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Maritime sector has always been influencing the global economy. Shipping facilitates the bulk transportation of raw material, oil and gas products, food and manufactured goods across international borders. Shipping is truly global in nature and it can easily be said that without shipping, the intercontinental trade of commodities would come to a standstill.

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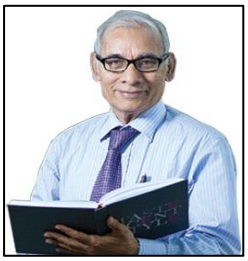

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Editorial

The IIRE Journal of Maritime Research and Development is conceived to provide a means of publishing and disseminating the results of academic research and scholarship. In doing so it is aimed to serve the following purposes:

1. To provide a stamp of quality and be indicative of the fact that the article is worth reading. The blind peer review process by researchers active in the field while being judgmental on quality and standing at one level, is also developmental and provides feedback and advice to authors.
2. To partner with the research community and through its selected papers both on empirical and theoretical findings, stimulate debate about particular topics and issues.
3. To provide for the indexing and cataloguing of articles for its wider access and use.
4. To provide a means of managing intellectual property rights and permissions.

It is widely said that tomorrow's world belongs to those who create, nurture and own intellectual property. Such an asset though intangible, forms a superior basis for sustaining growth over the long run. This journal aims to be such a repertoire for the international maritime industry.

All the five well researched papers are authored by researchers, with an amalgamation of varied maritime backgrounds. Tugsan is a master mariner from Turkey, Portia is a maritime lawyer in USA, Asha is a commercial manager from India, Nanda Gopal Reddy is a chief engineer from USA and Myself (Suresh Bhradwaj) is a master mariner from India.

Dr. Capt. S. Bhardwaj
Editor, IJMRD

1. REMOTE SENSING TECHNIQUES IN DETECTING OIL POLLUTION

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Abstract

Remote sensing data and techniques play an important role to combat and to detect oil pollution from satellite and aerial observations. It is possible to detect the spatial distribution and size of oil pollution using remotely sensed data in an emergency case of any oil pollution disaster. Based on information created from near real time satellite images, it is possible to generate an emergency contingency plan rapidly and support recovery actions. This paper examines the role of remote sensing techniques to detect and combat oil spills, to minimize their impact and to mitigate oil pollution.

Key Words: Oil Pollution, Remote Sensing, Synthetic Aperture Radar (SAR).

1. INTRODUCTION:

Marine pollution can be caused directly or indirectly by manmade sources giving energy or substance to the marine environment [1]. The sources of marine pollution are oil pollution, heavy metals and their production, bio-accumulation, disposal of radio-active materials, discharge of sewage, harmful algal blooms [2]. Shipping and maritime activities cause a great amount of marine pollution, generally. Oil is one of the major pollutant resulting from maritime activities [3].

International Convention for Marine Pollution Prevention from Ships defines oil as 'petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products' (other than petrochemicals which are subject to the provisions of the present Convention) [4].

Possible sources of ship based oil pollution are generally from the machinery spaces of the ships but for tankers the cargo washings and cargo wastes also are contributory. Ships generate oily waste products due to usage of heavy fuel oil sand other lubricating oils. During routine operations, oil tankers generate more waste water than other ships. Three categories of oily waste generally accumulate on board large vessels. These are bilge waste, sludge waste and oil cargo residue waste (slop) [5].

2. OIL SPILLS:

When oil is spilled into the ocean, the oil undergoes physical and chemical changes such as spreading, drift, mixing, evaporation, sedimentation, dissolution, emulsification, photo oxidation, and bio-degradation [6]. These changes can be called oil transport and weathering processes. In processing these changes, oil spills can form different pollution types and show different visual characteristics [6].

The composition and characteristics of an oil, together with a number of circumstances relating to the time and place of the spill, the amounts of oil, weather conditions determine how persistent the oil will be, how it will spread, whether it will evaporate or sink [7].

Most oil spills are accidental and thus unpredictable. Spills can happen, at any time of day or night, and in any weather condition [8]. However, once a spill occurs, the best approach for containing and controlling the spill is to respond quickly following a contingency plan and in a well-organized manner [9]. A contingency plan (or management strategy) looks at all the possibilities of what could go wrong and details upon actual events, including the contacts, resource lists, and strategies to assist in the response to the spill [8]. A well-designed contingency plan should be easy to follow and usually includes hazard identification, vulnerability analysis, risk assessment and response actions [8]. The plan can help minimize potential harm to human health and the environment by ensuring a timely and coordinated response. Well-designed local, regional, and national contingency plans can assist response personnel in their efforts to contain and clean up oil spills by providing information that the response teams will need before, during, and after spills [9]. Remote sensing technology is a useful decision support tool for contingency plan to mitigate oil pollution. The appearance of oil spills on water surface (varying thicknesses, colour changes, patches, borders) the degree of coverage, the position and time of observation are important factors for oil spill contingency plans to determine the quantities of hydrocarbon spilt using visible observation [10].

3. EMPLOYING REMOTE SENSING FOR DETECTING OIL POLLUTION:

Remote sensing is the science (and to some extent, art) of acquiring information about the earth's surface without actually being in contact with it. This is done by sensing and recording the reflected or emitted energy and processing, analysing, and applying that information [11]. Remote sensing provides different methods for acquiring information from oceans and seas. There can be many applications for remote sensing in different fields. [12]. Natural resource management, sustainable development, environmental degradation, and disaster management are most important topics nowadays for remote sensing [13]. As a matter of fact, big oil spill accidents cause a disaster not only at sea, but also affects the coastal environment. Oil spill monitoring, mapping and predicting oil spill extent and drift, strategic support for oil spill emergency response decisions, identification of natural oil areas for exploration are study areas for disaster management of oil spills employing remote sensing [12]. Rate and direction of oil

movement can be calculated with multi-temporal remote sensing data then entering these data to drift prediction modelling which makes further control and clean-up efforts more effective and easier [14].

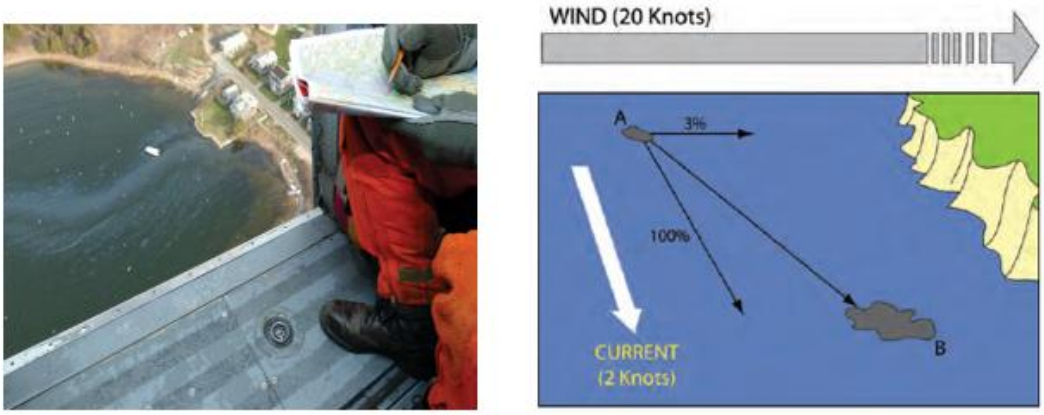

Figure 1: Oil spill contingency planning using remote sensing techniques [10]

3.1 Kinds of Remote Sensing Tools for Oil Spill Monitoring:

There are different remote sensing applications for detection of oil pollution/spills on sea surface. These include ultraviolet, visible, infrared and microwave wavelength regions of the electromagnetic spectrum. Oil gives different responses and signatures to radiation from different wavelengths. Multispectral and hyperspectral remote sensing [15], thermal infrared [16], synthetic aperture radar (SAR) [17], have different detection principles and imaging characteristics. Therefore, the detected targets of oil spills will be different in each remote sensing image.

3.1.1 Visible Remote Sensing

With the development of optical remote sensors and quantitative remote sensing studies, optical remote sensing technology used in marine oil spill monitoring has been improved [18]. Based on the radiance (brightness) of optical remote sensing satellite images or reflectance spectra of in situ measurements, the different oil spill pollution types can be identified [19]. Visual characteristics of marine oil spills help to improve the interpretation of optical remote sensing images [17]. Optical remote sensing technology to identify those oil pollution types is based on the theory of light

absorption, scattering, and reflection. The thickness of the oil slick spectra of background water are very important parameters to interpret oil spills [18].

Optical Sensors include cameras and scanners in the visible, infrared and ultraviolet ranges. Visible sensors are passive sensors that operating in the visible region of the light and are still widely used in oil spill remote sensing [20]. Sun-glint, wind sheen, see weeds, darker shore are the limits for visible remote sensing of oil. Visible sensors cannot normally operate at night as they are based on the reflectance of sunlight. But the advantages of Visible sensors are that they can be easily mounted on aircraft. Visible sensors are less costly and easy to use; therefore, they are often used to create the basic data in coastal areas [18].

Figure 2: Oil spill detection with visible sensor [21]

3.1.2 Infrared Sensors

Infrared sensors are passive sensors. The oil absorbs solar radiation and emits some part of it as the thermal energy mainly in the thermal infrared region (8-14 μm) [18] Oil has a lower emissivity than water in the thermal infrared region (TIR) and therefore oil has a distinctively different spectral signature in the TIR compared to the background water [22].

TIR is typically used for oil spill detection in the IR region. Thick oil absorbs greater amounts of radiation and as a result it appears hot in TIR. The oil of intermediate thickness appears cool in this region, but thin sheens cannot be detected in TIR. The thickness of the minimum detectable layer lies between 20 and 70 μm. The change from

hot to cold layer occurs between 50 and 150 μm [17]. At night, the reverse behaviour is observed: heat loss in oil is faster than in water and therefore, thick oil appears cooler than water [18].

3.1.3 Ultraviolet Sensors

UV scanners capture the ultraviolet radiation reflected by the sea surface. A UV sensor is a passive sensor as it uses reflected sunlight in the ultraviolet region (0.32-0.38 μm) for detecting oil spills [22]. Oil has stronger reflectivity than water in the UV region. Even a very thin oil film has a strong reflectance in the UV region. Very thin sheets of thickness (less than 0.1μm can be detected using a UV sensor. However, UV sensors cannot detect oil thickness greater than 10 μm [18]. UV images can only give information about the relative thickness of the oil slick. False detection may occur due to the wind sheen, sun glint and sea weeds. Interferences in UV are different from IR and a combination of these two techniques can provide improved results for oil spill detection [23]. UV images are based on the reflected sunlight and hence cannot operate in the night [22].

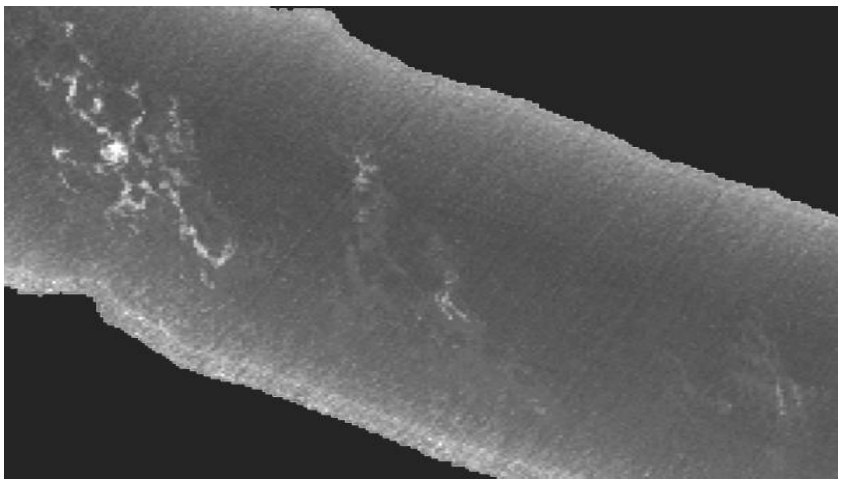

Figure 3: Oil has a higher refractive index than water [24]

3.1.4 Radar

Radar is an active sensor and operates in radio wave region. Radar waves are reflected by capillary waves on the ocean and therefore, a bright image is obtained for ocean water. Oil diminishes capillary waves and as a result, if oil is present in the ocean then

reflectance is reduced. Hence, the presence of oil can be detected as dark part in the bright image for the ocean [18]. Radar is useful as it can be used to detect oil over a large area [25]. Thus, it can be used as a first assessment tool to detect the possible location of an oil spill [22]. Radar can work in both inclement weather and at night. SAR (Synthetic Aperture Radar) and SLAR (Side Looking Airborne Radar) are the two most common types of Radar which can be used for oil spill remote sensing.

Figure 4: An oil slick off the Dutch coast as observed by a SLAR-equipped surveillance aircraft [27]

SAR has superior spatial resolution and range than SLAR [26]. However, SLAR is less expensive and predominantly used for air borne remote sensing. A SAR has superior spatial resolution and range than SLAR [26].

The most common Radar (microwave) sensor for oil detection on sea surface is the SAR [28]. SAR image is a measure of surface roughness depending on the backscatter. The main mechanism in detection of oil slicks is the dampening effect of oil on water. Dampening of sea waves results in reduced radar return from the affected area, so that oil slicks appear as relatively dark features on the SAR scenes [29]. RADARSAT, TERRASAR, ALOS, COSMO-SKYMED, ERS-2 SAR and TanDEM X are examples for SAR Satellite. Neither very calm sea nor very rough sea surface is favourable conditions for oil slick detection [26]. Briefly, SAR has the capability of operating in all weather conditions and covers wide area which makes SAR one of the most important techniques to monitor oil pollutions. Day and night observation, all-weather capability, high spatial resolution and wide area coverage are advantages of the SAR oil spill monitoring [7]. The presence of oil on the surface of sea causes damping effect on the

short wind waves (Bragg Waves) and reduces the radar back scattering. In such cases the oil spilled areas can be seen as dark patches in SAR images. An oil spill is physically a low backscatter area and appears as a dark area in SAR images. The figure shows how SAR catch spills from sea surface [30].

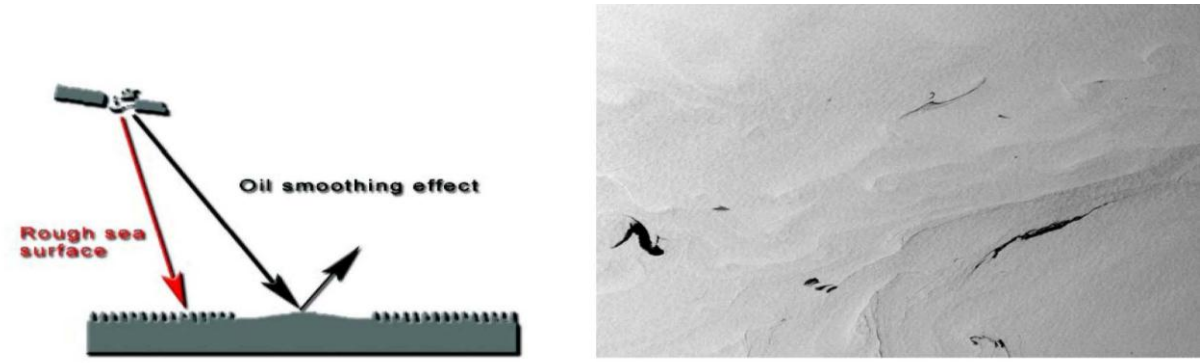

Figure 5: SAR mechanism: Detection of the dampening effect of oil on water [5].

Dampening is not only caused by low wind speed area, there are other physical natural phenomena also dampen the Bragg waves and generate dark areas (look-alikes). So, the major difficulty is to differentiate between oil spills and look-alikes of natural origin. Look-alikes include low wind speed areas, biogenic slick, rain cells, cold upwelling, current shear zones and ship wakes. Other limitations in detection are very calm sea and very rough sea surface. [5,7].

4. CASE STUDY:

The Black Sea region is one of the most important economic area around world. For world oil trade, Black Sea has very important trade pattern for tanker shipping, export of gas and oil products. Due to the heavy tanker traffic in Black Sea, ship source oil pollution is increasing proportionally. Black Sea is nearly a closed sea, connected to other seas with Turkish Straits and Kerch Strait. Black Sea oil density is more than other seas around world [7].

This case study covers Black Sea entrance area. Radarsat-1 SAR image is analysed to determine the oil pollution of sea surface. From SAR image, distribution of oil spill is clearly detected after pre-processing image analysis. In this case study,Radarsat-1 (C Band ScanSAR Narrow, 50x50 m nominal resolution, 25x25m pixel spacing, 300 km

swathwidth) is usedwith ENVI 5.0 and 4.8 Image Processing Programe to detect oil spill. Image processing steps are shown in Figure 6.

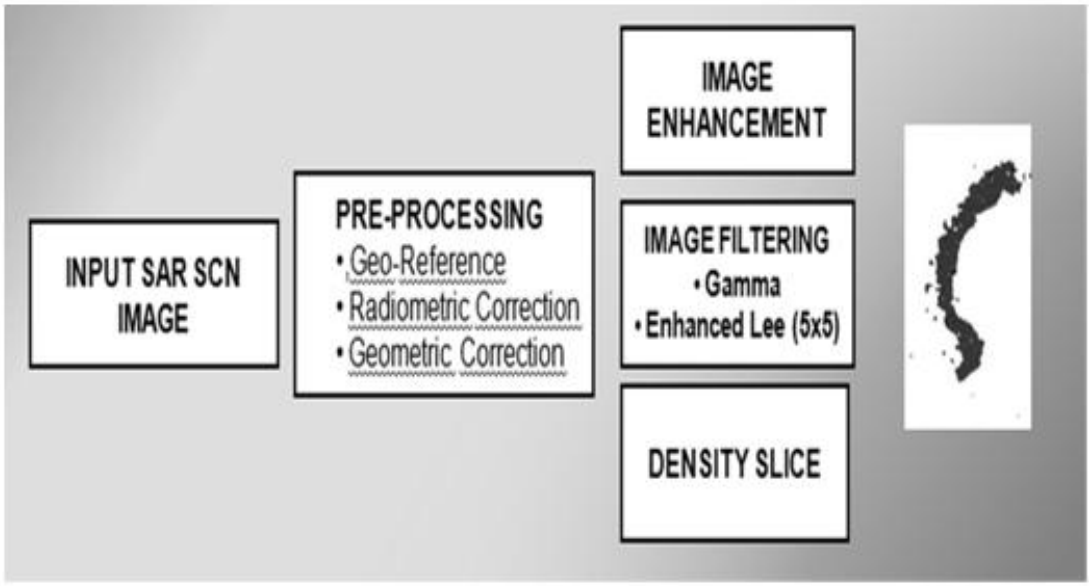

Figure 6: Image Processing Flow Chart of SAR Image 5 August 2012

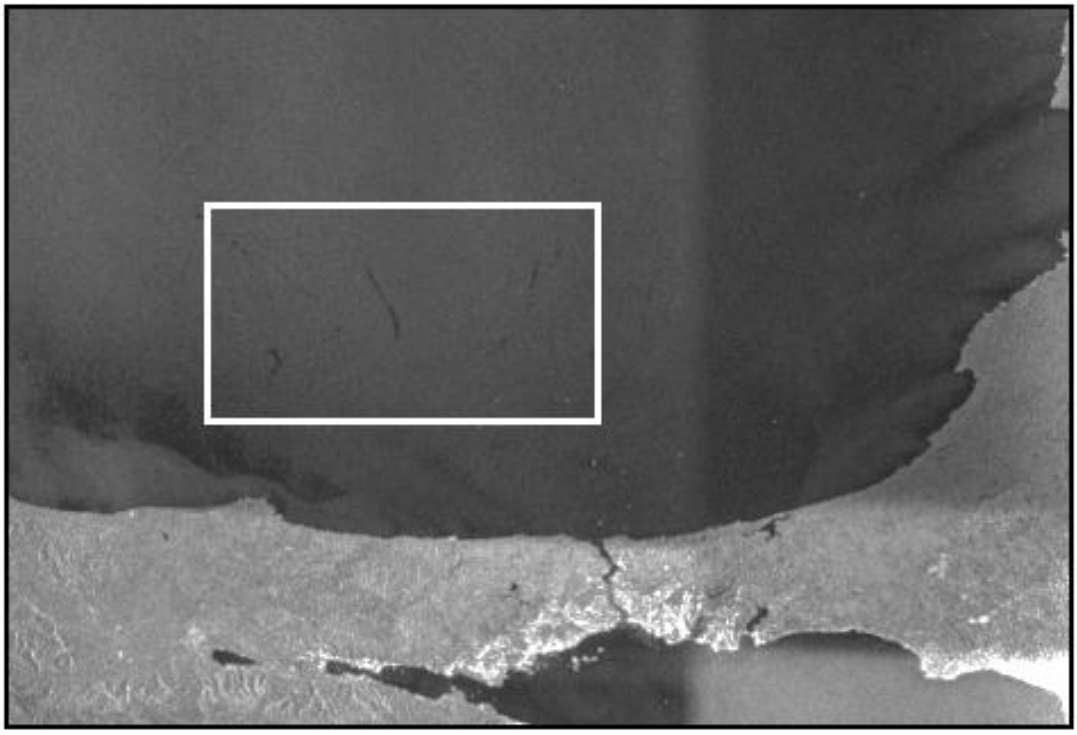

Figure 7: Raw image of Black Sea Entrance 5 August 2012, Radarsat 1

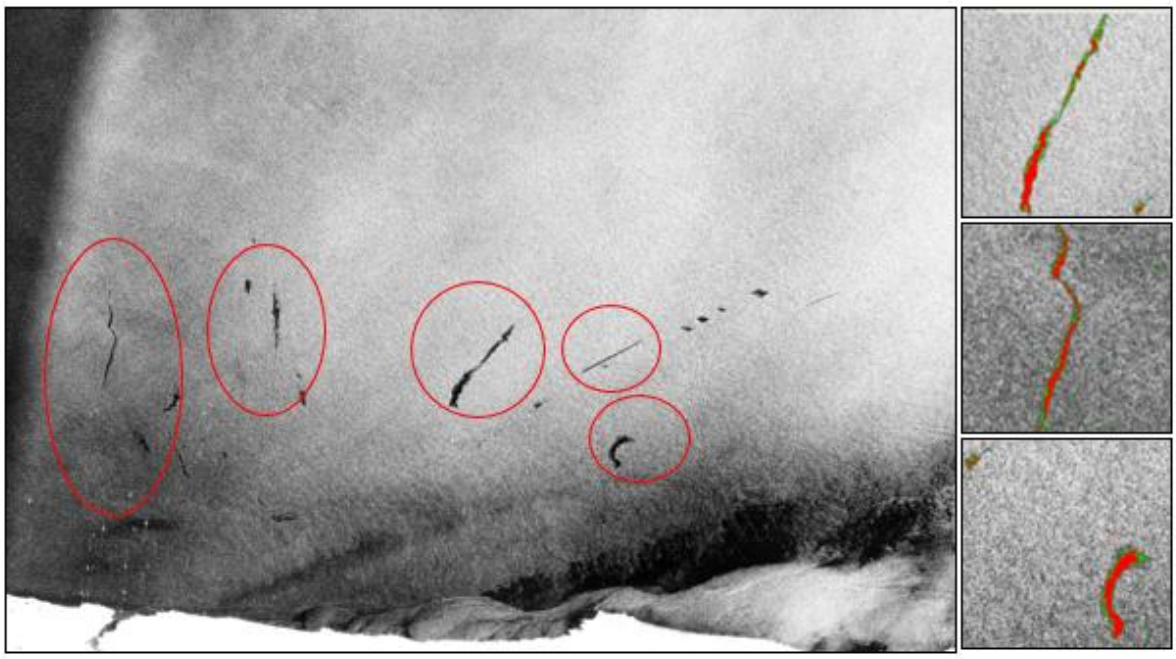

Figure 8: Location of Oil slicks after image enhancement

5. CONCLUSION

With the increasing capacity of sea borne transportation, marine pollution especially ship based oil pollution has become one of the important environmental issues. The technological developments in satellite technology have opened a new horizon in remote sensing and monitoring techniques. Especially, SAR is very effective for oil spill detection as discussed. Even very thin oil films can be detected from space, and such detections can be independent of weather and visual conditions (e.g., presence of a thick cloud formation).

Further, remote sensing system is a good decision making tool when locating oil spills on maps and for collecting and processing data quickly for oil spill surveillance. Every sensor provides effective focus for oil spill surveillance operations. Multi-sensor system (visible-IR/UV-Microwave) is the best for near real time remote sensing in a case of an oil pollution but in a close future small aircrafts, unmanned systems (drone) and ships radar will be more dominant for locating oil spill spatial distribution and spill size due to limitations and low temporal resolution of synthetic aperture radar system (SAR).

