Asia Pacific Science Press

Journal of Educational Theory and Practice
ISSN(O):3005-9313
ISSN(P):3005-9305
Vol. 2 No.4 (2025)

Research on a Multidisciplinary Talent Development Model for High-End Shipping Services

Ming Sun[1], Shiyun Xu[1], Kebiao Yuan[2]*, Midakpe P. Vortia[1]

1.College of Transport and Communications, Shanghai Maritime University, Shanghai, 201306, China

2.School of Economics and Management, Ningbo University of Technology, Ningbo, 315211, China

Corresponding author: Kebiao Yuan, ykbjob@163.com

Abstract: The global shipping industry is undergoing significant changes driven by digitalization, green and low-carbon development, and shifting geopolitical dynamics. These shifts create an urgent need to upgrade high-end shipping service talent from single-skill specialists to multidisciplinary professionals. However, traditional talent cultivation models face structural challenges, including rigid disciplinary barriers, weak collaborations between universities and industry, and slow response mechanisms to emerging needs. In response, this study proposes a C-P-R-I talent cultivation model which is centered on Curriculum Integration (C), Practice Driving (P), Responsive Mechanism (R), and Integrated Empowerment (I). This model restructures the knowledge framework through modular courses integrating shipping, management, finance, law and information technology." It strengthens practical learning through a dual approach of case studies and projects, supported by a hybrid virtual-physical practice platform. Additionally, it introduces a dynamic optimization mechanism based on industry-education alliances to improve students' interdisciplinary abilities and professional capabilities. By offering an adaptable and feasible innovation pathway, this research seeks to provide theoretical support and practical guidance for advancing high-quality development in the shipping services sector and for promoting innovation in higher education talent cultivation.

Keywords: High-End Shipping Services; Multidisciplinary Integration; Talent Cultivation Model; C-P-R-I Model; Deep Industry-Education Integration

Published: Dec 27, 2025

DOI: https://doi.org/10.62177/jetp.v2i4.941

1.Introduction

1.1 Research Background and Importance

The global shipping industry is undergoing profound transformation driven by digitalization, green and low-carbon transition, and geopolitical realignment. In this context, the competitiveness of international shipping hubs now depends not only on port infrastructure and throughput scale but increasingly on high-end knowledge-intensive service capabilities such as shipping finance, maritime arbitration, and digital governance. Although major Asian ports like Shanghai perform strongly in container throughput (surpassing 50 million TEUs in 2024) [1], they continue to lag behind global shipping hubs like London and Singapore in terms of soft power capabilities. Geopolitical conflicts, shifting trade policies, and carbon reduction targets have also collectively disrupted traditional operational models, increased costs and accelerating technological evolution. These

changes require advanced talents with more comprehensive skill sets. The industry no longer seeks only operationally skilled individuals; it urgently needs multidisciplinary professionals capable of integrating knowledge across fields to tackle complex and evolving challenges.

1.2 Research Objectives

Shipping education currently remains predominantly single-discipline, facing persistent problems such as rigid disciplinary barriers, weak links between theory and practice, and slow responses to industry demands, making it difficult to meet the needs for new talent. Therefore, grounded in the industry's real-world challenges, this paper proposes a multidisciplinary training model built on a modular curriculum that integrates "shipping + management + finance + law + information". Supported by a dual-drive teaching approach that combines case studies and projects with a blended virtual-physical practice platform, the study systematically enhances professional competence, offering a practical reference for the development of high-end shipping services and promoting innovation in higher education systems.

2.Research Status

2.1 The essence of High-End Shipping Services and Talent Demand

High-end shipping services have become the core competitive focus for global shipping hubs. Their scope has expanded from traditional ship brokerage and insurance to more knowledge-intensive domains such as shipping finance, maritime arbitration, and digital governance. This evolution not only shows business expansion but also reflects a nation's comprehensive level of shipping soft power. London's long-standing status as a leading global shipping center is supported by its advanced clusters of high-value-added services such as shipping finance, shipbroking, marine insurance, litigation, and arbitration, which collectively form the foundation of its soft [2]. Similarly, these trends can be observed in China's shipping factor market practices. Major shipping exchanges in Shanghai, Guangzhou, Wuhan, and Ningbo have comprehensively extended their business scope from vessel asset transactions to high-end value-added services including freight index derivatives, shipping fintech, blockchain data platforms, and green financial products [3]. Simultaneously, comparisons with international best practices in Hong Kong and Singapore reveals that building a comprehensive ecosystem covering green fuels, carbon finance, digital governance, and integrated derivatives trading, represent the leading direction for global high-end shipping services development.

The deepening of these concepts and the emergence of new business models further highlight the urgent need for high-end multidisciplinary talent. The effective provision of high-end services heavily relies on expert teams capable of bridging shipping, finance, law, and information technology. Intelligent shipping faces technical challenges such as data security, integration of multi-source heterogeneous data, and limitations of AIS data [4]. Meanwhile, advancing green ports is constrained by high infrastructure costs, inconsistent technical standards, and conflicts between operational efficiency and emission reduction targets. Addressing these complex issues cannot be achieved by professionals from a single discipline. Instead, the industry requires multidisciplinary experts with a cross-field knowledge structure that combines "shipping + intelligence + green" capabilities. Also, China is transitioning from being a "follower" to a "rule-shaper" in the global high-end shipping services market, with the bottleneck being the shortage of such multidisciplinary talent. Consequently, establishing a stable and credible institutional framework aligned with international standards and cultivating a talent pool has become decisive factor to determining the development level of a shipping hub [5].

While existing research [6] clearly outlines the market demand and strategic value of high-end shipping services, it largely treats these outcomes as a predetermined industrial goal. The underlying mechanisms and practical pathways for systematically cultivating, through educational reforms, a scalable group of versatile professionals capable of both delivering and advancing these high-value services remain significantly underexplored.

