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Skill Obsolescence and Workforce Resilience in the Shipping Industry: A Strategic HRM Framework

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Abstract

In a rapidly evolving global economy, the shipping industry faces significant challenges related to skill obsolescence and the need for workforce resilience. This abstract presents a strategic Human Resource Management (HRM) framework designed to address these challenges. As technological advancements, such as automation and digitalization, reshape operational processes in shipping, the demand for specific skills is continuously changing. Consequently, many maritime professionals find their existing competencies inadequate, leading to skill obsolescence. This phenomenon not only affects individual career trajectories but also poses risks to organizational performance, competitiveness, and long-term sustainability in the shipping sector. The proposed HRM framework emphasizes proactive workforce development strategies that align with the dynamic nature of the shipping industry. Central to this framework is the concept of lifelong learning, which encourages continuous professional development and adaptability among employees. By fostering a culture of learning, organizations can better prepare their workforce for emerging challenges and technological disruptions. The framework also highlights the importance of strategic talent management, which involves identifying critical skills gaps and implementing targeted training programs to bridge these gaps. Moreover, the framework advocates for collaboration between industry stakeholders, educational institutions, and policymakers to create relevant curricula and training opportunities that reflect the current and future needs of the shipping industry. This collaborative approach not only enhances the skillset of the workforce but also ensures that training remains relevant and effective. Additionally, the framework considers the role of employee engagement and motivation in building resilience. Engaged employees are more likely to embrace change and contribute positively to organizational adaptability. The strategic HRM framework proposed in this study serves as a comprehensive approach to mitigating skill obsolescence and enhancing workforce resilience in the shipping industry. By integrating continuous learning, strategic talent management, and stakeholder collaboration, organizations can not only safeguard their operations against the challenges posed by rapid technological change but also foster a more adaptable and skilled workforce capable of thriving in an uncertain future.

Key words: Skill Obsolescence, Work force Resilience, Strategic HRM, Skill Renewal in Shipping, Capability Enhancement.

JEL Classification: J24, L92, M53

1. Introduction

The global shipping industry is undergoing unprecedented transformation driven by environmental, technological, and geopolitical factors. Navigating this evolving landscape, firms face critical decisions on fleet renewal, port expansion, and global talent acquisition, as well as on human resources and skills. Many sectors experience altered demand for skills due to digitalisation, disruption, and automation, yet the maritime domain appears particularly vulnerable. As a consequence of ageing workforces and limited training opportunities, substantial segments of existing competencies risk becoming obsolete. Against this backdrop, a marine vessel retains its capacity for traversing a fluid global economy, but the term ‘maritime’ has become less salient. Container shipping companies increasingly view services from a supply-chain perspective. Seaport functions extend to logistics operations,

hinterland connectivity, and inland transport. The concept of maritime borders is fading, alongside a maritime-specific skill framework.

In this context, Skill Obsolescence and Workforce Resilience in the Shipping Industry emerges as a high-priority research area for Human Resource Management. Theoretical exploration and empirical investigation generate insights of immediate relevance to decision-makers across industry value chains, contributing to strategic asset management, human capital development, and mid-term workforce planning. The proposed framework also lays the foundation for an integrated Strategic HRM perspective that accommodates existing theories and addresses current gaps in the literature. Configuration of knowledge-intensive resources, onboarding of highly skilled staff, adoption of advanced technologies, and adaptation of business strategies form a core maritime capability set. Maritime training institutions enhance competency and policy learning through simulators, fostering widespread continuous improvement. Also efficient monitoring and oversight of crew activity remain imperative.

2. Literature Review

The shipping industry is significantly affected by rapid changes in operational and competitive conditions, largely driven by digitization, automation, and regulatory adjustments. Standard percepts of skill obsolescence and workforce resilience are therefore relevant. Consequently, competency gaps emerge because operational roles apparently require a greater emphasis on digital and cross-functional skills, while maritime professionals who possess an entirely different set of competencies than their youth must maintain relevant skills. Research says that traditional human resource management cannot effectively deal with these developments. Global shipping firms strive to imbue agility and, a few, resilience into their organisations. Both concepts underscore adaptability yet differ in focus, with agility centring upon the company and resilience on the workforce. An examination of contemporary skill obsolescence issues affecting marine personnel indicates that programme design for human resource management adaptation to these challenges is both feasible and timely (Asyali & Zorba, 2010).

Ling, Li (2022) suggest that life-long learning should be part of an organization's strategic goals. Both individuals and companies need to commit to reskilling and upskilling and make career development an essential phase of the future workforce. Great efforts should be taken to make these learning opportunities, such as reskilling and upskilling, accessible, available, and affordable to the workforce. The literature on Skill Obsolescence and Workforce Resilience in the Shipping Industry, when examined through a Strategic HRM lens, traces a complex trajectory from the disruptive pressures posed by Industry 4.0 to the continuously evolving competencies and nuanced measurement of resilience that are increasingly necessary for various seafaring professions. This introduction serves to synthesize three key articles in a well-considered chronological order, highlighting in detail how the forces of digital transformation, the ongoing development of competencies, and the critical measurement of resilience collectively shape and influence strategic human resource management within the shipping sector. By understanding and integrating these elements, organizations can better prepare themselves to navigate the challenges and opportunities that arise in this rapidly changing environment.

The earliest strand highlights the talent management challenges posed by the fourth industrial revolution. It argues that rapid technological advances such as robotics, augmented reality, the Internet of Things, big data, and 3D printing create a perfect storm for strategic HRM, widening gaps between existing capabilities and emergent role requirements. As organizations seek to navigate this pace of change, middle managers emerge as pivotal actors in change management and talent development. The piece cautions that many new roles (e.g., app developers, data scientists) did not exist a decade ago and that conventional education and talent pipelines are ill-equipped to supply the needed skills. Given these dynamics, traditional approaches such as poaching have limited efficacy due to skill shortages in the broader talent pool. This analysis foregrounds the strategic HRM task of aligning capability development with disruptive technology trajectories and places emphasis on how leadership at the middle-management level can bridge strategic imperatives and frontline execution (Whysall et al., 2019).