6. ACKNOWLEDGMENT:

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2. ANALYSIS OF IMPORTANT RECOMMENDATIONS MADE BY VARIOUS STUDY GROUPS FROM 1990 TO 2014 FOR THE PROMOTION OF COASTAL SHIPPING IN INDIA

Asha Pillai

PhD in Management Studies - Indian Coastal Shipping, from AMET University, Chennai.

Abstract

Water transport plays only an insignificant role in the domestic transportation sector in India, even though it is a mode which is economic and does less damage to the environment than the land modals. India's coastal shipping has been a problem area for at least the past four decades. A number of committees, consulting agencies and Government. supported organizations have made numerous studies and recommendations to the Government of India during the past 20 years in particular to make coastal shipping a more viable option for transportation.

This paper tries to formulate a matrix form of the important recommendations made by various study groups on Indian costal shipping sector from the year 1990 till 2014 and to sum up the implementations made so far at various levels.

Key Words: *Coastal Shipping, River Sea Vessel, Cabotage Policy, Inland Water Ways*.

1. INTRODUCTION:

Coastal shipping is an environment friendly and cheaper transport option compared to the road and rail option due to better economies of scale. Government of India envisages increasing the share of water transport mode to 10% from the present 7% by the year 2020[1].

A number of committees, consulting agencies and Government. supported organizations have made numerous recommendations to the Government of India, based on their studies, during the past two decades to make coastal shipping a more viable option for transportation. The Rail Sea coordination (Lokpur) committee report, 1957 (ADB and Planning Commission Report)[2], was the first to point out the coastal shipping issues and most of which exist even today. Almost all other groups/ committees formed in India ever since to carry out studies on coastal shipping repeated the same problems with slight variations.

2. ANALYSIS OF IMPORTANT RECOMMENDATIONS MADE BY VARIOUS STUDY GROUPS FROM 1990 TO 2014 FOR THE PROMOTION OF COASTAL SHIPPING IN INDIA:

A matrix form of the summary of the important recommendations and suggestions made by various study groups/committees formulated for the promotion of coastal shipping in India for the past two decades is given below in Table: 1.

The matrix is divided into two halves; first half exhibits the name of the study group and list out the important recommendations made by them for the development of coastal shipping in India.

In the second half, analysis of all the recommendations made by the groups is exhibited. For clarity of the report, the recommendations are grouped and listed under 6 major categories namely (i) Regulatory Support, (ii) Infrastructure Support, (iii) Fiscal and Financial support, (iv) Modal shift program, (v) Data base and communication, (vi) Others - Training / Awareness . Against each recommendation, details like the executing agency's name, whether financial investment required and the implementation status of the recommendation also is given.

Table: 1 Analysis of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014

Summary of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014			ANALYSIS OF ALL THE RECOMMENDATIONS MADE FROM 1990 TO 2014			
Sl. No	**Study group / Institution**	**Policy Recommendations made by the group**	**Recommendations**	**Executing Agency**	**Financial Investment**	**Status of Implementation**
1	**Asian Development Bank and Planning Commission, GoI Report (1990)[2]**	a. A separate and independent Directorate General for Coastal Shipping	**(i) Regulatory Support**			
		b. Cabotage law relaxation	Separate Coastal Shipping Directorate	Ministry of shipping	Yes	In April 2004, The DG of Shipping set up a special cell at the directorate, which looks after various aspects of coastal shipping to monitor the sector's development and find solutions for various bottlenecks. The key members of the cell include: The DG of Shipping (Chairman); Chief Surveyor with the GoI or his/her representative: Member Nautical Advisor to GoI or his/her representative: Member; Senior Deputy General of Shipping: Member; Local Nominee from the IPA: Member; Representative from INSA: Member; Representative from ICC: Member (Ref: No.12, EandY Report, pg15)
		c. Simplify customs and port procedures				
		d. Encourage intermodal transport				
		e. An inter-modal coordinating agency for allocating cargo to coastal shipping				
		f. Introduce inter-modal through document				
		g. Fund support				
		h. Availability of cost and volume statistics				
		i. Setting up of more minor ports along the Indian coast				
		j. De-regulate the over regulated coastal sector				
		k. Modal shift of potential cargo				
		l. Development of containerization				

Summary of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014			ANALYSIS OF ALL THE RECOMMENDATIONS MADE FROM 1990 TO 2014			
		m. Detailed studies required for development				
2	**Afzalpurkar Committee (1993)[3]**	a. Implementation of cabotage law, which reserves the movement of coastal trade of the country for its own flag vessels				
		b. Enactment of a separate law for coastal shipping	Promoting River Sea Vessels	DG Shipping	No	DGS Order No.1 dated 04.03.2014, Notification for construction, survey, certification and operations of Indian River Sea Vessels Type-1,2,3, and 4 (Ref Annexure No:3)
		c. Development of specialized wings in financial institutions to fund coastal shipping				
		d. Tax concession for fuel and spares				
		e. Building a separate cadre of seafarers with qualifications, who are different from those who are operating for ocean-going vessel, to ensure an adequate talent pool for the latter	Declaration of IV limits for different states	DG Shipping	No	DGS Order No.19 dated 16.09.2013
		f. The need to make suitable amendments to the Merchant Shipping Act or enact separate legislation for Coastal shipping, which have different specifications for coastal vessels as well as lower manning scales	Cabotage Policy Relaxation	Ministry of Shipping	No	GoI GO No. SR 1 4020 I 5 12009-MG/CS-VoI.Vl Idtd 2/09/15, Relaxation of cabotage restriction for special vessels such as RO-RO'Hybrid RO-RO, RO Pure Car Carriers, Pure Car and Truck Carriers, LNG vessels and Over-Dimensional, Cargo or Project Cargo Carriers Government of India General Order No: No. SW-1 50 1 1 /8/201 b-CSdtd 07/03/16, Relaxation of
		g. The need to design vessels such as RORO and silo vessels, which are suitable for transporting cement and food grains, to facilitate the				

Summary of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014			ANALYSIS OF ALL THE RECOMMENDATIONS MADE FROM 1990 TO 2014			
		movement of trucks across long distances				cabotage restriction for container transshipment port
3	**Tenth plan Sub Group (2002)[4]**	a. Establishment of coastal vessel traffic service (CVTS)	Customs procedure relaxation for coastal shipping	Ministry of Finance	No	Customs Circular No:16/98-Cus dated 11/03/98 excepting coastal vessels from filing IGM/EGM. (Ref Annexure No:6) Customs Public Notice No: F. No.450/69/2000-CUS IV dated 30th October 2001, permitting imported containers for coastal cargo.
		b. Continuation of cabotage law, supported by suitable fiscal and financial incentives				
		c. Ear marking of exclusive ports for coastal shipping on Indian coasts				
		d. Exclusive berths earmarked for coastal ships at all major ports				
		e. Laying down of less stringent construction, survey, load line and safety requirements for coastal vessels	Resolving Manpower issues including Manning Scales	DG Shipping	No	1. DGS order No.5 dated 15th July 2008, a guideline allowing local ship owners to hire foreign nationals as officers to manage and operate ships on a case-to-case basis. 2.DGS Circular dated 26.11. 2009, new guidelines with relaxed staffing rules for coastal vessels. (Ref Annexure No:9) 3. DGS Circular dated 12.01.2011, new guidelines with relaxed crewing or flagging requirement 4. DGS Circular dated 05.07.2013, new guidelines with relaxed
		f. Review of minimum manning scales for coastal vessels, keeping in mind the need to encourage coastal traffic on a commercial basis				
		g. Grant of customs duty exemption to ship owners and users at par with ship repair units, to enable them to import spare parts/equipment for coastal vessels				

Summary of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014			ANALYSIS OF ALL THE RECOMMENDATIONS MADE FROM 1990 TO 2014			
4	**Tata Consultancy Services Study (2003)[5]**	a. An independent body such as the Tariff Authority of Major Ports to regulate ports				manning scale in the engineering side
		b. Need for implementing an incentive plan based on budgetary support, linked to the quantum of cargo routed by the railways to sea transport, to be proposed.				
		c. Setting up of a special cell under the Dg of the shipping to guide and monitor the progress of the coastal industry and co-ordinate its activities with external agencies				
		d. Need for the central Government to finance the development of basic infrastructure for the 9 minor ports (Gopalpur, Cudddalore, Vizhinjam, Azhikal, Malpe, Karwar, Ratnagiri, Dharamtar and Magdalla), which would include capital dredging, breakwater, berths, back-up areas and wharves	Exemptions from the Merchant Shipping Act 1958	DG Shipping	No	DGS Order No.1 dated 04.03.2014, This regulation exempt ships other than passenger ships, oil tankers, and offshore support vessels, operating along the Indian coast and within the country's territorial waters from following sections : Sec-76 : Certificates of competency to be held by officers of ship Sec285and311: Cargo ship safety , construction and survey ;Sec 285: Prevention of collision Sec 288,289,and290:Lifesaving Appliances, Firefighting appliances; Sec 291: Radio
		e. Setting up of an autonomous body at the state level to ensure that funds are only used for the development of minor ports				

Summary of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014			ANALYSIS OF ALL THE RECOMMENDATIONS MADE FROM 1990 TO 2014			
		f. Need for import duty on bunkers and capital equipment and spares required for vessels to be waived to encourage the growth of coastal shipping.				Communication Requirements; Sec356: Safety of Navigation Sec 299A,300,303,307(2), (3) and 318: surveys and certifications; Sec 356C, E and F: Prevention of pollution, MS (Management for the Safe operation of ships) Rule: Domestic safety management , Sec 344O,QandR:Ship security measures, Sec 331,332: Carriage of cargoes
		g. Demand side incentives: Need for registered multimodal operators and shippers to be allowed a deduction from their taxable income, based on traffic volumes, if they transport cargo through coastal shipping				
		h. Integration of coastal shipping and Inland Water way transport to be promoted at Haldia and Cochin, where basic infrastructure is available, infrastructure to be created at Neendakara and TT shed at Kolkatta for such integration.				
5	**Eleventh plan Sub-Group, (2007)[6]**	a. Coastal shipping development fund(CSDF)to be established for soft lending for the acquisition of coastal vessels				
		b. Centrally sponsored scheme (CSS) proposed for the development of coastal shipping infrastructure.	**(ii) Infrastructure Support**			
6	**Draft Coastal Policy, DG Shipping (2011)[7]**	a. Promoting River-Sea Vessels	Setting up of more minor ports along the Indian coast	Ministry of shipping	Yes	These initiatives are recommended to be executed by the end of the 11th five-year plan (2007-2012)
		b. Infrastructural facilities				

Summary of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014			ANALYSIS OF ALL THE RECOMMENDATIONS MADE FROM 1990 TO 2014			
		c. Financial incentives including subsidies	Earmark dedicated berth for coastal ships	Ministry of shipping	No	and to extent to the 12th Five-year plan (2012-2017). Further all these initiatives, except one, require financial investments. Of these, four recommendations are to be carried out by MoS, two of them by the State Government (Maritime Boards) and the remaining one jointly by MoS, Ministry of Railways and Ministry of Road Transport and Highways
		d. Manning relaxation without compromising on the safety				
		e. Cabotage policy support	Adequate ship repair facility	Ministry of shipping	Yes	
		f. Declaration of IV limits in different states				
		g. Modal shift in cargo from rail and road	Dedicated warehouses /CFS for coastal cargoes	Ministry of shipping	Yes	
		h. Data-base and communication infrastructure				
		i. Legal issues	First and Last mile connectivity: Road / Rail /IWT, wherever applicable	Ministry of Railways Ministry of Road Transport and High Ways, IWAI, Ministry of Shipping	Yes	
7	**Twelfth five year plan sub-group report, (2011)[8]**	a. Winning over road/rail traffic				
		a. promote multimodal transport				
		b. Strengthen existing non-major ports along the coast				
		c. Promote Ro-Ro based coastal traffic				
		d. Set up dedicated warehouses for coastal cargoes	Adequate cargo handling equipment in the existing ports	State Maritime Board	Yes	
		b. Waive service tax on coastal/inland sea-freight as well as charter hire of coastal/inland vessels				
		c. Exemption on service tax for ship building				
		d. Infrastructure status for coastal shipping under section 80IA of the Income Tax Act	Channel deepening in the Non-Major ports	State Maritime Board	Yes	

Summary of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014			ANALYSIS OF ALL THE RECOMMENDATIONS MADE FROM 1990 TO 2014			
		e. Simplify customs procedures for coastal movement	**(iii) Fiscal and Financial Support**			
		f. Giving carbon credit benefits to the shipping companies				
		g. Enhancing competitiveness of Indian-flagged ships via-a-vis foreign flagged ships	Duty free bunkers and spares to coastal ships	Ministry of Shipping Ministry of Finance	No	These initiatives are recommended to be executed in the 11th five-year plan (2007-2012) and to extent to the 12th Five-year plan (2012-2017). Only two recommendations require financial investment, rest all are policy decisions jointly to be taken by Mos and Ministry of Finance. As per a GoI notification dated 07th Oct 2015, the Customs and Excise duty levied on bunker fuels, namely IFO 180 CST and IFO 180CST used in Indian Flag vessels for transportation of EXIM and Empty containers between two ports in India.
		h. Waive Duties and VAT on Bunker sales to coastal ships	Conferring the "declared goods" status to bunkers, capping VAT at 4%	Ministry of Shipping Ministry of Finance	No	
		i. Promotion of River-Sea vessels				
		j. Declaration of Inland Vessel (IV) limits for different states				
		k. Manpower issues including manning scales	Exempt tax for ship construction	Ministry of Shipping Ministry of Finance	No	
		l. De-link port tariff for coastal vessels from FG vessels and reducing it further by 30%				
		m. Bringing Non-Major Ports on par with Major Ports in the matter of extending lower tariffs to coastal shipping	Setting up a fund to finance deserving investment plans	Ministry of Shipping Ministry of Finance	Yes	
		n. Establishing a Coastal Development Fund for coastal ships				
		o. SRU status to individual ships			Yes	

Summary of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014			ANALYSIS OF ALL THE RECOMMENDATIONS MADE FROM 1990 TO 2014			
		p. Exception of customs duty on import of certain categories of vessels (Tugs, pusher crafts, dredgers and floating docks/cranes/production platforms *etc*.)	Soft loan and interest rate schemes (similar to those for the small and medium enterprise sector) to purchase coastal ships.	Ministry of Shipping Ministry of Finance		
		q. Cabotage policy support				
8	**Joint report of INSA, CII and Ernst and Young, (2011)[9]**	a. **Tax incentives**				
		Direct – Review Taxability of capital gains on the sale of qualifying ships and applicability of Minimum Alternate Tax (MAT) on profit on sale of qualifying ships and taxability of income from funds parked in short-term instruments pending its utilization for the acquisition of new ships.	Wavering the service tax on coastal sea freight as well as charter hire of coastal vessels.	Ministry of Shipping Ministry of Finance	No	
		Indirect – Review of duty on spares and bunker fuels. Waiver of customs and excise on marine fuels (IFO and HFHSD) for a period of seven years and fuels, capping VAT at 4%	According "infrastructure Status" to coastal vessels	Ministry of Shipping Ministry of Finance	No	
		b. **Infrastructure Support**	Lower port tariff for coastal vessels and cargo compared to foreign going vessel	Ministry of Shipping	No	40% reduction on vessel related and cargo related charges for coastal sector has been offered. Further reduction of 20% (total 60%) reduction on these charges has been recommended.
		- Development of several minor and intermediate ports along the Indian coast at regular intervals of 150-200 miles with adequate facilities.				
		c. **Funding Incentives**	**(iv) Promote modal shift from road/rail to coastal shipping**			

Summary of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014			ANALYSIS OF ALL THE RECOMMENDATIONS MADE FROM 1990 TO 2014			
		- Setting up a fund to finance deserving investment plans and Soft loan and interest rate schemes (similar to those for the small and medium enterprise sector) to purchase coastal ships	Stream line the multimodal transport operations	Ministry of Shipping	No	DG shipping promotes registration of operators under The Multimodal Transport of Goods Act, 1993 and publishes the list of valid MTOs registered with them. As per the published list, there are 748 registered operators are there in India as on 01.04.2014.
		- Loan structure and interest rates for coastal ships/river-sea vessels in line with established global norms for ship financing	Single multimodal document for the entire chain of transport	Ministry of Shipping	No	DG Shipping issued a circular dated 02.05.2013 on format for printing and issue of Multi Modal Transport Document (MTD).
		- Relaxation of external commercial borrowing (ECB) guidelines to enable the acquisition of used vessels				
		d. **Regulatory support**	Incentives for modal shift of cargo from road /rail to coastal shipping	Ministry of Shipping	Yes	Recommended to be executed in the 11th five-year plan (2007-2012) and to extend to the 12th Five-year plan (2012-2017).
		- Emphasizing the need for a separate coastal shipping directorate and moving ports out of the state list				
		- Integrating river-sea vessels operating within 12 miles of India's territorial waters outside the UNCTAD, UN and UNCLOS	Carbon Credit Scheme	Ministry of Shipping Ministry of Environment	No	Recommended to be executed in the 11th five-year plan (2007-2012) and to extent to the 12th Five-year plan (2012-2017).
		- Reviewing the river-sea vessel notification to further reduce operating expenditure to the bare minimum	**(v) Data base and communication infrastructure**			

Summary of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014			ANALYSIS OF ALL THE RECOMMENDATIONS MADE FROM 1990 TO 2014			
		- Widening the net of the river-sea vessel notification to bring more classes and sizes of vessels under its purview	Establishing a robust system to collect voyage specific data on coastal shipping and maintaining it effectively	DG Shipping Indian National Ship Owner's Association (INSA)	No	DG Shipping publishes through its website updated data regarding the tonnage status. Indian Port Association publishes Annual Reports on Port performances, which gives a wide idea. Voyage specific or cost specific data is not available freely at present. No statistics / data published in the INSA web portal for public use.
		- Relaxing the minimum technical and manning specifications for coastal vessels				
		- Extending access to the insurance schemes of overseas insurers				
		- According coastal vessels an 'infrastructure status'				
		- Setting up a coastal shipping central monitoring center to monitor all coastal vessels from the perspective of customs, immigration, health, pollution (including ballast water), safety and security.				
		- Introducing accelerated learning and performing systems that will ensure manpower availability for coastal shipping both ashore and on board.	INSA to publish an annual report on coastal tonnage and coastal cargo and work towards a coastal index	INSA	No	Not noticed in the INSA web portal.
9	**Report of the Committee on Standards for Coastal and Inland vessels; Sea limits for**	a. No recommendations on standards for coastal and inland vessels				
		b. No recommendation on Inland Vessel Limit (IV) and port wise recommendation	**(vi) Others**			

Summary of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014			ANALYSIS OF ALL THE RECOMMENDATIONS MADE FROM 1990 TO 2014			
	Inland Vessels; and Incentive scheme for modal shift of cargo from road/rail to waterways (2014)[10]	c. Incentive/ measures for promotion of coastal shipping				
		(i) For bulk vessels all new coastal cargoes on Indian flag vessels on demonstration of a fresh modal shift will be eligible for an incentive of @50 paisa per ton per nautical mile up to a maximum of 500 nautical miles.	LNG supply facility as an alternate fuel to coastal shipping	Ministry of Shipping Ministry of Petroleum and Natural Gases	Yes	Recommended to be executed in the 11th five-year plan (2007-2012) and to extent to the 12th Five-year plan (2012-2017).
		Initially, the new cargo eligible for an incentive will be fertilizer, food grains, steel, marbles, tiles, cement, sugar, salt and automobiles.	Introducing accelerated learning / training systems to ensure manpower availability for coastal shipping both ashore and on board.	DG Shipping	No	During the 11th Five year plan Indian Maritime university has been established and also efforts have been taken to streamline the Maritime education system. The efforts will continue in the 12th Five-year plan period too (2012 - 2017)
		The incentive will be for a period of five years as it is expected to create awareness and generate cargo for both ways.				
		(ii) For coastal container cargoes on Indian Flag Vessels, INR 1000 per TEU rebate may be given subject to a cap of 500 TEU per vessel in Terminal Handling Charges at both ends.				

Summary of Important Recommendations Made by Various Study Groups for the Promotion of Coastal Shipping in India from 1990 to 2014			ANALYSIS OF ALL THE RECOMMENDATIONS MADE FROM 1990 TO 2014			
		(iii) Port charges: It is recommended that the present rebate of 40% in vessel and cargo related charges for vessels other than thermal coal, POL including crude oil, iron ore and iron pellets for Indian Flag Coastal vessels be increased to 60% at both ends. The above schemes may be operational for a period of five years.	Setting up a coastal shipping central monitoring center to monitor all coastal vessels from the perspective of customs, immigration, health, pollution (including ballast water), safety and security.	DG Shipping	No	Expected to be executed in the 11th five-year plan (2007-2012) and now to extend to the 12th Five-year plan (2012-2017).
		(iv) Infrastructure: Also recommend that necessary infrastructure at major and non-major ports are developed to cater exclusively to coastal cargo movement.				
		(v) Ship Building: Recommends that a total excise and customs duty waiver may be given for the raw materials.				

3. CONCLUSION:

From the above analysis, it is evident that in the Indian context, coastal shipping sector has a set of very complicated issues for the policy makers to deal with. Although, a number of recommendations given by the study groups were accepted by the Government of India in principle, it appears that proper follow up and further development of policy recommendations is not carried out properly.

Though the committees, groups, institutions formed to study the issues of Indian coastal shipping and to recommend suitable solutions are of high caliber and repute, the presence of the actual players of the sector are very low. The involvement of all stake holders in policy planning is required to understand the actual requirements and challenges of the sector. The policy makers should know how various elements of supply chain and transportation systems work together to meet the needs of users and how coastal shipping can complement and support these systems.

The recommendations on the infrastructure, fiscal and financial support, subsidies require huge investments, which is of a concern for the Government of India at present. In order to boost the development of coastal shipping in India, there needs to be a push from the Government for funding of infrastructure, though other models like the PPP and viability gap funding could be considered in cases which are commercially viable.

It is also understood from the analysis that the issue facing coastal shipping sector is something that Ministry of Shipping and DG Shipping alone cannot address. It requires the co-ordination of other ministries such as Ministry of Finance, Ministry of Road, Transport and Highways, Ministry of Railways, Ministry of Petroleum and Natural Gases and the State Governments/ Maritime Boards.

To achieve the desired result of increasing the share of water transportation to 10% in domestic sector, it is desirable to have a single unified ministry with a clear mandate to deliver a multi-modal transport system that contributes to the country's larger development goals. The existing ministries should become departments focused on delivering effective transport infrastructure and services for each mode. Nearly every other country in the world has moved in this direction. If not practical to have a single

transport ministry, as pointed out in the NTDPC report[11], a new central body, the Central Logistics Development Council, comprising of industry members, ministry representatives, and financial and academic institutions should be set up with the mandate of promoting the logistics industry. This body should centralise activities like information collection, advice on required infrastructure and changes to policy and regulation, propose standards on equipment, technology and manpower.

The issues facing the coastal shipping sector is something that any one party alone cannot address. All stake holders should work together to make sure that some of these thorny issues are more widely understood and then addressed. The rules and procedures that make the physical infrastructure work are as important as the infrastructure itself.

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3. THE CHINA SEAS TERRITORIAL DISPUTES AND THE GLOBAL ECONOMY

Fikile Portia Ndlovu[1]

Abstract

With China claiming the 'nine dash or 南海九段线' territory in the South China Sea and the territorial sea conflict with Japan on the East China Sea, the discovery of natural resources in those disputed territories and concerns that American interests in those areas are being threatened, it is imperative that concerns are clarified within the global context. Justice over these disputed territories remains a global maritime priority. Applicable law must test the legality of actions by countries involved or holding interests in the disputed sea territories. More importantly, with national economies experiencing testing times and thus cautious about maintaining control over natural resources, it is important that peace and order is cultivated while respect for countries' interests remain cautiously secured and balanced as such disputes may escalate into economically disruptive military tensions. Global maritime economics also thrives on activities such as the exploitation and exploration of sea resources and thus it is useful to consider the impact of sea territorial disputes to such activities in the South and East China Sea. The disputed territories in casu aptly contain facts that will address the questions of justice raised in this paper. Territorial sea disputes are traditional public international legal concerns that affect countries' sovereign rights, important maritime trade routes and other commercial interests at sea. It is thus the purpose of this paper to call for strategies that will encourage continued international amity. With China being part of the driving engine for international trade, it has become more important to understand its role in the world economy and for the world to be sensitive to the interests China has.

