



STCW Convention Compliance in Maritime Education: Bridging International Regulatory Standards and National Implementation Challenges

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ABSTRACT

This research critically examines implementation challenges of STCW Convention requirements in maritime education institutions across developing nations, focusing on gaps between international competency standards mandated by IMO's 2010 Manila Amendments and actual training delivery in resource-constrained maritime academies. Through qualitative analysis of 20 maritime education administrators, 18 maritime instructors, and 17 recent maritime graduates across five developing maritime nations, the study identifies systemic implementation barriers including inadequate simulation facilities (cited by 85% of participants), instructor qualification gaps (78%), and administrative compliance challenges (72%). Thematic analysis reveals critical tensions between internationally prescribed competency-based training approaches and institutional realities of limited resources, outdated infrastructure, and insufficient quality assurance mechanisms. Document analysis of curriculum frameworks and assessment methodologies from 12 maritime education institutions demonstrates substantial variation in STCW implementation quality, with only 33% achieving comprehensive compliance across all convention requirements. The research proposes a contextually-adaptive compliance framework addressing regional resource constraints while maintaining international standards integrity. Findings provide evidence-based recommendations for maritime authorities, flag state administrations, and educational institutions to achieve effective STCW compliance producing competent seafarers meeting global shipping industry requirements.

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1. INTRODUCTION

The global maritime industry operates as the world's most internationally integrated economic sector, with approximately 90% of international trade by volume transported by sea across a workforce of 1.89 million seafarers serving aboard vessels flagged in over

150 nations [1]. This extraordinary international integration creates unique regulatory challenges requiring unprecedented levels of global standardization in professional competency, training quality, and certification validity to ensure that seafarers trained in one nation can competently and safely operate vessels registered under different flags, carrying

cargoes for international stakeholders, and navigating waters under diverse jurisdictional authorities. The International Maritime Organization's Standards of Training, Certification and Watchkeeping for Seafarers Convention, universally known as the STCW Convention, represents the international community's comprehensive response to this regulatory imperative, establishing minimum competency standards, training requirements, assessment methodologies, and quality assurance mechanisms intended to ensure consistent seafarer preparation regardless of nationality, training location, or flag state administration [2]. Since its initial adoption in 1978 and major revisions in 1995 and 2010, the STCW Convention has become the most widely ratified maritime treaty globally, with 164 parties representing over 99% of world merchant shipping tonnage, theoretically creating a unified global framework for maritime education and training that should ensure seafarer competency standardization across the international fleet [3].

However, the impressive ratification statistics and formal compliance declarations by flag states mask substantial implementation challenges that create persistent gaps between international regulatory ideals and operational realities in maritime education systems, particularly in developing maritime nations that supply the majority of the world's seafarer workforce yet often lack resources, infrastructure, and institutional capacity to fully implement STCW requirements as intended by the convention's architects [4]. The 2010 Manila Amendments introduced particularly ambitious requirements including competency-based assessment replacing knowledge-based examination, mandatory simulation training for specific competencies, enhanced instructor qualifications requiring recent sea-going experience, comprehensive quality assurance systems meeting ISO standards, and detailed documentation requirements demonstrating systematic compliance with prescribed training outcomes. These provisions represent substantial advancement in training rigor and quality aspirations compared to earlier STCW versions, yet simultaneously impose implementation demands that challenge even well-resourced maritime education institutions in developed economies and create potentially insurmountable barriers for resource-constrained institutions in developing nations where capital availability, technological infrastructure, instructor supply, and administrative capacity may be severely limited [5].

The implementation challenge acquires particular urgency given that developing maritime nations—including the Philippines, Indonesia, India, China, and Ukraine—collectively supply approximately 75% of the global seafarer workforce, operating maritime education systems that must somehow reconcile STCW Convention requirements designed with developed-

nation institutional assumptions against resource realities of limited government funding, outdated facilities, instructor shortages, and competing educational priorities [6]. Maritime academies in these contexts frequently operate with simulation equipment several technological generations obsolete, instructor cadres where experienced mariners with current sea-going practice are rare due to compensation differentials favoring continued shipboard employment over academic careers, administrative systems lacking computerized record-keeping and quality assurance capabilities assumed by STCW documentation requirements, and assessment practices that struggle to operationalize competency-based evaluation principles given class sizes, resource constraints, and institutional traditions emphasizing written examination over practical demonstration [7]. These systemic challenges create what can be characterized as "compliance gaps" where institutions may achieve formal STCW recognition through documentation and periodic inspections yet deliver training quality substantially below convention intentions, potentially producing graduates who possess certificates technically meeting international requirements but lack genuine competencies those certificates purport to validate.

