# Expert Group Judgment and its Role in the Maritime Industry: Presentation of a Case Study and Lessons Learned

**Nikolaos P. Ventikos, Pantelis G. Anaxagorou**

School of Naval Architecture and Marine Engineering, National Technical University of Athens, 9, Iroon Polytechniou Str. Zografou, 15773, GREECE
?-mail: niven@deslab.ntua.gr

**Abstract:**
*This paper addresses expert group judgment and its emerging role in the maritime industry. Hence after giving a very brief and generic introduction on expert judgment and its records in the marine sector, it continues with the presentation of the principles of the implemented methodology with regards to expert group analysis and rating. In this context, indicative results of this effort (case study) are presented so as to be able to draft the overall significance of such a task. It should be noted that shipping is the less documented industry as far as the study of human aspects is concerned. Moreover, the paper focuses on recorded problems and lessons learned from the specific application in terms of enhancing the efficiency and the usefulness of such an approach. Finally, it concludes with a short discussion that recapitulates the main points identified thought this effort.*

**Keywords:** Expert group judgment, Marine safety, Risk, Pollution

## 1. Introduction

Experts are sometimes used to identify hazards and rank their frequency or severity, or rank overall risks associated with accident scenarios. This way a two fold advantage may be gained: to ensure the proactive nature of the selected methodology and to override cases where there is a substantial lack of historical data. Hence, the expert group approach should either cooperate with other methods (such as distribution fitting of data, statistical analysis of integrated records etc), or be implemented as last option regarding the examination and elaboration of existing practices and future trends. Furthermore, the historical data may be evaluated by the use of expert judgment by which their quality and subsequent usefulness may be considerably improved (Dutch Delegation to IMO, 2006).

In applying expert judgment, different experts may be involved in a particular study. It is unlikely that their opinions will always be in agreement. It might even be the case that the experts have strong disagreements on specific issues; it is preferable though that a level of agreement as high as possible is reached. Nevertheless, if there is disagreement between the experts this should be adequately reported and documented in the results of the developed study. In effect, the transparency in the results can be enhanced by accompanying the outcome with a comprehensive indication of the level of agreement between the experts.

An example of such effort is the ranking that takes place at the end of the Formal Safety Assessment (FSA), Step 1 Hazard Identification. This corresponds to a subjective ranking approach in which each of the invited experts may develop an ordinal list of hazards and accident scenarios, starting with the most severe one (Dutch Delegation to IMO, 2006). In this context, many disagreements can be recorded, or different ranked lists can be established and therefore it is important to document the level and quality of disagreement between the various experts (e.g. through the usage of a concordance matrix).

The rest of the paper is structured as follows: the next section describes the outline, the framework and the targets of the implemented methodology along with the presentation of some indicative results from the selected exercise (case study). Then the paper identifies problems related to the assessment of expert group judgment and results and focuses on lessons learned from this procedure in the maritime sector. Finally, it ends with conclusions and insights arising from the above-described sections.

## 2. Outline of the Implemented Methodology and Indicative Results

The work and results that are described hereafter in this paper are mainly parts of work done by the authors in the outline of the 3-year EC funded project Pollution Prevention and Control (POP&C) which focuses on a rational risk-based approach for design and operation of tankers. Hence, one of its main objectives is to develop a risk-oriented post accident pollution mitigation and control framework, in terms of crew and onboard salvage activities for efficient confrontation of ship-source oil spills.

In this context, the POP&C Consortium has developed detailed event trees (ET) for all six selected tanker casualties; namely grounding, collision, contact, non accidental structural failure, fire and explosion. More specifically, for each of the aforementioned accident types an event tree structure was created containing event gates (i.e. important events or safeguards in the incident timeline) and scenario endings (i.e. descriptions of the overall scenario and outcome). A thorough event tree analysis was performed so as to identify and map all possible alternatives resulted from the examined accident envelop. Subsequently, these event trees were able to provide the base for the formulation of adequately structured and targeted questionnaires that aim at the assessment and scoring of the generated scenarios Indicatively, Figure 1 depicts the event tree structure for collision (Delautre & Tuzcu, 2005).

