompass (1) essential information about the occupation, including the corresponding job category/occupation type/industry type for this standard, as well as explanations and supplementary details (such as necessary educational and experiential qualifications, prerequisites, etc.); (2) description of job content, benchmark levels, primary responsibilities, job tasks, and job outputs; and (3) corresponding competency content based on responsibilities and job tasks, including behavioral indicators, competency levels, and competency components (knowledge [K], skills [S], attitudes [A]).

This study employed the IPO model to develop a competency model. Throughout the process, through secondary data consolidation, four interview sessions, and two expert focus group meetings, the ROV Supervisor Competency Standard was developed. This standard encompasses the required skill set for ROV supervisors in underwater operations. The occupational basic information, job content, and competency content for this competency model/standard are detailed below.

4.1 Occupational Basic Information

- Occupational categories: Science, engineering, technology (SET), and mathematics/engineering and technology
- Job category: (7233) Industrial machinery maintenance personnel
- Industry category: (M712) Professional, scientific, and technical services/construction, engineering services, and technical testing, analysis services
- Suggested educational, experiential, or qualification requirements for undertaking this occupation: (1) Bachelor's degree or higher, preferably in fields related to marine, surveying, electrical and electronic, or mechanical disciplines; (2) proficiency in English communication; and (3) over three years of experience as an ROV pilot

4.2 Job Content

- Job description: Plan underwater ROV operation safety and emergency response measures and take charge of ROV team management, leadership, and ROV project activities
- Competency level: 4 (having the ability to independently carry out tasks involving planning and design, requiring skilled techniques in situations that frequently change and under minimal supervision)
- Primary responsibility, tasks, and work outputs: The ROV Supervisor Competency Standard encompasses four primary responsibilities, including "T1 Safety and Emergency Response," "T2 Performance Management," "T3 Team Management," and "T4 Project Activities." The work tasks and outputs within each primary responsibility are outlined in Table 2

Marine Research of the National Academy of Marine Research
DOI: 10.29677/MR.202312_3(2).0004

Table 2. Primary Responsibilities, Work Tasks, and Work Outputs of the ROV Supervisor Competency Standard.

Primary Responsibility	Task	Output
T1 Safety and Emergency Response	T1.1 Team Safety Organization and Management	O1.1.1 Risk Management Plan O1.1.2 Safety Issue Examples
	T1.2 Team Emergency Response Management	
T2 Performance Management	T2.1 Managing, Evaluating, and Monitoring Performance	O2.1.1 Performance Management Documents
	T2.2 Training and Development	O2.2.1 Training Plan Document
T3 Team Management	T3.1 Team Management and Supervision	
T4 Project Activities	T4.1 Executing Project Activities	

4.3 Competency Content

- Work activities and competency levels: The work activities and competency levels corresponding to each task within the ROV Supervisor Competency Standard are outlined in Table 3 below.

Table 3. Work Activities and Competency Levels of the ROV Supervisor Competency Standard.

Primary Responsibility	Task	Work Activities	Competency Levels
T1 Safety and Emergency Response	T1.1 Team Safety Organization and Management	P1.1.1 Conduct risk assessment of critical areas in the work environment. P1.1.2 Identify key factors of safety management systems and manage specific situations effectively. P1.1.3 Provide safety operation briefings to clients, crew, and ROV team. P1.1.4 Evaluate risks and develop appropriate risk control measures for ongoing operations. P1.1.5 Offer suggestions in a timely manner to ensure the safe execution of project plans. P1.1.6 Establish safety issue examples and demonstrate the significance of safety to subordinates or colleagues. P1.1.7 Follow company reporting procedures for reporting abnormal issues.	4
	T1.2 Team Emergency Response Management	P1.2.1 Initiate emergency response actions in case of emergencies and assume appropriate leadership. P1.2.2 Ensure the ROV team and onboard personnel understand and review their emergency roles.	4

Marine Research of the National Academy of Marine Research
DOI: 10.29677/MR.202312_3(2).0004

