Original Article

An Impact Analysis of Marpol Annex 1, Legislative Developments on Oil Spills From Tankers

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Abstract

Gradual growing trend of marine transportation of oil inevitably results in accidental oil spills. The safety and preventive measures introduced internationally and nationally resulted in the reduction in the number of spills and amount of accidental releases to the sea in the past decades. However, recent incidents show that marine oil spills are unpredictable events that may cause significant damage to the environment, flora- fauna and coastal communities. The statistics of ITOPF- International Tanker Owners Pollution Federation and UNCTD- United Nations Conference on Trade and Development reports shows the percentage of tanker incidents which has occurred per year. Above databases are used for various studies in Shipping and found consistent and cross checked and continually updated. This paper analyzes the implementation of maritime environmental legislative Marpol regulation Annex 1 and impact on oil spills by tankers. The paper will focus on Marine oil spills worldwide over a 50 year period from 1970 to 2020 and discuss the relationship between Marpol Annex 1 versus Tanker oil spills.

Keywords: Marpol convention, Marpol Annex 1, Oil spills, double hull, Tanker Management and Self-Assessment programme-TMSA, International Tankers Oil Pollution Federation- ITOPF.

Introduction

Maritime transportation is the major form of international trade. Population growth, increasing standard of living, rapid industrialization, road congestion, and the development of technology, all of these contribute to the continuing growth in maritime transportation. Since 1980 the total international seaborne trade has increased by 69% in terms of weight. Tanker cargo has increased modestly as oil being the main source of energy provider for the world. Tankers carry nearly 2.0 billion metric tons of oil each year. With evolution of the Tanker fleet and transportation by sea, there is serious risk of oil pollution, both operational as well as accidental. The oil spills may cause serious harm to marine environment and can also cause heavy economic impacts to coastal states. [2].

In this study, key focus is to discuss how far world has succeeded achieving the goal of minimizing oil spills by analyzing the Marpol convention Annex 1 developments on oil spills by tankers during last 5 decades.

Main objective of the Study is to analyze maritime environmental legislative developments of Marpol Annex 1 on number of oil spills by tankers and oil spill volume.

Literature Review

The world's first oil tankers appeared in the nineteenth century and carried kerosene for lighting, but the development of the motor car fueled demand for oil. At the time of Second World War, the standard oil tanker was the T2 - 16400 tons deadweight, but tankers grew swiftly in size from the 1950's onwards. The first 100,000-tonne oil tanker was delivered in 1959 to cover the route from the Middle East to Western Europe round the cape of Good Hope. Shippers saw economies of scale in larger tankers and by the middle of 1960's, tankers of 200,000 tons weight, the Very Large Crude Carrier or VLCC had been ordered. [2]

The prospective for oil to pollute the marine environment was recognized by the International Convention for the Prevention of Pollution of the Sea by Oil in 1954 (OILPOL 1954). The Conference adopting by the United Kingdom government, and the Convention provided for positive functions to be undertaken by IMO when it came into being. The Convention established by International Maritime Organization has entered into force in 1958 just a few months before the OILPOL convention entered to force. So, International Maritime Organization effectively managed OILPOL from the start, firstly through its Maritime Safety Committee. [2]

MT Torrey Canyon built in 1967 ran aground when entering the English Channel and spilled her entire cargo of 120,000 tons of oil into the sea. T incident raised questions about procedures in place to prevent oil pollution from ships and also uncovered deficiencies in the present system for providing compensation following accidents at sea. It was fundamentally this incident that set-in motion the series of events that finally led to the adoption of MARPOL. [4]

Due to the enormous growth in the maritime transport of oil and the size of tankers, the increased amount of oil being carried at sea was a growing concerned for the world. Many countries feel that the 1954 OILPOL Convention was not adequate, despite the various amendments which had been adopted. In 1969 the International Maritime Organization decided to convene an international conference to adopt a completely new convention, which incorporate the regulations contained in 1954 OILPOL. At the same time, the Sub-Committee on Oil Pollution was renamed as the Sub Committee on Marine Pollution, to widen its scope, and this became the Marine Environment Protection Committee (MEPC), which was in time given the same standing as the Maritime Safety Committee, to deal with all matters relating to maritime pollution. The conference was set in October to November 1973, and introductory meetings began in 1970. [5]

