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Differentiated Training System for Shipping Service Professionals: The Case of Shanghai International Shipping Center

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Abstract: To address the dual challenges of intelligent and green transformation in the global shipping industry, this study conducts an in-depth analysis of Shanghai, an emerging global shipping hub, as its primary case study. It identifies core issues within the existing system, including homogenized training models, outdated curriculum content, and delayed responsiveness to industry demands. These issues are particularly evident in the inability to deliver precise, differentiated training for two critical groups: foundational talent and high-end professionals. To address this structural contradiction, this study proposes a systematic differentiated training framework centered on deepening tailored development, drawing on Singapore's international best practices. This framework aims to establish a standardized support system for foundational talent and an innovation-driven ecosystem for high-end professionals, outlining specific reform pathways across three dimensions: training models, curriculum systems, and industry-education integration. Finally, through systematic initiatives such as a lifelong learning certification system and the development of cutting-edge shipping innovation, this framework will propel Shanghai toward establishing a shipping service talent ecosystem that aligns with future industry trends, features a clear structure, and possesses resilience. This research does not only provide strategic guidance for Shanghai to overcome structural talent bottlenecks and achieve a leap in capability, instead, it also offers a universally applicable framework for categorized training and system upgrades to emerging shipping hubs worldwide facing similar transformation challenges.

Keywords: Shipping Services; Talent Development; Differentiation; Shanghai; International Shipping Center

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1.Introduction

Amidst profound global transformations in the shipping industry driven by decarbonization and digitalization, the competitive logic of international shipping hubs is undergoing a fundamental shift: from hard power competition based on port throughput to soft power rivalry centered on high-end service capabilities and talent capital. As an emerging international shipping hub, Shanghai has consistently ranked among the world's top ports in key metrics, such as container throughput. However, its competitiveness in high-value-added service sectors (such as shipping finance, maritime law, and premium consulting) remain significantly behind traditional hubs like London and Singapore. This developmental imbalance is characterized by structural contradictions in its talent supply: on one hand, the adoption of alternative fuel technologies, such as methanol

and ammonia, creates skill gaps for basic operational personnel. On the other hand, the growing complexity of international maritime regulations and the digital trade ecosystem has led to a severe shortage of high-end, multidisciplinary talent capable of driving industrial transformation.

The inherent cause of this predicament lies in the systemic homogenization of the current shipping services' talent cultivation system. The existing model fails to effectively distinguish between the fundamentally different talent attributes required for basic services versus high-end services. This results in a one-size-fits-all approach in setting training objectives, updating curriculum content, and implementing industry-education integration mechanisms. This lack of differentiated top-level design does not only lead to a misallocation of educational resources, but also prevents the talent supply side from dynamically responding to the rapid iteration of industry demand. Consequently, it severely restricts the increase in capability and sustainable development of Shanghai as an international shipping center.

Although existing research has noted shifts in shipping talent demand, it remains largely confined to localized analysis of individual roles (e.g., seafarers or maritime law professionals), lacking systemic studies that propose structural reforms for the entire training framework. This paper therefore, aims to systematically explore the establishment of a scientifically differentiated training system for shipping service professionals in Shanghai. The study will first establish a "foundational-to-advanced" analytical framework to diagnose core issues within Shanghai's current system. Based on Singapore's international experience, it then proposes a practical, differentiated system development pathway across dimensions, including training models, curriculum systems, and industry-education integration. This research aims to provide policy-oriented solutions and theoretical references for Shanghai and emerging global shipping hubs navigating industrial transformation challenges.

2.Literature Review

2.1 Transformation of International Shipping Hubs and Evolving Talent Demands

Academic consensus indicates that the competitive core of the global shipping industry is shifting from "hardware" infrastructure to "software" services and human capital. Long-term maritime data analysis covering 130 years of Lloyd's shipping data, demonstrates that East Asia's port network has evolved from a Singapore-Hong Kong-Yokohama triangular structure into a chain-based hub system encompassing Singapore, Hong Kong, Shanghai, and Busan, signaling Shanghai's emergence as a new hub [1]. However, the 2024 World Leading Maritime Cities report identifies persistent developmental imbalances. Although Shanghai has achieved global leadership in hardware metrics like port facilities and logistics efficiency, it remains significantly behind Singapore in high-end service sectors such as maritime finance and legal arbitration. This gap aligns with research findings indicating that Shanghai has fundamental weaknesses in building international shipping innovation capabilities and cultivating high-end professional talent reserves [2].

Parallel studies confirm a fundamental transformation in shipping workforce demand. In recent days, industry recruitment standards are evolving from traditional skills toward multidimensional competencies framework, with English proficiency now an important selection criterion for ocean -going crew members [3]. Additionally, a recognized gap persists between maritime law education and industry practice indicating a disconnect between academic training and real-world legal application in shipping [4]. The rapid deployment of disruptive technologies like artificial intelligence, machine learning, and blockchain has also further introduced new competency expectations [5]. Research focusing on emerging shipping hubs reveals faults in key professional competencies especially in English language communication, which continues to hinder talent readiness in non-traditional maritime centers [6].