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1. INTRODUCTION:

This paper is not yet another disingenuous proposal for world peace. The fact is conflicts ultimately lead to economic ruin and loss of lives, not to mention the exacerbation of the refugee crisis around the world. It is therefore crucial to introduce this paper by mentioning the fundamental veracities which are relevant to the topic of territorial disputes in the China seas, as diplomacy and peaceful negotiation required in international law and policy is encouraged. These veracities include an outline the current global economic trends and the contribution of the Chinese economy with some reference to leading maritime indicators such as the Baltic Dry Index (BDI or BDIY),[2] Harper Peterson Charterraten Index (HARPEX)[3] some Baltic and International Maritime Council (BIMCO)[4] reports, the Baltic Tanker Clean Index (BCTI) and the Baltic Tanker Dirty Index (BDTI)[5] which will be used to qualify the position of this paper. This will be done in order to draw inferences of the relevance of maintaining peaceful trade in the Asia Pacific region as the global economy endeavors to achieve resurgence post 2008 economic crisis. The selected economic indicators are relevant to shipping and other sea related activities within the scope of the paper. Further, the paper will outline the countries whose interests are directly affected by the South China Sea and East China dispute and their military influence in the region.[6] This will also lead to a brief outline of the general implications of military tensions on the rest of the globe should peace not be maintained in the outlined China Seas. The discussion on maintaining world peace is still as relevant as it was post world wars.

Finally and critically, this paper will explore the law and other pertinent legal issues on the disputes. The law pertaining to the exploration and exploitation of resources within the disputed regions will also be considered in order to make recommendations as to

[2] http://www.bloomberg.com/quote/BDIY:IND (accessed 4/16/2016).
[3] http://www.harperpetersen.com/harpex/harpexVP.do (accessed 4/16/2016).
[4] Branch A. E. *Elements of Shipping* 8 Ed. (2007) recommended reading, http://www.lloydslist.com/ll/ (accessed 4/16/2013) and https://www.bimco.org/en/News/2009/10/20_Baltic_Exchange_indexes.aspx (accessed 4/16/2016).
[5] Geman H. *Risk Management in Commodity Markets: From Shipping to Agriculturals and Energy* (2009) 155. http://www.lloydslistintelligence.com/llint/tankers/baltic-index.htm;jsessionid=CBA831BFF8748D23663B00FEEF983050 (accessed 05/07/2013) http://alstertrader.de/lang1/tanker_ffas.html (accessed 05/20/2016).
[6] The military rankings will be drawn from contributions by Global Fire Power (GFP) which does not take into account nuclear capabilities of countries being ranked. http://www.globalfirepower.com/ (accessed 4/16/2016). The information taken from GFP is simply used as an indicator, it is up to the reader to test the information provided in the public domain.

diplomatic strategies that may benefit interested parties. It is imperative to note that the 2008 credit crisis had severe impact on the shipping markets and thus such markets must be given room to recover.[7] An Asian military conflict would thwart any continuing economic recovery in the region. Active efforts to prevent China from turning into a financial 'graveyard' for Chinese economy dependent concerns (businesses) and economies must be maintained. Recent losses by a Korean based conglomerate and shipbuilding group, STX Group (which lost $435 million in investor funds, 2013) as China's demand for commodities waned in this context.[8]This example illustrates the economic impact of a less financially active China. The point of this paper is to warn against threats to peace and economic prosperity that can be created by military tensions over territorial disputes and to highlight the legal issues related to the disputes and to contribute to the knowledge of understanding the importance of China's peace to Asian, Pacific, American, African partners and smaller island nations (the entire globe) and general shipping business.

2. THE NATURE OF THE DISPUTES:

The nature of the China Seas territorial disputes both in the East and the South forms the basis of this paper thus it is appropriate at this stage to first summarize what is meant by the South China Sea and East China Sea maritime disputes for the establishment of context. The South China Sea dispute involves four countries in the Association of South East Asian Nations (ASEAN)[9] body, Brunei, Malaysia, Philippines and Vietnam who have overlapping territorial claims over the South China Sea against the claims of the People's Republic of China (and the Republic of China, Taiwan) hereinafter referred to as China and Taiwan.[10]

In the South China Sea territorial dispute are also interests of countries of the Asia Pacific Economic Cooperation (APEC)[11] region, a region which has member economies

[7] Madura J. *International Financial Management* (2011) 561.
[8] Kyunghee Park *China Turns Graveyard from Goldmine Hurting Ship Makers* 4 April (2013) http://www.bloomberg.com/news/2013-04-03/china-turns-graveyard-from-goldmine-hurting-ship-makers-freight.html (accessed 4/23/2016).
[9] http://www.asean.org/asean/asean-member-states (accessed 4/18/2016).
[10] Lowell D.W. *Asia-Pacific Security: Policy Challenges* (2003) 98. Beijing's stance on Taiwan is that it remains an inalienable part of China. See, Rigger S. *Why Taiwan Matters: Small Island, Global Powerhouse* (2011) 168.
[11] http://www.apec.org/ (accessed 4/18/2016).

of countries in the Pacific Rim and the ASEAN association. APEC countries that are most vigorous in the dispute are obviously China (and its allies), Brunei, Malaysia, Philippines, Vietnam the United States (US)[12] (as allies of disputing ASEAN countries or representing own national security interests). In 1995, the US Department of State stated that while it took no position on the legal merits of the competing territorial claims in the South China Sea, it would take seriously any restrictions on maritime activities that are not consistent with international law.[13] APEC member countries have met to discuss the South China Sea dispute on occasion and to establish codes of conduct in the area.[14] This is an ongoing and challenging conversation for APEC economy states.[15] The latest developments show that the Philippines has sought a legal remedy in terms of international law against China under the United Nations Law of the Sea, 1982 (UNCLOS).[16] The Philippines is pursuing the territorial dispute settlement by clarifying within international law maritime delimitation[17] as settled by the International Court of Justice[18] in cases *inter alia* such as *Maritime Delimitation in the Area between Greenland and Jan Mayen (Denmark v. Norway)*[19] and more recently *Territorial Maritime Dispute (Nicaragua v Colombia)*.[20]

In the East China Sea, the dispute is centered on conflicting claims of China (and Taiwan) against Japan. Both countries are APEC member economies with strong allies. The dispute is centered on the Senkaku (in the Japanese language) or Diaoyutai (in the Chinese language) islands.[21] The matter is yet to be settled and tensions continue to rise in the Senkaku/Diaoyutai islands. In the meantime Japan[22] and China continue to deploy military vessels to protect disputed sea territories on the East China Sea ensuring

[12] Valencia M.J. *China and the South China Sea Disputes* (1995) 27, 28.
[13] Song Y. *Managing Potential Conflicts in the South China Sea: Taiwan's Perspective* EIA Occasional Paper Number 4 (1999) 6.
[14] John C., Baker and David G., Wiencek *Cooperative Monitoring in the South China Sea: Satellite Imagery, Confidence Building Measures and the Spratly Islands Dispute* (2002) 207.
[15] Streans S. *APEC Leaders to Discuss Rival South China Sea Claims* Voice of America News/Asia 04 September (2012). http://www.voanews.com/content/apec_leaders_to_discuss_rival_south_china_sea_claims/1501632.html (accessed 4/18/2016).
[16] http://www.dipublico.com.ar/english/philippines-initiates-arbitration-against-china-over-south-china-seas-dispute/ (accessed 4/18/2016).
[17] For jurisprudence on maritime delimitation see, Shi Jiuyong *Maritime Delimitation in the Jurisprudence of the International Court of Justice* Chinese Journal of International Law (2010) 9(2): 271-291.
[18] Established in terms of the Charter of the United Nations, San Francisco 1945.
[19] Judgment of 14 June 1993. I.C.J. Rep. 1993.
[20] Judgment of 19 November 2012. I.C.J. Rep. 2012.
[21] Hong S., Van Dyke J.M. *Maritime Boundary Disputes, Settlement Processes, and the Law of the Sea* Publications on Ocean Development Vol. 65 (2009) 84.
[22] Damm J., Lim P. *European Perspectives on Taiwan* (2012) 115.

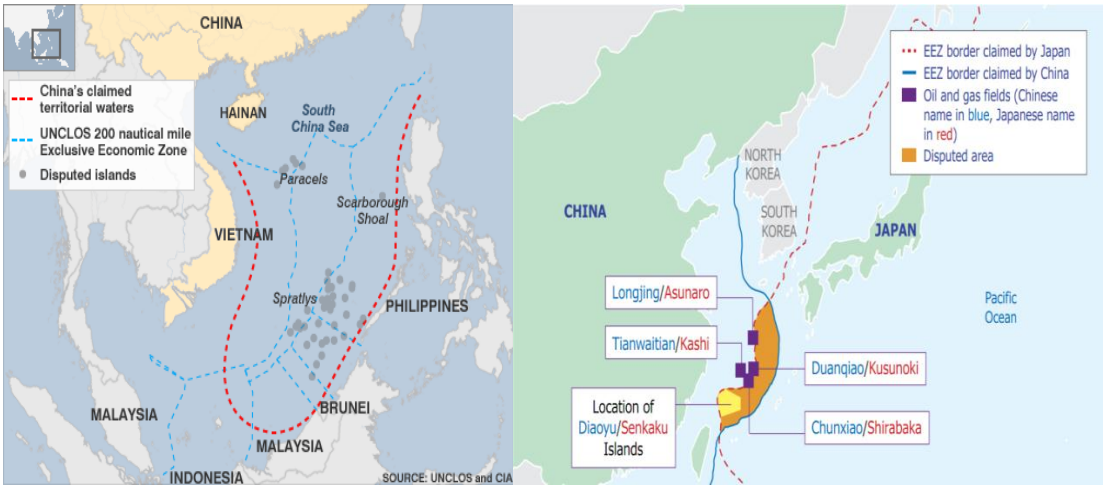
assertive Chinese military presence in the region.[23] Further, in May 2013, it was reported that Chinese maritime surveillance ships expelled Japanese vessels found in the territory of the Diayou/Senkaku.[24] It must be noted that serious military clashes with China in the disputed territory may warrant intervention by US forces.[25] In Figure 1, the first illustration shows the South China Sea dispute, the second one shows the East China Sea dispute and the third illustration shows the entire sea territory. Figure 2 shows the extent of the entire dispute in as far as the Bruneian, Philippines, Malaysian and Vietnamese claims are concerned in the South China dispute.[26]

The Wang Tieya Lecture in Public International Law[27] focuses on legal issues of maritime delimitation in the jurisprudence of the ICJ. It is submitted that this lecture is relevant to the discourse on the China seas and the disputes involved as it legally defines the legal nature of territorial sea disputes and maritime delimitation. The lecture also demonstrates with clarity, the developments of international law in the ICJ and how these developments affect the interpretation of the UNCLOS in territorial sea dispute matters. It is also submitted that it is correct to accept the case of *Maritime Delimitation and Territorial Questions between Qatar and Bahrain* (*Qatar v Bahrain*)[28] as one of the pertinent judgments that relate to the nature of territorial sea disputes. In a fashion similar to the China seas disputes, the case of *Qatar v Bahrain* focused on the following maritime delimitation legal issues: UNCLOS maritime zones, maritime delimitation law and development, identification of coasts and baselines, pre-existing agreement, delimitation of territorial sea, continental shelf and the Exclusive Economic Zone (EEZ), the start and end-point of such delimitation.[29] The nature of China's case also seems to be based on criticized historic claims[30] which were not successful in the ICJ case of *Delimitation of the Maritime Boundary in the Gulf of Maine Area (Canada v*

[23] EconomicTimes.IndiaTimes.com *China Deploys Navy Ships to Patrol Islands Disputed with Japan*17 April (2013). http://www.infowars.com/china-deploys-navy-ships-to-patrol-islands-disputed-with-japan/ (accessed 4/18/2016).
[24] http://www.china.org.cn/china/2013-05/26/content_28935203.htm (accessed 05/28/2016).
[25] Damm J., Lim P. *European Perspectives on Taiwan* (2012) 115.
[26] Refer to Figure 2 illustration as provided by Roselyn D. Middlebury College, Harvard Asia Quarterly available on geocurrents.info (accessed 4/29/2016).
[27]Shi Jiuyong *Maritime Delimitation in the Jurisprudence of the International Court of Justice* Chinese Journal of International Law (2010) 9(2): 271-291. http://chinesejil.oxfordjournals.org/content/9/2/271.full.pdf+html (accessed 14/05/2016).
[28] Judgment of 16 March 2001. I.C.J. Rep. 2001.
[29]Shi Jiuyong *Maritime Delimitation in the Jurisprudence of the International Court of Justice* Chinese Journal of International Law (2010) 9(2): 271-291. http://chinesejil.oxfordjournals.org/content/9/2/271.full.pdf+html (accessed 14/05/2013) 2 – 7.
[30] Luttwak E.N. *The Rise of China vs. the Logic of Strategy* (2012) 200.

United States of America).[31] It is important to note however that Article 15 of the UNCLOS recognizes historical title in certain instances involving the territorial sea between States with opposite or adjacent coasts.

[31] Judgment of 12 October 1984. I.C.J. Rep. 1984 340 par. 233.



South China Sea East China Sea

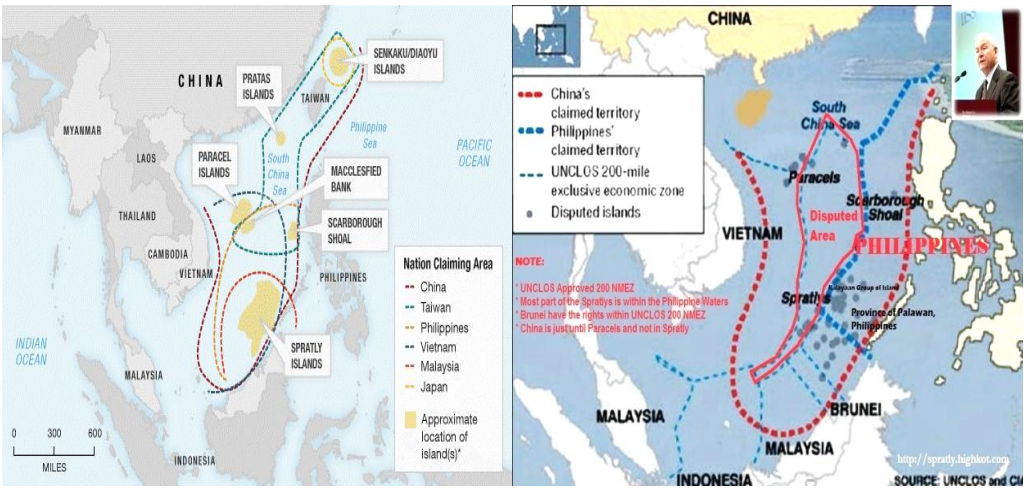


Figure 1: Disputed Areas

Figure 2: Disputed Claim in the South China Sea

3. TERRITORIAL DISPUTES AND UN GOALS:

The dispute embodies the staple relationship between Public International Law[32] and Private International Law[33] as there can be no question of successful private commercial relationships across national borders without the initial settling public international law relations. This rudimentary principle of encouraging peace and amity among nations for the purposes of encouraging economic prosperity forms the basis for the creation of the United Nations (UN).[34] To further maintain international peace, equity and other

[32] Hong N. *UNCLOS and Ocean Dispute Settlement: Law and Politics in the South China Sea* (2012) recommended reading. Boas G. *Public International Law: Contemporary Principles and Perspectives* (2012) 27 – 29. United Nations Convention on the Law of the Sea of 10 December 1982. http://www.un.org/Depts/los/convention_agreements/texts/unclos/unclos_e.pdf (accessed 4/16/2016).
[33] This includes international law that regulates and enables commerce and trade across national borders whether this involves carriage of goods by sea or exploration and exploitation of sea resources by various national and/or multinational corporations. http://www.admiraltylawguide.com/interconv.html (accessed 4/16/2016).
[34] Fawcett E., Newcombe H. *United Nations Reform: Looking Ahead after 50 Years* Science for Peace Dundurn Series (1995) 29 'After World War I, the League of Nations was formed, and after World War II the United

UN goals to achieve economic prosperity, which may become illusive in uncontrolled conflicting political interests, the International Court of Justice (ICJ)[35] was also created with specific reference to territorial dispute settlement strategies.

The UN instruments mentioned above caution that militant international disputes are a threat to international peace therefore peaceful strategies to resolve such disputes ought to be exhausted to avoid war.[36] Author Nong Hong, in a recent book, also recommends that the South China Sea dispute ought to be resolved by way of diplomacy, arbitration or a court order rather than armed conflict.[37] Understanding economic, security and military concerns of countries affected by this territorial dispute against the backdrop of international law and policies will allows for a percipient global insight on the future of shipping and other economic activities in the region. Further, having a background of conflicting national concerns in the region will allow an understanding of the intricate elements that will permit territorial dispute justice by identifying aspects that could be used for circumnavigating and balancing country-specific interests within the goals of the UN which are ideally meant for the protection of peace in international trade.

4. THE GLOBAL ECONOMY WITH SPECIFIC FOCUS ON CHINA:

It is imperative to understand the shape of the current global economy in the context of international trade matters pertinent to territorial disputes in the China seas in order to recognize the contemporary economic role of China in the world. The basic outline of the current international global economy, focusing on shipping markets and China, is employed in this paper to establish context and does not substitute more specialized literature and expert knowledge on this in depth subject.[38] The purpose of this section

Nations.' Martin Luther King Jr., Holloran P. Carson C. *The Papers of Martin Luther King Junior: Threshold of a New Decade* Volume V (1959) 298. Charter of the United Nations and the Statute of the International Court of Justice, San Francisco 1945. http://treaties.un.org/doc/Publication/CTC/uncharter.pdf (accessed 4/18/2013)

[35]Charter of the United Nations and the Statute of the International Court of Justice, San Francisco 1945. Article 33, Chapter V. http://www.icj-cij.org/jurisdiction/index.php?p1=5 (accessed 4/18/2016).

[36]Charter of the United Nations and the Statute of the International Court of Justice, San Francisco 1945. Chapter I. Article I (1).

[37] Hong N. *UNCLOS and Ocean Dispute Settlement: Law and Politics in the South China Sea* (2012) 2. See also, Kivimaki T. *War or World Peace* (2002).

[38] There are several specialist Maritime Economics works which will give the reader more knowledge on the subject. See, for example, Cullinane K. *International Handbook of Maritime Economics* (2011), Talley W.K. *The Blackwell Companion of Maritime Economics* (2012).

consequently is to answer two simple questions. What is the current shape of the global economy with special reference to shipping markets and what is the importance of China to the current global economy? Answering these questions will show that it is in the best interest of China and the general global economy to maintain peace in the region.

Pundits on shipping economics have a daily responsibility of interpreting the global economic indicators to measure recession or growth and recovery, their expert knowledge ultimately informs legal policy. The creation of bodies such as the International Monetary Fund (IMF) proves that maintaining balance in the global economy is not an insular task controlled by a single nation but one based on cooperation with other nations.[39] The interaction of markets and law, when implemented equitably, sustains economies through trade and thus a special reference to China and the global economy needs to be explained.

There are many factors that affect the growth or shrinking of national economies (which together form the global economy) at any particular time[40] and thus it is quite natural to see varied economic trends in different economies of countries in the world at different times. Author, Vihn Q. Tran captures aspects of this conversation in his book on profitable investments in a shrinking economy proving that it is possible to experience profitability even when an economy is struggling but he also makes it clear that war is a greater threat to any economy.[41] Those who stand to profit from a war on the other hand are left to face the moral dilemma of that choice.[42] As a general rule however any war reduces security so that that warring region's security threats affect other regions that would have any dealing with the region at war. This means that the profits of war are not as sustainable as those of peaceful times.

[39] The International Monetary Fund (IMF) is an agency of the United Nations that exemplifies the implementation of monetary policies that sustain balance in economies of member countries. See, Driscoll D.D. *What in the International Monetary Fund*? (1998) 1 – 3.
[40] Economist.com, The Economist and The Economist Intelligence Unit (EIU) *Growers and Shrinkers: The Fastest Growing and Shrinking Economies in 2013* (3 January 2013) hhttp://www.economist.com/blogs/graphicdetail/2013/01/daily-chart-1 (accessed 02/02/2016).
[41] Tran V.Q. *Market Upside Down: How to Invest Profitably in a Shrinking Economy* (2010) 33, 97, 271.
[42] Brandes S. D. *Warhogs: A History of War Profits in America* (1997) 199. The author aptly quotes the campaign address by Franklin D. Roosevelt in 1936 stating that, 'If we face the choice of profits or peace, the nation will answer-must answer-we choose peace.'

From a global economic trend standpoint, the 2008, 2009 Global Financial Crisis (GFC)[43] adversely affected many economies. The downturn of the global economy and its effect on global shipping markets has caused parties in litigation proceedings to contend this downturn as a factor to be taken account by the courts in security arrests. It is a point which is worthy of judicial notice.[44] The Asian region was not an exception to the crisis however recovery has been more positive for China.[45] The charge of the future is to maintain that economic soundness as China's economic strength is central to many trading partners[46] and other economic cooperation and development partnerships.[47] China Trade Data Services (CTD) is a China trade intelligence service that may be consulted for up to date trade statistics and tariffs from the Chinese intelligence perspective.[48] These CTD statistics are revealing in corroborating China's international trade contribution to the domestic economies of trading partners.

The accepted view among economy researchers is that economies of traditionally strong countries are shrinking while emerging markets are gaining ground, with China as one of the major emerging markets.[49] The US and Euro financial crises, for example, evidenced by losses of top AAA credit ratings[50] by some previously AAA rated economies.[51] The crises of the West and Europe have been leading examples of traditionally strong regions showing weaknesses in economic strength and recovery. The financial crises of these regions were centered on fiscal deficits which the national leaders are energetically attempting to resolve.[52] Sovereign debt is not a concern at this time for China however managing bad debt is also important for China. An economic expert recently warned that bad management of debt by China may lead to a greater

[43] Ciro T. *The Global Financial Crisis: Triggers, Responses and Aftermath* (2013) 1, 76.
[44] *Grand Spantounta and Others v TMT Bulk Corporation* (A66/11) ZAKZDHC 13 November (2012) 9 par. 22.
[45] Yang D. L. *The Global Recession and China's Political Economy* (2012) 1.
[46] Genzberger C. *China Business: The Portable Encyclopedia for Doing Business with China* (1994) 59, for the historical position. Slater J., Strange R., Wang I. *Trade and Investment in China: The European Experience* (2013) 4 – 13. See also the important role of the Chinese economy to the work of the Organization for Economic Cooperation and Development (OECD) established in terms of the Convention on the Organization for Economic Cooperation and Development, Paris 14 December 1960.
[47] http://www.oecd.org/about/membersandpartners/ (accessed 05/04/2016).
[48] http://www.chinatradedata.com/?gclid=CJ_6pIKa-7YCFYdMpgodXTUAsw (accessed 05/04/2016).
[49] Kose M. A. *Emerging Markets: Resilience and Growth Among Amid Global Turmoil* (2011) 30, 136.
[50] Shah A., Thomas S., Gorham M. *Indian Financial Markets: An Insider's Guide to How the Markets Work* (2008) 103, the authors explain that credit ratings depict '**credit** quality being typically denoted as "**AAA**" down to "C" denoting substantial risk and "D" denoting a defaulted security.' See, http://www.moodys.com/researchandratings (accessed 05/07/2016).
[51] Detrixhe J. *US Loses AAA Credit Rating as S and P Slams Debt Levels, Political Process* August 7 (2011) http://www.bloomberg.com/news/2011-08-06/u-s-credit-rating-cut-by-s-p-for-first-time-on-deficit-reduction-accord.html (accessed 05/04/2016).
[52] Arestis P., Sawyer M. *The Euro Crisis* (2012) 1. See discussion on Greece by authors.

financial crisis than that of the US and the Euro zone.[53] This would be an undesirable consequence for the world economy.

This rise of sovereign debt and shrinking economies is obviously not unique to the US or Euro zone as cases such as *NML Capital Limited (Appellant) v Republic of Argentina (Respondent)*[54] prove. In the NML case, a Cayman Island company referred to as a 'vulture fund' managed to secure summary judgment in terms of New York law against the Sovereign state of Argentina for defaults in the payment of government bonds and interest thereon.[55] This led to a subsequent immunity controversy when NML arrested an Argentinean naval vessel to enforce the judgment in the Ghanaian jurisdiction. However, release of the Argentine naval vessel was ordered by the International Tribunal on the Law of the Sea (ITLOS) in *The "ARA Libertad" Case (Argentina v Ghana).*[56]

The increase of international debt collection procedures before the courts may be profitable for attorney related work in the short term but it is also a cause for concern as it echoes that there are not enough money certain entities to pay for their debt. This is also an important economic indicator. China does not have the same problem as Argentina on this account. The Chinese economy is showing an increase in demand for both commodities such as iron ore and the shipping transport which supports haulage of such commodities at the highest capacity[57] and thus not in danger of vulture funds or debt collection proceedings against its government assets.

