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TARGETING ACCIDENT PRONE SHIPS BY THEIR BEHAVIOUR AND SAFETY CULTURE

Kim Salmi

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Abstract

This report concentrates on studying safety measuring by use of statistical means. It is the fourth deliverable of work package 1 of METKU-project, which is studying safety measuring and impact of ISM-code to safety of Finnish maritime transport.

The state of utilisation of safety related statistics in the Baltic Sea was analysed qualitatively. Both, the actual level of use and the level of usability of these statistics were considered. It was noted that efforts to systematic retrieval and use of safety related data and information to enhance maritime safety had started. This observation could be made, both within administration and within shipping companies. The weight in this report was put on evaluating methods and statistics, providing information that can be used for development of safety leading indicators. Based on committed analysis it can be concluded that companies with relatively healthy approach to safety and safety management can give and receive valuable information from systems such as INSJÖ and FORESEA. Highlighted requisitions for working incident reporting, as provider of indicative information, was considered to be the adequate safety culture.

During the evaluation of different sources of data and information concerning safety, a valuable source for targeting accident prone vessels was discovered. The Finnish Vessel Traffic Service (VTS) -operators have been reporting misbehaving vessels in their observation area since 2002. These reports had been qualitatively assessed by the Finnish Maritime Administration (FMA) to decide needed actions against the vessels present in these reports. These reports were trusted in the use of METKU-project to provide quantitative information concerning incidents described in these reports. 1648 VTS-reports of 1 to 51 pages were first transformed to electronic form and then analysed qualitatively, feeding simultaneously an excel database. This database formed the base for quantitative analysis of this report.

The selected new source of quantitative information was proved efficient on targeting accident prone vessels. Additionally, for the direct targeting information, the data provided by this database also indicates behavioural factors related to these reported incidents. The data was also cross-examined with data from other sources which proved that remarkable precision in targeting of accident prone vessels could be attained. The influence of safety culture and company influence on accident frequencies was also notified.

Possibilities on influencing for the safer maritime traffic in the GOF and in the whole Baltic Sea were evaluated feasible, both economically and politically. Thus administration by correct targeting and by strict, but just actions, can eliminate accident prone seafaring methods from the GOF and from the Baltic Sea. These actions enhance economies of safe and responsible shipping companies. When unhealthy competition, based on negligence of safety, is eliminated, the rest of the companies can continue their efforts towards the 0 accident goal and towards cleaner and safer Baltic Sea.

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TARGETING ACCIDENT PRONE SHIPS BY THEIR BEHAVIOUR AND SAFETY CULTURE

Tiivistelmä
Tämä raportti keskittyy tutkimaan tilastollisin menetelmin tapahtuvaa turvallisuuden mittaamista. Kyseessä on METKU-projektin ensimmäisen osaprojektin neljäs julkaisu. Osaprojektin tehtävänä on selvittää turvallisuuden mittaamista ja ISM-koodin vaikutusta Suomen merenkulun turvallisuuteen.

Turvallisuuteen liittyvien tilastojen käytön tasoa Itämerellä tutkittiin laadullisesti. Sekä tilastojen käyttö, että niiden käytettävyys arvioitiin. Todettiin että tilastojen ja tiedon systemaattinen kerääminen ja käyttö turvallisuuden parantamiseen on alkanut. Tämä huomio tehtiin sekä viranomaisten, että varustamoiden osalta. Tässä raportissa painotetaan menetelmiä ja tilastoja joiden tuottamaa tietoa voidaan käyttää turvallisuuden ”ennakoivien” indikaattoreiden kehittämiseen. Tehdyn analyysin pohjalta voidaan vetää johtopäätös: varustamot joiden suhtautuminen turvallisuuteen ja turvallisuusjohtamiseen on terveellä pohjalla, voivat sekä hyödyntää että vastaavasti hyödyttää systeemejä kuten INSJÖ ja FORESEA. Ehdoton edellytys, indikaatio informaatiota tuottavalle, toimivalle poikkeama raportoinnille on riittävä turvallisuuskulttuurin taso.

Tutkittaessa turvallisuus tilastoja ja tietoa, löydettiin merkittävä lähde onnettomuus alttiiden alusten kohdentamiseen. Suomalaiset Vessel Traffic Service (VTS) -operaattorit ovat vuodesta 2002 lähtien raportoineet tarkkailualueillaan huonosti käyttäytyvistä aluksista. Nämä raportit on aikaisemmin käsitelty Merenkulkulaitoksen sisällä päätettäessä tarvittavista jatkotoimista kohdistuen raportoituihin aluksiin. Nämä raportit uskottiin METKU-projektin käyttöön, tilastollisesti analysoitaviksi. 1648 VTS-raporttia, laajuudeltaan 1 - 51 sivua, muutettiin ensin sähköiseen muotoon. Sähköisessä muodossa olevat raportit analysoitiin yksityiskohtaisesti ja saatu tieto syötettiin excel-pohjaiseen tietokantaan. Tämä tietokanta toimi raportin tilastollisen analyysin perustana.

Valittu, uusi tilastollisen tiedon lähde voitiin osoittaa tehokkaaksi onnettomuusalttiiden alusten kohdentamisessa. Suoran kohdennustiedon lisäksi, tietolähde indikoi raportoitujen poikkeamien käyttäytymistekijöistä. Saatua indikaatioinformaatiota peilattiin myös muista lähteistä saatuun dataan. Tämä ristiin peilaaminen osoitti että erittäin tarkkaan kohdennukseen voitiin päästä. Myös turvallisuuskulttuurin ja varustamon vaikutus onnettomuusfrekvenssiin pystyttiin näyttämään.

Vaikuttamistoimet turvallisemman meriliikenteen puolesta Suomenlahdella ja koko Itämerellä arvioitiin, niin taloudellisesta kuin poliittisesta näkökulmasta, toteutettavissa oleviksi. Viranomaiset voivat siis, oikealla kohdistuksella ja tiukoilla, mutta oikeudenmukaisilla toimilla, poistaa onnettomuusalttiit toimintatavat Suomenlahdelta ja Itämereltä. Näillä toimilla parannetaan samalla turvallisten ja vastuunsa tuntevien varustamoiden kannattavuutta. Kun epäterve turvallisuuden laiminlyömiseen perustuva kilpailuasetelma poistetaan, jäljelle jäävät varustamot voivat jatkaa turvallisuuden kehittämistoimiaan kohti nollan onnettomuuden tavoitetta sekä puhtaampaa ja turvallisempaa Itämerta.

Avainsanat - asiasanat (ja luokat)
Turvallisuus, Meriturvallisuus, Indikaattori, Onnettomuus, Riski, ISM, VTS, Onnettomuus analyysi, Poikkeama raportointi,

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ABBREVIATIONS AND DEFINITIONS

AIBF	***Accident Investigation Board of Finland***
AIS	***Automatic Identification System***
EMCIP	***European Marine Casualty Information Platform***
EMSA	***European Maritime Safety Agency***
FMA	***Finnish Maritime Administration (From 1.1.2010 divided to TraFi and Finnish Transport Agency)***
GOF	***Gulf of Finland***
GOFREP	***Mandatory ship reporting system in the Gulf of Finland***
HELCOM	***Helsinki Commission – Baltic Marine Environmental Protection Commission***
IMO	***International Maritime Organisation***
INDICATOR	***A tool which presents variation of value of monitored subject***
ISM	***International Safety Management (-code)***
OHSAS	***Occupational Health and Safety Assessment Specification***
Paris MOU	***Paris Memorandum of Understanding***
PSC	***Port State Control***
RISK	***Measurable indicator of combination of frequency and severity of harm***
TraFi	***Finnish Transport Safety Agency***
VTS	***Vessel Traffic Service***

1 INTRODUCTION

Maritime traffic has traditionally been the least controlled form of traffic and this is due the "Freedom of seas" mentality. The international maritime culture, born by the influence of this mentality, has made, any restriction based safety development very slow, and often the pace is influenced by political agendas that don't necessarily have anything to do with actual maritime questions.

The pace of new safety influencing laws, treaties and conventions have thus followed true catastrophes; such as RMS Titanic, MV Estonia and MS Herald of Free Enterprise sinking's; where the severity of accident has truly forced the international community to take action. The ISM-code is one of these conventions.

Generally human error is considered as the main cause of accidents in maritime traffic. Recently the company safety culture influence on granting or restraining human error occurrence has been recognized. Thus, the ISM-code was developed to both restrain human errors and to generally elevate responsibility of shipping companies towards the safety of their vessels.

1.1 BACKGROUND

The METKU research project evaluates the impacts of the ISM Code on the maritime safety culture in Finland (METKU – Developing Maritime Safety Culture). The program started at Kotka Maritime Research Centre in the first quarter of the year 2008. The project lasts for 2,5 years. The METKU project is funded by the European Union and other financing comes from the European Regional Development Fund of Southern Finland, Regional Council of Päijät-Häme, City of Kotka and private companies.

The purpose of the METKU Project is to study how the ISM Code has influenced the safety culture in the maritime traffic. The project attempts to find the best practices for the shipping companies while improving their operations by implementing and developing their safety management systems.

The International Safety Management code (ISM) was established in three phases between 1996 and 2002, to improve safety at sea. After its implementation there have been several attempts on evaluating its true impact. However its actual weight has not been successfully defined as [Anderson, 2003] also concludes. The interview study concluded by [Lappalainen and Salmi, 2009], confirmed that ISM has influenced in change of safety culture in Baltic Sea and especially in Finnish shipping. Impact of this change was presented measurable by [Kiuru and Salmi, 2009] in analysis made from Finnish maritime accident reports.

1.2 METKU RESEARCH PROJECT, MERIKOTKA, AND MARINE TECHNOLOGY OF AALTO-UNIVERSITY

The METKU-project consists of the following work packages and responsible research partners:

- *WP1: Statistical measurements of maritime safety, Aalto-university School of Science and Technology, The Department of Applied Mechanics, Marine Technology*
- *WP2: Study the development of the Finnish Maritime Safety Culture, University of Turku, Centre for Maritime Studies*
- *WP3: Comparing ISM –OHSAS practices in shipping companies and port operations (ISM – OHSAS),Kymenlaakso University of Applied Sciences, Maritime Studies*
- *WP4: Exploring the Best Practises in shipping companies, Turku University of Applied Sciences, Ship Laboratory*
- *WP5: Safety management practices in Finnish maritime and port authorities, Kymenlaakso University of Applied Sciences*
- *WP0: Project management and communications, Kotka Maritime Research Centre*

Kotka Maritime Research Centre is a rapidly growing research centre located in Kotka, in Southeast Finland by the Baltic Sea and the Gulf of Finland. The research centre consists of professors, researchers, project managers and administrative staff, currently of over 20 person's altogether. The research staff belongs administratively to the Aalto-university, the Kymenlaakso University of Applied Sciences, the University of Helsinki and the University of Turku. Kotka Maritime Research Centre conducts research related to the maritime industry, maritime safety and marine environment especially in the Gulf of Finland and the Baltic Sea. Maritime transport and environmental safety threads have substantially increased in the Gulf of Finland and the Baltic Sea. Kotka Maritime Research Centre aims at reducing these threats through research and education. Maritime transport and port operations and their economic impacts are also important areas of research at the Centre.

The work package 1 is conducted by Marine Technology of the Aalto-university. School of Science and Technology of Aalto-university is the most prestigious seat of learning of technology in Finland. Since the organisational changes in 1.1.2008 the Marine Technology (ex. Ship Laboratory) belongs to the Department of Applied Mechanics, which is a part of the Faculty of Engineering and Architecture. The Marine Technology provides degrees and carries out research in naval architecture; ship design and ship structures, ship hydrodynamics, marine engineering, marine traffic safety and arctic marine technology. Marine Technology has four professorships, together with research scientists and technical staff of 20 persons. Additional personnel include about 5+15 graduate students and postgraduate students aiming at doctor degree. Current research activities are connected to light structures, fatigue of laser welds, analysis of ship grounding and collision process, simulation of the marine traffic in GOF to evaluate the risks, progressive flooding of large passenger vessel , hydroelasticity of large vessels, CFD development and use in naval hydrodynamics and dynamic stability of intact ship. Ship Laboratory has been the coordinator and/or a participant in many EU-funded projects, e.g.: ARCOP, EFFICIENSEA, EFFORT, FLOODSTAND, IRIS, INTERMODESHIP, DISCO, MSGOF, SAFEICE, SAFEWIN, SAFGOF, SANDWICH and SAND.CORe.

