ASSESSMENT OF HUMAN AND ENVIRONMENTAL IMPACTS OF SHIPBREAKING IN PAKISTAN AND ITS ADHERENCE TO ILO AND HGC GUIDELINES

Ahmad Talha
PhD Scholar at Law School, Dalian Maritime University
ahmadtalha80@yahoo.com

Sehla Noor
PhD Scholar at Law School, Dalian Maritime University
sehlanoor4@yahoo.com

Hafiz Muhammad Usama Hanif
LLM at Law School, Dalian Maritime University
hafizusama825@gmail.com

Abstract

South Asia is currently the largest center of shipbreaking throughout the world, which focuses on the intertidal beaching method because of cost efficiency and weak regulatory oversight. Pakistan's Gadani yard - whose yard, once one of the largest in the world - is an example of the juggling that takes place between international maritime law, environmental governance, and labor rights. This study seeks to present a compliance gap analysis of the ship recycling practices of Pakistan as compared to Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (HKC), Basel Convention, UNCLOS Part XII and ILO Labor Standards. Using doctrinal legal review, systematic analysis of literature, and secondary quantitative analysis of data, the study evaluates the ecological and occupational impacts. Findings show significant environmental degradation, such as cadmium in soil 12mg/kg, total petroleum hydrocarbons 3500 µg/L, or mercury and methylmercury in sediments, and elevated atmospheric PAHs and PCBs. Labor violations are still widespread, however, with sub-

living wages, high fatality rates, and informal contracting. While accessions of Pakistan's HKC in 2023 and the inaugurating of the first compliant yard in 2026 are steps ahead, gaps in progress remain owing to the prevalence of low levels of mechanization, unregulated practices of labor-based operations and incomplete infrastructure of downstream of hazardous waste management. The study concludes that in the absence of a robust domestic regulatory and enforcement, Pakistan's stance in global standards will be more in name than reality leaving human and environmental weak links unattended.

***Keywords*:** Shipbreaking, Hong Kong Convention, ILO Standards, Basel Convention, UNCLOS, Marine Pollution, Ocean Governance

1. Introduction

Ship recycling is an important but controversial aspect of the world maritime economy which is associated with legal issues (Dewan & Sibilia, 2024a). Regulated properly, it's a recovery of structural steel and recirculation of machinery and a goal of a circular economy, which is part of international environmental law (Chang et al., 2010). Regulated poorly, it sinks the toxic legacy of decades of international shipping via dumping the costs of externalities on environmental, health and safety onto the more economically marginal coastal yards (Dey et al., 2021). The more policy issue in the middle is not whether ships should be recycled, since they must be, but under what legal, technological, and labor conditions the process of dismantling may take place and who the residual cost in cases where those conditions are not satisfied (Du et al., 2018).

The IMO further adds that most commercial ship recycling done at a global level, is done by main countries: Bangladesh, India, and Pakistan (Talha, 2022). In the year 2024, 255 out of 409 vessels in the world had final destination in a South Asian yard and also In the year 2025, 214 out of 321 ships (out of 410) had final destination in yard South Asia (Rahman et al., 2026). Pakistan's national yard on Balochistan's coast has processed 24

vessels in 2024 and 15 ships in the year 2025 which is less than Bangladesh or India but critically important to Pakistan in terms of access it has in geology and laws (Zafar et al., 2025). Pakistan's formal regulatory posture has also changed materially that is also depicted in Figure 1. On 30th Nov 2023 the date of accession instrument of Pakistan was deposited to the HKC convention and date of coming into occurrence will be 26th June 2025 (Filiz & Çetin, 2026). In parallel, this project of SENSREC-DW was started by ILO and IMO with a focus on the development of occupational safety and decent work and hazardous waste capacity at Gadani. In January 2026, the first-ever HKC certified facility in Pakistan was decreed, which is, Prime Green Shipping certified by Bureau Veritas in November 2025 (Kakar et al., 2025).

Figure 1. Global Ship Recycling Dilemma

These developments bring to the fore a central empirical and legal question, which is has Pakistan moved from de jure accession to de facto compliance? The evidence base compiled in this article with cross-verified peer-reviewed source, official institutional sources and data from NGO monitoring sources indicate that the answer is still only partially affirmative. A compliance gap exists on environmental containment, labour governance, downstream waste management and public monitoring. This gap is not some implementation delay, in the post-ITLOS context of the strict interpretation of UNCLOS Articles 192 and 194, it is a material, continual legal deficit.

2. Literature Review

Shipbreaking in South Asia which is concentrated mostly in Bangladesh, India and Pakistan is an important industry as it accounts for 70-80% of the ship recycling in the world (Talha, 2023b). However, state of the Gadani yard in Pakistan is not well studied particularly with the advent of latest regulations after 2020 i.e., Basel Convention amendments and also Hong Kong International Convention (HKC) (Sardar et al., 2025). While the shipbreaking yards in Bangladesh and India have been much covered in research in particular in relation to the environmental and labour situation in shipbreaking yards, there has been less interest in the yard at Gadani's compliance with regulations and the socio-economic impact of the yard on the local population (Kakar et al., 2020a). Emerging research puts the importance of more quantitative and comparative research into perspective, especially that of adaptation of Gadani to the international standards and general socio-economic trade-offs of ship recycling practices.

2.1 Environmental Toxicology

It is an established baseline for seawater and fish contamination for Gadani for cadmium and nickel in humans risk assessment through hazard quotients. There is excellent elevation of HgT (270+-230 µg/kg) & MeHg (0.65+-0.69 µg/kg) in the active yard zone

sediments, which is several times higher as compared to the reference area (Kakar et al., 2021). The spatial extent of contamination was determined to be 69 sediment samples metals 3-53x above reference sediments with Pb, Zn and Ni exceeding effects range median (ERM) sediment quality guidelines at several locations (Kakar et al., 2025). The atmospheric pathway was measured by air samples collected at Sum of total of Σ7PCB, 0.065-7.35 nanograms (ng)/sample, Sum of total of Σ8PAH, 2.44-134.23 nanograms (ng)/sample and Sum of total of SCCPs, 0.18-25.6 nanograms (ng)/sample in and around Gadani yards air sample. Also, soil cadmium to 12 mg/kg twelve times the WHO guideline value of 1 mg/kg (Shakoor Khan et al., 2024).

