MERITURVALLISUUDEN JA -LIIKENTEEN TUTKIMUSKESKUS
KOTKA MARITIME RESEARCH CENTRE

MERI KOTKA

Euroopan unioni
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TKK

Safety Performance Indicators

for

Maritime Safety Management

Risto Jalonen & Kim Salmi / Teknillinen korkeakoulu

Maritime Safety seminar in Kotka 22.9.2009

METKU Merenkulun turvallisuuskulttuurin kehittäminen

Developing Maritime Safety Culture

Work Packages of the project METKU

WP 1:	**Maritime Safety Performance Indicators (TKK[1])**
WP 2:	Evaluation of the performance of Safety Management Systems in Finnish shipping companies (UTU[2])
WP3:	Comparing ISM –OHSAS practices in shipping companies and port operations (KyAMK[3])
WP4:	Exploring the Best Practises in shipping companies (TUAS[4])
WP5:	Safety management practices in Finnish maritime and port authorities (KyAMK[3])

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Developing Maritime Safety Culture

WP1: Safety Performance Indicators for Maritime Safety Management

Project planning for WP1 (Risto Jalonen) 2007

Contents of WP1:

- **Literature review (Risto Jalonen ja Kim Salmi)** **2009/May**
- Interview report (WP1/Kim Salmi & Risto Jalonen WP2/Jouni Lappalainen) 2009/September
- Accident analysis (Heini Kiuru ja Kim Salmi) 2009/October
- Statistical analysis (Kim Salmi) 2010/January
- Final report 2010

This presentation (today) will include:

- **Results of the literature review:**
- **Some definitions** – safety, risk, indicator etc.
- **Safety theory** – accident & risk models, system model
- **Safety Performance Indicators**
- **Discussion & Conclusions & Recommendations**

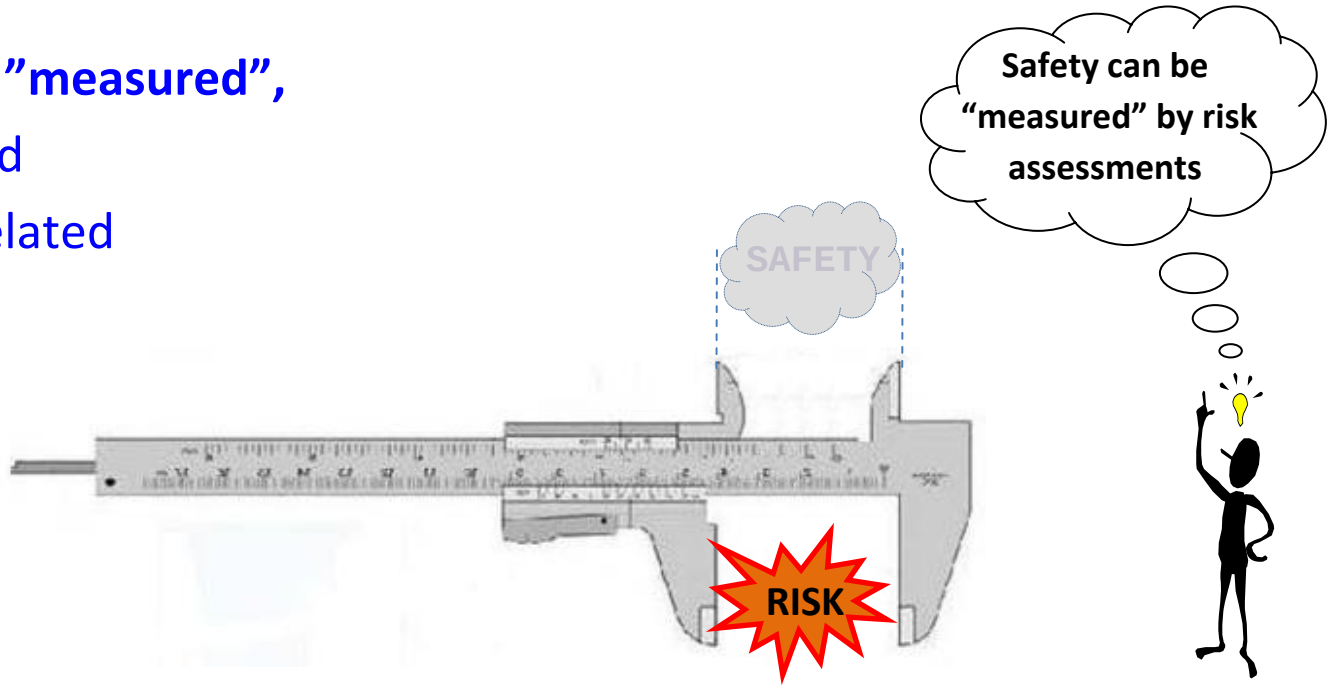
Definition:

