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| IALA Guideline |

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RISK MANAGEMENT

Edition 1.0

Document date

Revisions to this IALA Document are to be noted in the table prior to the issue of a revised document.

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| --- | --- | --- |
| Date | Page / Section Revised | Requirement for Revision |
| month/year approved by Council | Initial version of rewritten Guideline | aaaaaa |
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* We started with the working document/output of ARM 9.
* All changes accepted, but kept comments of Floris Goerlandt
* Rearranged sections and filled in some texts
* Started with more substantial text (scope, ISO31000 sections, data handling)
* First draft of key points for PAWSA

Todo Next:

* As we go along with filling in texts, decide on comments to either follow up or delete.
* Improve text Risk management process description
* The tables: which tools? Other than IALA toolbox, or is that beyond the purpose of this guideline (🡪WWA)? Decide on fields, fill in using OpenRisk or other sources as far as possible.
* For the IALA toolbox tools: propose text for key points and align with other underlying guidelines in cooperation with other subgroups
* Fill in section 5?

1 INTRODUCTION 5

1.1 Scope 5

1.2 Objectives 5

1.3 Rationale of the guideline 5

1.4 Relation with other IALA Guidelines 6

2 The Risk Management Process 6

2.1 THE ISO 31000 STANDARD ON RISK MANAGEMENT 6

2.1.1 Risk management principles 7

2.1.2 Risk management framework 7

2.1.3 Risk management process 7

3 Tools supporting Risk Assessment 9

3.1 Rationale of using supportive tools 10

3.1.1 Data collection 10

3.1.2 Data processing 10

3.1.3 Interpreting 11

3.1.4 Example 11

3.2 Tools table 11

4 The IALA toolbox 13

4.1 PAWSA 13

4.1.1 Application area 13

4.1.2 How it is used 13

4.1.3 Type of results 14

4.1.4 Input requirements 14

4.1.5 Strengths 14

4.1.6 Weaknesses 14

4.2 IWRAP 14

4.3 SIRA 15

4.4 Simulation 15

5 Selection of suitable tools 16

List of Tables

Table 1 Example of a table with the significant information in the first column **Error! Bookmark not defined.**

Table 2 Example of a table with the significant information in the first row **Error! Bookmark not defined.**

Table 3 Example of a table with coloured rows **Error! Bookmark not defined.**

Table 4 Example table **Error! Bookmark not defined.**

List of Figures

Figure 1 Overview of IALA documents related to risk management 6

List of Equations

Equation 1 Geographical range **Error! Bookmark not defined.**

Equation 2 Theory of Special Relativity **Error! Bookmark not defined.**

# INTRODUCTION

## Scope

This document provides guidelines to support AtoN authorities in applying risk management to their activities. The concept of the risk management cycle is introduced on basis of the ISO31000 standard. A selection guide for tools that can be used to provide risk related information, supporting risk management decision making, is given and the tools of the IALA Risk Management Toolbox are described in some more depth.

The intended audience of this Guideline is AtoN authorities and other maritime stakeholders.

## Objectives

This Guideline has following objectives:

1. To provide a broad understanding of the risk management process
2. To give some general considerations for implementing this process in organizations
3. To offer general guidance for the choice of appropriate tools to execute the risk management process

Objective i. is described in Section 2.2.

Objective ii. Is described in Section 2.1.

Objective iii. Is described in Sections 3 and 4.

## Rationale of the guideline

Regulation 13 of SOLAS Chapter V…

This purpose of this guideline is to provide AtoN authorities and other stakeholders in the maritime domain, of whom it is required to perform a risk assessment for any of the following reasons, with some insight into the process and some guidance to the available supportive tools and methods. Those reasons may be, but not limited to, the following examples:

* Periodic safety reviews;
* Monitoring the system (including the effects of previous systems);
* An emergency, accident or incident;
* A public request or complaint;
* Other decisions, changes, or modifications to the operations of the organization;
* Any number of internal or external events, including funding, operational and technical changes;
* Development and alteration of man-made offshore installations;
* Changing mariner practices.