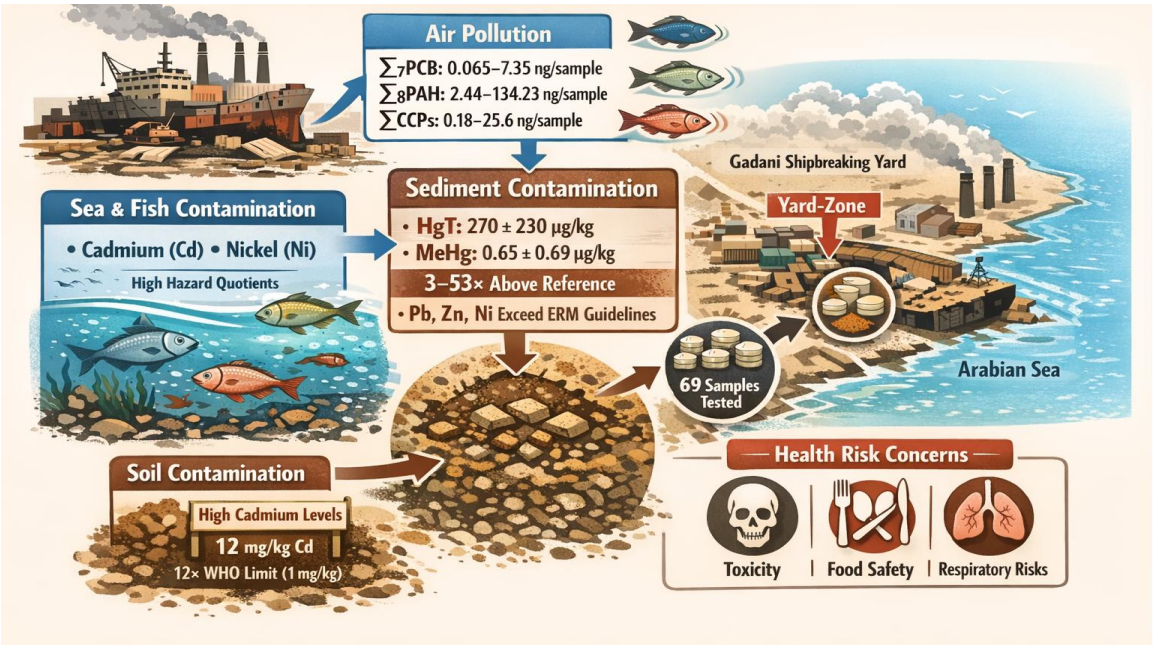

Figure 2. Environmental Hazards from Gadani Shipbreaking Yard

2.2 Occupational Health and Labour Rights

It found 'varieties of employee safety' in South Asian yards that the best-performing facilities showed managerial commitment, provision of PPE, and systems of training and certification, whereas weaker yards were more like informal operation of Gadani with

manual cutting of oxy-acetylene etc (Talha, Noor, et al., 2024). Without gas testing resulting in fatality rates 4-5 times of the global industrial average. It identifies three major determining factors of safety outcomes as the level of technology for safety, intensity of the disparagement of a regulatory nature and training culture. It is confirmed through conducting a large-scale field survey in Bangladesh, that explosion, fall and crushing risks are in-built into the process architecture of beaching-based recycling (Karim et al., 2024). For case studies of safety failures, the ACES FPSO explosion at Gadani in April 2016 with 29-31 fatalities and 58-71 serious injuries resulting from an estimated 375000 gallons of undeclared residual fuel are the defining safety failure case studies (Lin et al., 2022). It illustrated a multiplicity of simultaneous attempts at fail control, such as insufficient gas freeing, failure of taking a specific hazard assessment of every vessel, failure of emergency response, labour system, where migrant workers were exposed to residual risk without any form of contract protection

2.3 International Compliance with Laws

Pakistan has recently taken (November 2023) the Hong Kong International Convention (HKC) which is coming into force in 2024 as well. Despite this, compliance activity at Gadani is slow, with only 12% of EU flagged ships in 2025 expected to be demolished in certified yards the world over (Argüello Moncayo, 2016). The conflicts with the HKC have been shown in the Basel Convention (ratified in 1994) and the EU Ship Recycling Regulation (SRR) where there are greater level of waste controls comparing to the HKC's relaxed approach to waste controls (Glinski, 2022). ITLOS advisory opinions in 2014 We are witnessing interest in erga omnis protection of marine higher standards of global compliance and enforcement of environmental standards in shipbreaking (Pozdnakova, 2024) (Talha, 2023a).

2.4 Research Gap

Existing literature on South Asian shipbreaking centers on Bangladesh (Chittogram) and India (Alang) understudying Gadani yard in Pakistan that has 24 vessels dismantled in 2024 and post-2023 HKC ratification. Environmental toxicology attest recording of legacy heavy metals (such as Cd to 12 mg/kg soil & Pb to 1.96 µg/L sea water as TPH 3500 µg/L) but no information on 2026 PFAs and microplastics post certification monitoring. Occupational health has 83 fatalities (2015-2024), the highest in 2016 with 34 fatalities, with wages below living benchmarks by EUR 2.70-6.00 / day, but it does not have SENSREC-DW efficacy analysis Legal scholarship breaks down HKC/Basel/EU SRR tensions in one certified yard without regard for de jure/de facto gap, GIS pollution modeling, econometrics market decline (110-24 ships). This study helps address these temporal, methodological, geographical, and integrative gaps using hypercurrent multidisciplinary compliance assessment.

