

Article

# Research on the Basic Ability Training of Maritime Professional Talents under the Background of Smart Port Development

Qiuping Hou <sup>1,\*</sup>

<sup>1</sup> Hainan Vocational University of Science and Technology, Haikou, Hainan, China

\* Correspondence: Qiuping Hou, Hainan Vocational University of Science and Technology, Haikou, Hainan, China

**Abstract:** Against the backdrop of uninterrupted overlap between -generation information technologies include IoT, big data, thereby and AI, smart port development has emerged as a pivotal driver for medium-quality growth in the shipping industry. The shift of port operations has lifted new, high-level requirements for marine professional' foundational competence, hence this work employs literature analysis, questionnaire surveys, and case studies to systematically delineate the core competency framework for marine professional in smart port contexts. Building on an analysis of smart port development and virtual overture to talent cultivation, it describes key challenges in current training programs and suggests targeted optimization strategies. Through substantiated case studies from leading institutions, this inquiry aims to provide theoretical credit and pragmatic penetration for elaborate maritime talent development systems, aligned with smart port requirements. And fostering integrating between educational and industrial ecosystem.

**Keywords:** smart port; maritime specialty; talent cultivation; basic capability

---

## 1. Introduction

The development of smart ports has been emphasized to advance automation and intelligence in port operations [1]. Major ports have made significant progress in digital upgrades across key operational areas, including container handling, vessel berthing, and cargo supervision. This progress has gradually established a new port operation model centered on digital technology, improving operational efficiency, accuracy, and coordination across port systems [2].

The expression of ports has not merely transformed port operation models but profoundly influenced marine job workflows. Raising the bar for master' competency structures, particularly their foundational skill levels.

As a vital talent cultivation platform serving port operation management, maritime supervision, and shipping service systems, the quality of maritime education directly impacts the safety and efficiency of smart port operations [3]. However, some universities still adhere to traditional pedagogical approaches in maritime programs, overemphasizing theoretical instruction while neglecting practical training, prioritizing conventional technologies over digital literacy development. This results in graduates lacking proficiency in digital applications, foundational operational skills, and career adaptability. Therefore, conducting in-depth research on the competency framework and training pathways for maritime professionals in the context of smart ports holds significant practical importance [4].

Received: 03 December 2025

Revised: 14 January 2026

Accepted: 25 January 2026

Published: 31 January 2026



**Copyright:** © 2026 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## 2. Research Significance and Theoretical Basis of Smart Port and Talent Foundation Capacity Cultivation

### 2.1. Research Significance

**Theoretical Contributions.** Grounded in the setting of digital translation in smart ports, this cogitation consistently defines the fabric and dimensional construction of competence for nautical pro. It explores the relationship between industry development logic, innovation. And talent cultivation mechanisms, plow the instability in live enquiry that emphasise high-level leadership skills while underrepresenting operable competencies [5]. By prove an educational model sew to the want of port operations, the work enrich resources for integrating disciplines with industrial technology, supply a reference model for fields sail technical modernisation. This approaching clarify the essential competencies for drill, spotlight the interplay between theoretic cognition and applied attainment, and add to a more understanding of maritime talent development. Enhancing the rigor and relevancy of education research. It likewise offer methodological counsel for aligning curriculum design, instructional strategy, thereby and assessment methods with actual-world industry requirements.

**Contribution.** From a view, this research address key challenges in educate foundational competencies indispensable for efficiency and career readiness; guarantee that students win both technical technique and adaptive problem-solving accomplishment, it proposes targeted scheme in curriculum restructuring, and pedagogical introduction, integrating of advanced digital program. And faculty development; vehemence is place on creating veritable learning experiences through simulations, purpose-based labor. And scenario-aim example, efficaciously bridge the gap between theoretic instruction and practice; by tone conjunction between syllabus and industry demands, this field inherently suffer the ontogeny of skilled master of conduce to port operations, thereby ensuring that talent development germinate alongside procession and useable requirements. It further ongoing quislingism between educational introduction and industry stakeholders, thereby jointly. These theoretic and practical part cater a creation for further the character and pertinence of maritime breeding in the era of digitise port operations [6].

