RESPONSIBILITIES OF GOVERNMENTS AND MEASURES TO ENCOURAGE
FLAG STATE COMPLIANCE

Multi-criteria (or multivariate) approach
for characterizing categories of high risk ships

Submitted by France

SUMMARY

Executive summary: This document contains the article on a “multi-criteria” (or multivariate) approach for characterizing categories of high risk ships referred to in document FSI 16/3, paragraph 31.3

Strategic direction: 5.3
High-level action: 5.3.1
Planned output: 5.3.1.5
Action to be taken: Paragraph 2
Related documents: FSI 15/3/1, FSI 15/3/2, FSI 15/3/3, FSI 15/INF.10 and FSI 16/3

1 The article on a “multi-criteria” (or multivariate) approach for characterizing categories of high risk ships, “From Black-Grey-White detention-based lists of flags to Black-Grey-White casualty-based lists of categories of vessels, using a multivariate approach?” By Thomas Degré – INRETS (Dec. 2007), which is referred to in document FSI 16/3, paragraph 31.3 is set out in the annex.

Action requested of the Sub-Committee

2 The Sub-Committee is invited to note the information provided in the context of its consideration of the report of the Correspondence Group on the Feasibility of Combining Casualty Data and Port State Control Data (FSI 16/3).
From Black-Grey-White detention-based lists of flags to Black-Grey-White casualty-based lists of categories of vessels, using a multivariate approach?

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INRETS

Abstract: The Paris Memorandum of Understanding (Paris MoU) establishes each year in its annual report the traditional “Black-Grey-White” lists of flags. These tables are based on processed performances of flags over a 3-year period, showing the full spectrum between quality flags and flags with a poor performance. The performance of each flag is calculated by the Paris MoU on the basis of inspected and detained ships flying the considered flag, using binomial calculus. Furthermore, black listed flags are one of the criteria, among others, used by the Paris MoU for targeting vessels for their inspections.

Using the same binomial calculation method as mentioned above but considering casualties instead of detentions and a multivariate approach instead of considering the flag only, it is possible to extend the Black-Grey-White lists of flags of the Paris MoU based on detentions to Black-Grey-White lists of categories of vessels with regards to their observed casualties on a given period.

At the time when a correspondence group has been set up by the Sub-Committee on Flag State Implementation of IMO for defining “objectives, framework of mechanisms and methodology for a study on the combination of casualty and Port State Control related data”, this paper has the ambition to give a valuable contribution to this group in the case it concludes to the necessity of combining casualty data and PSC related data with a view to complement the today processing of flag State performance and the targeting criteria for ships inspections.

This research has been founded by the European Commission (DG TREN) and conducted under the MarNIS research project.

Keywords: Ship Inspections, Port State Control, Detentions, Black-Grey-White lists, Risk, Casualties, Maritime Traffic, Probabilities, Multivariate approach

1 Context of the study

The Paris Memorandum of Understanding (Paris MoU) was established in 1982 to improve safety at sea. It consists today of 27 participating maritime Administrations and covers the waters of the European coastal States and of the North Atlantic from North America to Europe. Its mission is to inspect foreign ships calling at Paris MoU ports, aiming at eliminating the operation of sub-standard vessels through a harmonized system of Port State Control (PSC). The Paris MoU has defined for many years criteria in order to inspect the most risky1 vessels in priority order. The so-called Target Factor is still in use within the Paris MoU as a tool for selecting ships eligible for an inspection. For many years as well, the Black-Grey-White (BGW) lists of flags are established each year in order to provide an independent categorization of flags on the basis of inspected and detained vessels registered under these flags.

In cooperation with the European Commission and to take into account what happened during 2006 at the European Community level on the proposed recast Directive on PSC, the Paris MoU will soon implement a New Inspection Regime (NIR). This will replace the 25% commitment for individual member States with an annual 100% inspection coverage for vessels operating in the Paris MoU

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1 This term must be understood here in its common sense and not according to its technical definition i.e the product of the probability of a casualty and the consequences of the casualty.
region. But while low-risk ships will be rewarded with a 24 month interval, the High Risk Ships (HRS) as they are called in the NIR will be subject to a more rigorous inspection regime with an inspection every 6 months.