Chinese business interests in maritime commerce currently demonstrate peaceful submissions to contractual agreements for arbitration and legal process as shown in *Beijing Jianlong Heavy Industry Group v Golden Ocean Group Ltd and another company; Beijing Jianlong Heavy Industry Group v Ship Finance International Ltd and*

[53] Ryan P. *Auditor Warns China Debt Crisis Could Dwarf GFC*, Friday April, 19 (2013) http://www.abc.net.au/news/2013-04-18/auditor-warns-china-debt-crisis-could-dwarf-gfc/4636648 (accessed 05/04/2016).
[54] [2011] UKSC 31 on appeal from [2010] EWCA Civ 41.
[55] [2011] UKSC 31 p 2.
[56] Order of 15 December 2012, ITLOS Reports 2012 p 5.
[57] Sheridan R. *Ore-Carrier Rates Climb to 10-Week High as Chinese Demand Gain*s 3 May (2013) http://www.bloomberg.com/news/2013-05-02/ore-carrier-rates-climb-to-10-week-high-as-chinese-demand-gains.html (accessed 05/06/2016).

Another Company.[58] The case was focused on the Chinese law, the State Administration of Foreign Exchange (SAFE)[59] In this case, the English commercial court distinguished and applied the principle of the 1929 decision of *Foster v Driscoll*[60] disallowing parties to enforce an illegal agreement where the contract is unlawful according to the laws of a foreign country. In the *Beijing* case, the illegality was alleged by a Chinese company contending that the guarantees made pursuant to certain charter party agreements were illegal in terms of Chinese law and that all the parties were aware of this illegality.[61]

The court held that the guarantees were enforceable in terms of English law as powerful commercial factors in the case supported the arbitration process and the parties' choice of law.[62] From the brief outline of the main economic factors on China above, it is evident that the Chinese economy is stable and shows gains. Continued strength of the Chinese economy has to be carefully managed through equitable law[63] so that all the positive development and investment in China is able to increase revenue to avoid the accumulation of empty infrastructures that may result in bad debt. The global economy requires all economies to be sufficiently strong[64] so that global prosperity may become less illusive. It is also the work of each country to make the best of the national and international trade policies to achieve economic stability. Constructive lessons on improving economies will continue to be an ongoing international endeavor.

4.1. Shipping Markets Economic Indicators

International trade is the common benefit of international economic harmony. It permits nations who are not allies, who may even have divergent political ideals to work

[58] [2013] All ER (D) 35 (May); [2013] EWHC 1063 (Comm).
[59] The Legislative Affairs Office of the State Council *Laws and regulations of the People's Republic of China: Economic Law* (2001) 450. (Promulgated by the **State Administration of Foreign Exchange** on January 14, 1995).
[60] [1929] KB 287; [1928] All ER Rep 130.
[61] [2013] All ER (D) 35 (May); [2013] EWHC 1063 (Comm) 1. 'It is illegal under Chinese laws for a Chinese legal person to make a foreign guarantee in favour of a foreign legal entity without having obtained the prior authorization of SAFE or to transfer funds out of China in order to make payment pursuant to a foreign guarantee which has not been approved and registered by SAFE. Violation of these requirements results in the invalidity and unenforceability of the guarantee and penalties applicable to the 'guarantor' and its officers. The Chinese courts will apply the mandatory provisions of Chinese foreign exchange law when considering the validity of the Guarantees, even though they contain a clause purporting to provide for the application of English law.' Para. 12.
[62] http://www.bailii.org/ew/cases/EWHC/Comm/2013/1063.html (accessed 05/07/2013) paragraph 46.
[63] Chinese SAFE law, for example, shows a national commitment to equitable and well-regulated economic law that seeks to avoid illegal transfer of money and other commercial crimes. The Legislative Affairs Office of the State Council *Laws and regulations of the People's Republic of China: Economic Law* (2001) 450. (Promulgated by the **State Administration of Foreign Exchange** on January 14, 1995). Tian X. *Managing International Business in China* (2007) 273.
[64] DeMartino G. *Global Economy, Global Justice: Theoretical and Policy Alternatives to Neoliberalism* (2002) 210.

together for the sake of economic prosperity and global participation in markets. This harmony permits politically opposed nations to work together as strategic partners if the relations fall short of friendly alliances. It has been stated by an author on Chinese foreign policy, for example, that, 'if one treats China like an enemy, China could become an enemy.'[65] This statement is an opinion that may be rebutted or contradicted however it does indicate that there has been a demonstrated desire by China, for example, to rise into economic power peacefully[66] unless aggravated or treated with hostility.

For the purposes of understanding shipping markets, what matters at this stage is that China is a major contributor to international trade. The shipping indicators form a record and an account of this global participation in shipping markets (international trade). The study of shipping market indicators is essential to the understanding of the practical day to day role of economies in international trade and movement of commodities. The role of Asian markets, China in particular, forms an important study of current to global trade trends within the context of this paper.

The indicators illustrate current Chinese economic power in buying, selling and transportation of commodities. Cargoes traded may be traded as either as dry bulk, containerized cargo, clean or dirty tanker products. These commodity movements on an international basis are reported in the BDIY, HARPEX, BCTI and BDTI indices. These indices are selected because they are more reflective of global markets and may be studied together with country specific indices that relate to different commodities, such as the Shanghai Containerized Fright Index (SCFI) and other indices recording imports and exports from China,[67] which complement the international reports and indices. Market news are also important to the understanding of current trends in the shipping markets, for example, there are reports on the need to address the Euro Asia shipping routes which are dogged by tonnage overcapacity and rising operational costs (*inter alia* fuel and other environmental[68] concern costs) signifying a shrinking shipyard

[65] Zhao S. *Chinese Foreign Policy: Pragmatism and Strategic Behavior* (2004) 244.
[66] Guo S. *China's "Peaceful" Rise in the 21st Century: Domestic and International Conditions* (2006) 171.
[67] http://en.sse.net.cn/indices/scfinew.jsp (accessed 05/20/2016).
[68] Installations on vessels to reduce pollution.

global market,[69] on the other hand there appears to be more economic growth for China evidenced by the ordering of new vessels from China to countries such as Iran, despite western sanctions.[70] Further, it seems that order books will continue to be filled by orders from owners who are benefiting from the current low cost of new building vessels.[71]

4.1.1. BIMCO Reports on Markets:

BIMCO is an internationally representative body[72] on shipping matters. BIMCO provides useful market analysis reports.[73] A brief consideration of some of these reports is relevant here. In terms of shipyards, BIMCO's market analysis report states that global shipyard output is slowing but the market is also showing a move from the traditional focus on conventional merchant vessels to focus on offshore products such as drilling ships (drill ships)[74], floating production, storage and offloading (FPSO), anchor handling tug supply (AHTS) vessels and other offshore industry support vessels[75] of this nature.[76] This market analysis shows that shipyards are looking to supply more profitable markets such as offshore oil and gas industries while the shipyard market deals with current merchant vessel tonnage overcapacity and the interest in larger vessels with fuel efficiency.

Shipbuilding seems to be more relevant in terms of exploitation and exploration of natural sea resources as the focus for economic growth according to the BIMCO report above as the offshore market seems to be more stable for the energies sector. It is

[69] Paris C. *Overcapacity, Fuel Costs, Hit Shipping Industry* Friday 3 May (2013) http://english.capital.gr/News.asp?id=1788742 (accessed 05/20/2016). Drewry Maritime Research *Supply/Demand: Asia-North Europe* (2013) http://ciw.drewry.co.uk/trade_route_analysis/supplydemand-asia-north-europe-3/ (accessed 05/20/2016).
[70] Independent Media *China Delivering 3 New Ships to Iran* Sunday, 12 May (2013) http://www.imra.org.il/story.php3?id=60971 (accessed 05/20/2016).
[71] 'It's been yet another week on increased new building ordering activity with Hellenic ship owners appearing rather active, on the back of attractive financing obtained in China. According to the latest shipbuilding report by Clarkson Hellas, most of the ordering has been happening in the dry bulk sector, but there have also been a number of new orders in the MR and LR2 coated tanker markets.' http://www.guineashippingcorp.com/aggregator/sources/1 (accessed 06/04/2016).
[72]https://www.bimco.org/About/~/media/About/Joining_BIMCO/Benefits_2012/Benefits_GENERAL_Members_10_2012.ashx (accessed 05/20/2016).
[73] https://www.bimco.org/ (accessed 05/20/2016).
[74] http://www.kongsberg.com/en/kog/news/2013/may/kongsberg-wins-contract-for-deliveries-to-four-drillships/ (05/25/2016).
[75] http://worldmaritimenews.com/archives/84505/gibdock-completes-refit-of-westerngecos-seismic-vessel/ (05/25/2016).
[76] https://www.bimco.org/en/reports/market_analysis/2013/0514_shipyard_oc.aspx (accessed 05/21/2016).

therefore not surprising that China would seek to invest in areas such as the disputed territories of the China seas in order to have control and access to natural resources. The China National Offshore Oil Corp (CNOOC) has recently completed Asia's biggest deep water platform in the South China Sea[77] as a testament to China's presence in that area both in terms of its shipbuilding capacity and the use of natural resources in the South China Sea.

The Chinese shipyard market is active and leading notwithstanding general global market difficulties.[78] This means that supplying the offshore market would be easy and profitable for China's shipyards. To illustrate China's shipyard preparedness, China is poised to benefit from the Greek economic crisis, for example, as China looks to invest in the struggling Greek economy which also has profitable natural resources such as natural gas which the Greek government is looking to privatize. This would lead to more orders for the Chinese shipyards for the purpose of increasing Chinese capacity for natural resources exploration, exploitation and transportation in Europe.[79]

In the meantime, it is business as usual with the shipyard markets' cross border cases being settled with peaceful court process as in the case of a shipyard contract dispute over the vessel, *MV Rodosi*.[80] The case was initially heard in the Ningbo Maritime Court in China. The final judgment following several stages of litigation resulted in a finding in favor of the Chinese shipyard while all litigation proceedings filed in the US by the ship owner were dismissed.[81] Further, China is active in obtaining technologies to bolster its shipbuilding.[82]

Turning to the tanker markets, for illustration, it is important to distinguish the clean tanker market from the dirty tanker market, clean tankers carry refined petroleum products such as kerosene, gasoline, jet fuel or chemicals. Dirty tankers carry heavier

[77] Juan D. *NCOOC Completes Asia's Biggest Deepsea Platform* 24 May (2013) http://www.chinadaily.com.cn/cndy/2013-05/24/content_16526905.htm (accessed 05/27/2016).
[78] Romann A. *Urgent Lifeline Needed for Shipbuilders* 2 April (2013) http://www.chinadailyapac.com/article/urgent-lifeline-needed-shipbuilders (accessed 05/21/2016). http://www.hellenicshippingnews.com/News.aspx?ElementName=TopStories (accessed 05/28/2016).
[79] Chang B. *China to Invest More in Greece* 18 May (2013) http://www.chinadaily.com.cn/business/2013-05/18/content_16508696.htm (accessed 05/21/2016).
[80] Judgment unreported in English.
[81] http://www.co-effort.com/en_US/people_show.asp?id=64 (accessed 05/25/2016).
[82] http://www.marinelog.com/index.php?option=com_contentandview=articleandid=4153:china-buys-license-to-build-new-lng-containership-familyandcatid=1:latest-newsandItemid=195 (accessed 06/12/2016).

oils such as fuel oil or crude oil.[83] In terms of the tanker market BIMCO reports, there was a demonstration of slowing demand for oil imports by the US since late 2013, a traditional high consumer of crude oil. This resulted in a slowing demand for sea going tankers into the US. The new large importer of crude oil is China which is building a large refinery capacity however it remains to be seen whether this demand of the product by China will offset slowing demand by the US. China is a market for Russian crude oil evidenced by relevant oil pipe constructions (which affect the demand for seagoing carriers)[84] and bilateral agreements.[85] It would seem that the Organization for Petroleum Exporting Countries (OPEC)[86] will wait to see how much China is willing to import while high oil prices will keep oil exporting nations in a good economic position. On the other hand, ship owners will have to contend with consequences of high operating costs and slowing demand for tankers into the US.[87]

5. APPLICABLE LAW AND IMPLICATIONS OF APPLICATION FOR CHINA SEAS DISPUTES:

Turning to the Public International Law aspect of the activities in the East and South China Sea, the law involved relates to Maritime Delimitation Law in international law as contained in the United Nations Convention of the Law of the Sea, 1982 (UNCLOS).[88] The UNCLOS instrument does not need to be reproduced in this paper. The UNCLOS seems to provide clearly expressed law on maritime boundaries in terms of the provisions of its Articles,[89] therefore one might consider that UNCLOS maritime delimitation rules would readily resolve the East and South China Seas disputes within the bounds of this international law. The practical situation in the China seas however shows that any expected ease of maritime delimitation in the China seas deputes is a

[83] Branch A., Stopford M. *Maritime Economics* (2013) 92.
http://www.nesteoil.com/default.asp?path=1,41,538,2035,13907 (accessed 05/25/2016).
[84] https://www.platts.com/im.platts.content/insightanalysis/industrysolutionpapers/espo0211.pdf (accessed 05/25/2016).
[85] http://rbth.ru/business/2013/04/08/russia_to_double_oil_exports_to_china_24779.html (accessed 05/25/2016).
[86] http://www.opec.org/opec_web/en/ (accessed 05/25/2016).
[87] OPEC World Oil Outlook (WOO) (2012) 27.
http://www.opec.org/opec_web/static_files_project/media/downloads/publications/WOO2012.pdf (accessed 05/25/2016).
[88]The 1982 United Nations Convention on the Law of the Sea (**UNCLOS**), which came into force on November 16, 1994.
[89] Part II, sections 1, 2 and 4; Part IV relating to archipelagic States; Part V relating to the Exclusive Economic Zone (EEZ) and Article 15 which provides for rules for maritime delimitation where States have adjacent or opposite coasts.

daydream. According to author Mak J. of the Malaysian Institute of Maritime Affairs, disputes in the China seas are not even dependent of the rules of UNCLOS but on China.[90]

It is obvious from ICJ case law that maritime delimitation is complex as there are many variables that inform what is a just and equitable maritime delimitation, however, it is submitted that the UNCLOS should be given its rightful place as an international instrument of law for equitable delimitation and territorial disputes settlement particularly in light of the fact that all the countries directly involved in the South and East China seas disputes are signatories.[91] However, it is not possible. As UNCLOS can only be used as a basis for maritime boundary delimitation, but such delimitation is often premised on determination of territorial sovereignty, as in the case of China's claims in the SCS. The Convention was signed to protect the Sovereign rights of coastal States while maintaining access to a forum that would settle territorial disputes. The US while an interested party in this Asia Pacific matter as a matter of its foreign policy,[92] it is not a signatory to the UNCLOS[93] and its involvement and military presence in the Asia-Pacific region is viewed with suspicion especially in recent times with China's strong economic and military presence being witnessed by the global community.[94]

Article 15 of the UNCLOS provides that where coasts of two states are opposite or adjacent to each other, neither of the states, failing a contrary agreement between them is permitted to increase its territorial sea beyond 'beyond the median line every point of which is equidistant from the nearest points on the baselines from which the breadth of the territorial seas of each of the two states is measured.' This maritime delimitation rule is also commonly referred to as the equidistance rule[95] as discussed in cases such as *Qatar v Bahrain*, where the equidistance rule was applied and adjusted to reach an

[90] Mak J., *The Law of the Sea After UNCLOS: Implications for the South China Seas Disputes* Malaysian Institute of Maritime Affairs (1995) 3.
[91] China, Brunei, Philippines, Malaysia, Vietnam, Japan.
[92] The Adelphi Papers *American Foreign Policy* First Published in 2006, (2013) 86, 87; 90.
[93] Walker G.K. *Definitions for the Law of the Sea: Terms not Defined by the 1982 Convention* (2011) 29.
[94] China accuses US of destabilizing region http://aje.me/170AHAp via @AJ English (accessed 06/12/2016).
[95] An absolute rule, which could be applied to maintain predictable law in every case. The ICJ however noticed that it would be important to take equity into account in maritime delimitation cases as the geography of a cost may allow a situation where application of the equidistance rule may result in inequity. Kolb R. *Case Law on Equitable Maritime Delimitation: Digest and Commentaries* (2003) 71.

equitable result in the circumstances.[96] In *Romania v Ukraine* the ICJ also carefully considered the equidistance rule as contended by the parties and came to the appropriate conclusion within the applicable law.[97] The exceptions to this rule involve situations where variance to the equidistance rule is permitted by virtue of historic titles or other special circumstances that dictate a variation of the traditional delimitation.[98] In the case of *Guinea-Bissau v Senegal*[99] State parties to the dispute had the matter subsequently removed from the court roll based on their agreement on delimitation.

Agreements between States appear to resolve these matters more amicably. China has the option to take this approach in the East and South China seas as diplomacy is the best and first step in addressing disputes of this nature and allows parties the opportunity to articulate their interests, clarify their demands and attempt to adopt strategies and memorandums of understanding on contentious issues. This ideal diplomatic manner of dispute settlement is not always possible where parties are not negotiating on the basis of an equal bargaining position as the parties with more power are likely to enforce their own interests against weaker parties. In such instances the law is an important standard to look to for equitable balancing of country specific interests.

The ICJ case of *Denmark v Norway*[100] however shows that existing agreements may have to be revised and challenged by parties at a later stage and thus they are not a guarantee or a more stable manner of settling territorial disputes in maritime delimitation cases. The States involved had approached the court to settle a maritime delimitation matter involving opposite coasts of the two countries. This delimitation decision had an impact on the continental shelf and fishery zones of the two States.[101] The chief argument by Norway was that there was a preexistent agreement between Jan Mayen and Greenland contained in a bilateral Agreement of 1965 and the 1958 Geneva

[96] Maritime Delimitation and Territorial Questions between Qatar and Bahrain. Judgment of 16 March 2001. I.C.J. Rep. 2001 p 41.
[97] Maritime Delimitation in the Black Sea (Romania *v.* Ukraine) Judgment of 3 February 2009. I.C.J. Rep. 2009 p 73, 74 paras. 217, 219. Refer to applicable maps.
[98] UNCLOS Article 15.
[99]Maritime Delimitation between Guinea-Bissau and Senegal. Order 8 November 1995. I.C.J. Rep. 1995 p 6.
[100] Case Concerning Maritime Delimitation in the area between Greenland and Jan Mayen (*Denmark v Norway)*. Judgment of 14 June 1993. I.C.J. Rep. 1993.
[101]*Denmark v Norway.* Judgment of 14 June 1993. I.C.J. Rep. 1993 p 8 - 13 paras. 9 - 19.

Convention on the Continental Shelf.[102] The 1958 Convention, referred to by parties in this case, was subsequently replaced by UNCLOS.[103]

The parties argued about the meaning of the agreement and the court had to make a decision on that agreement as a preliminary point.[104] The law discussed in the *Denmark v Norway*[105] is not only relevant in discussing doubts as to delimitation agreement between States but it also relates to maritime delimitation issues over islands in dispute[106] as in the case of the East and South China seas. This case therefore serves as a contribution to the jurisprudence on the international courts' interpretation as to agreed delimitations, such as those created by bilateral agreements between Sovereign States particularly if such agreements need to be debated by the international court. The first point is that such pre-existing agreements must be submitted before the court and accepted to be the pre-existing agreement by the parties[107] relying on it and any conflict as to its interpretation can be settled by the court.[108] The court may also be guided by the production of diplomatic correspondence and the appropriate 'special circumstances' which may inform the manner in which any pre-existing agreement is to be interpreted.[109]

On the preliminary point, the court considered the text of the agreement which provided for the governments of the kingdoms of Denmark and Norway establishing a 'common boundary between the parts of the continental shelf over which Denmark and Norway respectively exercise sovereign rights for the purposes of the exploration and exploitation of natural resources' in accordance with certain agreed terms.[110] The agreement provided for the method in which the median line was to be worked out between the two kingdoms in terms of Article I and Article II of the agreement however the court found that this definition did not apply to the disputed area providing for the definition of the position of the median line between Greenland and Jan Mayen and that

[102]*Denmark v Norway.* Judgment of 14 June 1993. I.C.J. Rep. 1993 p 14 para. 22.
[103] Makuch K., Pereira R. *Environmental and Energy Law* (2012) 215.
[104]*Denmark v Norway.* Judgment of 14 June 1993. I.C.J. Rep. 1993 p 14 para. 23.
[105] Case Concerning Maritime Delimitation in the area between Greenland and Jan Mayen (*Denmark v Norway).* Judgment of 14 June 1993. I.C.J. Rep. 1993.
[106]*Denmark v Norway.* Judgment of 14 June 1993. I.C.J. Rep. 1993 p 17 paras. 29 – 30 and p 51 para. 28.
[107] In this case a fully translated 1965 Bilateral Agreement was presented before the court and accepted as the authentic document. Ibid. p 48 paras. 22; 23.
[108]*Denmark v Norway.* Judgment of 14 June 1993. I.C.J. Rep. 1993 p 43 paras. 9 – 15.
[109] Ibid. p 55 para. 38.
[110]*Denmark v Norway.* Judgment of 14 June 1993. I.C.J. Rep. 1993 p 47 paras. 23 – 24.

this question was one that was still outstanding and needed to be determined by the court.[111]

In determining the applicable law for maritime delimitation in this case, it was established by the court that the pre-existing agreement had not only failed to settle the delimitation issue, it was also found that delimitation could also not be implied from the 1958 Convention to which both countries were a contracting party.[112] The court, by not accepting the contention that the pre-existing agreement was sufficient to clarify the entire delimitation law in this case, this serves as a caution for other future cases in the ICJ. The South and East China Sea disputes cases may be supported with diplomatic documentation or other documents containing bilateral agreements, but these must be tested in the ICJ properly in order to have a final result of clarity on delimitation as was the final case in *Denmark v Norway supra*. The documents presented by a part before the court may be challenged as to their authenticity, their interpretation and in light of other national and international law and this may pose a challenge to claims by countries involved in the East and South China sea disputes.

The court had to settle the arguments of the parties; on the one hand, Denmark was contending that the court should draw a delimitation line with proposed coordinates already established by Denmark according to where they believed the delimitation line should appear. Norway on the other hand requested a declaratory finding by the court as to the basis of the delimitation and this would have the effect of allowing the parties to enter into a negotiation and agree as to the actual delimitation.[113] Denmark and Norway were also not in agreement as to how many delimitation lines of delimitation needed to be established by the court.

Denmark was arguing for a single line of delimitation of the continental shelf and fishery zone area and Norway was arguing for two coinciding lines of delimitation, one being the median line for the continental shelf and the second being a line for the fishery zone area. According to Norway however the two lines would coincide and form two distinct boundaries and these two lines would be based on two separate systems of law

[111] Ibid. p 56 para. 40.
[112] Case Concerning Maritime Delimitation in the area between Greenland and Jan Mayen (*Denmark v Norway)*. Judgment of 14 June 1993. I.C.J. Rep. 1993 p 56 para. 40.
[113] Ibid. p 56 para. 41.

one being the Article 6 of the 1958 Convention and the other being customary law applicable to the fishery zones,[114] the point on applicable law being accepted by the court.[115] The lack of agreement concerning the delimitation of a continental shelf and fishery zone is, in the opinion of the ICJ in this case, what made the case of *Denmark v Norway* distinguishable from *Canada v United States of America: Case Concerning Delimitation of the Maritime Boundary in the Gulf of Maine Area* in that a single dual-purpose line was to be determined by the court.[116]

In coming to a conclusion in this case, it was found by the court that the 1982 UNCLOS did not apply as neither of the States had ratified it. Thus Article 6 of the 1958 Convention was the law to be applied concerning delimitation of the continental shelf. The applicable rule of law therefore provided that where coasts are opposite, delimitation is worked out on the basis of the median line (the equidistance line) between the territorial sea baselines. Once the median line is established, the court must consider whether or not there are other 'special circumstances' which exist that require another boundary line.[117] Referring to several decisions, for example, the delimitation of the continental shelf based on customary law in the *Case Concerning the Continental Shelf Libyan Arab Jamahiriya v Malta),*[118] the court established that the median line is a provisional line which could be adjusted for the purposes of achieving an equitable result where there are special circumstances such as the existence of islands across the opposite coasts in question.[119] Paragraphs 91 to 94 of the judgment, which had a majority of 14 to 1 votes, set out taking into account all the circumstances and law as to the location of the median line and found that that delimitation decided by the court in paragraphs 91 1nd 92 of the judgment was the most equitable one in the circumstances.[120]

5.1. Relevance of Delimitation Case Law to the China Seas Disputes:

[114] Ibid. p 57 para. 42.
[115] Ibid. pp 57, 58 para. 44.
[116] *Canada v United States of America*. Judgment 12 October 1984 I.C.J. Rep 1984 p 253. *Denmark v Norway.* Judgment of 14 June 1993. I.C.J. Rep. 1993 p 57 para. 43.
[117] *Denmark v Norway.* Judgment of 14 June 1993. I.C.J. Rep. 1993 p 60 para. 49.
[118] Judgment 3 June 1985. I.C.J. Rep. 1985.
[119] *Denmark v Norway.* Judgment of 14 June 1993. I.C.J. Rep. 1993 p 60 paras. 50, 51.
[120] Ibid. p 79 paras. 91, 92 and 94.