1.3 STRUCTURE OF WORK PACKAGE 1 (WP1) AND CONCLUSIONS OF PREVIOUS REPORTS

The purpose of work package 1 is to find and develop quantitative measuring methods for the use of maritime safety development. The research is concluded in 5 phases:

- Literature review, which was published May 2009, concerned on present measuring methods in maritime and other industry branches.

  SAFETY PERFORMANCE INDICATORS FOR MARITIME SAFETY MANAGEMENT – Literature review, Risto Jalonen and Kim Salmi, ISBN: (printed) 978-951-22-9944-7 / (electronic) 978-951-22-9945-4

- Interview study, made in co-operation with work package 2, which was published Sept 2009.

  SAFETY CULTURE AND MARITIME PERSONNEL´S SAFETY ATTITUDES – Interview Report, Jouni Lappalainen and Kim Salmi, ISBN: (printed) 978-951-29-4043-1 / (electronic) 978-951-29-4044-8

- Accident analyse, concerning on ISM effect on accidents that have happened to Finnish vessels and foreign vessels in Finnish coastal waters. Published in October 2009.

  ACCIDENT ANALYSIS; THE TOOL FOR RISK EVALUATION, Heini Kiuru and Kim Salmi, ISBN: (printed) 978-952-248-182-5 / (electronic) 978-952-248-183-2

- Statistical analyses of incident, accident, near-accident, and violation data acquired from administration and from private companies.

- Final report will summarize findings of earlier phases with expert commentary. It will include proposals for private sector as well as for officials according to these findings and expert commentaries.

The literature review of work package 1 [Jalonen and Salmi, 2009] presented the value of statistical approach in maritime safety development. Especially the importance of safety performance indicators in safety evaluation was estimated high. The use of these indicators in other industry branches was studied and following matters were highlighted:

- *The need for a sufficient flow of information between various actors and within the different organisational levels of the stakeholders in the maritime field is considered as important factor for preventive risk reduction*
- *The "blame free" reporting culture could assure the flow of correct information for statistical analyses*
- *The use of LEADING indicators, similar to, speed and traffic flows measured by cameras or quantity of drunken drivers stopped by police in road traffic, should be adopted by maritime administration.*
- *Functioning set of indicators can be very detailed as in aviation or simple as the set of Key Performance Indicators (KPI's) of the nuclear industry, both of these branches have proven to be remarkably safe.*

Interview study made by [Lappalainen and Salmi, 2009] with participation of seafarers and companies presenting all major sectors of Finnish maritime industry, concluded following.

- *Attitudes towards safety have improved both in managerial level and among seafarers during the last 15 years. The change of attitudes can be seen in managements support, materiel and moral, for safety and security issues. Seafarers show their changed attitude by following and complying safety measures, rules and regulation most of the time. Both management and personnel feel that safety is part of their day to day work.*
- *The influence of ISM-code was considered mainly positive, but the growing bureaucracy was pointed as a major defect. Major benefits of ISM were estimated to be, the better organisation of operations and the systematic approach to safety management which both lead to helping personnel to assimilate instructions and safe working methods. Seafarers also considered that the coming of ISM-code forced companies to participate and to take responsibilities concerning the safety.*
- *Interviews highlighted the following major lack in current situation concerning safety development: Gathering of safety information concerning near-accident, incidents and violations is still suffering from reluctance of seafarers to report their own mistakes. This missing information is hindering efforts made to prevent future incidents and accidents. Some reasons for this misbehaving are: the old punishment culture still existing at least in seafarers minds; clear reporting limits are not established; seafarers don't understand, thus are not correctly explained the importance of this information.*

Accident analysis [Kiuru and Salmi, 2009] was carried out by using accident reports, written by Accident Investigation Board of Finland (AIBF), as the main source of information. Following conclusions were made:

- *Accident analysis and statistics can be used as indicators for risk, but quantitative results should go through qualitative validation before use.*
- *The overall accident risk in Finnish shipping and in Finnish coastal waters in general has decreased within ISM-period.*
- *The average severity of accidents is increasing. The increase can be explained with industries general development of risk management concerning occupational safety, which has lead to considerable reduction of small accidents. While occupational safety has taken great leaps towards safe working environment, the safety development in vessel traffic safety has been slow.*
- *Significant part of accidents are predictable. Which signifies that due malfunctioning safety management: many vessels sail with obvious and present risk factors, taking conscious risks in their daily traffic and in worst case trying to hide these obvious endangering elements.*
- *Accident leading causes decreasing most due the positive impact brought by ISM-code are those connected to ISM or to human factors. Never the less these same causes still produce most of the accident risk. This means that the direction is good and that the targeting have been successful, but there is still much development to be done. The continuance of positive development is connected to successful implementation of the new safety culture.*
- *The fast development of technology has surely improved safety, but in the same time it has developed new threats concerning complicacy of equipment. These threats should be taken into account when plans for new ships and their maintenance are made as well as when maritime education is planned.*

1.4 CONTENT OF THIS REPORT

This report consists of three main issues:

- *Evaluation of the state of safety related statistics in maritime transport, particularly in Finnish shipping and maritime administration.*
- *Building and presenting possibilities of probabilistic use of a database based on VTS-operators violation reports.*
- *Estimating the influence and measurability of safety culture in safety*

The report is structured so that first the background of METKU-research project is introduced, followed with review of statistics and reporting in use for safety development in maritime traffic. After review a presentation of building and use of database consisting administration (VTS) gathered incident reporting. This presentation consists of cross-examination of data delivered by the database with data of other sources. At the end conclusions are made concerning the state of safety measuring, its future possibilities and also the influence of safety culture to it.

2 METHODOLOGY AND MATERIEL

The use of statistical tools in maritime safety development has been random. Both administration and private companies have been slow on adopting the culture of incident information gathering and use in statistical methods [Lappalainen and Salmi, 2009]. In this report existing information is gathered from different sources to statistically present that this kind of information can be used effectively to identify accident prone vessels and accident causing safety cultural factors. Quantitative analysis are supported with qualitative analysis where needed additional surety.

2.1 INTRODUCTION AND MATERIEL OF STATISTICAL ANALYSES

Analyses for this report are made by using several sources of information. (Vessel Traffic Service) VTS-operator violation/incident reporting provided by (Finnish Maritime Administration) FMA was used as base on which different approaches were build. First the paper reports were transformed on electronic form and then an excel database was built from the information of these reports. Information gathered from these reports presented in table 2.1.

Table 2.1 Type of information gathered from VTS-operator violation/incident reporting

Type of information	Presentation
Ship info	Name/IMO no/Flag/Type/GT/etc.
Time of incident	Start/End
Position	Geographical N-E / inland-sea
Method of identification	VHF/AIS/Radar/etc.
Speed	knots
Course	360°
Visibility	km
Wind direction	360°
Wind speed	m/s
Sea state	height (m) / wave height (m)
Contravention	Zombie/Rule10/etc.
Contact time	<10min/10-30min/>30min/no contact
Correct action after contact	Yes/No
Brake of rule due emergency OR SIMILAR	Yes/No
Brake of rule due passing another vessel (true and excuse)	Yes/No
Brake of rule (OR SIMILAR) due icebreaker/pilot/vts instruction	Yes/No
Brake of rule (OR SIMILAR) due OBSOLETE MAP	Yes/No
Cargo correct	Yes/No
Accident	Yes/No
Equipment (blackout etc.)	Yes/No
Close situation due manoeuvring or fault in navigation	Yes/No
Summary	Explication of incident

Accident statistics used in the report is provided by (Helsinki Commission) HELCOM. The identification information of vessels in this statistics was confirmed and complemented using Lloyds Register Fairplay provided ship register access. HELCOM statistics were chosen due it covers the whole Baltic Sea.

Paris MOU database was used to get information concerning vessel-specific problems during port state controls.

AIS data of vessels in GOF and northern Baltic Sea was used on limiting groups of concerned vessels in some of the approaches. Used data was from years 2006 to 2008 but had some periods missing, thus approaches were built minimising the influence of error due missing data.

Other national and European safety related systems and databanks that are operating or under development were also viewed for estimating their usefulness in statistical safety assessment.

Private Finnish shipping companies provided their own statistics and incident reporting to be used in defining causes behind accident susceptibility. The use of this information was restricted due the apparent difference of level of safety between these companies and the ones being targeted by the means explained in this report.

2.2 TARGETING ACCIDENT PRONE SHIPS BY THEIR RECORDED BEHAVIOUR

Areas under VTS observation, such as GOF, can provide behavioural information that can be used for quantitative as well as for qualitative analysis for safety development. Vessels breaking rules and regulations, or behaving otherwise strangely or even dangerously can be observed and reported. The information from these reports can be used either directly as indicators of safety level, or they can also be used to identify accident prone vessels. The identification gives administration the possibility, by inspections, to learn more about factors that make the vessel accident prone. By using VTS-reports for targeting vessels that show inadequate safety culture and seafaring knowhow, administration can limit their inspection efforts. Thus needed cross-examination of data from different sources can be limited to feasible amounts.

2.3 COMPARING REPORTS OF MISBEHAVING TO ACCIDENT STATISTICS

Some general quantitative information can be obtained by simple comparison of vessels of VTS-reports to accident statistics of corresponding geographical area and timeframe. By dividing VTS-reports to subcategories such as "zombies" and "conscious"[1], the accuracy of such information can be enhanced. By comparing these subcategories

[1] Zombie = Non reporting and/or replaying vessel; Conscious = Vessel that continues contravention she has already been notified for

with each other and by limiting certain reports that have been influenced by administrations own actions and instructions, high risk vessels with obvious similarities can be detected. These similarities can be used as indicators of risk in maritime traffic. Accident statistics used for this analysis was acquired from [HELCOM], some accidents not present in HELCOM statistics, but revealed by VTS incident reporting, were added. To show the potential of VTS-reporting as a tool for pre-identifying accident vessels, AIS information was used to limit compared accident vessels to those sailing in Finnish VTS observation areas.

2.4 COMPARING REPORTS OF MISBEHAVING TO PORTSTATE CONTROL REPORTS

As [Knapp and Frances, 2007] pointed out, the relation of PSC (Port State Control) found deficiencies and accidents can be presented in general level. With Knapp and Frances approach some flag states, vessel types, owners etc. can be considered more accident prone than others. When comparing VTS-reports to PSC-reports certain conclusions can be made concerning similarities between targeted vessels. These similarities concern both quantity and content of reported deficiencies.

By using VTS-reported vessels as a limited target group of PSC-reports the aim is to find answers to following questions:

1. *Are the pre-defined deficiencies, which indicate lack of safety culture, found from reported vessels during inspections. Thus are deficiencies concerning safety culture present in accident prone vessels?*
2. *Can the reported presence of these deficiencies be used for targeting accident prone vessels? –question follows if the first question can be answered with adequate precision.*

2.5 USING RECORDED BEHAVIOUR, AIS-DATA AND METEROLOGICAL INFORMATION TO MODEL ACCIDENT SCENARIOS

Reported (VTS) misbehaviours can be used as possible models for accident scenarios. When meteorological and chart information is added to these scenarios, the need of restrictions and navigational aid can be planned more efficiently. And by combining these models with recorded (AIS) close quarter passing's in narrow or otherwise challenging fairways, accident scenarios for operative use can be obtained.

2.6 USING COMPANY STATISTICS, REPORTING AND INTERVIEWS

Preparation for quantitative analysis was made by becoming acquainted with safety measures and culture of seven Finnish shipping companies by interviews [Lappalainen and Salmi, 2009] and by receiving additional information *including some statistics and reporting from four of them. This background information provides sufficient base of knowledge to build quantitative safety culture analyses. Information obtained by qualitative analysis methods can be used to provide limits and reference levels for quantitative analysis.*

2.7 APPLICATION OF FINDINGS OF PREVIOUS STUDIES

The research made earlier in METKU project will be compared to results of analysis made for this report. This comparison is made to validate and where seen necessary, object appraisals obtained with chosen methods. Some potential explication for obtained statistics is given on bases of earlier studies.