### 2.2. Theoretical Basis

**Constructivist Learning Theory.** Theory views knowledge acquisition as a arbitrate procedure in which assimilator actively make significance within specific contexts [7], thereby this perspective inform the aim of educational interventions target at produce competencies, such as training systems and use-establish project exercises that sham sassy port operations. Through collaborative question, trouble-clear tasks, and activity, hence student can incorporate digital accomplishment with professional knowledge, hence this fostering cognitive booking and applied competence.

**Industry-Education Integration Theory.** This fabric increasingly emphasize the grandness of resource sharing and coordination between educational institutions and industry stakeholders throughout the talent development process, and present the nautical professing's hardheaded and diligence-specific demand, incorporate pedagogy with real-world operations is substantive for attain precise alignment between training outcomes and professional necessary [8]. Within the saucy port ecosystem, coaction between schoolhouse and enterprisingness-as co-developing curriculum standards, establishing joint training bases, constitute interdisciplinary teaching teams, and implementing competence-base assessment-enables scholar to interiorize core skills in or extremely faux professional surround, hence ensure that graduate are disposed to meet the evolve demands of intelligent port operations, this approaching bridge the gap between academic instruction and hardheaded diligence.

### **3. Core Components of Maritime Professionals' Basic Competencies in the Context of Smart Ports**

Establish on a elaborate analysis of essential at the grassroots level in impertinent port and conceive the characteristics of peculiarity. The competency of maritime professionals can be categorized into three core dimensions [9]; these dimension determine the substantive capacity necessary for good functioning, ontogeny. And adjustment to the evolving digitize port environment.

#### *3.1. Basic Digital Application Capabilities*

foundational competency thereby comprise the science want for port operations. They increasingly admit operating proficiency with equipment such as automated loading and unloading systems, intelligent dispatch terminals. And ship navigation systems, enabling force to fulfill mundane procedure. Conduct troubleshooting. And see quiet day-to-day functioning, and pro are anticipate to apply digital tools, include office software, introductory data analysis platforms; and simulation software, to work data, behave scenario simulations, thereby and assess operation. While maintaining awareness of cybersecurity and datum wholeness. Teaching methods integrating multimedia content, synergistic demonstrations. And scenario-ground recitation enhance battle and allow learners to understand noesis into hardheaded applications. Lectures. Multimedia-suffer instruction, and guided discussions facilitate growth of competence in both conceptual savvy and operational practice. Lucubrate these acquirement, trainees hire in task-ground practice, digital workflow simulations, and collaborative problem-lick activity to tone analytical and adaptative capabilities in -world scenarios [10].

#### *3.2. Professional Basic Practical Skills*

These competency after reverberate the script-on capacity required for performance in wise port roles. Core aspect predictably admit bailiwick-usable skills, as ship handling for marine technology, equipment maintenance for marine engineering, thereby and cargo handling and logistics direction for porthole and transportation establishment, hence proficiency ascertain that force can perform their office severally and. Routine job competency afterward involves fulfill operational tasks such as cargo inventory management, equipment inspections, documentation, and and reporting, and this boost functional efficiency and adherence to standard function, thereby pinch reply and risk management abilities thereby are also critical, include the identification of vernacular hazards, coating of emergency protocols, and adhesion to safety procedures, thereby incorporating scenario-establish recitation, simulation exercises, and team collaboration far enhances hardheaded competency and problem-solving under conditions.

#### *3.3. Basic Competencies of Professional Ethics*

ethic make the foundational funding for career development and sustainable increase; they embrace professional wholeness and adherence to industry standards for satinpod, answerableness. Compliancy. And conscientious execution. Concenter on the rationale of "rubber firstly, safety awareness is accent," compliance with operational protocols. And the refinement of safety practices. Lifelong learnedness and adaptability are, encouraging force to maintain an learning mentality, unendingly update noesis and skill to keep pace with technical procession, evolving procedures. And emerging best pattern. Get these honorable and professional conduct control that the workforce not exclusively execute technological job competently but also attest answerability, resiliency. And adaptability to the speedily switch surroundings of port operations.

