A CONTRIBUTION TO THE ANALYSIS OF MARITIME ACCIDENTS WITH CATASTROPHIC CONSEQUENCE

Lusic Zvonimir M. Sc., Erceg Tonci

Faculty of Maritime Studies Split, Croatia
Zrinsko-Frankopanska 38, 21000 Split
Phone: +385 21 380 762

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Abstract

Maritime transport safety is being enhanced by introducing numerous technical measures, by building safer ships, developing new and more efficient methods of transportation, investing in human resources, increasing traffic surveillance and control, etc. Nevertheless, accident statistics show these measures are not sufficient, accidents with catastrophic consequences still happen. Environment had never been more vulnerable and it is only the question of time when the next accident will occur.

Statistics of serious maritime accidents, especially those related to oil tankers that caused significant pollution to environment will be introduced in this paper. Besides the statistics, causes of accidents will be analyzed with emphasis on causes structure and changes in the course of time.

Correlation between factors involved will be explained by comparing the traffic with accidents in certain periods. Also, impact of technical and technology development and quality of ships crew on accident will be analyzed. Safety measures that are to be introduced will be based on these factors with special accent on ships crews, investments in education and training and ship's crew working overload.

Introduction

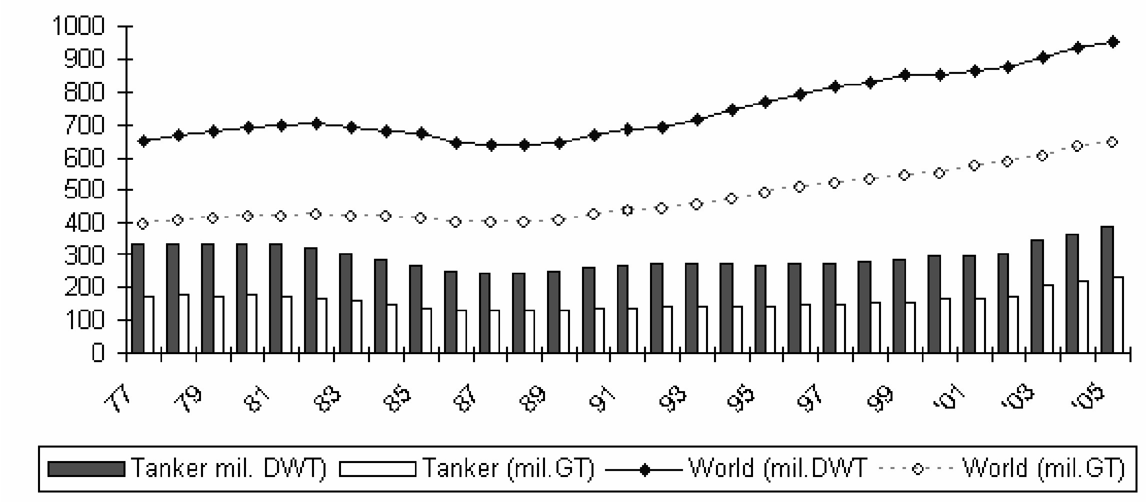
Maritime transport grows constantly as well as world trade fleet capacity which brings dense concentration of vessels on main waterways resulting in higher risk of accidents. Consequences of these accidents besides damages to property are human casualties and pollution of the environment. Passenger ships accidents lead to catastrophic human casualties while tanker accidents are directly linked with pollution to environment.

Quantity of oil and garbage polluting the seas is very high. Although most of the pollution does not originate from ships, large tanker accidents make significant and very sudden impact on the environment and their frequency and consequences should be minimized as low as possible.

In order to prevent maritime transport accidents and increase safety, many measures, more or less successful, were introduced over the years but the necessity to improve them and introduce new ones is obvious. In regard to high percentage of collisions and groundings caused by human factor that resulted in catastrophic consequences there is a need for improving the quality of ship crews and reducing their workload. Cooperation of coastal states in traffic management and surveillance as well as their emergency preparedness can significantly improve the level of maritime transport safety.