Reliability of both, used methods and acquired data, will be analysed either qualitatively or quantitatively.

3 REVIEW OF THE STATE OF MARITIME SAFETY RELATED STATISTICS AND RECORDS IN GOF AND IN THE BALTIC SEA REGION

The quantity of sources of maritime safety related statistics, in Baltic Sea region is vast. Even though there are reliable statistics made and used by different maritime administrations, major lacks can be observed:

> *Different statistics are concentrated on either detail level information on one studied problem or they are extremely general without detail level information. Due this the use of these statistics, with adequate precision, for finding causes that endanger the traffic is unfeasible. The missing standardization of statistics and the reporting behind these statistics is causing the problem of missing compatibility of statistics gathered by different administrations. The problem of non compatibility exists not only between administrations of different Baltic Sea coastal states but also on national levels.*

When defining safety levels all factors that derive to safety should be made clear, thus a comprehensive database with information about traffic flows, inspections, incidents, accidents and related external factors such as meteorological information would be advantageous. At the moment neither on national nor on international level such database exists.

The Finnish Maritime Administration [FMA] has an ongoing project for evaluation, harmonisation and development of data gathering and distribution among different officials concerned of maritime traffic and its safety. This project will be used for the profit of national elements and also for the EU level [SafeSeaNet] co-operation platform. In EU the EMSA (European Maritime Safety Agency) is developing [EMCIP] (European Marine Casualty Information Platform) accident reporting and investigation database. This type of harmonisation and standardisation will lead to more useful safety statistics and thus to more efficient safety development.

Existing accident statistics vary by their regional scopes as well as their information scope and reliability. In Finland the administration is using DAMA-accident database for accidents in Finnish coastal waters, this database is somewhat detailed but the regional scope limits the statistical usefulness of it. HELCOM (Helsinki Commission) gathers its own accident statistics about Baltic Sea, from coastal states, but the quantity of information they receive seems to be inadequate, for example all the accidents in DAMA are not found in HELCOM's database. It is also to be noted that some of the accident in HELCOM statistics that have happened in Finnish waters are not in DAMA. In [HELCOM] statistics there are also several mistakes concerning vessel information and due the lack of IMO number in vast part of the vessels-info, the validation of this statistic is laborious and in some cases unfeasible. Even with the explained lacks of validity and adequate information the HELCOM statistics are at the moment the source of preference due its unique geographical scope over the whole Baltic Sea.

The need of assessing accident leading causes to be able to restrict accidents from deriving has lead to realising of importance of human factor. The latest information received during METKU project [Lappalainen and Salmi, 2009] [Kiuru and Salmi, 2009] refers that negative impact of human factor can be controlled by sufficient level safety culture in the shipping companies. Thus the need of evaluating the level of safety culture has risen. For this reason the need of near-miss, incident and violation data, which produces human behavioural information as well as organisational information about concerned shipping companies should be gathered and used in safety assessments. Sources for such information are shipping companies themselves and the administration. For the METKU-project and more precisely for the benefit of this report, the FMAs VTS (Vessel Traffic Services) trusted their vessel violation reporting 2002 to 2009 in

GOFREP[2]-area and Finnish coastal waters, to be transformed in statistical form for analysis. Shipping companies provided their statistics, reporting and general safety information as well as interviews.

In the METKU-project some Finnish shipping companies authorised their safety systems being viewed. The use of statistics as a tool in safety development varies greatly among Finnish shipping companies. In some of the companies safety reporting is constant and the use of reports for statistics based safety development is visible. On the other hand in some of the companies no statistical data about the safety is gathered. [Lappalainen and Salmi, 2009]

One of the reasons for not using statistics was mentioned to be inadequate amount of reports, due small fleet. Gathering of statistics from similar type of companies to unique data base for further analysis can provide adequate amounts of information for statistical analysis. This type of approach is already in use in Sweden[INSJÖ], and similar system with new name (FORESEA) is under construction in Finland.

Company reporting is not and will not produce adequate info where needed the most. Companies which are most accident prone are also least advanced on matters of reporting and safety culture. This leads to the need of administration to take action against and for these bad companies, which are not endangering only themselves but also all the maritime traffic. Only in companies where a certain level of safety culture has been established can be expected to get truthful information about incidents and near accidents. Thus the use of systems such as FORESEA can be advantageous only to companies which are already relatively safe. Off course FORESEA will elevate the safety in Finnish shipping but it will not influence actions of the worst category.

To be able to identify accident prone companies, and their accident prone vessels with their accident prone crew a constant use of different statistics should be possible. EMSA is making an effort on building European accident database, the information gathered to this database should be well standardized and if possible different national historical accident data from certain period of time should be added to it.

In Finnish national level the use of violation reporting, presented in this report, should be encouraged to continue. This data would get added value if similar information from military/Border guard could be received to strengthen it. This national security related information would need filtering due obvious clearance issues, but it would help to cover the whole coastal area and thus help to get more information about vessel not using normal routs.

In overall, statistics can be used in two levels:

1. *To improve the safety of relatively safe companies by supporting their incident reporting.*
2. *To identify high risk vessels (by administration) and to carry out inspections on these vessels to produce more information (ParisMOU - Port State Control). This approach can also be used to provide additional information to number 1 approach.*

When preparation of materiel for statistical approach was started, the main focus was chosen to be: Finding best possible indicators comparing existing data from companies that have good safety levels. Thus some of the companies that were already interviewed in earlier stages of the Metku-project, were appealed to provide their safety related statistics, reports and/or some relevant information by further interviews. This positive approach proved that relatively

[2] GOFREP = The mandatory ship reporting system in the Gulf of Finland

good safety levels could be achieved by different methods and that these methods could vary by the size and other particularities of the fleet and the company.

Following information was acquired:

- *Incident reports*
- *Introduction to reporting systems*
- *Introduction to safety management systems*
- *Safety statistics (with applied safety indicators)*
- *Estimations of efficacy and usefulness of different methods concerning safety measurement and development*

Vessels of companies that provided access to their safety systems proved to be almost nonexistent in VTS-reporting and accident statistics, thus the use of information gathered from these companies, in this report, is used merely for comparison and reference. What can be concluded is that good results, in elevating safety awareness, can be achieved by using different methods. Instead of receiving direct information about which are the factors that make company safe, it can be seen that the safety as issue which is constantly present in all the actions of the vessel is the key element of making a ship safe. The most important work of the safety management is thus to boost the awareness of safety and to develop a culture of safety in the company.

4 ANALYSES WITH RESULTS

The first part of this chapter reveals results of quantitative and qualitative analysis. These analyses are based on the use of data base, constructed using Finnish VTS-centre made incident reporting as main source of information. The second part presents possibilities of use of qualitative analysis of safety culture influence on quantitative risk assessment. In the last part, the use of presented material for accident scenario modelling is shortly discussed.

4.1 TARGETING ACCIDENT PRONE SHIPS BY THEIR RECORDED BEHAVIOUR

The constructed data-base consists of VTS incident reports from 1st of November 2002 to August 2009. In most of the analyses only reports of years 2004, 2005, 2006, 2007 and 2008 were used. The limited use of 2002 and 2003 reports is caused mainly by missing reporting of several months: in 2002 from January to October and in 2003 from February to April. The limited use of 2009 reporting is mainly due the fact that this reporting is so recent that corresponding cross-examination material (for example. accident statistics) was not available.

4.1.1 DIRECT APPROACH

The most direct way of using VTS incident statistics is to compare reported vessels to HELCOM accident statistics (table 4.1). This approach proves already that general targeting of the VTS reporting is efficient and that it can be used as it is for identifying accident prone vessels. From table 4.1 can be observed that these accident prone vessels are often repeating both accidents and VTS reported contraventions. This type of negative constancy can be led to conclusion of insufficient comprehension of safety risks and risk management. Thus the safety culture development has been inadequate.

Table 4.1 Basic quantities of misbehaving vessels and reports made

Total number of identified vessel in the database with IMO number	Total number of database vessels that have had one or more accidents in Baltic sea in period of 2002-2008	% of database vessels have made 1 or more accidents during period of 2002-008	Average number of accidents by accident vessel in period of 2002-2008	Average number of VTS-reports per accident vessel in period of November 2002 to August 2009
1095	112	10,23 %	1,23	2,34

To get more detailed information concerning possibilities of preventing accidents from happening, a timeline between VTS reports and accidents was made. Results obtained with using timeline can be seen in table 4.2. It was assumed that all accidents related to VTS incident reports of year 2004 have already occurred and thus a reference timeline was based on the year 2004 reports. The time line of the year 2004 VTS reports was used to complete estimate of the probable number of accident vessel of reported vessels of years 2005, 2006, 2007 and 2008. General statistics of timelines is presented in table 4.3. The completion was made for 2005 estimation as presented in equation 4.1.

$$\frac{\frac{A}{1-(B-C)}-A}{E} + D = Corrected\ accident\ frequency\ estimation\ of\ 2005\ reported\ vessels \quad 4.1$$

A = Number of realized accidents 2005

B = % of accidents, derived at least 36 months after VTS reporting (year 2004 VTS reported vessels)

C = % of accidents, derived at least 36 months after VTS reporting (year 2005 VTS reported vessels)

D = % of VTS reported vessels (year 2005) that have realised an accident

E = Number of VTS reported vessel (year 2005)

Estimates for 2006, 2007 and 2008 follow the logic presented in equation 4.1.

Table 4.2 Comparison of VTS-reports and accidents by year (with corrective estimations)

	2004	2005	2006	2007	2008
Vessels in VTS-reports	472	302	199	129	84
Accident vessels	48	44	31	14	13
% of vessels accident	10,17 %	14,57 %	14,07 %	10,85 %	15,48 %
Accident after VTS-report	38	26	13	7	3
% of vessels accident	8,05 %	8,61 %	6,53 %	5,43 %	3,57 %
% of vessels accident with estimated correction		9,31 %	8,65 %	12,85 %	13,39 %
Accident vessels total	38	28,1	17,2	16,6	11,3

In table 4.2 the line: "Accident vessels" includes all the vessels that have been reported in corresponding year and have had an accident sometime between 1.1.2002-31.12.2008. It does not make a difference if accident happens before or after the VTS-report.

Table 4.3 Timeline statistics

Time line: VTS report year	Average time line (months)	Standard deviation	% under 6 months	% under 12 months	% over 12 months	% over 24 months	% over 36 months
2004	19,22	12,95	26,67 %	42,22 %	57,78 %	35,56 %	20,00 %
2005	17,79	12,42	20,83 %	54,17 %	45,83 %	33,33 %	12,50 %
2006	15,78	7,14	11,11 %	33,33 %	66,67 %	11,11 %	0,00 %
2007	5,20	1,84	80,00 %	100,00 %	0,00 %	0,00 %	0,00 %
2008	1,00	0,00	100,00 %	100,00 %	0,00 %	0,00 %	0,00 %

From the table 4.2 can be seen that the number of misbehaving vessels have been decreasing approximately by one third each year and in the same time the precision[3] has raised from year 2004 to 2008 by two thirds. These findings support precedent conclusions [Kiuru and Salmi, 2009] that the overall accident probability in Finnish shipping and coastal waters has decreased during the late ISM period.

By scrutinizing VTS-reported incidents into categories presented in the table 4.4, the influence of safety culture into accident susceptibility is obvious. The explication of categories presented in table 4.4 is following:

- **Zombie** *in this report signifies vessel that don't fulfil her reporting obligation and/or can't be contacted with standard communication canals. Equals deaf and potentially cruising without active control.*
- **Conscious** *signifies that vessel continues its contravention even after VTS operator intervention.*
- **Repentant** *signifies vessel that was contravening some regulations but corrected her action as by VTS operator request.*
- **Faulty man/nav** *signifies vessel that due lack of knowhow in manoeuvring or navigation, cause near accident.*
- **Zombie+other** *signifies vessel with Zombie type of contravention with some other reason, either contravention or cause such as engine problem or blackout.*
- **Winter reported** *-category was used to verifier if vessels that do winter navigation (here vessels reported January to March) are less or more accident prone than vessels in general.*

Table 4.4 Partition of reports in subcategories of VTS incident database.