The 1973 conference incorporated much of 1954 OILPOL and its amendments into Annex I covering oil, while other annexes covered chemicals, harmful substances conceded in packaged form, sewage and garbage. Annex I lengthened and improved on 1954 OILPOL in several ways. It specified requirements for constant monitoring of oily water discharges and incorporated the requirement for Governments to provide shore reception and treatment facilities at oil dealing terminals and ports. Also established many Special Areas in which stricter discharge standards were applicable, including the Mediterranean, Red Sea and Gulf and Baltic Sea areas. As it turned out, there was slow movement at ratifying the Convention and the non-ratification of MARPOL became a main concern. The same time, a series of accidents involved with tankers in 1976-1977, mostly at or near United States

waters and including the grounding of the MT Argo Merchant, led to demands for more rigorous action to control accidental and operational oil pollution. The MT Argo Merchant ran aground off Massachusetts on December 1976. It was a small tanker which carried 27,000 tons of oil, but effected huge public concern as the oil slick endangered New England resorts and Georges Bank fishing ground sea areas. [2]

The MARPOL Convention was adopted on 1973 at International Maritime Organization. The Protocol of 1978 was adopted in response to a spate of tanker accidents in 1976-1977. The 1973 MARPOL Convention had not however entered into force, the 1978 MARPOL Protocol absorbed the parent Convention and the combined instrument entered into force in 1983. [5]

IPIECA- (International Petroleum Industry Environmental Conservation Association) is the global oil and gas industries association for environmental and social issues. IPIECA was formed in 1974 which subsequently initiated the United Nations Environment Programme (UNEP). IPIECA is the global association connecting both the upstream and downstream oil and gas industry on environmental and social issues. IPIECA's membership covers more than half of the world's oil production. IPIECA is the industry's main channel of communication with the United Nations. As per their annual report 2020, while the amount of oil produced and transported has amplified as the world's economy has expanded, the general number of large spills has significantly decreased. This reduction is mainly due to efforts by companies operating throughout the oil supply chain to develop more efficient preventive measures. [6]

There are lot of published literature that explains or preaches oil spills and trend but there is relative lack of empirical studies examining oil spills by Tankers and environmental legislative developments. This study focuses on analysis of maritime environmental legislative regulations Marpol Annex 1, and developments of tankers to minimize oil spills.

Oil spills can appreciably affect the environment and surrounding of local communities. Even with advanced safety measures in place, the risk of an oil spill still remains. Since new oil resources in remote and sensitive environments are developed, there are new risks and challenges to be attended.

Research Methodology

The study focuses on secondary data of oil spill statistics 1970 to 2020 and convenience sampling method used in the study. Oil spill data used in this study are from the Environmental Research Consulting Spill Databases which collected data from a large number of sources and databases, including International Maritime Organization, International Tanker Owners Pollution Federation-ITOPF, United Nations Conference on Trade and Development- UNCTD statistics and other national and regional environmental agencies. On a continuously updated basis, the data are crosschecked and corrected with current information and new information on past events. Above Data gives more realistic picture on Tanker oil spills and they are reliable and approved by IMO.

A Least Significant Different test (LSD test) was utilized to analysis the relationship between Marpol Annex 1 legislative developments and Marine oil spills. MS Excel and SPSS software

were utilized for the purpose of analysis of the collected data.

Limitation of the study:

I. Less than 7 tones oil spills not taken into consideration as most of them are not reported and
unable to get correct figures.
II. Oil products as cargo transferring taken into considerations and tankers and non-tanker vessels'
bunker oil not taken in to account.
III. Study analyses is limited to Maritime Environmental Legislative developments of Marpol
convention Annex 1.

Discussion

The International Convention for the Prevention of Pollution from Ships (MARPOL) is that the main international convention aimed toward the prevention of pollution from ships caused by operational or accidental causes. Marpol consists of 6 annexes. In this study, main focus is on Annex 1 and how its implementation helped to minimize oil spills in Marine Environment.