Building on this, the literature expands to identify emerging competencies for logistics professionals in the digital era. A systematic literature synthesis maps the competencies that logistics workers must acquire to operate effectively within digitally enabled supply chains. The authors articulate a framework of competencies shaped by

recent technological trends and emphasize that the relevant literature spans business, management, and accounting domains, reflecting the interdisciplinary nature of logistics work in a digitized environment. The methodological focus, layered database searches with filters for digital technologies, logistics competencies, and the logistics keyword, ensures the relevance of identified competencies to contemporary shipping contexts. The consequence for strategic HRM is a call to reframe workforce development around these emergent capabilities, acknowledging that ongoing digitalization reshapes required skill sets and the organizational learning agenda (Yi Koh & Fai Yuen, 2022).

A more recent strand concentrates on resilience in seafaring, examining how resilience is defined, conceptualized, and measured across studies. The systematic review synthesizes literature from 2003 to 2023 to illuminate the diversity of definitions and the variability of measurement approaches. It emphasizes the need for reliable and valid instruments tailored to the seafaring context, given its unique stressors and operational demands. The review's rigorous screening process narrows a broad literature base to a focused corpus that clarifies conceptualizations of resilience and highlights methodological considerations for assessment. For strategic HRM, this work reinforces the imperative to embed resilience as a core dimension of workforce capability, informing selection, training, and well-being initiatives in a high-risk, high-stress environment (Janssen et al., 2024).

Digital disruption fundamentally reshapes and transforms what workers must know and what they are capable of doing; as a result, emerging competencies must be meticulously defined, nurtured, and cultivated to meet the evolving demands of the market; furthermore, resilience must be clearly defined and measured in detail to ensure workforce robustness and adaptability under operational pressures. This integrated perspective strongly supports a strategic Human Resource Management (HRM) framework that effectively aligns talent development initiatives with ongoing technological evolution while embedding resilience as a core capability within maritime organizations to thrive amidst continuous change and challenges.

2.1. Skill Obsolescence in Maritime Contexts

Skill obsolescence is defined as a decay of productivity that occurs at an accelerated pace when technology advances (Adams & Salopek, 2021; Cottam & Van Loon, 2021). Organizational stakeholders have become increasingly aware of the implications of ocean and environmental sustainability on competitiveness as a result of the COVID-19 pandemic. If shipping organizations cannot change their skillsets to navigate the repercussions of these developments, they risk incurring sizable productivity losses .

Obsolescence risk correlates heavily with the skills and profiles of an organization's workforce. Balancing the skills of incumbents with changeable components can therefore slow the depreciation of skill value. However, this perspective is seldom used to prioritize the targeted workforce for a given strategy because the notion of change is too implicit. Organizations need a structured framework to identify a profile that remains resilient and a continuum that delineates on which aspects vulnerability is likely.

The assessment of maritime skill need and change is sometimes conducted in a discrete manner using aggregated maritime employment and training statistics. Such assessments do not cater for the centralized and multi-role nature of many maritime organizations and the frequent shifts in organizational strategy. Furthermore, the trending change is often indirect or implicit. A capacitated perspective helps forecast the level at which change is required. However, such approaches do not convey the organizational dimension across the entire industry. As a result, examining the specific occasion of change and linking it to the maritime context is imperative.

2.2. Workforce Resilience and Human Capital

Investments in training are expected to appreciate with an aging workforce, skill obsolescence, and a face-off on emerging technology. In the face of economic crises, organizations in the maritime sector seek to maintain their competitive edge through restructuring, expansion, and modernization. These strategies require various organizational resources and capabilities that are nurtured through employee engagement and training. Competitiveness applies to both hard and soft aspects of human resource management.

The maritime industry is currently impacted by an economic downturn following the 2007–2008 global economic crisis. The nature of human resource behavior responds and adapts to crises as well as to natural surroundings.

Maritime firms react to changes in various manners, with a selection of policies expected from an external perspective. Human resource management in maritime firms require a different emphasis on training and skill development from what is discussed in general human resource management texts.

Human resources are the important component for attaining labor productivity, quality improvements, business strategy discount, and supply chain initiatives. Retaining competitive advantage depends on establishing, developing, and deploying unique resources and capabilities that improve all components of human resource management. These are not easy to initiate and require careful thoughts and attempts. Maritime firms require training and education for maintaining the competitive edge in the significantly priced landscape.

2.3. Strategic Human Resource Management in the Shipping Sector

The strategic importance of Human Resource Management (HRM), in particular for the implementation of Strategic Human Resource Management (SHRM), is increasingly recognized. Given the rapid developments in information technology, the adoption of the Maritime Labour Convention (2006), and the mounting global competition for human capital, the shipping sector is confronted with challenges that elevate the need for SHRM (Asyali & Zorba, 2010). While the human capital issue represents a serious challenge for many countries, it acquires critical importance for developing countries where national technical capacities in maritime fields have yet to be significantly enhanced and where the related infrastructures are still limited. Within Turkey, human resources capacity-building for national needs in shipping, shipbuilding, and seafarer training therefore emerges not only as a leading necessity but also as a strategic priority. The rapid development of Turkey as a centre in the global maritime trade and the growth of the Turkish merchant fleet require the establishment of well-integrated, comprehensive, and systematic priorities for human resources development.