2.2 Structural Transformation in Shipping Talent Demand

The global shipping industry is experiencing a fundamental shift toward green technologies and intelligent operations, which is reshaping its talent requirements. There is an increasing talent demand for professionals with multidisciplinary, composite competency structures. Supply-demand imbalance also exists for high-level, multidisciplinary shipping talent as a forming a key constraint on the industry's sustainable development [7]. Empirical evidence illustrated in Figure1, indicates

that the talent currently required by the industry must possess cross-disciplinary knowledge backgrounds or work experience. Their competency dimensions must span multiple related fields including shipping finance, logistics management, shipping economics, maritime law, shipping information, and shipping transactions. Among these, data and digital skills (80%) and green technology and ESG compliance (65%) have emerged as the most prominent capability gaps. These multidimensional competency requirements significantly exceed the scope of traditional single-discipline training frameworks, underscoring the urgency of advancing interdisciplinary education.

Figure1: Distribution of Areas with "Significant Skill Gaps" Reported by Shipping Companies

Amid this transformation, the rapid advancement of technologies such as Artificial Intelligence (AI) has become a key force reshaping talent competency framework. The ports and shipping sector accelerate their digital and intelligent transformation, demand for highly skilled professionals continues to rise, while traditional classroom-centered teaching models struggle to meet industry's evolving needs [8]. As a result, a micro-professional training and management system guided by the principles of interdisciplinary collaboration, coordinated education, and demand orientation was proposed to counter this challenge [9]. This framework aims to precisely meet the new competency requirements posed by the trends toward green, intelligent, and unmanned shipping. Recent studies further refined this competency framework [10], advocating that maritime universities systematically restructure their curricula, teaching objectives, and content to cultivate interdisciplinary talents possessing three core skill sets: "maritime + intelligent," "maritime + green," and "maritime + cross-domain."

Given these fundamental shifts in competency structures, talent cultivation strategies must undergo parallel reform. Survey research [11] highlights that shipping enterprises and institutions highly require a transition from traditional single-skill models to demand-driven, diversified pathways emphasizing international perspectives, interdisciplinary capabilities, and deep industry-education integration. It was also confirmed that the shipping industry has seen significant increases in both the quantity and quality of talent demand, rendering traditional training methods inadequate to meet market needs [12]. Based on this, they explored interdisciplinary training models and supporting systems at the undergraduate and graduate levels within higher education institutions. From the educational philosophy level, the shipping industry transitions was argued on from extensive to intensive development, integrating shipping-specific curricula with ideological and political theory is essential to strengthen the sense of responsibility and mission among talents aspiring to build a maritime powerhouse [13]. Notably, improving the strategic value of talent also demands innovation in organizational learning cultures. Empirical research reveals that talent contributes even more significantly to sustainable performance than leadership within shipping companies [14]. Their findings highlight that building a "learning-oriented" organizational culture is a key approach to effectively nurturing and developing shipping talent.

As evidenced above, existing research has formed an essential consensus on the kind of talent the industry needs:

interdisciplinary professionals with cross-disciplinary knowledge, international perspectives, and innovative practical capabilities. This demand-side perspective strongly argues for the urgency of advancing multidisciplinary education. However, these studies primarily advocate for change at the level of principles. The operational core question of "how to systematically reconstruct the training system" still requires an integrated framework to provide a practical solution.

2.3 Limitations of Existing Shipping Talent Development Models

In response to new talent demands that is driven by structural transformation in the shipping sector, the existing mainstream talent development model presents systemic limitations in adaptability. The major issue lies in the deep contradiction between the traditional discipline-centered, theory-oriented framework and the goal of cultivating multidisciplinary, integrated talents. Specifically, these limitations are evident in three key areas.

Firstly, in knowledge system construction, disciplinary barriers remain rigid. University curricula largely deepen vertically within single disciplines like navigation or logistics, lacking effective mechanisms for interdisciplinary integration [15]. As a result, students struggle to develop the systematic knowledge frameworks required for advanced operations like shipping finance, maritime arbitration, and digital governance. This education system places excessive emphasis on academic grades while neglecting the development of comprehensive competencies, leaving students unable to integrate knowledge across disciplines to solve complex business challenges [16].

Secondly, in terms of competency development, the tendency to "prioritize theory over practice" continue to persist. Traditional classroom instruction remains dominant, lacking sufficient project-based learning, case studies, and industry-academia collaboration [17]. Neglecting practical skills hinders students' ability to translate theoretical knowledge into real-world problem-solving capabilities [10]. This disconnects between training methods and the goal of cultivating comprehensive, practice-oriented competencies leaves graduates unprepared for actual shipping disputes, technological applications, or risk management scenarios.

Finally, in terms of responsiveness, talent development remains slow and poorly aligned with industry demands. Curriculum content and teaching objectives in higher education institutions update slowly, failing to incorporate cutting-edge topics such as artificial intelligence, green regulations, and geopolitical risks in a timely manner [7]. At the same time, a widespread phenomenon of "working in isolation" persists between universities and enterprises. University training programs are misaligned with real industry needs, while enterprises struggle to effectively empower talent through on-the-job training due to the lack of high-level training systems [15].

As a result, the existing model shows structural deficiencies across knowledge frameworks, competency development, and responsiveness. Minor adjustments are insufficient to address these issues. Only through systemic reconstruction—establishing a new model characterized by breaking disciplinary barriers, deepening industry-education integration, and possessing dynamic responsiveness—can the vast gap between talent supply and industry demand be effectively addressed.