Annexes	Date of Entry into force
Annex I – Regulations for the Prevention of Pollution by Oil	2 October 1983
Annex II – Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk	2 October 1983
Annex III – Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form	1 July 1992
Annex IV – Prevention of Pollution by Sewage from Ships	27 September 2003
Annex V – Prevention of Pollution by Garbage	31 December 1988
Annex VI – Prevention of Air Pollution from Ships	19 May 2005

Table 1 – Marpol Annexes , Constructed by Author
Source : https://www.researchgate.net/Marpol

Marpol Annex I (Oil) came into force on 02nd October 1983 and contains conditions for discharge of mixtures containing oil and additionally needs applicable to the development and instrumentation of tankers larger than 150GRT and other ships larger than 400GRT. This Annex relies on the principle that oil and water is not easy to separate. It contains requirements relating to the operation, construction and instrumentation of ships. The operational needs stipulate the conditions that ships could discharge water/oil mixtures into the ocean. The different construction needs are such to minimize the probabilities of oil freight tank penetration within the event of accident, i.e. double hull construction and protecting locations with segregated ballast tanks. Needs for minimizing oil pollution from oil tankers within the event of bottom damages penetrating the freight oil tanks. [2]

The development and instrumentation are needed to suit the discharge conditions. Other construction needs are such to reduce the probabilities of oil leaks in case of accident i.e., double hull construction and protecting location of segregated ballast tanks. Requirements for minimizing oil pollution from oil tankers within the event of bottom damage are enclosed as below. [7]

A. Control of Operational Discharge of Oil **(**Discharges outside special areas)

Any discharge to the sea of oil or oily blends from the cargo area of an oil tanker, shall be proscribed except where all the following conditions are satisfied:

a. The tanker is not in a dedicated special area;
b. The tanker is over 50 nautical miles from the closest territorial land.
c. The tanker is making way, enroute;
d. The rapid rate of discharge of oil content does not exceed 30 liters per nautical mile;
e. the total quantity of oil discharged into the sea does not exceed for tankers delivered on or

before 31st December 1979, as defined in regulation 1.28.1, 1/15,000 of the total quantity of the particular cargo of which the residue formed a part, and for tankers delivered after 31st December 1979, as defined in regulation 1.28.2, 1/30,000 of the total quantity of the particular cargo of which the residue formed a part; and

f. the tanker possesses operational an oil discharge monitoring and control system and a slop tank pre arrangement as required by this Annex. [5]

B. Marpol Annex 1 Special Areas

There are several particular sensitive areas defined by Marpol as special areas .By definition special area is an ocean area where for recognized technical reasons, oceanographical, ecological and traffic conditions special obligatory plans are required. [5]

MARPOL Annex I: Oil

Special Areas	Adopted on	Entered into force
Mediterranean Sea	2-Nov-1973	2-Oct-1983
Baltic Sea	2-Nov-1973	2-Oct-1983
Black Sea	2-Nov-1973	2-Oct-1983
Red Sea	2-Nov-1973	2-Oct-1983
"Gulfs" Area	2-Nov-1973	2-Oct-1983
Gulf of Aden	1-Dec-1987	1-Apr-1989
Antarctic area	16-Nov-1990	17-Mar-1992
North West European waters	25-Sep-1997	1-Feb-1999
Oman area of the Arabian Sea	15-Oct-2004	1-Jan-2007
Southern South African waters	13-Oct-2006	1-Mar-2008

Table 2 – Marpol Annex 1- Oil, Special Areas _Constructed by author Source: https://marinerscircle.com/special-areas-marpol

Oil or oily mixtures discharges in special areas into the ocean totally prohibited. The provisions of this regulation shall not apply to the discharge of clean or segregated ballast.

C. SOPEP - Shipboard Oil pollution Emergency Plan

To help Administrations and shipowners meet these necessities, IMO has formed rules and regulations event of oil pollutions at sea.

Regulation 37 of MARPOL Annex requests that oil tankers of a 150 gross tonnage and more and over 400 gross tonnage cargo ships to carry an approved Shipboard Oil Pollution Emergency Plan (SOPEP) [2]

It is recommended to have onboard tankers marine oil spill kits. Marine oil spill kits are designed as a marine oil spill response measure to be deployed easily and effectively. They must be used in combination with the vessel's response plan as required by Marpol Annex 1 regulations. Contents of the kit are, 1 roll of plastic bags, 2 sorbent pads , 6 pairs spill kit gloves, 6 disposable boiler suits, 6 pairs safety boots, 25 liters aqaubreak PX a water based cleaning chemical, 1 jet spray tool, 1 oil spill kit bag with 1000 liters capacity. [8]

Figure 1 - Oil Spill Response Kit, Source: https://survitecgroup.com/

D. Marpol Annex 1_ IOPP Certification

After satisfactory of survey of each vessel, International Oil Pollution Prevention (IOPP) certificate will be issued by Classification society certifying that the vessel occupied with all mandatory equipment, complying requirements and regulations as well crew are trained and familiar with Marpol Annex 1 procedures. [2]

The validity of the IOPP certificate is five years and certificate subjected to annual and intermediate verifications by Classification societies where vessel is inspected to make sure that the vessel following all required regulations and requirements as per Marpol Annex 1.