Development of the World merchant Fleet and the World Cargo Traffic

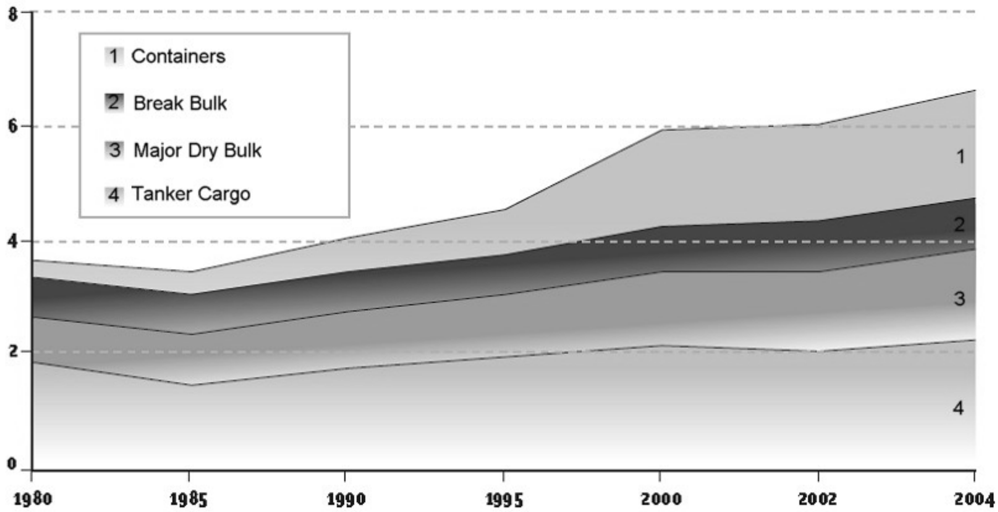
Figure 1. World Merchant Fleet (ships >=100 GT)



Source: www.oecd.org (Lloyd's World fleet Statistics, London, up to 2000)
www.coltoncompany.com (Lloyd's World fleet Statistics, London , from 2001 to 2004)
World fleet Statistics, London, 2005. (for ships>=100GT)

World's trade fleet capacity continuously grows and it is hard to expect this trend will change in near future. Possible changes can be expected in fleet's structure, growth of ships capacity and percentage of sophisticated transportation technologies (new generation container vessels, tankers, LNG/LPG carriers, etc.).

Figure 2. World seaborne cargo movements (billion tonnes)



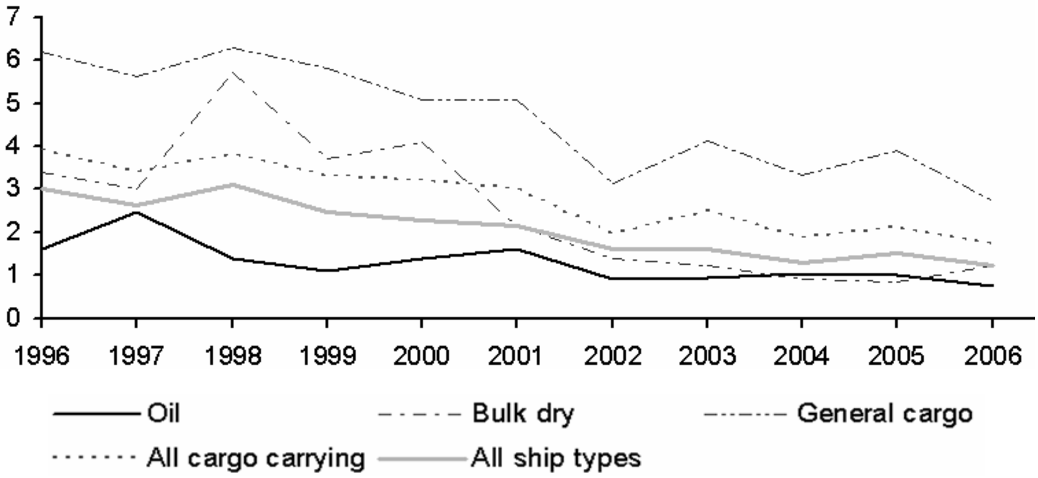
Note: Major dry bulk includes iron ore, grain, coal, bauxite/aluminia and phosphate;
Break bulk includes minor bulks (forest, steel, fertilizers, agricultural products);
Containers include general cargo.
Source: www.canada.org.tw

World seaborne trade had also increased over last decades with emphasis on dangerous cargoes such as oil and oil products.