3. Research Methodology

This research is conducted with the help of a mixed-methods legal and empirical research approach, which, by using a combination of a doctrinal analysis of the legal phenomena, on the one hand, and a systematic synthesis of secondary quantitative data, on the other, aims to uphold the firm standards of the international maritime law scholarship (Adv. Ahmad Talha, 2022). Primary legal sources have been retrieved from institutional repositories of official bodies and consist of text of the Hong Kong International Convention (HKC), retrieved from the International Maritime Organisation's (IMO) GISIS database, the Basel Convention, retrieved from the United Nations Environment Programme (UNEP), ILO Convention No. 170 (Chemicals Convention), ILO Guidelines on Safety and Health in Shipbreaking, as well as relevant domestic legislation retrieved from Pakistan, including the Balochistan Ship Breaking Industry Rules 1979, and Pakistan Environmental Protection Act 1997. Empirical data related to the environmental contamination (Heavy metal concentrations and Total Petroleum Hydrocarbon (TPH)

concentrations) and occupational health (fatality rate and wage structures) have been obtained from the peer-reviewed journal articles published after the year 2020. Additional statistical information relating to shipbreaking volumes and reports of such occurrences were taken from the NGO Shipbreaking Platform's Annual Impact Reports in the years 2023, 2024 and 2025 and World Bank sector assessments (Talha, Sardar, et al., 2024). The study is based on a "Compliance Gap Analysis" matrix which is the result of mapping the de jure requirements of the HKC (e.g., Ship Recycling Facility Plans, Inventories of Hazardous Materials) and ILO Standards (e.g., hazard communication, right to refuse unsafe work) and the de facto operational realities at Gadani. The environmental information is compared with the threshold levels established by World Health Organization (WHO) and guidelines established by Basel Convention in respect of environmentally sound management of dismantling wastes. Only peer-reviewed articles and official data of the UN/IMO/ILO as well as verified data of NGOs has been used and there was no speculation printing of any economic forecast and any non-peer-reviewed journalistic pieces just for the sake of analytical rigor.

4. Finding and Discussion

4.1 Working Safety and Labour Right

4.1.1 Incident Patterns at Ghadani

The figures of the Gadani incident are presented in Table 1 opposed to the annual reports of NGO Shipbreaking Platform, EMSA (2025) and Isle of Man Ship Registry (2024) on the casualty list. The dominating is the spike of the 2016 accident, the ACES FPSO explosion about 29-31 fatalities and 58 to 71 injuries in one incident which is due to undeclared residual fuel and insufficient gas freeing and missing emergency response infrastructure (EMSA, 2025), (IMSR, 2024). South Asian yards, which includes Gadani, suffered from a total of around 355 fatalities between 2015-2024, which was according to

derived data provided by the NGO Shipbreaking Platform, and according to these data Pakistan was the cause of about 15 of the South Asian totals (NGO, 2025).

Year	Pakistan Ships Dismantled	Fatalities	Severe Injuries	Primary Causes (% of incident type)
2015	85	7	14	Falls (40%), fumes/asphyxiation (30%)
2016	**72**	**29–31***	**58–71***	**Explosion/fire – FPSO ACES (60%)**
2017	54	11	22	Falls (45%), crushing (30%)
2018	61	9	18	Crushing (50%)
2019	35	5	12	Fumes/asphyxiation
2020	42	6	15	Fires, falls
2021	38	4	10	Crushing
2022	31	3	8	Asphyxiation
2023	28	2	6	Falls
2024	24	2	5	Equipment failure

Table 1. Reported Gadani Incidents (2015-2024)

Note: Casualty figures are minimum estimates due to structural under-reporting of migrant-worker incidents.

Even after HKC came into force, regional safety data does not bear out the notion of any improvement in safety, including the 11 deaths and ≥ 62 injuries across South Asia in 2025. The post-HKC data also given in Table 2 confirms convention ratification without

operational follow-through, facility authorization, training and formal contracts and emergency response, does not in itself reduce the rate of incidents (NGO, 2026a) .

Safety Variant	Fatality Rate	Injury Rate	Key Controls
High (EU/OECD-certified)	≤0.5 per 100 ships	2–5 per 100 ships	Dry-dock/slipway; full gas-freeing; ISO 45001; independent audits
Medium (Certified Asian yards)	3–5 per 100 ships	15–25 per 100 ships	Partial PPE provision; SOLAS pre-cleaning; SRFP in place
Low (Informal beaching – Gadani)	**10–15 per 100 ships**	50+ per 100 ships	Manual oxy-acetylene cutting; no gas-free certificates; no OSH training

Table 2. Safety Performance by Facilities Type

Note: Informal beaching safety figures represent the lower end of compliance; approximately 80% of South Asian shipbreaking volume operates in the low-safety category per EMSA (2025).

4.1.2 Labour informality as a variable of compliance

The central deficit from the point of view of labor rights, in the case of Gadani, is the informality on a structural basis. The workforce is comprised of seasonal migrants from Khyber Pakhtunkhwa and other interior provinces; most of the workforce has no access to a written employment contract; access to PPE is patchy; training is minimal; and social protection is negligible. Day wage of about 2-6 Euro/day (PKR 800-1,500) less than minimum monthly wage of Pakistan, PKR 37,000 (about EUR 120). Post-incident compensation is said to average about USD 2,000 and this compensation provides neither deterrence for the operators nor actual compensation to affected families (Talha, Noor, et al., 2024).

Under the International Labour Organization Conventions, No. 155 (C155), workers have the human right to refuse unsafe work without prejudice and under the International Labour Organization (ILO) Guidelines on Safety and Health in Shipbreaking 2004, gas-free certificates are a requirement before any hot work will be carried out (Samarasekera, 2025). Neither of the requirements are operationally implemented in the informal yards at Gadani. Below 20% being less than 20% is considered to be below 20% for core OSH indicators as per the ILO 2025 SENSREC-DW diagnostic report (ILO, 2025), (Talha, Tayyab, et al., 2023). Until workers are affordably guaranteed a contract status with proper verification, training, the tools to evacuate workers to safety, and access to emergencies medical care to an HGC facility, compliance with the HKC cannot be credibly claimed.

4.2 Contaminations of Environment

4.2.1 Heavy Metals in the Seawater, Fish and Sedimentation

Heavy metal concentration, as can be seen in Table 3, has a huge impact on the marine ecosystem. The sea water lead concentration range (0.05-1.96mg/L) that is to say a range of 2-3× of the Miani Hor sea coast reference baseline (Kakar et al., 2020b) (Ahmad Talha et al., 2025). Cadmium of fish tissue, averaging 0.03-0.15 mg / g provided the biggest hazard quotient on the consumption of children's risk, that is, the direct relationship of chemistry on the ship to food security on the coast of Balochistan. In Table 3, the widest spatial picture can be found. Metals have been shown for 69 samples with the concentration of 3-53x over the reference at active yard sites (Kakar et al., 2025).