The decisions on delimitation discussed above are relevant to the China seas disputes. The countries involved in the China seas disputes are signatories to the UNCLOS and thus the principles of equity which guide the application of the UNCLOS by the ICJ will be of paramount importance to whatever decisions are taken by the ICJ concerning these disputes in light of relevant law, custom and other provisions of Article $38^{(1)}$ of the Statute of the International Court of Justice.[121] Article $38^{(2)}$ of the Statute of the International Court of Justice provides that, '…provision shall not prejudice the power of the court to decide a case *ex aequo et bono* (from equity and conscience) if the parties agree thereto.'

This means that countries to a dispute may at any stage agree to equitable solutions among themselves and the court itself is guided by law which is aimed at achieving justice and equity. What one also draws from applicable law in delimitation cases is that the ICJ prefers the equidistance delimitation method, where applicable and takes into account any circumstances that may make the application of equidistance delimitation unfair.[122] Further, the decision of the court ensures equitable exercise of equal rights to marine resources where the delimitation results in overlapping country interests.[123] This means countries may have to share resources and the limits of these overlapping interests in the South China seas disputes may be what needs to be articulated in order to settle the disputes altogether, however, there is nothing stopping the countries from agreeing to the terms of the settlement of the disputes the ICJ may step in to help resolve the matter, however, ICJ can only step in when both/ all parties to the dispute are willing. Parties also have other avenues for dispute resolution available to them in these matters, for example, arbitration in the Permanent Court of Arbitration which will be discussed more specifically in relation to the Philippines and China as this paper progresses.[124]

5.2. Exploitation and Exploration of Resources in the Disputed Regions:

[121] The Statute of the ICJ forms part of the United Nations Charter and is integral to the process of maintaining international justice. See http://www.icj-cij.org/documents/?p1=4andp2=2andp3=0 (accessed 10/29/2016).
[122] *Denmark v Norway.* Judgment of 14 June 1993. I.C.J. Rep. 1993 p 79 para. 92.
[123] Ibid. p 79 para. 91.
[124] http://www.pca-cpa.org/showpage.asp?pag_id=1288 (accessed 10/29/2016).

Prior to exploring the law applicable to the exploration and exploitation of natural marine resources in the East and South China Sea, it is important to first document what these resources are. Countries that possess, control and manage their natural resources to the benefit of their own country specific interests demonstrate national power, pride and are at a better position when it comes to the dictation of methods for protecting national interests. It is therefore important that where natural resources in disputed sea territories exist, the manipulation of those resources is properly clarified so that sovereign rights of countries are not undermined. The situation in the East and South China Seas shows that there are serious national security complaints and jurisdictional issues listed by countries in the disputed region. The Philippines, for example, launched a currently ongoing arbitration case against China on 22 January 2013 in *The Republic of the Philippines v The People's Republic of China* in a matter concerned with 'with respect to the dispute with China over the maritime jurisdiction of the Philippines in the West Philippine Sea.'[125] The arbitration case occurs against a background of an alleged general observation that China is displaying imperialistic rule in the region[126]which not only affects diplomatic relations in the region but it also affects military allies and other trading partners like the EU who have economic interests in the region.[127]

Throughout history, natural resources and control of territories has been one of the sources of military tensions for nations[128] or war.[129] Political scientists and warfare specialists have postulated some theories concerning territorial disputes and military tensions[130] including the fact that war may be something that is endemic to the human condition.[131] Theories and reasons for war will continue to be addressed in social and political sciences and reflected in law and thus with reference to the East and South China Seas disputes, it is prudent to consider how resource control in the region applies to determine the reasons for the tension in the first place. In his book on the causes of war, Van Evera, quoting Dhal's work on political analysis and the theory of resource

[125] The case is launched in terms of Annexure VII, Articles 1 - 13 of the UNCLOS Convention, which contains all the relevant articles for regulating arbitration proceedings. The Permanent Court of Arbitration is registrar over the matter permitting the two parties to come to a legitimate forum to settle the dispute. See, http://www.pca-cpa.org/showpage.asp?pag_id=1529 (accessed 11/06/2016).
[126] http://www.imoa.ph/tag/itlos/ (accessed 11/04/2016).
[127] http://www.imoa.ph/eu-vital-interest-open-secure-west-philippine-sea-says-official/ (accessed 11/04/2016).
[128] http://www.enviroliteracy.org/subcategory.php/222.html (accessed 11/06/2016).
[129] Van Evera S. *Causes of War: Power and the Roots of Conflict* (2013) 105 – 107.
[130] Orend B. *War* The Stanford Encyclopedia of Philosophy (2008) Edward N. Z. (ed). http://plato.stanford.edu/archives/fall2008/entries/war/, see point 3 on the theory of realism for example.
[131] Baylis J., Wirtz J.J. and Gray C.S. *Strategy in the Contemporary World* (2012) 21.

cumulativity, a theory that states that in the control over a resource, that resource is cumulative if the possession of the resource eases the control of other resources. Van Evera states that the theory of cumulativity is applicable to international relations and may be used as a measure of power for the controlling political community. This is the explanation of the theory in practical terms:[132]

> *'The cumulativity of a given resource is a function of two factors: the utility of the resource for acquiring or protecting other resources, and the cost of extracting the resources from its territory, including the cost of policing and administering the territory. If the utility exceeds the extraction cost, cumulativity is positive. If they are equal, cumulativity is zero. If extraction cost exceeds utility, cumulativity is negative-the resource is a millstone that drains the possessor's power."*[133]

To further explain the theory above and the variance of utility in cumulative resources, Van Evera goes on to make an example that, Germany's defense industry, for example, is a much more useful cumulative resource that allows control of other resources as opposed to retaining, for example, Cuba's tobacco surplus.[134] It is submitted that due to the powerful economic position of China, its geographic positioning, together with its engineering and military strength, retaining possession and control over the disputed territories in the East and South China Seas, would allow China to gain cumulative resources in the region because of the resources in those regions. It is therefore appropriate to first ask, what natural resources exist in the disputed territories of the East and South China Seas? Secondly it is important to ask, what International Law regulates the conduct of parties in the exploitation and exploration of resources in that region? Answering these questions will ensure that the sources of tensions, even if arguable, are identified and isolated and the expected conduct in law is clarified for all military political communities involved.

[132] Van Evera S. *Causes of War: Power and the Roots of Conflict* (2013) 106.
[133] Ibid.
[134] Ibid.

5.2.1. The Region's Oil and Gas Reserves, Shipping Lanes and Applicable International Law:

There is a diversity of academic works making reference to the natural resource richness of the islands in the East and South China Seas disputes,[135] whether in the form of fishing stocks, oil or gas in the area, extending to the area of the West Philippine Sea.[136] It is thus relevant to determine whether or not these resources are located within the power of certain countries in the region in terms of applicable international law. Are the resources on the disputed islands and maritime territories under specific national jurisdiction, in this case China or other ASEAN nations or are they part of international waters? History records a confirmed scientific report first introduced in 1968, specifically known as the then named UN Economic Commission for Asia and the Far East (ECAFE)[137] survey mission, showing that likely oil and gas reserves in the Senkaku/Diaoyutai islands in the East China Sea which historically attracted the interest and involvement of the US.[138] In the South China Sea, the US Energy Information Administration (EIA) also produced a report detailing the natural resources in the South China Sea region.[139]

The assertiveness of China in these disputed maritime territories together with the control over natural resources is evident in actions taken by China such as the reported declaration by China that the South China Sea for example is a core national security interest for China, this is coupled with actions by China to challenge the presence of US naval surveillance ships, the Impeccable and the Victorious in 2009. Some also consider that this action of China is mainly for its security reasons. China also challenged the Philippines on fishing activities in the Scarborough Shoal. China also unilaterally banned fishing in the Gulf of Tonkin thus consequently detaining

[135]Till G., Chan J. *Naval Modernization in South East Asia: Nature, Causes and Consequences, J. McCaffrie* (2013) 38. Marketos T.N. *China's Energy Geo-Politics: The Shanghai Cooperation Organization and Central Asia* (2008) 110. See, also Mark J. Valencia, Jon M. Van Dyke, Noel A. Ludwig *Sharing the Resources of the South China Sea* (1999) 9.
[136] http://globalnation.inquirer.net/93347/intl-law-experts-laud-ph-stand-on-sea-row (accessed 12/05/2016).
[137] Now known as the Economic and Social Commission for Asia and the Pacific (UNESCAP or ESCAP), based in Thailand.
[138]McCormack G, Satoko Oka Norimatsu *Resistant Island: Okinawa Confronts Japan and the United States* (2012) 216.
[139] http://www.eia.gov/countries/regions-topics.cfm?fips=scs (accessed 01/08/2014).

Vietnamese fishing vessels. China also pressured US energy company ExxonMobil to stop exploratory works off the Vietnamese coast.[140]

In 2013 it was reported that China's maritime assertiveness continued as it was branded in a media article as continuing its maritime harassment of a US naval ship on international waters.[141] In 2013, on the East China Sea vicinity it was also reported that China had for the first time in history unilaterally imposed an East China Sea Air Defense Identification Zone (ADIZ) which raised concerns that mistakes in observing the regulations of the zone may lead to military confrontations with Japan which would ultimately pull in the US as a Japanese ally.[142]

With natural resources in the region and the potential national security concerns raised, it is important to mention the applicable international law regulating expected conduct of a coastal or otherwise country with regard to the exploitation and exploration of resources. The UNCLOS is clear on the sovereign rights and duties of a coastal State[143] the rights of a costal State in relation to the exploitation and exploration of sea resources within national jurisdiction[144] and provides that the exploration and exploitation of the common heritage of mankind, the 'area' which is regulated by the International Seabed Authority.[145] Section 5 of the UNCLOS provides for the procedures of the duly established dispute resolution forum, in the form of the International Tribunal for the Law of the Sea (ITLOS).[146] In terms of international law, the potential conflict areas are identified with sufficient clarity for disputing regions. However, it is not expected that China will simply calculate its territory in terms of UNCLOS and withdraw from taking control of some of the areas and islands in the nine dash area or the Diaoyutai area. In fact, it is not expected that such claims to territories will be resolved by countries simply agreeing to give up control of resource rich territorial zones.

Further, there is an important aspect to these disputes, that being the crucial shipping lanes in the region. Shipping lanes are crucial to international trade and peaceful global

[140]Till G., Chan J. *Naval Modernization in South East Asia: Nature, Causes and Consequences, J. McCaffrie* (2013) 38.
[141] http://www.washingtontimes.com/news/2013/dec/13/us-navy-china-showdown-chinese-try-halt-us-cruiser/ (accessed 01/06/2014).
[142] http://swampland.time.com/2013/12/04/why-chinas-new-air-defense-zone-matters/ (accessed 01/06/2014).
[143] Article 2, Part II, UNCLOS.
[144] Article 56.
[145] Annex I, Resolution I. Article 153. http://www.isa.org.jm/en/home (accessed 01/08/2014).
[146] http://www.itlos.org/index.php?id=15andL=0 (accessed 01/08/2014).

relations. The UNCLOS regulates the conduct of States in relation to access and passage over shipping lanes in section 3. Shipping lanes and rights of passage, if not carefully regulated and observed may be used by an aggressive power to cause military tensions. An example of this type of threat would be for instance threats to close the Strait of Hormuz in the Gulf region, another prime example of an important global shipping route, central to tanker and crude oil markets, among other trades.[147] In terms of the East and South China Seas disputes, there appears to be a historical and continued peaceful observation of the rules of international law pertaining to rights of passage of foreign ships particularly for commercial purposes.[148]However, the impact of the conduct of China is expected to continue to be amiable in terms of controlling the busy shipping lanes as these directly affect regional and global trade relations. However, some scholars may argue that the issues of International Shipping Lanes (ISL) are not so relevant to the maritime disputes.

International law and its application has been tested in a few cases brought before the ITLOS on matters raised by the East and South China Seas disputes, for example, *Dispute concerning delimitation of the maritime boundary between Bangladesh and Myanmar in the Bay of Bengal (Bangladesh/Myanmar),*[149] *Request for an advisory opinion submitted by the Sub-Regional Fisheries Commission (SRFC),*[150] a matter which is *sub judice*. These cases can be used as guides for the future decisions that will influence the trends that international forums may adopt when considering the East and South China Seas disputes and the questions of exploration and exploitation of resources in the disputed regions. What is clear is that the parties have a right to exercise control over their own territories however opposition and international courts may be approached to settle matters if it is found that a nation in the region is overstepping its boundaries in international law.

[147] http://news.nationalpost.com/2012/03/20/iran-has-no-plans-to-shut-strait-of-hormuz-despite-threats-kuwait-assures/ (accessed 01/06/2014).
[148] Johnston D.M., Gold E., Tangsbkul P., Dalhousie Ocean Studies Programme *International Symposium on the New Law of the Sea in Southeast Asia: Developmental Effects and Regional Approaches [sic]* (1983) 201.
[149] Judgment of 14 March 2012, ITLOS Reports 2012. Case number 16.
[150] Order of 20 December 2013, ITLOS Reports 2013. Case number 21, where China's, statement demonstrated a strict adherence to the procedure and rules of UNCLOS in approaching jurisdictional matters in the case, showing China's commitment to the respect for the UNCLOS.
http://www.itlos.org/fileadmin/itlos/documents/cases/case_no.21/written_statements_round1/C21_8_China_orig_Eng.pdf (accessed 01/08/2014).

6. BRIEF NATIONAL MILITARY CONSIDERATIONS FOR COUNTRIES INVOLVED:

It would take several chapters of written work to fully explore the position of China, Brunei, Philippines and Malaysia in the South China Sea and Japan in the East China Sea dispute over the Diaoyutai/Senkaku islands. Further, as the territorial disputes continue and partially become a subject for formal determination in the international forum as in the case of *The Republic of the Philippines v The People's Republic of China*,[151] full reports on the position of China in the South China Sea will be available in the public domain following the conclusion of the matter in formal court. Briefly with regard to the East China Sea, according to diplomatic papers obtained from the office of the ambassador of Japan to Fiji, Japan's position in the East China Sea is that Japan respects China and upholds its relationship with China in a very high position for many reasons including the fact that 'Japan has provided 45 billion dollars' worth of official development assistance (ODA) to China since 1979 because of the importance Japan places on China's role on the global scene. Japan was also a strong supporter of China's accession to the WTO.' However, the Senkakus are a point of contention for the two countries. Japan holds that the Senkaku islands are an inherent part of Japanese territory and it will continue, together with its allies (the US in particular),[152]to defend its territory.[153]

The military rankings of the countries directly involved in this dispute are a subject of extensive military science and international law however it is clear that the US as an interested super power matters greatly to its allies in the Asia-Pacific region protecting their territories.[154] International relations expert at the People's University in Beijing, Cheng Xiaohe, correctly stated that the tensions in the region reflected 'The competition for leadership in East Asia.'[155] What cannot be ignored in these disputes is the main point, war must be avoided. Competition for power and leadership among Pacific powers must be approached with care as China's position in international trade affects

[151] http://www.pca-cpa.org/showpage.asp?pag_id=1529 (accessed 11/06/2016).
[152] http://sam.gov.tr/wp-content/uploads/2013/03/1Joel_Campbell.pdf (accessed 01/08/2014).
[153] Office of the Japanese Ambassador to Fiji, quotes from *The Position Paper* (obtained 2012).
[154] http://www.globalfirepower.com/countries-listing.asp (accessed 01/08/2014).
[155] http://latinotimes.com/latinos/937068-china-defiant-as-joe-biden-visits-amid-air-zone-tension.html?__rmid=349001340.html (accessed 01/08/2014).

many domestic economies, seeking to uphold leadership in East Asia must not risk the destruction caused by war. Countries that benefit through trade with China will be affected; countries that benefit from China's prosperity including booming local economies of smaller island nations that are tourism based will also be severely affected by an Asian war.

7. CONCLUSION:

In conclusion this paper has considered the territorial disputes that have been the focus of Asia-Pacific foreign policy debates for a few years especially with the continuing growth position of China's economic and military strength in the region. As this is a paper mainly concerned with international trade in maritime terms it has been clarified how different maritime commerce markets that make up the global commercial relationships as powerfully influenced and affected by China's trade activities. This paper has also carefully outlined and called for a warning against undesirable military disputes or total war in China. War results in ruined markets, zero investment, forced removals and refugees and many other painful and destructive consequences. China has become a strong global financial player that benefits the US, African countries, BRICS and many Pacific nations. China also plays a very important role in every sector of the shipping markets whether it is container trade, shipbuilding, to name a few examples, war should not interrupt this positive international trade position of China. China is also having its own domestic concerns that require focus to build the nation further and like all nations a strong nation creates a stronger and more prosperous world, all these are aims that are encouraged in international relations and UN instruments which are used in this paper to practically suggest solutions to territorial disputes. It is recommended that having established the importance of Asian economic power to the globe, efforts to avoid the escalation of military tensions in the region should be meticulously pursued. The recommendation is that the high respect should continue to be given to international law regulating rights of nations over territorial seas without disrespecting ancient traditional agreements which are fully accepted by all countries involved.

Further, endeavors must be made by all countries to exhaust diplomatic resolutions to resolve territorial disputes so that agreements that are equitable in terms of benefiting from the natural resources in those areas are agreed to in a fair and globally sound

manner. War will hinder the progress China is making generally and it will interrupt the continuing development of naval capacity and machinery. For example, China exported submarines for the first time in 2013.[156] With much development that is taking place in China it is concluded that the factors that affect China and Asia as a whole, equally impact the rest of the world therefore China must focus on developing technologies, legal rules, business strategies, territory sharing agreements and other diplomatic approaches to the maritime disputes that will maintain peace in the region and consequentially the whole world. China's power does not have to be seen disapprovingly especially where the principles and the spirit of international law and equity is followed.

[156] http://www.strategypage.com/htmw/htsub/articles/20131206.aspx (accessed 01/08/2014).

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4. INTEGRATED OFFSHORE POWER STATION FOR HARNESSING RENEWABLE ENERGY RESOURCES

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Abstract

Since the dawn of civilization mankind could have used wind power for various purposes, but according to documented history wind power has been in use since the year 5000 BC by the ancient Egyptians. The Egyptians discovered that wind could be used as a source of energy for grinding corn, pumping water and other similar applications. The wind is a free, clean, and inexhaustible source of energy. It has served mankind well for many centuries. The first practical application of wind energy was witnessed in 4000 BC in the form of a single square sail on a sailing ship. As is already a well-known fact, wind is produced by the uneven heating of the earth surface by the sun. Thus, the concern over climate change grows and new policies are being drafted at different levels in the government to support various types of renewable energy. The government policies are driving the need to identify and construct new power plants that will utilize renewable resources to reduce greenhouse gas emissions. The fossil fuel power generation plants of the past, are getting outdated and causing more harm to the environment with their emissions. The operating and maintenance cost of various renewable energies were reviewed and found that offshore wind farms were the highest, around twenty eight percent. This higher cost can be compensated by generating higher power from the higher velocity of wind at sea. The demand for electricity in the country is ever on the rise. Simultaneously, the pressure to reduce the emission of greenhouse gases through excessive burning of fossil fuels is also on the increase. To meet these two conflicting requirements one of the possible ways out is to harness the renewable sources of energy like the wind energy in a big way. But setting up wind farms[1] on land is also beset with problems concerning suitable land acquisition and other related issues. Hence the best alternative is to go to the sea for setting up offshore wind farms. It is a well-known fact that the wind regime at sea is far superior to the wind regime on land thus making sea[2] the ideal alternative for locating wind farms

***Key Words*:** Offshore, Wind Farm, Operation, Maintenance, Optimization, Wind-Turbine.

1. INTRODUCTION:

Humans have roamed the face of the earth for thousands of years emerging as the most dominant species, having acquired the gift of knowledge and the power of technology our control over nature and its elements have progressed exponentially as time wore on. As the most dominant species on earth we have reached a point in our existence, where we are faced with a crisis; a quest to find a practically unlimited and clean form of energy resource, or in other words a Renewable resource.

In present day 21st century, we have witnessed a huge rise in global population, having reached the 7 billion mark already and counting, there is a dire need for us to sustain ourselves in the most beneficial way possible. With depletion of conventional natural resources such as fossil fuels day by day, there is an unmistakable necessity to discover and utilize new alternative forms of energy[3]. There is also a looming necessity of reducing greenhouse gasses which has been around for years. There are opponents of global warming who claim "the global warming that we are experiencing is just the result of natural cycles". Some scientists claim the global warming we are experiencing is not manmade. There are also critics who argue that renewable energy sources have severe drawbacks, such as having to use natural resources to produce a wind mill, or using large amounts of land to host massive quantities of solar panels. There are even those who believe that we are not in danger of depleting our traditional energy sources such as oil since although the cost of oil has increased, it is not severe enough to indicate there is a problem. Despite differing reasons, it is clear that the solution to our energy problems is to transition from traditional energy sources to renewable energy sources[4], thereby reducing greenhouse gas emissions, ending our dependence on foreign oil, and as a sheer testament to our progress in the field of science and technology symbolizing the human spirit of inquisitiveness and the burning desire to advance beyond limits.

Fortunately, there are many solutions to finding a viable means of alternative renewable energy resource of which wind energy promises to be the most promising and upcoming means, in terms of efficiency and affordability. The wind energy, although it was exploited for thousands of years, the re-emergence of wind energy for electric power generation in the grid-connected mode is of relatively recent origin. Since the mid-seventies, when work began in earnest on harnessing wind, the development of wind

energy technology has made significant progress. Wind energy is a free and inexhaustible source of energy. Unlike fossil fuels such as coal and oil, which exist in a finite supply and must be extracted from the earth, will lead to high environment cost. The technical feasibility of using wind as a major source of energy has now been established, and wind energy today ranks as one of the most promising of the renewable energy technologies for generating electricity. Wind energy, like most terrestrial energy sources, comes from solar energy. Solar radiation emitted by the sun travels through space and strikes the Earth, causing regions of unequal heating over land masses and oceans. This unequal heating produces regions of high and low pressure, creating pressure gradients between these regions.

The second law of thermodynamics requires that these gradients be minimized--nature seeks the lowest energy state in order to maximize entropy. This is accomplished by the movement of air from regions of high pressure to regions of low pressure, what we know as wind. Large scale winds are caused by the fact that the earth's surface is heated to a greater degree at the equator than at the poles. Prevailing winds combine with local factors, such as the presence of hills, mountains, trees, buildings and bodies of water, to determine the particular characteristics of the wind in a specific location. Air has mass, moving air in the form of wind carries with it kinetic energy. A wind turbine converts this kinetic energy into electricity. The energy content of a particular volume of wind is proportional to the square of its velocity. Thus, a doubling of the speed with which this volume of air passes through a wind turbine will result in roughly a fourfold increase in power that can be extracted from this air. In addition, this doubling of wind speed will allow twice the volume of air to pass through the turbine in a given amount of time, resulting in an eightfold increase in power generated. This means that only a slight increase in wind velocity can yield significant gains in power production[5]. Today, wind power is a truly global phenomenon and is beginning to figure in national energy plans as an important source of energy, income and employment. With current advances in technology and innovations, wind power farms generate between 17 and 39 times as much power as they consume, as compared to 16 times for nuclear plants and 11 times for coal plants, according to certain studies conducted. Several European countries, especially United States, Germany, Denmark, the Netherlands, United Kingdom and Spain and India now have national wind energy programmes. Wind is one of the most cost-effective of the renewable energy technologies, and the resource is widely

distributed around the world.

2. HISTORY OF ANCIENT WINDMILLS:

Windmills are machines that convert the power from wind into kinetic energy. They manifested in different forms to perform a variety of tasks like grinding grain, pumping water for farms, livestock, salt farms, timber milling, stone sharpener and ventilator for forging. Countries like Egypt, European countries, China, Persia, Netherlands, mid-west of America and the Australia had been developing and deploying the technology for centuries. These early machines were, no doubt crude and mechanically inefficient, but they served their intended purposes well for many centuries.

Wind at very low speeds was enough to drive a winch motor and for transforming its kinetic energy into useful mechanical work. The type of windmill construction depended on the location, the kind of work, and the amount of work that it needed to perform. The architecture **Figure 1.1** of these windmills differed from one country or region to another. The Dutch even constructed a multi storied tower with each floor allocated to grinding grain, removing chaff, storing grain and finally using the lowest floor as a residence for the windmill workers' families.