E. International Maritime Organization, Flag states and Port State Control

The International Maritime Organization (IMO) is the administrative body that is chargeable for all shipping activities. As of 2020, there are 174 member states of the International Maritime Organization. With legislative of international conventions, IMO follows mandatory regulations and requirements to control pollution from Ships. [9]

The flag state is the country where the respective Ship registered and Flag state maintains regulations and requirements on board their ships as per Marpol conventions.

On the other hand, Port State Control (PSC) is responsible of inspection of foreign ships in national ports to validate that the condition of the ship and its apparatus comply with the requirements of international protocols and the ship is crewed and functioned in compliance with rules.[9]
During every port State control inspection, the ship's Oil Filtering Equipment, IOPP certifications, crew training, preparedness for the emergency and maintenance are verified as per MARPOL Annex I. For this purpose, Port State control officer (PSCO) uses a questionnaire listing items that covered the essential information to investigate whether a ship complies with the requirements. In case vessel fails to demonstrate the compliance of Marpol regulations, recommendations and corrective actions will be suggested by Port State Control Officers which should be attended by Ship staff promptly and take necessity corrective measures.[9]

F. Tanker vetting Inspections

A review of Tankers to measure that a vessel, its employees and its management's meet the terms with international legislation and trade standards, so as to facilitate a prospective charterer to achieve the suitability of a vessel to carry their cargoes. Vetting and approvals can make sure that the Tankers are appropriate to carry prescribed consignment of shipment and obliging mandatory Marpol and safety standards. [2]

G. Double hull Tanker constructions

Double hull tanker constructions were introduced to make sure protection against pollution at the event of a collision or stranding.

The amendments introducing double hulls were contained in Regulation 13F - prevention of oil pollution in case of collision or stranding. The amendments were adopted in 1992 March and entered into force in 1993 July. Regulation 13F applies to new tankers defined as delivered on or after 6th July 1996, while existing oil tankers must fulfill with the requirements of 13F not later than 30 years after the date of their

delivery.

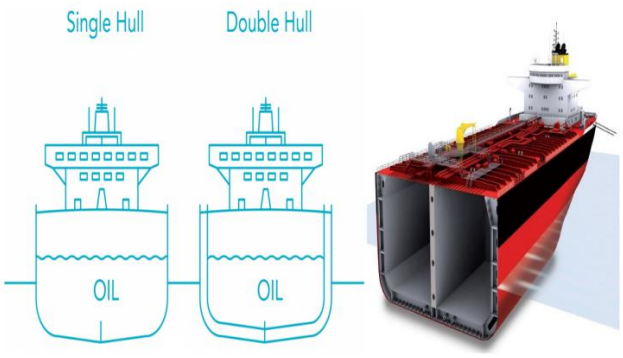


Figure 2 – Double hull tanker construction Source : https://pbs.twimg.com/media

Tankers of 5000 dwt and above must be fitted with double bottoms and wing tanks lengthen the full depth of the ship's side. This regulation allows middeck height tankers with double sided hulls as a substitute to double hull construction tankers. Oil tankers of 600 dead weight and above but less than 5000 dwt must be fitted with double bottom tanks and the capacity of each cargo tank is restricted to 700 cubic meters, if not they are fitted with double hulls. The MEPC also adopted regulation 13G, alarmed with existing tankers which makes provision for an enhanced survey programs .[7]