Contaminant	Gadani Concentration (2020–2025)	Limit	Fold Excess	Ecological / Health Pathway
Pb (Lead)	0.05–1.96 mg/L	0.03–0.97	2–3×	0.45–1.2 µg/g

		mg/L (Miani Hor)		
Ni (Nickel)	0.026–0.25 mg/L	0.01–0.10 mg/L	2.5×	0.12–0.8 µg/g
Mn (Manganese)	0.15–0.92 mg/L	0.07–0.45 mg/L	2×	1.2–3.5 µg/g
Cd (Cadmium)	0.01–0.08 mg/L	<0.01 mg/L	3–5×	0.03–0.15 µg/g
Hg-Total (sediment)	270 ± 230 µg/kg	Reference area mean	Multiple ×	Bioaccumulative
MeHg (sediment)	0.65 ± 0.69 µg/kg	Reference area mean	Multiple ×	Neurotoxic pathway
Pb, Zn, Ni (sediment)	3–53× reference	Reference area (21 stns)	3–53×	ERM exceedance
Cd (soil/sediment)	≤12 mg/kg	WHO: 1 mg/kg	12×	Groundwater leaching

Table 3. Heavy Metal Contamination Marine Ecosystem

Note: ERM = Effects-Range Median sediment quality guideline.

4.2.2 Persistent Organic Pollutants in the Air

The presence of pollutants in the atmosphere for Table 4 of elevated PAHs, SCCPs and PCBs at and around Gadani shows that the hazard perimeter is well beyond the tidal cutting zone to the residential and transport zones (Islam et al., 2023). The finding of PCBs deposition in the shipbreaking sites is of special importance: PCBs are listed in the Stockholm Convention on Persistent Organic Pollutants (2001) and under Basel Annex A

which means that the uncontrolled release of PCBs will lead to specific legal obligations on the international community independent of the HKC (Shakoor Khan et al., 2024).

Pollutant	Peak Concentration	Regulatory Threshold	Status	Ecological Impact
TPH (Total Petroleum Hydrocarbons)	3,500 µg/L (water column)	WHO: <10 µg/L	350×	Anoxia; 70% dissolved-oxygen drop
PAHs (Σ8)	2.44–134.23 ng/sample (air)	EU surface water: <20 ng/L	Exceeds	Mangrove die-off (~50% local loss)
SCCPs (short-chain chlorinated paraffins)	0.18–25.6 ng/sample (air)	Stockholm Convention restricted	Detectable	Sediment toxicity; food-chain transfer
PCBs (Σ7)	0.065–7.35 ng/sample (air)	Basel Convention Annex A	Detectable	Bioaccumulation; POP designation

Table 4. Atmospheric Pollutants Contamination

The beaching model is structurally contributing to this rise in the uncontrolled hazardous release probability by the lack of engineered containment in the process of dismantling in the intertidal area. UNCLOS Article 204-206 for active monitoring of the environment and reporting the same to the people have unfortunately not been realized by absence of a state-supervised monitoring program at Gadani (Riaz et al., 2025). ITLOS's (2011, 2024) 'best available science' and continuous monitoring requirements mean that Pakistan must do more than act on rules on paper in Pakistan must show that it is operationally alert (ITLOS, 2024).

4.3 Framework of the Legality and the Law

Complete layered legal structure with its compliance gaps for Pakistan are mentioned in Table 5 compiled from the primary sources. The important structural finding is that the domestic legal architecture of Pakistan is still fragmented in that the Balochistan Ship Breaking Industry Rules, 1979, which pre-dates all modern conventions, fell on weakest legal hooks, while the Pakistan Environmental Protection Act, 1997, which provides the fullest powers to protect the environment has seen fewer than 10 facility environmental approvals and major prosecutions at Gadani in the decade 2015-2025.

Instrument	Core Obligations	Pakistan Relevance	Verified Compliance Gap
UNCLOS Part XII (1982)	Duty to protect marine environment; EIA; monitoring; cooperation	Coastal-State baseline; ITLOS (2011, 2024) interpret as stringent due-diligence	No dedicated monitoring programme; no public annual environmental report at Gadani
Hong Kong Convention (HKC 2009/2025)	IHM; facility authorisation; SRFP; ship-specific SRP; reporting	Binding on Pakistan from 26 June 2025 (accession: 30 Nov 2023)	1 certified yard (Jan 2026); 11 pending; no consolidated domestic implementing statute
Basel Convention (1989) & Technical Guidelines (2003)	ESM of hazardous dismantling wastes; Ban Amendment; chain-of-custody manifests	Applies to asbestos, PCBs, Hg residues, sludges, contaminated scrap	No verified chain-of-custody for downstream waste; FoC re-flagging enables circumvention
EU Ship Recycling Regulation (2013/1257)	EU-flagged ships → listed facilities only; IHM mandatory for non-EU ships at EU	European List (Feb 2026): 41 facilities — zero in South Asia	Market exclusion persists; EU tonnage routed via cash buyers and FoC flags

	ports		
ILO Guidelines on Safety & Health in Shipbreaking (2004); C155; C187	Gas-free certificates; PPE; written contracts; emergency response; training; social security	OSH benchmark binding through Pakistan's ILO membership	Compliance <20% per ILO SENSREC-DW diagnostic (2025); informal workforce dominates
Balochistan Ship Breaking Industry Rules, 1979	Plot allocation; basic licensing under Balochistan Development Authority	Predates all modern conventions; no hazardous-waste controls	~80% yards licensed; <10% comply with environmental discharge limits; zero major prosecutions 2015–2025
Pakistan Environmental Protection Act, 1997 (amended 2012)	EIA (ss.12–17); pollution discharge limits (s.11); fines (ss.17)	Broader environmental powers; federal–provincial jurisdictional divide	Only ~2/40 Gadani yards certified under PEPA Rules 2021; federal–Balochistan EPA overlap unresolved

Table 5. Legal Framework and Compliance Gaps for Pakistan

Note: FoC = flags of convenience. ESM = environmentally sound management. IHM = Inventory of Hazardous Materials. SRFP = Ship Recycling Facility Plan. SRP = Ship Recycling Plan.