Hence, the event trees were transformed into accident scenarios and corresponding questionnaires which the experts were called to assess with regards to their anticipated frequency and severity, in terms of human losses, damage to the involved vessel and the impact to the marine and littoral environment. This means that the experts were asked to state their opinion (through provided scales for the examined parameters) for a sequence of events given that the marine accident under consideration has already occurred; therefore focusing on post accident activities and mainly on the control and mitigation of ship source oil pollution. Table 1 gives the scale provided to the experts regarding the severity to the environment for the elaborated accident scenarios (Ghozlan et al, 2006).

After obtaining the results from the expert group judgment the scope of the analysis focused on determining and/or simulating which of the events and safeguards were perceived by the experts as important ones during the assessment of the provided questionnaires. This way, the manner that the experts confronted and evaluated the specific event trees can be put under the spotlight in the outline of identifying how they differentiated the practical value of one rank from the other in each of the examined scales and scenarios. Moreover, the critical events per scenario, according to the experts, could be adequately screened so as to understand their thinking and scoring, the existence of consensus, but also issues of precision and suitability for the event trees along with the overall efficiency of the methodology. It is noted that the usage of the concordance coefficient suggested by the IMO was not possible due to the nature and the structure of the integrated approach, i.e. severity scales and ranking procedures (Dutch Delegation to IMO, 2006).

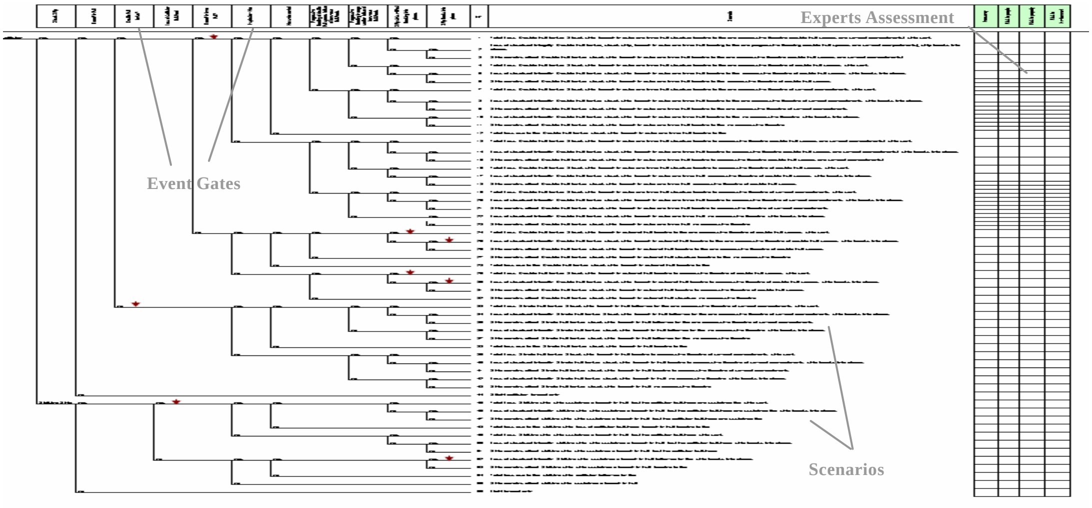


*Figure 1: Provided event tree structure for tanker collisions.*

*Table 1: Environmental impact index.*

| $S_E$ | Severity | Description |
|---|---|---|
| 1 | Minor | Non significant spill until a few barrels of pollution at sea |
| 2 | Significant | A few tones of pollution to sea. Situation is manageable |
| 3 | Severe | Significant pollution demanding urgent measures for the control of the situation and/or the cleaning of affected areas |
| 4 | Catastrophic | Major pollution with difficult control of situation and/or difficult cleaning of affected areas |