Maritime Casualty Statistics

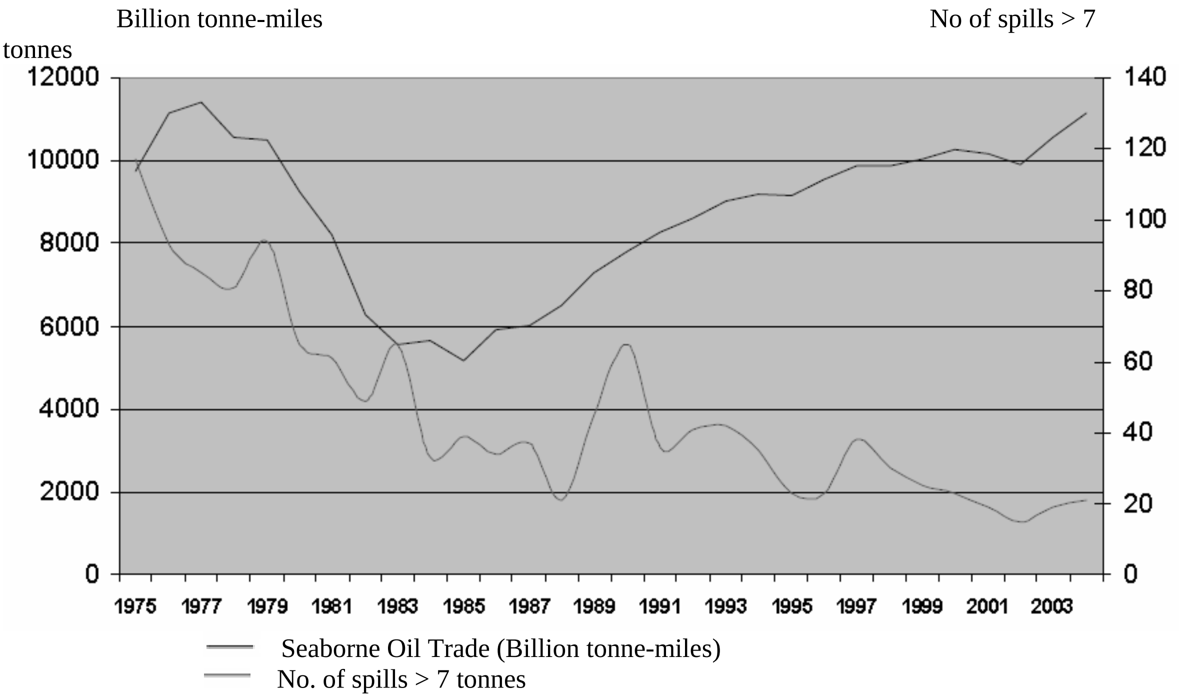
In order to achieve an estimate of maritime transport safety measures success, ship casualty statistics and comparison of accident frequencies with the increase in world trade fleet and maritime transport density are of significant importance.

Figure 3. Loss rate (per 1000 ships at risk)



Source: World Casualty Statistics, 2001, 2006.