Among international shipping hubs, Singapore offers the most representative case of systematic workforce development. Its success is attributed to the establishment of long-term, multi-layered and well-structured national maritime talent pipeline.

Singaporean universities have demonstrated strong outcomes in cultivating composite talents through industry-academia collaboration and integration [7]. Singapore defines human resources as a core pillar of national competitiveness, implementing systematic strategies for foreign talent recruitment and local talent retention [8]. Sustained national investment in education has also been empirically verified, with strategic alliances established with top institutions like Massachusetts Institute of Technology (MIT), it has successfully integrated internationally advanced educational concepts with local needs [9]. Furthermore, the country's "Brain Gain" initiative has effectively attracted high-end international maritime professionals [10].

Notably, the Singaporean talent development system stands out for its systematic and sustained policy approach, offering valuable reference for addressing both the quantity and quality of shipping talent reserves in Shanghai's international shipping center.

2.2 Theory and Practice of Differentiated Cultivation

The theoretical framework of differentiated talent cultivation exhibits multi-level, interdisciplinary developmental characteristics. A "six-stage, multi-module" cultivation system model has been proposed in previous literature revealing structural deficiencies in high-skill professional development particularly in structural talent fields such as architecture [11]. Within the Society 5.0 transformation framework, people-centered strategic talent management models have also been advocated, emphasizing human centric competency formation over industrial-centric training logic [12]. Foundational classification theory further establishes a distinction between academic-oriented and technical-oriented talents development pathways, providing a crucial basis for the differentiated design in higher education institutions [13]. This concept has since been expanded across talent, technology and industry development dimensions to reinforce the theoretical validity of multidimensional differentiated cultivation frameworks [14]. At the practical level, several classification-based training frameworks have been introduced, including the "Four-Line Integration" model and industry-linked classified cultivation plan [15],[16]. While these offer case references, they face limitations in comprehensive application due to professional specificity. Qualitative research further shows practical strategies for executing differentiated policy pipelines [17], while the German advanced vocational training model provides international insights for China's differentiated training system [18].

2.3 Classification of Shipping Service Personnel

The transformation of the shipping service workforce structure is exhibiting pronounced trends toward specialization and stratification. Scholars observed significant polarization in the shipping service sector: where high-end positions urgently require composite talents with data analysis and cross-disciplinary collaboration capabilities, and entry-level roles face pressing demands for skill upgrading [19]. Sustainable industry transformation drivers, particularly energy management have become key to global shipping. The industry increasingly demands new talent possessing both specialized technical expertise and interdisciplinary perspectives [20]. This shift in demand reveals a misalignment between talent development systems and industry requirements. Leading industry research emphasizes that shipping companies must place talent at the core of their sustainability strategies [21]. At the foundational workforce level, empirical studies indicate a dual challenge in current seafarer training mechanisms: the absence of well-established career progression pathways coupled with inadequate capacity-building systems to address technological transformation [22]. At the high-end talent level, universities are encouraged to establish interdisciplinary training models, ensuring precise alignment between talent competency and industry demands through innovative curriculum systems [23]. AI-based personalized learning pathways have also been validated as a promising mechanism to effectively bridge the gap between traditional teaching and industry transformation [24]. Additionally, applied research further supports diversified training mechanisms through university-enterprise collaboration and long-term international maritime partnerships [25].

2.4 Research Gaps and Research Value

Existing academic research has explored the restructuring of talent demands driven by the global shipping industry's center of gravity shift, intelligent and green technologies, as well as the systematic experiences of leading international shipping hubs (e.g., Singapore). There is a widespread recognition of the necessity for structural reform in shipping talent cultivation systems. However, a critical review of existing literature reveals significant shortcomings in constructing systematic, differentiated talent cultivation frameworks.

Firstly, existing research tends to adopt a homogenized and descriptive analytical perspective, lacking systematic frameworks for differentiated training that clearly differentiate "foundational operational personnel" from "high-end composite maritime professionals" in terms of cultivation objectives, curriculum architecture, competency standards and evaluation mechanisms. This analytical limitation weakens theoretical guidance where solutions often reduce systemic restructuring to fragmented curriculum or skill optimization rather than structural system transformation.

Secondly, existing literature lacks a vertically integrated ecological closed-loop in constructing key mechanisms. On one

hand, existing classification studies predominantly rely on static analysis, lacking foresight into the dynamic evolution of talent structures amid industry technological transformations, while insufficiently exploring synergistic development mechanisms between the two talent categories. On the other hand, although some theoretical frameworks address multi-tiered training, they fail to adequately account for the unique characteristics of the shipping service industry. Practical gaps notably exist in the depth of industry-education integration and the comprehensiveness of lifelong learning systems.

