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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 |

* 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?

Todo following ARM 11

* ~~Incorporate comments from ppt Francis~~
* ~~Compress intro in ISO~~
* What is the intented audience? Just AtoN authorities or anyone involved in nautical risk assessment?
* Tools can provide Justification of decisions
* Examples of application of IALA tools (short indication of what, why and how; more elaborate in underlying tool guidelines)
* ~~One of the objectives of using tools and procedures is to reduce subjectivity~~
* Stick to FSA (instead of ISO)
* Complete list of risk management part (ISO material), ch 2
* Complete chapter choice of tools, perhaps with examples?

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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 7

2.1 THE IMO Formal Safety Assessment: FOCUS ON RISK ASSESSMENT 7

2.2 THE ISO 31000 STANDARD ON RISK MANAGEMENT: FOCUS ON ORGANIZATIONAL RISK MANAGEMENT 9

3 The IALA toolbox 9

3.1 PAWSA mkii 10

3.2 IWRAP 11

3.3 SIRA 12

3.4 Simulation 13

3.5 the rogerform 14

4 Selection of suitable tools 14

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 guidance to AtoN authorities in applying risk management to their activities. Formal Safety Assessment (FSA) has been recommended by the International Maritime Organization (IMO) for use by maritime authorities. The broader concept of organizational risk management, within which FSA should be integrated, is described by the ISO31000 standard. The tools of the IALA Risk Management Toolbox are introduced, indicating how they can support the risk management process.

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

## Objectives

This Guideline has following objectives in the context of the requirements for the competent AtoN authorities:

1. To provide a broad understanding of the risk management process
2. To strengthen the practice and increase the objectivity of maritime risk assessment by providing standardized tools and procedures
3. To offer general guidance for the choice of appropriate tools to execute the risk management process

## Rationale of the guideline

Regulation 13 of SOLAS Chapter V states:

*Contracting Governments undertake to arrange for the establishment of VTS where, in their opinion, the volume of traffic or the degree of risk justifies such services.*

*Each Contracting Government undertakes to provide, as it deems practical and necessary either individually or in co-operation with other Contracting Governments, such aids to navigation as the volume of traffic justifies and the degree of risk requires.*

The purpose of this guideline is to provide guidance to AtoN authorities and other stakeholders in the maritime domain, to support assessment of the above mentioned degree of risk in their jurisdiction, in order to strengthen the decision making basis for complying with the above SOLAS obligations. A documented risk assessment could be undertaken for several purposes and due to various internal and external circumstances. These include, but are not limited to:

* Periodic internal safety reviews;
* Other decisions, changes, or modifications to the operations of the AtoN authority;
* The occurrence of an incident, accident, or emergency;
* Developments or changes in the traffic volumes and/or patterns;
* Development or changes of man-made offshore installations;
* A stakeholder request or complaint.

## Relation with other IALA Guidelines

This document provides an overview of the risk management process, focusing on how the IALA Toolbox links with FSA. For more elaborate descriptions of these tools, reference is made to other IALA documents throughout the text. Figure 1 illustrates the structure of the IALA guidelines, in particular the specific documents relating to 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

**Figure 1. IALA Guideline on Risk Management: Overview of associated documents**

# The Risk Management Process

The Formal Safety Assessment (FSA) adopted by the International Maritime Organization (IMO) is a structured and systematic process. It aims at enhancing maritime safety, including protection of life, health, the marine environment and property. This is done by using risk analysis and cost-benefit assessment. FSA is briefly described in Section 2.1.

The International Standard on Risk Management ISO 31000:2018, adopted by the International Organization for Standardization, provides a generic description of the risk management process. It is based on best practices, extensive consultation and expert input, and links the risk assessment with organizational processes. It is used in many industries, including various maritime sectors. The key concepts of ISO 31000:2018 are outlined in Section 2.2.

## THE IMO Formal Safety Assessment: FOCUS ON RISK ASSESSMENT

The Formal Safety Assessment (FSA) is a process for supporting decision making, making use of risk analysis and cost benefit assessment. It aims to achieve a balance various technical and operational issues, including the human element, and between maritime safety or protection of the marine environment and costs. The International Maritime Organization has first adopted FSA in 2002, through MSC/Circ.1023/MEPC/Circ.392, recommending the use of FSA for the maritime sector. The current version of the procedure is described in MSC-MEPC.e/Circ.12/Rev2.

