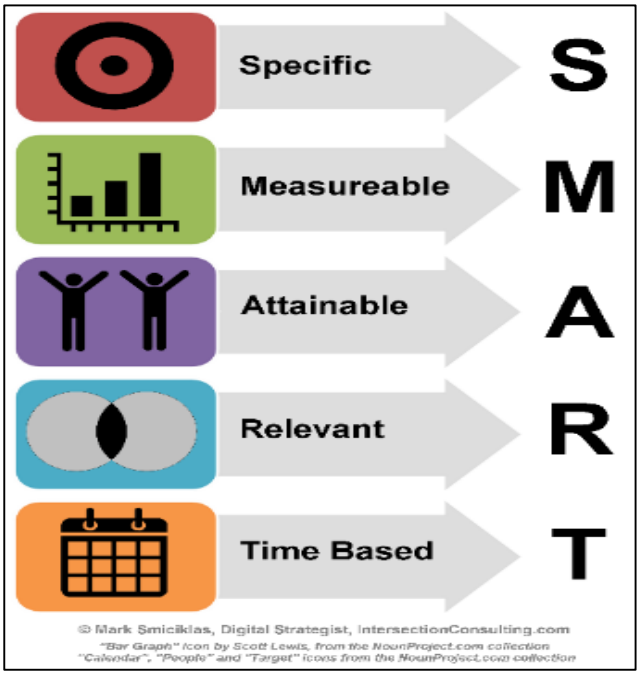
IMPLEMENTATION OF SMART METHODOLOGY TO MAXIMIZE MARITIME RESILIENCE PERFORMANCE

ABSTRACT: We present a SMART resilience improvement performance procedure for maritime as a continuous plan-act-measure-improve cycle where objectives fulfil SMART (Specific, Measurable, Assignable, Realistic and Time related) criteria. Decisions are based on a FMADGM (fuzzy multi-attribute decision group decision making) tool and is focused on minimization of inadequate standard procedures and maximization of efficiency as productive safety requires. Provided solution should be compliment to FSA (formal safety assessment) methodology, the existing Risk management as well as accident analysis results. The impressive novelty of the procedures assessment not only in terms of risk but also in terms of efficiency is presented. The teamwork spirit is underlined since all the involved persons participate in decision making procedure. The presented model is bringing forward new perceptions towards operation procedure efficiency and should be used complimentary to the operation risk assessment. Attributes either beneficiary or costly, as fuzzy, relative numbers, linguistic, objective or subjective are evaluated. Initial weights to evaluators, to attributes and experience level for each evaluator, attribute) pair are defined. Several alternative ordering methods are utilized. The best fit method is visually suggested and presented. Finally model is tuned adjusted by using multi criteria algorithm of the administrator preference expertize.

The model functional specifications as well as the conclusions based on the users' feedback are presented.

Keywords: FMADGM, TOPSIS, Normalization, Multi-criteria analysis, Cost-Benefit analysis, Resilience



Background

SMART procedure

SMART is a mnemonic acronym, giving criteria to guide in the setting of objectives, for instance in project, operation, risk, human resource management., The letters S and M usually mean specific and measurable. The other letters have meant different things to different authors, as described below. Additional letters have been added by some authors.

SMART criteria are commonly attributed to Peter Drucker's management by objectives concept. The first-known use of the term occurs in the November 1981 issue of Management Review by George T. Doran. The principal advantage of SMART objectives is that they are easier to understand and to know when they have been done. Ideally speaking, each corporate, department, and section objective should be:

Notice that these criteria don't say that all objectives must be quantified on all levels of management. In certain situations it is not realistic to attempt quantification, particularly in staff middle-management positions. Practising managers and corporations can lose the benefit of a more abstract objective in order to gain quantification. It is the combination of the objective and its action plan that is really important. Therefore serious management should focus on these twins and not just the objective. In this respect operations taken place on board are considered as procedures which may be improved

(**Specific**), their efficiency and risk level should be quantified (**Measurable**), the team to plan, act measure, evaluate and improve should be specified (**assignable)** in a given time horizon (Time related).

Specific – target a specific area for improvement.

Measurable – quantify or at least suggest an indicator of progress.

Assignable – specify who will do it.

Realistic – state what results can realistically be achieved, given available resources.