3. Theoretical Framework

Although the shipping industry, like many other sectors, underwent significant upheavals during and after the global financial crisis, fiscal distress was not the sole challenge to maritime talent development. The recent emergence of global economic uncertainties, geopolitical disputes, persistent COVID-19 repercussions, and the transition towards greener workflows have compounded the challenge. Not only are firms under pressure to export new offerings and modernize existing products, they must also do so under stricter imperatives of sustainability, safety, and competitiveness (Whysall et al., 2019). To meet system-level demands while maintaining organizational viability, the shipping industry must nurture fresh technological, managerial, and organizational capabilities from a steadily receding base of human resource preparation.

Resilience, analogous to systemic agility, supports timely detection and adaptation to altering external pressures and stakeholder expectations, and is thus crucial for sustaining corporate operation and harnessing recovery opportunities. Fluid timeframes, spiralling uncertainties, and a multitude of competing trajectories hamper optimal investment decision-making and long-range workforce planning. To safeguard preparatory engagement, a dynamic capability perspective can help firms continue development even amid accumulating ambiguity.

3.1. Dynamic Capability Perspective

A dynamic capability perspective emphasizes an organization's ability to sense changes in the environment, seize new opportunities, and reconfigure existing assets and skills (Yao & Meurier, 2012). An organization's agility, the ability to respond quickly to and exploit changes depends ultimately on its skill set and how these skills are managed. Maritime agility, therefore, is a function of both the specific competencies and capabilities unique to the maritime sector and the broader skill sets and attributes that foster dynamism. Together, these elements shape the maritime sector's responsiveness to environmental change or discontinuity, enabling organizations to anticipate and accommodate often disruptive stimuli.

The resource-based view of the firm and its extension to the dynamic capabilities and maritime agility perspectives highlight the relationship between human resources, ocean competencies, and the potential for improved performance in an evolving sector. Recognized resources and skills become restrictive for organizations operating

in a rapidly changing sector unless further investments are made to broaden or deepen existing resources. Maritime organizations therefore cannot treat human resource development as an independent effort; rather, the upgrading of maritime skills and capabilities must be aligned with the development of other resources in order to maintain or enhance overall competitiveness.

3.2. Resource-Based View and Competitiveness

According to the Resource-Based View (RBV), firm-specific resources contribute to sustainable competitive advantage (B. Barney & M. Wright, 1997). Resources must be Valuable, Rare, Inimitable, and Non-substitutable to be advantageous. These criteria may also apply to human resources that are central to realizing the Dynamic Capability Perspective (DCP) in shipping, where RBV concepts deepen understanding of maritime agility. Significant Vadex resources (e.g., strategic partnerships with hardware and software providers) and Emirate Capabilities (e.g., damage-control monitoring, real-time refurbishing, fleet repositioning) demonstrate value and rarity, enabling stronger competitive positioning. Vadex-Verte appointment of Global Hiring Managers in Singapore and Hong Kong facilitates cross-border mobility and reinforces the compelling training proposition offered through the Autonomous Remote Survey and modular vessel fittings.

HR systems can provide firms with temporary competitive advantage. For instance, compliance with international standards of quality and environmental responsibility is a firm-specific capability that becomes increasingly common over time, leading to competitive parity. Core maritime capabilities that support the distinctive sensing, seizing, and reconfiguring aspects of DCP apply equally to land-based applications and therefore cannot readily confer competitive advantage. To explore maritime-specific assets that enable agility, the RBV is integrated with the DCP and Agility theory.

3.3. Change Management and Organizational Learning

Planned organizational transformations and a rapidly changing operating environment heighten the need for updates to technology and associated skills in the maritime sector. While organizational change is prevalent, it often fails to result in fundamental cultural shifts. Aiming to facilitate foundational and cultural alterations, the Change Management model offers guidelines for organizing effort and supporting stakeholder engagement throughout the process (Whysall et al., 2019). Coupled with Organizational Learning, the model fosters a continuous adaptation mindset, enabling maritime companies to remain cognizant of emerging changes, renew all aspects of their operating model, and sustain both economic viability and societal relevance over the longer term.

Maritime firms are frequently subject to dramatic technological and regulatory changes brought about by exogenous drivers. External world shifts also impose further, indirect transformations on maritime actors, making them incapable of independently remodelling their existing operational configurations. Prioritizing changes within the organization structure, processes, and culture empowers firms to reinvigorate their broader business model, shape the nature of external changes, and determine modifiable components and boundaries within the operating model that align with the organization's vision. Emphasis on changes of this nature grants firms time to digest and clarify the precise effects and implications of external disruptions. In combination, Change Management and Organizational Learning therefore provide substantial added value to shipping companies operating in environments characterized by uncertainty and high volatility.

4. Environmental and Technological Drivers

The digitalization of the shipping industry opens opportunities for efficiency gains through automation and artificial intelligence (AI). However, the International Maritime Organisation (IMO) considers the sector among the least digitised and warns that insufficient investment slows innovation and development. Digital opportunities extend to ports and logistics, where the transportation system lacks connectivity and standardisation (Whysall et al., 2019). A systematic evaluation of the impact of digitalisation and automation on roles, competencies, and labour demand remains necessary.

Promotion of workforce innovation and the pursuit of a new generation of merchant fleets can enhance maritime competitiveness and build resilience. Marine digitalisation is an enabler of fleet autonomy. Autonomous ships rely on information technology, advanced information collection, sensor fusion, cross-domain information sharing, and intelligent decision-making. Ports also seek to adopt smart-port models, utilising advanced information technologies to integrate and optimize port logistics. Construction of smart-port systems opens a new opportunities for connectivity, efficiency, and green operation.