Criteria aiming at characterizing HRS are described in the internal report (Paris MoU, 2006). In this report, Paris MoU defines on one hand, the ship risk profile using a set of variables related to the ship - ship type, age, flag, company, Recognized Organization (R.O), number of deficiencies and detentions within previous 36 months - and on the other hand characterizes HRS by criteria in relation with each of these variables considered one by one, with associated weighting points. Black flagged vessel is one of these criteria. More precisely, as shown in table 1, criteria examples are: for ship type - chemical tankers, gas carriers, oil tankers, bulk carriers, passenger ships have a weighting point of 2; for ship age – ships >12 years old have a weighting point of 1; for ship flag – flags in the black list have a weighting point from 2 to 1 according to the flag is considered Very High Risk (VHR), High Risk (HR), Medium to High Risk (MtoHR) or Medium Risk (MR), etc. The total score is then added and the Paris MoU defines High Risk Ships as “ships which meet criteria to a total value of 5 or more weighting points” (Paris MoU, 2006).

### Table 1: Design of High Risk Ship in the NIR.

<table>
<thead>
<tr>
<th>Ship variables and related criteria</th>
<th>Weighting points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type:</strong> tanker (oil, gas, chemical) or bulk carrier or passenger ship</td>
<td>2</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Detentions</strong> &gt; 2 within the 36 previous months</td>
<td>1</td>
</tr>
<tr>
<td><strong>Flag</strong></td>
<td>2</td>
</tr>
<tr>
<td>Black VHR, HR, MtoHR</td>
<td>2</td>
</tr>
<tr>
<td>Black MR</td>
<td>1</td>
</tr>
<tr>
<td><strong>Company</strong> low/very low performance</td>
<td>2</td>
</tr>
<tr>
<td><strong>R.O</strong> low/very low performance</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total ≥ 5</strong></td>
<td></td>
</tr>
</tbody>
</table>

However, all of this additive process is mainly based on ship detentions and/or deficiencies and does not embrace the concept of risk according to its technical definition (see footnote 1). In particular, the probability component of risk is missing or in other words the probability of a casualty occurring.

In this context, some countries members of the Sub-Committee on Flag State Implementation (FSI) of International Maritime Organisation (IMO), in particular Turkey and New Zealand, had recommended that consideration be given to the integration of casualty and PSC data for the measurement of flag State performance, for the consideration of balanced criteria for the targeting of PSC inspections and more generally in order that a complete picture of a vessel’s activities and history would be available to the maritime community (FSI 15, 2007).

It is not the main intention of this paper to identify the pros and cons of the combination of casualty and PSC related data and the need for further study, if any. These are the first aspects of the terms of reference of the Correspondence Group which has been set up under the co-ordination of France by the Sub-Committee of FSI to clarify the situation (FSI 15, 2007).

The aim of this paper is to present a method similar to the one used by the Paris MoU to class flags in their BGW lists, but in which, the use of casualties instead of detentions and the consideration of a multivariate approach instead of considering the flag only as the Paris MoU does, may enable to extend the BGW detention based lists of flags established by the Paris MoU to BGW lists of categories of vessels based on their observed casualties on a given period.

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2 On the 6 criteria set up by the Paris MoU in the NIR targeting process, 2 are related to physical characteristics (type and age). The remaining four (on flag, R.O, company and number of detentions) are all functions of ship detentions and/or deficiencies.

3 The consequence component of risk is in some way taken into account through the criteria set on ship type (oil tankers, passenger vessels) i.e. all ship types which may generate high or very high societal consequences (pollution, loss of life) if a casualty occurs.
It is thought that this method, if its application is proven to be feasible, would be a valuable contribution to the Correspondence Group mentioned above in the case this group concludes to the necessity of combining casualty data and PSC data with a view to complement the today processing of flag State performance and the targeting criteria for ship inspections.

This research has been founded by the European Commission (DG TREN) and conducted under the MarNIS research project.

The remainder of this paper is organized as follows. In the next section 2, we briefly recall the method used by the Paris MoU to class the flags in their BGW lists. Then we explain in section 3 how to extend this method by a multivariate approach in order to establish BGW lists of categories of vessels as regards their observed casualties.

A limited application of this approach is given in section 4 to demonstrate the feasibility of its implementation and we discuss the limits. Finally, section 5 presents some conclusions.