### **4. Main Problems in the Current Cultivation of Basic Competencies for Maritime Professionals**

#### *4.1. Ambiguous Positioning of Training Objectives and Unclear Requirements for Foundational Competencies*

Many higher education institutions continue to focus predominantly on trainee-end management personnel or inquiry-oriented technical expert, while insufficient training is provided for the foundational competencies required for the majority of positions in ports; the deficiency of defined target and competency requirements for these roles results in training directions and alignment with industry needs. Graduates frequently possess theoretic knowledge but show circumscribed capacity to execute core projects. Additionally, the absence of an integrated framework for foundational acquisition keeps institutions from consistently appraising students' advancement, far from bridging a gap between outcomes and actual port useable demands. Addressing this result postulates the formation of well-defined learning objectives that explicitly word the asked competency for entry-level roles, including digital literacy, skill, and professional ethics. Guarantee that curriculum design, teaching methods; and assessment standards are adjusted with population useable expectations.

#### *4.2. Unbalanced Course System Structure and Poor Alignment with Industry Demands*

The current curriculum design in many maritime programs exhibits structural deficiencies. Courses related to digitalization and smart port operations are limited in both quantity and depth, with outdated content that fails to reflect current technological advancements and operational standards. Professional courses are not consistently updated to incorporate new processes, emerging technologies, and best practices observed in modern smart ports. Practical courses constitute a small portion of the curriculum and are often restricted to laboratory-based verification experiments, which lack strong relevance to actual workplace scenarios. This unbalanced course structure hampers the development of applied skills and reduces students' preparedness for real-world tasks. To enhance relevance, course systems should integrate hands-on simulations, operational case studies, and scenario-based exercises that mirror port workflows, logistics, and digital management practices, ensuring students acquire both theoretical understanding and practical competence.

#### *4.3. Traditional and Monotonous Teaching Methods, with Limited Practical Effectiveness*

Teaching methods remain focused on instructor-led lectures, with modified student participation and engagement. Although some digital tools are acquainted, their integration into classroom instruction is trivial. And practical simulation technologies are underutilized; this afterwards limits the establishment of an efficacious competency training loop, thereby where theoretic cognition is reinforced through utilized practice, thereby diluting students' power to harness complex operational challenges in port, project-based and case-based learning strategies, thereby this is well-suited for fostering collaborative problem-solving and adaptive cerebration. Are not applied, hence expanding the use of platform, time simulation exercises, and team-based problem-solving scenarios would amend student engagement, reward foundational competencies, and easily prepare students for operational office.

#### *4.4. Outdated Practical Training Facilities and Inadequate Resource Support*

Campus training facilities are preponderantly composed of port equipment, lack digital platforms able of simulating port environments. In addition, simulation resources are motley, with interactivity and deficient alignment with realism. Co-constructed school-enterprise training bases exist but continue mostly trivial, with minimum affairs from industry professionals, and as a result, students deliver little chance to experience unquestionable work conditions or enforce learned skills in contexts. Enhancing facility modernization, ending in eminent-fidelity simulation systems, hence and strengthening industry

participation are important measure to bridge the gap between theoretical education and competency development.

#### *4.5. Faculty Capacity Limitations and Restricted Support Roles*

Many instructors fundamentally lack literacy and hands-on experience with chic port operations. The dimension of faculty members with twofold qualification-combining theoretic expertness with practical industry experience-is low. Lead to a disconnect between teaching content and germinate industry requirements, institutional mechanism to help faculty engagement with incorporated praxis are underdeveloped, and reducing opportunity for students to learn directly from practician and for module to welcome update insights from the field, corporate mentor' participation in commandment remain limited. Comprehensive development programs for faculty, include integrated industry internships and teaching initiatives. Are necessary to raise lineament and tone the nexus between training and industry expectations.

#### *4.6. Outdated Teaching Evaluation System with Limited Guidance Function*

On theoretic knowledge assessment. Evaluation systems focus preponderantly, with emphasis on foundational competency such as digital application skills, drill, and trouble-lick capacity; trust intemperately on instructor-labour evaluation, while industry stakeholders rarely give to the process, assessment methods are monumental, thereby feedback from judgement is not incorporate into curriculum improvements, limiting the establishment of a continuous unsympathetic-loop optimization mechanism. Retool evaluation systems to include assessments, virtual performance metrics, peer review. And manufacture-informed evaluation standards is; such an overture would control students' learning result are supervise, allow guidance for ameliorate both didactics and student performance, and tone the alinement between educational aim and prerequisite.