Time-related – specify when the result(s) can be achieved.

scheme 1: SMART attributes

SMART criteria in setting the objectives of the resilient system could be expanded with two additional variables: Evaluation and Review becoming procedures **SMARTER.**

Continuous Improvement methodology: The key components

The SMART methodology is in align with the continuous improvement cycle suggested by OCIMF (Oil companies' international maritime forum) in TMSA (tanker management and self-assessment) guidelines. The key components are: ***Plan, Act, Measure and Improve*** covering the SMART criteria for the resilient maritime system.

FSA (Formal Safety Assessment)

The smart procedures development methodology should be complied and complimented with a structured risk assessment program (RAP) for ships operation covering operational, accident, security and environmental risks with a unified approach, which is usually in place on board. The dominant Danaos RAP program is designed according to the aforementioned approach considering risk assessment as an endless procedure utilizing business learning mechanisms based on industry and company previous experiences. An integration approach of hazardous processes risk estimation with evaluation of hazardous events consequences is provided to support Risk Assessor to estimate risks with accuracy (*according to the Code of Safe Working Practices for* ***Merchant Seamen published by MCA, which is based on BS 8800 standard****)* and Risk Manager to implement plan of actions to reduce *the consequences or the probability of occurrence (****Risk management definition BS 4778).***

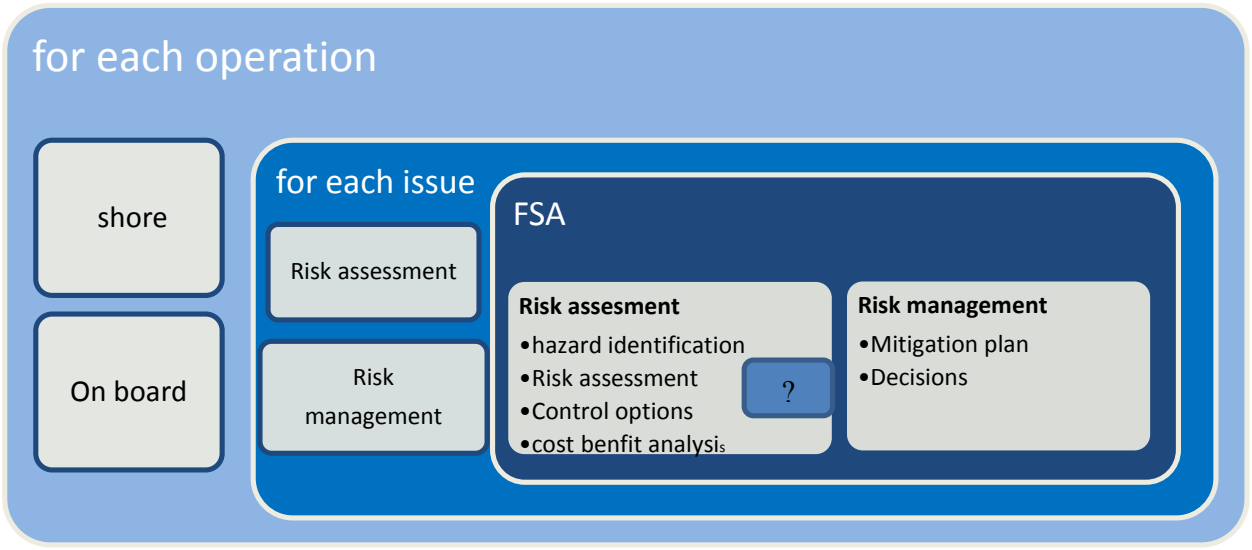


Figure 20 FSA Diagram

RAPs should be designed to provide a useful easy to use tool for registration, review, print, send and receive computerized risk assessments. User repeats the FSA cycle (the recommended by IMO formal safety assessment methodology) for the operations occurred on-board according to the figure 20 diagram.

Standing orders & operation instructions inadequacy

This factor was the second most responsible among underlying factors as listed in figure 22 for system-crew link to fail). The way the ship operates its organizational structure a safety culture will be greatly influenced by the shipping company it belongs to. Each shipping company has their own standard procedures available in booklets,

ALERTS

Non-Standard procedures are not allowed.
ACCIDENTS FACTOR DUE TO NON COMPLIANCE WITH STANDARD PROCS IS ONE OF THE HIGHEST.
Improvements. Refinements, clarifications are highly recommended.
JUST IN CULTURE IS A MUST

Just-in culture is a must.