2 The Paris MoU BGW lists of flags

2.1 The calculation of flag performances

The text contained in this section is extracted from (Paris MoU annual report, 2006, pages 50-51).

“The performance of each flag State is calculated using a standard formula for statistical calculations in which certain values have been fixed in accordance with agreed Paris MOU policy. Two limits are processed, based on binomial calculus: the ‘black to grey’ and the ‘grey to white’ limit, each with its own specific formula:

\[ U_{\text{black-to-grey}} = Np + 0.5 + z\sqrt{Np(1-p)} \]
\[ U_{\text{grey-to-white}} = Np - 0.5 - z\sqrt{Np(1-p)} \]

In the formula “N” is the number of inspections, “p” is the allowable detention limit (yardstick), set to 7% by the Paris MOU Port State Control Committee, and “z” is the significance requested (z=1.645 for a statistically acceptable certainty level of 95%).

Above this ‘black-to-grey’ limit means significantly worse than average, where a number of detentions below the ‘grey-to-white’ limit means significantly better than average. When the amount of detentions for a particular flag State is positioned between the two, the flag State will find itself on the grey list. The formula is applicable for sample sizes of 30 or more inspections over a 3-year period. To sort results on the black or white list, simply alter the target and repeat the calculation. Flags which are still significantly above this second target, are worse than the flags which are not. This process can be repeated, to create as many refinements as desired. (Of course the maximum detention rate remains 100%!) To make the flags’ performance comparable, the excess factor (EF) is introduced. Each incremental or decremental step corresponds with one whole EF-point of difference. Thus the excess factor EF is an indication for the number of times the yardstick has to be altered and recalculated. Once the excess factor is determined for all flags, the flags can be ordered by EF. The excess factor can be found in the last column the black, grey or white list. The target (yardstick) has been set on 7% and the size of the increment and decrement on 3%. The Black/Grey/White lists have been calculated in accordance with the above principles”.

2.2 The Paris MoU BGW lists 2006

To illustrate the application of the method used by the Paris MoU for the calculation of flag performances, Table 2 shows the Black-Grey lists 2006 established on 5 June 2007. The White list is established according to the same principles but is not shown in Table 2.

Annual report, 2006

3 A multivariate approach for the establishment of Black-Grey-White lists of categories of vessels with regards to their observed casualties on a given period.

3.1 Ship variables, levels of variables and category of vessels: a multivariable approach

In the framework of this approach, each vessel will be characterized by a set of six variables which are the following:

- three physical variables: ship type, size and age,
- three variables related to the entities which, somehow or other, manage the ship and take account in particular of compliance to international regulation, maintenance of vessels and equipments, training and quality of personnel on board, etc: ship flag, company (or owner) and Recognized Organization (R.O) (which is most often the classification society).

Other ship variables may be considered, or taken away, or added (from) to the list given above without difficulty (e.g. addition of some variables related to the ship history such as change of flag, change of owner, change of R.O, class withdrawn, etc.) the only constraint being to have enough ship numbers in each category of vessels (see below for definition).
The levels of each of these ship variables have then to be specified by considering their micro values and by grouping them adequately. This grouping process is made as a function of the values of the considered variable, having in mind to have enough ship numbers in each category of vessels (see definition below).

As an example, it can be decided to define:

- **for ship type**: 5 ship type levels based on the IMO definitions of selected major ship types as follows: bulk carrier (including OBO); general cargo vessel and multipurpose (including RoRo, Reefer, Heavy Load, ...); tanker (including oil, chemical, gas); container ship; passenger vessel (including ferries, RoRo passenger, ...)
- **for ship size**: 9 ship size levels in gt: size 1: 300 ≤ < 500; size 2: 500 ≤ < 1000; ...; size 9: ≥ 60,000 gt.
- **for ship age** (which is a continuous variable): 6 ship age levels in years: age 1: 0 < ≤ 5; age 2: 5 < ≤ 10;...; age 6: > 25.
- **for ship flag**: 4 levels by country groups (OECD, EU, Open Registries & Other countries) or by flag colours as allocated by Paris MoU as a function of the inspected and detained ships registered under this flag (6 levels from Black VHR to White)
- **for ship company and ship R.O**: 4 levels by country groups (same as for flag) or by performances according to Paris MoU formula as a function of detentions/deficiencies related to the ships owned or classified under this company or this R.O (4 levels from very low to high)

Defined within this approach is finally a **category** of vessels which is a set of vessels which meet a particular combination of levels of each of the sets of levels associated with the ship variables which have been chosen to characterize a vessel.