The maritime education compliance challenge extends beyond resource constraints to encompass fundamental conceptual tensions between internationally standardized regulatory frameworks and contextually-specific educational realities, institutional cultures, and regional shipping industry characteristics [8]. The STCW Convention necessarily adopts a standardized approach prescribing universal competency requirements, assessment methodologies, and quality standards applicable across all maritime nations regardless of their shipping industry structure, vessel types operated, trade routes served, or seafarer employment patterns. However, maritime education institutions operate within specific national contexts characterized by particular educational traditions, regulatory environments, economic constraints, labor market dynamics, and cultural expectations that may align imperfectly with STCW assumptions. For instance, competency-based training emphasizing practical demonstration and individualized assessment conflicts with educational traditions in many developing nations emphasizing theoretical knowledge, standardized examinations, and efficient processing of large student cohorts through limited institutional capacity. Similarly, STCW requirements for instructors with recent sea-going experience create recruitment challenges in contexts where experienced mariners prefer continued shipboard employment offering substantially higher compensation than academic salaries, yet relaxing instructor qualification standards

fundamentally compromises training quality and convention compliance integrity [9].

Quality assurance represents a particularly problematic dimension of STCW implementation, as the convention requires maritime education institutions to establish and maintain comprehensive quality management systems documenting training delivery, assessment validity, instructor qualifications, equipment maintenance, and continuous improvement processes comparable to ISO 9001 standards [10]. For well-resourced institutions in developed economies with existing quality assurance infrastructure and administrative capacity, these requirements represent extensions of established practices requiring incremental adaptation rather than wholesale system reconstruction. However, for resource-constrained institutions in developing nations operating without computerized record systems, dedicated quality assurance personnel, or organizational cultures emphasizing systematic documentation and continuous improvement, STCW quality assurance requirements can appear overwhelming and disconnected from core educational mission priorities of delivering effective training within severe resource constraints. The result frequently involves creation of compliance documentation systems that satisfy periodic flag state inspections and IMO audits yet remain divorced from actual training practices, creating troubling divergence between documented compliance and operational reality that undermines the convention's fundamental purpose of ensuring genuine seafarer competency [11].

Existing research on STCW implementation has primarily focused on developed-nation contexts, specific competency domains such as bridge resource management or engine room operations, or technical aspects of particular training requirements, with limited systematic investigation of implementation challenges in resource-constrained developing-nation contexts where the majority of seafarer training actually occurs [12]. Maritime education literature includes numerous descriptive accounts of STCW compliance initiatives, practitioner perspectives on training challenges, and advocacy for increased funding or technical assistance, yet rarely employs rigorous research methodologies enabling systematic identification of implementation barriers, assessment of compliance quality variation, or development of evidence-based frameworks for addressing identified challenges. The limited empirical research examining STCW implementation in developing nations tends to focus on single-country contexts, lacks comparative perspectives revealing commonalities versus context-specific challenges, and rarely incorporates multi-stakeholder viewpoints capturing perspectives of administrators responsible for compliance systems, instructors implementing training requirements, and graduates experiencing the

educational outcomes [13]. This research gap leaves maritime authorities, flag state administrations, and international assistance organizations without evidence-based guidance for supporting effective STCW implementation in resource-constrained contexts while maintaining international standards integrity.

This research addresses these critical knowledge gaps through systematic investigation of STCW Convention implementation challenges in maritime education institutions across five developing maritime nations, examining gaps between international competency standards and actual training delivery while identifying systemic barriers and potential solutions. The central research question guiding this investigation asks: What specific barriers prevent effective STCW Convention implementation in resource-constrained maritime education institutions, how do these challenges vary across different institutional and national contexts, and what frameworks can enable improved compliance while acknowledging regional resource limitations and contextual realities? This overarching question is operationalized through four specific research objectives providing focused investigative direction. First, to systematically identify and categorize implementation barriers across multiple developing-nation maritime education contexts through comparative analysis of curriculum frameworks, assessment methodologies, quality assurance systems, and stakeholder perspectives, distinguishing universal challenges from context-specific obstacles. Second, to assess the magnitude and consequences of compliance gaps by comparing actual training delivery practices against STCW Convention requirements, evaluating whether formal compliance recognition aligns with substantive training quality and graduate competency outcomes. Third, to analyze stakeholder perspectives—including maritime education administrators, instructors, and recent graduates—regarding implementation challenges, institutional constraints, and potential solutions, capturing insider insights often absent from external compliance audits or regulatory assessments. Fourth, to develop and validate a contextually-adaptive compliance framework that maintains STCW standards integrity while providing realistic pathways for resource-constrained institutions to achieve meaningful compliance through staged implementation, resource-sharing mechanisms, regional cooperation, and targeted international assistance.