Enhancing maritime safety, regulating the safety of civil vessels, and ensuring environmental protection have occupied significant agenda worldwide. Operation guidance, not only for automation but also for other technologies including AI, Cloud, and Smart devices is critical in the era of digitalisation. Maritime training, international competence assurance, and competency assessment are important elements to be considered. At the same time, professional regulations also are undergoing a great evolution. Competence levels are hired by consulting and refactoring the traditional regulations and recommence a new training and certification cycle since approval.

4.1. Digitalization and Automation in Shipping

Rapidly advancing digital technologies such as artificial intelligence, big data, and the Internet of Things are transforming work processes, activities, and skills across multiple industries. Automation of routine, repetitive tasks has intensified, and many jobs are evolving in unexpected ways. These developments raise vital questions for Human Resource Management (HRM): how to track changing occupational requirements, which careers are becoming obsolete, which are growing in demand, and the corresponding future competencies HRM should prioritize (Whysall et al., 2019). Digitalization and automation in shipping exert similar influence on tasks, roles, competences, and demand for labor. E-commerce drives greater containerization and multi-modal logistics, while industry 4.0 changes decision-making scopes and patterns. Monitoring and predicting these global trends requires incorporating technology and regulatory analysis into the discipline. The leading impacts of digitalization and automation on the shipping sector are summarized (Kecić, 2019).

Port activity is increasingly governed by hybrid laws of supply and demand instead of logistic or maritime criteria, although the latter remain relevant. Regardless of the influence of technology, the industry remains shaped by diverse geographical, socio-political, demographic, and economic specifications.

4.2. Regulatory and Safety Imperatives

Shipping firms are subject to increasingly strict regulatory, inspection, and liability requirements for health, safety, environmental, and sustainability considerations; companies failing to comply suffer significant reputational—and even financial—damage. Compliance with such obligations frequently involves the installation of specific technologies or the implementation of particular systems, with related training imperatives (e.g., shipboard safety, pollution prevention, ballast water management). National or international regulations, and associated enforcement measures, may further compel training to ensure compliance with international maritime conventions or treaties. Authorities accordingly might expect shipping organizations to establish procedures for demonstrating that mandatory skills and competencies are maintained, reinvigorating the training and skills development effort.

Shorter international supply chains and increased competitive pressure heighten the need for broad training initiatives. Where shipping organizations opt to hire any of the myriad new technologies and systems currently available, such choices impose intensive training requirements on personnel for successful implementation, operational continuity, and potential upgrade. Furthermore, as firm strategies and business models are redefined in response to digitalization, automation, and the COVID-19 pandemic, the meaning of an entry-level position or the general proficiency required for it may likewise change, necessitating corresponding adaptation of training programmes.

4.3. Globalized Operations and Talent Mobility

Globalization has led to extraordinary international talent mobility among organizations in many industries. In maritime contexts, a number of factors shape and constrain the movement of human resources across borders. Regulations often require that maritime personnel holding specific certifications must serve exclusively on vessels

flagged to the State that issued the corresponding certificates. Financial sanctions—increasingly imposed on designated owners and operators—may limit an individual's ability to accept or continue specific assignments. Additionally, personnel may be barred from transferring to certain corporate positions for the duration of specific contracts due to direct competition with former employers. These complex arrangements form an intricate nexus of constraints on personnel movement across borders and assignments, highlighting the need for organizations to establish and retain an extensive pool of qualified candidates at all times (Farndale et al., 2010).

Globalization has fueled intense competition for qualified labor in the shipping industry, exacerbating existing talent shortages. Shipping companies, ports, and other related stakeholders continuously battle to attract, cultivate, and retain qualified personnel who are often highly mobile and may easily move among multiple employers within and outside the sector. Organizations seeking to enlist or retain qualified personnel therefore face mounting pressure to provide compelling compensation packages, promote a supportive corporate culture, offer attractive benefits, and identify and communicate future development opportunities to meet burgeoning demand for high-quality labor, including both graduates and experienced professionals.

5. Skill Obsolescence Assessment in Maritime Roles

Sustained digitalization and pursuit of resource efficiency are shaping the new operational environment for shipping firms, thus creating fresh challenges for workforce management. The drivers of change, namely digitalization and regulatory imperatives, influence both the types of competences needed and the processes for ensuring their continuous replenishment, consequently accentuating the need for firms to monitor and renew their internal stock of skills. Given that these processes take place alongside considerable inter- and intra-firm diversity, for the purposes of effective development and implementation of appropriate, tailor-made solutions, the following maritime career pathways are assessed: (i) captaincy, navigation, and marine engineering; (ii) port operations and logistics; and (iii) marine administrative and support functions.

Captains, mates, pilots, and marine engineers have a long tradition of skills-based training and certification. Formal training and evaluation is supported by extensive, standardized simulator-based programmes leading to uniformity of training content, and by a system of revalidation that closely monitors, reinforces, and preserves skills associated with the role and that does not depend on the number of hours at sea or deviations in the practical training programme. Moreover, while even well-trained, experienced seafarers face evidence of obsolescence effect due to lengthy time ashore, the provision of regular shore-based and simulator training appears to have somewhat mitigated the effects. The overall conclusion is that systematic sensing of emerging developments at terminals and training relevant to both existing and newly identified processes as well as associated competences would seem to be advisable.

5.1. Captaincy, Navigation, and Marine Engineering

The operational functions of maritime captaincy, navigation, and marine engineering are at a lower risk of skill obsolescence than other maritime occupations. Nevertheless, these roles are not immune from obsolescence pressures, and there is a slight tendency for skill renewal to take precedence over updating existing competencies. Globally, the evolving state of technology in the maritime shipping industry is raising new questions about crewing levels and operational procedures. Consequently, developments in labour demand still require maritime companies and educational programmes to adopt pre-emptive measures in their human resource management frameworks.