In Table 1, the five steps of the FSA process are listed. The table also lists some key questions addressed in each step, and outputs which are obtained by executing the different phases.

**Table 1. Formal Safety Assessment process: Steps, key questions, and outputs**

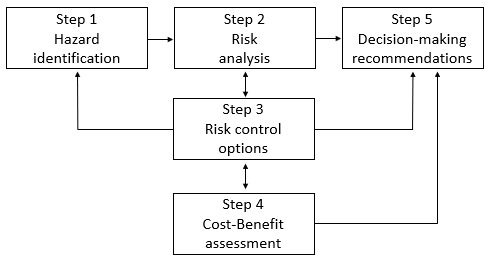
|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Name** | **Key question** | **Outputs** |
| 1 | Hazard identification | What might go wrong? | A list of all relevant potential accident scenarios with potential causes and consequences |
| 2 | Risk analysis | How likely is the risk to occur?  If it happens, how severe would be the consequence | Estimation of likelihood and consequences of the potential accident scenarios, ranking of these scenarios |
| 3 | Risk control options | Can matters be improved? | Potential measures to reduce the likelihood of occurrence of the identified risks, or limit their consequences should they occur |
| 4 | Cost-benefit assessment | What would it cost?  How much better would it be? | Costs associated with the different risk control options, and an assessment of how cost-effective they are compared to how much they reduce the risk |
| 5 | Decision-making recommendations | What actions should be taken? | Documented information about the hazards, their associated risks and the cost effectiveness of alternative risk control options is provided to decision makers |

In Figure 2, the process flowchart of the different steps in FSA is shown. First, the hazard identification (Step 1) is performed. From this step, the relevant potential accident scenarios and their causes and consequences are found. With this information, the risk analysis (Step 2) is performed. The likelihood and consequences of the different identified accident scenarios are estimated, and a ranking is made. For the scenarios determined as priority, usually the highest ranked scenarios, risk control options are identified (Step 3). This means that potential measures to reduce the likelihood of accident occurrence, or the severity of their consequences, are thought of and their effects on reducing the risk estimated. In other words, there is an iteration between Step 3 and Step 2. At this point, there are three main strategies to follow.

In the simplest strategy (**Strategy 1**), the information about hazards, the estimated risks (likelihood and consequences) and their ranking, and the risk control options and their estimated risk-reducing effect, is gathered and summarized as an input for decision makers. In this strategy, the sequence in the process flowchart is Step 1, Step 2, Step 3, Step 5.

A more elaborate strategy (**Strategy 2**) is essentially the same as Strategy 1, but after estimating the risk-reducing effect of the risk control options (Step 3), a cost-benefit assessment is performed. This means that the costs of implementing the risk control options is estimated. This information is combined with their estimated risk-reducing effects. Finally, an estimate is obtained of how much the different risk control options help to reduce the risk, in relation to how much they cost. As in Strategy 1, the produced information about hazards, risks, and risk control options, including their cost-effectiveness, is gathered and summarized as an input for decision makers. In this strategy, the sequence in the process flowchart is Step 1, Step 2, Step 3, Step 4, Step 5.

In the most comprehensive strategy (**Strategy 3**), the same process is followed as in Strategy 2, but in addition an iteration is performed after risk control options are identified (Step 3). This means that at that point, a new hazard identification step is taken (Step 1), because it is possible that new risk control options introduce new hazards and risks to the system. The risk levels of the system with these new hazards are estimated (Step 2), and if necessary additional risk control options specified (Step 3). Usually, at most one iteration of steps 1 to 3 is performed. At this point, Strategy 3 can either proceed directly to gather the produced information as inputs for decision makers, as in Strategy 1. Otherwise, a more elaborate process can be followed similar as for Strategy 2, by adding an additional step where the cost-benefit of implementing the risk control options is assessed (Step 4).



**Figure 2. Formal Safety Assessment Process: Steps and flow of information**

In the FSA process, several risk assessment tools can be used to support the different steps. Such tools thus help with hazard identification, risk analysis, estimating the effects of risk control options. Some tools are dedicated to only one of these steps, while other tools may have a role in different steps. Tools can be different for instance in the kind of input data required, the level of expertise and training needed to use the tool, and the resources needed for executing it (time, people, etc.).