The implemented methodology for assessing expert group judgment and its results covers both consequence and risk oriented approaches and it comes from the field of classification and rule based knowledge theory (Quinlan, 1993, Louviere et al, 2000). This is an original way of confronting problems that have not drawn attention up to date within the maritime industry. In particular, this method comprises from the following key steps (Ghozlan et al, 2006):

- Obtaining the answers from the experts;
- Statistically process these answers (this is done in a two fold manner covering both consequences and risk);
- Mapping the distribution of the votes/scoring derived by the experts;
- Assessing the expert judgment and exploring the recorded consensus;
- Developing rules and decision trees;
- Identifying the critical events in the presented chain of events (i.e. the event gates of the event tree/questionnaire structure) and therefore achieving of training the model with regards to what the experts perceived as important in terms of events and how they actually proceeded in the scoring of the numerous provided scenarios per type of casualty.

In effect, the results based on the elaboration of experts answers regarding the very high consequence (for the environment) grounding scenarios can be effectively manifested as below (Ghozlan et al, 2006):

- Single hull tanker that Suffered a breach in hull and run hard aground;
- Double hull tanker that suffered a breach in inner hull and run hard aground;
- Single or double hull tankers that break into pieces;
- Single or double hull tankers that sink without breaking into pieces.

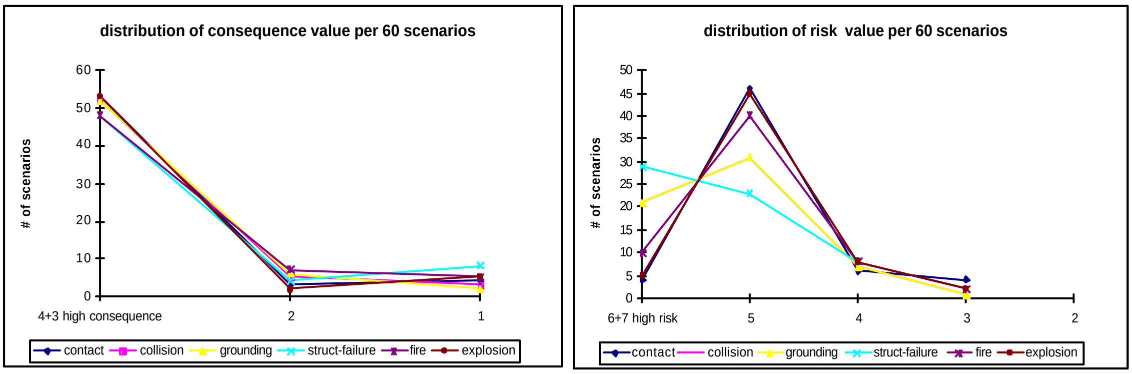


*Figure 2: Distribution of expert scoring for consequence and risk per 60 accident scenarios.*

Figure 2 shows the way that the tanker casualty scenarios were overall assessed by the experts (Ghozlan et al, 2006). In particular, its left part gives that in terms of consequence most of the presented scenarios were attributed with high consequences for the environment, whereas in terms of risk (right part) the majority of the accident types incorporate medium risk incidents, except mainly from the case of non accidental structural failures. Hence it is the consequence factor that actually drives the fluctuation of risk which is traditionally given as the combination between probability and consequence (Taylor, 1979).