The most critical institutional deficit is the absence of a unified and consolidated Ship Recycling Act effecting the express domestication of the HKC, distribution of competent authority jurisdictions, downstream wilt chain accountability, and the attachment of enforceable sanctions (Shah et al., 2017). The HKC's requirements for certification are based on an incompatible, and much older, framework without legislation. Importantly, ITLOS's 2011 Advisory Opinion states clearly that pursuant to due diligence, factors including the adoption of rules and vigilance in enforcement, administrative control over private operators, and monitoring of activities are necessary (Blankson et al., 2024). Pakistan has not reached that standard throughout the Gadani complex.

4.5 Comparative analysis of Pakistan against its Neighbour Countries

IMO and NGO Shipbreaking Platform come to an agreement that India has more than 100 private Statements of Compliance issued by classification societies at the Alang-Sosiya complex but has no formally HKC-authorized facility (Dewan & Sibilia, 2024b). Statements of Compliance are private certification instruments which predated and are distinct from formal HKC Regulation 16 facility authorization (Khan & Sadiq, 2023). This distinction is of legal importance and it is reflected in Table 6.

Metric	Pakistan	Bangladesh	India
HKC Ratification	30 Nov 2023	Party (2023)	Party (2019)
Certified/Authorised yards (early 2026)	1 certified (Prime Green, BV, Nov 2025); 11 pending	17 approved yards under HKC framework	>100 private Statements of Compliance (classification societies); no formal HKC authorisation
Vessels dismantled – 2024	24	130	101
Vessels dismantled – 2025 (verified)	15	88	111
Domestic ship recycling legislation	No consolidated act; fragmented 1979	Ship Breaking & Recycling	Recycling of Ships Act 2019

	Rules + PEPA 1997	Enterprises Act 2018	
Worker OSH project	SENSREC-DW (ILO-IMO, Nov 2024–Dec 2026)	Various ILO interventions (Phase III)	Domestic OSH framework
EU European List inclusion	**No**	**No**	**No**
South Asian fatalities (2025)	Regional: 11 deaths, ≥62 injuries (all three countries combined per NGO SP 2026)	→	→
Basel Ban enforcement	Weak; FoC vessels enter routinely	Weak; Comoros/Tanzania flag loophole documented	Weak; same structural gap

Table 6. Comparative Compliance Matrix of Pakistan, India and Bangladesh

Pakistan's dismantling volume decline from 110 vessels in 2014 to 15 in 2025 reflects both reduced global demolition demand and growing ESG-linked market pressure, which is also illustrated in Table 7 (Hosen et al., 2025). Despite this volume contraction, Gadani's legal and environmental significance is not diminishing: the risk profile per vessel remains high given the persistence of intertidal beaching, the documented contamination legacy, and the informality of the workforce (Dar, 2025).

The EU dimension sharpens this analysis. The 41-facility European List (February 2026) includes no South Asian yard. EU-flagged tonnage representing approximately 30% of the world merchant fleet (European Commission, 2026) is therefore legally excluded from Gadani under the EU SRR (Xu et al., 2025). This creates structural incentives for reflagging through convenience registries (Comoros, Palau, and Tanzania) and cash-buyer transactions, a documented circumvention pathway that undermines the Basel Ban Amendment for non-OECD disposal (Tola et al., 2024).

Year	Pakistan	Bangladesh	India	Notes / Global Context
2014	110	85	145	340+
2018	61	213	176	450+
2020	42	180	165	387+
2022	31	204	173	408+
2023	28	196	167	391+
2024	24	130	101	255 (South Asia); 409 global
2025	15	88	111	214 (South Asia); 321 global

Table 7. Ship Dismantle Volume Trends (2014 – 2025)

5. Policy Recommendation

5.1. Consolidated Domestic Legislation

Pakistan should revoke 1979 rules on the Balochistan Ship Breaking Industry and carry out an integral Ship Recycling Act expressly domesticating HKC, defining Basel Waste chain obligations and UNCLOS observation duties, defining responsible authority for clear 'jurisdictions' over 'federal' maritime 'regulatory' 'customers labor,' 'environmental,'

and 'provincial' authorities' bodies, beaching gas-free data with IHM verification certificate before beaching, and mandatory 'public' accident and occupational disease registry attached to enforceable, proportionate sanctions. Bangladesh's overseas business operating in India gives us an important model of comparison in legislative art in the form of the Ship Breaking and Recycling Enterprises Act, 2018, and the Recycling of Ships Act, 2019, of India, with reservations attached to its own implementation flaws.

5.2. Man-made Environmental Infrastructure

Bare intertidal beaching should be replaced as much as possible with alternatives for modified beaching techniques that include (a) impermeable and concrete working surfaces with drain collection; (b) dedicated hazardous material segregation and storage zones with secondary containment mentally; (c) auditable chain of custody manifests for asbestos, PCBs, mercury-bearing residues and sludges, and for contaminated scrap (Basel Technical Guidelines, 2003); and (d) licensed onward transport to certified treatment, storage, and disposal facilities (Talha, Mukhtar, et al., 2023). An environmental monitoring program (sea water, sediment, fish tissue, and ambient air) conducted on a standing basis on an annual basis and with public reporting shall constitute an absolute minimum of due diligence issued in accordance with UNCLOS Articles 204 - 206 (United Nations, 1982; ITLOS, 2024).

5.3 Labour Formalization

Labor formalization is a compliance aspect with the ILO C155, C187, and HKC SRFP requirements and not welfare. Mandatory written contracts of employment, pre-employment medical checks, verified certificates of gas-free condition as a prerequisite for any hot work, fit-for-task PPE, and regular emergency drills with results in writing and, in accordance with the requirements by law, social security enrollment should per se become a condition for authorizing the facility. A centralized accident registry with

annual reporting by facilities would address the standard in ITLOS for 'vigilance in enforcement' and would permit independent compliance monitoring by the international community.

5.4 Communication: Transparency and Monitoring

Pakistan should practice regular attitudes to publish quarterly environmental monitoring data as published by the competent authority; yearly inspection and enforcement reports of the facilities; development of an accessible database of accidents and incidents; and cumulative environmental impact assessment of the Gadani coastal zone at regular intervals (Talha, Tayyab, et al., 2023). Port State Control mechanisms under Hong Kong Control (HKC) or Basel compliance reporting or ILO labor inspection are all external frameworks of verification that Pakistan should be actively engaging in instead of resisting.