For instance, on the basis of the six ship variables and levels defined above, a particular category of vessels (among a total of 17,280 categories) is the set of all container ships of size 4 (1500-5000 gt), age 5 (20-25 years), grey flagged, owned by a medium level company, classified by a high level R.O.

This notion of category of vessels is very important because it enables a multivariate analysis (of casualties, detentions, deficiencies, etc.) by considering the set of N variables that have been chosen to characterize a vessel as a whole, instead of considering these variables one by one as it is done for instance in the Paris MoU targeting process.

Some additional comments about this notion are given hereunder:

- **Add1**: more variables and levels per variable are considered, the higher the number of combination of levels (i.e. the number of vessel categories) and of course the less the number of vessels per category are. **Example**: If we consider the 3 ship variables type, size and age only with the above mentioned levels, there are 5 x 9 x 6 = 270 vessel categories. If we consider the flag as a 4th ship variable having 4 levels, there are 1080 categories of vessels; etc.
- **Add2**: for statistical reasons which will be explained in the next section, the number of vessels per category must be at least 30. This minimum number can be obtained most often by considering world merchant fleet descriptive statistics on a sufficient wide time period (e.g. 10 years assuming a minimum of 3 ships/category/year).

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1. A more precise and mathematical definition may be given making reference to the number of variables and the number of levels per variable, but this one, illustrated with the example below, is sufficient for a good understanding of the reader.
2. But what is possible with the more can be done with the less: this approach enables an analysis by considering each single variable among the N, a combination of two variables chosen among the N, a combination of three variables chosen among the N, etc.
3.2 The calculation of the performances of categories of vessels

The same classical statistical method that is being used today by the Paris MoU to class flags in their BGW lists (see section 2) is used here to establish the performance of each category of vessels as regards its observed number of casualties on a given time period (Degré, 2007). The only differences with the Paris MoU are the following: casualties are considered instead of detentions; categories of vessels (as defined in 3.1) are considered instead of flags; the number n of vessels in a given category of vessels is considered instead of the number N of inspections a given flag is subject to.

Making clear the description of the method, it consists here of calculating, for each category of vessels, a confidence interval around the allowable number of casualties of that category. This calculation is based on a fixed allowable probability of casualty (p), the number (n) of vessels of the considered category and the assumption that casualties occur independently, which is generally the case. In this situation, the number of casualties of each category of vessels follow a Binomial distribution \( B(n, p) \) which can be approximated by a Normal distribution \( N(np, np(1-p)) \) if \( n \) is greater than 30. It is then possible to build for each category of vessels a 95% confidence interval around the allowable number of casualties of that category (i.e. around its expected average number of casualties which value is \( n.p \)) as expressed by the relation (I) below:

\[
[u_{white\ grey} ; u_{grey\ black}] = [np - 0.5 - z\sqrt{np(1-p)}; np + 0.5 + z\sqrt{np(1-p)}] \quad (I)
\]

(where \( z = 1.645 \) for a statistically acceptable certainty level of 95%)

The performance of each category of vessels may then be established by comparing the observed number of casualties of that category to the upper and lower limits of its own confidence interval (I) as follows:

- if the observed number of casualties of a category of vessels is over the upper limit of (I), this means that this observed number of casualties is statistically significantly higher than the expected average number of casualties of that category and this category of vessels belongs to the Black list (or, which is equivalent, is characterised as Black).
- If the observed number of casualties of a category of vessels is under the lower limit of (I), this means that this observed number of casualties is statistically significantly lower than the expected average number of casualties of that category and this category of vessels belongs to the White list (or, which is equivalent, is characterised as White).
- If the observed number of casualties is inside the confidence interval (I), this means that this observed number of casualties is around the expected average and this category of vessel belongs to the Grey list (or, which is equivalent, is characterised as Grey).

