



UNIVERSITY of STRATHCLYDE
**MARITIME SAFETY
RESEARCH CENTRE**



Use of STAMP/STPA to model organizational risk and safety management at cruise and ferry companies

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Outline

- Background
- Methodology
- Analysis
- Conclusions

Background

- Started work on PhD in January 2017
- Basic hypothesis was that if a cruise or ferry operator implements strong risk management, the safety record and financial performance of the company should improve
- Latest risk management approach is to implement Enterprise Risk Management (ERM), a holistic method for understanding risk
- At end of first year, the most significant comment was to determine what model to use to analyse safety and risk management, which ultimately led to STAMP

Background - continued

- In maritime ship operating business the requirement for risk assessment is contained in the International Maritime Organization (IMO) (part of the UN) International Safety Management Code:

Paragraph 1.2.2 states:

Safety management objectives of the company should, inter alia;

- Provide for safe practices in ship operations and safe working environment;
- Assess all identified risks to its ship, personnel, and the environment, and establish appropriate safeguards; and
- Continuously improve safety management skills of personnel ashore and aboard ships.

Background - continued

- Risk definitions:
 - Risk is the possibility of harm or loss associated with an activity, or the likelihood of an incident happening that may result in danger to life, property or the environment, or may lead to commercial disputes and litigation (Mandaraka-Shepard, 2014)
 - Enterprise Risk Management is a process, effected by an entity's board of directors, management, and other personnel, applied in *strategy setting and across the enterprise*, designed to identify potential events that may affect the entity and manage risks to be within its risk appetite to provide reasonable assurance regarding the achievement of entity objectives. (COSO, 2004)
 - Risk is defined in terms of the effectiveness of the controls used to enforce safe system, i.e., the design and operation of the safety control structure. (Levesen, 2018)

Background - continued

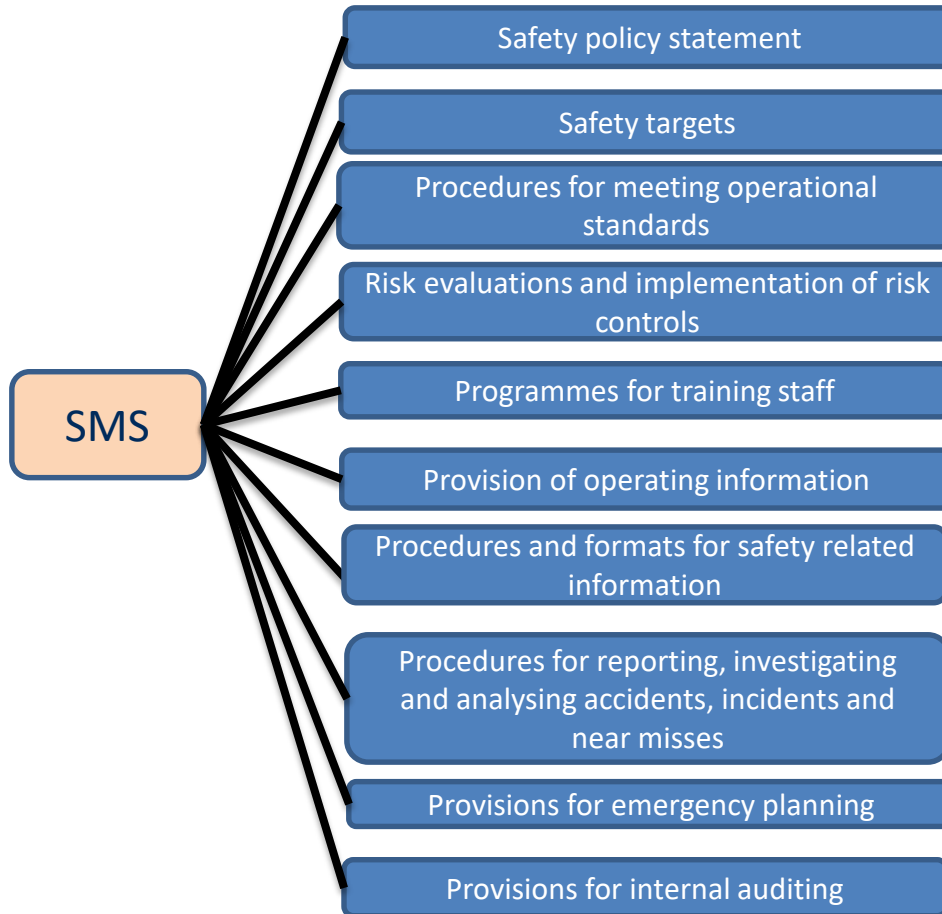
Corporate ERM Maturity levels from the Risk and Insurance Management Society (RIMS)