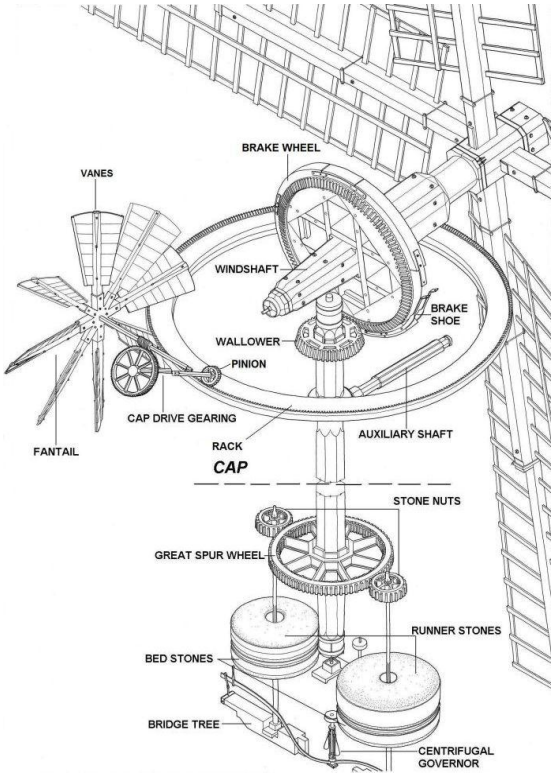

Figure 1.1: Wind Operated Stone Grain Grinder

The power of wind, harnessed and directed by machines of many designs, freed the serfs of the middle ages from some backbreaking tasks. In Holland, the windmill allowed low land reclamation, pumping water up from land that could be made fertile and productive. He had many inventions, one of them being the first steam engine invented in 60 AD. He also invented a windmill and a water pressure device which will open and close doors. His inventions find mention in his book titled "Pnuematica".

Wind had been used for hundreds of years to power sailing vessels and to drive windmills, but it wasn't until the late 19th century that the first wind turbine for electricity generation came into use[8]. This windmill was built by Charles Brush (inventor of several technologies key to the then nascent electrical industry), stood 17 meters tall and had 144 rotor blades, all made of cedar wood. Soon thereafter Poul la Cour, a Dane, discovered that fast rotating wind turbines with fewer rotor blades generated electricity more efficiently than slow moving wind turbines with many rotor blades. The most common use of wind power was in medieval and ancient ships where the sails acted as an efficient means of capturing and directing the force impinged by the breezes in the high seas. Discovery of wind mill technology for human utilities also

dates back to ancient Greece. Hero of Alexandria is believed to have invented the basic principles for offsetting the energy advantage from windmills to automate the grinding of grains. Persia is believed to be the birthplace of windmills with vertical axis sometime between 600 and 800 AD. These windmills were slowly deployed across the Middle East, Central Asia, China and India. The horizontal axis windmills were extensively used in the North-western Europe to grind flour **figure 1.2** in the 1180 AD. Around this period windmills were used to pump sea water in China and Sicily.

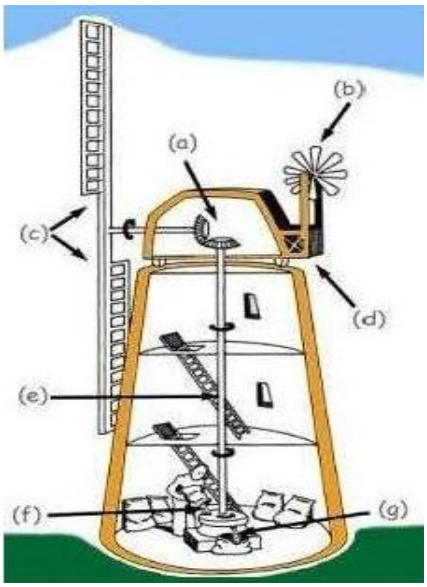

Figure 1.2: Vertical Axis Wind Operated Mill

a) Bevel gear b) Anenometer c) Blades Yawing mechanism
e) Vertical drive shaft f) Rotating grinding stone
g) Stationary grinding stone.

The English were the first to introduce windmills in America in the 16th century. These early machines were crude and mechanically inefficient, but they served their intended purpose well. They were made from local materials and with cheap labor. Many people were employed in maintenance work, due to its crude construction of the machine. Their sizes were determined by the materials locally available. A need for more power was met by building more wind turbines rather than larger ones. In 1745 Edmund Lee of Brock Mill near Wigan, provided the solution which would be applied to windmills and even wind turbines and a patent was granted. The horizontal axis rotor design was used widely by the Greek. This was adapted by Thailand and China for wind pumps because of its high starting torque, low stalling speed, low weight and cost. It easily

adjusts to the higher wind velocities. The development organizations in countries like Sri-Lanka, India, Ethiopia employed this design for areas with limited resources of materials and skill. In India, a 10-m diameter sail windmill with eight triangular cloth sails of the Greek configuration was constructed in Madurai by the windmill committee for irrigation by using the low speed winds in southern part of India.

Denmark was the first country to use the wind for generation of electricity. Windmills depend upon different principle as applied to sail boats. The use of many vanes on a windmill makes the difference in dispersion of wind, varying resistance and hence the speed. In 1870 the multi vane windmill design of Europe conquered the American continent but not locally. This design was immigrated to many other countries of Europe. In 1870, the wooden blades were replaced by thin aerodynamically shaped metal blades. It was observed the light weight metal sails were rotating at higher speed and needed a gear box to match the machine speed. Between 1850 and 1900, American Midwest installed six million small windmills on farms for operating irrigation pumps.

3. WINMILLS FOR POWER GENERATION:

The Danes were using a 23-m diameter wind turbine in 1890 to generate electricity. Star, Eclipse, Fairbanks-Morse and Aerometer companies became famous suppliers in North and South America. In the 19th century electric generators were used on the Sailing ship "Chance" in New Zealand. A significant source of industrial power in Netherlands was met by this type of wind mill. There were about 2500 windmills in Denmark by the end of 19th century employed for mechanical loads like pumps with the mills generating about 30 MW[9]. The Americans even constructed a 5-mast sail ship with 40,000 square feet of canvas as sails for harnessing the wind, for a case study on "increasing the speed of the sail boats" and found it to be a success. Some investigations were carried out in India in 1880 but it was felt that the wind in most areas was too uncertain and too variable. The investigation and trails were carried out with an aero motor 4.88 m diameter windmill mounted on a 21.33 m tower pump lifting water 9.84 m high at Madras. Gearing between the rotor and pump was 3⅓ to 1. Several days' observation was carried on the trail of the anemometer fixed to the windmill tower. It was proved that when the wind velocity exceeded 1.34 m/sec, a certain amount of work was done but a steady breeze of 3.23 m/sec was needed to keep the mill in continuous

motion. It was also noted that this wind pump would be capable of irrigating 10 acres when the water had to be raised 7.62 meters. Considering the capital cost of the windmill, depreciation and interest, a monthly maintenance charge of Rs.25 was found to be economical comparing the cost of 2 pair of cattle used to tap the same amount of water requires Rs. 67. So, the windmill proved to be more economical. The problem with windmills was getting them to start under light wind conditions. A strong wind force is required to overcome the friction and to keep the blades moving sufficiently to carry out work. This shows the low density of wind will stall the moment of the blades.

The commercial wind-electric plants using two- and three-bladed propellers appeared on the American market in the year 1925. The most common brands were Wincharger (200 to 1200W) and Jacobs (1.5 to 3 kW). These were used on farms to charge storage batteries which were then used to operate radios, lights, and small appliances with voltage ratings of 12, 32, or 110 volts[10]. During the 1930's the speed of the windmill was controlled by introducing a coiled governing spring to the top of the vane by varying the surface area of the blades with that of the wind. The turning of the windmill was carried at the floor level manually, using for this purpose a steel wire around the base of the mill and by pulling it as required and using band type friction brake to prevent it from rotating back. The American style windmill was introduced in the year 1930. The windmill was connected to a water pump, consisting of a cylinder, a piston and delivery valve was installed for raising the water up all the way high to a tank on top of a farm house. The discharge pressure by this pump was noticed to be around 5 kg/cm2. The gravity flow of water from high tank drove a hydraulic wheel and a dynamo which generated small current to light up 20 electrical lights. When this current was in excess, it was used to charge a storage battery for use during "no wind period". From 1930 to the late 195Os, many large prototype wind-electric generators, the largest of which was rated at 1,250 kW, were constructed and tested in several countries, including Denmark, the United Kingdom, France, Germany, the USSR and the United States of America. Although technically successful, they were not generally adopted because they were not cost competitive with large-scale fossil-fueled generation.

Russia has developed modern horizontal axis wind generator called WIME-3D in Balaklava near Yalta, USSR in 1931. This was 100kW generator mounted on a 30 meters' tower, connected to the local grid. It had a 30mtrs rotor with three blades. It

had an annual load factor of 32 percent which is close to the present-day wind machines. The world's first alternating current wind turbines appeared in the 1957, pioneered by Poul La Cour's former student Johannes Juul. This was a 24 meters' diameter wind turbine at Gedser and ran for 10years till 1967 with a three bladed, horizontal axis turbine similar to those now running for commercial wind power development. In the early 196Os, the NEYRPIC organization of France, constructed a 1,000 kW and 3,000 Volts asynchronous AC wind electric generator which supplied a maximum output of 220,000 kWh. They were heavy duty machines, many of which exist today.

The journey of this clean and abundant resource to the modern-day world has been long and arduous. Yet the Windmill is perhaps one of the few man-made devices that have evolved over the centuries to serve man kind in various ways. The evolution process has been in spurts spread over several eras. After experimenting with both the horizontal axis as well as vertical axis machines for ages, mankind seems to have settled for the horizontal axis machines because of the advantages it offers over the vertical axis machines. However even today, in the 21st century efforts are still on to see if the vertical axis machines could be suitably developed for use as generators. The modern day horizontal axis windmill is a highly-optimized version of the very first windmill in history, with all the high-tech safety features to enhance its operational life. Thanks to technological advances, wind energy is the fastest growing energy source in the world. Wind power is safe for the environment and does not produce any atmospheric emission or greenhouse gases. Since wind depends on the sun, it is a form of solar energy. As long as the sun shines, there can be wind power, making it unlimited.

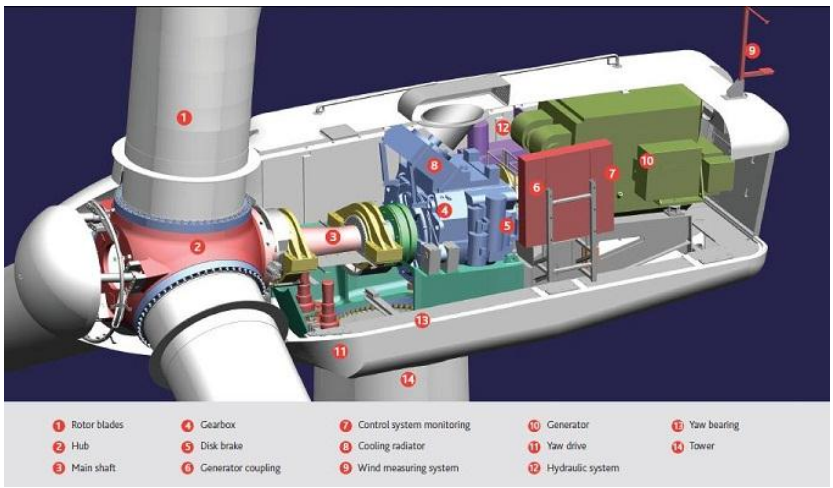

Figure 1.3: Modern Wind Mill Major Components

The windmill has undergone numerous changes and developments and what we have now all over the world is a “wind turbine” **figure 1.3**. A wind turbine is a mechanical assembly that converts the energy of wind into electricity. The three key elements of any wind turbine are the rotor, the nacelle which contains the gearbox **figure 1.4**, the generator, control and monitoring equipment and the tower. Modern wind turbines are far removed from their historic predecessors. They are highly sophisticated machines built on aerodynamic principles. These principles were developed from the aerospace industry, incorporating advanced materials and electronics. Modern wind turbines are designed to deliver energy across a range of wind speeds. It is the modern-day counterpart of a windmill constructed for the sole purpose of harvesting the wind power and transforming it into electricity. Wind turbines, like windmills, are mounted on a tower to capture the most energy. At 30 meters or more aboveground, they can take advantage of the faster and less turbulent wind. Turbines catch the wind's energy with their propeller-like blades[11]. Usually, two or three blades are mounted on a shaft to form a rotor. A blade acts much like an airplane wing. When the wind blows, a pocket of low-pressure air forms on the downwind side of the blade, this low-pressure air pocket then pulls the blade towards it, causing the rotor to turn. This is called a lift. The force of the lift is actually much stronger than the wind's force against the front side of the blade, which is called drag. The combination of lift and drag causes the rotor to spin like a propeller, and the turning shaft spins a generator to make electricity through a gear box as shown in **figure 1.4.**

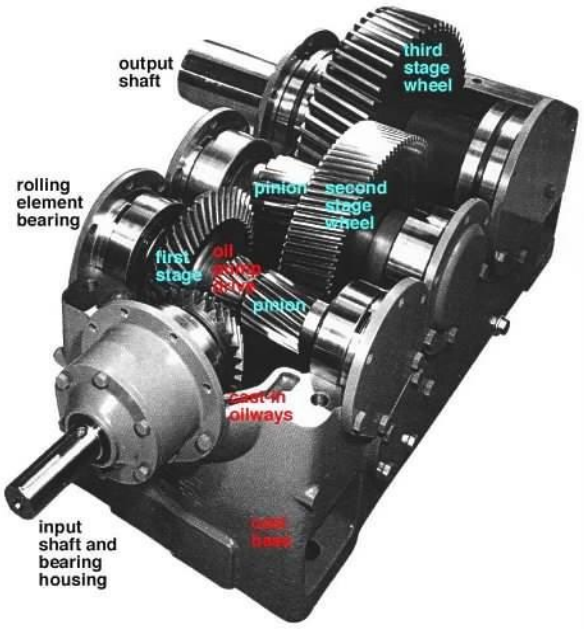

Figure 1.4: Windmill Generator Transmission Gear Box**.**

Wind turbines can be used as stand-alone applications, or they can be connected to a utility power grid or even combined with a photovoltaic (solar cell) system. For utility-scale sources of wind energy, a large number of wind turbines are usually built close together to form a wind plant. Several electricity providers today use wind plants to supply power to their customer's standalone wind turbines are typically used for water pumping or communications. However, homeowners, farmers, and ranchers in windy areas can also use wind turbines as a way to cut their electric bills. Small wind systems also have potential as distributed energy resources. Distributed energy resources refer to a variety of small, modular power-generating technologies that can be combined to improve the operation of the electricity delivery system. Modern wind turbines are designed to work most efficiently at wind speeds of about 40 kilometers per hour. The wind is often stronger and the blade speed or blade angle should automatically adjust for generating clean energy with optimum efficiency. This being carried out efficiently with the aid of computer controlled systems.

Wind power has also forayed to the shipping and marine industry. As we have witnessed in the past, just like sail boats there are now realistic ideas to integrate the wind turbine technology with offshore platforms and operate as forerunners in harvesting and producing clean boundless energy and transmitting it to the shore, thereby reducing carbon footprints and other noxious emissions which may occur in a

conventional shore based operation. The rise of this trend of setting up off shore wind farms has been conducted in various countries with varying degrees of success. Unlike the typical usage of the term "offshore" in the marine industry, offshore wind power includes inshore water areas such as lakes, fjords and sheltered coastal areas, utilizing traditional fixed-bottom wind turbine technologies, as well as deep-water areas utilizing floating wind turbines and even in a sail ship **figure 1.5.**

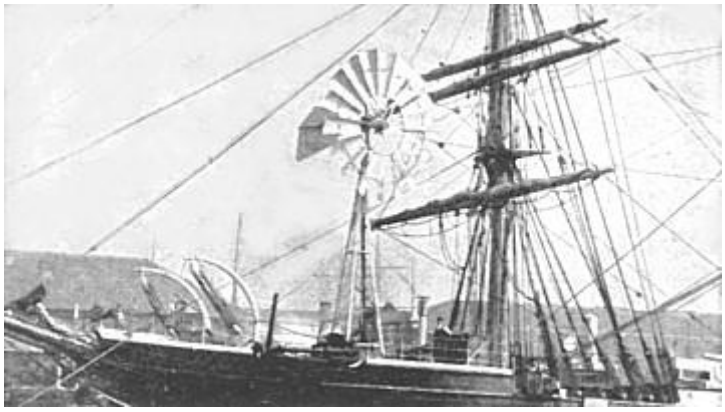

Figure 1.5: First Windmill Installed Sail Ship in 1901

The first offshore wind park, a 5 MW installation near Vindeby, Denmark, came online in 1991. By the end of 2002, there were ten offshore wind farms in operation worldwide are all in Northern Europe with a combined generating capacity of 250 MW. This represents a compound annual growth rate of 43%. This development has been fuelled largely by the presence of good wind resources in the North and Baltic Seas and by the availability of ever larger, more efficient turbines with which to tap this resource. “Mega” turbines, those that can generate 1 MW of power or greater, reached large-scale production in 1998, and today “multi-megawatt” turbines with capacities of 2.5 MW are being installed in some locations. As of 2013, the 630 MW London Array is the largest offshore wind farm in the world, with the 504 MW Greater Gabbard wind farm as the second largest, followed by the 367 MW Walney Wind Farm[12]. All are off the coast of the UK. These projects will be dwarfed by subsequent wind farms that are in the pipeline, including Dogger Bank at 9,000 MW, Norfolk Bank (7,200 MW), and Irish Sea (4,200 MW). In the end of June 2013 total European combined offshore wind energy capacity was 6,040 MW. UK installed 513.5 MW offshore wind power in the first half year of 2013.

Europe is the world leader in offshore wind power, with the first offshore wind farm being installed in Denmark in 1991. In 2013, offshore wind power contributed 6.6MW megawatt of the total 11,159MW of wind power capacity constructed that year. By January 2014, 69 offshore wind farms had been constructed in Europe with an average annual rated capacity of 482MW in 2013, and as of January 2014, the United Kingdom has by far the largest capacity of offshore wind farms with 3,681MW. Denmark is second with 1,271MW installed and Belgium is third with 571MW. Germany comes fourth with 520MW, followed by the Netherlands (247MW), Sweden (212MW), Finland (26MW), Ireland (25MW), Spain (5MW), Norway (2MW) and Portugal (2MW). By January 2014, the total installed capacity of offshore wind farms in European waters had reached 6.562MW. Projections for 2020 calculate a wind farm capacity of 40 GW in European waters which would provide 4% of the European Union's demand of electricity.

Offshore wind power can help to reduce energy imports, reduce air pollution and greenhouse gases (by displacing fossil-fuel power generation), meet renewable electricity standards, and create jobs and local business opportunities. However, according to the US Energy Information Agency, offshore wind power is the most expensive energy generating technology being considered for large scale deployment". The advantage is that the wind is much stronger off the coasts, and unlike wind over the continent, offshore breezes can be strong in the afternoon, matching the time when people are using the most electricity. Offshore turbines can also be "located close to the power-hungry populations along the coasts, eliminating the need for new overland transmission lines".

Most entities and individuals active in offshore wind power believe that prices of electricity will grow significantly, as global efforts to reduce carbon emissions come into effect. It is expected the cost per kWh to fall from 2014, and that the resource will always be more than adequate in the three areas Europe, United States and China.

The current state of offshore wind power presents economic challenges significantly greater than onshore systems - prices can be in the range of 2.5 to 3.0 million Euro/MW[13]. The turbine represents just one third to one half of costs in offshore projects today, the rest comes from infrastructure, maintenance, and oversight. Larger

turbines with increased energy capture make more economic sense due to the extra infrastructure in offshore systems. Additionally, there are currently no rigorous simulation models of external effects on offshore wind farms, such as boundary layer stability effects and wake effects. This causes difficulties in predicting performance accurately, a critical shortcoming in financing billion-dollar offshore facilities. A report from a coalition of researchers from universities, industry, and government, lays out several things needed in order to bring the costs down and make offshore wind more economically viable:

- Improving wind performance models, including how design conditions and the wind resource are influenced by the presence of other wind farms.
- Reducing the weight of turbine materials.
- Eliminating problematic gearboxes.
- Turbine load-mitigation controls and strategies.
- Turbine and rotor designs to minimize hurricane and typhoon damage.
- Economic modeling and optimization of costs of the overall wind farm system, including installation, operations, and maintenance.
- Service methodologies, remote monitoring, and diagnostics.

In 2011, a Danish energy company claimed that offshore wind turbines are not yet competitive with fossil fuels, but estimates that they will be in 15 years. Until then, state funding and pension funds will be needed. Bloomberg estimates that energy from offshore wind turbines cost 161 Euros ($208) per Mega Watt Hour. In Belfast, the harbor industry is being redeveloped as a hub for offshore wind farm construction, at a cost of about £50m. The work will create 150 jobs in construction, as well as requiring about 1metric ton of stone from local quarries, which will create hundreds more jobs. "It is the first dedicated harbor upgrade for offshore wind[14]".

As the first Offshore Wind farms move beyond their initial Warranty periods with the Turbine Equipment Manufacturer an increase in alternative Operations and Maintenance support options is evident. Alternative suppliers of spare parts are entering the market and others are offering niche products and services many of which are focused on improving the power production volumes from these large renewable energy

power plants. Offshore wind resource characteristics span a range of spatial and temporal scales and field data on external conditions. Necessary data includes water depth, currents, seabed, migration, and wave action, all of which drive mechanical and structural loading on potential turbine configurations. Other factors include marine growth, salinity, icing, and the geotechnical characteristics of the sea or lake bed. Several things are necessary in order to attain the necessary information on these subjects. Because of the previous factors, one of the biggest difficulties with offshore wind farms is the ability to predict loads. Analysis must account for the dynamic coupling between translational (surge, sway, and heave) and rotational (roll, pitch, and yaw) platform motions and turbine motions, as well as the dynamic characterization of mooring lines for floating systems. Foundations and substructures make up a large fraction of offshore wind systems, and must consider every single one of these factors.

The problem becomes complicated when the machines are required to be moved out of the nacelle for major repair work to be carried out on the machines in a workshop, thus making the operation and maintenance (OandM) cost of windmills relatively, expensive. In the case of offshore wind farms, the issue grows in complexity as the entire OandM operation needs to be carried out at sea using floating cranes, jack-up rigs, barges, *etc*. for the purpose, thus pushing the OandM costs further upwards. According to one estimate, the OandM cost of an offshore wind farm could be as high as 23% of the total installation cost of the wind farm, mainly because of the not-too-friendly marine environment. Clearly, there is a need to reduce the OandM cost of offshore wind farms in order to make it cost competitive with its onshore counterpart. One possible way of reducing the OandM costs of an offshore wind farm is to shift the major machinery which are normally installed inside the nacelle, to an enclosed space on a fixed platform located at the base of the windmill tower.

The main machinery components that require monitoring and minor repairs are the gear box and the induction generator. By shifting both these machinery components out of the nacelle to the base of the tower, the OandM costs would be considerably reduced. This is because, such a move will obviate the need for hiring floating cranes, jack-up rigs, and similar heavy equipment, which are otherwise necessary for carrying out OandM activities in the nacelle at sea. Further, shifting both the gear box and the generator would require a vertical shafting with a large diameter and the consequent

heavy weight of the shaft which again would call for suitable but expensive thrust bearings for bearing the weight of the shaft. It is therefore necessary to opt for shifting one of the two machines i.e. either the gear box or the generator to the base of the tower. As the generator is more susceptible to mal functioning in the marine environment thereby requiring constant attention, it is felt that between the generator and the gear box, preference should be given to the former for shifting to the base of the tower. Maintenance costs account for about 20% of the total cost of energy[15.] Much of this is for unscheduled, but statistically predictable, maintenance. These costs increase steadily with increased wear and tear on the turbines. Since the amount of wear and tear is roughly proportional to the amount of power produced, maintenance costs are roughly proportional to energy production. A reasonable rule of thumb for large wind farms is $0.005/kWh. Property taxes, land use, insurance, transmission, substation maintenance, and general and administrative costs together account for the remaining 10% of the total cost of energy.