The ISO International Standard on Risk Management, ISO 31000:2018, provides a generic description of the risk management process. It is based on best practices, extensive consultation and expert input, and is widely used in many industries. We adapt the generic guidelines from this standard for the specific context of the IALA members.

The ISO document distinguishes three aspects of risk management: the basic principles, the framework for embedding the process in an organisation, and the process itself. This guideline mainly focusses on the process.

It must be pointed out that there are similar guidelines aimed at other fields of work also; in particular the widely used Formal Safety Assessment (FSA) guideline from IMO is worth thorough reading. Attention is also drawn to results of the Open Risk project (<http://www.helcom.fi/Lists/Publications/OpenRisk%20Guideline%20for%20pollution%20response%20at%20sea.pdf>) where a large number of tools has been evaluated. To some extend the contents of this guideline are taken from the OpenRisk report.

## Relation with other IALA Guidelines

The purpose of this document is to provide an overview of risk management and available tools. For more elaborate descriptions of these tools, reference is made to IALA guidelines throughout the text. Figure 1 illustrates the structure of the IALA guidelines, particularly the guidelines for the IALA toolbox.

R1002

Risk Management for Aids to Navigation

G1123

IWRAP

G1018

Risk Management

G1124

PAWSA

G1138

SIRA

G1058

G1097

Simulation

Training syllabus

Risk Management – PAWSA, IWRAP Mk2, SIRA & SIMULATION

1. Overview of IALA documents related to risk management

# The Risk Management Process

## THE ISO 31000 STANDARD ON RISK MANAGEMENT

Risk management describes the task of preventing, reducing or altering the consequences of risk through choosing appropriate risk mitigation measures. It includes often trade-offs between costs and benefits of different risk mitigation measures as well as choices related to risk tolerance level. Risk assessment, on the other hand, is focused on providing the knowledge for risk management and associated decision-makers on where to reduce risk and what alternative to choose.

The ISO 31000 standard provides guidelines on managing risk faced by organizations. The application of these guidelines can be customized to any organization and its context, including decision making at all levels. In order to understand the concept of risk management in this standard, it is important to consider three fundamental aspects: the principles underlying risk management, the framework under which risk management is conducted in a given organizational setting, and the generic risk management process. This section provides a brief overview of the first two aspects, while the third is outlined more in detail.

### Risk management principles

The principles are underlying commitments, values and considerations which are commonly taken as best practices in risk management activities. Therefore, they should be considered when establishing the organization’s risk management framework and processes. The ISO 31000 standard lists eight principles for risk management which are as follows:

|  |
| --- |
| The eight principles underlying risk management |
| 1. Integrated - it is part of all organizational activities |
| * risk management is a part of all safety critical functions of AtoN from top to bottom levels |
| 2. *Structured and comprehensive* – it is aimed to lead to consistent and comparable results |
| * risk management activities are well organized in the maritime administration with clear responsibilities |
| 3. *Customized* - it is tailored and proportionate to the organization’s context and objectives |
| * risk management activities of maritime administrations are defined in a realistic way considering the internal resources and external working environment |
| 4. *Inclusive* - it involves internal and external stakeholders, to consider their knowledge and views, and to facilitate awareness and information |
| * risk management of maritime administration includes communication with stakeholders, including definition of tasks and responsibilities for risk mitigation measures |
| 5. *Dynamic* - it anticipates, detects, acknowledges and responds to changes in the organization’s internal and external context |
| * risk management of maritime administration includes continuous monitoring of changes in risk level and risk mitigation measures as needed |
| 6. *Based on the best available information* - historic and current information is used, and future expectations are considered, accounting also for associated limitations and uncertainties |
| * data used for the risk management of maritime administration consists of both quantitative and qualitative sources in order to make the risk picture as good as possible |
| 7. *Considerate of human and cultural factors* - human behaviour and culture influence all aspects of risk management at each level and stage |
| * risk management of maritime administration should consider the local human aspects within its internal and external context |
| 8. *Continuously improved* - through learning and experience |
| * risk management of maritime administration should follow the idea of plan-do-check-act continuously |