2.4 Research Gaps

Existing research demonstrates that scholars have increasingly recognized the shipping industry's shift from "hardware scale" to "hardware-software synergy". There is a widespread acknowledgment that multidisciplinary integration is essential for cultivating high-end, composite shipping service professionals. However, a critical research gap persists. Most existing studies remain at the level of problem identification, emphasizing the necessity of reform, or offering general recommendations. What is still lacking is a detailed elaboration on a holistic framework design and implementation pathway for constructing an operational, systematically implementable talent development model that organically integrates multidisciplinary knowledge such as shipping, management, finance, law, and information. This study aims to bridge this gap. The following sections will first conduct an in-depth analysis of the specific challenges confronting current training models. Subsequently, it will propose and elaborate on a novel, systematic multidisciplinary talent development model to address the core issues repeatedly highlighted but not yet effectively addressed in existing literature.

3.Real-World Challenges in Cultivating High-End Shipping Service Talent

The global shipping industry is undergoing unprecedented transformation, with the digital technology revolution, geopolitical realignment, and green low-carbon transition. These shifts impose new and complex demands on the training model for

high-end shipping service professionals. Traditional discipline-centered training systems have become disconnected from industry demands. This chapter analyzes the current predicaments in cultivating high-end shipping service talent from four dimensions, namely: digital technology integration; geopolitical response; green and low-carbon transition; and university-enterprise collaboration mechanisms, revealing the practical obstacles to advancing multidisciplinary integration.

3.1 Challenges in Digital Technology Integration: Knowledge Gaps and Lack of Interdisciplinary Mechanisms

In the post-pandemic era, the rapid advancement of digital technologies presents an urgent challenge to talent development. The core contradiction lies in the industry's digital transformation demanding rapid knowledge iteration from professionals, while existing training systems lag significantly in both knowledge updating and interdisciplinary integration.

Primarily, knowledge gaps and skill divides continue to expand. Technologies like artificial intelligence, big data, and blockchain have become deeply embedded in high-end service scenarios such as ship energy efficiency management, intelligent scheduling, and supply chain finance. However, in maritime academy curricula, cutting-edge modules like smart ship operations and maintenance, and digital navigation systems account for less than 18% [11]. The curriculum remains centered on traditional maritime technologies and shipping management, failing to systematically incorporate cutting-edge digital technologies into required courses. This creates significant gaps in students' knowledge frameworks, leaving them ill-prepared for practical tasks involving intelligent systems and data analysis. Research on Nordic shipping enterprises confirms that a key bottleneck in the industry's digital and service-oriented transformation is the imbalance in talent structure [18]. A large proportion of industry employees possess traditional vessel operation experience but lack digital skills, while external digital talent often lacks understanding of the shipping sector's unique characteristics. Consequently, cultivating and attracting hybrid professionals proficient in both vessel operations and digital technology is recognized as a critical requirement for driving the industry's sustainable development. Moreover, shipping professionals will transition from traditional roles as vessel operators and maintainers to becoming observers of intelligent systems, initial processors of data information, integrators of cross-disciplinary knowledge, and practitioners of human-machine collaboration [19]. A significant skills gap has emerged between educational offerings and these evolving demands.

Furthermore, implementing interdisciplinary training faces multiple systemic barriers. Effective integration requires collaboration across fields such as shipping, information technology and law, yet these domains widely differ in their knowledge systems, curriculum structures, and faculty backgrounds, lacking effective cross-disciplinary integration mechanisms and shared platforms [7]. Additionally, there is a severe shortage of "dual-qualified" instructors proficient in both shipping operations and digital technologies. Incentive mechanisms, evaluation standards, and benefit distribution systems for cross-departmental collaborative education remain underdeveloped [20]. These systematic barriers make it difficult for students to build a comprehensive "shipping + digital" knowledge structure within the limited duration of their academic programs.

At a deeper level, entrenched talent paradigms pose a major challenge to digital skill adoption. When integrating digital technologies, the shipping industry faces not only hard constraints of knowledge and mechanisms but also soft constraints from traditional talent perceptions. Enterprises cling to talent philosophies rooted in "giftedness theory" and "exclusion of the exceptional," severely impedes organizational learning and the dissemination of new skills rendering even the most advanced management systems or technical training ineffective [21]. Therefore, industry-education integration must go beyond technical knowledge transfer to jointly build a learning ecosystem that encourages continuous growth and embraces trial-and-error, thus removing cultural barriers to the development of versatile talent.

3.2 Challenges from Geopolitical Shifts: Weak Risk Response and Rule Awareness

Geopolitics has evolved from a macro backdrop into a critical factor directly impacting shipping operations. Events like the Russia-Ukraine conflict and the Red Sea crisis have triggered route diversions, spikes in freight and insurance costs, exposing the global shipping system's extreme vulnerability. Traditional education models, heavily focused on technical and operational skills, prove inadequate in addressing such complex international risks.

On one hand, heightened shipping security risks have exposed inadequate training in crisis decision-making. Geopolitical conflicts continuously disrupt maritime market structures and security through mechanisms like economic sanctions, military

standoffs, and terrorism [22]. High-end shipping service professionals must transcend purely technical perspectives, acquiring capabilities in international political-economic analysis, geo-risk identification, and rapid crisis decision-making. However, existing curricula severely lack content on international relations, geopolitics, and crisis management. This leaves students poorly equipped to maintain shipping continuity and security through strategic adaptability when confronting extreme scenarios such as supply chain disruptions or route blockades. On the other hand, awareness of global shipping governance rules remains weak. As global shipping governance system is increasingly politicized, shipping alliances evolve into political-economic communities where commercial logic intertwines with national interests [23]. This necessitates professionals with deep understanding of international rules, cross-cultural negotiation skills, and policy judgment to participate in the new round of rule-making. However, existing training models insufficiently address these requirements, limiting students' ability to contribute to national participation in global shipping governance. To navigate complex geopolitical shifts, future training models must systematically integrate modules on international rules, geopolitics, and crisis management into curricula, focusing on cultivating students' strategic thinking and macro-level adaptability.