Safety Safety is the **state**
in which the **risk** of harm to persons,
environment or property damage
is reduced to, and maintained at,
or below, an acceptable level
through a continuing process of
hazard identification and
risk management

Safety can not be measured **directly, safety** has to be measured **indirectly**

"... like the depth of water can be measured using ambient pressure as an indicator of water depth, or like the sound of a whistling kettle acts as an indicator of water temperature in the kettle."

Thus, **safety** can be **"measured",**
by assessing **risk** and
by the use of risk-related
safety indicators !



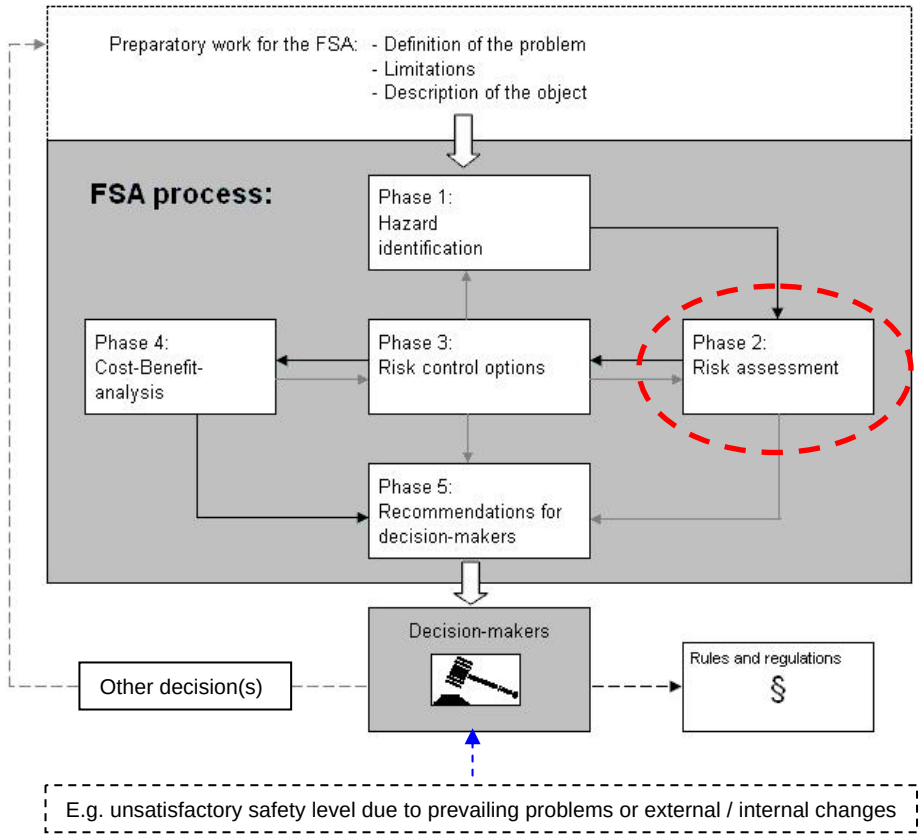
Definition:

Risk Risk is the chance of harm, in terms of probability and severity of the consequences

Risk Assessment is one part of Formal Safety Assessment (FSA)

FSA enables rational decision-making process in Safety Management

FSA is targeted mainly for Administrators' use, but this methodology offers an approach for other levels of **system** hierarchy, too, since it contains elements required for reasonable safety management, if sufficient and reliable information (of the system) and **flow of information** for it can be guaranteed



A description of FSA can be found in "Guidelines for Formal Safety Assessment (FSA) for use in the IMO rule-making process" in MSC /Circ.1023-MEPC/ Circ.392 [IMO, 2002]