In summary, these research gaps precisely explain the entry point and value of this study. This paper aims to surpass partial optimization and phenomenological exploration by constructing a differentiated training system framework. This framework takes the "basic-advanced" dichotomy as its logical starting point, deeply aligns with the characteristics of the shipping industry, and comprehensively covers dimensions including objectives, curricula, integration, and evaluation. This research does not only seek to provide a systematic solution for Shanghai to resolve structural contradictions in talent cultivation, instead, it also aims to offer a reference-worthy practical pathway for emerging global shipping hubs at similar developmental stages as they navigate the dual challenges of industrial upgrading and talent competition.

3.Analysis Framework and Methodology

3.1 Theoretical Framework of a Differentiated Cultivation System

To effectively diagnose the challenges of homogenization in talent cultivation for Shanghai's international shipping center and to provide a solid theoretical foundation for constructing its differentiated training system, this study builds upon theories of categorized training and tiered instruction from the fields of education and talent management [26-28]. This is to establish a distinguished theoretical framework applicable to shipping service talent development. These theories emphasize that teaching strategies should be adjusted according to individual learner differences to break away from the traditional "one-size-fits-all" model. Differentiated training pathways should therefore be designed based on the fundamental variations among talent groups particularly in knowledge structures, competency requirements, and long-term career development trajectories. Guided by these theoretical principles and considering the increasingly complex talent demands and inherent structural characteristics of the shipping service industry, this paper operationally categorizes shipping service talent into two core categories: "foundational talent" and "high-end talent" [29-30]. These categories exhibit significant differences in training objectives, core competencies, and career development pathways (see Table1). This study highlights that such differentiated training extends beyond merely distinguishing talent characteristics. It includes systematic design across multiple dimensions including: training models, curriculum systems, and industry-education integration. This framework aims to reveal structural gaps by clearly categorizing and analyzing the current state and core issues of Shanghai's existing training system.

Table1: Framework for Differentiated Classification of Shipping Service Talents

Classification Criteria	Basic Shipping Service Talent	High-End Shipping Service Talent
Core Positioning	Operational Execution Level	Strategic Decision-Making Level
Basic Characteristics	Skill standardization, process standardization, high demand	Knowledge-intensive, innovation-driven, high strategic value
Training Objectives	Proficient, reliable, and efficient	Driving industry transformation with global competitiveness
Scope of Responsibilities	Shipping management, services, and operational support	High-value-added global shipping services
Capability Requirements	Expertise in Professional Skills	Mastery of Cutting-Edge Technologies
	Foreign Language and International Competence	Cross-Domain Integration
	Process Collaboration Skills	Innovative R&D Capabilities

3.2 Research Methodology and Data Sources

Based on the aforementioned analytical framework, this study employs a case study approach, selecting Shanghai as a representative case. As the world's largest container port city, Shanghai is undergoing a critical transition from "hardware scale" to "software services," presenting highly representative structural talent challenges. Throughout the research,

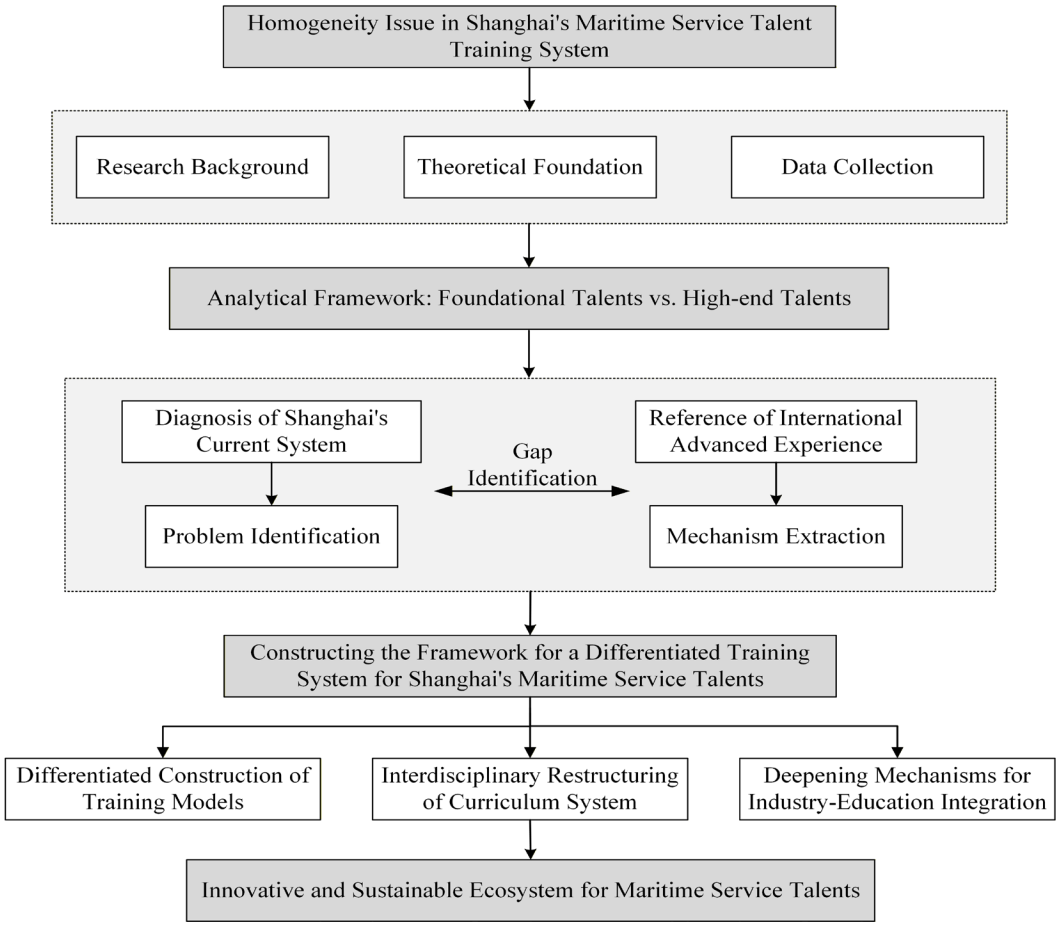
Singapore's relevant practices are introduced as a source of experiential reference and insights, aiming to provide feasible pathways and analytical support for Shanghai to establish a differentiated talent development system.