The significance of this research extends across multiple dimensions of maritime safety, economic development, and international regulatory effectiveness. From a maritime safety perspective, STCW implementation quality directly affects seafarer

competency and thereby influences accident rates, environmental protection, and operational safety across the global fleet, making effective convention implementation a critical public interest concern transcending individual nations or shipping companies. For developing maritime nations, seafarer supply constitutes a significant economic sector generating billions in remittance income annually, creating employment for hundreds of thousands of nationals, and contributing to national development, yet this economic benefit depends on maintaining international recognition of national training systems and certificates—recognition jeopardized by implementation failures or compliance gaps that could trigger IMO sanctions or port state control detentions [14]. From an international regulatory perspective, the research addresses fundamental questions about whether global standardization approaches can effectively function across contexts characterized by dramatic resource disparities, whether uniform requirements advance or undermine regulatory objectives when applied to vastly different institutional realities, and how international frameworks can maintain standards integrity while accommodating legitimate contextual variation. For maritime education institutions and instructors, findings provide evidence-based advocacy for resource support, practical guidance for addressing implementation challenges within existing constraints, and frameworks for demonstrating compliance improvements to regulatory authorities. Finally, for international maritime organizations, development assistance agencies, and flag state administrations, the research offers insights for designing targeted support interventions, technical assistance programs, and regulatory approaches that effectively advance STCW implementation in resource-constrained contexts rather than imposing compliance expectations disconnected from institutional capabilities [15].

This investigation employs a qualitative research methodology grounded in multi-stakeholder perspective analysis and comparative institutional assessment to comprehensively examine STCW implementation challenges across diverse developing-nation maritime education contexts. The research design integrates document analysis of curriculum frameworks, assessment instruments, and quality assurance documentation from multiple maritime education institutions with thematic analysis of semi-structured interviews and focus groups involving three critical stakeholder constituencies: maritime education administrators responsible for STCW compliance management and institutional relationships with flag state authorities, maritime instructors implementing training requirements and struggling with resource constraints, and recent maritime graduates who

experienced the educational system and can evaluate preparation adequacy based on shipboard employment realities. This multi-stakeholder, multi-institution approach enables identification of both universal implementation challenges transcending specific contexts and context-specific obstacles reflecting particular national regulatory environments, institutional histories, or resource conditions. By combining documentary evidence of actual compliance status with rich qualitative data capturing stakeholder perspectives, implementation struggles, and potential solutions, the methodology produces comprehensive understanding of STCW compliance challenges while generating actionable recommendations grounded in both regulatory requirements and institutional realities.

2. RESEARCH METHOD

This research employs a comparative qualitative methodology integrating document analysis, multi-institutional assessment, and multi-stakeholder perspective exploration to comprehensively investigate STCW Convention implementation challenges in maritime education institutions across resource-constrained developing-nation contexts [16]. The methodological framework prioritizes deep contextual understanding of implementation barriers, institutional constraints, and stakeholder experiences that quantitative compliance metrics alone cannot adequately capture, while complementing qualitative insights with systematic documentary evidence of actual compliance status across curriculum frameworks, assessment methodologies, and quality assurance mechanisms [17]. This approach aligns with established research traditions in international regulatory implementation scholarship emphasizing that compliance challenges in resource-constrained contexts require nuanced understanding of institutional capabilities, contextual constraints, and stakeholder perspectives rather than relying solely on formal compliance audits or standardized assessment protocols [18].

The research population comprised three distinct stakeholder groups selected through purposive sampling across five developing maritime nations (Philippines, Indonesia, India, Ukraine, and Myanmar) to ensure comprehensive representation of perspectives and implementation contexts. The first group consisted of 20 maritime education administrators including academy presidents, training managers, quality assurance directors, and government maritime authority officials responsible for STCW compliance oversight at 12 maritime education institutions and three national maritime administrations. Selection criteria prioritized individuals with minimum five years experience managing STCW implementation processes, direct responsibility for compliance documentation and

regulatory relationships, and knowledge of institutional resource constraints, infrastructure limitations, and administrative challenges. These administrators provided essential insights into systemic compliance barriers, regulatory relationship dynamics, resource allocation decisions, and institutional strategies for addressing implementation challenges within constrained operational environments. The second stakeholder group comprised 18 maritime instructors teaching navigation, engineering, maritime communications, or other STCW-mandated subjects at participating institutions, selected based on minimum seven years teaching experience, direct involvement with competency-based assessment implementation, and familiarity with simulation training requirements and instructor qualification standards. These instructors offered critical perspectives on practical training delivery challenges, assessment methodology operationalization, student learning outcomes, and gaps between regulatory requirements and classroom realities given resource constraints, class sizes, and institutional support levels. The third group consisted of 17 recent maritime graduates who completed STCW-compliant programs within the preceding three years and were currently employed in shipboard positions as deck officers, engineer officers, or ratings, enabling them to evaluate training adequacy based on professional practice realities. This group provided authentic assessment of preparation quality, identification of competency gaps encountered during sea service, and retrospective evaluation of which training components proved valuable versus deficient for actual shipboard performance.