Position	Shipname	Year	Location	Spill size (tonnes)
1	ATLANTIC EMPRESS	1979	Off Tobago, West Indies	287,000
2	ABT SUMMER	1991	700 nautical miles off Angola	260,000
3	CASTILLO DE BELLVER	1983	Off Saldanha Bay, South Africa	252,000
4	AMOCO CADIZ	1978	Off Brittany, France	223,000
5	HAVEN	1991	Genoa, Italy	144,000
6	ODYSSEY	1988	700 nautical miles off Nova Scotia, Canada	132,000
7	TORREY CANYON	1967	Scilly Isles, UK	119,000
8	SEA STAR	1972	Gulf of Oman	115,000
9	SANCHI*	2018	Off Shanghai, China	113,000
10	IRENES SERENADE	1980	Navarino Bay, Greece	100,000
11	URQUIOLA	1976	La Coruna, Spain	100,000
12	HAWAIIAN PATRIOT	1977	300 nautical miles off Honolulu	95,000
13	INDEPENDENTA	1979	Bosphorus, Turkey	95,000
14	JAKOB MAERSK	1975	Oporto, Portugal	88,000
15	BRAER	1993	Shetland Islands, UK	85,000
16	AEGEAN SEA	1992	La Coruna, Spain	74,000
17	SEA EMPRESS	1996	Milford Haven, UK	72,000
18	KHARK 5	1989	120 nautical miles off Atlantic coast of Morocco	70,000
19	NOVA	1985	Off Kharg Island, Gulf of Iran	70,000
20	KATINA P	1992	Off Maputo, Mozambique	67,000
21	PRESTIGE+	2002	Off Galicia, Spain	63,000
36	EXXON VALDEZ+	1989	Prince William Sound, Alaska, USA	37,000
132	HEBEI SPIRIT+	2007	South Korea	11,000

Major oil spills since 1967 (quantities have been rounded to nearest thousand)

Table 3: Major oil spills since 1967, Source ITOPF 2020

VI. Data Analysis

Before implementation of Marpol Annex 1 1983 versus after implementation of Marpol Annex 1

International Tanker Owners Pollution Federation (ITOPF) maintains a database of oil spills from oil tankers. This contains information on accidental spillages since 1970.

The data collected includes the type of oil spill, the spill amount, the cause and location of the incident and the vessel involved. Spills are generally categorized by size, <7 tones, 7–700 tones and >700 tones Information is now held are nearly 10000 incidents. The vast majority of which (81%) fall into the least category <7 tones, These spills are small (few tones less than 7 tones) and information on numbers and amounts is incomplete due to the conflicting reporting of smaller incidents worldwide.

It is apparent from Table 4 that the number of large spills [>700 tons] has decreased considerably during the last 4 decades during which records have been kept. A turn down can also be observed with medium sized spills [7–700 tons] in Table 2. Here, the average number of spills in the 2000s was 18, whereas in the 1990s the average number of spills was almost double this number. It can be seen that the number of accidental oil spills in both size groups has reduced in each successive 10 year period over last 40 years.

Year	Oil Spills 7 to 700 tons	Oil Spills over 700 tons	Total Oil spills over 7 tons	Average Total spills for last 10 years
1970	7	30	37	
1971	18	14	32	
1972	48	27	75	
1973	28	31	59	
1974	90	27	117	**78**
1975	96	20	116	
1976	67	26	93	
1977	69	16	85	
1978	59	23	82	
1979	60	32	92	
1980	52	13	65	
1981	54	7	61	
1982	46	4	50	
1983	52	13	65	
1984	26	8	34	**45**
1985	33	8	41	
1986	27	7	34	
1987	27	10	37	
1988	11	10	21	
1989	33	13	46	
1990	51	14	65	
1991	30	7	37	
1992	31	10	41	
1993	31	11	42	
1994	26	9	35	**36**
1995	20	3	23	
1996	20	3	23	
1997	28	10	38	
1998	25	5	30	
1999	20	6	26	
2000	21	4	25	
2001	17	3	20	
2002	12	3	15	
2003	19	4	23	
2004	17	5	22	**18**
2005	22	3	25	
2006	13	5	18	
2007	13	4	17	
2008	8	1	9	
2009	7	1	8	
2010	4	4	8	
2011	5	1	6	**7**
2012	7	0	7	
2013	5	3	8	
2014	4	1	5	
2015	6	2	8	
2016	4	1	5	
2017	4	2	6	
2018	4	3	7	
2019	2	1	3	
2020	3	0	3	