5.5 Just Transition, Financing Fairly

Ship recycling brings steel and employment to the locals, and any attempt to fit the ban without an alternative infrastructure for its replacement would distribute the risk, not lessen it. A just transition enshrines the right to social insurance guarantees for workers during the timeframe of facilities upgrades; wage regularization so that compliance costs are not borne mainly by workers; emergency medical coverage; significant participation of coastal fishing communities in a process of designing environmental monitoring because they are directly impacted; and phased-in milestones of the upgrade with international financing to support this. The Rs 12 billion plan for modernization declared by the Government of Pakistan is a great signal; it needs international technical assistance through SENSREC-DW and possible IFI co-financing in order to scale up to operational level.

6. Conclusion

Gadani just is like a real turning point in the regulations. Pakistan's Hamburger Tears to Electricity (HKC) accession, SENSREC-DW project and also the opening of first certified facility in January 2026 is a reality in developing the institution. These are, however, not enough. The cross-verified evidentiary record compiled in the present article determined that the multi-pathway contamination foundation of core human and environmental ills of intertidal beaching has not been solve by accession and evident still remains in sediments, sea water, fish and air; domestic safety information continues to attest to ongoing deaths & injuries despite HKC entry in force; domestic regulation is still patchy; and downstream hazardous waste infrastructure is incomplete (Noor et al., 2024). The key finding is therefore one of a compliance gaps rather than compliance absence. Pakistan, therefore, is not outside the international convention architecture anymore, but it is still a huge distance away from having a fully operational system of safe, transparent and environment safe recycling. There's the problem of closing that gap, and that's integrated legislation, engineered containment, labour formalization, public monitoring, and financially just transition financing and sequenced and resource matched and legally grounded. Until such measures are implemented and concretely enforced, therefore, the transition process in Pakistan will be legally promising but practically incomplete. The normative end point is obvious and attainable: Pakistan has not to give up ship recycling. It must change Gadani from a coastal risk transfer mechanism to legal accountability of a recycling cluster demonstrably in line with HKC inconsistent with Basel and compatible with UNCLOS legal obligations of due diligence under UNCLOS as understood by ITLOS obligations of UNCLOS. The global maritime community has a common interest that that transition will be successful.

6.1 Limitations of Study

This research suffers from a host of methodological and contextual limitations and these should be recognized in an honest way. Most importantly, the article does not give birth

to a fundamental data in the field. It is based fully on secondary synthesis of the peer-reviewed studies, official reports of the institutions, outputs of monitoring of the non-governmental organizations. The contamination numbers indicated in tables 3 and 4 are based on discrete sampling campaigns and cannot be interpreted as continuous and real-time evaluation of the environmental condition of Gadani. Temporal variation in tidal flushing, seasonal dismantling volumes and facilitating atmosphere dispersion depending on weather, means that concentrations reported are likely to be an underestimate of peak exposure events or an overestimate of exposure during periods of low activity. The statistics on accidents and fatalities put on the basis of the figures of the NGO Shipbreaking Platform, EMSA and IOM are the minimum estimates. Structural underreporting forms only one of the documented characteristics of the informal shipbreaking labour markets - migrant workers lacking formal labour contracts would have little access to official communication channels for reporting accidents; employers have financial incentives for underreporting; and a lack of medical infrastructure in provincial centers such as Gadani has historically had no capacity for systematic occupational disease surveillance. There is almost certainly more of the actual burden of occupational harm, such as chronic respiratory disease, from exposure to asbestos and silica, toxicity from heavy metals such as chromium, and hearing loss from noise exposure than as measured by the compiled incident tables. Comparative data for Bangladesh and India is based on the NGO Shipbreaking Platform's annual numbers of vessels, which are based on estimates with boundaries of year classification uncertainties of roughly the order of plus or minus five percent. Legal analysis is based on international treaty obligations and their domestic operationalization; however, the modeling of economic costs of proposed reforms or the fiscal capacity of Pakistan's government to finance the identified infrastructure investments are important practical constraints that will be faced by future economic modeling research.

6.2 Research Direction in the Future

The most urgent is longitudinal environmental monitoring at Gadani based on the trends of contamination before, during and after the time period of the SENSREC-DW intervention. The current peer-reviewed evidence shows a very well-characterized background of pre certification of sediment, sea water, fish and respiration pathways. A structured follow-up sampling campaign at the same stations in 2026-2027, will be the first empirical test to observe if the results of the HKC certification and the SENSREC-DW capacity building result in measurable improvement in the environment at a South Asian beaching yard.

If the implementation of Pakistan's expected Ship Recycling Act is to happen, then legal analysis of the appropriateness of Pakistan's statute to operationalize requirements in the HKC's Regulation 16 and facility authorizations, Basel chain of custody requirements, and ILO C155/C187 occupational safety and health requirements is critical. Economic modeling of the transition path from informal beaching to engineered and HKC-compliant recycling to Gadani is a major gap in the body of research. Capital requirements - operational cost differential questions, scrap price sensitivity questions, financing modes and mechanism including IMO Green Voyage 2050 set of instruments, IFIs loans and trades private green finance tools, and strict cost benefit analysis and scenario analysis are followed to underpin credible policy design. "Atmospheric persistent organic pollutant" was an unexplored area of research related to the community health burden of the airborne hazard footprint of Gadani. Epidemiological studies on the impact on respiratory health, neurological effects of mercury and lead exposure, and cancer rates in the population residing in residential settlements near the yard would properly involve the right to health dimensions along with the kind of human health studies evidence base needed for future litigation and compensation claims and the setting of regulatory standards. GIS-based pollution dispersion modeling methods coupled with biomonitoring of workers and members of the general public would make a significant scientific contribution as well as a practical case for more urgent regulatory

reform at Gadani and by extension of methodology at similar beaching yards all over South Asia.