Figure 21 : Rules to be met

as a guide of how to operate the ship in case of emergency or any other situation. The main cause that leads to the human error is the insufficient company's standing orders and procedures. The company policy and their standards may contribute to the incident, if for example company standing orders are inadequate or safety procedures may not be operated. Inadequate operating instructions are also responsible for leading to the human error. When the company's procedures and instructions are incorrect, too ambiguous or even misleading, it will lead to errors in human's performance on board the ship. Complacency in this situation is also leading to human errors if the organization is not satisfied with a standard performance. Safety culture is another factor that may result in an incident since it includes characteristics of large scale bodies that influence the approach taken to safety issues, as well as resources inadequacy (the resources needed to complete a job effectively and safely with the respective time, finance & personnel).

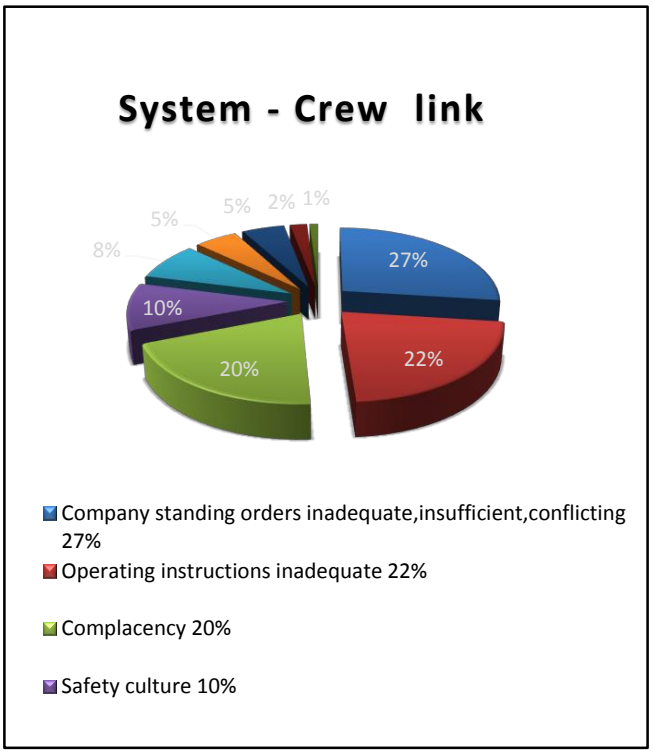


Figure 22 System - Crew link pie chart

Measurable objective criteria is required for Decision Making

Alternative proposals for setting up standard procedures should be evaluated and ordered by their feasibility and applicability taking into account a number of procedural attributes. The **FMAGDM** (Fuzzy multi-attribute group decision making tool is developed as build in module in the tool. This suggested multi-criteria decision

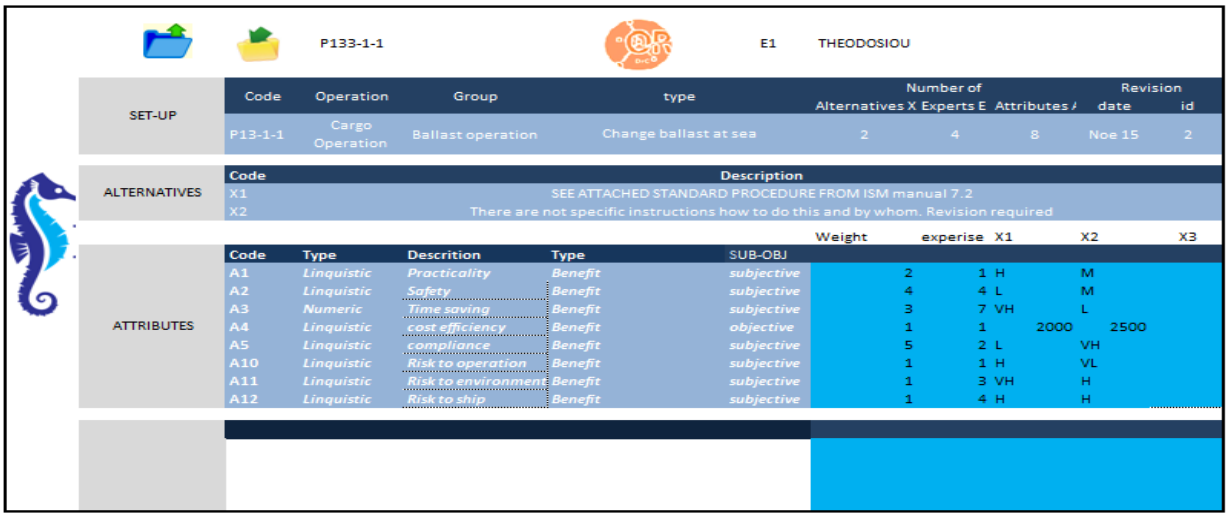


Figure 23: SPA experts' evaluation screenshot

should be compared with the conventional simplified CBA (Cost benefit analysis) one incorporated in FSA methodology. Different techniques may be applied to order alternative proposals.