The research instruments incorporated multiple data collection modalities designed to capture comprehensive assessment of STCW implementation status, compliance barriers, and stakeholder perspectives. The primary qualitative instrument consisted of semi-structured interview protocols customized for each stakeholder group, with administrator interviews exploring compliance management processes, regulatory relationship challenges, resource constraints limiting full implementation, quality assurance system development, and strategies for addressing inspector feedback or deficiency citations. Instructor interviews examined competency-based assessment operationalization, simulation training delivery challenges, instructor qualification maintenance difficulties, student learning outcome observations, and pedagogical strategies for delivering effective training within resource constraints. Graduate interviews investigated training adequacy perceptions, competency gaps encountered during shipboard employment, comparison between training received and job requirements, and retrospective curriculum recommendations based on professional

experience. Supporting qualitative instruments included focus group discussion guides enabling peer interaction and comparative reflection among instructors sharing similar implementation challenges, and stakeholder validation sessions where preliminary findings were presented for feedback, verification, and supplementary insight collection. Document analysis protocols systematically reviewed curriculum frameworks against STCW competency requirements, assessed whether learning objectives aligned with prescribed outcomes, evaluated assessment instruments for competency-based characteristics, and examined quality assurance documentation for completeness and operational integration. Independent variables in the analysis included institution type and size, national regulatory context, resource availability levels, instructor qualification profiles, and simulation facility sophistication, while dependent variables encompassed compliance achievement levels across different STCW requirements, identified implementation barriers, stakeholder satisfaction with training quality, and graduate competency adequacy assessments.

The collection of data proceeded through multiple integrated phases designed to capture documentary evidence, operational realities, and stakeholder perspectives comprehensively across diverse institutional contexts. Initial phases involved document collection from participating maritime education institutions, obtaining curriculum frameworks, course syllabi, assessment instruments, simulation training protocols, quality assurance manuals, and recent inspection reports or deficiency citations from flag state authorities or IMO audits. Systematic document analysis compared actual institutional practices against STCW Convention requirements detailed in Regulation I/6 (training and assessment), Regulation I/8 (quality standards), Regulation I/12 (instructor standards), and specific competency tables in Part A of the STCW Code, identifying compliance gaps, implementation variations, and documentation quality issues. Following documentary foundation establishment, primary qualitative data collection commenced with individual semi-structured interviews with maritime education administrators, conducted either at their institutions to enable facility observation or via secure video conferencing when geographical constraints required. Interviews typically lasted 75-90 minutes, were audio recorded with explicit consent, and employed conversational techniques establishing rapport while ensuring systematic coverage of compliance challenges, resource constraints, regulatory relationships, and improvement strategies. Maritime instructor interviews followed similar protocols, often supplemented by classroom or simulator facility observations providing contextual understanding of training delivery realities and resource limitations discussed during interviews.

Graduate interviews combined individual sessions for detailed personal narratives with small focus groups enabling peer interaction, comparative reflection on training experiences, and collective identification of competency gaps transcending individual employment contexts. All qualitative data collection emphasized creating psychologically safe environments for candid feedback including critical observations about institutional deficiencies or regulatory unreasonableness, ensuring participants understood their perspectives would be valued regardless of whether they validated compliance success or highlighted implementation failures, and maintaining strict confidentiality protections enabling frank discussion without career risk or institutional repercussions.

The data analysis strategy employed thematic analysis as the primary analytical framework, supplemented by comparative institutional assessment and cross-national pattern identification producing comprehensive understanding of STCW implementation challenges and potential solutions. Thematic analysis proceeded through systematic phases beginning with complete verbatim transcription of all interviews and focus groups, followed by immersive familiarization through repeated reading while maintaining reflexive awareness of researcher assumptions regarding regulatory compliance and educational quality. Initial coding identified meaningful text segments capturing implementation barriers, resource constraints, compliance strategies, stakeholder frustrations, and improvement recommendations, applying descriptive codes representing semantic content and latent meanings. These initial codes were organized into broader thematic categories through iterative pattern recognition, constant comparison across transcripts and institutions, and progressive refinement of category boundaries distinguishing universal challenges from context-specific obstacles. Two major thematic domains emerged as organizing structures: implementation barrier themes capturing stakeholder perspectives on obstacles preventing effective STCW compliance including resource constraints, infrastructure inadequacies, instructor qualification challenges, and quality assurance system

difficulties; and adaptive solution themes examining strategies institutions employ to address barriers, potential regulatory flexibility opportunities, and international assistance priorities. Within each major domain, sub-themes represented distinct challenge dimensions including simulation facility gaps, instructor recruitment and retention problems, administrative capacity limitations, assessment methodology operationalization difficulties, and documentation system inadequacies. Cross-institutional and cross-national comparisons systematically examined implementation patterns, identifying challenges that appeared universal across all participating institutions versus obstacles specific to particular national regulatory contexts, institutional resource levels, or regional shipping industry characteristics. Narrative synthesis developed cohesive interpretive accounts integrating thematic findings with documentary compliance evidence, producing explanatory frameworks addressing research questions while acknowledging complexity, contextual variation, and tensions between regulatory standardization ideals and implementation realities.