To ensure analytical objectivity and multidimensionality, this study employs triangulation to collect multi-source data, primarily comprising the following three categories:(1) Policy Documents: Systematically collected policy documents issued by Shanghai Municipality and Pudong New Area between 2015 and 2024 concerning shipping center development and talent cultivation (e.g., the "14th Five-Year Plan for Building Shanghai into an International Shipping Center"). Additionally, referenced strategic blueprints published by Singapore's Maritime and Port Authority (MPA) and Ministry of Education (MOE) to facilitate institutional comparisons and insights. (2) Curriculum Frameworks: Representative maritime curricula from Shanghai Maritime University and Nanyang Technological University (NTU) were selected. Key data—including course structures, credit systems, and internship arrangements—were extracted to diagnose issues of homogeneity and obsolescence in existing programs. (3) Industry Reports: Authoritative industry reports from Det Norske Veritas (DNV), the International Chamber of Shipping (ICS), and Lloyd's Register were integrated to obtain forward-looking data on green shipping and digital skill requirements, supporting the analysis of talent development directions.

3.3 Analysis Process Design

This study follows a logical pathway of "theory-driven—empirical diagnosis—benchmarking—system construction" (as illustrated in Figure1 below). Based on the constructed "basic-advanced" differentiated theoretical framework, content analysis is employed to systematically code and interpret the aforementioned multi-source data. The analysis identifies systematic weaknesses in Shanghai's current talent cultivation model with specific emphasis on curriculum content, and industry-education integration. These deficiencies collectively explain the root causes of Shanghai's talent homogenization and its relative lag in high-value maritime service competencies. Subsequent sections leverage Singapore's experience as a reference to systematically propose specific countermeasures for building differentiated pathways in cultivating both foundational and high-end talent.

Figure1: Route for Differentiated Cultivation Research



4.Diagnosis of Shanghai's Training System Based on a Differentiated Framework

As a globally important international shipping hub, Shanghai's shipping services face severe structural challenges and homogenization issues with their talent development system. Research indicates that Shanghai exhibits significant talent gaps and service capacity deficiencies in high-value-added sectors such as shipping insurance and maritime arbitration [31]. Relevant policies have limited penetration into enterprises and the high-end shipping services market also remains insufficiently mature, resulting in the persistent shortage of specialized, internationally oriented talent reserves [32]. Compared with Singapore, Shanghai attracts fewer global shipping functional institutions, leading to a persistent outflow of high-end business [33]. Additionally, structural disparities exist between the two in port-city synergy and high-end shipping service capabilities [34]. From a systemic perspective, the root cause of these persistent challenges (such as insufficient supply of high-end talent, inadequate internationalization, and poor market alignment) can be traced to the absence of a differentiated training mechanism. This chapter conducts a detailed diagnosis of the current state of differentiation within Shanghai's shipping service talent training system based on the aforementioned "basic-to-advanced" differentiation theoretical framework, focusing on three core dimensions: training models, curriculum systems, and industry-education integration.