		2004			2005			2006			2007			2008	
	% of all reported vessels	% of vessels in the category accident	% of all the accidents	% of all reported vessels	% of vessels in the category accident	% of all the accidents	% of all reported vessels	% of vessels in the category accident	% of all the accidents	% of all reported vessels	% of vessels in the category accident	% of all the accidents	% of all reported vessels	% of vessels in the category accident	% of all the accidents
zombie	77,33 %			78,48 %			66,83 %			51,16 %			45,24 %		
accident zombie	8,47 %	30,08 %	83,33 %	10,60 %	24,06 %	72,73 %	7,54 %	11,28 %	53,57 %	5,43 %	10,61 %	50,00 %	4,76 %	10,53 %	30,77 %
conscious	1,48 %			4,64 %			8,54 %			16,28 %			11,90 %		
accident conscious	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	2,33 %	14,29 %	21,43 %	1,19 %	10,00 %	7,69 %
repentant	16,53 %			9,93 %			11,56 %			14,73 %			19,05 %		
accident repentant	1,69 %	10,26 %	16,67 %	1,99 %	20,00 %	13,64 %	3,02 %	26,09 %	21,43 %	0,78 %	5,26 %	7,14 %	3,57 %	18,75 %	23,08 %
faulty man /nav	2,12 %			4,30 %			7,54 %			18,60 %			21,43 %		
accident faulty man /nav	0,00 %	0,00 %	0,00 %	0,99 %	23,08 %	6,82 %	2,01 %	26,67 %	14,29 %	2,33 %	12,50 %	21,43 %	3,57 %	16,67 %	23,08 %
zombie+other	8,47 %			23,51 %			19,10 %			15,50 %			8,33 %		
zombie+other / accident	0,64 %	7,50 %	6,25 %	1,32 %	5,63 %	9,09 %	2,51 %	13,16 %	17,86 %	3,88 %	25,00 %	35,71 %	0,00 %	0,00 %	0,00 %
Winter reported vessel	1,27 %			33,44 %			16,08 %			20,93 %			11,90 %		
Accident-Winter reported vessel	0,21 %	16,67 %	2,08 %	5,63 %	16,83 %	38,64 %	2,51 %	15,63 %	17,86 %	0,78 %	3,70 %	7,14 %	2,38 %	20,00 %	15,38 %

The most important category is "Zombie". The decreasing partition of both Zombie reports and accidents of the Zombie reported vessels can be seen as direct influence of ameliorating safety culture of vessels.

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[3] *Precision, indicates that partition of accident vessels in the group of VTS-reported vessels is increasing*

The small partition of accidents in the category of "Conscious" can at first hand look peculiar, but the explanation for this comes also from the safety culture: The old maritime culture glorifies talented masters that get their ships through any problem they may have. The old generation that has survived till now with this attitude have developed their emergency skills in adequate level to be able to avoid most of the major accidents (and hide the smaller ones they may have had). These same masters are also the most stubborn ones, so they will continue disregarding and undermining new regulations and manners of seafaring till their retirement. While skills of this older generation with higher risk tolerance make them less accident prone, their example as the sole authority in the vessels they serve is dangerous for the younger generation. These old seafarers are the true visualisation of the widely used term: "change resistance".

On the contrary of category "Conscious", the category "Repentant" seem to obey well instruction given by VTS-operators, but still they are much more accident prone than the first. By being categorised as repentant signifies either that the OOW[4] *could not explain why the vessel was contravening regulations and this reveals missing knowhow or adequate tools such as up to date charts, or the OOW didn't care about following regulation at the first place, but obeyed when got caught. In both of the explained cases, a lack of general safety culture and of rule obedience is visible.*

When observing the category "winter reported vessel", a conclusion can be made that: challenging environment brings out lacks of skills and knowhow more efficiently and thus vessels reported during winter months are present in accident statistics approximately one and a half times as often as reported vessels in general.

When comparing the presence of different vessel types in VTS-reporting (figures 1.1, 1.2, 1.3, 1.4 and 1.5) and partition of accidents of the same group (figures 1.6, 1.7, 1.8, 1.9 and 1.10) following observations and conclusions can be made (figures based on table 1 of appendix 1):

- *Relative portions of different vessel types in VTS-reporting have remained approximately in the same level during the observed period of time.*
- *Tanker accident portion seems to be decreasing, this could be due reinforcing self regulation of safety matters in oil and gas industry.*
- *Tugs are over presented in accident portions. And a large part of Tug category accidents are not added in accident statistics (due the small size of vessels) or as in 2006 calculations (2) accident vessels are without IMO number thus they are not counted. (If counted: Tug portion of reported/reported accident vessels 2006 = 3,48% / 22,22%.*

[4] *OOW = Officer On Watch*

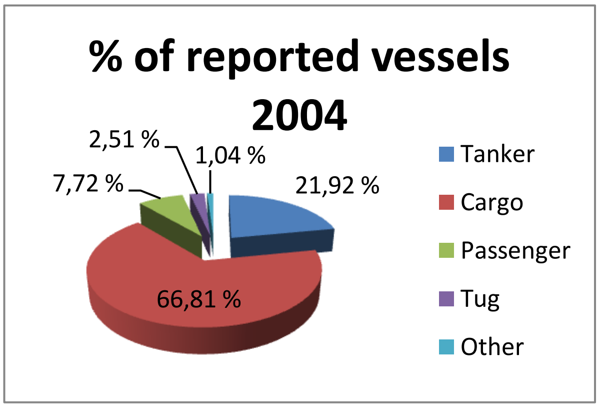

Figure 4.1 VTS-reported (2004) vessels by type

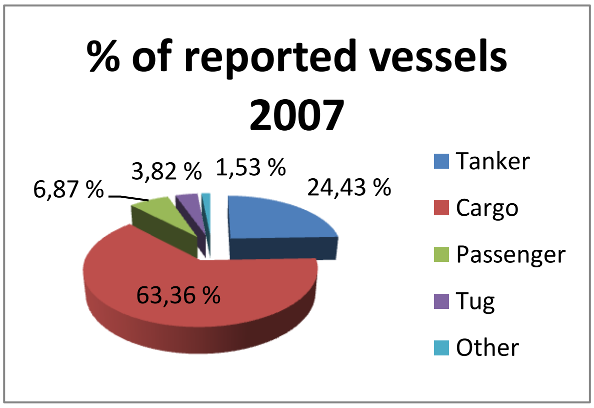

Figure 4.4 VTS-reported (2007) vessels by type

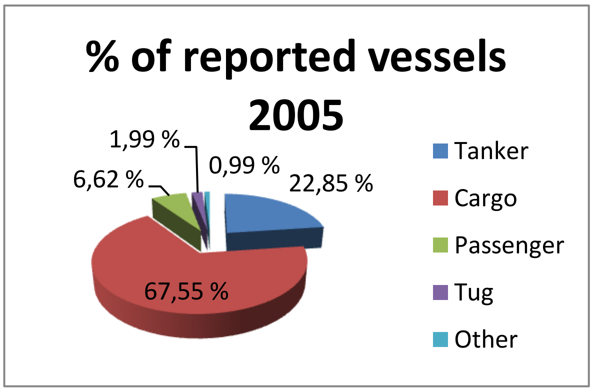

Figure 4.2 VTS-reported (2005) vessels by type

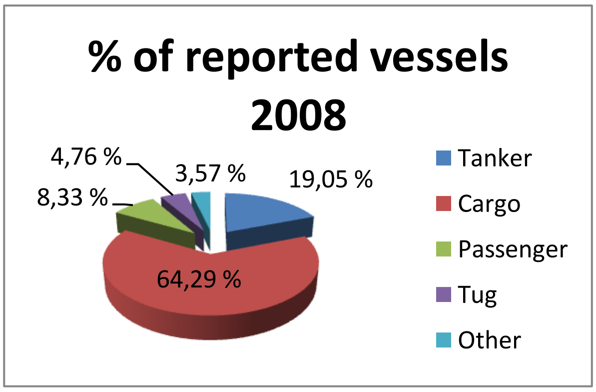

Figure 4.5 VTS-reported (2008) vessels by type

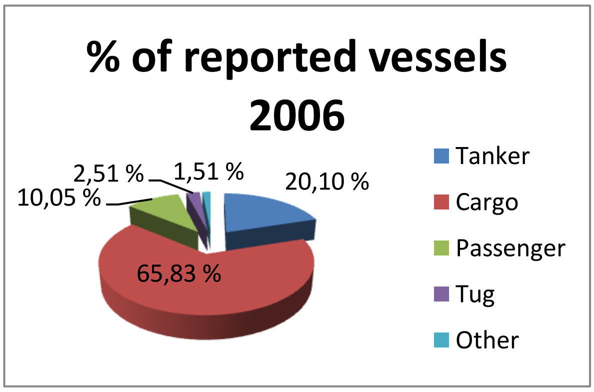

Figure 4.3 VTS-reported (2006) vessels by type

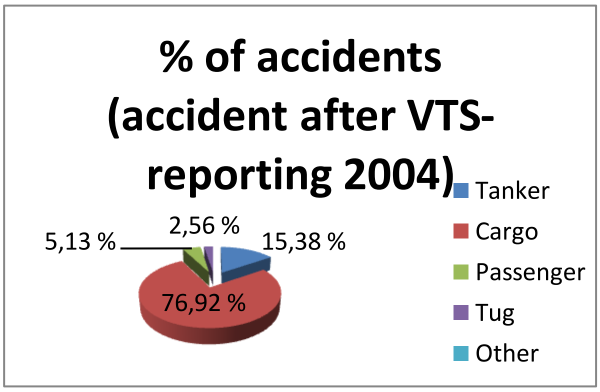

Figure 4.6 VTS-reported (2004) accident vessels by type

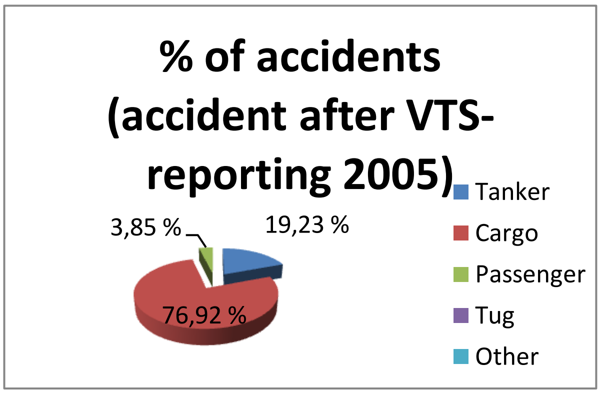

Figure 4.7 VTS-reported (2005) accident vessels by type

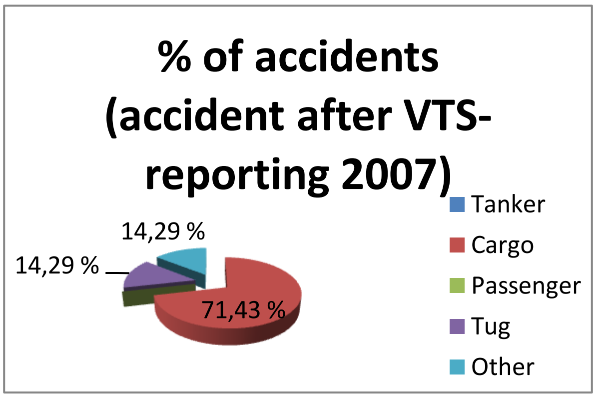

Figure 4.9 VTS-reported (2007) accident vessels by type

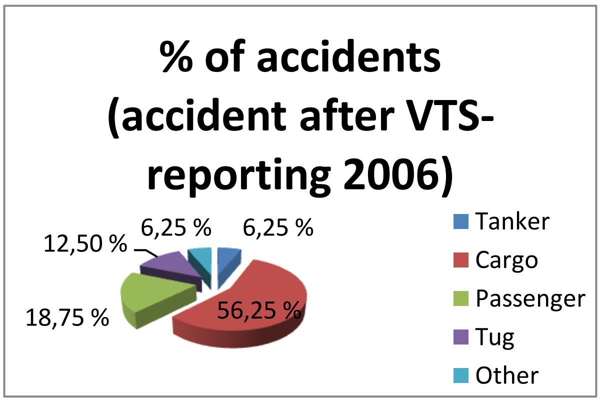

Figure 4.8 VTS-reported (2006) accident vessels by type

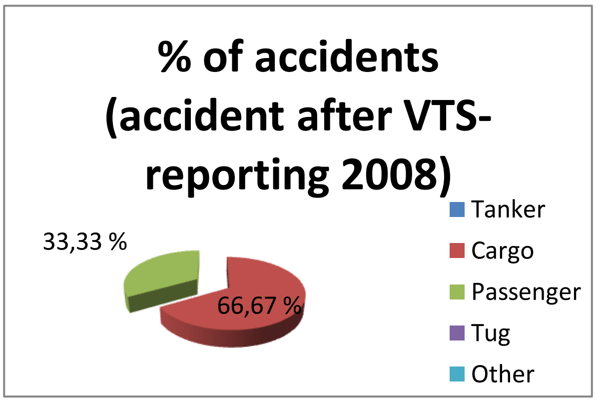

Figure 4.10 VTS-reported (2008) accident vessels by type

Accident distribution of year 2008, figure 4.10 should be disregarded due the time line between VTS-reports and accidents have not yet had time to realise and thus the first three accidents should not be considered as ready distribution. Also the 2007 distribution, figure 4.9, may suffer considerable error due less than half of expected accidents, table 4.2, have realised so far.