3.3 Challenges of Green and Low-Carbon Transition: Dual Shortcomings in Technical Knowledge and Governance Capabilities

The International Maritime Organization's (IMO) emissions reduction strategy and the global climate agenda are propelling the shipping industry toward a green and low-carbon future. This represents not only a technological revolution but also a restructuring of governance systems and economic logic, imposing new demands on the knowledge and capabilities of professionals. Previous research on major shipping countries shows that leading green shipping practices integrate vessel design, fuel selection, port operations, and national policies into a complex ecosystem, requiring talent with broad interdisciplinary integration capabilities [24].

There are significant gaps in green technology literacy. Achieving the IMO's 2050 emissions reduction targets requires expanding new technologies including clean fuels such as: LNG, methanol, hydrogen; energy-efficient vessel designs; and carbon capture. High-end shipping service professionals must understand the fundamental principles, application scenarios, and economic viability of these green technologies while mastering international standards such as the Energy Efficiency Design Index (EEDI) and Carbon Intensity Indicator (CII). However, traditional curricula centered on shipping economics and management exhibit substantial gaps in this area, leaving students with limited understanding of core technologies driving the industry's green transformation. Also, sustainable governance capabilities have become more essential. The green transition has introduced carbon trading, green finance, and ESG (Environmental, Social, and Governance) standards, shifting the industry's economic logic from profit-centric to sustainable value creation. Consequently, future professionals must develop competencies in green financial product design, ESG assessment, and sustainable operational decision-making [25]. This necessitates educational systems integrating engineering, economics, and management disciplines to offer new interdisciplinary modules such as "Green Shipping Management" and "ESG and Shipping Finance," thereby addressing students' current gaps in sustainable governance.

3.4 Challenges in Industry-Academia Collaboration: Weak Practical Training and Lack of Feedback Mechanisms

Industry-education integration is essential for nurturing multidisciplinary talent. However, current university-industry collaboration still suffers from deep-seated issues of "working in isolation," resulting in inadequate development of students' innovative practical skills. The fundamental barriers to digital transformation in the shipping industry stems more from structural challenges such as conservative organizational cultures, employee resistance to change, rigid departmental silos, and a shortage of digital talent [26]. These internal industry challenges further reflect a broader disconnect between universities and enterprises in talent development.

Practical training components often become mere formalities and severely disconnected from the real-world scenarios of high-end shipping services. Although universities commonly offer introductory internships and production placements, their content is frequently limited to basic operations. Internship positions offered by enterprises fail to engage students in high-value-added business processes such as shipping financial product design, maritime arbitration case handling, or digital

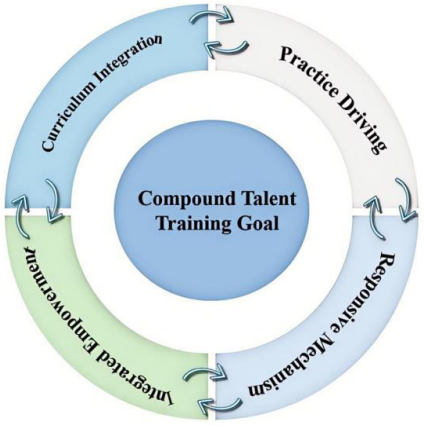
platform development [17]. As a result, students have very limited opportunities to develop multidisciplinary competencies in authentic industry settings. Thus, the " theory over practice" bias. Additionally, the lack of engineering practice background among faculty constitutes a core obstacle to deepening practical teaching. Instructors are required to possess extensive industry experience to guide students in solving complex engineering and practical problems. However, there is a severe shortage of "dual-qualified" instructors proficient in both shipping operations and digital technologies especially in the engineering field. The maritime education faculty should not only impart theoretical knowledge but also possess substantial engineering practice experience to cultivate students' practical abilities and comprehensive competencies [27]. Yet, heavy teaching workloads and underdeveloped incentive structures tend to discourage faculty from gaining industry experience. This hinders their ability to fully leverage their critical role in guiding students' practical innovation. Consequently, even well-designed practical components often yield limited results. The deeper issue lies in the lack of a two-way feedback mechanism between universities and industries. Academic curricula and course content slowly update and do not incorporate emerging challenges encountered by enterprises during their green and intelligent transformations. Simultaneously, businesses lack effective channels to communicate new skill requirements back to the university for enhanced curriculum design [15]. The absence of this two-way feedback mechanism is one of the critical causes of the structural mismatch between talent supply and industry demand. Furthermore, corporate recruitment practices that prioritize narrow operational skills over interdisciplinary and innovation capabilities further weaken students' motivation to engage in deep practical learning.

As observed in the shipbuilding sector, shipping companies rarely consider students' technological innovation achievements as hiring criteria, resulting to student disengagement from innovation activities [27]. This same logic applies in the high-end shipping sector: if corporate recruitment continues to prioritize singular operational skills over interdisciplinary knowledge integration and innovative competencies, university-built practical training systems will struggle to gain students' full attention and participation.

4.Establishing a Multidisciplinary Talent Development Model for High-End Shipping Services

Previous analysis indicates that traditional single-discipline training models exhibit structural deficiencies in knowledge frameworks, competency development, and response mechanisms, rendering them insufficiently equipped to address the complex challenges posed by digital convergence, geopolitics, and green transformation. To bridge the gap between talent supply and demand, this chapter proposes a C-P-R-I training model (as shown in Figure2) centered on four core features: Curriculum Integration, Practice Driving, Responsive Mechanism, and Integrated Empowerment. This model aims to systematically address the aforementioned challenges and provide a feasible way for effectively supplying high-end shipping professionals.