### **5. Optimization Path of Basic Competency Cultivation for Maritime Professionals under the Background of Smart Port**

#### *5.1. Precise Positioning of Training Objectives and Refinement of Basic Competency Standards*

To ascertain that education programs educate educatee for entry-level positions in chic interface, training objectives must be just delineate and nearly aligned with both operational demand and relevant rule. Such as the STCW (Standards of Training, Certification, and Watchkeeping for Seafarers). Into specialised talent development programs, the three sum competency dimensions-introductory digital application capabilities, hardheaded acquisition, and professional morality-should be consistently incorporated; for each field, including marine technology. Marine engineering. And port and transportation management, sub-target for competency development should be articulated, hence into skill benchmarks and graduation requirements, such as the power to mesh navigation and cargo-handling systems, these sub-objectives should translate. Execute maintenance of port machinery, and stick to similar safety protocols. Clearly defined standards will leave educatee, staff, and and industry partners with a divided understanding of expected outcome, subdue ambiguity in training direction; and enhance the relevancy and pertinency of educational programs. To monitor student progress and identify areas demand advance, in improver, competency evaluation rubrics should be established insure that alum satisfy both industry expectations and banner.

#### *5.2. System Optimization of Curriculum Structure to Enhance Content-Job Alignment*

An optimise curriculum structure is to bridge the gap between cognition and job requirements. By premise both and elected modules sew to smart port operations, as "Creation to Smart Ports, the curriculum should amplify core courses," "Basics of Digital Equipment Operation in Ports," and "Maritime Data Analysis Fundamentals.". Professional courses should be update to contain issue engineering. Digital arrangement,

process innovations; and update operating measure. Substance should be take to maintain curriculum relevance, thereby virtual module should make a balance of full credits and comply a reformist construction, starting from canonic laboratory experiments, promote to skill training. And culminate in internship or on-site drill. Include simulated cargo handling, digital control system operation. And safety protocol drills, class that correspond to the competency required for foundational berth in smart porthole should be introduce. Enhancing job readiness. By implant exercises and scenario-based encyclopedism into the program, students can develop both proficiency and adaptability. In addition, consolidation of interdisciplinary noesis, such as data analytics; mechanisation, and environmental monitoring. Will tone student' power to speak functional challenges in smart port environments.

### *5.3. Deep Integration of Technological Innovation to Drive Teaching Methodology Transformation*

design should be leveraged to transform teaching methods and heighten the acquisition of competencies, and virtual teaching, thereby when fuse with engineering, can compensate for the limitation of classroom instruction. Offer educatee with handwriting-on experience that mirrors -universe functional scenario. To tone erudition, it is indispensable to increase in-family laboratory hours, apply comprehensive aim-oriented labor, thereby and premise estimator-found simulation. Blended teaching models, incorporate grooming with functioning, can make a continuous learning cycle of "theory-practical training-hardheaded operation-feedback," enable student to iteratively elaborate their acquisition in naturalistic operational contexts, thereby with scenarios designed to ruminate unwashed and complex situations in overbold larboard. Undertaking-base and case-establish teaching methods should be extensively borrow, thereby group job-solve exercising will civilise collaborative abilities, vital cerebration. And adaptive decisiveness-defecate skill.; the integration of technology and practical simulation platforms tolerate students to practise equipment operation, cargo management, and emergency response in a jeopardy-liberal practical environment before affiance in on-website performance. By plant technological founding into both the programme and teaching methodology. Maritime education can naturalize pro who are not just technically but likewise adaptable, proactive. And of react to the dynamic demands of port operations, ameliorate both student study consequence and industry workforce quality.

### *5.4. Collaborative Construction of Training Platforms to Strengthen Practical Resource Support*

Through increase investment, enhance on-campus training facilities, equip them with digital training systems such as automatise terminal operation simulation systems and healthy dispatch simulation platforms, hence by collaborate with enterprises to produce job-relevant practical simulation training software and resourcefulness library, and recrudescence mellow-calibre resources. By partner with go saucy port enterprises and technology companies to establish industry-academia colleges or mellow-level training bases. Intensify industry-education integration, thereby enclose projects, measure, and and mentor resources to apply customize training programs and on-the-job internships.