References

Adv. Ahmad Talha. (2022). ADMINISTRATIVE AND JUDICIAL FRAMEWORKS FOR ARMED NON-STATE ACTORS' LAW ENFORCEMENT AND ORGANIZATIONAL STRUCTURES. *Pakistan Journal of International Affairs*, *5*(4). https://doi.org/10.52337/pjia.v5i4.640

Ahmad Talha, Amina Iqbal, & Faisal Shahzad Khan. (2025). Revisiting the Geneva Conventions: Are the Four Core Conventions Sufficient for 21st Century Warfare? *The Critical Review of Social Sciences Studies*, *3*(2), 2213–2229. https://doi.org/10.59075/97c2c362

Argüello Moncayo, G. (2016). International law on ship recycling and its interface with EU law. *Marine Pollution Bulletin*, *109*(1), 301–309. https://doi.org/10.1016/j.marpolbul.2016.05.065

Blankson, E. R., Ohene-Obeng, N. K. A., Awuah, B. A., Oduro, D., Ewool, J., & Gbogbo, F. (2024). Heavy Metal Bioaccumulation in Highly Consumed Pelagic and Benthic Fish and Associated Health Risk. *Biological Trace Element Research*, *202*(8), 3781–3788. https://doi.org/10.1007/s12011-023-03943-2

Chang, Y.-C., Wang, N., & Durak, O. S. (2010). Ship recycling and marine pollution. *Marine Pollution Bulletin*, *60*(9), 1390–1396. https://doi.org/10.1016/j.marpolbul.2010.05.021

Dar, Dr. S. B. (2025). Ship- Source Marine Pollution, Legal Theory, Law and Practice: The Regime of Pakistan's Perspective. *Journal of Nautical Eye and Strategic Studies*, *5*(1), 52–70. https://doi.org/10.58932/MULG0055

Dewan, C., & Sibilia, E. A. (2024a). Global containments and local leakages: Structural violence and the toxic flows of shipbreaking. *Environment and Planning C: Politics and Space*, *42*(1), 80–101. https://doi.org/10.1177/23996544231208202

Dewan, C., & Sibilia, E. A. (2024b). Global containments and local leakages: Structural violence and the toxic flows of shipbreaking. *Environment and Planning C: Politics and Space*, *42*(1), 80–101. https://doi.org/10.1177/23996544231208202

Dey, A., Ejohwomu, O. A., & Chan, P. W. (2021). Sustainability challenges and enablers in resource recovery industries: A systematic review of the ship-recycling studies and future directions. *Journal of Cleaner Production*, *329*, 129787. https://doi.org/10.1016/j.jclepro.2021.129787

Du, Z., Zhang, S., Zhou, Q., Yuen, K. F., & Wong, Y. D. (2018). Hazardous materials analysis and disposal procedures during ship recycling. *Resources, Conservation and Recycling*, *131*, 158–171. https://doi.org/10.1016/j.resconrec.2018.01.006

EMSA. (2025). *Annual Overview of Marine Casualties and Incidents 2025*. European Maritime Safety Agency. https://emsa.europa.eu/damage-stability-study/items.html?id=5562

Filiz, T., & Çetin, B. (2026). Global trade dynamics of the shipbreaking industry: A complex network analysis approach. *International Journal of Shipping and Transport Logistics*, *22*(2), 235–262. https://doi.org/10.1504/IJSTL.2026.151953

Glinski, C. (2022). Liability of shipowners and classification societies for environmental damage and unsafe working conditions at recycling yards. *Review of European, Comparative & International Environmental Law*, *31*(3), 468–482. https://doi.org/10.1111/reel.12455

Hosen, S., Alam, O., Al Amin, M., Arif, M. S., Das, C., & Sultana, N. (2025). Impact of shipbreaking industries on the Sitakunda coastal environment, Chattogram by analyzing water quality parameters. *Marine Pollution Bulletin*, *211*, 117451. https://doi.org/10.1016/j.marpolbul.2024.117451

ILO. (2025). *Safe and Environmentally Sound Ship Recycling and Decent Work in Pakistan (SENSREC-DW)*. International Labour Organization. https://www.ilo.org/resource/other/safe-and-environmentally-sound-ship-recycling-and-decent-work-pakistan

IMSR. (2024). *Annual summary report of casualties, accidents and incidents 2024*. Isle of Man Ship Registry. https://www.iomshipregistry.com/media/pkrnr1y5/2024-iom-annual-summary-casualty-report-final.pdf

Islam, Md. N., Ganguli, S., Tanvir, E. M., Rifat, Md. A. H., Saha, N., Peng, C., & Ng, J. C. (2023). Human Exposure Assessment of Mixed Metal/Loids at and Near Mega-Scale Open Beaching Shipwrecking Activities in Bangladesh. *Exposure and Health*, *15*(1), 69–84. https://doi.org/10.1007/s12403-022-00477-1

ITLOS. (2024). *Request for an Advisory Opinion submitted by the Commission of Small Island States on Climate Change and International Law, Advisory Opinion, Case No. 31*. International Tribunal for the Law of the Sea. https://www.itlos.org/fileadmin/itlos/documents/cases/31/Advisory_Opinion/C31_Adv_Op_21.05.2024_orig.pdf

Kakar, A., Hayat, M. T., Abbasi, A. M., Pervez, A., Mahmood, Q., Farooq, U., Akbar, T. A., Ali, S., Rizwan, M., El-Serehy, H. A., & Abdel-Daim, M. M. (2020a). Risk Assessment of Heavy Metals in Selected Marine Fish Species of Gadani Shipbreaking Area and Pakistan. *Animals*, *10*(10), 1738. https://doi.org/10.3390/ani10101738

Kakar, A., Hayat, M. T., Abbasi, A. M., Pervez, A., Mahmood, Q., Farooq, U., Akbar, T. A., Ali, S., Rizwan, M., El-Serehy, H. A., & Abdel-Daim, M. M. (2020b). Risk Assessment of Heavy Metals in Selected Marine Fish Species of Gadani Shipbreaking Area and Pakistan. *Animals*, *10*(10), 1738. https://doi.org/10.3390/ani10101738

Kakar, A., Jonsson, S., & Mahmood, Q. (2025). Elevated concentration of selected heavy metals in Gadani shipbreaking area, Pakistan. *Regional Studies in Marine Science*, *91*, 104507. https://doi.org/10.1016/j.rsma.2025.104507

Kakar, A., Liem-Nguyen, V., Mahmood, Q., & Jonsson, S. (2021). Elevated concentrations of mercury and methylmercury in the Gadani shipbreaking area, Pakistan. *Marine Pollution Bulletin*, *165*, 112048. https://doi.org/10.1016/j.marpolbul.2021.112048