Level 1 Ad Hoc	No coordinated focus on risk management
Level 2 Initial	Some risks identified, silo focused, audit focused
Level 3 Repeatable	Risks are tracked, enterprise risks identified, risk management plan
Level 4 Managed	Business planning and investments are linked to risk, board of directors briefed periodically
Level 5 Leadership	Corporation understands its risk tolerance/appetite, risk is part of the day to day management of the organization with a strategic focus

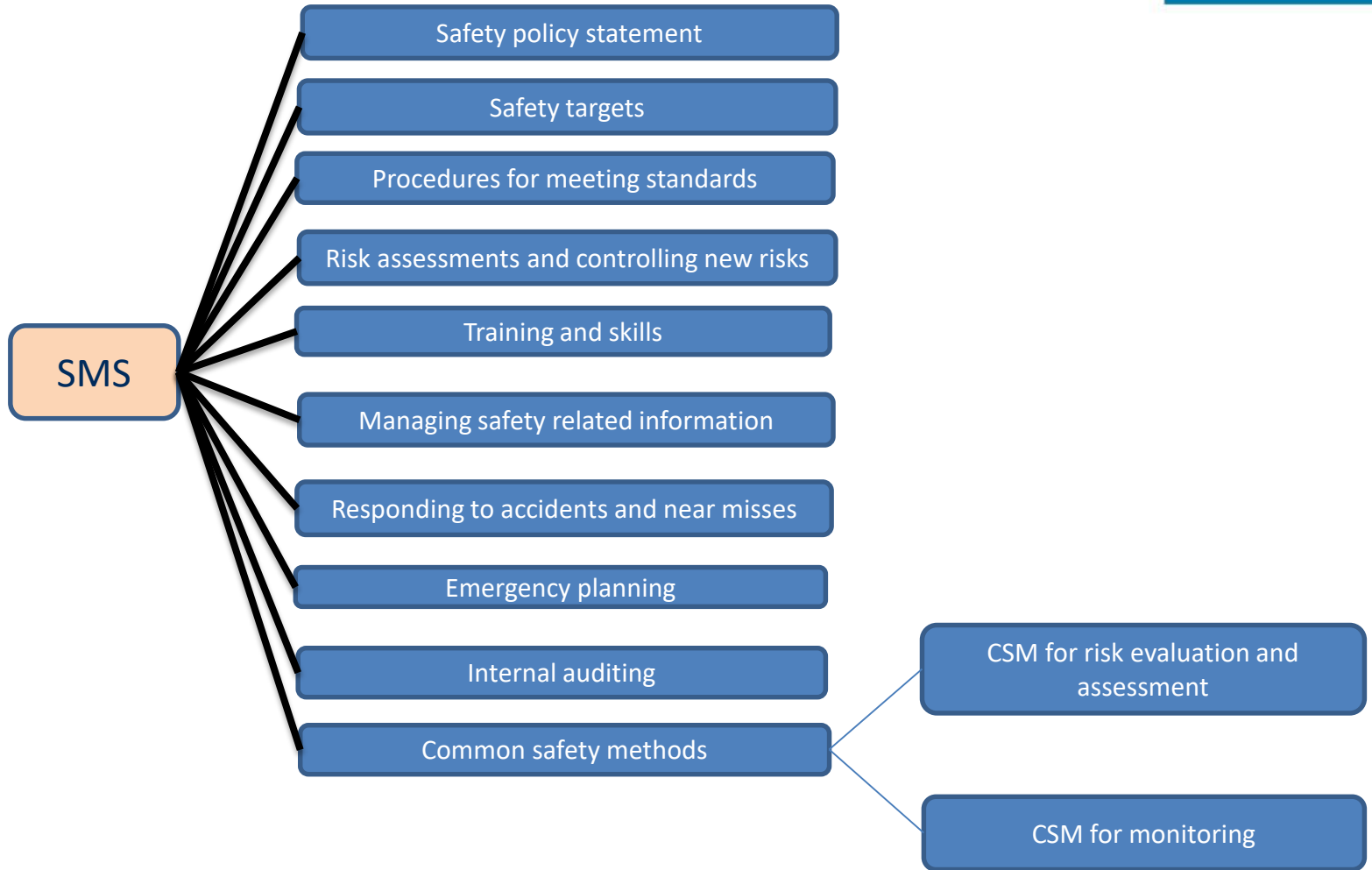
Background - continued

- Other safety critical transportation industries were reviewed to determine their approaches to risk and safety
 - Railways
 - Airlines

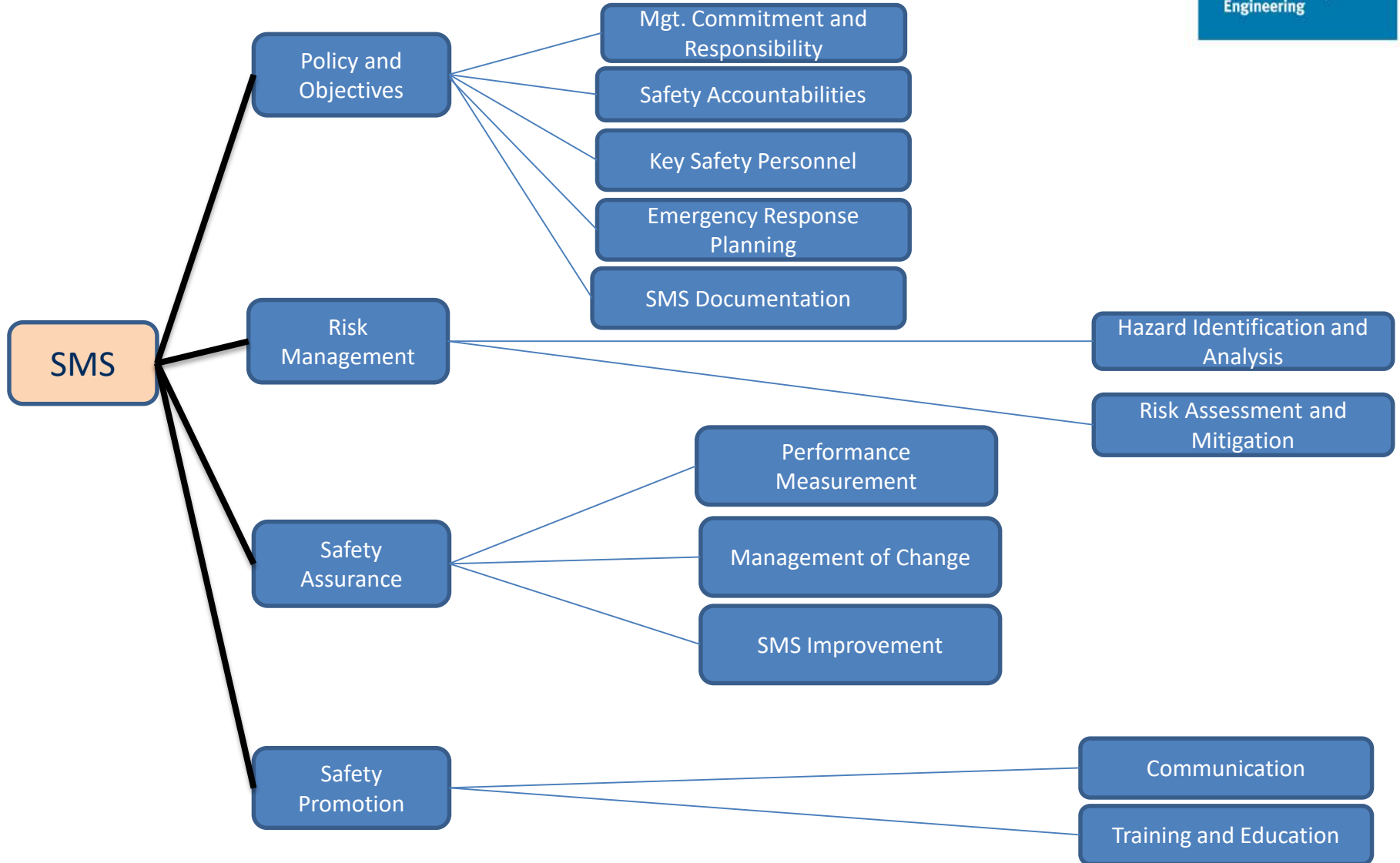
European Union Directive 2004-49 Rail Safety Management System