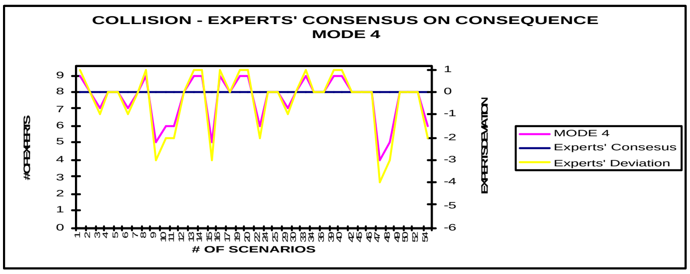


*Figure 3: Analysis on experts consensus on very high consequence scenarios for collision.*

Indicatively, Figure 3 presents that in case of collision, less than 3% of the very high consequence scenarios received minimum consensus, i.e. 5 out of 9 votes of the involved experts. This means that a very significant consensus level was reached in terms of consequences and that almost all of the experts perceived and assessed the scenarios in the same manner.

## 3. Identified Problems and Lessons Learned

Through this exercise (i.e. assessment of expert group judgment in relation to tanker safety and protection of the marine and coastal environment) various problems of the procedure were identified and numerous lessons were drafted and learned. In any case, the aggregated total of such an effort points to a complex puzzle of the maritime sector that cannot be considered as a trivial issue and therefore it demands to be dealt with extreme caution.

In this context, the size and the qualitative composition of the expert group are of great importance from practical point of view; the number of experts, their different expertise and experience levels are critical parameters of an investigation process in order to be able to come up with realistic and revealing results. It is noted that in the case study presented in this paper the expert group comprised by 9 members representing most of the stakeholders of the maritime industry, e.g. international bodies, shipping companies, academia etc.

Moreover, the mosaic of experts in terms of expertise and experience can alter the gravity center of answers/assessments and therefore lead to the assignment of weight factors in order to acquire realistic and representative results. In the described exercise most of the experts decided about the impact on the environment based on the extent of the hull damage and the consequent fate of the vessel ignoring further operational issues that might change the scenario ending and mitigate the pollution magnitude.

Figure 4 (its left part) gives the distribution of expert assessment for collisions with very high consequences; thus scenarios #11, #22 and #47 have received by the experts the entire spectrum of impact indices and scenarios #10, #12, #36, #42, #45, #46, #48, #54 present a significant range of ratings (Ghozlan et al, 2006). Figure 4 (its right part) shows the respective results for structural failures with very high consequence to the environment; in this case the experts present a complete consensus.

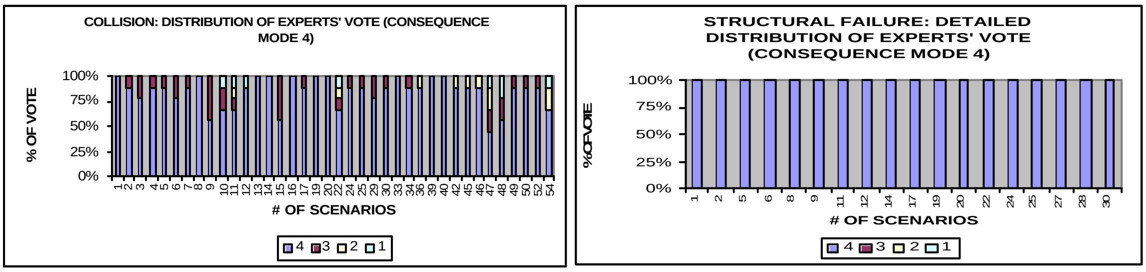


*Figure 4: Expert group judgment assessment for collision and structural failure.*

Another issue is the possible cooperation between experts leading to identical assessments and therefore to potentially non useful and not exploitable responses. This means that some type of supervision and/or answer screening should be in place so as to ensure the quality and fruitfulness of the field of replies. Figure 5 illustrates that experts #1, #6 and #8 gave identical answers for the cases of collision and fire; this might be a case of cooperation between these experts and therefore it demands further analysis and elaboration (Ghozlan et al, 2006).