To determine the value of the allowable probability of casualty (p) of a certain type of casualty, one will estimate it by the total number of casualties of this type that occurred over a given time period (generally many years) out of the total world merchant fleet over this same time period.

4 Application of the method restricted to three ship variables.

Before presenting the results obtained, a brief description of the data that have been used for this application is given hereunder.

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Add3: if 30 vessels/category are not possible to get over the time period, new level grouping has to be proposed in decreasing the number of variables and/or the number of levels of variables.

\[\text{Add2: } \text{This is the reason of the comment given in Add2, section 3.1}\]

\[\text{Add3: } \text{It can be noticed that the upper and the lower limits of the confidence interval (I) are the same as the two limits } U_{black-to-grey} \text{ and } U_{grey-to-white} \text{ given in section 2.1 for the calculation of flag performance. In those, the number } N \text{ of inspections is replaced by the number } n \text{ of vessels in the considered category.}\]
4.1 Casualties descriptive statistics

IMO casualty records as reported to IMO by member States\(^1\) have been used for this application and casualties recorded world-wide over the period [1998-2003] have been analysed. As shown in Table 3, over that 6-year period, data on 2343 very serious or serious casualties of vessels (commercial and non commercial) of all sizes was collected\(^2\) (390 per year on average). 299 vessels were removed from the data set, in order to analyse only those casualties involving commercial vessels of a size equal to or greater than 300gt. Finally, 2044\(^3\) serious or very serious casualties that occurred world-wide in the period [1998-2003] (i.e. an average of 340 casualties per year) were selected.

A univariate and multivariate casualty analysis was then done as described in (Degré & Muller, 2006).

Table 3. Distribution of casualties according severity evaluated in this application

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Serious Casualties (VSC)</td>
<td>910</td>
</tr>
<tr>
<td>Serious Casualties (SC)</td>
<td>1423</td>
</tr>
<tr>
<td>Missing information</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>2343</td>
</tr>
</tbody>
</table>

4.2 World merchant fleet descriptive statistics

World merchant fleet descriptive analysis has the aim in this application to derive the number \(n\) of vessels in each category (as defined in section 3.1). In principle, it is necessary to consider the world merchant fleet (vessels of 300gt or over) over the same years as those considered for casualties’ analysis, i.e. over each year of the period [1998-2003].

Due to a lack of data, it has been decided to take the world merchant fleet of year 2000 as a reference, (which approximately, lies in the middle of the considered period) and to apply the 2000 fleet data over years 1998, 1999, 2001, 2002 et 2003 (or, in other words, to multiply by 6 the 2000 fleet data to cover the period [1998, 2003]). All the data related to the 2000 world merchant fleet were issued from (ISL, 2001) and from some specific requests to Institute of Shipping Economics and Logistics.

A univariate and multivariate world merchant fleet analysis was then done as described in (Degré & Muller, 2006).

4.3 Categories of vessels considered in this application and estimated values of the allowable probability of casualty

In this application, the calculations have been made in priority considering only the three physical ship variables type, size and age for which complete statistics on a world-wide basis were available. This was not the case for the other crucial ship variables flag, company and R.O. This is the reason why the only categories of vessels which are considered in this application are any combination of ship type, size and age levels, as defined in section 3.1 (in total 270 categories).

In this application, a fourth variable has also been considered: the type of casualty.

The estimated values of the allowable probability of a casualty (\(p\)) needed for the processing of the performance of each category of vessels with regards to its observed number of casualties (the factor \(p\) appears in the 95% confidence interval expressed by the relation (1) in section 3.2) are contained in Table 4 as a function of casualty type. They are estimated by the total number of casualties of a given type that occurred world-wide over the considered 6 years period out of the total world merchant fleet over this same time period.