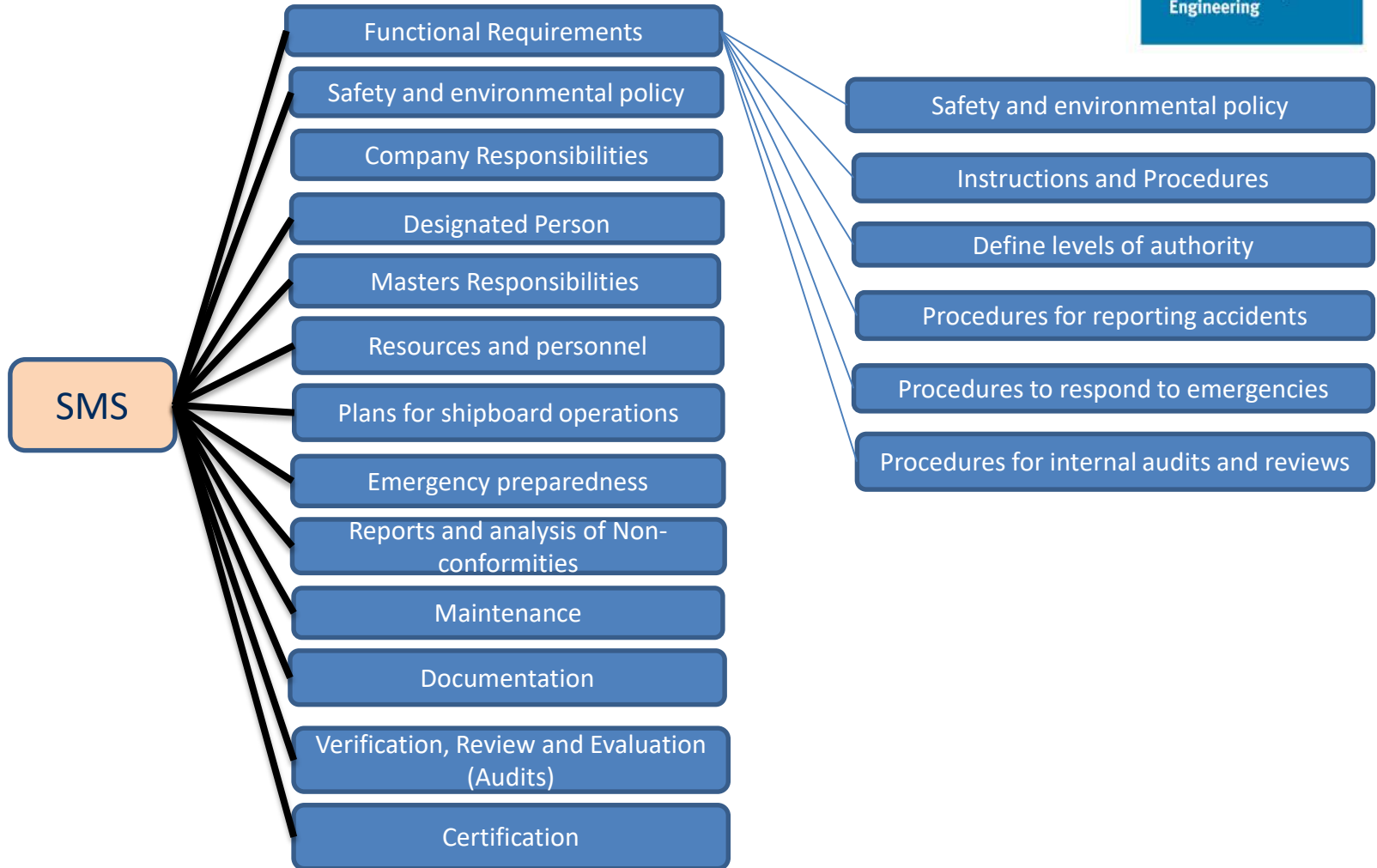
UK Rail Safety and Standards Board (RSSB)