5.2. Port Operations and Logistics

Port operations and logistics comprise the functions of cargo processing, storage, handling, and transportation that facilitate inter-and intra-modality movements within and beyond ports. Although many tasks remain manual, companies continue to automate to improve productivity and service levels. Consequently, some positions like cargo and warehouse clerks are at high risk of obsolescence. Other roles, though less likely to disappear, require constant skill renewal as operations transform through digitalization, automation, and integration with supply chains.

Ports are critical nodes of the global maritime transportation system and enablers of trade and logistics through the transfer of goods. The modern, automated port and logistics terminal can be defined as a platform where shipments are received, stored, transferred, and forwarded to the next leg of transport (Asyali & Zorba, 2010). Port operation and logistics functions, viz., port management, port operation, port development, worldwide logistics management, warehouse management, cargo survey, cargo documentation, and procurement, are performed by logistics firms and service companies.

Infrastructure and upload facilities; containers, ro-ro, and bulk-cargo handling; bulk gas and chemicals storage; chemical and gas-pipeline systems; cargo survey and documentation; and equipment maintenance are routine tasks invoked to complete logistics jobs. The Digitalized and Automated Service Terminals (DAST) ship-to-shop Logistics System provides multiple logistic services, ranging from barge to land transportation services. The coordinated intermodal service combining marine and land transport adds value to logistic services. The introduction of a DAST service system to a port logistics service company modifies the operational process of business, resulting in reshaped authorities, modified unified-applications, and supplementary system requirements for port service and forwarder work.

Port operation and logistics have been an important part of maritime strategic planning, and electronic service systems have great impact on logistics firms. Some key changes involve operation processes through updating time management to understand service requirement. Firm logistics activities also vary; e.g., provision of firm logistics, de-coupling the roles between service provider and freight carrier belonging to either the forwarder or the terminal. Software integration with other business applications, such as finance, EP etc., is also necessary after implementing such a system, not only for generating elaborate financial reports but also for facilitating proper management and tracking of equipment (cargo and containers) across multiple service stages. Integration among major service providers, e.g., shipping company and forwarder, tends to be another essential requirement after launching the DAST as such inter-service needs grow.

Port operation and logistics are subjects of maritime strategic planning, and electronic service systems significantly impact logistics firms. Key changes include process modifications requiring adjusted time management to accurately determine service needs and variation in logistics activities, such as separating the roles of service provider and freight carrier between forwarders and terminals. Post-implementation software integration with other business applications, finance, ERP, etc. is crucial for generating comprehensive financial reports and enabling effective management and tracking of equipment (cargo and containers) across multiple service stages. Integration between major service providers, such as shipping companies and forwarders, becomes an essential requirement as inter-service demands increase.

6. Strategies for HRM Adaptation

Skill obsolescence and workforce resilience remain significant challenges for shipping firms. In dynamic environments characterized by rapid technological change and competitive pressures, organizations must continuously sense, seize, and reconfigure their skill portfolios to maintain adaptability.

Strategic Human Resource Management (HRM) addresses workforce resilience through demand-driven skill development aligned with corporate strategy. Maritime professionals report ongoing training needs in safety, operations, and emerging digital applications. For shipping companies, an overarching goal of HRM adaptation centers on continuous adjustment of workforce planning, acquisition, and development practices.

Five priority strategies have emerged in practice. First, organizations enhance workforce planning and conduct demand scenarios to anticipate future profiles and skill gaps. Second, training institutions design programs for all levels, primary upskilling within positions and reskilling to adjacent roles, guided by explicit learning objectives. Third, talent attraction and retention strategies specify vehicle fleets, operational scale, hard and soft skills, and training incentives to navigate localized supply constraints. Fourth, organizations establish proactive skills-learning ecosystems and nurture partnerships with educational providers, training institutions, and industry bodies.

Finally, leaders implement structured change management practices and conduct leadership development initiatives to embed a proactive skills-learning culture. (Asyali & Zorba, 2010).

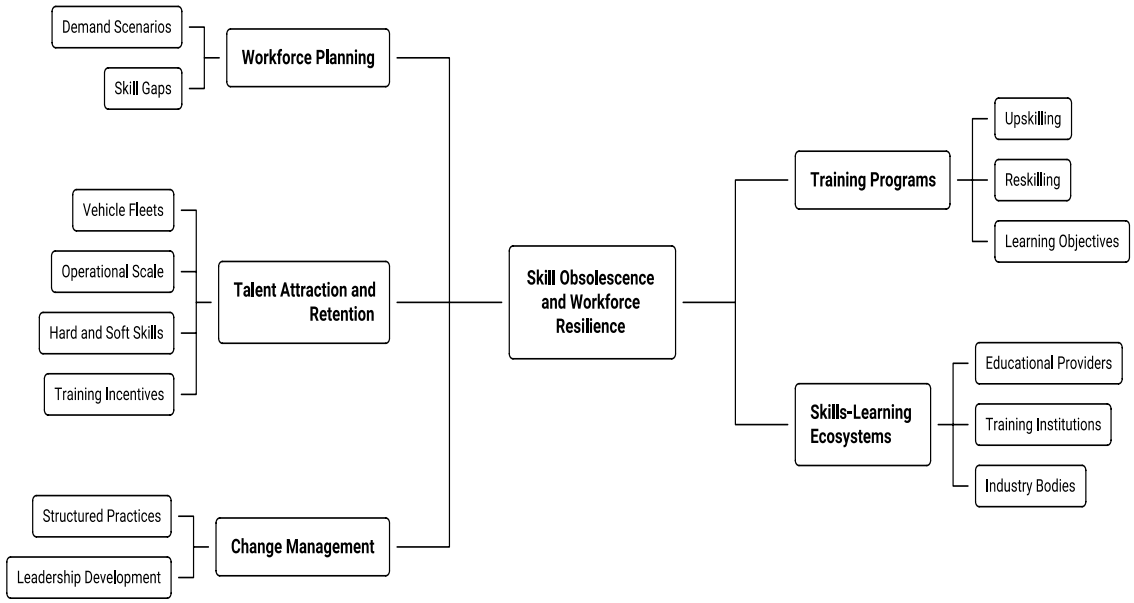

Fig 1. Strategies for Skill Obsolescence and workforce resilience.