### Risk management framework

The purpose of the risk management framework is to assist the organization in integrating risk management into significant activities and functions, including decision making. This requires support from stakeholders, particularly top management. The development of the framework includes integrating, designing, implementing, evaluating and improving risk management across the organization. These are outlined next:

|  |
| --- |
| **Five topics to consider in the risk management framework development** |
| 1. ***Integration*** - Integrating risk management to AtoN activities relies on an understanding of its structures and context. Top management of the administration should ensure that risk management is integrated into all its activities and demonstrate leadership and commitment. Everyone in the administration has responsibility for managing risk. |
| 1. ***Design*** - Design of the risk management framework for AtoN activities consists of several tasks. This includes learning about the administration itself and its context, articulation of risk management commitment, assigning administrative roles and responsibilities, allocating sufficient resources as well as establishing procedures for communication and consultation. |
| 1. ***Implementation*** *-* The AtoN authority should implement the risk management framework primarily through developing an appropriate plan including time and resources, identifying where, when and how different types of decisions are made across the administration, ensuring that its arrangements for managing risk are clearly understood and practiced. Moreover, successful implementation of the framework requires the engagement and awareness of stakeholders. |
| 1. ***Evaluation*** - The evaluation of the risk management framework involves periodically measuring of the AtoN authority performance against its purpose and implementation plans, determining whether it remains suitable to support its objectives. Based on this, the improvement of the framework is performed. This involves adapting to internal and external changes, and continuously improving the framework and its integration throughout the administration. |
| 1. ***Improvement*** *-* The AtoN administration should continuously improve the suitability, adequacy and effectiveness of the risk management framework and the way the risk management process is integrated. Whenever relevant gaps or improvement opportunities are identified, it should develop plans and tasks and assign them to those accountable for implementation*.* |

### Risk management process

The process is a specific set of steps taken to define the scope and focus of the risk management questions, and to provide answers to these.

The generic risk management process as described in the ISO document consists of five consecutive stages and two parallel activities, as illustrated in Figure 2. Each is described next. The part consisting of stages 2, 3 and 4 is usually referred to as risk assessment.

1. Establishing the context

The aims and objectives of the risk management have to be decided in this first stage. The limits of the system for which risks are assessed must be defined. External stakeholders, and the extent to which they will be involved in the risk assessment are considered. Also legal, regulatory, financial and social factors may be part of the context. The overall objectives and aims of the organisation, governance strategies, roles and responsibilities, reporting guidelines can be regarded as the internal context of the risk assessment.

Risk acceptance criteria are set, decision making principles and procedures to account for different risk perceptions are formulated.

1. Risk identification

Hazards, possible failures and unwanted events associated with the system or activity are identified in this step. Evidence is vital and may come from reported accidents, models and simulations. Accident investigations, expert judgement of knowledgeable stakeholders and incident data from similar systems may be sources of inspiration.

1. Risk analysis

Risk analysis aims at the evaluation of the identified risks. The ISO document states: ‘Risk analysis involves consideration of the causes and sources of risk, their consequences and the probability that those consequences can occur. Factors that affect consequences and probability should be identified’.

For each identified risk the following steps are taken:

1. Estimate the probability of the event to occur;
2. Estimate the severity of the consequences in case the event occurs;
3. Assess the strength of the evidence for the probability and consequence estimation;
4. Combine probability, consequence and strength of evidence in a risk scale.
5. Risk evaluation