The development of offshore wind turbines in recent years has made great progress and the reason was the high demand for renewable energy source. There are many countries involved in offshore wind power research in design concepts of transmission system and components for 1 to 10 MW range. It was a well-known fact that the power density of hydraulic machines is three times higher than the advanced electric motors. The majority of wind turbines currently under development rely on mechanical gearboxes to convert the low speed, high-torque rotary motion of the rotor to a high-speed rotation suitable for electricity generation. The mechanical gearboxes have the advantages of being a readily available mature technology with a significant disadvantage offering only one speed ratio, increasing failures and downtime. The recent development in wind turbine transmission system was a hydraulic driven variable speed gearbox, allowing direct connection to a synchronous generator output shaft and doing away with the electrical power converter. The designer claims 20% decrease in nacelle weight with this innovation. The system uses a hydrodynamics torque converter providing a variable speed relationship to the output shaft. It was a mechanical solution for variable speed operation, combining the use of a planetary gear system and torque converter. The torque converter was well matched to the wind turbine rotor in a hydraulic system and arranged to decouple the input/ output shafts by absorbing the input torque and damping the vibrations. The cost of this system was substantially decreased with advantages of

lowering the cost of this system was substantially decreased with advantages of lowering the nacelle weight and losses in electrical power converter. The variations in the wind stream velocity have to be accounted for by using variable speed generator system and/ or variable pitch control on the rotor blades. A hydraulics transmission system typically consists of a low-speed pump, connected directly to the shaft of the rotor, a high-pressure hydraulics circuit with power electronics, which may include a storage accumulator and a high-speed motor that drives the electrical generator. As per the theory, either the pump or the motor has variable displacement capability, thus hydraulic transmission offer an infinite speed ratio range. In practice, overall performance is optimized, if both are variable displacement machines.

In the scope of developing a wind turbine generator using a hydrostatic transmission for wind energy plants, a 1.5 MW power class wind turbine is considered. The main intension is to do away with the commonly used gearbox and the frequency converter. The idea is to utilize a slow turning radial piston pump that is directly connected to the turbine shaft to transfer the wind power into a hydraulic pressure of high intensity. This high pressure is used to power a hydrostatic motor which could convert back into mechanical power to drive the constant speed generator. The high transmission ratio that is needed in a turbine could easily be achieved by the displacement ratio of pump and motor. A hydrostatic transmission allows merging the functions of a mechanical transmission with those of a frequency converter. This means the varying, low rotation speed of the turbine is transferred into a constant rotation speed at the generator. The needed continuous variable ratio is realized by changing the displacement of the hydraulic pumps or motors. The varying wind conditions, gusts of wind and the tower structure effects the transmission with load intense torque fluctuation. The outstanding damping and control characteristics of the hydraulic drive trains can be used to conserve the drive train as well as the structure of the turbine including the electric power and at partial load of a turbine. The combination of overall efficiency and cost of the system could return the entire turbine investment in a shorter span. In this research, the efficiency at different operating points has to be weighed according to the probability of occurrence of the corresponding wind speed. According to the long lifecycle of a wind turbine the selected components should be robust, easy to maintain in order to lower the operating and maintenance costs. All possible errors to be detected at an early

stage with the stringent trail test at manufacturer's facility in order to prevent any risk of damaging the system component during the turbine operating life.

4. OFFSHORE WIND FARM PROJECTS:

Twenty-two years have passed since the world's first offshore wind farm, Vindeby (5MW) was built in Denmark[16]. Today, the world offshore wind power has an installed capacity of 4,620 MW, representing about 2% of total wind power installed capacity. More than 90% are installed off northern Europe, in the North, Baltic and Irish Seas, and the English Channel. Most of the remaining offshore wind farms are located in two demonstration projects off China's east coast. However, there were also great expectations placed for major deployment elsewhere; governments and companies in Japan, Korea, the United States, Canada, Taiwan and even India have shown enthusiasm for developing offshore wind farms in their waters. However, the best-selling wind turbines in 2002 were those with rated capacities of 750 to1500 kW with a market share of more than 50% and capacities above 1,500 kW were 30 percent. According to the future projections worldwide, a total of 80 GW offshore wind turbines could be installed by 2020 with three quarters from Europe.

The selection for an offshore wind farm site is important for determining the total energy cost and the economic viability. The objective is to evaluate the capital investment cost for an offshore wind farm to access the cost of energy. Operation and maintenance (OandM) costs constitute a sizeable share of the total annual costs of a wind turbine. The operating and maintenance costs are attracting greater attention and manufacturers are trying to lower these costs significantly. The developments of new type of modern turbines are built to minimize the service visits and lower the downtime. The installed capacity of offshore wind power has been increasing rapidly despite increased capital cost, operation and maintenance costs. The reason for the growth in offshore wind farms capacity are high wind resources, availability of space, low visual and noise impact, better understanding of the economic risks and high financial incentives.

The challenges for current offshore wind turbines must withstand the harsh marine environment. The introduction of the stringent regulation in marine environment has

resulted in the reduction of reliability levels for the offshore wind turbines. The maintenance of growing high numbers of offshore wind turbines compared to onshore wind turbines represents a major challenge in reliability, yet cost effective source of electricity. The current practices used by the offshore wind farm operators for maintenance is reactive response maintenance. This means wind turbine repairs are taken at the first opportunity or as soon as a failure is detected. This Operation and Maintenance (OandM) strategy is based on excess maintenance practice leading to high cost per unit of energy produced. The current strategy is not economical for an existing offshore wind farm due to lower number of wind turbines were in operation. Most of the present wind farms are located close to shore at shallow waters. The future offshore wind farms were planned far from shore in remote locations due to the strong winds present there. This can lead to an expensive maintenance strategy since large resources were to be acquired to meet the technical challenges.

Computers are used for a planned intervention maintenance strategy for offshore wind farms. It was also to investigate its technical and financial benefits, when compared against the current practice. Considering a planned intervention maintenance policy, the repairs and maintenance of offshore wind turbines were undertaken at predefined intervals during the operational year. The parameters collected and computerized periodically were: wind farm capacity factors, time to failure, time to repair, transportation means and distance to shore, technical and economic feasibility, failures and maintenance related cost. The research and investigation in operating maintenance of each wind turbine necessitates the use of ships and helicopters which emit carbon dioxide and maintenance strategy for existing offshore wind has proved more failure rates especially in the electrical and electronic systems.

A challenging aspect of offshore wind farms is the logistic that needs to be pre-planned according to the distance from shore and the weather conditions at the site. The transportation of maintenance technicians to the wind turbines location were performed by workboats. They were restrained by the wave height and poor accessibility resulting in long downtimes, leading to employ helicopters escalating the capital investment. The logistic and maintenance support companies for offshore wind farms were more crucial for the new projects installed in deeper water. The planning of the scheduled maintenance activities will optimize the availability of offshore wind energy power

generation. Maintenance activities at wind power systems consist typically of corrective maintenance activities and preventive maintenance including scheduled service maintenance activities. Onshore wind turbines were generally serviced and inspected twice a year. However, due to higher transportation costs and production losses, wind turbines located offshore were often serviced only once a year during the month of April or August every year.

The experiences based in Germany, Spain, the UK and Denmark has shown that the operation and maintenance costs, over the lifetime of a turbine were generally estimated to be around 1.2 to 1.5 eurocents per kWh of wind power produced. The Spanish data indicates that less than 60 per cent of this amount goes strictly to the operating and maintenance of the turbine installations, labor costs and spare parts. The remaining 40 per cent was split equally between insurance, land rental and overheads. The total operating and maintenance costs from a German wind farm from the years 1997 to 2001[17] were split into six different categories. The expenses pertaining to buying power and land rental were included in the operation and maintenance costs. For the first two years of its turbine's lifetime as a standard, manufacturer's warranty was covered. Whereas, the German's wind farm data for operation and maintenance costs was a small percentage of 2 to 3 per cent of total investment costs. This was for the first two years and was corresponding to 0.3-0.4 c € /kWh. The total operation and maintenance costs were found to be increasing gradually to 5 per cent of the total investment costs and found to be around 0.6-0.7 c €/kWh.

The offshore and onshore wind industry started operation in many countries over a decade. The investment by public, private and governments had invested heavily in wind power. The current energy policies around the world imply that there was a lot of untapped potential investment yet to come. Most existing wind farms has been built onshore but some countries have also started more investment in offshore wind, the United Kingdom in particular had aspirations for offshore wind farms a decade ago, to make up nearly one-third of its generating capacity by the year 2020. Higher and steadier offshore winds make offshore wind farms more productive.

The costs of building offshore wind farms require huge investments and with complicated supply chain management. This is due to the relatively limited number of

installation vessels and the long queues in suppliers' order books. The production volumes of equipment and spare parts are limited. Most of the countries onshore and offshore wind farms have been delayed or blocked by difficulties in getting government's permission and requirement of investments. The offshore wind farms offer the flexibility to locate closer to major ports with a little distance to shore, reducing transmission losses and avoid congestion. The physical space available for onshore turbines in most countries is either limited or expensive, but building offshore allows a significant increase in the total potential contribution. In addition, the wind energy sectors provide employment and generates the growth of the wind energy directly especially in the supply chain. Keeping this in mind it is a viable option to hire a specialized workforce to monitor and maintain such sophisticated parts of the system. These individuals must have undergone extensive training for offshore practices and are cultivated to serve the demanding technical aspects of an offshore facility. Such a workforce is already being employed onboard vessels in the shipping industry throughout the world, these individuals are seasoned to face the demands of an off-shore worksite and show prudence in working for extended periods of time away from land and society. As mentioned several times above; offshore wind farms can be a huge leap in employment sector especially in the marine industry where number of prospective seafarers are increasing day by day on a global scale, by opening the gates to such state of the art offshore facilities many brilliant and skillful minds and hands can be employed to make the most out of the huge investment being made on the wind farms. Governments can help to spur development of such platforms by revising regulations and providing financial incentives to wind power producers.

5. INTEGRATED OFFSHORE RENEWABLE ENERGY:

Offshore integrated platforms are less obtrusive than wind farms on land, as their apparent size and noise is mitigated by distance. The concept of an offshore integrated platform is a big challenge in every aspect of practicality but certain advantages must be addressed;

- Putting wind turbines away from the land ensures no noise pollution and no adverse effects to the migration of bird species and other sensitive habitats.

- The environmental benefits of wind power are felt locally, regionally and globally. Wind power can displace power from fossil fuel-powered plants, and thereby help to improve local air quality, mitigate regional effects such as acid rain, and reduce greenhouse gas emissions.
- All energy projects have fixed costs — permitting and regulatory reviews, transmission lines and another infrastructure. These costs exist whether you're putting up one turbine or one thousand. So, the bigger the project can be, the more fixed costs can be spread out, making the electricity cheaper. On land, most wind projects are constrained by surrounding areas and can only expand so far. But offshore, there is potential to build massive projects.
- Building turbines off the coast of major cities eliminates the need for thousands of miles of transmission lines to bring wind power from various regions or even countries.
- The wind is much stronger on the ocean and other water bodies, where there are no terrain features, buildings, or other obstructions to slow it down. That means that a turbine can generate more energy over the year compared to the same model in most locations on land.
- Tidal energy is environment friendly energy and doesn't produce greenhouse gases.
- Efficiency of tidal power is far greater as compared to coal, solar or wind energy. Its efficiency is around 80%.
- The energy density of tidal energy is relatively higher than other renewable energy sources.
- By integrating Wind energy and tidal energy in a single offshore facility, maximum energy can be harnessed with a one-time investment venture. This is a very effective means of unifying all the available technology to harness the boundless renewable and clean energy the oceans have always promised us.

Many so-called reliable sources of electricity suffer from unexpected outages, such as nuclear reactors and coal plants that shut down, often at short notice, for safety repairs or maintenance. Yet no one proposes to back up a coal or nuclear power plant with a similar amount of generation from another plant. The reality is that wind energy is naturally variable, but not unreliable. Power plants emit pollutants as a by-product of

power generation, but also may account for further emissions in connection with plant construction, operation, and decommissioning. For example, the mining and transport of fuel are themselves energy-intensive activities, with associated emissions and environmental impacts. Wind compares favorably to traditional power generation on this metric as well: lifecycle CO2 emissions per unit of power produced by a wind farm are about 1% of that for coal plants and about 2% of that for natural gas facilities. Traditional power generation makes use of large amounts of water for the cooling of condensers and reactors and in mining processes. Overall, the power sector returns about 98% of the water it uses back to the source. However, much of this water is returned to lakes or streams containing heavy metals (from mining) or at significantly higher temperatures, causing damage to local ecosystems. In contrast, wind power makes use of small amounts of water, primarily for cleaning rotor blades. Developers of offshore wind farms must consider the potential impacts of construction and operation of the wind turbines on sea life, including mammals, fish, plants and birds.

The exact nature of these impacts will vary widely from site to site, due to the varied conditions found at sites around the world. Experience to date gives no strong indication of severe environmental impacts, though research on this subject is still sparse. Other energy sources receive subsidies in many forms, including tax deductions, loan guarantees, and liability insurance and leasing of public lands at below market prices. Some, like the depletion allowance for oil and gas, are permanent in the tax code. Additional indirect subsidies include government money for research and development programs and policy provisions in government legislation. The largest subsidy may be that the environmental impacts from fossil fuel use are not reflected through higher costs of those energy sources. Instead, all of society must pay the price for dirty air, polluted water, climate change, dangerous fuel spills, and hazardous clean-up and disposal of fuel byproducts attributed to other energy sources.

6. ECONOMICS OF WINDMILLS:

The capital costs have halved and now average about $ 1,000/KW. They are expected to decline to $ 750-850/KW, within the next few years. Operation and maintenance (OandM) costs have dropped four-fold over the last decade to 1-1.5 c/KWh, and are

likely to drop to less than 1 c/KWh by the year 2005. Availability factors have increased from 60 percent to over 95 percent, and generation can be predicted with certainty on a long-term basis. Capacity factors now vary from 20-30 percent, and are expected to increase to 30-45 percent by the year 2005[6]. With the output from a modern turbine in a good wind area now averaging 800-1,000 KWh/year/Sq.m. of rotor swept area, the specific energy yield has nearly doubled. The annual energy output is t 2 million KWh/MW. The construction lead-time is less than six months and wind turbine installations are highly modular

New innovations such as variable speed wind turbines are expected to improve energy capture, reduce stresses and increase turbine life. The evolving wind turbine technologies employ flexible, lightweight blades and larger rotor diameters ranging up to 66 meters, improved designs, modern technological attachments; direct drive transmission; increased height up to 90 meters with aerodynamic tower design and advanced electronic controls. These technological developments will help to break the certain statistical shortcomings of the present scenarios in wind farm practices and related costs; in terms of land area the energy output is far greater than the pre-existing technologies. Average wind speeds over water are typically 20% higher than nearby locations on land. Thus, due to the cubic relationship between velocity and power, an offshore turbine can expect to capture 50% more wind energy than a similar onshore turbine. In addition, because of the lower wind shear at a given height above water compared to that same height above land, offshore turbines can be built with shorter towers and can last longer. Due to technical and economic limitations, offshore wind farms are currently limited to relatively shallow waters. In the future, wind turbines could be mounted on floating platforms, tethered to the sea floor. These turbines could be situated in deeper waters where they would be invisible from land and could take advantage of even stronger open ocean winds. Instead of feeding electricity into the grid, they could be used to produce hydrogen that would then be shipped or piped to shore. Preliminary feasibility studies suggest that facilities of this type could be built; however, further research is needed before such a wind farm can become a reality

Wind power is the world's fastest growing source of electricity. Generating capacity grew at an average annual rate of 25% between1990 and 2000, exceeding less than 2% annual growth in each of nuclear, oil and natural gas, and an average annual decline of

1% in coal consumption over this period. As of the end of 2002 total global wind generating capacity **figure 1.7** exceeds 31,000 MW, and provides about 65 billion kWh of electricity annually. This is enough to meet the needs of over 6 million average homes. Generating capacity is mainly concentrated in just five countries; Germany (36%), the U.S. (18%), Spain (14%), Denmark (10%) and India (6%) together account for 84% of the total. The experiences of other countries have provided useful information on policy initiatives, technology development institutional linkages, legislation, pricing, *etc*., which are necessary for successful programme development, particularly in developing countries. India has taken up a fairly ambitious program me, faced as it is with growing shortage of power and energy. The interest stems not only from the fact that wind power is proving to be cost-effective, but also because it is modular, has short gestation, and is environmentally benign.

The Wind Power Programme in India was initiated towards the end of the Sixth Five Year Plan, in 1983. A market oriented strategy was adopted from the very beginning of the programme. This has led to the successful commercial development of the technology. The key elements of the strategy are:-

- implementation of a comprehensive Wind Resource Assessment Programme
- induction and demonstration of state-of-the–art wind turbine equipment
- association of the State Electricity Boards and the industry from inception

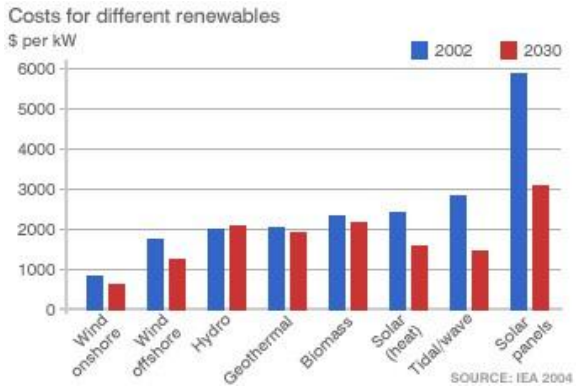

Figure 1.6: Cost of Different Renewable Energy

The broad based National Programme includes wind resource assessment activities; research and development support; implementation of demonstration projects to create

awareness and opening of new sites; involvement of utilities and industry; development of infrastructure capability and capacity for manufacture, installation, operation and maintenance of wind electric generators; and policy support. The programme aims at catalyzing commercialization of wind power generation in the country. Research and Development activities are undertaken through Research Institutions, National Laboratories, Universities and Industry, for development of cost-effective and systems for improvement in quality of power generation from wind power projects[7].

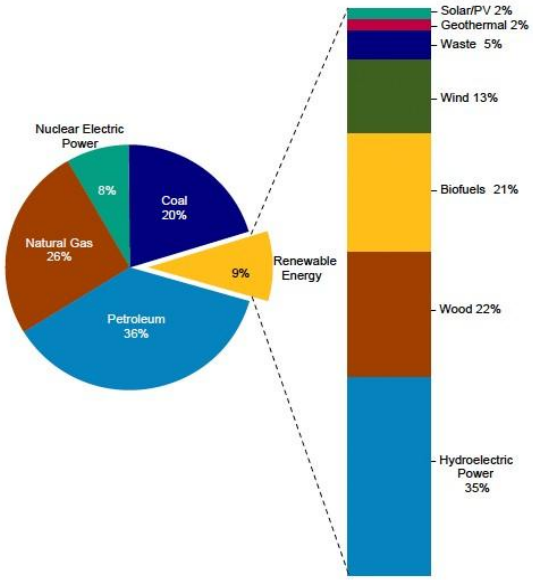

Figure1.7: Renewable Energy as Share of Total Primary Energy Consumption 2011

As wind energy is not generally cost-competitive **figure 1.6** with the other renewable sources of electricity generation, the pattern of development has been largely dependent on the supporting mechanisms provided by national governments. Wind costs have declined steadily and a typical installed cost for onshore wind farms is now around US$ 1 600/kW and for offshore around US$ 2 400-3 000/kW. The world wind energy installation steadily is growing **figure 1.8.** The corresponding electricity costs vary,

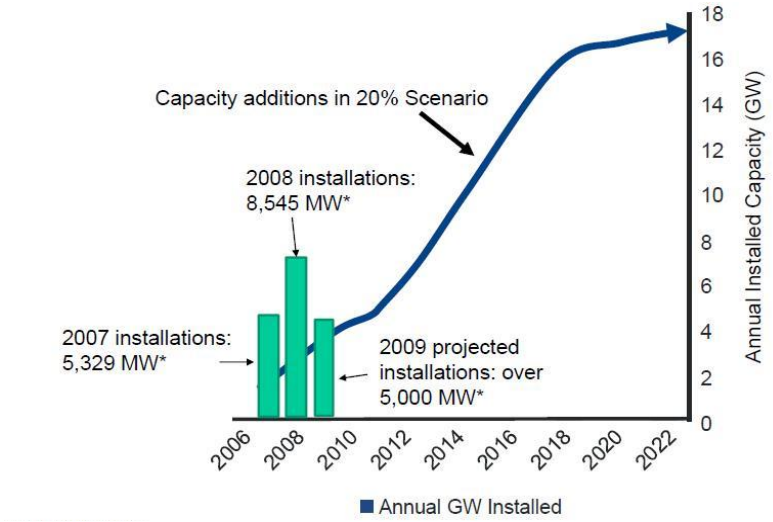

Figure 1.8: World Installation Wind Energy Growth

owing partly to wind-speed variations and partly to differing institutional frameworks. A review of future costs by the Sustainable Development Commission suggested that installed costs onshore in 2020 will lie between 55% and 92% of the 2001 level. Applying a cautious multiplier of 81% to the 2005 level suggests the 2020 level may be around US dollars 1250 per kW. A more optimistic cost projection from the Global

Wind Energy Council suggests US $1 000/kW. Offshore wind is less well developed, with worldwide capacity around 750 MW, but there are substantial plans in the pipeline. Two of the estimates in the Sustainable Development Commission report suggest installed costs by 2020 will be about 57% of any previous level.

The cost of electricity from wind has two components, the capital cost repayments along with interest and the other component is operation costs and maintenance. The latter component accounts for roughly 20% of the onshore wind generation cost and 15% of the offshore generation cost. The term "operation and maintenance" covers a wide range of cost such as land or seabed rent, insurance, servicing, spare parts, electricity purchases from the grid and administration costs. The most important aspects were to focus on the servicing, spare part components, scheduled and unscheduled maintenance. This was estimated to be anywhere from 28 percent to 40 percent of operating and maintenance cost. The estimated amounts were $40/kW/year for onshore wind and $74/kW/year for offshore wind. These costs were expected to fall around 30% for both onshore and offshore by 2030 **figure 1.6**. The reasons for this fall were due to

improved maintenance strategies, technological innovations in component material and remote sensing components.

The costs in offshore servicing for scheduled and unscheduled maintenance including replacement of parts were dropped substantially accordingly to a recent research in offshore wind farm project maintenance. The cost fell from $40/kW/year in 2008 to $25/kW/year in 2012. The average length of full-service contracts has increased from 4.5 years in 2008 to 6.9 years in 2012. The decreasing cost and increasing contract length suggest that turbine reliability is increasing. A further research shows that operating and maintenance costs increased on an average from $21/kW/year in 2008 to $31/kW/year in 2011.

7. NEW INNOVATION:

The demand for electricity in the country is ever on the rise. Simultaneously, the pressure to reduce the emission of greenhouse gases through excessive burning of fossil fuels is also on the increase. To meet these two conflicting requirements one of the possible ways out is to harness the renewable sources of energy like the wind energy in a big way. But setting up wind farms on land is also beset with problems concerning suitable land acquisition and other related issues. Hence the best alternative is to go to the sea for setting up offshore wind farms. It is a well-known fact that the wind regime at sea is far superior to the wind regime on land thus making sea the ideal alternative for locating wind farms.

According to the European Union, offshore wind farms of 5000 MW capacity will be set up along the European coastline for generating clean electricity by end 2010. India, with a 7500km coastline and coastlines surrounding Andaman and Nicobar and Lakshadweep islands is well placed to harness the abundantly available wind energy at sea. Indications are that offshore wind farms are soon going to become a reality around our coast. Because of the higher wind speeds and longer duration of wind availability, higher capacity generation of electricity is possible at sea. But the main problem connected with offshore wind farms is the high operation and maintenance (OandM) costs because of the not so friendly environmental conditions at sea. According to an estimate the OandM cost of offshore wind farm could be as high as 23% of the total

cost.

The principal reason for the high OandM cost is the need for the deployment of special jack-up type crane barges for OandM operations of windmill machinery consisting of, among other things, the induction generator and the main gear box (weighing in tons) which are located in a crammed space inside the nacelle which is at a height of 30m to 40m above the sea level. In order to make the per unit cost of electricity from offshore wind farms comparable to that from an on-shore wind farm, the OandM cost needs to be brought down. This can be achieved by redesigning the main machinery lay out in the nacelle.

Marine engineers are familiar with the deep well pumps used on tankers and product tankers. These pumps have deck mounted motors driving the pumps which are located deep inside the tanks using very long vertical shafting. Adopting similar concept the main machinery presently located inside the nacelle at the top of the tower can be moved and installed in an enclosed space on an offshore platform at the base of the windmill tower with a long shafting driving the main machinery *i.e*. the induction generator and the gear box. This arrangement will considerably reduce the OandM cost of an offshore wind farm.