6.1. Workforce Planning and Scenario Analysis

Skill obsolescence is a major challenge for workforce resilience in the shipping industry, affecting all maritime professionals at sea or ashore. In preparation for potential disruption of maritime activities, seafaring, shore-based fleet operations, and logistics professionals must assess how roles, competencies, and career pathways will evolve.

Systematic workforce planning and scenario analysis helps to project future demand for maritime expertise, pinpoint sensitive skill areas, and anticipate learning requirements. The arrival of increased digitalisation and automation does not imply an immediate decline in demand for maritime professionals; large workforce segments remain exposed to skills obsolescence. The outcome of these larger transitions ultimately depends on regulatory and operational frames of reference, and the anticipated timeframes are still uncertain for many regions and firms (Asyali & Zorba, 2010).

6.2. Training, Upskilling, and Reskilling Programs

Shipping firms face a paradox: rapidly changing technology drives demand for skilling, yet the sector also exhibits apparent resilience, with employment stability, enduring roles, and little automated replacement of labour. Often regarded as among the first to be taken by the ParEex, such maritime skills still retain value and regulations confirm that to perform maritime duties legally one must possess verified competences. Apparent disruptions and a perceived maritime divide clay differ between traditional and modern roles across-sector across poor, high and middle-income set depending sector.

6.3. Talent Acquisition and Retention in a Competitive Market

In the past, workforce planning was focused on estimating staffing (headcount) needs. Many organizations now realize that capacity planning demands a much broader approach. The emphasis is increasingly on identifying the specific capabilities required to meet capacity needs. The continued advancement of training and simulation technologies enables reference training needs at each key step, thereby accelerating workforce readiness. This is where specific scenarios can be applied to assess workforce readiness. Questions on capacity including the time needed to upskill/extend roles, the extent to which training already exists and is being leveraged, and the degree

of supervisory regressions expected can be defined and explored. Addressing these key questions allows organizations to synchronize their strategic objectives.

6.4. Learning Ecosystems and Partnerships with Education Providers

Building learning ecosystems for lifelong education and partnering with external training providers become crucial for the shipping supply chain. Learning ecosystems integrate education and job, linking workplaces and training institutions, coordinating efforts of government, educational providers, and businesses to ensure fit between the curriculum and the labour market (Smith et al., 2013). Such partnerships widen access to specialist workshops offered by equipment manufacturers, service suppliers, or other stakeholders. Collaborating with educational institutions and professional bodies often supports compliance with regulatory training requirements and industry-recognised certification of competence (Edler & Infante, 2019). Among international 8 global shipping and port operator hubs, Singapore stands out for its resilience initiatives.

Organizational knowledge has become a strategic asset underpinning competitiveness in an increasingly turbulent world. Knowledge management covers the processes for creating, capturing, sharing, and utilizing knowledge. Knowledge transfer within organizations reshapes existing knowledge or stimulates the creation of new knowledge when such knowledge is acquired by the receiving entity, be it an individual, group, or organization.

Knowledge retention seeks to document and store knowledge to facilitate its passage to future users. Both constructs are of utmost importance to the industry because understood and calibrated knowledge assets are fundamental for defining potential trajectories for the evolution of skill requirements, and because the organization cannot grow its set of capabilities and skill potential needed to address available opportunities and stay resilient to changes, without building on accumulated knowledge, hence effective renewal of organizational knowledge is needed. Considerable information must be shared among employees, yet formal procedures for knowledge transfer are often scant or not implemented at all, despite a need for sharing tacit knowledge as many employees approach retirement (Igoa-Iraola & Díez, 2024). Additionally, knowledge retention through documentation is hampered by the fact that much important knowledge is neither digital nor in other formal ways publicly accessible.

Learning ecosystems foster a genuine culture of workplace education and enable shipping companies to continually adjust their human capital to evolving expectations and changing environments. By allocating resources for continuous improvement in port services, transport connectivity, or supply-chain inefficiencies, they avoid major disruptions and remain competitive. Process automation, electronic documentation, and enhanced security alongside a hygienic environment emerge as salient post-COVID requirements.

6.5. Change Management and Leadership Development

Organizational transformation and leadership capability have garnered increasing scholarly attention, with studies highlighting their mutually reinforcing interaction. Leadership assumes crucial importance in empowering employees to embrace organizational change, aligning individual initiatives with collective effort. Maritime institutions should therefore focus on cultivating leaders capable of stimulating individual and group motivation to foster continuous skill adaptation and cultural evolution to maintain competitive edge and resilience in a fast-changing environment.

The shipping sector has witnessed numerous extensive transformations, heightening the significance of leadership development. Yet the literature indicates inadequate investment in training programmes for developing maritime domain-specific leadership capability, a situation compounded by a preponderance of short-term expedient measures. Systems and processes for identifying and nurturing potential leaders are often lacking, and development initiatives tend to concentrate on domain-related rather than leadership skills.

Different maritime organizations undergo transformation at varying speeds, influenced by changing customer preferences and broader industry demands. Leadership ability to act decisively, coordinate essential people and resources, evaluate potential impacts, and engage all stakeholders to build a shared vision capable of guiding transformation remains indispensable.