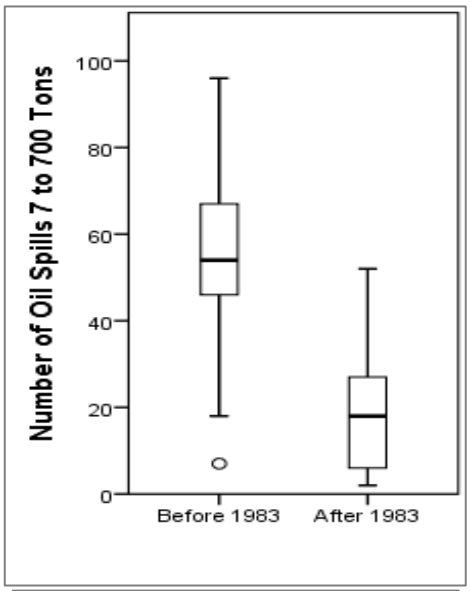
Table 4 : Annual number of oil spills (>7 onnes) Source ITOPF ,constructed by author

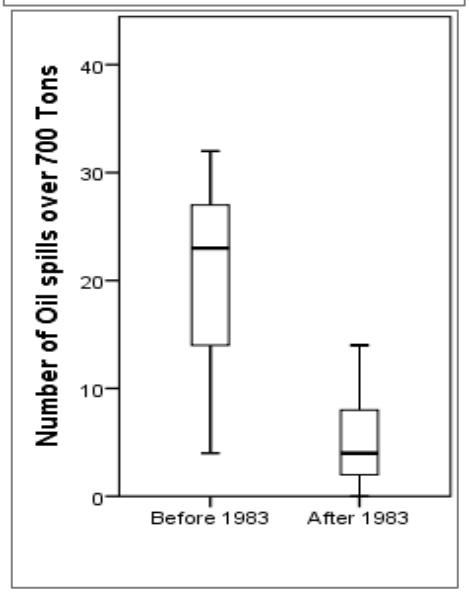
It is apparent from Table 5 quantity of Oil spills has decreased considerably during the last 4 decades during which records have been kept. There was a distinguishable incident at Table 1 where "Sanchi" tanker which collided with a Cargo ship in 2018. Due to this 113000 tons of oil spilled to sea. When evaluating the reason for this spill it is evident that spills occur due to Collison and Fire mainly due to human error. Apart from above occurrence there is clear downward trend of quantity of oil spill.

Year	Quantity (Tonnes)	Year	Quantity (Tonnes)
1970	383000	1997	72000
1971	143000	1998	13000
1972	313000	1999	29000
1973	159000	2000	14000
1974	173000	2001	8000
1975	351000	2002	67000
1976	364000	2003	43000
1977	275000	2004	16000
1978	393000	2005	18000
1979	636,000	2006	23000
1980	206000	2007	19000
1981	48000	2008	3000
1982	12000	2009	2000
1983	384000	2010	12000
1984	29000	2011	2000
1985	85000	2012	1000
1986	19000	2011	7000
1987	30000	2012	5000
1988	190000	2013	7000
1989	174000	2014	5000
1990	431000	2015	7000
1991	167000	2016	6000
1992	167000	2017	7000
1993	140000	2018	116000
1994	130000	2019	1000
1995	12000	2020	1000
1996	80000		

Table 5 : Annual quantity of oil spills (>7 tonnes) – Source ITOPF ,constructed by author.
[Quantities have been rounded to nearest

thousand]





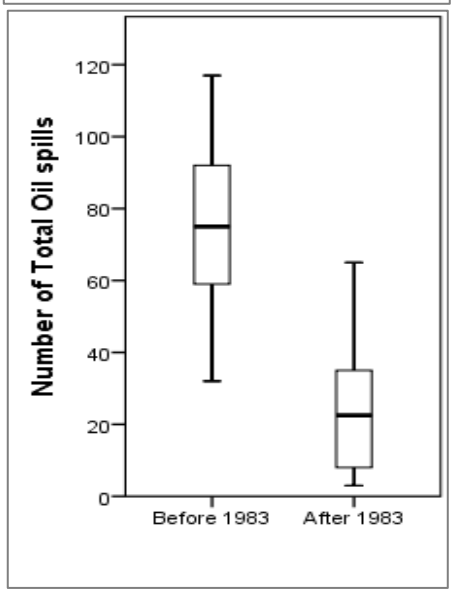


Table 6 - Number of Oil Spills, Source: IBM SPSS software

Hypothesis 1

H0 – There is no significant different between Number of oil spills before 1983 and after 1983

Vs

H1 – There is a significant different between Number of oil spills before 1983 and after 1983