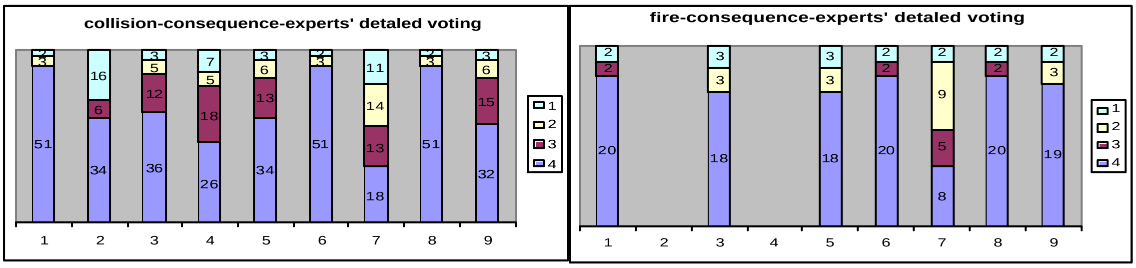


*Figure 5: Detailed experts voting distribution for collision and fire.*

The above Figure also points out the importance of the factor of time limits; to this effect, the answers for collisions were collected by all nine experts whereas in the case of fire (the respective questionnaire was provided to the experts towards the end of the procedure) only six of them finally managed to complete the required answers (Ghozlan et al, 2006). This means that the time limits for the progress and conclusion of expert group judgment should be set in such a manner that the experts can read, think and decide upon the inquired subjects without stressing deadlines or other equivalent constraints that can cloud and disorientate their assessment. It is noted that the usage of simple questionnaires or a detailed explanation of what the experts should do, how many questionnaires are to be completed, how to rate and which are the predefined rank scales usually help towards this direction.

Finally, the combination of different scale ranges such as in case of risk oriented approaches can confuse the experts and weaken their judgment; hence they must realize the range and meaning of each of the provided index matrices. More specifically, in the examined exercise (case study) the provided scales for all types of consequences ranged from 1 (low) to 4 (high) whereas the scale for frequency was from 1 (low) to 7 (high). However as the results showed the experts seemed to assess all factors (including frequency) within the range from 1 to 4 ignoring in practice the frequency rate scale.

## 4. Discussion – Conclusions

Expert group judgment in the maritime industry can prove itself to be extremely useful and valuable in terms of increased safety, efficiency and environment friendliness. Nevertheless its practical application demands extreme caution in order to ensure exploitable and realistic results. Some of the key points raised in such an exercise are briefly drafted below:

- Adequate number of experts;
- Suitable mixture of experts (expertise and experience levels);
- Proper time allocation through the procedure;
- Adequate explanation to the experts of the work expected by them;
- Avoidance of (extensive) cooperation between experts;
- Tangible and measurable scales for scoring (index matrices);
- Identification of the way that the experts think and assess the provided questionnaires.

## 5. Acknowledgements

Work on this paper was supported in part by the EC project POP&C (Contract No. FP6-PLT-506193).

## 6. References

Delautre S., Tuzcu C.(2005), “HAZID Analysis & Ranking”, Technical Report for the POP&C European project, WP2/Task 2.3 & Task 2.4, Paris, France (confidential).

Dutch Delegation to IMO (2006), “Formal Safety Assessment: Report of the Correspondence Group”, International Maritime Organization, MSC 81/18, London, UK.

Ghozlan F., Anaxagorou P.G., Ventikos N.P., Psaraftis H.N., Mikelis N. (2006), “Pollution Mitigation and Control Measures”, Technical Report for the POP&C European project, WP7/Task 7.1, Nantes, France (confidential).

Louviere, J.J., Hensher, D.A., Swait, J.D. (2000), “Stated Choice Methods Analysis and Applications”, Cambridge University Press, Cambridge, UK.

Quinlan, J.R. (1993), “Combining Instance-Based and Model Based Learning”, Proceedings of ML’93 (Utgoff, Ed), Morgan Kaufmann, San Mateo, Ca.

Taylor, J.R. (1979), “A Background to Risk Analysis”, Riso National Laboratory, Copenhagen, Denmark.