Primary Responsibility	Task	Work Activities	Competency Levels
T2 Performance Management	T2.1 Managing, Evaluating, and Monitoring Performance	P2.1.1 Review performance evaluation plans for ROV team members. P2.1.2 Collect and assess evidence demonstrating members' performance based on evaluation indicators. P2.1.3 Evaluate and provide feedback on members' job performance during offshore operations. P2.1.4 Complete performance management documents.	4
	T2.2 Training and Development	P2.2.1 Implement training and assess training effectiveness for senior, grade 1, and grade 2 technical engineers.	4
T3 Team Management	T3.1 Team Management and Supervision	P3.1.1 Motivate personnel at each responsibility level to engage in decision-making through effective communication and empowerment. P3.1.2 Ensure continuous updates to technical operation and safety documents and assign appropriate personnel. P3.1.3 Adapt leadership style per the needs of tasks, teams, and personnel. P3.1.4 Establish and communicate effectively with customer representatives and onshore project teams/managers. P3.1.5 Keep records of team management consistently updated.	4
T4 Project Activities	T4.1 Executing Project Activities	P4.1.1 Understand project performance requirements and project equipment operation procedures to assist in formulating and executing ROV-related plans and diving plans. P4.1.2 Follow company reporting procedures for reporting project activities.	4

- Knowledge and skills: Competency content, knowledge, skills, and attitudes. Based on the ROV Supervisor Competency Standard, the corresponding knowledge (K) and skills (S) for each task are outlined in Table 4.

Table 4. Knowledges and Skills Corresponding to Each Task of the ROV Supervisor Competency Standard.

Primary Responsibility	Task	Knowledge (K)	Skill (S)
T1 Safety and Emergency Response	T1.1 Team Safety Organization and Management	K01 Risk Management K02 Safety Management Systems K03 Safety Issue Examples K04 Reporting Procedure for Incidents	S01 Hazard Identification S02 Risk Assessment and Control S03 Presentation Skills S04 Operational Safety Management S05 Communication Skills S06 Case Compilation S07 Demonstration Skills S08 Reporting Skills S09 English Communication

Marine Research of the National Academy of Marine Research
DOI: 10.29677/MR.202312_3(2).0004

Primary Responsibility	Task	Knowledge (K)	Skill (S)
	T1.2 Team Emergency Response Management	K05 Safety Leadership and Management K06 Team Emergency Response Management	S04 Operational Safety Management S05 Communication Skills S09 English Communication S10 Leadership Skills S11 Emergency Response Organizational Operations
T2 Performance Management	T2.1 Managing, Evaluating, and Monitoring Performance	K07 Principles of Goal Setting K08 Performance Assessment Indicators K09 Performance-related Behavioral Issues	S05 Communication Skills S09 English Communication S12 Performance Assessment S13 Feedback Skills S14 Documentation Skills
	T2.2 Training and Development	K10 Training Modes K11 Training Effectiveness Levels	S15 Training Design S16 Training Effectiveness Evaluation S17 Job Guidance
T3 Team Management	T3.1 Team Management and Supervision	K12 Team Organization and Management K13 Work Distribution K14 Documentation and File Maintenance K15 Adaptive Leadership	S05 Communication Skills S09 English Communication S10 Leadership Skills S14 Documentation Skills S18 Auditing Skills
T4 Project Activities	T4.1 Executing Project Activities	K04 Reporting Procedure for Incidents K16 Project Management	S05 Communication Skills S08 Reporting Skills S09 English Communication S19 Basic Project Management Skills

- Attitudes: The attitudes (A) that should be possessed in the ROV Supervisor Competency Standard are shown in Table 5.

Table 5. Attitudes of the ROV Supervisor Competency Standard.

Attitudes (A)
A01 Proactive Initiative: Demonstrates the ability to act without being instructed or prompted by others, promptly addressing issues and taking steps to solve them. Willingly assumes additional responsibilities to achieve goals.
A02 Integrity and Honesty: Displays high ethical standards and trustworthy behavior. Maintains the organization's integrity as a guiding principle, understanding the impact of violating ethical standards of the organization, oneself, and others.
A03 Pursuit of Excellence: Sets challenging work goals for oneself and commits wholeheartedly to achieving or exceeding established targets. Constantly seeks breakthroughs and improvements.
A04 Team Collaboration: Actively participates in and supports the team, encouraging each other to achieve team goals collectively.
A05 Stress Tolerance: Effectively handles and manages highly stressful situations or pressures with composure, such as tight deadlines, complex individuals, unexpected events, and critical circumstances. Uses appropriate methods to alleviate personal stress.
A06 Willingness to Take Risks: Demonstrates a tendency to venture into situations with uncertain outcomes, where the chances of success are limited but the rewards of success are high.
A07 Prudent Attention to Detail: Approaches task execution with meticulous consideration and carefully manages all aspects of the process. Diligently reviews each procedure, maintaining a high level of focus on precision.