During the interviews [Lappalainen and Salmi, 2009] some thoughts were presented concerning safety threats caused by foreign flagged vessels in GOF. From the table 4.5 (distribution of VTS-reported(2004)vessels by flag) can be observed that, VTS-reported vessels of flags generally assumed relatively safe such as Finland, Sweden, Germany and UK are among the most accident prone (over 10% of reported vessels accident within 4years). This would suggest that VTS-reporting is able to identify with adequate precision the resting group of "bad apples" in otherwise "clean basket". The "clean basket" refers that all these flags are stated repeatedly by Paris MOU [Paris MOU, 2009a] as "white flags", meaning that vessels under these flags are assumed to be the safest. These same flags are present constantly in the VTS-reporting (figure 4.11) as is also Russia.

The partition of Russian flagged vessels in VTS-reporting is extremely high and constant (figure 4.11), but this can partially be contributed to high density of Russian flagged vessels in GOF. When dissecting information concerning Russian flagged VTS-reported accident vessels it can be noticed, table 4.6, that the distribution of vessels is rather homogeneous: Old and small general cargo vessels, table 4.7. So rather than concluding that Russian flagged vessels are accident prone, the conclusion should be that Russian flagged old general cargo vessels are accident prone.

Table 4.5 Distribution of 2004 VTS-reporting by flag

2004 VTS reported vessels (472 vessels, from which 48 found in accident statistics)				
Flagstate	% of VTS reported vessels 2004	% of all VTS(2004) reported accident vessels	% of all VTS (2004) reported accident vessels (accident after reporting 2004)	(total of 38 vessels) % of reported vessels accident after report
ANTIGUA & BARBUDA	3,75 %	8,51 %	2,70 %	5,88 %
BAHAMAS	4,86 %	2,13 %	2,70 %	4,55 %
BARBADOS	0,00 %	0,00 %	0,00 %	0,00 %
BELGIUM	0,22 %	0,00 %	0,00 %	0,00 %
BELIZE	1,32 %	0,00 %	0,00 %	0,00 %
BERMUDA	0,22 %	0,00 %	0,00 %	0,00 %
BULGARIA	0,00 %	0,00 %	0,00 %	0,00 %
CAMBODIA	1,10 %	0,00 %	0,00 %	0,00 %
CAYMAN ISLANDS	0,22 %	0,00 %	0,00 %	0,00 %
CHILE	0,00 %	0,00 %	0,00 %	0,00 %
CHINA	0,22 %	0,00 %	0,00 %	0,00 %
COMOROS	0,00 %	0,00 %	0,00 %	0,00 %
CROATIA	0,22 %	0,00 %	0,00 %	0,00 %
CYPRUS	4,64 %	4,26 %	2,70 %	4,76 %
DENMARK	2,43 %	0,00 %	0,00 %	0,00 %
DOMINICAN	0,88 %	0,00 %	0,00 %	0,00 %
ESTONIA	2,21 %	4,26 %	2,70 %	10,00 %
FINLAND	3,53 %	4,26 %	5,41 %	12,50 %
FRANCE	0,22 %	0,00 %	0,00 %	0,00 %
GEORGIA	0,44 %	0,00 %	0,00 %	0,00 %
GERMANY	2,65 %	4,26 %	5,41 %	16,67 %
GIBRALTAR	3,09 %	4,26 %	2,70 %	7,14 %
GREECE	0,66 %	0,00 %	0,00 %	0,00 %
INDIA	0,00 %	0,00 %	0,00 %	0,00 %
IRISH REPUBLIC	0,22 %	0,00 %	0,00 %	0,00 %
ISLE OF MAN	1,77 %	8,51 %	10,81 %	50,00 %
ITALY	1,99 %	0,00 %	0,00 %	0,00 %
JAMAICA	0,22 %	0,00 %	0,00 %	0,00 %
LATVIA	0,00 %	0,00 %	0,00 %	0,00 %
LIBERIA	2,87 %	2,13 %	2,70 %	7,69 %
LITHUANIA	0,66 %	2,13 %	0,00 %	0,00 %
LUXENBOURG	0,44 %	2,13 %	2,70 %	50,00 %
MALAYSIA	0,00 %	0,00 %	0,00 %	0,00 %
MALTA	4,19 %	2,13 %	2,70 %	5,26 %
MARSHALL ISLANDS	0,88 %	0,00 %	0,00 %	0,00 %
MYANMAR	0,44 %	0,00 %	0,00 %	0,00 %
NETHERLANDS	9,93 %	6,38 %	2,70 %	2,22 %
NETHERLANDS ANTILLES	1,55 %	2,13 %	2,70 %	14,29 %
NORTH KOREA	0,00 %	0,00 %	0,00 %	0,00 %
NORWAY	5,08 %	2,13 %	2,70 %	4,35 %
PANAMA	4,86 %	2,13 %	2,70 %	4,55 %
POLAND	0,22 %	0,00 %	0,00 %	0,00 %
PORTUGAL	2,43 %	4,26 %	5,41 %	18,18 %
RUSSIA	16,34 %	14,89 %	18,92 %	9,46 %
SAINT VINCENT AND THE GRENADINES	4,19 %	4,26 %	5,41 %	10,53 %
SINGAPORE	0,88 %	0,00 %	0,00 %	0,00 %
SLOVAKIA	0,00 %	0,00 %	0,00 %	0,00 %
SOUTH KOREA	0,22 %	0,00 %	0,00 %	0,00 %
SPAIN	0,22 %	0,00 %	0,00 %	0,00 %
SWEDEN	3,31 %	8,51 %	8,11 %	20,00 %
TAIWAN	0,00 %	0,00 %	0,00 %	0,00 %
THAILAND	0,22 %	0,00 %	0,00 %	0,00 %
TURKEY	0,44 %	0,00 %	0,00 %	0,00 %
TUVALU	0,22 %	2,13 %	2,70 %	100,00 %
UK	3,09 %	4,26 %	5,41 %	14,29 %
UKRAINE	0,00 %	0,00 %	0,00 %	0,00 %
VANUATU	0,22 %	0,00 %	0,00 %	0,00 %

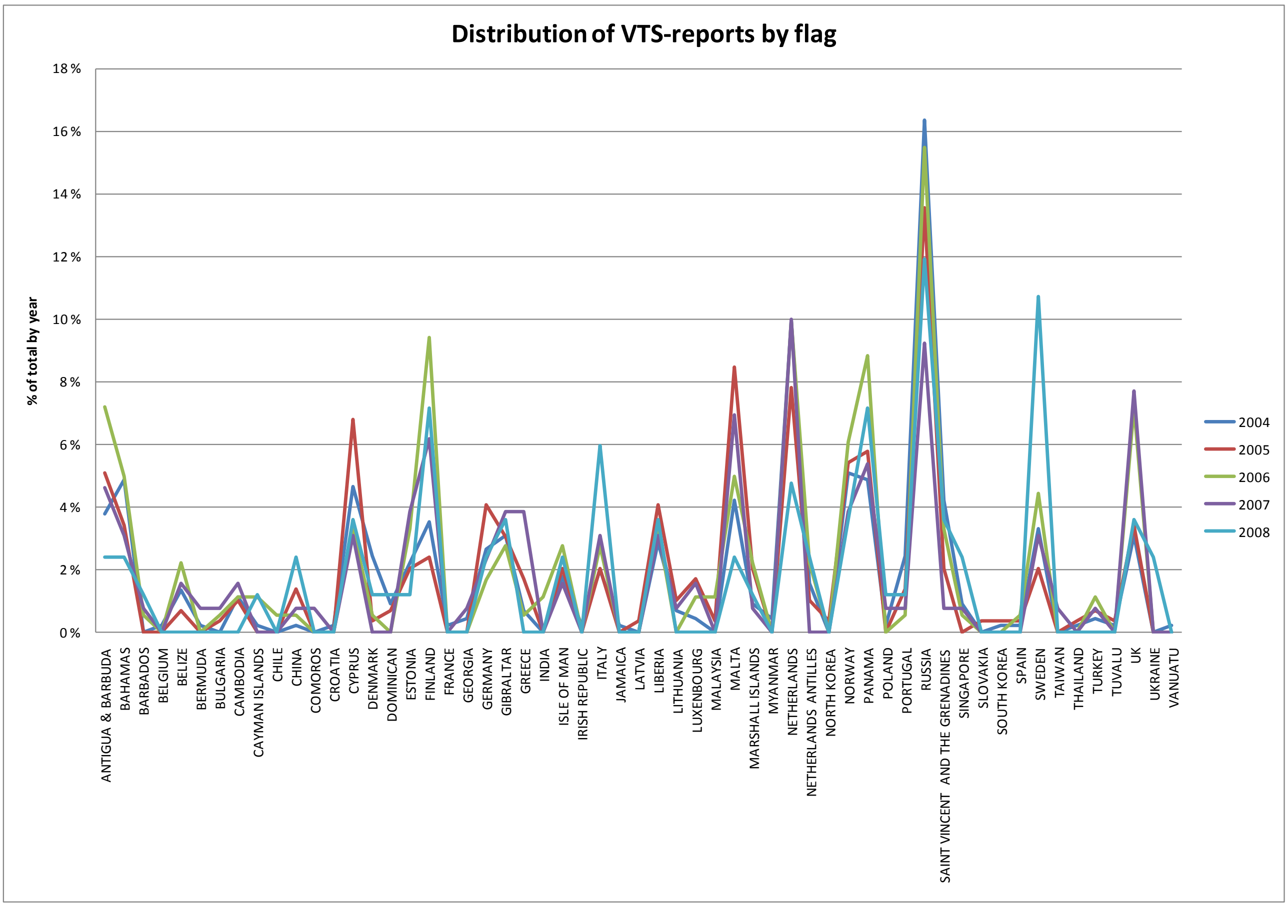

Figure 4.11 Distribution of VTS-reports 2004-2008 by flag

Table 4.6 VTS-reported (2004-2006) Russian accident vessels (accident after report)

YEAR OF VTS-REPORT	VESSEL TYPE	GT	AGE OF VESSEL
2004	GENERAL CARGO	2406	40
2004	GENERAL CARGO	2466	29
2004	GENERAL CARGO	1926	27
2004	OIL TANKER	14937	18
2004	GENERAL CARGO	2516	24
2004	GENERAL CARGO	3086	14
2004	GENERAL CARGO	1719	14
2004	Average for general cargo	2353	25
2005	GENERAL CARGO	1926	28
2005	GENERAL CARGO	2478	25
2005	GENERAL CARGO	2457	27
2005	GENERAL CARGO	3466	16
2005	GENERAL CARGO	2264	13
2005	Average for general cargo	2518	22
2006	GENERAL CARGO	3466	17
2006	GENERAL CARGO	2466	31
2006	GENERAL CARGO	1926	29
2006	GENERAL CARGO	2516	25
2006	GENERAL CARGO	3466	17
2006	Average for general cargo	2768	24

As was concluded from table 4.6, vessels of certain type and age, flying under certain flags can be considered more accident prone than others. But the categorizing can be further continued by comparing companies[5] behind these vessels. Information concerning companies related to 2007 HELCOM area accident vessels that have also been identified by VTS-reporting can be seen in table 4.7.