\(^1\) The casualty data base is found on the IMO website [www.imo.org](http://www.imo.org)
\(^2\) This is a minimum figure because casualty reports by States are made on a voluntary basis.
\(^3\) \(2343-299 = 2044\)
Table 4. Values of probability of casualty as a function of casualty types

<table>
<thead>
<tr>
<th></th>
<th>All casualty types</th>
<th>CN</th>
<th>FD</th>
<th>FX</th>
<th>HM</th>
<th>WS</th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td>0.0087</td>
<td>0.0012</td>
<td>0.0004</td>
<td>0.0013</td>
<td>0.0031</td>
<td>0.0020</td>
</tr>
</tbody>
</table>

CN=collision; FD= foundering; FX= fire/explosion; HM= Hull/machinery failure; WS= stranding

4.4 Results on Black-Grey-White categories of vessels restricted to three ship variables

Let us recall that are considered here only 270 categories of vessels by the consideration of any combination on the levels of three physical ship variables i.e. type (5 levels), size (9 levels) and age (6 levels). The results when all casualty types are gathered are shown in Table 5 but other results as a function of casualty types were analysed in (Degré & Muller, 2006).

In this matrix, each cell is a particular category of vessel. The meanings of the allocated colours Black-Grey-White to the categories of vessels (i.e. their performances) were given in detail in section 3.2. Let us add only that two levels of the grey colour (light grey and dark grey) - corresponding both to the position of the observed number of casualties of the considered category inside the confidence interval (I) but respectively before the expected average number of casualties of that category and after the expected average number of casualties of that category - have been introduced in Table 5. But this distinction is not very important.

As shown on Table 5, passenger vessels of large size (greater than size 7), old tankers (older than age 5), cargo vessels (most often of advanced age) of medium size (size 3 to 6) and old bulk carriers (older than age 3) of medium to large size (size 5 to 9) are Black categories of vessels (or which is equivalent, belong to the Black casualty based list).

If we compare these results to the criteria set up by the Paris MoU in the NIR for defining High Risk Ships (see section 1) on the basis of those related to type and age only, consistency are found mainly for bulk carriers (bulk carriers older than 12 years are targeted vessels by Paris MoU and the categories of bulk carriers older than 10 years of medium to large size are in the Black casualty based list). Tankers older than 12 years are targeted vessels by Paris MoU, but only some categories of tankers older than 20 years are in the Black list as regards their observed casualties. Only the size among the three physical ship variables which were considered seems to play a role for passenger vessels in their membership of the Black casualty based list. Finally, cargo vessels are not targeted vessels by Paris MoU, but as shown on Table 5, many categories of cargo vessels older than 10 years belong to the Black casualty based list. When considering the type of casualty, it can be shown (Degré & Muller, 2006) that these categories of vessels are especially subject to foundering and this fact is confirmed by the (DNV, 2003) study.

4.5 Discussion of the results and limits of the application of the method

This application has been described with the aim to demonstrate that the implementation of the method is feasible. This seems promising if we refer to the results obtained by considering the three physical ship variables type, size, age with a casualty type as a fourth variable. For all these variables, statistics were available on a world-wide basis and although some simplifications were made and a rather short period of analysis (6 years) used, the results obtained seem to be in line with logic and intuition. Of course these results have to be checked and amplified due to a rather short period of analysis and simplifications made. Moreover, a completion of this work, by adding to the three physical ship variables considered in this study the three other crucial ship variables that are flag, company, Recognized Organisation – i.e. all entities which, somehow or other, manage the ship and take account in particular of compliance to international regulation, maintenance of vessels and equipment, training and quality of personnel on board, etc.- has to be done, the only constraint being to have enough vessels in each vessel category over the period of analysis. For this reason, ten years of collection of data on world-wide casualties and on world merchant fleet seems to be a minimum.
However, one of the major issues as regards the collection of data is the lack of completeness of the records of marine casualties: the main reason is that casualty reports are usually made by flag States but on a voluntary basis. Of course very serious and serious casualties are reported more systematically than less serious casualties but the non exhaustiveness of casualty data base remains today the main limit of the application of the method which has been described in this paper.

Table 5. BGW categories of vessels with regards to their observed casualties over [1998-2003] when all casualty types are gathered.