Figure2 C-P-R-I Training

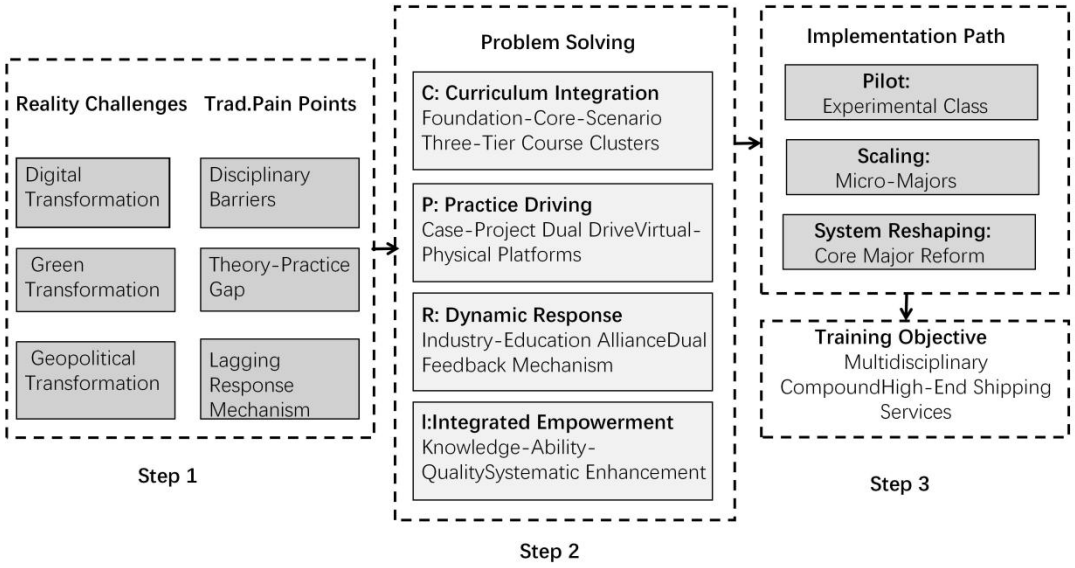


4.1 Overall Framework of the C-P-R-I Model

The proposed C-P-R-I model constitutes an integrated system centered on defined learning objectives, comprising four interconnected and mutually supportive subsystems. Its core aim is to transcend disciplinary boundaries and enhance

professional competencies. “Curriculum Integration (C)” serves as the knowledge foundation, breaking down barriers between shipping, management, finance, law, and information disciplines to reconstruct students’ knowledge frameworks. “Practice Driving (P)” serves as the competency engine, transforming knowledge into real-world problem-solving skills through dual-track “case-project” initiatives and “virtual-physical integration” platforms. “Responsive Mechanism(R)” functions as the regulatory hub, ensuring curriculum alignment with industry frontiers by building an agile ecosystem of industry-education integration. Ultimately, the synergistic interaction of these three elements collectively achieves “Integrated Empowerment (I)” enhancing students’ comprehensive competencies, and preparing them to lead the future development of the shipping industry. This framework fundamentally moves beyond the linear thinking of traditional models, emphasizing nonlinear interactions among elements and holistic effectiveness (as shown in Figure3).

Figure3: Overall Framework of the C-P-R-I Model



4.2 Curriculum Integration (C)

To address these gaps, the model implements a three-tiered “Foundation-Core-Scenario” curriculum cluster as shown in Table1 below. This structure is designed to systematically develop the knowledge frameworks that students require to navigate complex and uncertain industry landscapes.

Table1: Curriculum Architecture

Curriculum Tier	Curriculum Module	Example Course Name	Competency Objectives
Foundational Course Tier	Mathematics, Physics, and Economics/Management Foundations	Fundamentals of Economics/Finance, Operations Research and Statistics, Fundamentals of Green Shipping, Big Data and AI in Shipping, Digital Twin	Solidify Foundations in Mathematics, Economics/Management, and Green Shipping
Core Curriculum Layer	Management	Route and Schedule Optimization, Shipping Brokerage	Enhancing Shipping Operations and Management Capabilities
	Finance	Maritime Finance, Ship Financing, Marine Insurance	Mastering Shipping Finance and Risk Management Skills
	Technical	Green Shipping and Low-Carbon Technologies, Energy Efficiency Management	Acquire green technology and energy efficiency analysis capabilities
Scenario Integration Layer	Cases and Projects	“IMO 2050 Emissions Reduction Strategy,” “Red Sea Crisis Route Optimization,” “Blockchain Applications in Shipping Finance”	Enhancing judgment in complex scenarios and cross-disciplinary problem-solving capabilities

At the foundational course level, the model prioritizes strengthening students' competencies in mathematics, economic, management, and green shipping. Courses such as Economic and Financial Foundations, Operations Research and Statistics, Green Shipping Fundamentals, Shipping Big Data and AI, and Digital Twins are structured to provide a solid knowledge base for advanced studies.

At the core curriculum level, students deepen their specialized competencies through track-oriented modules. Management courses such as Route and Schedule Optimization and Shipping Brokerage; the finance courses offer Shipping Finance, Shipping Finance Practice, Marine Insurance, and Ship Financing; while technical courses focus on Green Shipping and Low-Carbon Technologies and Energy Efficiency Management.