Table 4.7 Comparison of 2007 indicated companies (green = clean company)

TYPE OF COMPANY	COMPANY ORIGIN	VESSELS / (registred by Finnish AIS)[6]	ACCIDENT VESSELS	ACCIDENT VESSELS %	VESSELS IN VTS-REPORTS	VESSELS IN VTS-REPORTS %
CHARTER	SWEDEN	11	4	36,4 %	3	27,3 %
		10	4	40,0 %	3	30,0 %
MANAGER	NETHERLANDS	10	1	10,0 %	2	20,0 %
		7	1	14,3 %	2	28,6 %
CHARTER	SWEDEN	25	3	12,0 %	9	36,0 %
		25	3	12,0 %	9	36,0 %
MANAGER	GERMANY	7	0	0,0 %	0	0,0 %
		4	0	0,0 %	0	0,0 %
MANAGER	NETHERLANDS	21	0	0,0 %	2	9,5 %
		16	0	0,0 %	2	12,5 %
MANAGER	GERMANY	95	5	5,3 %	7	7,4 %
		63	5	7,9 %	7	11,1 %
MANAGER	LATVIA	3	1	33,3 %	1	33,3 %
		3	1	33,3 %	1	33,3 %
MANAGER	SPAIN	7	1	14,3 %	1	14,3 %
		2	1	50,0 %	1	50,0 %
MANAGER	LATVIA	19	0	0,0 %	4	21,1 %
		19	0	0,0 %	4	21,1 %
MANAGER	RUSSIA	3	2	66,7 %	3	100,0 %
		3	2	66,7 %	3	100,0 %
MANAGER	GERMANY	6	3	50,0 %	1	16,7 %
		4	2	50,0 %	1	25,0 %
MANAGER	RUSSIA	3	1	33,3 %	2	66,7 %
		3	1	33,3 %	2	66,7 %
MANAGER	RUSSIA	9	2	22,2 %	3	33,3 %
		9	2	22,2 %	3	33,3 %
MANAGER	RUSSIA	5	1	20,0 %	2	40,0 %
		5	1	20,0 %	2	40,0 %
MANAGER	GERMANY	7	0	0,0 %	2	28,6 %
		7	0	0,0 %	2	28,6 %
MANAGER	UK	6	1	16,7 %	1	16,7 %
		1	1	100,0 %	1	100,0 %
MANAGER	NORWAY	99	0	0,0 %	6	6,06 %
		75	0	0,0 %	6	8,00 %

[5] Managing and/or chartering companies

[6] Registered by Finnish AIS = Vessels proved to voyage in GOF and in Finnish coastal waters. This limited group should be used instead of the whole fleet of the company.

The list in table 4.7 is not complete, information concerning vessels and companies have been gathered using company web pages and ParisMOU PSC information [Paris MOU, 2009b], and may suffer of inadequate reliability. In table 4.7 there are also 5 companies which were noted to have 0 accident vessels, from these companies 3 were identified in first place due vessel that have been changing manager, thus these companies are clean. The 2 other companies with 0 accidents had apparently cut their contacts to vessels that got them identified. When actual fleet of these two companies was verified against Port State Control information (approach explained more detailed in next chapter) it was confirmed that these companies belong to the accident prone list.

When table 4.7 company origins are viewed, it can be seen that they are all Europeans, thus with common goal of safe Baltic Sea, they could all be forced to change their company policies towards safer by national laws and regulations, without need of IMO acceptance. It can be seen that companies presented in table 4.7 present companies of various sizes, with exception of Russian companies which are all rather small. Earlier presented hypotheses that "Russian flagged old general cargo vessels are accident prone" should thus be presented: "Russian shipping companies with small fleet of old general cargo vessels seem to be accident prone". But as can be noticed from tables 4.5 and 4.7 Russia is not the only Baltic Sea state having these accident prone companies. And as presented in chapter 4.1.1 tugs are also over presented in statistics and by studying deeper VTS-reported tugs, a Finnish company with all its tugs over 50 GT reported is identified. Tugs and companies providing tugs can be considered as part of the safety net, with icebreakers, VTS and pilot services. This safety net cannot have weak links if expected to work when needed the most.

When estimating the efficiency of VTS-incident reporting in identifying accident prone vessels, the approach can be turned to verify how big portion of accident vessels of certain period were pre-identified by VTS-reporting. This approach was concluded using 2007 accidents in Baltic Sea, table 4.8. Accident vessel IMO numbers were first filtered with AIS-information, so that only the accidents where vessel had voyaged in Finnish AIS-recording areas within a year before/after her accident were considered. This limited group consisted 79 of all the 124 of 2007 accident vessels. From these 79 vessels, 18 were pre-identified by VTS incident reporting, thus 22,78% of accidents could have been avoided with keeping these vessel in ports or by changing the way they operate. This would mean that by adopting similar reporting system around Baltic Sea, with appropriate possibilities and tools to "correct" these accident prone vessels (and companies) a direct cut of almost one fourth of accidents could be expected. The year 2007 was chosen for the approach due available AIS-data for limiting concerned vessels was available.

Table 4.8 VTS-reporting versus HELCOM accidents (filtered with AIS-data)

2007 HELCOM accidents	Reported accidents	Vessels in Finnish AIS recording	In VTS-reporting pre-accident
Count	124	79	18
% of all the accidents		63,71 %	14,52 %
% of AIS-limited accidents			22,78 %

AIS filtering was also used to get comparable information concerning VTS reported and non reported vessels in Baltic Sea, table 4.9. When comparing AIS registered vessels from period of January to June 2006 to year 2006 VTS reported *vessels it can be noticed that accident probability[7] of VTS reported vessels is approximately 1.5 times the normal. Or almost a double if table 4.2 presented corrected accident frequency estimation of 8,65% is used. This rather low rise of accident probability between these two groups can be concerned rather alarming: 1 to 2 vessels of every hundred vessels travelling in Baltic Sea would end up into accident statistics every year.*

Table 4.9 Comparison of VTS-reported and non reported vessels accident statistics[8]

Comparison of accident statistics of VTS-reported and non reported vessels	Quantity	% of vessels in HELCOM accident statistics 2002-2008	% of vessels in HELCOM accident statistics 2006 -2008	% of vessels accident after being reported by VTS
AIS registred vessels Jan - Jun 2006 (not VTS-reported with accident statistics entry)	2384	8,35 %	4,61 %	
VTS-reported vessels 2006	199	14,07 %		6,53 %

4.1.2 RESULTS OF COMPARING REPORTS OF MISBEHAVING TO PORTSTATE CONTROL REPORTS

Port State Controls made under Paris MOU umbrella reveal deficiencies concerning safety of vessels [Paris MOU, 2009b]. [Knapp and Frances, 2007] posed the relation of these deficiencies to accident probabilities.

VTS reported (2004-2008) vessels with accident in HELCOM statistics after the VTS reporting were cross-examined with Paris MOU PSC data. Total count of concerned vessels was 72, from which 4 vessels were still discounted due 0 PSC inspection reports were found. A reference group for comparison was gathered using vessels which had been registered by Finnish AIS. This reference group was formed by selecting first 12 vessels registered in January, April, July and October 2006. After removing duplicates, vessels indicated in VTS-reporting and vessels with 0 PSC inspections, the reference group consisted of 34 vessels from which 3 were also indicated in HELCOM accident statistics. The basic data of the comparison in table 4.10 reveals that the randomly chosen reference group has more detentions per inspection than the accident group, which would state that the reference group has more safety related problems than the accident group. When comparing the VTS accident group to 2008 Paris MOU average statistics [Paris MOU, 2009a], it can be concluded, that the targeted VTS accident group has less deficiencies and slightly less detentions than average vessel inspected by Paris MOU PSC regime. This would refer that PSC scope should be re-orientated.

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[7] Probability has been derived from frequencies presented in tables 4.2 and 4.9

[8] AIS registered vessels are used as reference group, presenting average vessels sailing in GOF

Table 4.10 Statistics of PSC inspection comparison between VTS-reporting and reference group

	Vessels	average quantity of deficiencies	number of inspections	average number of detention causing deficiencies	detentions	inspections / detention	average % of inspections with 0 deficiencies
VTS accident group	68	2,8	561	4,1	27	20,8	45,42 %
Reference group	34	3,0	268	3,9	17	**15,8**	44,48 %
PSC 2008		3,4	24647		1220	20,2	42 %

When lists of deficiencies of the VTS accident group and the reference group were scrutinized into types of deficiencies reflecting safety cultural aspects presented in former reports [Kiuru and Salmi, 2009] [Lappalainen and Salmi, 2009] . Five types of deficiencies were thus considered significant in presenting possible lacks of safety culture on board, table 4.11:

1. *ISM related deficiencies*
2. *Missing charts and nautical publications*
3. *Missing/non conformity of passage plan*
4. *Missing/technical problems of navigational aids and communication equipment (radar, radio etc.)*
5. *Repeating deficiencies concerning cleanness of machinery/working spaces*

Table 4.11 Occurrence of PCS deficiencies indicating lack of safety culture

Occurrence of deficiencies indicating lack of safety culture	0/5	1/5	2/5	3/5	4/5	5/5	Average
VTS accident group	13,24 %	25,00 %	11,76 %	26,47 %	16,18 %	7,35 %	2,29
Reference group	8,82 %	47,06 %	20,59 %	14,71 %	8,82 %	0,00 %	1,68

The aging of vessel may lead to more and dirtier maintenance work on board and thus older vessels with otherwise working safety management system may sometimes be punished for this weakness. Thus the 5th deficiency was removed to present the change of results in table 4.12.

Table 4.12 Occurrence of PCS deficiencies indicating lack of safety culture (without cleanness of machinery/working spaces)

Occurrence of limited deficiencies indicating lack of safety culture	0/4	1/4	2/4	3/4	4/4	Average
VTS accident group	14,71 %	25,00 %	11,76 %	30,88 %	17,65 %	2,12
Reference group	11,76 %	44,12 %	32,35 %	5,88 %	5,88 %	1,50

From table 4.11 can be observed that 60% of VTS accident group vessels have had 2 or more deficiencies indicating problems of safety culture, when comparing this to table 4.12 results, it can be seen that the same 60 % can now be found when counting categories 2 or more deficiencies. Thus this would indicate that the 5th deficiency is less important in indicating missing safety culture.

The reference group has with both of the approaches approximately the same result, 55% of vessels have 0 to 1 of these indicator deficiencies. Zero vessels in reference group had all 5 deficiencies present while 7,35% of accident group had them all. Only 11,8% of reference group had 3 to 4 deficiencies with the limited approach, while corresponding percentage in the accident group was 48,5%.

When the three accident vessels of reference group are viewed, following can be observed:

- *one has 3 indicating deficiencies present with the repeating cleanness issue and 20% of 0-deficiency inspections.*
- *two of them have only one indicating deficiency (charts / passage plan) with 60% and 87,5% 0-deficiency inspections.*

The conclusion is that by targeting vessels with 3 to 4 true deficiencies (not including the easily seen cleanness issue) approximately half of the accident prone vessels could be pre-identified. When vessels with less deficiencies but with deficiencies concerning charts and route planning will be added to this group, most of the future accident vessels can be pre-identified.

The 0 accident vessel companies, table 4.7, stated belonging in to accident prone list in chapter 4.1.1 had PSC records presented in table 4.13. The seven vessel company has approximately the same average of indicator deficiencies as the VTS-accident group and the 19 vessel company has approximately one and a half times the average values of the VTS-accident group. And when viewing deficiencies concerning missing charts and passage plan, both companies have only two without neither of these deficiencies, corresponding 28,6% and 10,5% of all the vessels. This shows that in these companies the problem of inadequate safety culture is not concerning some single vessels, but is truly a problem of the whole company. Thus company safety management is not working adequately to improve the company safety culture. Especially the 19 vessel company can be considered as danger element for the whole maritime traffic and to the environment of the Baltic Sea.