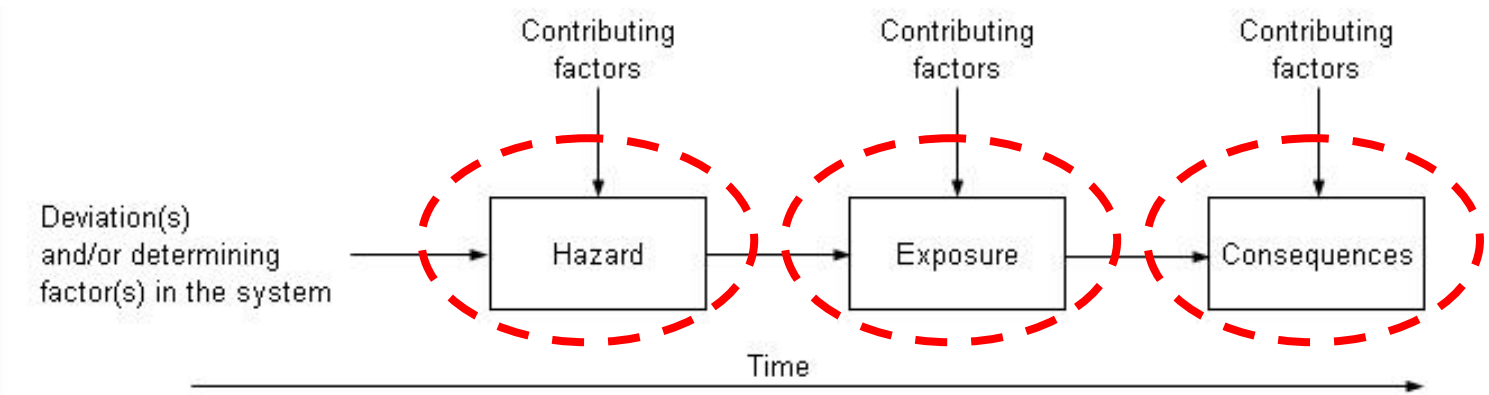
Safety theory:

In order to be able to have a good control of various types of risks it is useful to distinguish different types of accident models, e.g.:

a) sequential accident models,

b) epidemiological accident models and

c) systemic accident models



An example of a sequential accident process model, adopted from V. Rouhiainen [1990]

Safety theory – safety performance indicators:

Attention should be given to all known **hazards** **and their** **consequences**.
This has already been done in the maritime sector with a varying success.

However, **proactive safety management** developes and maintains also an efficient **system** for identifying new hazards and changes, identifying/controlling determining factors and/or deviations in the system as well as the contributing factors to detrimental consequences.

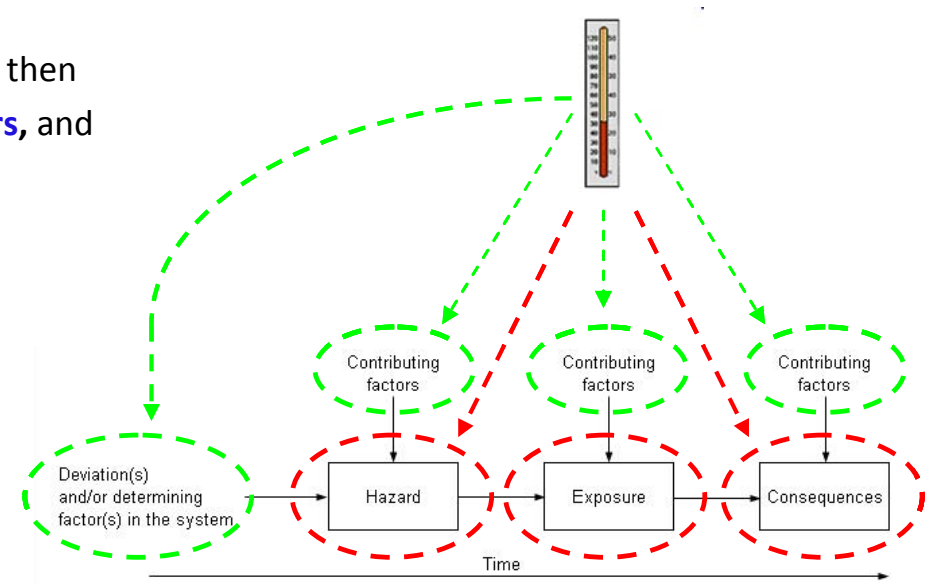
The phases of choice of **safety indicators**:

1) First in the areas of **hazards** and their **consequences**, then

2) including the causes of accidents, **contributing factors,** and

3) **deviations** and **determining factors** in the system

Note! It is important to have an appropriate number (not too many!) of **safety performance indicators** of various types in place to form this system



Definitions

Indicator **”An instrument that indicates the condition of a machine or the like”**
(Webster’s Encyclopedic Unabridged Dictionary of the English Language)

indicate **”to be a sign off; betoken; evidence; show”**
(Webster’s Encyclopedic Unabridged Dictionary of the English Language)

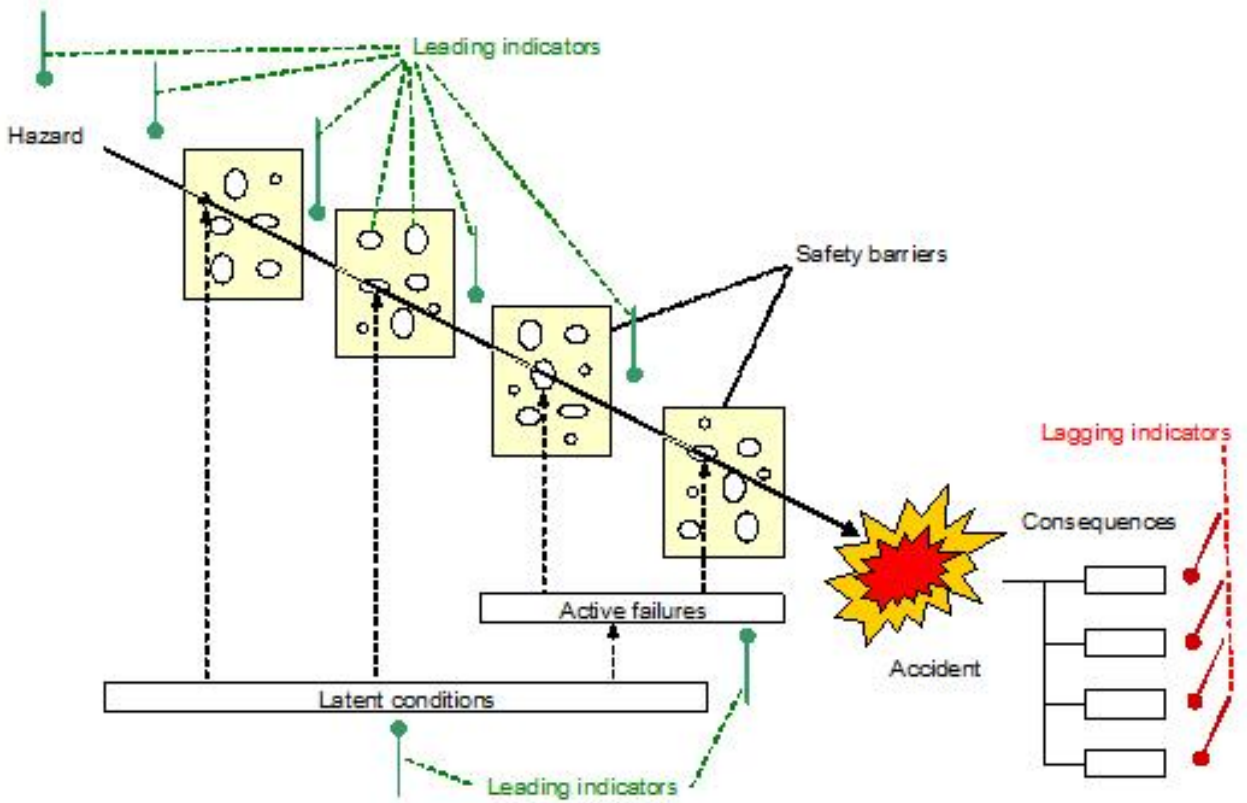
and in Finnish  language:

Indikaattori ”Osoitin, ilmaisin” (Nykysuomen sanakirja, 1. osa ”A-I”, 2. painos, WSOY, 1957, s. 656)