4.1 Homogenized Training Models

Shanghai's shipping service talent cultivation system has established a comprehensive chain from vocational colleges to postgraduate programs, providing a stable talent supply for foundational fields like port operations and vessel navigation. According to statistics from the Shanghai Municipal Commission of Transport, 28 universities in the city offer majors closely related to shipping. Doctoral and master's programs are concentrated in seven institutions, focusing on transportation engineering, naval architecture, and ocean engineering. The undergraduate level covers 11 majors, including transportation and navigation technology across 21 institutions (enrolling approximately 3,100 students annually). The vocational education stage focuses on 15 practical majors, such as marine engineering technology and aircraft electromechanical equipment maintenance, involving seven institutions (enrolling approximately 2,500 students annually). However, Shanghai's strategy for cultivating high-end talent relies heavily on policy guidance and talent recruitment. Key initiatives such as the "List of Key Shipping Institutions" and the "Shanghai Shipping Talent Shortage Development Catalog," provide subsidies, individual income tax incentives, and support services for executives in Pudong New Area and Lingang New Area. However, these measures primarily function as attraction mechanisms rather than organic talent cultivation. The pilot "dual certification" program for shipping professionals, launched in 2016 (training 141 jointly certified talents by 2022), remains limited in scope. This external resource-dependent model struggles to effectively address the shipping industry's structural shortage of specialized workforce. For instance, DNV's authoritative 2025 Shipping Outlook Report predicts that with over 50% of vessels in the orderbook utilizing alternative fuels, approximately 33,000 additional seafarers will require standardized training in new fuel operations within the next three to four years. Concurrently, the complexity of the International Maritime Organization's (IMO) net-zero framework demands that high-end professionals possess strategic integration capabilities spanning regulations, technology, and economics. This reflects shortcomings in domestic capacity for cultivating top-tier talent. In general, while Shanghai's foundational talent development model meets scale requirements, it remains deficient in fostering core competencies like international perspectives and cross-cultural communication skills. High-end talent cultivation relies excessively on external recruitment, with domestic training mechanisms yet to achieve effective breakthroughs. This results in homogenized training models across different talent tiers, lacking targeted approaches.

4.2 Curriculum Lag and Content Homogeneity

Despite the substantial scale of Shanghai's maritime talent development system, its curriculum content exhibits significant lag and homogenization in addressing global industrial transformation, particularly in green shipping and digitalization. The International Maritime Organization's emissions reduction policies have intensified global competition for green shipping talent. Lloyd's Register forecasts a global shortage of approximately 450,000 dual-fuel vessel crew members by 2030, highlighting the urgent need for curriculum updates amid rapid technological iteration in shipping.

However, Shanghai's existing curricula lag significantly behind international best practices in both content relevance and training standards. This issue manifests not only in the insufficient integration of emerging technologies and international

regulations but also in a homogenized course design that fails to effectively differentiate between the specialized practical skills required for entry-level personnel and the interdisciplinary knowledge integration and innovative thinking demanded of high-end talent. For instance, digital competency training programs in Shanghai universities (e.g., Shanghai Maritime University), remains focused on prioritizing tool-oriented computer courses like C programming, without mandatory courses in big data analytics or AI applications. This fails to support the computational thinking skills essential for developing high-end talent. Simultaneously, in the green shipping sector, the curriculum lacks standalone core courses like "Shipping and the Environment" or "Decarbonization Technologies," which hinders systematic coverage of cutting-edge regulations and technologies. Furthermore, Shanghai remains disadvantaged in critical areas like seafarer training facilities and practical training opportunities. Consequently, this curriculum homogeneity prevents foundational graduates from mastering current global technical regulations and high-end graduates from acquiring international vision and innovation competencies, which may lead to structural knowledge.

4.3 Superficial Industry-Education Integration

Shanghai has established a multi-tiered framework for advancing industry-education integration. Policy support explicitly promotes deep collaboration among industry, academia, and research, with the Municipal Education Commission facilitating corporate-university partnerships across 28 institutions. For instance, Hongkou District's "curriculum-certification integration" initiative provides RMB 50,000 per project to institutions participating in the pilot support programs. This is aiming to link academic education with professional qualification certification. This "order-based" training model aims to improve graduates' job readiness and address the industry's urgent demand for frontline skilled workers. Additionally, platforms like the North Bund International Shipping Forum provides institutionalized channels for industry-academia-research dialogue. However, current industry-education integration remains fragmented and operationally shallow reflecting inadequate university-enterprise collaboration and low efficiency in translating outcomes into practical applications. The most direct evidence of this superficiality lies in the structure and duration of practical training components. Taking Shanghai Maritime University's international shipping program as an example, its training plan reveals that practical teaching segments predominantly rely on one-week short-term simulation exercises (such as shipping agency or port internship simulations) as core content.