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7. Implementation Framework

An operational framework outlines the requirements, resources, and implementation steps for effective change management, facilitating adaptation to emerging prerequisites. It encompasses governance structures, stakeholder engagement, resource allocation, and processes for monitoring and improvement.

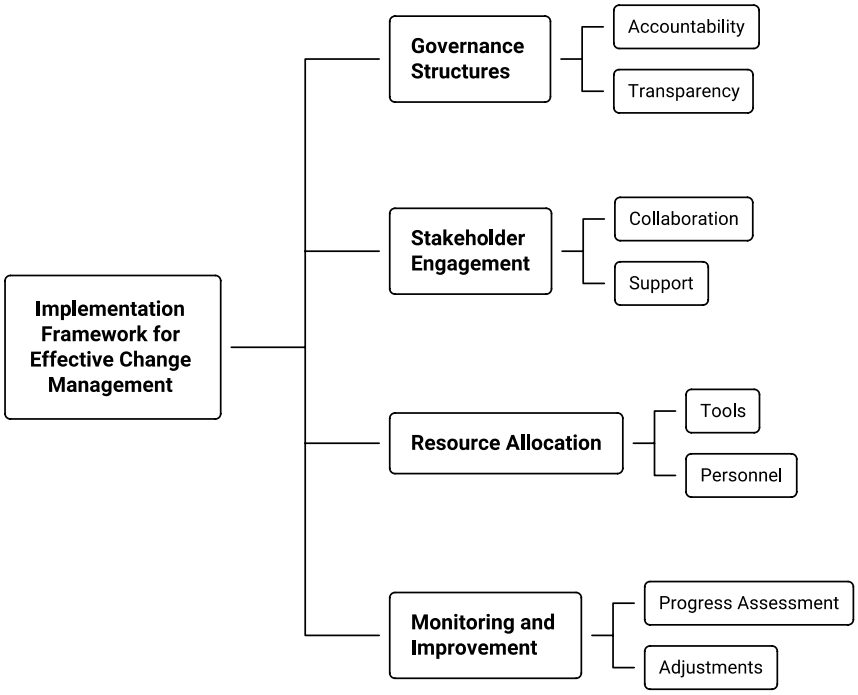

Fig 2. Implementation framework for effective change Management

Skill renewal initiatives necessitate organizational commitment and a compelling purpose. Tactical and operational strategies align with business objectives, while overarching foresight captures long-term intent. Strategic governance informs policies that safeguard the organization's purpose and values throughout transitions, promoting management cohesion.

7.1. Governance and Stakeholder Engagement

Skills obsolescence originates from changes in technology or the production process that render some previously acquired skills less valuable. In the shipping industry, systematic global studies have indicated that skill demand may evolve faster than the speed of learning in several roles, implying a high risk of obsolescence. The term 'workforce resilience' has emerged as a topical concept to examine adaptability and skill renewal at an institutional level. For an organization, the ability to respond to change, uncertainty, and disruptions is a capability. For employees, resilience means having strong technical skills that can be renewed and complemented by other, external skills and attributes. To mitigate obsolescence, organizations need to assess which skills are at risk, develop an institution-wide workforce strategy, and consider strategic Human Resource Management (HRM) and contingency planning.

Strategic Human Resource Management (HRM) has only recently begun to gain attention in the maritime industry. The tendency to manage human resource practices reactively and on a short-term basis prevails. Senior management may not yet appreciate Human Resource Management (HRM) as a key driver of business strategy. As a consequence, maritime firms may be missing opportunities to exploit and develop human resources as valuable, sustainable, and, above all, unique and maritime-specific resources. In addition to the strategic

dimension, HRM covers the relationship between the type and sequence of Human Resource (HR) policies and practices and individual, organizational, and industrial performance, which is relevant for the maritime industry.

7.2. Resource Allocation and Investment Priorities

The shipping industry is gradually recovering from the global economic crisis that began in 2008, with significant green shoots observed in the market. Many companies have encouraged their employees to undertake training programmes and re-evaluate their strategies during the downturn. In addition to retention, the formulation and implementation of Human Resource (HR) Strategies by Maritime Shipping Companies during this period are of paramount importance. Three types of corporate strategy are considered: Growth Strategy, Stability Strategy, and Turnaround Strategy. The HR Strategies to be followed during these three types of corporate strategies are identified. These two concepts will be discussed in the following sections, clarifying the interconnections between corporate strategy and HR strategy as well as deriving appropriate HR strategies for the Shipping Industry. These strategies will support Maritime Companies in refreshing their economic strategies while maintaining and not demotivating their human resources which are critical for their future.

7.3. Monitoring, Evaluation, and Continuous Improvement

The implementation framework sets out governance structures, stakeholder engagement, resource allocation, and monitoring mechanisms for the proposed Skill Obsolescence and Workforce Resilience adaptation strategy.

Effective Skill Obsolescence and Workforce Resilience management requires careful monitoring, evaluation, and continuous improvement. The maritime context entails rapidly changing external conditions and technological developments. A dynamic adaptation capability is therefore essential, focused on timely sensing, seizing, and reconfiguring of required skills and organizational practices (Marin, 2014). Feedback loops should connect capacity-building initiatives to strategic and operational goals and conditions. Predefined Key Performance Indicators (KPIs) enable systematic follow-up and decision-making on proposed measures. Roadmaps and standards for KPI definition can facilitate consensus among involved stakeholders.

The structure and dynamics of KPIs depend on the corresponding adaptation stages and decisions. Predefined KPIs guide initial learning and provision of support functions. While all three maritime Dynamic Capability dimensions - agility, comprehensiveness, and intensity- are relevant throughout the implementation process, the greater strategic focus on compliance, community development, or corporatization at earlier stages warrants prioritizing agility, comprehensiveness, and intensity of corresponding initiatives.