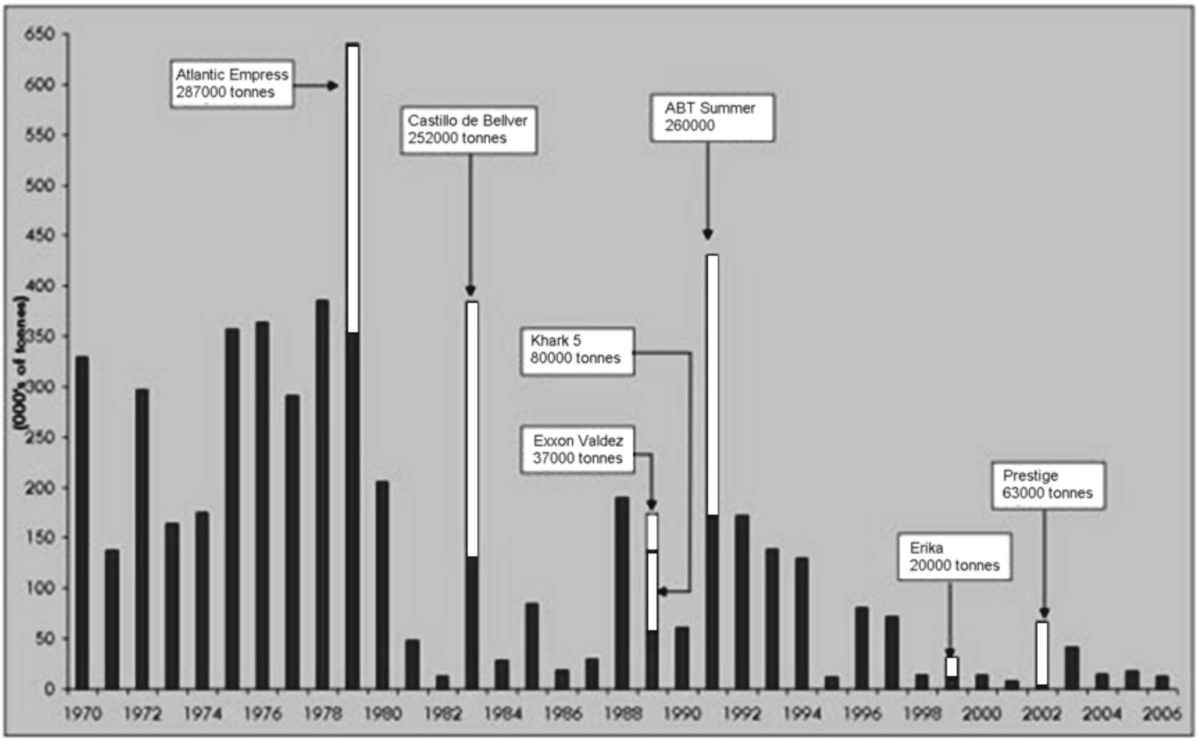
Figure 4. Number of Tanker Spills (7 tonnes and over) and Seaborne Oil Trade from 1974-2004



Source: www.itopf.org

From the figures presented above a conclusion can be made that number of total loss accidents is decreasing as well as the number of accidents with catastrophic impact on the environment.

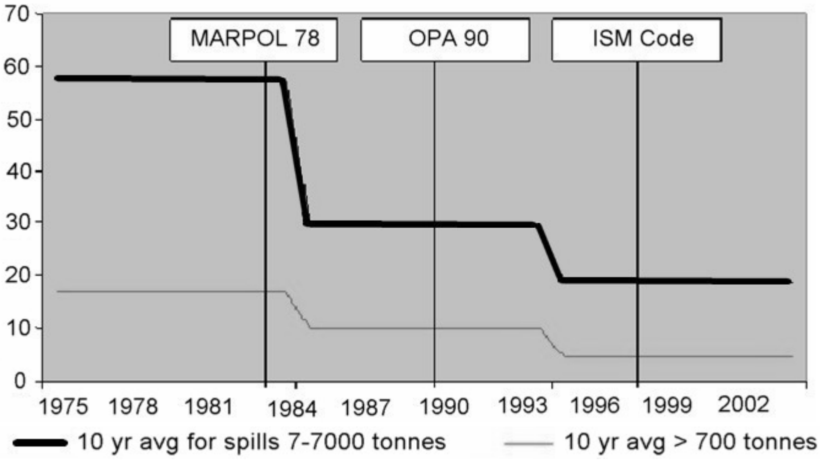
Figure 5. Quantities of Oil Spilt



Source: www.itopf.org

Together with the decrease in accident frequency quantity of oil split into sea had also decreased. Reason for this can be identified in international maritime legislation which introduced different measures dealing with pollution from ships and human errors.