In Section xx, a brief overview is given of the IALA toolbox, highlighting in which steps of the FSA process the different IALA tools primarily have a role. Guidance is also given about the selection of an appropriate tool xxx [Note: this should be check wrt the structure of the document!]

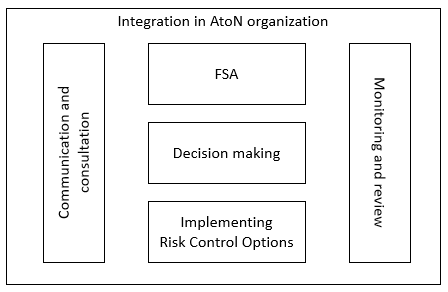
It is worth noting that the IALA tools focus specifically on methods for identifying hazards (Step 1), analysing risks (Step 2), and estimating the effects of risk control options (Step 3) related to ports, waterways, and sea areas. However, other there are many generic tools for risk assessment available, which may also be useful to support the decision making process for AtoN authorities. Such generic tools can be found in other guidelines, such as: xxx [which ones to refer to? FSA, ISO31000, OpenRisk]

Tools will not always be necessary to use or there may not be an adequate tool available. In those cases the five steps may still serve as a checklist of the items that should be documented for any risk treatment. The standard form proposed in Annex X is based on that

## THE ISO 31000 STANDARD ON RISK MANAGEMENT: FOCUS ON ORGANIZATIONAL RISK MANAGEMENT

Once a risk assessment is made using appropriate tools, there are additional

* Risk assessment is only one part of risk management: two further things to consider to make Risk Assessment effective in an organization AtoN authority, see Figure 3



1. Communication and consultation

Good communication with stakeholders, such as the mariner, shipping companies and classification societies, is essential. 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 RCO 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.

>> in progress <<

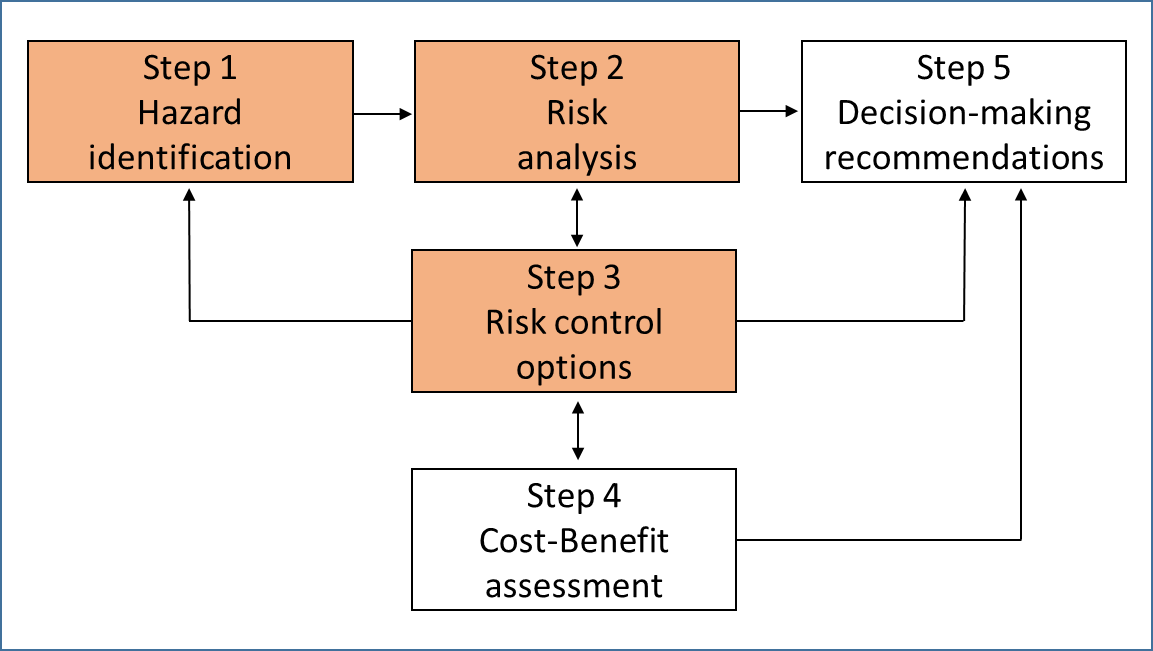
# The IALA toolbox

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), simulation and the RogerForm. 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 mkii