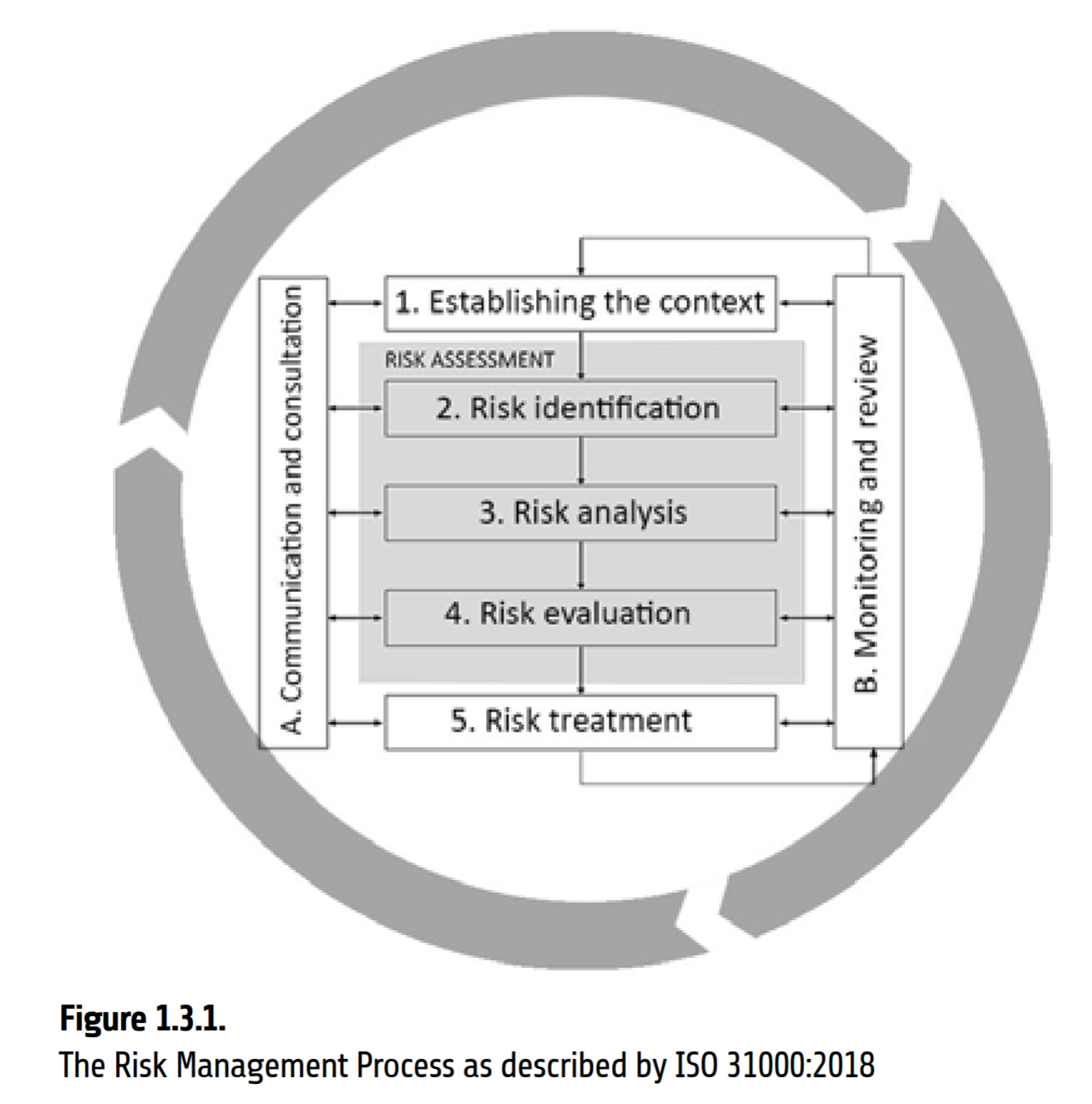
In this step the acceptability of the risk values as found in stage 3 is rated. The criteria for acceptance of risks are already defined in stage 1.

– barriers, ALARP, Cost-Benefit Analysis.

Focus on changes of risk level rather than absolute figures.

1. Risk treatment

The risks that are in stage 4 found to be unacceptably high, have to be treated by implementing risk control and mitigation measures.



1. The Risk Management process as described by ISO 31000:2018

* Identifying appropriate risk control options to decrease the risk to the level considered to be acceptable. The risk control options available include improved co-ordination and planning; training; rules and procedures including enforcement; navigational, meteorological and hydrographical information; radio communications; active traffic management and waterway changes;

1. Communication and consultation

Good communication with stakeholders, such as the mariner, shipping companies and classification societies, is important. Understanding of the needs, interests and influence of stakeholders, including their risk perceptions and their legal and operational responsibilities is vital for the effectiveness of the entire risk management process.