Although a 16-week graduation internship is scheduled, it is typically placed in the final semester, making it highly vulnerable to disruption from job searching and postgraduate application pressures, often resulting in a shallow engagement rather than competency formation. Furthermore, the credit allocation for practical training remains disproportionately low. This model treats practical training as an addition to theoretical learning rather than central to skill development. Such superficiality creates a structural disconnect between talent cultivation and industry demands, leaving graduates ill-equipped to respond to global industrial transformations. It struggles to provide authentic training environments for high-risk areas like alternative fuel vessel operations, as emphasized in the DNV report. It also fails to offer high-end talent cross-disciplinary and high-complexity project experience (e.g., compliance cost analysis under IMO NZF, digital supply chain integration). As a result, collaboration focuses on talent quantity supply, not co-developed or co-innovation curriculum ecosystems, deepening Shanghai's structural misalignment with global industry transformation frontiers. This chapter identifies Shanghai's maritime talent cultivation system based on differentiated training theory and a "basic-advanced" dichotomy framework for shipping service personnel. Analysis reveals that, despite Shanghai's substantial training scale, the system exhibits severe homogenization across three core dimensions: training models, curriculum content, and industry-education integration. This undifferentiated training mechanism directly leads to deep-seated issues such as insufficient supply of high-end talent, inadequate internationalization levels, and structural mismatches between talent and market demands. Particularly in the face of global challenges like green and digital transformation in shipping, homogenized training has become a key bottleneck in the advancement of Shanghai's international shipping center capabilities. Therefore, the establishment of a differentiated training systems that are capable of meeting the needs of talent at various levels, has become an inevitable choice for Shanghai to achieve a leap in its shipping functions.

5.Pathways for Building a Differentiated Training System for Shanghai's Shipping Service Talent

Building on the structural diagnosis presented in Chapter 4, this chapter aims to construct a differentiated training system tailored to Shanghai's industrial conditions and responsive to its persistent structural challenges. Informed by Singapore's advanced training experience and based on a "foundational-to-advanced" analytical framework, this study proposes a systematic solution. This solution adopts a dual-track approach of "foundational support and high-end drive," covering three core dimensions: training models, curriculum systems, and industry-education integration. It is underpinned by lifelong learning and a cutting-edge innovation ecosystem. The following sections will first analyze Singapore's specific experiences, then outline a sequential implementation path for Shanghai based on this framework.

5.1 Lessons from Singapore's Shipping Talent Development

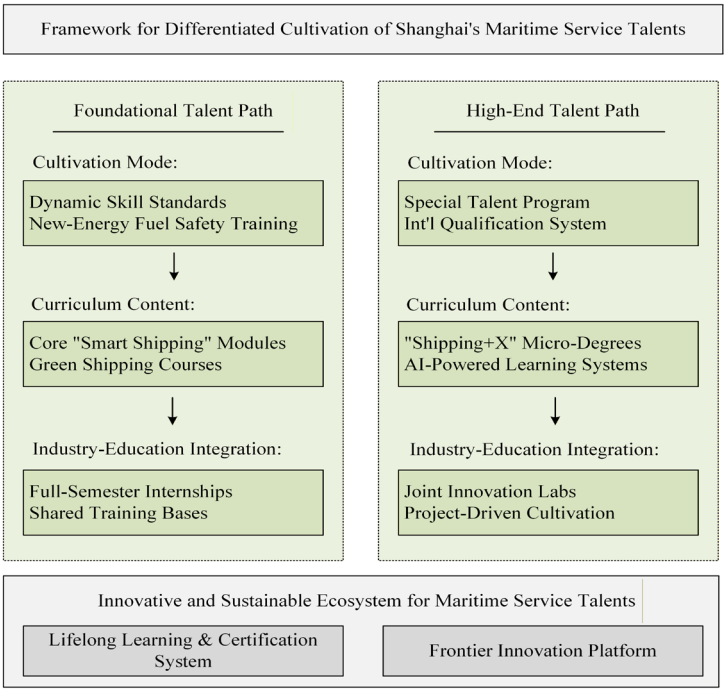
As the globally recognized international shipping center with the strongest comprehensive capabilities, Singapore has consistently ranked first in the World Leading Maritime Cities report for several consecutive years. This achievement stems from its successful establishment of a multi-layered, highly coordinated, and industry-aligned differentiated talent cultivation system. Importantly, Singapore's model reflects systematic institutional engineering rather than simple accumulation of resources, offering valuable strategic direction for Shanghai's transition towards service-led maritime competitiveness. At the top-level design stage of its training model, Singapore established the Maritime Skills Framework through multi-agency collaboration, including the Maritime and Port Authority (MPA). This model provides unified competency benchmarks and career pathways for the industry. For entry-level talent, programs like the Tripartite Maritime Training Award (TMTA) ensure standardized and efficient supply, significantly reducing seafarer training cycles from 31 to 22 months. For advanced composite talent, initiatives such as the Global Internship Award (GIA) and PIER71™ foster a composite ecosystem supporting international exposure, entrepreneurial and technological innovation. From a curriculum foresight perspective, Singapore has achieved real-time alignment between technological advancements and educational content. Its Maritime Energy Training Facility (METF) platform has also transformed the safe operation of alternative fuels like methanol and ammonia into globally leading standardized training modules, ensuring foundational skills remain synchronized with international safety standards.

Simultaneously, institutions like Nanyang Technological University (NTU) have addressed the gap between talent, knowledge systems, and industry demands at its source.