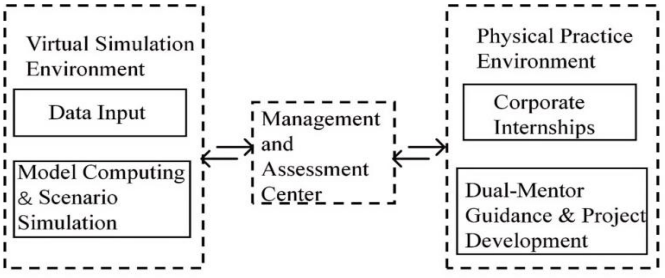
At the scenario-based level, teaching dynamically integrates cutting-edge industry challenges through case studies, workshops, and real-world project collaborations. For instance, in exploring intelligent shipping technologies, students examine real-world challenges like the limitations of AIS data and multi-source heterogeneous data integration, alongside blockchain applications in shipping supply chain finance and transparency enhancement, directly engaging with data security and technological innovation hurdles. In green governance modules, analytical frameworks are designed around implementation challenges and policy drivers for IMO emission reduction strategies and shore power technology as core green port initiatives [4].

The entire curriculum follows our-stage progressive path. In the first year, students compete foundational liberal arts courses in engineering, economics science, management and mathematics. The second year focuses on core shipping courses that build essential capabilities in operations research, data science, economics, management and regulatory frameworks. In the third year, students select one of the five specialized tracks, that is: Maritime Finance, Maritime Economics, Maritime Operations Management, Port Operations Management or Maritime Research Consulting, and also undertake advanced courses alongside intensive industry immersion. The final year centers on capability expansion, where the students work under joint university-enterprise supervision to apply multidisciplinary knowledge in cross-functional team projects and graduation thesis or designs, thereby transitioning from disciplinary learners to versatile problem solvers.

4.3 Practice Driving (P)

To address challenges in university-industry collaboration and the imbalance between theory and practice, this model centers practical application as the core competency development thread. It employs a dual-track case-project hybrid teaching reform throughout the entire process of cultivating high-end shipping service talent. The core objective is to enable students to transform multidisciplinary knowledge into professional competencies for solving systemic problems within complex scenarios that closely mirror real-world conditions. Case-based teaching focuses on developing judgment in complex scenarios, featuring real-world dilemmas such as "Fleet Renewal Strategies for IMO 2050 Emissions Targets" and "Route Optimization and Supply Chain Resilience Management Amid the Red Sea Crisis." This approach guides students to dissect intricate interconnections between technology, economics, policy, and geopolitics. Project-based learning emphasizes action and creation. Students undertake comprehensive tasks like "Designing Green Shipping Transition Roadmaps" or "Developing Prototypes for Digital Maritime Evidence Platforms," completing the entire process from technical feasibility analysis and business model construction to compliance reviews. This enhances their collaborative innovation and cross-domain problem-solving capabilities. To support this academic reform, the model concurrently builds a "virtual-physical integrated" practice platform, with its operational framework. (see Figure4)

Figure4: Operational Framework of the Practical Platform



At the physical level, project-based internship bases are established in collaboration with leading shipping enterprises, institutionalizing a "dual-mentor system" to ensure students engage deeply in high-value-added operations like shipping financial product design and digital platform development, rather than merely performing routine tasks. Simultaneously, faculty members are actively encouraged to pursue industry-academia-research collaborations within enterprises, feeding cutting-edge practices back into teaching to alleviate the bottleneck of dual-qualified instructors.

At the virtual level, a shipping management simulation system based on digital twin technology has been developed. This system simulates dynamic scenarios such as carbon quota trading, port congestion, and route disruptions caused by geopolitical conflicts. Within this secure "digital sandbox," students practice replacing intuition-driven decisions with data-informed approaches, thereby strengthening their market sensitivity, risk prevention capabilities and resource optimization skills [28]. This environment enables repeated trial-and-error and strategy refinement with zero operational risk, effectively enhancing students' strategic decision making and risk management competencies.

Complementing this, the evaluation system for this model will shift from summative knowledge assessments to formative evaluations of process-based outcomes. Student project reports, case analyses, simulated negotiation performances, and decision-making logic within simulation systems will become key metrics for assessing their knowledge integration, innovative thinking, and practical application abilities, thereby comprehensively and objectively reflecting their competency development trajectories.

4.4 Responsive Mechanism (R)

The persistent lag and disconnect between talent cultivation and industry demands represent a critical weakness in traditional models. This model elevates dynamic responsiveness to a strategic level, committed to building a self-evolving, agile training ecosystem. Its cornerstone is the establishment of a "High-End Shipping Service Talent Cultivation Alliance" involving universities, shipping enterprises, financial institutions, law firms, government departments, and industry associations. This alliance serves not as a symbolic forum but as a substantive governance entity responsible for jointly developing training standards, reviewing curriculum content, and co-developing teaching resources. Its core function is to establish an institutionalized, two-way feedback and knowledge circulation mechanism.

On one hand, the alliance ensures continuous infusion of industry knowledge into education, where corporate experts serve not only as guest lecturers but as co-developers of curricula. The latest industry challenges and technological trends are swiftly transformed into teaching cases or updated course modules through the alliance mechanism. On the other hand, it strengthens the outward flow of academic knowledge into industry. University faculty members gain practical experience and research inspiration through the alliance, while their research outcomes provide decision-making support for enterprises. More importantly, the alliance has established a data-driven quality monitoring system. Through regular graduate career tracking, employer satisfaction surveys, and industry talent demand analysis, it generates assessment reports that serve as objective grounds for dynamically adjusting training programs (e.g., bi-annual fine-tuning). This mechanism ensures that the entire training model resonates with the rapidly evolving shipping industry, providing it with the vitality for continuous self-optimization.