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

PAWSA supports steps 1, 2 and 3 of the FSA process. The hazards are first identified and evaluated (assuming there are no risk control options effective) by a group of experts, and then the risk is evaluated again when risk control options are in place. The PAWSA process has been completed in many ports and waterways to decide whether additional risk mitigating measures were required. 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 be 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

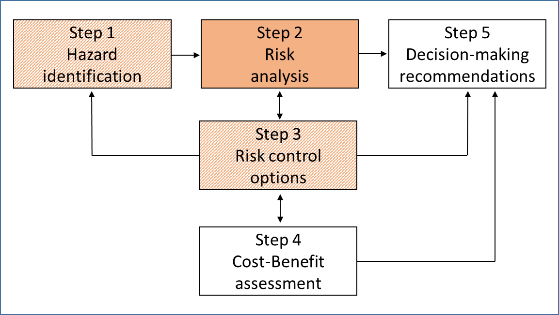
The workshop needs professional preparation and facilitation. A relatively large number of experts are required for the, typically, two day long workshop.

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

The IALA Waterway Risk Assessment Program (IWRAP) is characterised as the quantitative risk assessment tool. From the density and composition of traffic flows within the layout of the fairway and its environment, the likelihood of occurrence of different accident types is calculated.

Application area

IWRAP supports steps 1 (to some extent), 2 and 3 (to some extent) of the FSA process. The hazards that can be identified are groundings, allisions and collisions. The calculated likelihood of those accidents can be differentiated by ship type and ship size class, and be presented as a heat map on top of an ENC or chart bitmap.

How it is used

Starting from AIS data[[1]](#footnote-1), IWRAP can be used to reveal ‘hotspots’ in an area where the traffic density distribution leads to relatively high risk levels. Moreover, considering changes in the traffic layout (maybe due to mitigating measures or external claims), 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.

Type of results

Results are numerical, hence the qualification “quantitative tool”. The statistical expectance of the number of occurrence of groundings and collisions per year for the entire study area is produced. The geographic distribution groundings and collisions can also be shown in colours, indicating the number of groundings per m stranding line or the number of collisions per m2 fairway area.

Input requirements

* Traffic density.  
  Assuming AIS data is available: the recorded AIS data over significant period of time and the entire area of interest. The desired extent of this period depends on the traffic intensity and possible weekly or seasonal changes. Both the static and dynamic AIS ship messages are used and are imported and processed by IWRAP.
* Geographical description of the study area.  
  Normally a digital chart or otherwise a paper nautical chart is used as a basis, as this significantly improves the interpretation and presentation of traffic data and results of the calculations. However, for the calculations only the geographic contours of potential grounding areas (if any) are Incorporated into the IWRAP model.   
  If a simple scan of a paper chart is used, geographic reference points can be indicated to be incorporated in the model.

Strengths

* Quick results
* Analysis of traffic patterns, characterisation with fitted lateral distribution function
* Presentation of areas with relative high density of allisions/collisions and groundings
* Compare different scenarios

Weaknesses

* As the analysis is based on AIS data, the traffic pattern relates to a past period. To evaluate the risk in a future situation, e.g. after the effectuation of a Risk Control Option, the changes in traffic pattern have to be put in by the user based on his or her expertise.
* The effectiveness of Risk Control Options that would affect causation factors cannot be demonstrated, unless the causation factors are altered by hand, based on an assumed effectiveness.
* The likelihood of allisions/collisions and groundings is calculated, not the consequences.

## 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.

Application area

When using PAWSA 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.

Being a structured approach for an expert session, all relevant hazards and associated risks may be covered. The effectiveness of Risk Control Options is evaluated by the same expert group. Based on this outcome a recommendation for the decision makers is formulated. In this way the FSA steps 1, 2, 3 and 5 are covered. An explicit cost-benefit assessment is not included in the method, the recommendation of risk control options is primarily based on their perceived effectiveness.

How it is used

A group of experts discusses types of hazards, possible accident scenarios and rate likelihood as well as the magnitude of consequences. The process is structured as a number of consecutive steps. By using hazard categories and checklists the discussion is fed, so that the chance of missing relevant scenario’s is minimised.

Type of results

The risk figure of all scenarios considered are plotted in a risk matrix. If there are risks that need mitigation, the expected effect of recommended measures is displayed in another risk matrix. Besides the matrices, the report reflecting the process to these matrices is an essential part of the results.