Group Statistics

	class	N	Mean	Std. Deviation	Std. Error Mean
oilspills7to700	Before 1983	13	53.38	25.487	7.069
	After 1983	38	18.11	12.814	2.079
oilspillsover700	Before 1983	13	20.77	9.248	2.565
	After 1983	38	5.21	3.967	.644
Totaloilspills	Before 1983	13	74.15	26.876	7.454
	After 1983	38	23.32	16.361	2.654

Table 7 – Group Statistics: IBM SPSS software

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
oilspills7to700	Equal variances assumed	6.181	.016	6.526	49	.000	35.279	5.406	24.416	46.143
	Equal variances not assumed			4.788	14.131	.000	35.279	7.368	19.490	51.069
oilspillsover700	Equal variances assumed	23.583	.000	8.451	49	.000	15.559	1.841	11.859	19.258
	Equal variances not assumed			5.884	13.541	.000	15.559	2.644	9.869	21.249
Totaloilspills	Equal variances assumed	5.902	.019	8.127	49	.000	50.838	6.255	38.267	63.409
	Equal variances not assumed			6.425	15.157	.000	50.838	7.912	33.988	67.688

Table 8 – Independent Samples test: IBM SPSS software

Levene's Test for Equality of Variances:

The p-values of Levene's test is less than 0.05 in all 3 cases, therefore reject the null of Levene's test and conclude that the variance is significantly different before and after 1983.

T-test for Equality of Means:
The p-values of t-test is less than 0.05 in all 3 cases, therefore reject the null of t-test and conclude that the variance is significantly different before and after 1983.
Since $p < 0.05$ is less than the significance level $\alpha = 0.05$, therefore null hypothesis is rejected, and conclude that, There is a significant different between implementation of Marpol regulations Annex 1 and Number of oil spills events.

With evaluation data it is evident that there is significant difference of Number of oil spills after implementation of Marpol Annex 1. Number of Oil spills showing a downward trend with effects of Marpol regulations.

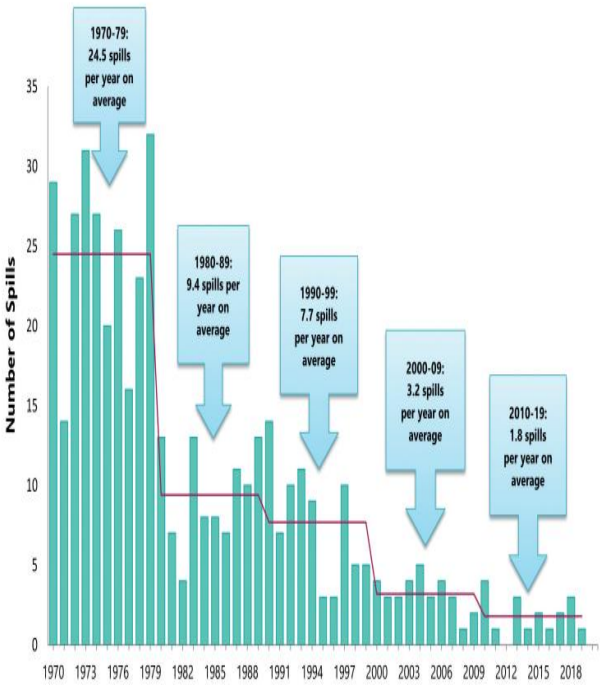


Figure 3 – Number of Oil spills, Source: ITOPF

Hypothesis 2
H0 – There is no significant different between quantity of oil spills before 1983 and after 1983
Vs
H1 – There is a significant different between quantity of oil spills before 1983 and after 1983

Group Statistics

	class	N	Mean	Std. Deviation	Std. Error Mean
quantity	Before 1983	13	265846.15	167507.137	46458.121
	After 1983	38	66842.11	99474.980	16136.973

Table 9- Group Statistics: IBM SPSS software

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
quantity	Equal variances assumed	6.105	.017	5.171	49	.000	199004.049	38481.176	121673.23	276334.86
	Equal variances not assumed			4.046	14.999	.001	199004.049	49180.879	94177.13	303830.96

Table 10- Independent Samples test: IBM SPSS software

Levene's Test for Equality of Variances:
The p-values of Levene's test is less than 0.05, therefore reject the null of Levene's test and conclude that the variance is significantly different before and after 1983.