4.5 Integrated Empowerment (I)

The coordinated operation of the Curriculum (C), Practice (P), and Responsive (R) subsystems ultimately converges on the value of Integrated Empowerment (I) for students. This concept emphasizes that the model aims not simply the accumulation of knowledge, but rather to systematically cultivate students' ability to integrate multidisciplinary knowledge to solve systemic problems, make effective decisions in complex and uncertain environments, and develop the innovative thinking and leadership required to drive industry transformation. This is achieved through a convergent curriculum system, authentic practice-driven learning, and an agile response ecosystem. Together, they form a comprehensive implementation structure designed to nurture versatile, forward-looking professional for the future of high-end shipping services. The three major implementation phases and their corresponding core tasks are summarized in Table2 below.

Table2: Implementation Pathway and Phase Tasks

Implementation Phase	Core Tasks	Expected Outcomes
Pilot Exploration	Establish a "High-End Shipping Services Experimental Class" to validate the C-P-R-I full-cycle model	Develop replicable and scalable standardized training programs and management systems
Expansion and Promotion	Make mature modules available university-wide as "micro-majors" or minor degree programs	Break down disciplinary barriers to establish a new framework for interdisciplinary collaborative training
System Reengineering	Feed successful practices back into the core major training programs	Drive substantive enhancement and systematic restructuring across relevant university programs

In terms of implementation, a three-step strategy is recommended: "Pilot Exploration - Expansion and Promotion - System Restructuring." The first stage involves establishing a "High-End Shipping Services Experimental Class" for comprehensive pilot validation. In the second stage, mature course modules should be made available to relevant majors in universities as "minor specializations" or "minor degrees". Finally, successful experiences should be systematically integrated into the curriculum design of primary majors, driving in-depth reform and substantive enhancement across maritime, business, law, information, and other disciplines. In terms of safeguards, the key lies in deepening institutional coordination. Universities must fully recognize faculty contributions and achievements in interdisciplinary curriculum development, industry-academia collaboration, and case-based teaching within their internal evaluation and incentive systems. This approach breaks down departmental barriers and stimulates faculty's intrinsic motivation to participate in model reform. Through the systematic operation of this entire C-P-R-I model, this framework ultimately enables the cultivation of multidisciplinary, composite talents tailored to high-end shipping service.

5.Conclusion

This study shows that the global shipping industry is undergoing profound transformation driven by digitalization, green initiatives, and geopolitical realignment. As a result, the core competitiveness of high-end shipping services has shifted from traditional asset scale to knowledge-intensive soft power. However, existing shipping talent development systems remain constrained by structural issues such as disciplinary silos, disconnect between theory and practice, and delayed responses to industrial changes, rendering them inadequate to support this transformation. To address these challenges, this paper proposes a multidisciplinary talent development model centered on Curriculum Integration (C) - Practice Driving (P) - Responsive Mechanism (R) - Integrated Empowerment (I).

This model breaks down disciplinary boundaries between shipping, finance, law, and information technology, reconstructing a three-tiered curriculum system (Foundation-Core-Scenario) that bridges knowledge gaps in digitalization and green governance. It enhances students' professional competence in tackling complex engineering and management challenges through a dual-drive teaching approach (Case-Project) and a blended virtual-physical practice platform. Additionally, it establishes a dynamic, agile feedback system through an industry-education alliance to mitigate the lag between educational content and industrial development. Overall, this systematic approach offers a viable innovative pathway to address the mismatch between supply and demand for high-end shipping talent.

Although this study proposes a systematic training model, some limitations remain due to the scope of study and practical constraints, requiring further refinement in future work. The proposed C-P-R-I talent development model is innovative however; it is limited by its theoretical foundation and lack of large-scale empirical long-term tracking of pilot programs. Future research should conduct long-term tracking of pilot programs to assess graduates' outcomes and verify the model's effectiveness. Furthermore, the current methods for evaluating multidisciplinary integration skills rely more on qualitative assessment, therefore, a standardized quantitative assessment system should be developed. Finally, the success of the model depends on faculty development, and future work should explore institutional incentive mechanisms that support cross-disciplinary collaboration and cultivate dual-qualified instructors.

Funding

This research was supported by Ningbo Philosophy and Social Sciences Planning Project (grant no. G2025-6-3).

Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Reference

[1] Andersen, M. (n.d.). New global report ranks top container ports worldwide. DNV GL. Retrieved December 5, 2025, from https://www.dnv.com/news/2025/new-global-report-ranks-top-container-ports-worldwide

[2] Wang, B., & Liu, J. (2019). Comprehensive evaluation and analysis of maritime soft power based on the entropy weight method (EWM). In Journal of Physics: Conference Series (Vol. 1168, No. 3, p. 032108). IOP Publishing. https://doi.org/10.1088/1742-6596/1168/3/032108

[3] Jia, Y. (2025). Benchmarking global high-end shipping services: Reflections on the digitalization, greening, and internationalization of shipping factor markets. Property Rights Guide, (07), 5–10.

[4] Xiao, G., Wang, Y., Wu, R., et al. (2024). Sustainable maritime transport: A review of intelligent shipping technology and green port construction applications. Journal of Marine Science and Engineering, 12(10), 1728. https://doi.org/10.3390/jmse12101728

[5] Sun, M. Z. (2025, April 11). Finance bolsters Shanghai's efforts to address shortcomings in high-end shipping services [Newspaper article]. China Water Transport News, (005). https://doi.org/10.28142/n.cnki.ncsyb.2025.000737

[6] Tan, C. F., & Hao, S. Q. (2023). Current status and recommendations for developing high-end shipping services in the Guangdong-Hong Kong-Macao Greater Bay Area. Water Transport Management, 45(03), 1–9. https://doi.org/10.13340/j.jsm.2023.03.013

[7] Zhang, Y., Chen, X., Zhang, Q., et al. (2021). Construction of an interdisciplinary training platform for shipping talents. In Proceedings of the International Conference on Economics, Law and Education Research (ELER 2021) (pp. 360–367). Atlantis Press.