1. (kemia) aine, jonka väri muuttuu toisen aineen happamuuden tai emäksisyyden muk.
2. (tekniikassa) **jonkin tapahtuman tai muutoksen näyttävä osoitin** tai osoitinlaite
3. yhteiskunta-, talous- ja ympäristötieteissä sekä laatujärjestelmissä jokin **tunnusluku, joka kuvaa asioiden tilaa ja kehitystä**
(Lähde (luettu 19.9.2009): http://fi.wiktionary.org/wiki/indikaattori)

Safety performance indicators:

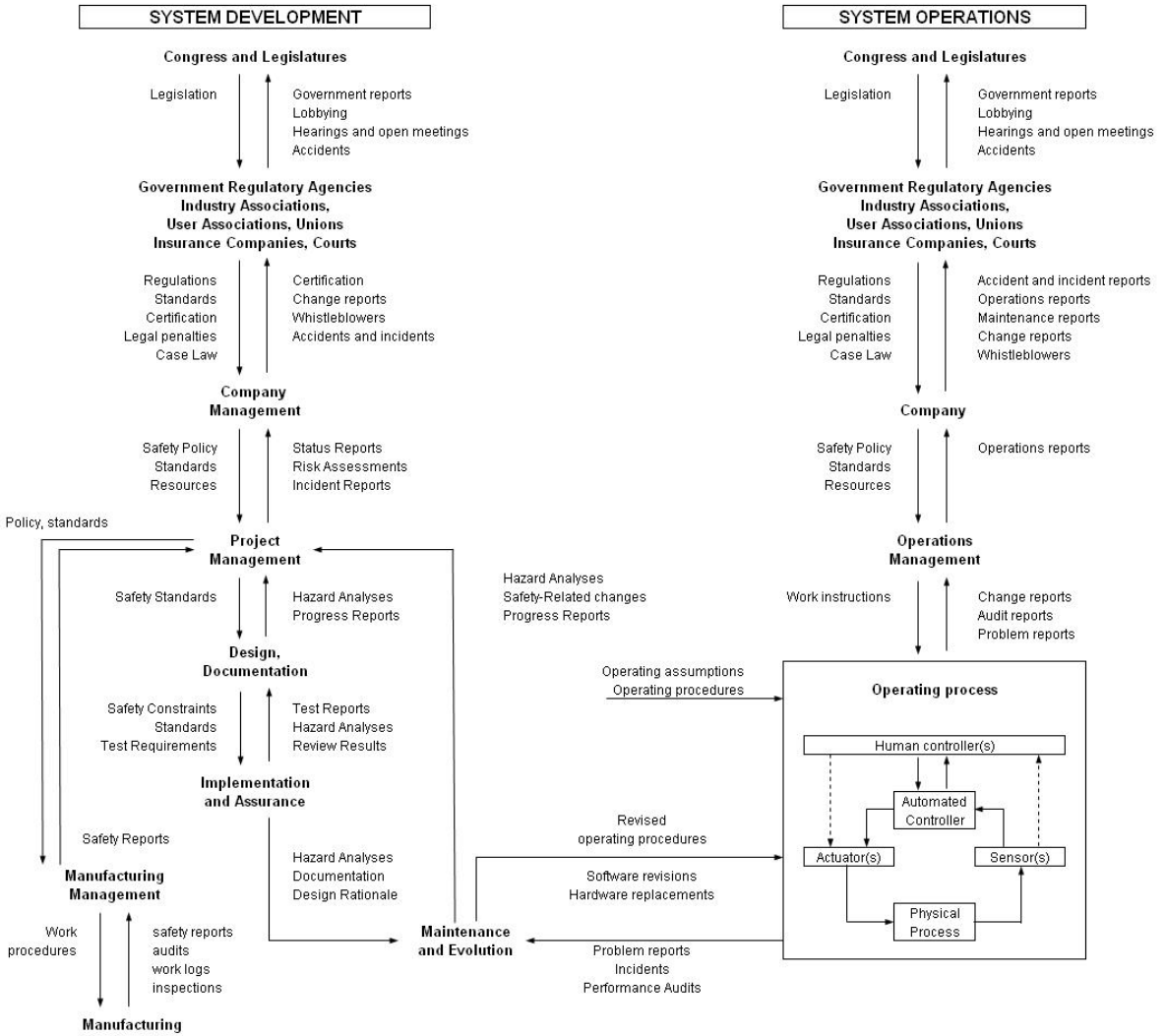
The Swiss-cheese model by J. Reason [1997] is adopted here to illustrate some possibilities for "placing" the **leading** and **lagging** safety indicators.