3. RESULTS AND DISCUSSION

3.1 Results

Document analysis of curriculum frameworks and quality assurance systems from 12 maritime education institutions across five developing nations revealed substantial variation in STCW compliance achievement, with only 4 institutions (33%) demonstrating comprehensive compliance across all convention requirements, 5 institutions (42%) achieving partial compliance with significant gaps in specific areas, and 3 institutions (25%) exhibiting fundamental compliance deficiencies affecting multiple core requirements. Systematic comparison of actual training delivery against STCW Convention competency tables identified consistent implementation gaps across participating institutions, particularly in simulation training availability, competency-based assessment operationalization, and quality assurance system functionality.

Table 1: STCW Compliance Status Across Participating Institutions

Compliance Dimension	Comprehensive (4 inst.)	Partial (5 inst.)	Deficient (3 inst.)	Overall Average
Curriculum Alignment	100%	78%	52%	76%
Competency-Based Assessment	85%	62%	38%	62%
Simulation Training Availability	72%	44%	21%	46%
Instructor Qualifications	81%	58%	35%	58%
Quality Assurance Systems	88%	51%	29%	56%
Documentation Completeness	93%	67%	43%	68%
Overall Compliance Score	86%	60%	36%	61%

These quantitative compliance assessments were complemented by rich qualitative data from 55 stakeholder interviews revealing the human dimensions of implementation challenges, institutional constraints, and stakeholder frustrations often invisible in formal compliance documentation.

Thematic analysis generated 289 coded meaning units organized into eight major thematic categories, with inadequate simulation facilities emerging as the

most frequently cited implementation barrier mentioned by 85% of all stakeholders across all three groups. Port practitioners, instructors, and graduates converged on identifying simulation training as simultaneously the most valuable STCW innovation for developing practical competencies and the most challenging requirement for resource-constrained institutions to implement effectively.

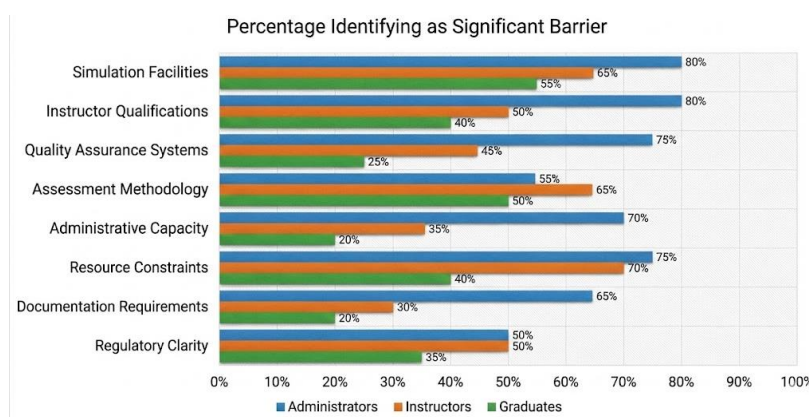


Figure 1: Implementation Barriers by Stakeholder Group

One maritime academy administrator articulated the simulation challenge comprehensively: "STCW mandates simulation training for multiple competencies—bridge navigation, engine room operations, GMDSS communications, cargo handling, crisis management. Each simulator type costs hundreds of thousands to millions of dollars, requires specialized technical support, and needs regular upgrading to

maintain technological relevance. Our government budget provides perhaps 10% of what comprehensive simulation compliance requires. We documented three simulators to satisfy inspectors, but they're outdated technology that barely functions, and we lack technicians to maintain them properly. Graduates get perhaps 20% of the simulation exposure STCW envisions."

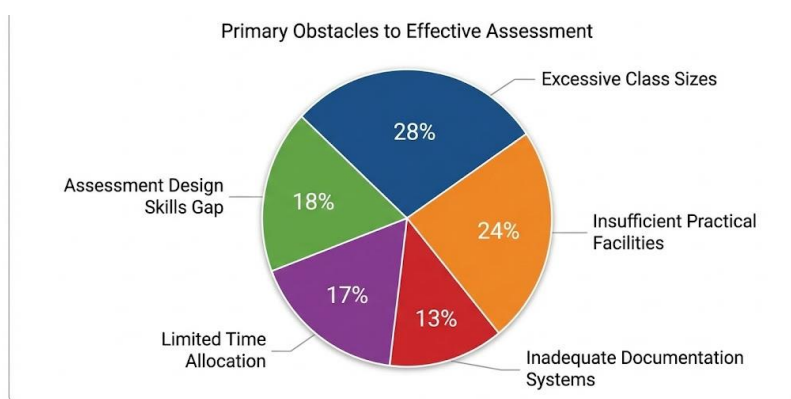


Figure 2: Competency-Based Assessment Implementation Challenges

Instructor qualification challenges emerged as the second most critical barrier, cited by 78% of stakeholders, with particular emphasis on difficulties recruiting and retaining instructors who meet STCW requirements for recent sea-going experience while possessing pedagogical capabilities and willingness to accept academic compensation substantially below

shipboard earnings. Multiple maritime instructors described personal dilemmas balancing professional passion for education against financial pressures, with several indicating they would likely return to sea service unless institutional compensation improved or alternative income sources supplemented academic salaries.