Input requirements

All relevant factual (!) data on traffic composition and density, fairway layout, traffic services, accident reports etc. is needed for a successful expert session.

Strengths

* Very flexible; any risk may be discussed
* no minimal size of expert group

Weaknesses

* Assessment of likelihood and consequence solely based on expert opinion
* Risk score as multiplication of ordinal numbers has no direct relation with the ‘real’ estimated risk

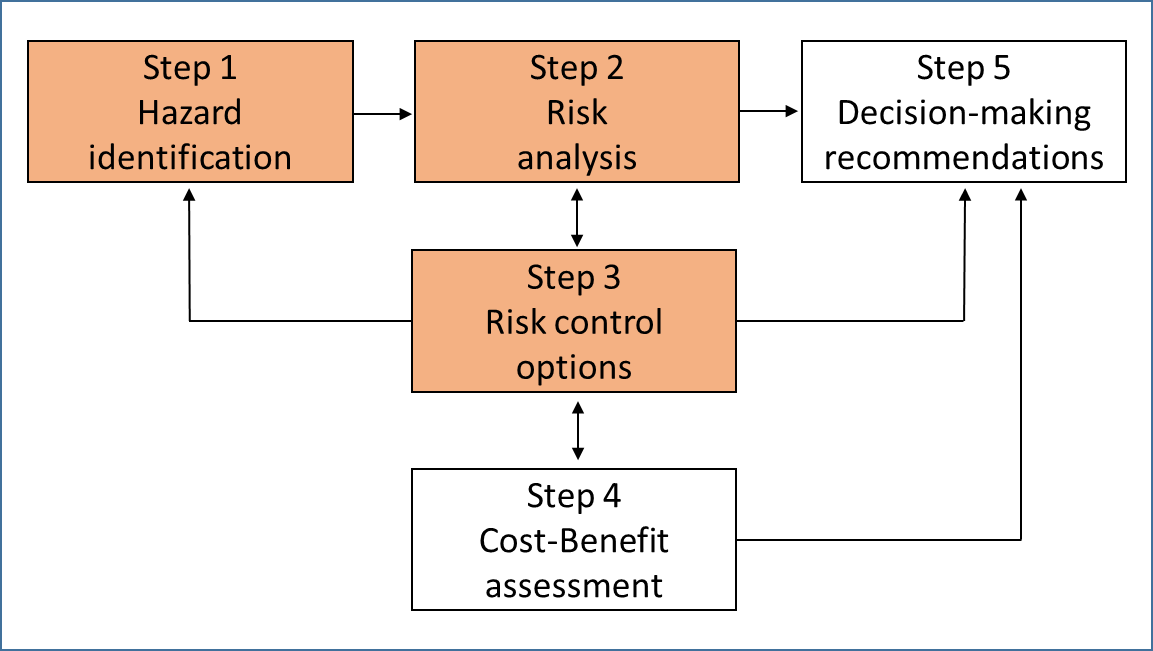
## Simulation

Simulation (ref$$, ) may come in different forms:

* Traffic simulation
* Fast-time manoeuvring simulation
* Bridge simulation
* AtoN simulation

and may be combined, e.g. a bridge simulation with integrated AtoN simulation. Which form is to be used depends on the type of questions that the simulation is being used to address.

Application area

Simulation can be a valuable tool to assess the value of risk control measures being considered.

A bridge simulator is frequently used for the design of fairways and harbour entrances, to check whether the task of bringing a specific ship in (or out), in various environmental and traffic conditions, can safely be completed under human control.

If the provision of AtoN is one of the factors that need investigation, care must be taken that the information that the human on the simulator derives from the simulated AtoN, accurately resembles the real-world situation.

Fast-time replay of AIS data, which is a facility provide by IWRAP MkII, visualises the traffic behaviour in real life. A traffic simulation model may be capable of resembling this behaviour. If the model is also sensitive to proposed risk control options, the expected traffic behaviour may be output of the simulation.

How it is used

Dependent on the type of simulation.

Type of results

Dependent on the type of simulation.

Input requirements

Dependent on the type of simulation.

Strengths

Using simulation techniques, the reaction of a human controller (i.e. navigator, helmsman and / or pilot) on simulated situations may be analysed. This way the modelling of the human element is avoided.