Safety theory:

An example of a systemic model:
General form of a model of
Socio-Technical Control,
adopted from [Leveson, N. 2004]

This Socio-Technical Control -model makes it easy to understand why **free flow of relevant information**, e.g. in the format of incident reports, being able to attain the actor(s) on the relevant hierarchy level, with the executive power (i.e. having the control on sufficient resources) and capability for decision-making / action and **commitment to safety** , is so important safety indicator



A few examples of safety performance indicators from various fields:

- **Aviation – The culture of reporting**

  - Free flow of safety related information is enabled by the no-blame safety culture
  - Safety performance indicators have been in use for a long time already, some examples of such indicators (picked from a list* of 10 titles in case of **Part C** Aircraft maintenance and repair) are:

    i) Incorrect assembly of parts or components of the aircraft found during an inspection or test procedure not intended for that specific purpose

    iii) Any defect found in a life-controlled part causing retirement before completion of its full life

    v) Any failure, malfunction or defect of any system or equipment, or damage or deterioration thereof found as a result of compliance with an airworthiness directive or other mandatory instruction issued by a regulatory authority (2 subtitles)

    vii) Non-compliance or significant errors in compliance with required maintenance procedures

    viii) Products, parts, appliances and materials of unknown or suspect origin

    ix) Misleading, incorrect or insufficient maintenance data or procedures that could lead to maintenance errors

*Source: Directive of the European Parliament and of the Council on a mandatory system for occurrence reporting in civil aviation [2003/42/EC]

A few examples of safety performance indicators from various fields:

- **Road transport – Leading indicators**

  Safety performance indicators for car traffic have been in use for long, some examples of leading and lagging indicator titles from this sector of transportation are:

  - observance of the rules of the road, frequency of violations or dangerous actions in traffic, e.g. speeding and the number of ”drunken drivers”; the portion of alcohol and/or drug users in traffic
  - use of mandatory (or voluntary) safety equipment (e.g. safety belts),
  - road conditions
  - efficiency of trauma management (this could also be lagging indicator)

A few examples of safety performance indicators from various fields:

- **Offshore – Occupational safety vs. catastrophes**

  Safety performance indicators have been introduced and taken into use, here is an example of a list of the three high level Key Performance Indicators adopted in the UK sector and related to major incident potential, source: workshop report [OGP, 2008] :

  - KPI 1: Loss of containment (number of reportable hydrocarbon releases)
  - KPI 2: Number of significant non-compliances (uncorrected deficiencies with function, performance or management of defined Safety Critical Elements)
  - KPI 3: Production impact from integrity failures

A few examples of safety performance indicators from various fields:

- **Nuclear industry – General indicators, some examples**

Safety sectors and indicators of Finnish NPPs [STUK, 2008]

A.I Safety and quality culture

1. Failures and their repairs
2. Exemptions and deviations from the Technical Specifications
3. Unavailability of safety systems
4. Occupational radiation doses
5. Radioactive releases
6. Keeping plant documentation current
7. Investments in facilities

A.II Operational events

1. Number of events
2. Direct causes of events
3. Risk-significance of events
4. Accident risk of nuclear facilities
5. Number of fire alarms