Figure 6. Ten-year Averages for the Number of Tanker Spills in Relation to the Introduction of Shipping Regulations



Source: www.itopf.org

Figure 6. shows statistics of accidents compared with entry into force of three major maritime law regulations : MARPOL Convention, Oil Pollution Act and International Safety Management Code. Also, almost in same time with the ISM Code and STCW Convention entered in force. A conclusion can be made that introduced regulations have had a positive impact on maritime accidents frequency and reduced damage to environment but besides these regulations significant contribution to maritime safety was made by modern technical solutions in shipbuilding (i.e. double skin tankers) and navigational aids in the same time frame. Application of satellite positioning systems enabled continuous and relatively reliable

positioning while satellite communications systems (GMDSS-Global Maritime Distress and Safety System) increased communication capabilities and access to information significant to safety of navigation (i.e. weather reports, emergency support, etc.). Traffic management and surveillance was improved by application of modern radar and computer systems together with AIS (Automatic Identification System) and satellite tracking. Accuracy of long term weather predictions and satellite communications enabled improved voyage planning and possibility of ship routing by shore based personnel dealing with voyage optimization. Global communications systems and emergency preparedness organization has improved emergency support and recovery measures efficiency. Introduction of these electronic aids took place together with application of new regulations at the end of twentieth century.

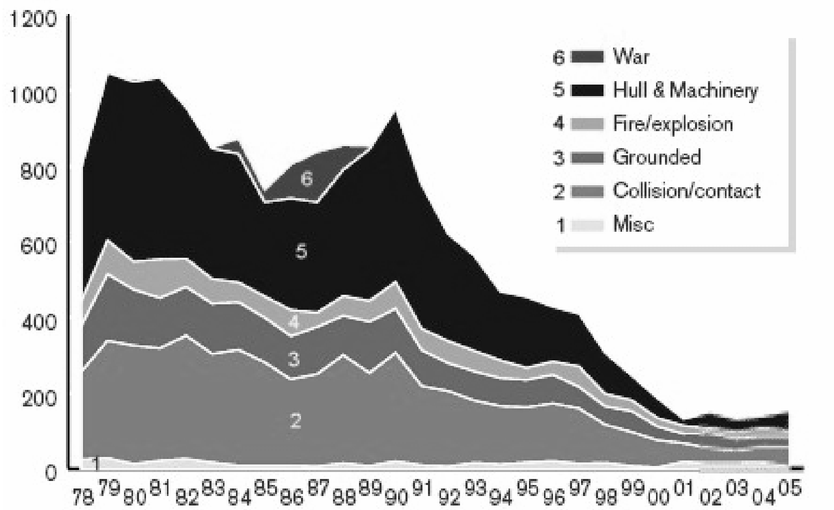
Accident structure concerning their cause does not show significant changes. Human factor still has the most significant influence on accident causes which can be proven by the number of collisions and groundings and pollution accidents during loading/discharging operations in ports.

Figure 7. Incidence of spills by cause, 1974-2006

	< 7 tonnes	7-700 tonnes	> 700 tonnes	Total
OPERATIONS				
Loading/discharging	2821	332	30	3183
Bunkering	548	26	0	574
Other operations	1178	56	1	1235
ACCIDENTS				
Collisions	173	296	97	566
Groundings	235	222	118	575
Hull failures	576	90	43	709
Fires & explosions	88	15	30	133
Other/Unknown	2181	148	24	2353
TOTAL	7800	1185	343	9328