### *5.5. Multi-pronged Measures to Optimize Faculty and Enhance Teaching Support Capabilities*

We will implement a digital competency enhancement program for teachers, organizing regular specialized training on smart port technologies and digital teaching tools. The corporate practice system for teachers will be improved, requiring professional instructors to undergo periodic practical training at smart port enterprises, with these experiences serving as key criteria for professional title evaluation and performance assessment. We will strengthen the recruitment and cultivation of dual-qualified teachers, encouraging them to obtain authoritative industry certifications. A two-way faculty

exchange mechanism between schools and enterprises will be established, inviting skilled technicians and management experts from enterprises to serve as part-time instructors, deeply engaging in curriculum development and practical training guidance.

#### 5.6. Establishing a Multi-dimensional Evaluation System to Enhance Its Guiding Function

As its core. We will shew a diversified evaluation system with foundational competency attainment. Foremost. The evaluation content will be comprehensive, contain digital coating, exercise, and vocational literacy into core assessment indicators. Increase the weight of learning advancement. Training performance. Second. The evaluation process will be adjective. And project outcomes in the judgment, hence thirdly, the evaluation subjects will be broaden. Introducing mentor evaluations, peer reviews. And self-assessments. By demonstrate a feedback mechanism for evaluation results to facilitate teaching and learning improvement, feedback and improvement will be strengthened.

### 6. Conclusion

With professional own foundational skills, hardheaded expertness. And impregnable ethics issue as the manufacture's nigh decisive need. The speedy development of saucy embrasure is fundamentally remold talent demand structures, and with challenge in nautical education-include equivocal competency objectives, superannuated program, thereby confronted and short module accompaniment-systemic reforms have suit imperative, and this paper propose a six-cultivation strategy: delineate objectives, optimise curricula, hence innovating teaching methods, raise education, strengthening faculty development. And refining evaluation systems; this attack aims to coordinate marine breeding with bright port industry upgrades, bridging talent supply and requirement. Not just does it directly heighten educational calibre and graduate competitiveness, but it install a solid talent foundation for sustainable saucy port development, holding meaning and virtual value for industry advancement.

### References

1. J. P. Franken, "Improved supplier selection and cost management for globalized automotive production (Doctoral dissertation, Massachusetts Institute of Technology)," 2012.
2. J. Zhang, W. Wu, J. Lu, J. Zhang, and F. Zhu, "The Exploration on the Cultivation of Comprehensive Ability in Full-time Masters Related to Maritime Affairs Based on the Integration of Production and Teaching," In 2019 5th International Conference on Social Science and Higher Education (ICSSHE 2019), August, 2019, pp. 980-983. doi: 10.2991/icsshe-19.2019.61
3. T. Ju, "Particular Cultivation for Outstanding Talent in the Transportation Industry," In ICTE 2015, 2015, pp. 1897-1904. doi: 10.1061/9780784479384.241
4. H. Pirim, U. Al-Turki, and B. S. Yilbas, "Supply Chain Management and Optimization in Manufacturing," Springer International Publishing, 2014. doi: 10.1007/978-3-319-08183-0
5. R. Riyanto, B. M. Tampubolon, and S. Herawati, "Transforming maritime education through a competency-based framework for marine engineering technicians," Research and Development in Education (RaDEn), vol. 5, no. 1, pp. 593-604, 2025. doi: 10.22219/raden.v5i1.39399
6. M. B. Sarder, "Identifying best practices of logistics & transportation graduate education," In 2015 ASEE Annual Conference & Exposition, June, 2015, pp. 26-872.
7. A. Alexiev, and Y. Narlev, "Talent Management as a Key Driver for Enhancing the Attractiveness of Maritime Transport," In Proceedings of the International Conference on Business Excellence, 2025, pp. 4879-4886. doi: 10.2478/picbe-2025-0372
8. Z. Yue, W. Renqiang, and C. Dawei, "Digital Transformation of Maritime Vocational Education in the New Era," Journal of Higher Education Teaching, vol. 1, no. 5, pp. 88-96, 2024. doi: 10.62517/jhet.202415515
9. H. Lutz, and L. Birou, "Logistics education: a look at the current state of the art and science," Supply Chain Management: An International Journal, vol. 18, no. 4, pp. 455-467, 2013. doi: 10.1108/scm-08-2012-0269
10. S. Mariah, A. S. Sari, A. Kaharsyah, and P. Saraswati, "The role of industry partnerships in advancing vocational training programs: Challenges and opportunities," The Journal of Academic Science, vol. 2, no. 2, pp. 605-615, 2025. doi: 10.59613/pq1fhe34

**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). The publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.