A.III Structural integrity

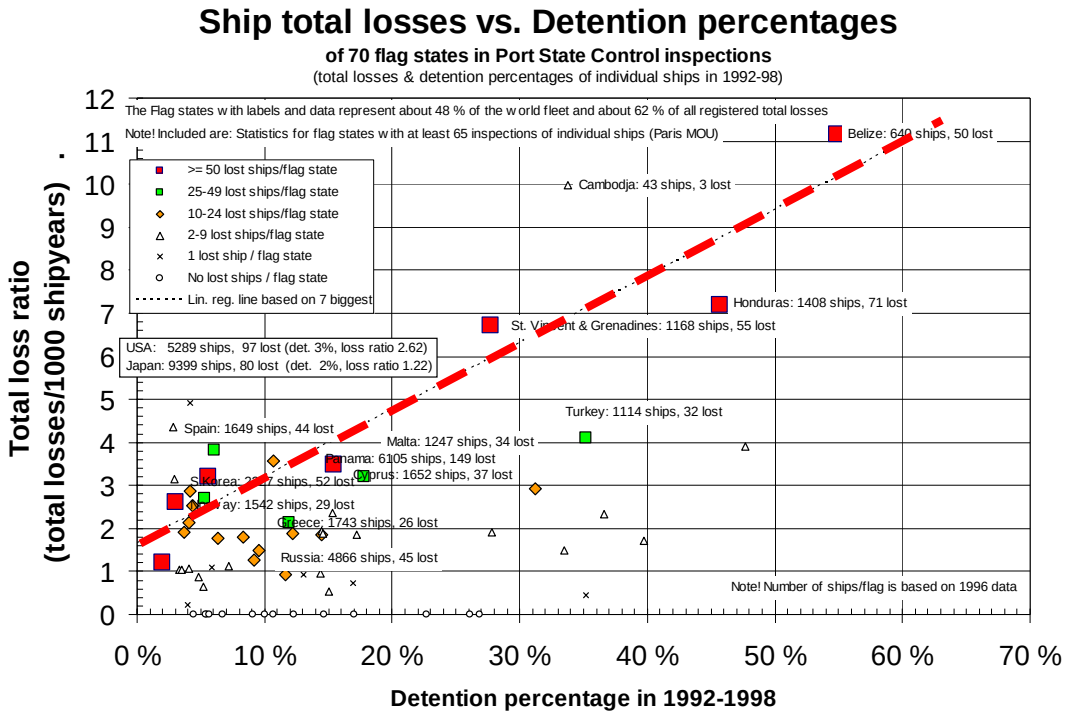
1. Fuel integrity
2. Primary and secondary circuits integrity
3. Containment integrity

Examples of safety performance indicators from maritime safety

- **Total loss vs. loss ratio**
- **Detentions in PSC-inspections**

The ratio between the number of total losses and the number of ships seems to have some dependency on the detention percentage of the Flag State.

Thus, a detention for a single ship or shipping company or the detention percentage of ships in a Flag State may be used as coarse, general safety performance Indicators (with certain limitations).



Detention: **a serious deficiency or multitude of deficiencies that must be corrected before the vessel is allowed to leave the port** [Kristiansen, 2001]

Literature Review

The "clear grounds" for a detention are defined by the IMO [Knapp, 2006] as follows:

1. *the absence of principal equipment or arrangements,*
2. *ship's certificates are clearly invalid,*
3. *certificates are incomplete, not maintained or falsely maintained,*
4. *evidence from general impression and observation reveals serious hull or structural deterioration that may place at risk the structural, watertight or weather tight integrity,*
5. *evidence from general impression and observation reveals serious deficiencies in the area of safety, pollution prevention or navigational equipment,*
6. *master or crew is not familiar with essential shipboard operations relating to the safety of ships or the prevention of pollution,*
7. *key members cannot communicate with each other,*
8. *emission of false distress alerts followed by proper cancellation procedures,*
9. *receipt of a report of complaint containing information that the ship is substandard*

All of these can be treated as lower level safety performance indicators.

An inspection may also result in a "deficiency". It is also a safety performance indicator.

Deficiency: **A deficiency is a non –conformity, technical failure or lack of function**
If found in an inspection, a deadline for correction will be given.

Discussion

The use of “safety performance indicators” varies considerable in the maritime branch

Most of the SPIs are regulated by IMO, the national administrations and by the industry itself

Stability indicators, e.g. the ship’s GM_0 and the area under GZ-curve, as well as for example the Ice Class, are some examples of (technical) Safety Performance Indicators

A quantitative or a qualitative risk assessment may generate several assessments of certain probabilities or frequencies. These numbers may often be used as SPIs.