The most popular is TOPSIS (Technique of ordered preference by similarity to ideal solution) for more than two solutions and normalized weighted average. This new holistic approach of cost/ productivity safety (known as safety II) is the challenge for implementation.

THE CHALLENGE

The methodology, the tool, the novelty, the innovation

Hereby a description of methodology, objectives and implemented SPA (Smart procedures assessment) solution based on terms which previously explained is given as follows:

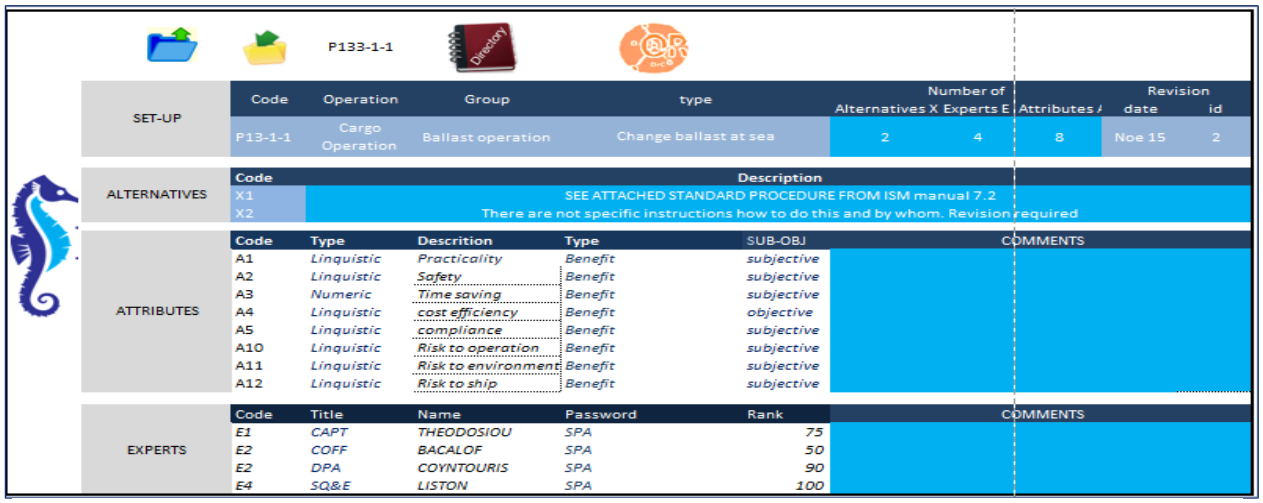


Figure 25 24 :SPA administration setup screenshot

SMART resilient procedures assessment and implementation is a continuous improvement *plan-act-measure-improve cycle* methodology where objectives fulfill SMART criteria, decisions are based on a FMAGDM tool and is focused on minimization of inadequate standard procedures risk and maximization of efficiency. Provided solution should be compliment with FSA methodology, the existing Risk assessment and management as well as accident analysis tools. Principal constraints, recommendations and objectives are summarized in figure 21.

The impressive novelty is the procedures assessment not only in terms of risk but and in terms of efficiency as well. Furthermore the teamwork spirit is underlined since all involved persons participate in decision making procedure. This approach is highly interest and should be used complimentary with the operation risk assessment.

SMART procedures assessment (SPA) set up

Administrator configures the SMART assessments. The decision making team (Experts and expertise level), the attributes (name, cost/benefit, objective/subjective, linguistic/ fuzzy) and the alternative suggestions.

Giving the appropriate credentials administrator enters in the main screen. There is the option to load one old SPA, to view the directory of existing SPAs as well as to create a new one (figure 25).