[8] Yu, X. (2023). Research on the cultivation of talents for port and shipping industry based on artificial intelligence. In Proceedings of the 2023 IEEE 3rd International Conference on Social Sciences and Intelligence Management (SSIM) (pp. 284–287). IEEE. https://doi.org/10.1109/SSIM58869.2023.10159304

[9] Yang, Z., Gao, Q., & Cui, J. (2024). Exploration and practice of competency-based digital transformation in maritime education: Intelligent navigation and intelligent ship micro-specialty. In Proceedings of the 2024 5th International Conference on Information Science and Education (ICISE-IE) (pp. 329–333). IEEE. https://doi.org/10.1109/ICISE-IE59738.2024.10518660

[10] Dong, M. (2024). Exploration and practice of maritime talent cultivation amidst major transformations in the shipping industry. Pearl River Water Transport, (15), 32–34. https://doi.org/10.14125/j.cnki.zjsy.2024.15.024

[11] Shi, Z. H., Zhong, Y., & Chen, Z. C. (2025). Shipping talent cultivation needs under the new development pattern of Shanghai International Shipping Center. Pearl River Water Transport, (16), 103–107. https://doi.org/10.14125/j.cnki.zjsy.2025.16.031

[12] Zhang, Y., Zhu, H., Tao, D., et al. (2021). Interdisciplinary training models for shipping talents in universities. In Proceedings of the International Conference on Artificial Intelligence and Logistics Engineering (pp. 228–237). Springer International Publishing. https://doi.org/10.1007/978-3-030-86472-9_23

[13] Yang, T. Y., & Zhao, R. (2025). Enhancing talent cultivation capabilities in shipping to foster outstanding maritime professionals. Pearl River Water Transport, (13), 128–130. https://doi.org/10.14125/j.cnki.zjsy.2025.13.027

[14] Pantouvakis, A., & Vlachos, I. (2020). Talent and leadership effects on sustainable performance in the maritime industry. Transportation Research Part D: Transport and Environment, 86, 102440. https://doi.org/10.1016/j.trd.2020.102440

[15] Zhang, Y., Zhang, C., Zhang, Q., et al. (2022). Training mode of compound talents in Wuhan shipping enterprises. In Proceedings of the International Conference on Computer Science, Engineering and Education Applications (pp.

526–538). Springer International Publishing. https://doi.org/10.1007/978-3-031-06252-3_49

[16] Wang, H. (n.d.). A brief discussion on the cultivation of applied maritime talents under the new mode of intelligent shipping. [Journal Name Unknown]. (Note: Missing journal name and volume/issue; supplement if available)

[17] Cui, Y., & Liu, J. G. (2020). Research on the training model for shipping talents in the context of the 21st Century Maritime Silk Road. Research on Maritime Education, 37(03), 60–65. https://doi.org/10.16850/j.cnki.21-1590/g4.2020.03.012

[18] Chavez, C. A. G., Brynolf, S., Despeisse, M., et al. (2024). Advancing sustainability through digital servitization: An exploratory study in the maritime shipping industry. Journal of Cleaner Production, 436, 140401. https://doi.org/10.1016/j.jclepro.2024.140401

[19] Pang, Y. S. (2025, June 6). As the wave of intelligence surges, how should shipping talent development respond? [Newspaper article]. China Transportation News, (006). https://doi.org/10.28099/n.cnki.ncjtb.2025.002053

[20] Li, Y., Guan, H., & Liu, K. (2024). Study on cultivation mechanism for intelligent navigation talents based on "discipline crossing, interdisciplinary integration". In Artificial Intelligence, Medical Engineering and Education (pp. 614–623). IOS Press. https://doi.org/10.3233/AISE240062

[21] Pantouvakis, A., & Karakasnaki, M. (2018). The human talent and its role in ISM Code effectiveness and competitiveness in the shipping industry. Maritime Policy & Management, 45(5), 649–664. https://doi.org/10.1080/03088839.2017.1376131

[22] Zhao, P., & Zhao, T. (2025). The relationships between geopolitics and global critical minerals shipping: A literature review. Ocean & Coastal Management, 262, 107559. https://doi.org/10.1016/j.ocecoaman.2025.107559

[23] Wang, X. D., & Li, Z. F. (2025). The metamorphosis process and evolutionary logic of global shipping alliances. Journal of Dalian Maritime University (Social Sciences Edition), 24(03), 1–12.

[24] Lee, T., & Nam, H. (2017). A study on green shipping in major countries: In the view of shipyards, shipping companies, ports, and policies. The Asian Journal of Shipping and Logistics, 33(4), 253–262. https://doi.org/10.1016/j.ajsl.2017.09.002

[25] Kotcharin, S., & Maneenop, S. (2020). Geopolitical risk and corporate cash holdings in the shipping industry. Transportation Research Part E: Logistics and Transportation Review, 136, 101862. https://doi.org/10.1016/j.tre.2020.101862

[26] Raza, Z., Woxenius, J., Vural, C. A., et al. (2023). Digital transformation of maritime logistics: Exploring trends in the liner shipping segment. Computers in Industry, 145, 103811. https://doi.org/10.1016/j.compind.2023.103811

[27] Wang, G., Yuan, J., Li, S., et al. (2019). Cultivation system of innovative talents in ship and ocean engineering complex engineering. In Proceedings of the International Conference on Applications and Techniques in Cyber Security and Intelligence (pp. 1–7). Springer International Publishing. https://doi.org/10.1007/978-3-030-39919-2_1

[28] Guo, S. T., & Xu, K. (2021). Global digitalization trends in shipping and response recommendations. China Ocean Shipping, (02), 62–65.