One of the most important fields for new SPI development is within the operational area of maritime traffic

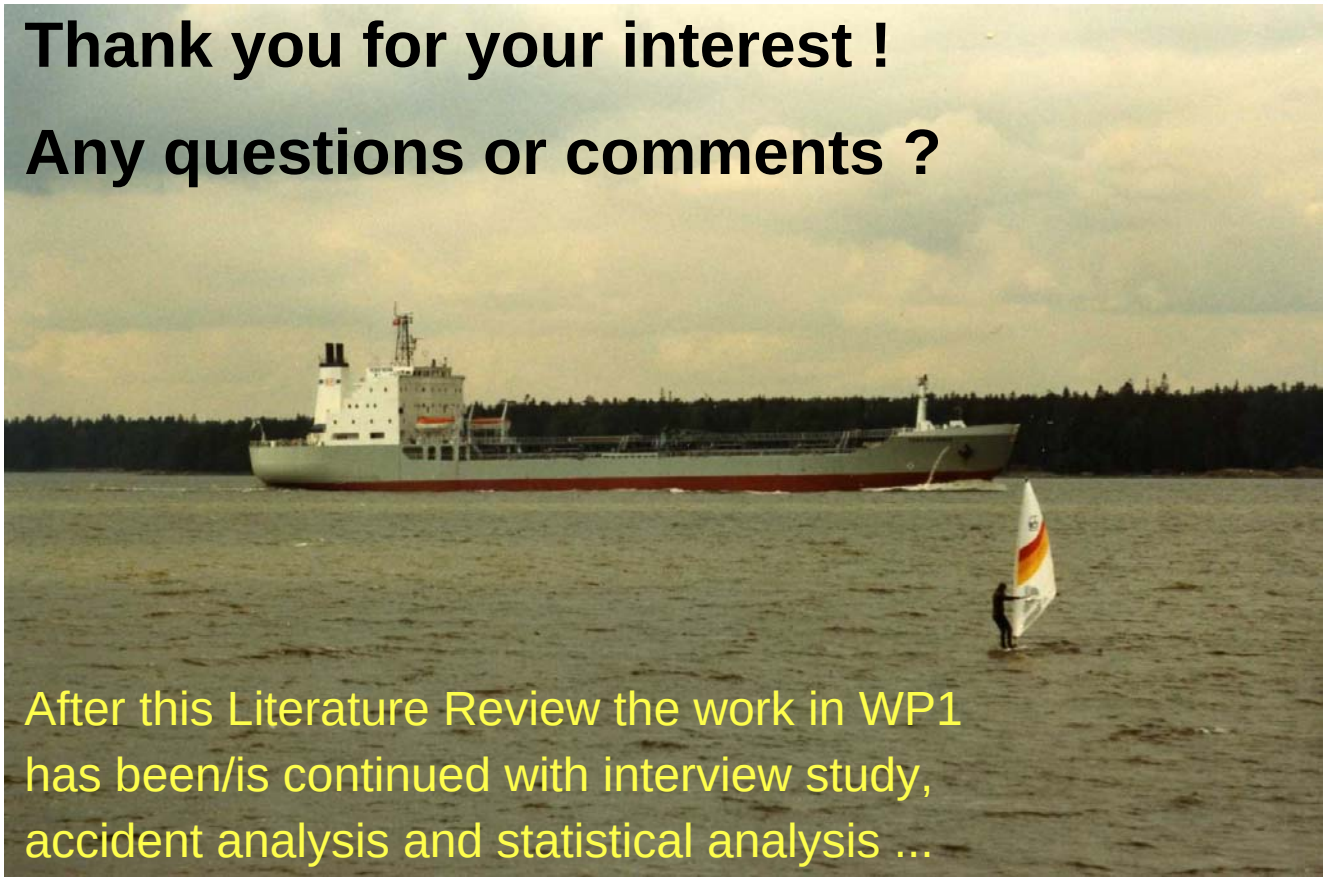
Note! Safety Performance Indicators that are used somewhere else may not offer ready-to-use indicators for the maritime transportation sector. Each field of activities should develop and use SPIs that are fit to the specialities of the field.

Maritime Safety Management has to use and develop its own safety performance indicators!

It is, however, instructive to get acquainted with the safety indicators in use on other fields, especially within transportation sector

Conclusions & Recommendations:

- **An efficient information system** based on the use of **risk modeling** is needed
- Significant **leading and lagging safety performance indicators** should be in use or developed to serve the various hierarchies of maritime safety management
- The development/use of efficient **safety performance indicators** in the maritime sector should be continued
- An ideal safety information system facilitates analysis and synthesis of data taking into account:
  - status of the system (internal & external)
  - incident reports and incident statistics,
  - accident investigation reports and accident statistics
  - trends in society, technology and traffic (on several levels), as well as developments in science and R&D
  - etc.
- **FSA-approch may offer the best basis for the development of such a system**



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