Its maritime studies programs mandate courses such as "Shipping and the Environment" and "Introduction to Data Science and Artificial Intelligence" reflect a strategic shift toward environmental governance literacy and digital-driven analytical competency. NTU also applies interdisciplinary "Shipping + X" model, cultivating future industry leaders with cross-disciplinary understanding and problem-solving capabilities.

In the dimension of industry-education integration depth, Singapore has elevated collaboration beyond long-cycle institutional embedding rather than short-term internships. Maritime education programs in NTU mandates a full-semester (10-credit) Professional Internship as a core requirement, ensuring students engage in real, and complex mid-to-long-term corporate projects. This replaces traditional graduation internships, effectively overcoming the limitations of short-term placements. Simultaneously, Singapore achieves a comprehensive, multi-tiered industry-education integration model through university-industry joint R&D centers (e.g., the Maritime Electrification Center) and initiatives like the MaritimeONE Scholarship, ensuring talent development drives industrial innovation. Singapore's experience demonstrates that the effectiveness of differentiated training lies in establishing an institutional system that tightly integrates strategic frameworks, curriculum design, and practical components. For Shanghai, the institutional development should draw upon this systemic approach rather than isolated replication of specific measures. Based on this, this study constructs a differentiated training framework for Shanghai's shipping service talent, as illustrated in Figure2. This framework systematically integrates the core logic of dual main threads, three dimensions, and one supporting pillar, providing a clear blueprint for subsequent strategic discussions.

Figure2: Framework of the Differentiated Cultivation System



5.2 Implementing a Differentiated Training System Based on "Foundational Support and High-End Drive."

To address the issue of homogenization in Shanghai's training model and achieve precise talent supply, a tiered and categorized differentiated training system must be established. Singapore's long-standing practice of achieving precise talent positioning through standardized training for foundational personnel and specialized programs for high-end talent offers critical strategic insights. For foundational talent, Shanghai should expedite reform in vocational maritime education. The government must lead industry organizations and enterprises in establishing a dynamically adjusted vocational skills standards system. This aims to swiftly address the international shipping industry's urgent need for skill updates, particularly the large-scale incremental demand for alternative fuel crew members (e.g., methanol, ammonia fuel). Reforms must thoroughly align talent development objectives with international maritime technical standards, prioritizing the implementation of new energy fuel safety operation protocols and the construction of practical training facilities. Systematic training in new energy fuel safety operations should be conducted to ensure that the supply of foundational talent possesses standardized efficiency and immediate operational capability.

For high-end talent, Shanghai should capitalize its existing shipping industry cluster advantages, toward deeper professional competency cultivation. A "Special Program for High-Level Shipping Talent" should be established, featuring training plans that incorporate international laboratory rotations and industry mentor systems, alongside the development of internationally aligned qualification certification frameworks. The training objectives for these professionals must center on understanding and navigating complex international regulations like the IMO Net Zero Framework (NZF), while developing strategic capabilities to leverage data analytics for investment and operational optimization. By prioritizing improvements in the development environment for high-end services such as shipping finance and maritime law, Shanghai can attract and retain top talent through an industrial ecosystem and competitive positions, thereby strengthening its competitive position in global maritime "soft power" competition.

5.3 Building an "Intelligent + Interdisciplinary" Curriculum System

Addressing Shanghai's challenges of outdated and homogenized curricula requires modernizing and restructuring the curriculum system to establish a new "Smart + Interdisciplinary" framework. Singapore's strategic embedding of digital and green competencies into university curricular provides a valuable paradigm reference.

First, digital competency must be repositioned as a core knowledge foundation for all shipping professionals rather than

an optional technical supplement. Courses such as "Shipping Data Analytics" and "Introduction to Maritime Artificial Intelligence" should be upgraded into mandatory core modules forming a structured "Digital Intelligence Shipping" module. Simultaneously, in response to new International Maritime Organization (IMO) regulations and global decarbonization trends, mandatory "Green and Low-carbon" courses must be introduced, including Alternative Fuel Technologies and Risk Management, Shipping Carbon Markets, and Finance. Universities should establish channels for dynamic course adjustments and rapid updates to ensure teaching content responds with zero lag to cutting-edge industry technologies, achieving a strategic restructuring of the knowledge system.

Secondly, Shanghai should promote curriculum flexibility and interdisciplinary integration. Inspired by Singapore's "Shipping + X" curriculum model, institutions should break down disciplinary barriers by systematically establishing micro-majors or dual-degree programs like "Shipping + Fintech" and "Shipping + Maritime Law." This can be achieved by reducing the proportion of traditional, rigid general education credits, freeing up more credit space for students to pursue deep integration and interdisciplinary electives. Universities should leverage existing platforms like national key laboratories, to build a full-chain talent development mechanism covering "basic research—technology development—industrial application." Future efforts should focus on exploring the introduction of tools like generative AI to develop specialized intelligent learning systems for enabling precise knowledge delivery for high-end talent.