Offshore wind energy projects are not entirely similar to wind energy projects onshore. There are many advantages and disadvantages exist. A majority of future wind energy projects will go offshore to harness this clean energy. Offshore wind energy projects have major advantages since powerful winds available at sea. Recent research has proved that offshore winds blow 40 percent more often offshore than onshore. The disadvantage of offshore wind energy farms are high construction costs. Offshore wind energy projects need to be powerfully built in order to withstand rough weather conditions; the costs of installing an offshore wind turbine can be compromised with the high-power generation. The power generation can be further increase by introducing contra rotating wind turbine system. Recent research has calculated that that return on investments for offshore developments can be as high as 18 percent which gives some certainty to investors in combination with incentives and other tax benefits. In fact, investments in offshore wind energy sector grew by 30% in 2010 compared to the 2009 across the world. Offshore wind energy is clean, renewable energy source that can

reduce the need for fossil fuels, and by doing so help tackle climate change and air pollution.

Offshore wind mills utilizing contra-rotating fan blades have been in for some time. This technology exists in ship's propelling system and tested on large ocean going ships in heavy seas. There were many advantages over the single bladed propeller but one most impressive advantage to the researchers was that the ship could generate additional thrust which reduced ship's engine load thereby the fuel consumption. This could be further implemented and investigated in offshore wind mills, since there is an un-interrupted wind available at sea just a few kilometers from the coast. The combination of this additional wind resource and the wind mill contra-rotating fan blades could easily lead to generate anywhere between 15 to 25 percent more electricity than the existing wind mills. This could additionally bring down the cost of the electricity generation.

The existing wind turbine technologies' in the world are single rotor systems, which provide simplicity, reliability and durability. The advancement in technology and research over the years has shown numerous improvements in design and material have enhanced energy conversion efficiency of these single rotor systems into dual system. The blades have better aerodynamic characteristics and the complicated sun gears with reduced noise have better torque transmission efficiency. The alternators have been developed to with stand jerk load during gust wind or gale storms along with higher electrical efficiency. Even with many improvements, single rotor systems are able to transfer only a small amount of the total wind energy into useful electrical energy.

A friend of Betz who is sometimes described as the "father of modern wind energy collection theory", Mr. Hans Honneff penned a book on the use of contra-rotating wind turbine that used two rotors. This is one fan disc behind the other driving two halves of an electrical generator terming it as "Wind Turbine". The concept was for very large wind turbines with three fan discs to a tower and each measuring 150meteres diameter, generating a total of 21 MW. Albert Betz confirmed that the maximum energy conversion efficiency is about 59% when the axial steam of wind speed is reduced by two third across a single rotor disc blades. Similarly, in practice most wind turbines convert less than forty percent of the wind energy into electrical energy. Therefore,

sixty percent of the potential wind energy escaped or wasted without being harnessed. The main reason may be that a single rotor cannot be designed to achieve large changes in velocity. The concept is similar to the pressure velocity compounding steam turbine, where the steam energy is optimized and similar concept could even be used in the wind turbine. This concept of velocity compounding directed to multiple rotors in tandem and could be applicable to wind turbines.

In blade and turbine engineering the energy collected by two or more rotors in series is coupled. This method was confirmed for storing wind energy experimenting with numerous model trials in 1976 by Simon Bromet (unpublished manuscript). The fact was published recently following some trials by the California Energy Commission but using a conventional alternator. An attempt to test the effect of contra-rotating was made by Trimble Windmills in the period 1976-82. A small (5kW rated at 10 m/sec wind speed) machine was built and a number of them were sold to farmers for heating in isolated places simultaneously with domestic lighting. The machines had a contra-rotating permanent magnet alternator with sail wing blades attached to each half. The current collection was through slip rings, while the full coupling effect proved by Mr. Bromet was not achieved. This probably due to the two sets of blades being too close together with each delivering a Cp of 0.37. There is further research and development required in blade spacing.

The contra-rotation electricity generation does not require a gearbox, thus saving costs and energy loss. Hanns Honneff placed his “generating ring” almost at the tip of the rotors, where the angular speed is greatest. A theoretical study of contra-rotating electrical machines is known of Mr. Hans Honneff envisaged very large rotors on barge mounted, with the energy collection at the base of the rotors rather than all-round the edge. A similar proposal for a large single rotor made by Mullett in 1956 is quoted by Bockris.

Possibilities exist in the contra-rotating wind turbine system which, could be investigated for power production and performance characteristics. The contra-rotating wind turbine system is a patented technology and has large potential for further research to augment the capacity. The intention to study this project is to determine the feasibility of improving wind energy using contra rotating wind turbine system efficiently. The

research scope exists into enhancing the performance of the contra-rotating system and to achieve higher wind energy efficiency, in order to reduce the energy cost (Rs/kWh) by thirty percent. There is also scope in the development of the contra-rotating dual rotor system design in order, to lower the cost of the wind turbine to allow economic transition with increased capacity early.

The scope of research exists in design solutions to the problem of transmitting the net torque generated by a contra-rotating turbine system to an existing electrical power-generating unit. Successful commercialization of contra-rotating wind turbine systems could reduce the cost of electricity and to promote increased power production. This could stimulate business and employment opportunities in wind turbine industries worldwide. The benefits would give more wind-generated power per acre of land on land and sea by using common facilities such as floating platforms, support towers and possibly generators. There is a scope in further research into the economics of wind turbines specially to assess cost effectiveness of the counter-rotating design versus single rotor system and power production performance with grid connected power loading.

A pilot project was part of the research portfolio of the California Energy Commission. The study of the contra rotor wind turbine system was funded and incorporated by Appa Renewable Energy Systems, California, USA. The performance of a contra-rotating wind turbine equipped with two Nordtank 500 kW turbines was studied. The main result of the study was to carry performance test at high wind speeds and found to be satisfactory. It was suggested to reduce the rotational speed of the contra rotating wind turbine, in order to capture more energy at low speeds. The performance of the contra rotating wind turbine can be improved if it is operated for low wind speeds at the tip-speed-ratio where a maximum Cp to be obtained. The modern wind turbine has a high-power coefficient (> 0.5). The efficiency of a contra rotating wind turbine quipped with two modern wind turbine rotors could be considered. The overall annual energy production of the new contra rotating wind turbine system would increase considerably.

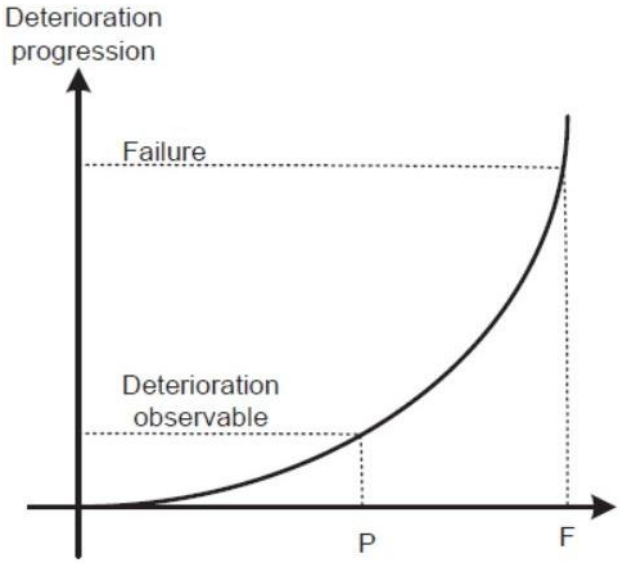

Figure 1.9: Deterioration Observation Curve Concept

The research in contra- rotating windmills is not limited but also an intensive research in offshore wind mill lubricating oil condition monitoring system is required, since it is the main source for generating electricity. The underground ocean laying electric cables for offshore wind farms and drinking water pipelines ashore is a proven technology. A similar system could envisage for renewing system lubricating oil or to remotely top up the system. This could further lead to reduce OandM cost. Thus, the conclusion chapter could be useful for further research towards optimizing offshore wind mills and the data could be computed and analysed using MATLAB –Simulink.

8. MAINTENANCE STRATEGY CONCEPTS:

Maintenance is defined as the combination of all technical and corresponding administrative actions, intended to retain a component or restore it to a state in which it can perform its required function. A common classification of maintenance strategies was based on the standard wind farm procedures. Corrective maintenance (CM) was carried out after a failure has occurred and was intended to restore an item to a state, in which it could perform its required function. Preventive maintenance (PM) was carried out at predetermined intervals or corresponding to a prescribed criteria and was intended to reduce, the probability of failure or performance degradation of a component. There were two main approaches for preventive maintenance strategies:

Time Based Maintenance (TBM) was a preventive maintenance was carried out in accordance with established intervals of time but without previous conditional investigation. Time Based Maintenance was suitable for failures that were age-related and for which the probability of failure could be established. Condition Based Maintenance (CBM) was a preventive maintenance based on performance and / or parameter monitoring. Condition Based Maintenance consists of all maintenance strategies involving inspections or permanently installed Condition Monitoring Systems (CMS) to decide on the maintenance actions. Inspection could involve the use of man power, monitoring techniques or function tests. Condition Based Maintenance could be used for non-age related failures. This activity could be used if the ability to detect or diagnose the degradation in time, in a cost-effective manner.

The ability to detect the deterioration in time was linked to the concept of the P-F curve **figure 1.9,** represents a typical deterioration of the condition of a component in time. The point of time is represented by letter P, indicating a potential failure. The point of time is represented by letter F, indicating deterioration leading to a failure. A Condition Based Maintenance strategy was effective, if it could identify the deterioration well in advance.

9. CONCLUSION:

Though the challenges are many the future seems promising and not too distant a dream. If countries and organizations all over the world join hands and set apart differences and work towards a common goal of realizing the need for an integrated off shore platform for harnessing renewable energy, then such a day will come where peaceful coexistence and economic prosperity prevails. In addition, the following points are to be implemented on a fast track to save the earth from the fast-growing global warming and environmental pollution: -

1) In order to lower the pollution from the ships and the industry, all types of renewable energy resources are to be deployed.

2) Lands for onshore installation are exhausted / expensive, alternate to this is to go to sea for tapping the wind / tidal / wave and solar energies on an offshore platform.

3) The operating and maintenance cost have to be brought down. This can happen if numerous offshore platforms are deployed to generate more power.

4) Wind mill components from inside atop of the nacelle can be re-located onto the tower base of an offshore platform driven by hydraulic pumps for power generation.

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5. INNOVATION – TECHNOLOGY – REGULATORY REGIME – GREEN SHIPPING GLOBAL DIVERSITY OF EXPECTATIONS - HOW CAN TRADE MANAGE THE CONTRADICTIONS?

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Abstract

The shipping sector faces unprecedented challenges from regulatory regimes to meet ambitious and zealous environmental objectives. Given its global scale, there is a need to bring in a voice of reason on what is achievable and how to go about it from those that will eventually be tasked to actually implement these goals. The challenge is therefore to innovate to bring in better efficiency. Such innovation promises much needed reduction in industry's carbon footprints creating a convergence of environmental goals with commercial incentives.

The question will be whether the investment in such innovation be worth the combined savings in fuel and environmental costs. And how can the industry manage these global diversities of expectations and contradictions?

Key Words: Regulatory Compliance, Green Shipping, Technology, İnnovation.

UNDERSTANDING THE NEXUS:

1. INNOVATION AND TECHNOLOGY ADVANCEMENT:

Technology stems from the acquisition of new knowledge and is as a result of scientific enquiry. Technological change today is among the most prominent of all things that can change the rules of competition. The companies that apply competitive strategies like differentiation through technology usage, market focus and competitor analysis are more likely to be high performers (Porter, 2004; Panayides 2003).

Jenssen (2003) affirms that in the face of aggressive competition from low-cost economies in Asia, it is imperative for high-cost countries like Norway, to build their competitiveness in most industries, including shipping, on innovation and knowledge-intensive products to create distinctive competitive advantages that are difficult to imitate.

Lorange (2001) when speaking of strategic re-thinking in shipping companies cites many examples of Nordic owned tonnage companies that embark on technological innovations as they move from pioneering a concept to rapid expansion and there-by be world leaders.

The MARSIKT (2000) is a research and development project funded by the Norwegian Ship Owners Association. Its main objective is "To improve the competitiveness of the Norwegian maritime sector by developing new technology and new forms of organisation, focusing on shipping companies' commercial and technical operations."

Innovation hence, is an effort to create something new, to create differentiation through technology, and is thus an '*economic objective'*. The slow and selective diffusion of technological innovations then becomes a source of competitive advantage over a strategically significant time span. The advantage obtained by being an early adopter is cumulative because early adopters add to their advantage by making additional adoptions before many competitors have made their first adoption of the new technology.

2. TECHNOLOGY ADVANCEMENT, SAFETY AND ENVIRONMENT PROTECTION:

Shipping is a high asset value industry. Failure of either a technological or a human kind, causing a single marine accident, carries the risk to cause damage to property, loss of life and pollution of the environment on a scale that is unlikely to be equalled in any other sector of industry and almost certainly in no other mode of cargo transport.

It was originally considered that the optimum ship was simply the most profitable one, and that in the long run, competitive markets would ensure that this would be that with the lowest costs. However, in maritime transport, as elsewhere, there has been an increasing concern with safety and the protection of the environment. Following several well publicised disasters, this economic approach has been extended to maritime safety and environment protection in general, which has to be factored in beyond the lowest cost principle and as value-added services.

A firm creates value for its customers and returns for itself by offering better perceived quality in any differentiated feature for which customers are willing to pay a premium (Hambrick and Fredrickson, 2001). Value creation is the *raison d'être* for firms (Woiceshyn and Falkenberg, 2008); and whenever technology can be shown to give greatly improved safety and environmental protection at an affordable cost there will be inevitable pressure for its introduction.

While acknowledging the inevitability of technological advancements, its uptake in shipping is seen to be driven predominantly by (a) new regulations in the aid of enhancement of safety and environment protection and (b) the need to be competitive. However, the economic logic of low costs underpins every technology change decision, be it a reactive compliance ideology or a more proactive stance of value creation in enabling vessel operation to be more efficient.

At the same time, there are expectations that the industry will be ever greener, ever safer and ever more efficient and it is the role of innovative shipping company to satisfy them all and at the same time to remain economically viable. As Peter Drucker (2007) the famous management guru puts it, "The first duty of business is to survive and the

guiding principle of business economics is not the maximisation of profits, it is the avoidance of loss."

3. INDUSTRY APPREHENSIONS:

However, there are serious apprehensions within the industry! For example, some noting from the author's earlier research (Bhardwaj, 2013) on similar topics reveal,

> Progress however gets hampered by the question of 'who should pay' for these investments and there was a need to provide evidence of payback from innovations. Perhaps, those offering devices or improvements to efficiency might consider financing these on a 'no cure, no pay' basis. (A)

> Regulatory changes were still not always clear and industry generally is anxious not to be taken down 'a blind alley' on a range of regulation based technical changes that owners must be taking on-board. For example, where is there any proper impact assessment data to justify the regulation demand? (B)

What seemed to emerge from research findings was that while the ship's staff to an extent welcomed the considered increase in safety and environment protection, probably because it concerned their own selves more, the companies were seen to be reticent about its need and cost implications, *even apprehending safety used as ploy to push in more technology*.

The interviews therefore indicated that technology integration was largely because of a reactive stance to regulatory or customers' directive compliance rather than a proactive initiative that often gets marred in the myopic view on cost-benefit analysis by the decision makers.

There was thus a need for a responsible compliance regime that would assess all risks and its cost-effectiveness prior mandating requirements.

4. REGULATION DRIVEN COMPLIANCE CULTURE – REGULATION OF TECHNOLOGY:

There is an established leading theory of regulatory politics, that concentrated industry groups could capture regulation and bend it to serve their own interests (Wiener, 2004). These suppliers put up a barrage of prominent eye-catching graphics extolling the virtues of technology and it takes a while to scratch beneath the surface to discover a slightly less enthusiastic take on the matterwith self-serving objectives.

In a global scenario like that of shipping, one fall-out is that if the technology move is costly, the economically advanced countries that regulate first, take the lead in selling new technologies to countries that follow. It is often reported that it is this club of economically advanced countries and the body of technology suppliers through their country representatives at the IMO, dominate the proceedings in pushing the technology agenda. Often this is done behind the shield of safety enhancement and green shipping that finds appeal and ready buy-in.

In the global context, the policy making is seen to get politicised with a self-serving agenda of the constituent members of policy making bodies belaying the notions of any common good for the industry. The issue, particularly in safety-critical industry like shipping becomes that the dividing line between *social* regulation on health, safety, environment and *economic* regulation of technology gets blurred when technology is passed off as enhancing safety. The regulation of technology follows the leading theory of interests lobbying to shield business profits. The theory that it is the subgroups of the industry that drive technology in the garb of social regulation on safety, health and environment, do so to serve their own parochial advantage by raising rival firms' cost, endures (Wiener, 2004).

Stiglitz (2006) has argued that the developed world has carefully crafted laws which give innovators the exclusive right to their innovations and the profits that flow from them. In cases like pharmaceutical industries the costs go beyond money when access is denied to affordable lifesaving drugs and highly profiteering companies researching on lifestyle drugs rather than lifesaving drugs simply because the poor cannot afford to pay for the drugs. RandD intensity defined as the ratio of RandD expenditure to GDP is an important determinant of innovation. This is in excess of 4% in OECD countries

with USA alone accounting for 41% in the OECD area gross domestic expenditure in 2009 (Dumont et al. 2011, OECD, 2011).

5. MANAGING CONTRADICTIONS:

Having clarified the nexus of Innovation-Technology-Regulatory Regime-Green shipping, one can now move to the issue of managing the contradictions.

Since this industry is driven by regulatory regimes, it thus calls for exercising care and caution in framing regulations. Indeed, there can be more imaginative ways of rulemaking. *There is a need to move from Regulation of Technology to Technology of Regulation.*

Different regulatory mechanisms do exist, like performance standards, management system requirements, taxes and incentives, tradable allowances, information disclosure, *etc*. that can affect differently and influence consequences. Thus, for example, a technology requirement approach may turn out to be less effective at stimulating technology change than a performance standard or tradable allowance as in carbon emissions. If say scrubbers were mandated for washing off the sulphur-di-oxide emissions prior to its release to atmosphere, firms would have lesser incentives to invent better methods. The Goal Based Standards (GBS) approach now being adopted by the IMO is one such example where the IMO would state what has to be achieved, leaving classification societies and ship designers the freedom to decide how best to employ their professional skills to meet the requirements.

Another major development is the *regulatory impact assessments* to forecast the impacts of new regulations before their enactment through Formal Safety Assessment (FSA) thus encouraging regulatory innovation in testing alternate designs of technology and regulation and selecting the best. The IMO is seen to be adopting this of late that promises enabling balance between various technical and operation issues, including the human element and between safety and costs. However, as yet there are few empirical investigations of actual impacts sighted.

A strategy much used particularly in the area of environment protection is *technology forcing*, where the regulator specifies a standard that cannot be met with existing technology, or at least not at an acceptable cost (Gerard and Lave, 2005). The intent is to elicit advances in technology and force firms to invest in RandD, whereas firms want regulators to delay or relax standards. The outcome of such conflicts then determines the rate of technological innovation and its diffusion. This option may enjoy more political support than others like gasoline taxes. The IMO in its efforts towards mandatory energy efficiency measures for international shipping is seen to embrace this approach with its Energy Efficiency Design Index (EEDI) for new ships along with its set of guidelines. A more tempered approach is with the Ship Energy Efficiency Management Plan (SEEMP) that uses the *management system* approach and provides a mechanism for operators to improve their energy efficiency of ships over time.

Social rules, practices and standards of accountability characterise an industry at any given time and have as significant an impact on safety and environmental protection as traditional command-and-control regulations by the State that rest on tacit assumption that government regulations are the only source of accountability. Self-regulation is in fact a notable trait of professional organisations.

In the maritime industry, it was the insurance sector that created the classification societies as a way to reduce uncertainty and to manage marine risk. Many classification societies have now assumed statutory functions on behalf of flag states thus blurring the distinction between intermediary institution and a system of self-governance. Abrasions in as much as lowering of standards have been noticed though, because classification societies are not monopolistic and have competitive practices, a trend noted in times of sluggish demand for ships when ship owners in a bid to cut operating expenses engaged in ‘class hopping’. Also, a case in point was the use of high tensile steel and poor design produced by shipyards that led to a number of bulk carrier losses in the mid-80s (ABS, 1992; Intercargo, 1995). However, it is notable that the marine system of governance has displayed a surprising ability to address its own institutional failures in a timely manner. Marine insurers being institutional counterparts to classification societies, could force ship owners to be registered with reputable classification societies to obtain adequate insurance and a superimposed system of self-governance in IACS came to be exercised (Furger, 1997). IACS adopted developing

Common Structural Rules (CSR) to remove variations and achieve consistency, and further to be incompliance with IMO's Goal Based Standards. This changes the *century-long practice* of independent classification rule making and also marks a significant step taken by IMO, as it has never been involved in the past in the detailed convention requirements for the structures of the ships (Kim, 2005).The IACS press release of 2nd July 2012 confirms the placing of draft IACS harmonised CSR on its website and states that the harmonisation project is also set out to achieve full compliance with the IMO's GBS which comes into force in the middle of 2016 (IACS, 2012).

The regulatory framework in the shipping industry in practice extends much beyond the IMO and flag states. The fragmentation of the industry and the range of organisations and decision – making structures involved can be illustrated by the typical example of a German owned ship flying a Panama flag, manned by Indian officers and Filipino crew carrying Saudi crude oil to Japan. The ship may be classed with the Norwegian classification society, have her hull and machinery insurance placed in London and her cargo insurance in Paris.

With such a multitude of stakeholders of different nationalities, the regulation of the shipping industry is inevitably complex. There are then intra- and inter-organisational relationships within and among the various members of the global maritime community. These intermediary organisations also interact to form both systems of self-governance and private systems of governance. Examples are the International Association of Classification Societies (IACS), International Association of Independent Tanker Owners (INTERTANKO), International Association of Dry Cargo Ship Owners (INTERCARGO), *etc*. Porter (1995) points out that INTERTANKO is a good example of *self-governance* where membership is subject to a number of requirements, and members found not in compliance may be expelled from the association. Classification Societies, Marine Insurance companies and Protection and Indemnity (PandI Clubs, who are concerned with safety of crew and integrity of cargo), also have the ability to set standards of accountability among ship owners and ship operators (Fueger, 1997).

In summary, in a global shipping environment with fragmented structures of organisation and split incentives for number of stakeholders in a venture, if regulation,

as it strongly emerges, is to be the basic means of driving technology uptake, then it is calls for far more caution and imagination in its making and its implementation.

6. POLICY RECOMMENDATIONS:

A responsible and risk-assessed regime of regulatory and customer requirements is thus seen to be the key driver in enhanced technology integration in modern ship management practices. If the potentials are there as seen to be, then it needs the attention of the policy makers' like the IMO, Maritime Administrations, Classification societies and industry organisations like Oil Companies International Marine Forum (OCIMF) and Society of International Gas Tankers and Terminal Operators (SIGTTO).What is fundamentally lacking is *policy entrepreneurship* that will encourage policy innovators who will develop and test new forms and approaches to regulation for greater effectiveness, less caustic side-effects, even less cost and promote other desirable attributes. Regulatory design should be about consequences – what works, how much, with what costs and side effects compared to the available alternatives. The influence of regulation on technology is complex and as Wiener (2004) puts it, depends on the *"technology of regulation"* that aids governance - the actual design of instruments of enforcement.

There is thus a need for the rules to become more performance based with defined outcomes, rather than set technological solutions in a prescriptive format. This would also allay the view that it tacitly supports influence of commercial players in the adaptation of technology. Prescriptive regulations tend to be a distillation of experience and as such become less and less relevant over time. It is the innovator that is best placed to ensure the safety of design rather than the regulator. Care should also be taken to see that the additional regulations do not add to the administrative burdens on the ships' crew and calls for a user-centric approach in even designing of regulation in as much as the design and implementation of technology integrated practices. The user-centric approach puts employees in the centre where they play an active role in identifying potentials for rethinking of business regulation and how burdensome experiences can be reduced (DMA, 2011).

Lastly, all the gaps stem from a lack of synergy between research and practice that results in the practitioners insufficiently aware of relevant research and at the same time

research tends to be not sufficiently informed by the body of knowledge gained from practices. In the shipping domain, particularly, there is a need to develop methods and tools to more effectively leverage the knowledge and insights gained from practice and improve the cross-dialogue between research and practice.

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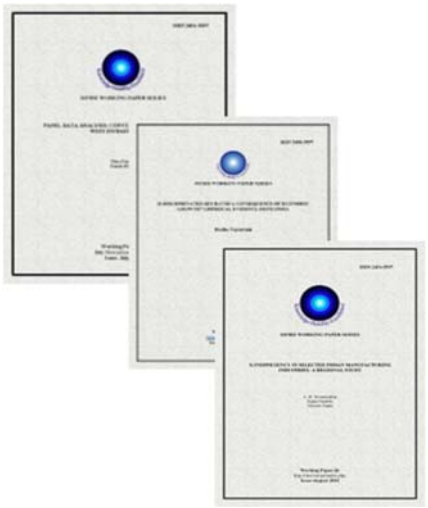

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