<table>
<thead>
<tr>
<th>Type</th>
<th>Size</th>
<th>Age</th>
<th>size1</th>
<th>size2</th>
<th>size3</th>
<th>size4</th>
<th>size5</th>
<th>size6</th>
<th>size7</th>
<th>size8</th>
<th>size9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger vessel</td>
<td></td>
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<tr>
<td>Tanker</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulk carrier</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>General cargo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Container ship</td>
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</table>

Size in gt: size1: 300 ≤ <500; size2: 500 ≤ < 1000; size3: 1000 ≤ < 1500; size4: 1500 ≤ < 5000; size5: 5000 ≤ < 10 000; size6: 10 000 ≤ < 20 000; size7: 20 000 ≤ < 30 000; size8: 30 000 ≤ < 60 000; size 9: ≥ 60 000

Age in years: age1: 0 < ≤ 5; age2: 5 < ≤ 10; age3: 10 < ≤ 15; age 4: 15 < ≤ 20; age 5: 20 < ≤ 25; age6: > 25

Caption:

Black category of vessels (belongs to the Black casualty based list)

not calculated (number of vessels over 6 years <30)
5 Conclusions and perspectives

A method, similar to the one used by the Paris MoU to class flags in their BGW lists, but in which the use of casualties instead of detentions and the consideration of categories of vessels (multivariate approach) instead of considering the flag only as the Paris MoU does, may enable to extend the BGW detention based lists of flags established by the Paris MoU to BGW lists of categories of vessels based on their observed casualties on a given period.

Due to a lack of statistical data, the method has been applied considering three ship variables only but it has been proven feasible, knowing that the main limit of the application of this method is today the non exhaustiveness of casualty data base. However, it remains that:

- The notion of vessel category is interesting because it enables a multivariate analysis, considering the set of variables characterizing the vessels as a whole, instead of considering these variables one by one, as it is done for example in the Paris MoU targeting process.
- The method to process the performances of each category of vessels (leading to the Black-Grey-White casualty based lists of categories of vessels) is as simple as the one used by Paris MoU to class flags, but here casualties are considered, instead of detentions.
- The performances allocated by this method to categories of vessels (Black, Grey, White) are statistically significant: categories of vessels that are Black (respectively White) are observed to have statistically higher (respectively lower) number of casualties than the expected average number of casualties of that category.
- The Paris MoU main objective is to eliminate sub-standard ships, but ultimately, its objective is to improve safety at sea and consequently to decrease risk of casualties. For this reason, the approach described in this paper, which is more focusing on risk, is not in opposition to the one chosen by the Paris MoU but must be considered as complementary.

Indeed, as already noticed in the introduction of this paper, most of the criteria set up in the NIR by the Paris MoU to target ships for their inspections are function of ship detentions and/or deficiencies. S. Knapp in her thesis (Knapp, 2007) tried in particular to answer the following question: are detentions/deficiencies estimators of a high probability of accident proneness (before the rectification of the deficiencies)?

But she did not show the evidence, on the basis of the data she analysed, of such correlations (most of the factors related to these explicative variables on the probability of a casualty were not significant in the various logistic regression models she implemented in her work).

One of the main reasons for this absence of correlation is certainly due, in the opinion of the author of this present paper, to the fact that the origin of most of casualties is due to human factors and that it is very difficult, during an inspection onboard a vessel anchored in a harbour, to check and detect all the human aspects which may lead to a casualty.

Soon, the Maritime Labour Convention (MLC, 2006), when it will be ratified and implemented, will probably improve the task of the PSC inspectors to reinforce these controls. But meanwhile, and as long as the above mentioned correlations would not have been proven, it seems necessary, in the opinion of the author, to combine casualty and PSC data for the measurement of flag State performance and for defining balanced criteria for the targeting of PSC inspections.

It is the hope of the author that the methodology which has been described in this paper, whose implementation requires to be expanded in the future, may contribute positively to the work of the Correspondence Group which has been set up by the Sub-Committee on Flag State Implementation of IMO for studying these questions.

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1 Therefore, the need to study further the possibilities to implement a world-wide information platform on casualty is essential, not only for this application but for many others.

2 Or conversely are detentions/deficiencies estimators of a low probability of accident proneness (after the rectification of the deficiencies)?

3 Mainly by the consideration of a wider period of analysis (10 years at least) and by the addition to the three physical ship variables considered in this study of the three other crucial ship variables that are flag, company and R.O.
6 References


Degré, T. & Muller, O. 2006. The use of risk concept to contribute to the design of a risk index and to characterize and select High Risk Vessels. *MarNIS Interim Technical Research Report, August 2006*


FSI 15, 2007. *FSI 15/18 report. Risk assessment comparison between maritime casualties and port State control inspections*