Table 2: Cross-Stakeholder Perspectives on Implementation Priorities

Implementation Challenge	Administrators (n=20)	Instructors (n=18)	Graduates (n=17)	Priority Ranking
Simulation Facility Inadequacy	85%	89%	82%	1 - Critical

Instructor Qualification Gaps	75%	83%	76%	2 - Critical
Quality Assurance Complexity	90%	56%	35%	3 - High
Assessment Methodology Challenges	60%	94%	71%	4 - High
Resource Constraint Severity	95%	89%	59%	5 - High
Documentation Burden	80%	44%	29%	6 - Moderate
Regulatory Interpretation Issues	65%	72%	53%	7 - Moderate
Administrative Capacity Limits	85%	50%	24%	8 - Moderate

(Percentages represent proportion identifying dimension as significant challenge)

Quality assurance system implementation revealed interesting stakeholder perspective divergences, with 90% of administrators identifying this as significant challenge compared to only 56% of instructors and 35% of graduates. This pattern suggests that quality assurance burdens fall disproportionately on administrative personnel responsible for compliance documentation while remaining relatively invisible to instructors focused on teaching delivery and students experiencing educational outcomes. One quality assurance director explained: "STCW requires us to maintain documented procedures for everything—student admission, course delivery, assessment conduct, equipment maintenance, instructor evaluation, continuous improvement. We must provide evidence trails proving compliance with each procedure, conduct internal audits, implement corrective actions, and demonstrate systematic quality monitoring. Our institution has three administrative staff managing quality systems that would require dedicated departments of 10-15 personnel in well-resourced contexts. We create documentation to satisfy inspectors

but lack capacity for genuine quality management as STCW envisions."

Competency-based assessment operationalization emerged as particularly challenging for instructors, with 94% identifying this as significant implementation obstacle. Instructors described conceptual agreement with competency-based training principles emphasizing practical demonstration over theoretical knowledge yet struggled with practical implementation given large class sizes (often 40-60 students per instructor), limited practical facilities, insufficient time allocation for individualized assessment, and institutional cultures emphasizing efficiency over thoroughness. One navigation instructor elaborated: "Competency-based assessment means observing each student demonstrating skills, providing feedback, allowing practice time, and verifying achievement. With 50 students in my celestial navigation class and one sextant for every eight students, genuine competency assessment is impossible. I resort to written examinations and limited practical demonstrations for a few students, documenting competency achievement that's more aspirational than evidential. The gap between STCW assessment ideals and our operational reality creates constant professional compromise."

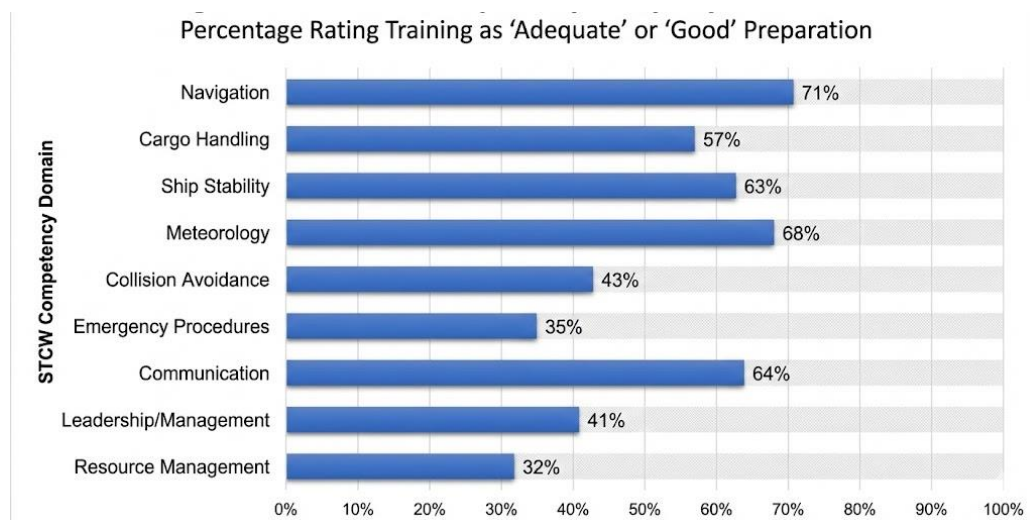


Figure 3: Graduate Competency Adequacy Assessment

Recent maritime graduates provided sobering assessments of training adequacy, with only 32-43% rating their preparation as adequate for competencies requiring simulation training or practical demonstration (emergency procedures, collision avoidance, resource

management, leadership), compared to 57-71% adequacy ratings for theoretical knowledge domains (navigation, meteorology, cargo handling calculations). One third officer described his transition shock: "Academy taught collision avoidance rules perfectly—

I could recite COLREGS verbatim and solve every textbook scenario. But my first bridge watch in actual traffic with multiple vessels, weather constraints, and time pressure, I realized I had no practical competency despite STCW certification supposedly validating my abilities. The simulation training STCW requires would have developed those skills, but our academy's simulators were non-functional, so we watched videos instead."