Table 4.13 Indicator deficiencies by company

Occurrence of deficiencies indicating lack of safety culture	0/5	1/5	2/5	3/5	4/5	5/5	Average
7 vessel company	0,00 %	14,29 %	57,14 %	14,29 %	14,29 %	0,00 %	2,29
19 vessel company	0,00 %	0,00 %	10,53 %	31,58 %	47,37 %	10,53 %	3,43
Occurrence of limited deficiencies indicating lack of safety culture	0/4	1/4	2/4	3/4	4/4	Average	
7 vessel company	0,00 %	28,57 %	42,86 %	28,57 %	0,00 %	2,00	
19 vessel company	0,00 %	0,00 %	15,79 %	52,63 %	31,58 %	3,14	

4.2 QUALITATIVE ANALYSIS OF SAFETY CULTURE INFLUENCE

When measuring culture or other behavioural factors a set of indicators is often build using expert evaluation on what could indicate the best certain type of behaviour. Then this type of behaviour is charted statistically and received distributions are used to explain chosen events. In most cases the quantitative result needs to be qualitatively evaluated afterwards to assure its validity. In many cases, all the wanted information cannot be measured with quantifiable measures in the first place and thus the qualitative analyse has to be used. In the previous chapter 4.1 quantitative analyses were presented with some qualitative analyses supporting them. In this chapter the materiel used for quantitative analyses is reanalysed qualitatively. Some material is also presented only in qualitative form.

4.2.1 RESULTS OF USING COMPANY STATISTICS, REPORTING AND AUDITING

As was presented by [Lappalainen and Salmi, 2009], the use of statistics for safety development in Finnish shipping companies varies considerably. One of the companies in Finland where the use of statistics have been taken into level of daily tool is Neste Shipping. Neste shipping due its connection to O&G branch is constantly measuring its safety performance; -this information is required by their clients. The improvement of safety during the years 2003 to 2008 in Neste Shipping has been remarkable, they have been able to cut their incidents to one third during this time. In the O&G branch the economical impact of working safety system can be quantified by measuring for example safety related refusals (potential client refuses to use tanker due safety related deficiencies). Surely developing and maintaining of all comprehending safety measuring costs money and time, but in O&G costs can be compensated in form of new contracts, less medical payments etc.

Even without self-regulating branch and demanding clients a statistical approach of safety can deliver information concerning success of company strategies and can thus be used as a tool. Applied indicators may give information concerning causes, sites, human influence etc. Especially different indicators of human influence can be considered important when measuring the effectiveness of safety management and thus the implementation of safety culture.

Some companies have not found the added value of statistical approach, but are still committed to safety. This commitment shows with comparable presence of safety as the primary issue of day to day actions, as in the companies with more sophisticated safety measuring systems. Strategic changes in safety issues in this kind of companies are based solely on expert evaluations and company politics, and are thus more difficult to justify, especially when costing money.

The common links between viewed companies were the constant presence of safety as an issue and emphasising of importance of internal auditing. Auditing in here covers verification rounds made by vessel crews as well as audits made by company safety management. These two factors develop culture of vigilance where deficiency is no longer an anomaly which has to be hided due fear of punishment, but rather an anomaly which has to be assessed and eliminated to assure safety and quality. [Grabowski and al., 2007] presented that to improve organisational safety culture the following four safety factors have to be concerned:

1. *Hiring personnel*
2. *Orientation in safety*
3. *Promotion of safety*
4. *Formal learning system*

In these four companies viewed, all four factors were at the minimum level followed and at the maximum measured with multiple indicators.

As the reporting becomes more of a routine, more truthful reports can be expected, and thus the assessment will give true indicators of how to develop safety. The companies that provided their data and interviews for METKU project will both benefit and profit systems such as INSJÖ and FORSEA, referred in chapter 3, due their adequate reporting and working safety management. Companies presented as problematic in chapters 4.1.1 and 4.1.2 cannot give or receive any added value to/from these systems before they manage to resolve bigger safety cultural issues onboard their vessels.

4.2.2 OBSERVATIONS FROM VTS-REPORTS

When presenting information statistically some important but rare event may get hidden behind the numbers and thus a qualitative analyse of VTS-reports was also made. Even though true ecological catastrophes have been avoided in the GOF, there have been occasions where skills and luck have been tested, as presented in figures 4.12 and 4.13.

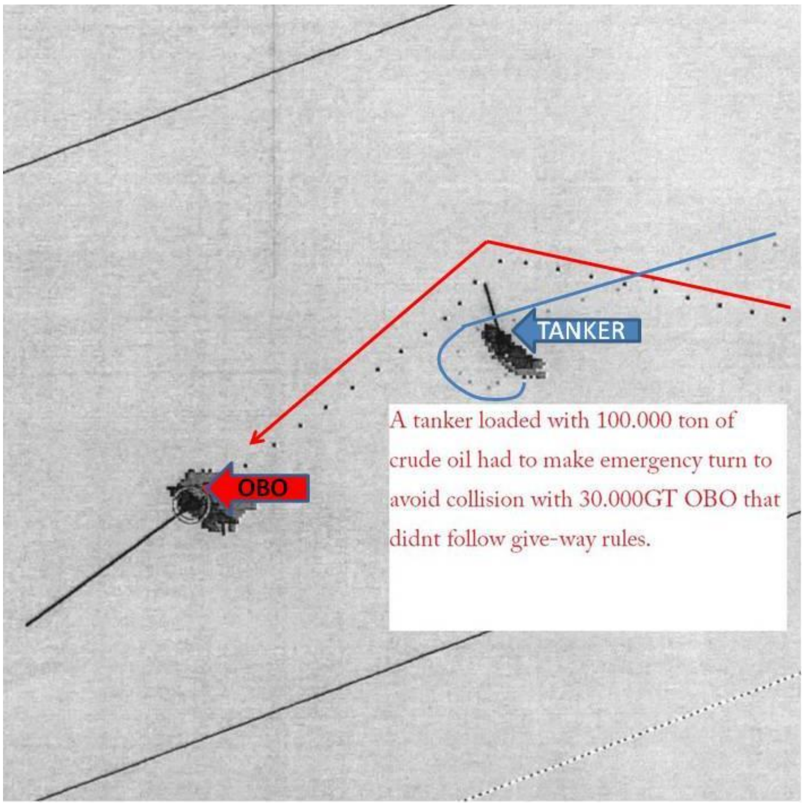

Figure 4.12 VTS print screen: Close by oil catastrophe

The close by situation presented in figure 4.12 shows clearly threats of misbehaving and the need of rule obeisance.

The description presented in figure 4.13 shows not only the bad misjudgement of the "sleeper" but also the inexistence of safety culture onboard the vessel. There should be two persons in the bridge all the time to assure the safe navigation, in this case it is obvious that the custom was of having only one.

Description of incident and its reasons:

When crossing Helsinki Traffic eastern reporting line no contact was taken from [redacted] The vessel did not reply to Helsinki Traffic calls on any channels (16, 60) and it didn't turn to west according to the normal traffic flow. A little later Finnish Coast Guard was alerted because the ship was continuing towards danger at Finnish territorial waters and still no contact despite of many attempts. The Coast Guard tried to awake the ships attention with several DSC-calls with no responding on [redacted] The ship continued with the same course and speed and when it had approximately one hour of sailing before possible grounding the coast guard patrol ship Tavi left it's anchoring position at north west of Kallbådaground and was heading to meet the ship. Appr. 11' before the first shallows ship altered its course to west. The first contact was taken on ch 60 and on ch 80 a person who had just arrived to the bridge told he had found the bridge empty. This was reported to the Coast Guard. A few minutes later on the second contact the person on the bridge told the person thought to be missing was found in one of the ship's cabins.

Figure 4.13 VTS incident report: Example of "zombie" -Just in time wakeup

The change of reporting regime in GOF showed that many vessels are still unaware of new regulations years after their coming into force. Naturally the number of vessels not knowing how to act in GOFREP is decreasing every year, but for example 2008 there were still 38 zombie reported vessels and the reporting obligation started July 2004. Seafarer are tired of new rules (comment received during interviews [Lappalainen and Salmi, 2009]), but by implementing new rules the functioning of company safety management can be measured: Companies where safety management is not functioning as it should, the new regulations are not followed, thus these companies can be identified with systems such as VTS-reporting.

4.2.3 OBSERVATIONS FROM PSC INSPECTION INFORMATION

The effort made by Paris MOU countries by the means of PSC [Paris MOU, 2009a], is huge and it surely has positive effect on diminishing accidents in maritime traffic. As quantitative analysis presented in chapter 4.1.2, it seems that the VTS-identified accident vessel group is detained less often than average vessel and this needed some qualitative assessment for clarification. By reading results of PSC a major malfunction can be observed:

Missing charts, nautical publications and navigational aids don't seem to be sufficient reason for detention!

And as observed in chapter 4.1.1 and earlier by [Kiuru and Salmi, 2009], these same factors cause accidents directly and indirectly with other factors.

Another interesting observation is that vessels with constant list of over 10 (with pikes up to 40) PSC deficiencies can sail years without detentions or banning.

4.3 ACCIDENT SCENARIO MODELING

At the moment efforts are put around the globe on modelling the safety of maritime traffic. There are two major goals in this pursuit:

1. *Strategic level: Probabilistic models for forecasting future needs of traffic control and guidance as well as needed changes of infrastructure and fairway limitations. Example presented in [SAFGOF].*
2. *Operative level: Dynamic models that can be used operatively by administration on preventing accidents and which can later be developed for use of autopilots. Example presented in [EfficienSea].*

Geometrical models such as [Macduff, 1974] and [Fujii, 1974] are not giving adequate precision due the missing human interface and thus new models imitating human behavior are needed. In [EfficienSea], such behavioural *information is believed to be found using AIS data of vessel tracks. In [SAFGOF] approach the expert board was used to find behavioural factors behind accident probabilities.*

The potential of VTS-reports as a source of information for both of the previously presented approaches cannot be presented individually, but rather with a set of other tools. The information gained with analysis presented in chapter 4.1 and 4.2 should be used as a supplement for analysis made using geometrical and system based approaches. After the balance between human-factor, geometrical and system based probabilities is found, the use of vessel track (AIS) information combined with meteorological information can be used to provide probabilities which should be validated by expert board consisting active seafarer from administration as well as from private sector.

5 CONCLUSIONS

The conclusions [Jalonen and Salmi, 2009] made earlier in METKU-project concerned the positive impact of systematic utilisation of leading and lagging indicators. The use of these indicators in safety modelling for the safety development of maritime traffic is validated in this report. Necessary tools are already invented, or at least modifiable from existing tools, to provide information and data that can be used as input for probabilistic models of safety. In this report two main issues concerning safety and its measuring were highlighted:

- *How can accident prone vessels and companies be targeted and what are the factors that make these vessels and companies accident prone.*
- *The influence of safety culture to safety*

Conclusions regarding both issues are drawn below.

5.1 CONCLUSIONS OF TARGETING

The presence of quantifiable data that can be used in the role of leading indicators of safety was demonstrated while presenting analyses and results in chapter 4. By cross-examining different statistical information, such as VTS-reports, HELCOM accident statistics, Port State Control reports and AIS data of traffic flows, it can be claimed that VTS-reports can be used directly as set of indicators to target accident prone vessels with adequate precision. The accident frequency of the targeted vessels is up to two times higher than that of an average vessel sailing in GOF. It was also noted that the average yearly accident frequency in Baltic Sea is rather high, 1 to 2%. The conclusion is that difference between safe vessels and average vessels can already be multiplied in powers.

By using the VTS-report targeted vessels as a reference group to identify the unused potential of Paris MOU PSC, the possible effect of chosen indicators got highlighted. By using these two systems (PSC and VTS-reports) simultaneously and thus identifying accident prone companies among their vessels gives administration an extremely defined target group. Even though many of these accident prone vessels sail under non European flags, managing companies are mostly European, thus under national laws and regulations jurisdiction.