5.4 Deepening Technology-Driven Industry-Education Integration

To address the superficial nature of current industry-education integration in Shanghai, it is imperative to elevate university-enterprise collaboration from mere resource exchange to a deep synergy mechanism centered on knowledge co-creation and risk-sharing. Singapore's approach that embeds long-term, institutionalized professional internships into core training processes and fostering an ecosystem where joint industry-academia R&D enriches teaching, offers a reference path for Shanghai's transformation. This extension must be grounded in tiered talent development needs. For foundational talent cultivation, institutionalized practice is paramount. Modeled after Nanyang Technological University's 10-credit semester-long Professional Internship, Shanghai should adopt a system that mandate 4–6-month enterprises industrial project participation, supported by credit conversion and institutional safeguards. Concurrently, Shanghai should collaborate with enterprises to establish high-standard "shared training bases," integrating the latest corporate technical specifications, operational standards, and real-world industrial data scenarios into teaching to achieve "job-ready graduates."

For high-end talent, the focus should shift to joint R&D innovation and industrial incubation. To address innovation bottlenecks in high-end services, Shanghai should lead government-university-industry collaborations to establish "Future Shipping Industry Labs" modeled after Singapore's PIER71™. These platforms must concentrate on cutting-edge fields like smart shipping and green energy, transforming enterprise-identified industrial bottlenecks into university-led research and innovation projects. By anchoring development in real-world industrial R&D initiatives, they will build sustainable training mechanisms that seamlessly bridge theoretical learning with practical application.

5.5 Enhancing Lifelong Learning and Cutting-Edge Innovation Ecosystems

The sustainable operation of Shanghai's differentiated training system requires systematic support from lifelong learning mechanisms and an innovative environment, though a "Lifelong Skills Certification and Development System for the Shipping Services Industry" as demonstrated in Singapore's long-term national strategy.

In the lifelong learning dimension, differentiated skill-upgrade pathways must be established. For entry-level personnel, prioritize developing "micro-certificates" in low-carbon operations and digital maintenance. Leverage the "1+X" certification system to directly link skill accreditation with salary increases and talent residency policies, incentivizing existing workers to continuously upgrade their skills. For high-end talent, collaborate with top international business schools and maritime institutions to launch industry leadership programs focused on macro-strategy and global carbon market issues, enhancing their standing within international discourse frameworks.

In the innovation ecosystem dimension, an external environment supporting talent transformation must be cultivated. Shanghai should establish a pioneering zone for shipping technology innovation in the Lingang New Area, concentrating on building open R&D platforms for green fuel bunkering and autonomous intelligent vessel navigation to provide authentic

technical validation environments for industry-education integration. Simultaneously, specialized institutions like the Shanghai Institute of Shipping Research should also develop new training programs in intelligent vessel operations and maintenance, as well as new energy vessel handling. Guiding social capital to establish technology transfer funds will accelerate the application of cutting-edge technologies and the transition of traditional talent into new technical fields. This will ultimately form a sustainable shipping service talent ecosystem where "talent drives industry, and industry nurtures talent."

6.Conclusion

Through systematic analysis of the current status and challenges in Shanghai's shipping service talent cultivation system, and drawing on Singapore's advanced experience, this study clearly indicates that establishing a differentiated cultivation system driven by a dual-track approach—covering both foundational and advanced levels—is the key pathway to resolving talent bottlenecks during Shanghai's green and digital transformation as an international shipping center. Research findings reveal that the core issue in Shanghai's current training system lies in the structural mismatch between talent supply and industry demand. This stems from the system's homogenization—addressing differentiated needs with a single model. These factors collectively create a dilemma where foundational talent lacks sufficient skill updates while high-end strategic talent remains in short supply, severely constraining Shanghai's advancement in high-end service capabilities.

The theoretical value of this study lies in constructing a differentiated training analysis framework—spanning "basic to advanced" levels—tailored for the shipping service industry. It clarifies the fundamental distinctions between these two talent categories in core positioning, competency requirements, and training pathways, offering a novel analytical perspective for subsequent research. At the practical level, the study offers a systematic set of differentiated training strategies for Shanghai's international shipping center development. Specific measures include: implementing a "foundational support-high-end driven" differentiated training system; reconstructing a "smart + interdisciplinary" dynamic curriculum system; deepening technology-oriented industry-education integration mechanisms; and enhancing lifelong learning systems while strengthening cutting-edge innovation ecosystems.

Regarding application prospects, the proposed differentiated training system does not only directly serve Shanghai's strategic need to elevate its international shipping hub capabilities, instead it also provides crucial reference for talent development model innovation in emerging global shipping centers. However, while this study presents a comprehensive framework, further refinement is required to translate theory into practical effectiveness. Future research should focus on refining differentiated training standards, improving evaluation systems, and fostering collaborative mechanisms among government, enterprises, and educational institutions to drive deeper transformation from theoretical research to practical application.

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Conflict of Interests

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

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