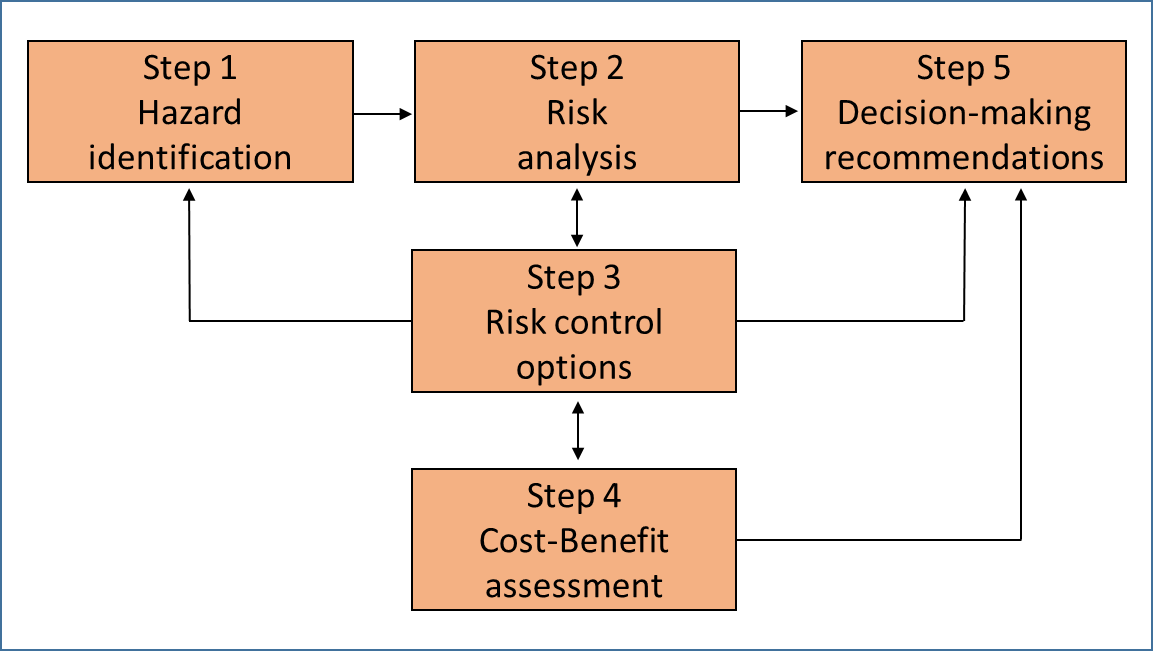
Weaknesses

A simulation is always the simulation of a mathematical model of some behavioural aspects of the real world system. The validity of the simulation depends on whether all aspects relevant to the problem are modelled and to what extent the modelling really resembles this real-world aspect.

## the rogerform

The Rogerform may be seen as a standardised documentation form for any risk assessment, to record the risk considered and the reasons behind the chosen mitigation (in any). Also when other tools are used, it is encouraged to use this form to provide a concise report of what has been done and why.

Application area

The documentation applies to all steps. The way it supports those steps is by providing the descriptions of what elements are to be considered in each step.

How it is used

The form may be used by someone doing a risk assessment on his own as well as by a group of experts. For each element of the form, the relevant data are filled in. The form is archived electronically.

*(note: it may be considered to use specified tags to facilitate searching through the forms)*

Type of results

The results are that for each risk assessment there is a standardised document that states the considerations and, if any, tool results, that led to the decision.

Input requirements

Strengths

The form

* facilitates the documentation of a risk assessment;
* also serves as a checklist for items that should be considered;
* provides standardisation of documentation

Weaknesses

* tools for, e.g., processing and presentation of data are not part of the form. However, any other tool may be used in combination with the form.

# Selection of suitable tools

There is not a ‘one size fits all’ method to perform a risk assessment. It can be helpful to recognise three phases in the process: data collection, data processing and expert discussion. Most tools apply to the second phase but provide the experts in the third phase with valuable information. Depending on the nature of the case to be assessed, the data available, and the financial and human resources, the most suitable tool(s) or method(s) may be selected. The third phase cannot be skipped, the results of a risk calculation always must be interpreted by an expert. Documentation of all three phases is very important.

Insert (part of) chapter 3.1 contents?

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.

1. Theoretically, traffic data can be put in by hand if AIS data is not available. However the amount of work involved and data quality issues make this very impracticable. [↑](#footnote-ref-1)