*Based on the presented findings it is recommended that Baltic Sea states, co-operatively, start to build VTS-reporting system covering the whole Baltic Sea and choose needed corrective actions to eliminate non safe seafaring from the Baltic Sea. Such actions would lead to a considerable decrease of accidents in Baltic Sea, with very little investment, at the same time **reinforcing economies of responsible and safe shipping companies.***

5.2 SAFETY CULTURE INFLUENCE

The most simple way of emphasising the influence of safety culture in maritime safety is to note that targeting which conclusion was presented in chapter 5.1, was based on indicators build on base of suggested lack of safety culture. To simplify, safety culture can be considered as working culture. Companies where working culture (here safety culture) cultivates efficiency and quality, are easily recognised. The same can be said about companies where efficiency and quality are not expected nor measured. Thus the presence and the level of safety culture can be recognised by auditing, and its influence can be measured using indicators developed with information of these audits.

Negative Key Performance Indicators (KPI's) used in this report to capture lacks of adequate safety culture:

- *Indifference to rules and regulations*
- *Deficiencies (either lacking or malfunctioning) of safety related material and equipment onboard*
- *ISM (and especially organisational) related problems*

To provide information for these indicators sets of lower level indicators presented in chapters 4.1.1 and 4.1.2 were used.

6 SUMMARY AND FURTHER RESEARCH

The development of the safety culture enhances incident reporting which leads not only to safer traffic, but it also brings several secondary advantages to various safety and security related issues. These secondary effects are standardised information assessment methods concerning vessels, crews and transported goods; controllable traffic flows; and clearer limits on what can be considered as anomaly on sea.

Different parties that can use these secondary effects on their advantage are: police, customs, health authorities and anti- terrorism/piracy authorities. The last argument should interest not only Baltic Sea EU members, but also Russia which has great ambitions on strategic Baltic Sea energy logistics.

The work carried out in this report demonstrates that accident prone companies can be identified and information indicating missing safety culture can be recognised. However, this report still stayed rather general level on describing effects of safety culture to safety. Thus it would be important to use the described targeting information and methods further: By studying influencing cultural factors onboard these accident prone vessels, one can learn to recognise and to model safety culture so that it can be implemented in future probabilistic accident/traffic models.

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Appendix I

Table 1. VTS-reporting by Vessel type

2004 VTS reported vessel

	% of reported vessels 2004	% of accidents	% of accidents (accident after VTS-reporting 2004)	% of reported vessels accident after report
Tanker	21,92 %	14,29 %	15,38 %	5,71 %
Cargo	66,81 %	79,59 %	76,92 %	9,38 %
Passenger	7,72 %	4,08 %	5,13 %	5,41 %
Tug	2,51 %	2,04 %	2,56 %	8,33 %
Other	1,04 %	0,00 %	0,00 %	0,00 %
	100,00 %	100,00 %	100,00 %	

2005 VTS reported vessel

	% of reported vessels 2005	% of accidents	% of accidents (accident after VTS-reporting 2005)	% of reported vessels accident after report
Tanker	22,85 %	15,91 %	19,23 %	7,25 %
Cargo	67,55 %	75,00 %	76,92 %	9,80 %
Passenger	6,62 %	9,09 %	3,85 %	5,00 %
Tug	1,99 %	0,00 %	0,00 %	0,00 %
Other	0,99 %	0,00 %	0,00 %	0,00 %
	100,00 %	100,00 %	100,00 %	

2006 VTS reported vessel

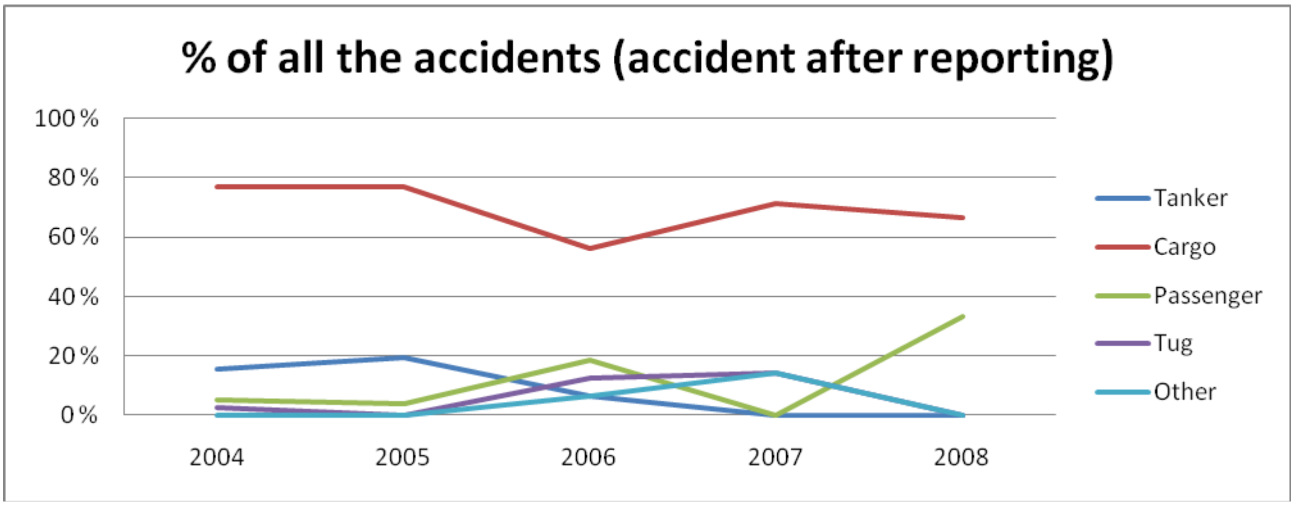
	% of reported vessels 2006	% of accidents	% of accidents (accident after VTS-reporting 2006)	% of reported vessels accident after report
Tanker	20,10 %	12,90 %	6,25 %	2,50 %
Cargo	65,83 %	61,29 %	56,25 %	6,87 %
Passenger	10,05 %	16,13 %	18,75 %	15,00 %
Tug	2,51 %	6,45 %	12,50 %	40,00 %
Other	1,51 %	3,23 %	6,25 %	33,33 %
	100,00 %	100,00 %	100,00 %	

2007 VTS reported vessel

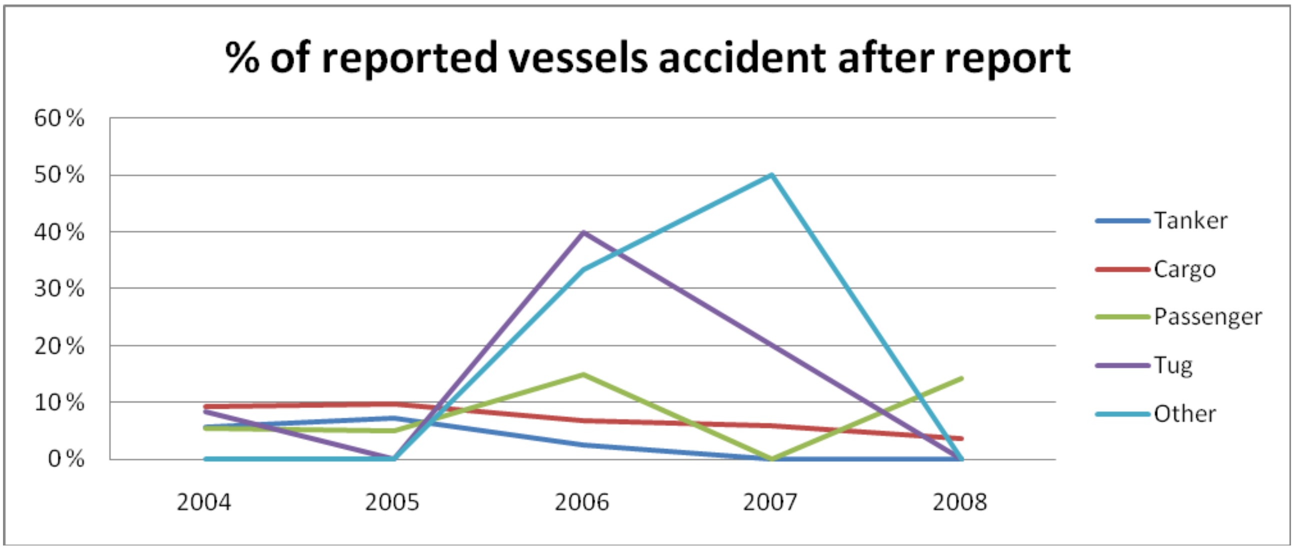
	% of reported vessels 2007	% of accidents	% of accidents (accident after VTS-reporting 2007)	% of reported vessels accident after report
Tanker	24,43 %	0,00 %	0,00 %	0,00 %
Cargo	63,36 %	64,29 %	71,43 %	6,02 %
Passenger	6,87 %	14,29 %	0,00 %	0,00 %
Tug	3,82 %	14,29 %	14,29 %	20,00 %
Other	1,53 %	7,14 %	14,29 %	50,00 %
	100,00 %	100,00 %	100,00 %	

2008 VTS reported vessel

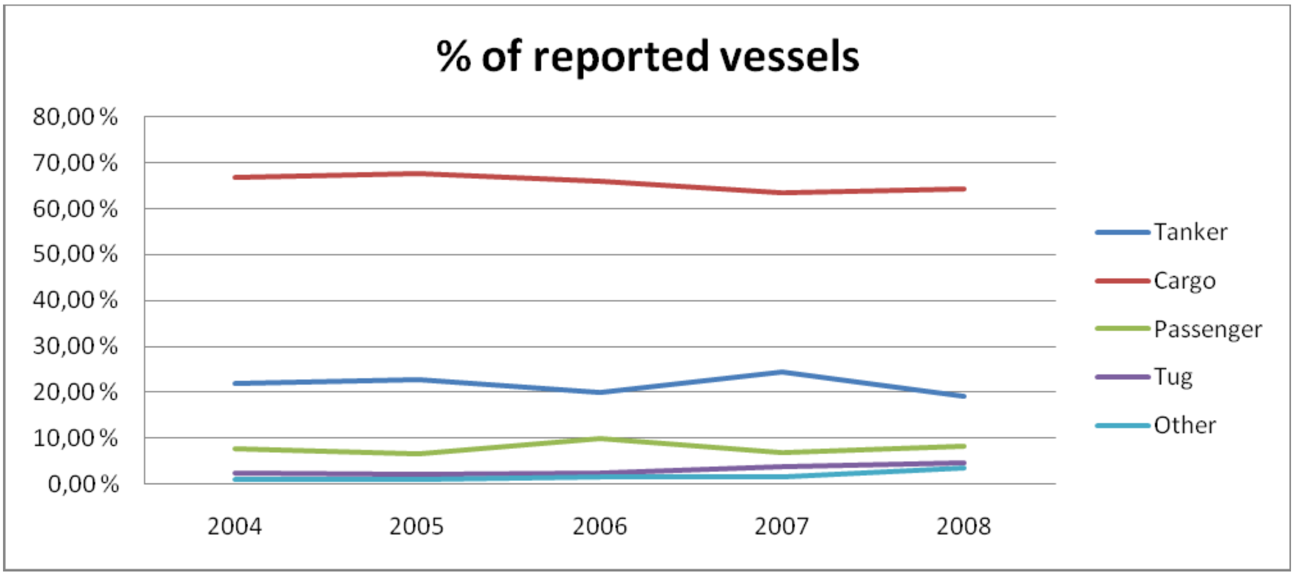
	% of reported vessels 2008	% of accidents	% of accidents (accident after VTS-reporting 2008)	% of reported vessels accident after report
Tanker	19,05 %	7,69 %	0,00 %	0,00 %
Cargo	64,29 %	84,62 %	66,67 %	3,70 %
Passenger	8,33 %	7,69 %	33,33 %	14,29 %
Tug	4,76 %	0,00 %	0,00 %	0,00 %
Other	3,57 %	0,00 %	0,00 %	0,00 %
	100,00 %	100,00 %	100,00 %	



% of all the accidents (accident after reporting)
100 %
80 %
60 %
40 %
20 %
0 %
2004
2005
2006
2007
2008
Tanker
Cargo
Passenger
Tug
Other



% of reported vessels accident after report
60 %
50 %
40 %
30 %
20 %
10 %
0 %
2004
2005
2006
2007
2008
Tanker
Cargo
Passenger
Tug
Other



% of reported vessels
80,00 %
70,00 %
60,00 %
50,00 %
40,00 %
30,00 %
20,00 %
10,00 %
0,00 %
2004
2005
2006
2007
2008
Tanker
Cargo
Passenger
Tug
Other

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