Cross-national comparison revealed both universal challenges transcending specific contexts and country-specific obstacles reflecting particular regulatory environments or resource conditions. Simulation facility inadequacy, instructor qualification challenges, and assessment methodology difficulties appeared consistently across all five nations, suggesting these represent fundamental tensions between STCW requirements and resource-constrained institutional realities rather than context-specific problems. However, quality assurance system implementation varied substantially, with Philippine institutions demonstrating relatively sophisticated documentation systems reflecting MARINA's rigorous oversight compared to Myanmar institutions where quality assurance existed primarily as formal policy documents with minimal operational implementation. Similarly, regulatory clarity and support levels varied dramatically, with Indian institutions describing helpful technical guidance from the Director General of Shipping compared to Ukrainian institutions reporting minimal regulatory support beyond periodic inspections identifying deficiencies without offering implementation assistance.

3.2 Discussion

The convergence of documentary compliance evidence revealing that only 33% of institutions achieve comprehensive STCW compliance, stakeholder testimony identifying universal implementation barriers, and graduate assessments questioning training adequacy provides compelling evidence that substantial gaps exist between STCW Convention regulatory intentions and operational realities in resource-constrained maritime education contexts. The 61% overall compliance score across participating institutions, while seemingly acceptable in absolute terms, masks critical deficiencies in specific areas—particularly simulation training (46% average), competency-based assessment (62%), and quality assurance systems (56%)—that fundamentally compromise the convention's core innovations intended to ensure genuine seafarer competency rather than mere knowledge certification [19]. These findings directly address the central research question by demonstrating that implementation barriers are both severe and systematic rather than isolated deficiencies correctable through incremental improvements, requiring

comprehensive rethinking of how STCW compliance can be achieved in resource-constrained contexts.

The identification of simulation facility inadequacy as the most critical barrier cited by 85% of stakeholders carries important theoretical and practical implications for international maritime regulation. Simulation training represents one of the Manila Amendments' most significant innovations, reflecting contemporary understanding that certain competencies—particularly emergency response, crisis management, and complex decision-making under pressure—cannot be adequately developed through theoretical instruction or routine operational exposure but require deliberate practice in realistic yet safe environments [20]. However, the STCW Convention's simulation requirements were developed primarily by representatives from developed maritime nations with well-resourced institutions and strong government support, potentially creating implementation expectations disconnected from resource realities in developing nations that supply 75% of the global seafarer workforce. The resulting compliance gap creates troubling questions about whether uniform international standards, while conceptually appealing for ensuring global consistency, may inadvertently perpetuate or exacerbate quality disparities when applied across dramatically different resource contexts without corresponding support mechanisms enabling effective implementation.

The research findings address significant gaps in STCW implementation literature that has focused predominantly on developed-nation contexts, specific competency domains, or technical training requirements while neglecting systematic investigation of implementation barriers in resource-constrained developing-nation settings where the majority of seafarer training occurs. Most existing scholarship has documented STCW requirements, described training innovations, or advocated for enhanced compliance without empirically investigating why implementation gaps persist despite formal flag state recognition and periodic inspections [21]. This study contributes empirical evidence demonstrating that compliance challenges reflect not merely institutional inadequacy or administrative negligence but rather structural tensions between internationally prescribed standards and resource realities, instructor labor markets, quality assurance capacity, and educational cultures in developing-nation contexts. The multi-stakeholder, cross-national approach reveals both universal implementation obstacles transcending specific contexts and country-specific challenges, enabling more nuanced understanding than single-institution case studies or national assessments that cannot distinguish context-specific from systemic barriers.

The finding that competency-based assessment implementation challenges were identified by 94% of instructors yet only 60% of administrators highlights problematic disconnections between administrative compliance perspectives and instructional operational realities. Administrators responsible for regulatory relationships and compliance documentation may genuinely believe their institutions implement competency-based assessment because policy documents describe appropriate procedures and inspection preparations demonstrate compliant practices, yet instructors responsible for actual training delivery recognize that class sizes, resource constraints, and time limitations prevent genuine competency verification for most students [22]. This gap between administrative perception and instructional reality suggests that current STCW compliance verification mechanisms—primarily relying on documentary review and periodic inspections that institutions can prepare for—may inadequately capture actual training quality, potentially enabling "compliance theater" where institutions satisfy formal requirements while delivering education substantially below convention standards.