T-test for Equality of Means:
The p-values of t-test test is less than 0.05, therefore reject the null of t-test and conclude that the variance is significantly different before and after 1983.

Since $p < 0.05$ is less than the significance level $\alpha = 0.05$, therefore null hypothesis is rejected, and conclude that, There is a significant different between There is a significant different between implementation of Marpol regulations Annex 1 and oil spill volume.

With evaluation data it is evident that there is significant difference of quantity of oil spills after implementation of Marpol Annex 1. Quantity of Oil spills showing a downward inclination with effects of Marpol regulations.

Conclusion

As identified, the safe transportation of liquid petroleum shows a track record that has been improving. The shipping industry, IMO, port

states and other organizations have taken many actions to decrease these undesirable events. With MARPOL Annex 1 new industrial programs underway not only to prevent oil spills but continue to improve safety and emergency preparedness onboard. The time may come when oil will be replaced by other energy sources, but in today's demanding world, where approximately 198300 tons of fuel, of all various types, are moved each day. [11]

There is an overall downward trend in the number of oil spills and the volume of oil split during last 4 decades. It has been found that large quantities of oil split can result from just few incidents, the cause of which is typically collisions, groundings or hull failure. But it should be noted that the frequency of these incident is declining.

After careful analysis of the data the paper shows that there is a clear downward trend of spills, spilt volume as well as number of spill incidents of Tankers. This has achieved with contribution to implementation and enforcement of conventions and regulations, as the study analyses implementation of Marpol Annex 1 shows significant difference in oil spills before and after implementation of above legislative developments.

This paper argues that there is a potential decrease of oil spill volume and number of spills after analyzing spill data with implementation of Marpol developments from 1970 to 2020. World’s tanker oil spill reduction in volume as well as number of spills depends on various facts. This is a gradual process which takes time, training, adoption, technology and good seamanship practice with good safety behavior onboard to achieve the goal of safer environment and Cleaner Ocean.

Suggestions and Recommendations

Shipping industry and coastal states need to continue efforts in spill reduction, prevention and cleanup. The Marine Environment Protection Committee (MEPC) needs to become a reality to provide additional safety to the environment. Constant research in oil spill cleanup and prevention needs to be continued. The tanker designs and safety arrangements should ensure the least amount of oil is spilled when an accident occurs. Assessments on current training practices need to be continually reviewed and enhanced when necessary. Safety practices in all oil operations must be continually stressed and reviewed to make sure safe vessel passage. In addition, future waterway structures need to be surveyed and examined to provide the least accident-prone environment.

Emphasis in this all important aspect of petroleum movement must never take a back seat position. It has been assessed that the reduction of oil pollution to zero was impossible if oil was to continue to be transported by sea. Accordingly, efforts must continue in this decisive aspect of petroleum management to ensure the highest potential caliber of petroleum movement safety, to provide the maximum possible protection to the environment. This should result in a continuous reduction in oil spills, and their impacts, in years to come.

Several international standards are recommended for certification of management policies and programs. Navigational watch practices to include recommendations covering standards for navigation duties, anchor watches, engineering watches and security rounds for tanker vessels. There should be recommended written emergency procedures by the shipping companies to cover all probable emergency

conditions and appropriate actions under such conditions. Regarding personnel policies, recommended that the tanker and tank barge crew members required to participate in a comprehensive personnel training program which covers vessel orientation, detailed requirements for each position, regular refresher training and frequent safety and response drills. Also crew members to be monitored for fitness and receive yearly performance evaluations.

The person in charge of oil transfers to be proficient in English and multinational crew should use a common language understood and spoken by ships' crew. Proper communication has to be established prior to transfer petroleum products one tanker to another, to a barge or to a shore facility.

Strict rules to be employed by the tanker owner/operator ensure that no crew member is under the influence of alcohol or illicit drugs while performing their duties.

It is recommended by IMO to have marine oil spill kits onboard tankers. Marine oil spill kits are designed as a marine oil spill response measure to be deployed easily and effectively.

Suggestions for Further Research

This study mainly focuses on MARPOL environmental legislative developments and oil spills related to tankers carrying oil as cargo.

Study oil pollution trend with non-tanker vessel bunker oil which is used for engine consumption, Study economy impact of tankers and non-tankers oil spills, Analysis of safety legislative developments on tanker safety and A review of new designed tanker's oil spill prevention procedures are some of future research opportunities with regard to oil spills.

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