In many cases the risk treatment results in RCOs that have to be funded and implemented by others. Communicating the findings to them may be supported by e.g. maps displaying risk levels, risk matrices and probability-consequence diagrams.

1. Monitoring and review

Quality management should ensure that information processed in the five stages is adequately utilised. This activity should also address changes over time in the environment and the system itself. The risk management should be always up to date.

The grey arrows in Figure 1 depict a continuous cyclic process to resemble a periodic re-evaluation of the adequacy of the applied tools and information sources. There is also a loop on a smaller scale: when RCOs are selected, part of the risk assessment should be repeated.

# Tools supporting Risk Assessment

## Rationale of using supportive tools

The Risk Assessment (stages 2-4) involves collecting, processing and interpreting of data. Tools to support those activities are very useful for a number of reasons:

* Data sets tend to be very large (AIS data as a good example). Selection, querying and visualisation of these data are essential to derive useable information from those.
* The use of a tool improves repeatability and consistency. It is desirable that the outcome of a risk assessment is not dependent on which individuals take part in the assessment. Although in practice some influence is inevitable, tools and procedures can help to minimise the dependency.
* Tools provide a means to document the risk assessment. Documentation of considerations, opinions and decisions during the assessment process is important for a number of reasons. It improves the repeatability and it serves as a source to substantiate the final outcome. This may be important in legal matters but also to indicate whether there is new information that was not considered originally.

### Data collection

Each risk assessment should be based on factual data, as far as available. Important sources are:

* Nautical Chart and pilot data. Additionally: hydrographic surveys, environmental sensitivities, habitation, recreation activities, etc.
* VTS reports, recordings and interviews
* Hydro-meteo data: statistics of wind, waves and currents
* Traffic volumes, differentiated by ship type and size, dangerous or harmful cargo
* Marine accident data and reports

A very useful source is historical AIS data. Not only does it show traffic volumes but also the lateral distribution of traffic (what distance is kept to obstacles, buoys and other vessels), the sailing speeds and sometimes sudden manoeuvres that may indicate dangerous situations. For analysis of AIS data, tools are needed to extract useful information from the bulk of messages transmitted.

### Data processing

Essentially, the purpose of this phase is to provide the experts in the interpretation phase with more insight in the data provided in the data collection phase. To this end, the basic data from the collection phase are combined, compared to references, presented on maps and in graphs, etc. The data on traffic intensity and traffic pattern, and the data on the physical characteristics of the study area are used to identify specific hazards and shipping accident scenarios. Some examples are given next.

General design guidelines are very useful in identifying ‘substandard’ situations that could increase the likelihood of accident scenarios. A well-known example is the PIANC Guideline for the Design of Access Channels (PIANC MarCom Working Group 121, 2014), which recommends minimum width and depth of a harbour approach channel depending on vessel dimensions and environmental conditions. Comparing the actual data to the recommendations of the Guideline yields a qualification, that forms a starting point for the discussions of the expert panel on the probability of a grounding in the approach channel.

Presentation of historical accident data on a chart can reveal hotspots in the area. These may or may not coincide with identified hazards. There will be a strong correlation between the traffic intensity and the number of accidents. This must be taken into account when judging the fairway quality.

This is also the phase in which tools are utilised to analyse AIS data. The most straightforward way is plotting all positions from the messages gathered as dots on a chart. The traffic hotspots and main routes are immediately visualised this way. For all AIS related analyses it must be realised that small (non-SOLAS) vessels are invisible as far as they are without transponder. Drawbacks of the direct plotting are, that the density of dots is dependent on the time span of the recording and the sailing speeds (and also on the coverage of AIS reception). Somewhat more informative is plotting vessel tracks distilled from consecutive positions.

There are numerous reports on the analysis of AIS data, aimed at a description of the behaviour of vessel traffic. Most studies use the concept of a ‘Potential Area of Danger’ – a circular or elliptical domain around ‘Own Ship’ that each vessel tries to keep clear of other vessels or obstacles. Criteria for automatic selection of near-miss situations from AIS data may be formulated on basis of reconstructed CPA and TCPA values. The number of near-miss situations can be used as an indication of risk level in an area.