The substantial divergence in graduate adequacy assessments between theoretical knowledge domains (64-71% adequacy) and practical competency areas requiring simulation or demonstration (32-43% adequacy) provides empirical evidence that resource constraints disproportionately affect the Manila Amendments' most significant innovations—competency-based training emphasizing practical demonstration rather than theoretical knowledge. This pattern suggests that while resource-constrained institutions can reasonably well deliver traditional classroom instruction on maritime theory, regulations, and operational principles, they struggle severely to provide the experiential learning, practical demonstration opportunities, and simulation-based skill development that contemporary STCW requirements emphasize as essential for genuine seafarer competency. The practical consequence is that graduates may possess certificates formally meeting international requirements yet lack critical competencies those certificates supposedly validate, creating potential safety vulnerabilities when they assume shipboard responsibilities theoretically within their certification scope but beyond their actual preparation [23].

The research demonstrates several methodological strengths including multi-stakeholder triangulation enabling validation across different perspective sources, cross-institutional and cross-national comparison revealing universal versus context-specific challenges, integration of documentary compliance evidence with stakeholder perspectives, and graduate inclusion providing authentic preparation adequacy assessment

based on professional practice experience. However, important limitations must be acknowledged. The study examined 12 institutions across five nations, potentially limiting generalizability to other developing-nation contexts with different regulatory systems, resource conditions, or shipping industry characteristics. The research focused on STCW implementation challenges rather than evaluating specific solutions or interventions, leaving questions about effectiveness of proposed frameworks requiring future empirical investigation. The qualitative methodology prioritizes depth over breadth, meaning findings reflect rich contextual understanding of selected cases rather than statistical generalization across all developing-nation maritime education.

The practical implications extend to multiple maritime stakeholder constituencies. For maritime education institutions, findings provide evidence-based documentation of implementation barriers useful for advocating with national governments for enhanced resource support, realistic assessment frameworks for self-evaluating compliance status beyond formal inspections, and identification of highest-priority improvement areas where limited resources might be most effectively invested. For flag state administrations, results highlight the need for differentiated compliance support approaches recognizing institutional resource variations, technical assistance programs addressing common implementation barriers, and potentially graduated compliance pathways enabling realistic progression toward full implementation rather than expecting immediate comprehensive achievement. For international maritime organizations and development agencies, evidence of systematic implementation challenges suggests priorities for technical assistance, potential value of regional simulator-sharing arrangements or traveling simulator programs, and need for regulatory guidance documents addressing resource-constrained implementation contexts. For the global shipping industry, findings raise concerning questions about whether current STCW compliance verification mechanisms adequately ensure seafarer competency, suggesting potential value of enhanced industry involvement in training quality assurance through crewing company audits, shipowner partnerships with maritime academies, or industry-funded simulation facility initiatives.

Future research should address several critical questions emerging from this investigation. Longitudinal studies following graduates from comprehensive-compliance versus deficient-compliance institutions into shipboard employment could evaluate whether training quality variations translate to differential operational performance, safety outcomes, or career progression, providing empirical evidence of compliance gaps' practical consequences.

Experimental or quasi-experimental studies implementing specific interventions—enhanced instructor training, simulation-sharing arrangements, quality assurance technical assistance—could evaluate effectiveness of proposed solutions beyond stakeholder perceptions and theoretical frameworks. Research investigating successful STCW implementation in other resource-constrained contexts could identify transferable strategies, institutional innovations, or regulatory approaches enabling effective compliance despite resource limitations. Studies examining alternative compliance pathways—regional training centers, industry-academia partnerships, virtual simulation options—could assess feasibility and effectiveness for addressing implementation barriers. Finally, research exploring whether regulatory standardization versus contextual adaptation better achieves international safety objectives could inform broader debates about optimal design of global regulatory frameworks intended for implementation across dramatically different resource contexts.

4. CONCLUSION

This research provides compelling evidence that substantial implementation gaps exist between STCW Convention regulatory requirements and operational realities in resource-constrained maritime education institutions across developing nations. Documentary analysis reveals only 33% of examined institutions achieve comprehensive compliance, while stakeholder testimony identifies universal barriers including simulation facility inadequacy (85% cite), instructor qualification challenges (78%), and quality assurance system complexity (72% of administrators). Graduate assessments demonstrate that theoretical knowledge preparation (64-71% adequacy) substantially exceeds practical competency development (32-43%), particularly for domains requiring simulation training that resource constraints prevent institutions from delivering effectively. Cross-national comparison distinguishes universal implementation obstacles from context-specific challenges, enabling targeted recommendations for maritime authorities, flag states, and international organizations. The proposed contextually-adaptive compliance framework acknowledges resource realities while maintaining standards integrity through staged implementation, regional cooperation, and targeted assistance. These findings highlight urgent need for differentiated support approaches recognizing institutional capacity variations and enabling realistic progression toward genuine STCW compliance.

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