8. Implications for Policy and Practice

The shipping industry is vital to global economic growth and a key source of employment around the world. The maritime sector has strong interlinks with other parts of the economy to the extent that policy measures affecting one segment can have repercussions on the functioning of another segment. The economic crisis is expected to have ramifications throughout the maritime system, highlighting the need for coherence and vigilance in policy measures.

The vulnerability of a segment to a wider crisis is likely to influence the policy measures employed. The changing maritime environment raises major concerns about whether maritime nations will continue to adopt policies that ensure a viable and competitive shipping sector.

Human Resource Management (HRM) policies and practices in the maritime sector are also essential to the effective operation of organizations and underpin a nation’s competitiveness. The sustainability of Human Resource Management (HRM) in maritime firms is increasingly being challenged by a rapidly evolving business environment, leading to a need for further research on the development of appropriate frameworks such as the one proposed in this paper.

9.1. Policy Interventions to Support Skill Resilience

Policy makers seeking to ensure that shipping firms have access to a sufficiently skilled workforce to adapt to environmental pressures should consider several interventions. Addressing skill obsolescence, which is shaping the workforce resilience capabilities of the sector, can be supported through financing for training of future leaders, international harmonization of training systems and certification requirements across ports and countries, and measures to incentivize employers to strengthen the reskilling and upskilling of their personnel.

Governments can finance training measures specifically targeted towards the development of professionals in positions of responsibility and future leaders under long-term contracts in the maritime sector. This action would help to reduce the consequences of obsolescence in the sector that can evolve rapidly over time. Certification and training requirements for shore-based personnel in the maritime field, for which there are currently different regimes in different countries and ports could be harmonized. The maritime shipping sector benefits from standardized regulations for ships and equipment, but support for a common certification and education/qualification standard has yet to emerge. Such measures would facilitate the movement of candidates across ports and countries to address skills obsolescence and reskill personnel for alternative jobs in the sector that deploy transferable, or where appropriate, already acquired skills. In addition, the exposure of marine shore-based personnel to digitalization in education and training would assist in addressing skills obsolescence in a domain rapidly undergoing change. Finally, measures can be envisaged to stimulate companies to recalibrate their approach towards personnel reskilling and upskilling in light of the rapid changes that maritime companies are undergoing due to technological advances. A low-cost incentive supporting these actions is the introduction of tax privileges or grants for employers who invest significantly in reskilling and upskilling their staff. Such actuations incentivize retention and further advance skills not yet exhausted towards obsolescence.

9.2. Implications for Human Resource Management Research

Skill obsolescence remains a significant challenge to agile and resilient firms in volatile and uncertain environments. Traditional contingency approaches relating firm strategy to HRM and training practices do not address the subjective nature of skill obsolescence and the need for continuous skill renewal. Maritime skill obsolescence attaches to specific roles, occupational licenses, and content-related skills across multiple pathways. Yet, significant skills underlie operational, regulatory, and safety requirements already provided on company platforms. The limited scholarly exploration of maritime skill obsolescence restricts theoretical developments relating HRM to Strategic Management in this critical. Consequently, skill obsolescence remains an understudied problem for HRM researchers, especially regarding skills rather than structural or demographic attributes.

Skill obsolescence accumulates through prolonged inactivity and inadequate renewal of specific skills, curtailing firm agility. Skill renewal constitutes an essential HRM challenge at the intersection of individual competence and organizational functionality. Heavy reliance on specific roles and the multi-path, role-specific nature of maritime skill obsolescence complicate HRM responses. Leading Global Shipping Hubs implement various adaptation measures to accommodate maritime skill obsolescence, including scenario analysis, articulated Training Plan design, targeted Talent Acquisition, Learning & Development Ecosystem establishment, marketplace Positioning, and Learning Culture reinforcement. Maintaining adaptability during restructuring, mid-path, fire-fighting responses, pro-active engagements, or destination-specific configurations constitutes a key maritime competence. The limited theoretical underpinnings and firm-level focus of maritime HRM adaptation reinforce its status as an emerging area for research, a maritime challenge requiring further exploration in the HRM domain.

10. Conclusion

Skill obsolescence in the dynamic maritime industry threatens not only the upkeep of individual capabilities, but also firm human capital and competitiveness. As such, workforce resilience, the capacity for adaptive renewal of organizational skills in the face of disturbance, has emerged as a crucial strategic priority. This study establishes

a Strategic Human Resource Management (HRM) framework to enhance workforce resilience against obsolescence in maritime skillsets.

Building on leading models of personnel and development practices, the research illuminates the maritime industry-specific human-capital resource configurations that underpin well-documented agility and change-capability advantages. A solid understanding of obsolescence and resilience on a sector-specific basis supports systematic adaptation of such configurations and offers a contribution to the ongoing dialogue on the fit between theory and practice in Strategic HRM.

Three maritime capability-enhancement lenses - those of Dynamic Capability, Resource-Based View, and Organizational Learning- integrate theoretical and practical adaptation considerations around sensing, seizing, and reconfiguring; competitiveness; and change management. The resulting Strategic HRM framework pinpoints comprehensive Skill-Obsolescence Assessment, Alignment of Human-Capital Development, and Enabling Governance and Management as core action-and-structure areas. The dissemination of fleet-modernization, land-accessibility, and trainer-participation case-material illustrates regional circulation variations in skill-set composition and foci on ports, logistics, and training elements.

Obsolescence indicators for several maritime roles guide attention toward particular alteration channels. Evolving domestic and international training initiatives spur recognition of upskilling facilitation provision, learning-culture cultivation, and preparation for calibrated personnel-system reconfiguration.

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