### Interpreting

In the final step of the risk assessment, the Risk Evaluation, a qualification or quantification of the safety level or risk is made. If needed, the possibility of risk reduction measures and their effectiveness are also evaluated.

Some tools are classified as quantitative (e.g., IWRAP) as they produce numbers like the expected number of collisions per year. However, such a number is meaningless if it is not interpreted by an expert knowing the limitations of the tool and its input data.

Decision are made on basis of the results of the data interpretation phase, regarding the acceptability of a risk and the need for mitigating measures. Although in some cases this phase will be expedited by a single expert, usually expert panel discussions are needed. The expert panel bases its discussions (as far as possible) on the output of the preceding data collection and processing phases.

Especially if a larger group of experts and stakeholders is involved, a facilitator must assure that each expert’s opinion is taken and that the decision is not governed by the loudest participants.

Tools may be helpful to structure the discussions and facilitate the documentation.

### Example

In the following example the data handling phases are indicated for a risk assessment using IWRAP. The interpretation of the expected number of accidents, calculated by IWRAP, yielded that mitigating measures were needed and that an adaptation of the fairway layout could be beneficial. Moreover, in this case the effect of the adaptation can be reflected by IWRAP, so that a new calculation is made. Note that this will not be the case for all possible measures, and another tool, or expert opinions only, may be available for an assessment of the proposed situation.

Data collection

Data interpretation

Data processing

AIS data

CHART data

Adapt fairway

IWRAP

#coll/year

## Tools table

Many tools and methods are available that can provide useful information to support risk management, including the decision making. Table 1 in this section provides a limited overview of those tools and methods, with a very short description of the tool and its applicability. Table 2 indicates which parts of the process are supported, the resources needed and whether IALA provides training for the tool.

1. Tools and methods supporting risk management

|  |  |  |
| --- | --- | --- |
| Tool/Method | Application | Description |
| 1. ALARP |  |  |
| 1. Bayesian networks |  |  |
| 1. Bow-tie analysis |  |  |
| 1. Brain-storming |  |  |
| 1. Cost-benefit analysis |  |  |
| 1. Delphi method |  |  |
| 1. IWRAP II |  |  |
| 1. PAWSA II |  |  |
| 1. SAMSON |  |  |
| 1. SIRA |  |  |
| 1. Structured interviews |  |  |

1. Characteristics of Tools and methods supporting risk management

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tool/ method | Function | | | Risk assessment stages | | | | IALA Training Course available? | Use of Resources | Level of expertise needed | ? |
| Collection | Process | Interpreting | Identification | Analysis | Evaluation | Treatment |
| 1. ALARP |  |  |  |  |  |  |  |  |  |  |  |
| 1. Bayesian networks |  |  |  |  |  |  |  |  |  |  |  |
| 1. Bow-tie analysis |  |  |  |  |  |  |  |  |  |  |  |
| 1. Brain-storming |  |  |  |  |  |  |  |  |  |  |  |
| 1. Cost-benefit analysis |  |  |  |  |  |  |  |  |  |  |  |
| 1. Delphi method |  |  |  |  |  |  |  |  |  |  |  |
| 1. IWRAP II |  |  |  |  |  |  |  |  |  |  |  |
| 1. PAWSA II |  |  |  |  |  |  |  |  |  |  |  |
| 1. SAMSON |  |  |  |  |  |  |  |  |  |  |  |
| 1. SIRA |  |  |  |  |  |  |  |  |  |  |  |
| 1. Structured interviews |  |  |  |  |  |  |  |  |  |  |  |

# The IALA toolbox

For supporting risk assessment, IALA suggests the use of a number of supportive tools: Ports and Waterways Safety Assessment (PAWSA), IALA Waterway Risk Assessment Program (IWRAP), Simplified IALA Risk Assessment method (SIRA) and simulation. These are described in more detail below. Some tools may be characterised as ‘quantitative’ when they result in numeric risk figures, whereas a tool that produces results in terms of acceptability may be called qualitative. However, it can be argued that no numerical result can be accepted as ‘the truth’ but instead is a starting point for expert evaluation.