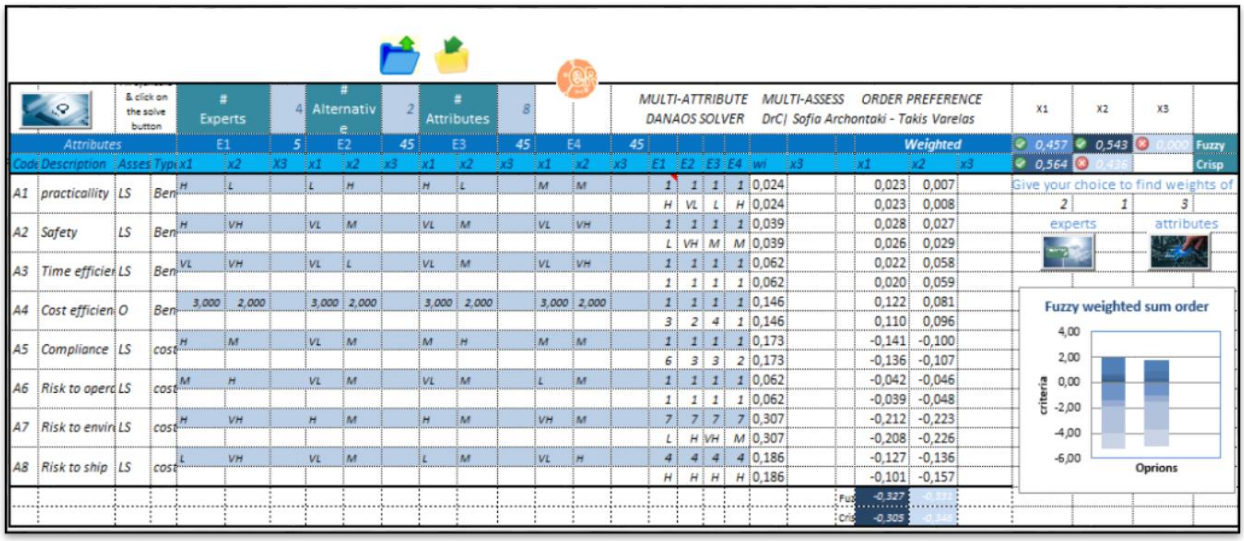


Figure 28 A Solution screenshot

After finalization the SPA should be saved. System generates appropriate alerts to experts to initiate their reviews.

SPA evaluation

Expert is alerted to start his evaluation. Using the appropriate credentials is entered in the evaluation screen. He provides his assessment, his weights as well as his knowledge level for each attribute (figure 23). Since his evaluation is finalized Expert save his appraisal and an appropriate notification is generated to administrator.

Solving

When all evaluators have finalized their evaluation, administrator is triggered accordingly to start the decision making process SPA.The weights of each expert are linearly normalized. Relative degree of agreement is calculated for each expert-alternative pair and is taken into account for experts' weight refinement are calculated for each alternative and expert. Fuzzy trapezoidal values are defuzzificated and attribute weights are vector normalized. Weighted values are for all alternative/attributes pairs and TOPSIS as well as vector weighted average ranking methods are applied Figure 28).

Conclusions

For each procedure when you perform a specific task there are usually several minor or major variations. It is highly significant the knowledge and the expertise of the existing alternatives. Furthermore for each variation is equally important to know the specifications, the prerequisites, and the constraints of each alternative for evaluation of the applicability in a given operation. Even better human creativity and expertize

may produce new innovative variations. **So endless refresh of knowledge and expertise repository from external and internal resources is highly recommended.**

A SOP (standard operation procedure) is defined, documented and distributed to the vessels to be followed during the corresponding performing operation. SOP should not be considered as static. **SOP should be dynamic.** The environment is continuously changed and SOPs should be refined, improved are sometimes should be replaced.

In this respect SOP' objectives should be **SMART**. One key element is the efficiency and risk level quantification **(measurable).** FSA includes a primitive cost/benefit stage of potential alternative or revised controls. The suggested SPA suggests a multi-attribute group decision making methodology **(FMGADM)** where procedure attributes are evaluated as crisp or fuzzy numbers, objectively or subjectively and as cost or benefit.

TOPSIS method is evaluated and is proved -as expected- as non-applicable when alternatives are only two. In last case the normalized weighted method is accepted as the most suitable.

The replacement of expert's weight with the consensus coefficient, which takes into account the relative degree of agreement between experts, is accepted as suitable. We have concluded to a relaxation factor β which determines the initial weight and relative agreement weight analogy equals to 0.4.

The objectively assigned weights for each alternative /attribute/ and expert related knowledge are adjusted in order to have the same ordered lists whether multicriteria or cost/ benefit analysis is used.

SPA has been deployed on board in fifty vessels as an extension of obligatory standard risk assessment operation. In a period of two months 281 more or less revised SOPs are submitted and 32 of them which has been evaluated successfully are in place and have been distributed over the fleet. During the same period of the previous year only 5 requests of change have been submitted and no one has been applied.

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