Karim, B. A., Mahmood, G., Hasija, M., Meena, B., & Sheikh, S. (2024). Assessment of heavy metal contamination in groundwater and its implications for dental and public health. *Chemosphere*, *367*, 143609. https://doi.org/10.1016/j.chemosphere.2024.143609

Khan, D. M. Z., & Sadiq, M. F. (2023). Law Enforcement within Maritime Zones of Pakistan: Impediments, Opportunities and Way Forward. *The Beacon Journal*, *3*(1). https://beacon.mcepk.org/index.php/ojs/article/view/28

Lin, L., Feng, K., Wang, P., Wan, Z., Kong, X., & Li, J. (2022). Hazardous waste from the global shipbreaking industry: Historical inventory and future pathways. *Global Environmental Change*, *76*, 102581. https://doi.org/10.1016/j.gloenvcha.2022.102581

NGO. (2025). *Press release: Platform publishes list of ships dismantled worldwide in 2024*. NGO Shipbreaking Platform. https://shipbreakingplatform.org/platform-publishes-list-2024/

NGO. (2026a). *Press release: Platform publishes list of ships dismantled worldwide in 2025*. NGO Shipbreaking Platform. https://shipbreakingplatform.org/platform-publishes-list-2025/

Noor, S., Talha, A., Sardar, T., & Noor, O. A. (2024). Analysis of Adoption of Mudarabah and Musharakah in Pakistan. *International Journal of Trends and*

Innovations in Business & Social Sciences, *2*(4). https://doi.org/10.48112/tibss.v2i4.949

Pozdnakova, A. (2024). Ship Recycling and the Right to a Healthy Environment. *The International Journal of Marine and Coastal Law*, *39*(3), 561–570. https://doi.org/10.1163/15718085-bja10188

Rahman, M. H., Chen, T., Yeasmin, S. M., Tan, X., & Khan, M. H. R. (2026). Coral geochemical archives reveal shipbreaking-driven heavy metal pollution in the Bay of Bengal. *Marine Pollution Bulletin*, *222*, 118888. https://doi.org/10.1016/j.marpolbul.2025.118888

Riaz, S., Khan, M. J., Rani, I., Ali, A., Qazi, M. A., Sameer, M., Khadija, Hussain, N., & Sherzada, S. (2025). Heavy metal contamination in some commercial marine fishes of Pakistan. *Food Additives & Contaminants: Part B*, *18*(2), 135–142. https://doi.org/10.1080/19393210.2025.2457046

Samarasekera, U. (2025). Toxic trade: Shipbreaking in South Asia. *The Lancet Planetary Health*, *9*(10). https://doi.org/10.1016/j.lanplh.2025.101333

Sardar, T., Talha, A., & Ahmed, M. (2025). The Consequence of the US-China Trade War on the Global Economy and Multilateral Trade Strategy. *International Journal of Applied and Advanced Multidisciplinary Research*, *3*(8), 531–556. https://doi.org/10.59890/ijaamr.v3i8.86

Shah, S. A., Hussain, H., & Hussain, M. (2017). Skill Gap Analysis in the Ship Breaking Industry of Pakistan. *American Journal of Industrial and Business Management*, *07*(11), 1244–1254. https://doi.org/10.4236/ajibm.2017.711088

Shakoor Khan, A., Akbar Khan, S., Abbasi, A., Hajjar, D., Makki, A. A., Almahasheer, H., Moursy, A. R. A., & Jiménez-Ballesta, R. (2024). Characterization of persistent organic contaminants in the atmosphere of Gadani's ship breaking yards and its surrounding: Implications for sustainable ship recycling practices.

Environment International, *185*, 108531. https://doi.org/10.1016/j.envint.2024.108531

Talha, A. (2022). Evolution of Exemptions to Carrier in Different Maritime Legal Regime. *Journal of Contemporary Issues in Business and Government*, *28*(03), 455–470. https://doi.org/10.47750/cibg.2022.28.03.035

Talha, A. (2023a). The Preponderance of International Courts in the Conflict of Treaty Law and Customary International Law. *Annals of Human and Social Sciences*, *4*(II). https://doi.org/10.35484/ahss.2023(4-II)50

Talha, A. (2023b). The Snags of Maritime Piracy Facing the Maritime Trade: Implications for the Blue Economy and Maritime Laws. *Journal of Development and Social Sciences*, *4*(III). https://doi.org/10.47205/jdss.2023(4-III)01

Talha, A., Mukhtar, S., & Mustafa, M. (2023). A Comprehensive Study of Blasphemy and Freedom OF Speech in the Light of Islamic Jurisprudence and the Pakistani Legal Perspective: A Critical Analysis. *Global Legal Studies Review*, *VIII*(II), 43–53. https://doi.org/10.31703/glsr.2023(VIII-II).06

Talha, A., Noor, S., & MA, M. (2024). Environmental Rights as Human Rights: A Case Study of Pakistan and Multiple Approaches towards their Recognition. *Pakistan Social Sciences Review*, *8*(4), 82–97.

Talha, A., Sardar, T., Ahmed, M., & Sardar, R. (2024). Addressing for Corporate Malpractice in the Transnational Supply Chain: Prospects for Redressal in Pakistan. *International Review of Basic and Applied Sciences*, *11*(4), 21–35.

Talha, A., Tayyab, M., & Sardar, T. (2023). Child Rights and Its Implementation Status in Pakistan. *Journal of Asian Development Studies*, *12*(3), 512–524. https://doi.org/10.62345/jads.2023.12.3.39

Tola, F., Mosconi, E. M., Marconi, M., & Gianvincenzi, M. (2024). Navigating the EU Ship Recycling Market: Economic and Environmental Perspectives. *Journal of Circular Economy*, *2*(3). https://doi.org/10.55845/FJTP4757

Xu, J., Chen, J., & She, S. (2025). Green governance of global shipbreaking: Key problems and reform pathways. *Journal of Cleaner Production*, *533*, 146995. https://doi.org/10.1016/j.jclepro.2025.146995

Zafar, S. A., Prof. Dr. Sajid Mehmood Shehzad, & Dr. Humera Akhtar. (2025). Ship-breaking Industries through the Lens of Dependency: A Comparative Analysis of Gadani & Chittagong Yards. *JISR Management and Social Sciences & Economics*, *23*(2), 30–45. https://doi.org/10.31384/jisrmsse/2025.23.2.2