## PAWSA

PAWSA (ref$$) provides a (strict) framework for performing an expert session on navigational risks. Originally developed by USCG to evaluate the benefit of coastal VTS’s the method has matured to a generic tool for the evaluation of navigational risk and effectiveness of mitigating measures.

Application area

The PAWSA process has been completed in many ports and waterways in the US, to decide whether VTS was needed there. It is a generic tool for the evaluation of navigational risk and effectiveness of mitigating measures.

How it is used

Typically a PAWSA session involves a group of about 30 experts, led by an experienced facilitator assisted by an operator, taking 2 days. The tool includes a mathematical engine to weigh the experts’ opinions against each other, resulting in a qualification of risk categories in terms of acceptability.

Type of results

The assessment by this tool indicates whether the existing risk level in the waterway is:

* **Acceptable** and no further work is needed unless changes occur in important criteria, such as the traffic pattern or the types of ships using the waterway;
* **Not Acceptable** but the risk control options necessary to make the risk level of the waterway acceptable have been identified adequately;
* **Not Acceptable** and more detailed study is necessary to enable the risk control options that will make the risk level of the waterway acceptable to be identified adequately.

The mathematical engine does produce a numerical value, but this should only be interpreted in the qualitative terms as indicated.

Input requirements

The tool itself is fed by the responses of the workshop participants. However, for a successful workshop all usable data should be collected and ready to presented to the workshop in a easy to understand and flexible manner. Smartboards with ENCs can be used effectively.

Strengths

Using PAWSA all available local expertise and information may be utilised. The method takes care of the different levels of expertise across the workshop participants. As all stakeholders take part in the process, they are inclined to support the results.

Weaknesses

The workshop needs professional preparation and facilitation. A relatively large number of experts is needed for the, typically two day long, workshop.

The success of the workshop builds on the relevant factual information to be at hand in a presentable way at the workshop. Finding the right participants may be a challenge.

## IWRAP

Starting from AIS data, IWRAP (ref$$) can be used to reveal ‘hotspots’ in an area where the traffic density distribution leads to relatively high risk levels. Moreover, considering changes (being it mitigating measures or external claims) in the traffic layout, the resulting change in risk level and risk distribution is clearly shown. However, expertise is still needed to interpret the results, appreciating the limitations of the manual input and the calculation model itself.

## SIRA

Compared to PAWSA, SIRA (ref$$) provides a much easier applicable tool to structure an expert panel risk assessment. The basis of the method is the risk matrix, in which the probabilities and consequences of the most relevant accident scenarios have to be filled in. When using PAWSA or IWRAP is beyond the possibilities of an administration, application of SIRA may provide a suitable alternative. In other cases SIRA can also be used as additional tool….

* What is it used for?
* What kind of results do you get?
* What data do you need to do it?
* What are its strengths?
* What are its weaknesses?

## Simulation

Simulation (ref$$, ) may be useful in different stages of the risk management process:

1. Revealing unsafe situations

The channel layout, with traffic flow (which can be based on AIS data) and available AtoN, the

1. Evaluation of effectiveness of measures
2. Validation of proposed mitigation

Demonstration and Documentation

By providing a simulation tool to the user, an overall improvement in safe and efficient operation can be realised by assisting in demonstrating the operation of the waterway, channel design and associated AtoN, before the reality of navigating a vessel in the area. Simulations can provide a high level of realism as long as the purpose of the simulation is matched by the accuracy of the models and the simulation facility. Hence, accuracy of manoeuvring models of vessels, environment and associated Aids to Navigation, together with appropriate planning and setup of simulated scenarios, should be carefully considered.

* What is it used for?
* What kind of results do you get?
* What data do you need to do it?
* What are its strengths?
* What are its weaknesses?

# Selection of suitable tools

Some thoughts:

* If AIS data is not available, using IWRAP is difficult.
* For PAWSA a large group of experts and an experienced facilitator are necessary
* Simulation is not always capable of capturing the desired level of detail and accuracy (w.r.t. AtoN simulation)
* Expertise is always needed. Tools provide support and a means to document decisions.