Marine Research of the National Academy of Marine Research
DOI: 10.29677/MR.202312_3(2).0004

5 CONCLUSION

5.1 Conclusions

As technology advances, ROVs have become crucial for underwater operations to meet the demands of ocean development and sustainability demands. These vehicles are employed for various tasks, including underwater inspections and maintenance. Even though extensive technical research on ROVs has been conducted domestically for many years, the issue of talent cultivation in this field has received minimal attention. Therefore, this study focuses on developing personnel specifications for ROV operations. Guided by expert recommendations and a comprehensive reference review, and in response to the practical need for local professional talent development, this study aims to establish the key occupational category of "ROV supervisor."

This study finally developed and completed the ROV Supervisor Competency Standard, which includes occupational basic information, job content, and competency content. The total output has four main job responsibilities, six work tasks, four work outputs, 21 behavior indicators, 16 knowledge items, 19 skills, and seven attitudes.

5.2 Suggestions

Establishing a competency standard can serve as a valuable reference for businesses designing workforce standards, guide educational institutions and training organizations in structuring their curriculum content, and help individuals understand the industry's capability expectations. The ROV Supervisor Competency Standard developed in this study primarily references the specifications provided by the IMCA and relevant guidelines, along with the collaborative insights of experts with extensive practical experience in the field. This study can play a pivotal role in the preliminary analysis phase of localizing courses. Subsequently, the content of the competency standard can facilitate the planning and execution of training programs, the development of assessment criteria, and even the implementation of capability evaluations. Furthermore, given that the competency standard is informed by international benchmarks like the ones set by the IMCA and relevant guidelines, the results of this study can serve as a foundation for exploring the feasibility and strategies to align domestic training with international certifications.

ACKNOWLEDGEMENTS

This study is in part a result of the "Research on Competency and Practice of ROV Professional Training" funded by the National Academy of Marine Research.

REFERENCES

Transparency Market Research (2020). *Remote Operated Vehicle (ROV) Market.* https://www.transparencymarketresearch.com/remote-operated-vehicle-rov-market.html

Industrial Development Administration, Ministry of Economic Affairs (2020). *Estimation of Professional Talent Demand in the Offshore Wind Power Industry for 2021-2023.* (in traditional Chinese). https://ws.ndc.gov.tw/001/administrator/18/relfile/6037/9072/d4dd1d51-3612-4052-9737-a554f0c5a693.pdf

Workforce Development Agency, Ministry of Labor (2022). *Guidelines of Competency Standard Development.* (in traditional Chinese). https://icap.wda.gov.tw/Knowledge/knowledge_downLoad.aspx

Chang, P. C. (2022). Human Resource Demand Analysis for the Operations and Maintenance Phase of the Offshore Wind Power Industry. Marine - Diversification of marine industry development. Taiwan Marine Industry Federation. (in traditional Chinese).

International Marine Contractors Association (IMCA) (2020). *Guidance on Competence Assurance and Assessment: Remote Systems & ROV Division.* International Marine Contractors Association. https://www.imca-int.com/product/guidance-on-competence-assurance-and-assessment-remote-systems-rov-division/

NORSOK (2020). Remotely operated vehicle (ROV) services, NORSOK U-102:2020. NORSOK Standard.

Subnet Service Ltd. (2023). *ROV Industry Training Courses.* https://www.subnetservices.com/training/courses/rov/rov-course-list

Subsea7 (2023). *ROV vacancies.* https://careers.subsea7.com/Search.aspx

JNCC (2018). *Remotely Operated Vehicles for use in marine benthic monitoring. Marine Monitoring Platform Guidelines No.1.* JNCC, Peterborough. https://data.jncc.gov.uk/data/4abdba96-8ade-468d-8f80-c23a6ad87dc5/JNCC-MMPG-001-FINAL-WEB.pdf

DOI: 10.29677/MR.202312_3(2).0004