Source: www.itopf.org

Figure 8. Tanker incidents by cause 1978-2005



Source: www.intertanko.com

Causes of large tanker accidents

Figure 9. Major Oil Spills Since 1967

Rank	Shipname	Year	Location	Spill Size (tonnes)	Cause
1	Atlantic Empress	1979	18 M NE off Tobago, West Indies	287000	Collision
2	ABT Summer	1991	700 M off Angola	260000	Expl., leak from cargo tank
3	Castillo de Bellver	1983	35 M off Table Bay, South Africa	252000	Fire, leak from cargo tank
4	Amoco Cadiz	1978	Off Brittany, France	223000	Grounding, Steering F.
5	Haven	1991	Genoa, Italy	144000	Fire, leak from cargo tank
6	Odyssey	1988	700 M off Nova Scotia, Canada	132000	Fire, structural failure
7	Torrey Canyon	1967	Scilly Isles, UK	119000	Grounding, navigation error
8	Sea Star	1972	Gulf of Oman	115000	Collision
9	Texaco Denmark	1971	North Sea, off Belgium	105000	NA
10	Irenes Serenade	1980	Navarino Bay, Greece	100000	Fire, cargo in forepeak
11	Urquiola	1976	La Coruna, Spain	100000	Grounding, uncharted rock
12	Hawaiian Patriot	1977	300 M off Honolulu	95000	Fire, hull crack
13	Independenta	1979	Bosphorus, Turkey	95000	Collision
14	Julius Schindler	1969	Off Ponta Delgada, Azores	95000	NA
15	Jakob Maersk	1975	Oporto, Portugal	88000	Grounding
16	Braer	1993	Shetland Islands, UK	85000	Grounding, Engine failure
17	Khark 5	1989	120 M off Atlantic coast of Morocco	80000	Expl., ballast tank leak
18	Aegean Sea	1992	La Coruna, Spain	74000	Grounding, loss of steering
19	Sea Empress	1996	Milford Haven, UK	72000	Ground., pilot misjudged tide
20	Katina P	1992	Off Maputo, Mozambique	72000	Hull failure
21	Nova	1985	78 M S of Kharg Island, Iran	70000	N/A
22	Wafra	1971	In the Atlantic, off South Africa	67000	Engine room flooded
23	Prestige	2002	Off Galicia, Spain	63000	Hull failure
24	Othello	1970	In Tralhavet Bay, Sweden	60000	Collision
41	Exxon Valdez	1989	Prince William Sound, Alaska, USA	37000	Grounding, navigation error
-	Tasman Spirit	2003	Entrance to Karachi Port, Pakistan	30000?	Grounding

Source: www.coltoncompany.com & www.itopf.org

From the data shown above number of large accidents is being reduced over time, also and quantity of oil spilled in to the sea. Although these statistics are promising, one large accident is sufficient to change situation.

Main causes of accidents are groundings, collisions, fire (explosion) and failure of essential ship systems. Structure of tanker accident causes and causes in general remains the same over time with human element as the most significant factor.

Accident prevention measures

In regard to accident statistics it is obvious that applied measures have had positive influence on reducing the number of large accidents. It is necessary to point out technical demands concerning shipbuilding and ship equipment, more stringent inspections and development of reliable positioning systems. Concerning the fact that the percentage of accidents caused by groundings and collisions is still very high further measures dealing with traffic management and surveillance, crew training, better workload distribution, etc. can be applied.

Crew issue

It has already been stated that large part of accidents is caused by collisions and groundings and analysis of the accidents had identified human factor as their main cause. Besides usual human errors large part of accidents is caused by exhausted crew mostly during passages through high traffic density areas and in conditions where many ports of call have been visited over short period of time. It is very easy to calculate and determine whether the average workload of a deck officer on a ship with standard deck crew (three deck officers) complies with hours of rest defined by STCW requirements. Required minimal crew number does not correspond to working conditions and additional deck officer should be added to the crew. Some shipping companies have already sought this problem and included additional crew members as per workload conditions and STCW requirements. To reduce crew working overload one of available measures is better inspection from port authorities.

Quality of ships crew in relation to qualified personnel shortage on world scale also presents a very significant problem. There are also different education systems of deck officers and engineers. Need for manpower in many cases neglect the quality of crews and solution is often found in poorly educated personnel attending simple and time efficient courses of doubtful quality. Another problem can also be identified regarding the additional training of personnel taking their educational background and nationality into consideration. STCW deals with minimal requirements for seafarers necessary to obtain certain endorsements but various nations have different approach to these regulations so discrepancies between different national education systems are significant.

New Approach to Safety

In 1998 International Safety Management(ISM) Code came into force. Shipping companies were required to establish and implement their safety policy through Safety Management System(SMS). Instead of focusing only on shipboard organization, ISM code demanded ship comapanies to completely reorganize their organization on shore providing the necessary resources and shore-based support to shipboard personell. So far some negative factors have been identified in ISM Code application. Some of these are too much paperwork and voluminous manuals concerning the SMS, dealing with irrelevant procedures, no feeling of involvment in the system by the shipboard personell, not enoguh people or time to undertake the extra work and lack of support from the shipping company (Anderson, 2002). ISM code still has a positive impact on maritime safety as shown many analysis. One of these is "Analyze to assess the impact of the ISM Code on the safety of ships", ordered by The Maritime Safety Committee (MSC). Respond from 32 National Maritime Administrations[1] was follow [IMO]:

- 15 Administrations experienced a decrease in their ships being detained by PSC after the implementation of the ISM Code in 1998, and 17 after its application to all ships in 2002. 11 and 9 respectively (1998 and 2002) experienced no change in detentions, and 2 and 4 respectively suffered an increase. The survey did not investigate the reasons for these changes.
- Similar trends were observed in the number of marine casualties under those administrations. 18 (since 1998) and 15 (since 2002) experienced a decrease in casualties; 11 and 11 observed no change at all, and 1 and 5 observed an increase in marine casualties.
- A similar trend was observed in the number of serious workplace accidents on the ships under these Administrations. The survey did not attempt to gather cause and effect information to establish a direct link between ISM implementation and the variations discussed above.
- 28 of 31 administrations carried out PSC inspections. Of these, 13 reported a decrease in the detentions in their ports since 1998, 6 reported no change, and 8 an increase. The same data from the 2002 extension to the ISM Code are 9 decrease, 8 no change and 10 increase.

[1] Represented almost half the world SOLAS convention fleet tonnage and had issued ISM certificates to some 3 000 ship operating companies.

Regarding implementation of ISM and other international regulations it is necessary to point out that this implementation is not unique for the entire world. There are countries in which some important international conventions still have not been adopted; also those who did it have different approach to implementation. Adequate surveillance and inspection in many cases depend on material and human resources of specific country.

Ship's Routing and Traffic Surveillance
Analysis has undoubtedly shown that introduction of ships routing systems reduces the number of accidents and their consequences. The best proof of this finding is Dover Strait area where 60 collisions occurred in period from 1956 to 1960 and after routing system application only 16 over the period of 20 years (Squire, 2003).
Routing system in high density traffic areas should be accompanied by traffic surveillance system, to additionally improve the safety of traffic. Some accidents analyses have found that traffic surveillance service did not respond in proper manner in certain cases. One of the main problems was cooperation between coastal states and their failure to act on time to prevent the accident especially in areas with high density traffic near their borders. Once established, traffic management and surveillance systems should be monitored and if necessary improved.
In many cases responsible authorities (countries, companies, responsible persons, etc.) are not wiling to take proper action to prevent accident or to decrease the consequence of accidents due to own interest (mainly large expenses), or due to lack of knowledge and experience failed to employ proper measures.

Technical and Technological Development
Technological development of cargo transportation by ships is based on optimization related to transport efficiency generally dealing with minimization of expenses to achieve higher profit. Investments in safety, if not directly linked to profit is considered as an expense. On the other hand application of state of the art navigation systems and automatic systems can significantly improve certain aspects of trade, reduce crew number and increase safety, but at the same time requires additional education and training of the crew. Dealing with navigation problems should not be influenced by problems with electronic aids to navigation. Errors in use of electronic equipment and over reliability can completely put on side their function of increase of safety.
As per accidents statistics in some heavy traffic area (i.e. Dover Strait) recently there was no decrease of accidents and potentially hazard situation. The main reason is heavy traffic and lack of knowledge of the COLREG. Significant role in this have modern navigation technique based on electronic navigation aids (GPS, electronic charts, Integrated bridge systems, etc.) causing that mariners are relying too heavily on these systems and are not being dully diligent in adhering to the COLREGS (Squire, 2003).

Conclusion

Maritime traffic is in continuous growth as well as world fleet capacity in regard to world market demands. Together with the world seaborne cargo movement increase there is an increase in dangerous cargo transportation, especially of oil cargo and oil products. To keep the number of accidents and their consequences on same level, or even reduce, it is necessary to continuously work on improvement of safety measures. From already introduced accident prevention measures with good results it is necessary to point out maritime legislation followed with traffic management and surveillance systems, especially useful in congested waterways. Use of modern technical solutions, from electronic navigation aids to sophisticated ship's automatic systems in some circumstances is not showing expected results, mainly due to human errors and failures. In the future, measures that are relatively easy to implement, in aim to increase safety of maritime traffic, should be based on already proved measures, i.e. with improving existing safety measures it is the simplest and fastest way to reduce possibility of accidents. When maritime legislation is regarded, better surveillance of law implementation should be achieved. Investments in crew should be increased with special attention on education and training, but taking into consideration different knowledge and capabilities of each person. Additional attention should be pay on awareness of crew about interaction between human and electronic navigation aids. Also, crew working overload should be avoided as much as possible.

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