International Civil Airlines Organization (ICAO)

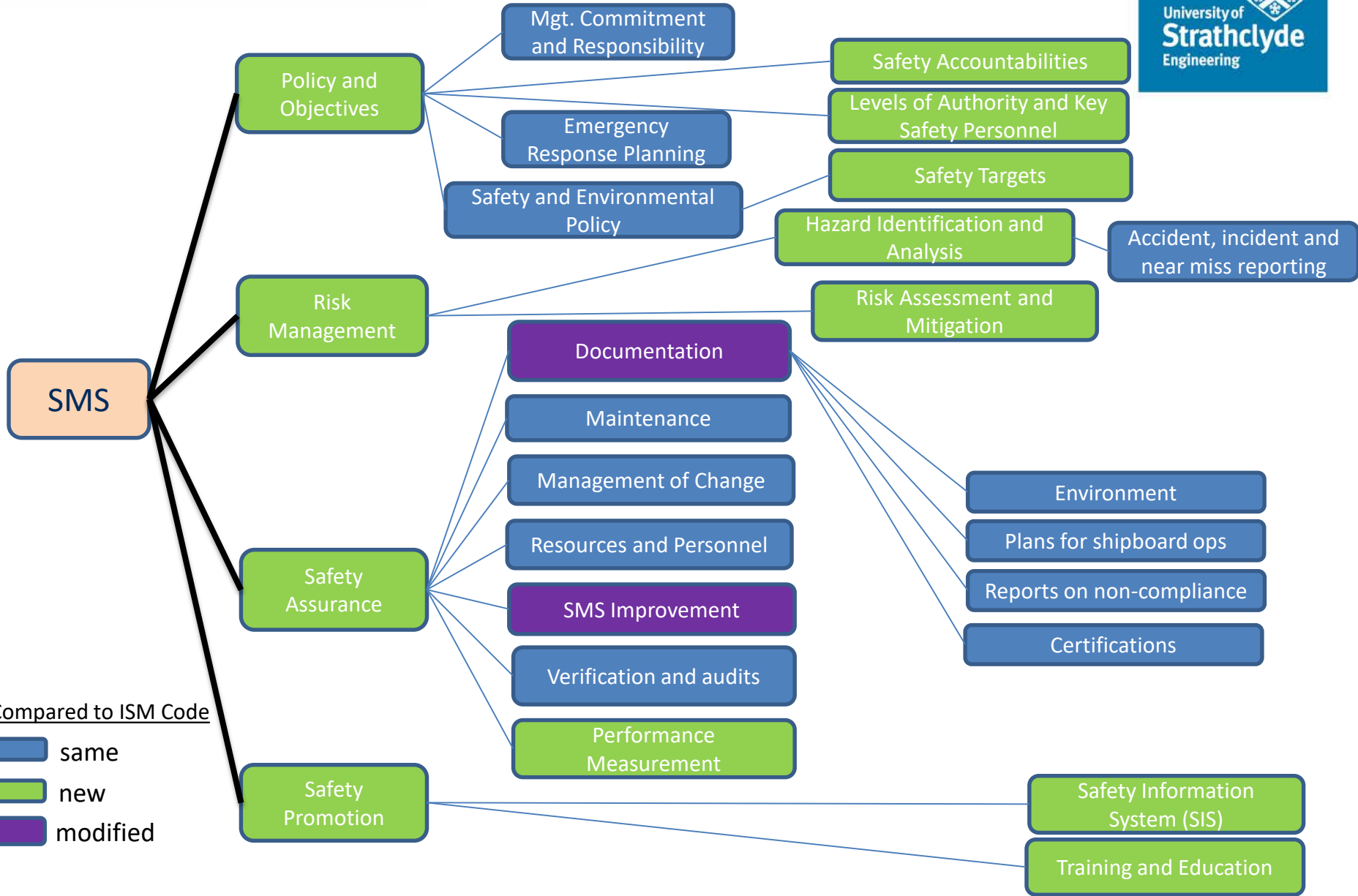


ISM Code*



* Revised Effective 2015

Proposed Generic SMS for Cruise and Ferry Operators



Background - continued

- Generic SMS template was created by merging the best of the ICAO framework with the IMS Code's SMS for ships
 - Establishes a sound framework for all aspects of risk and safety management to analyse each company

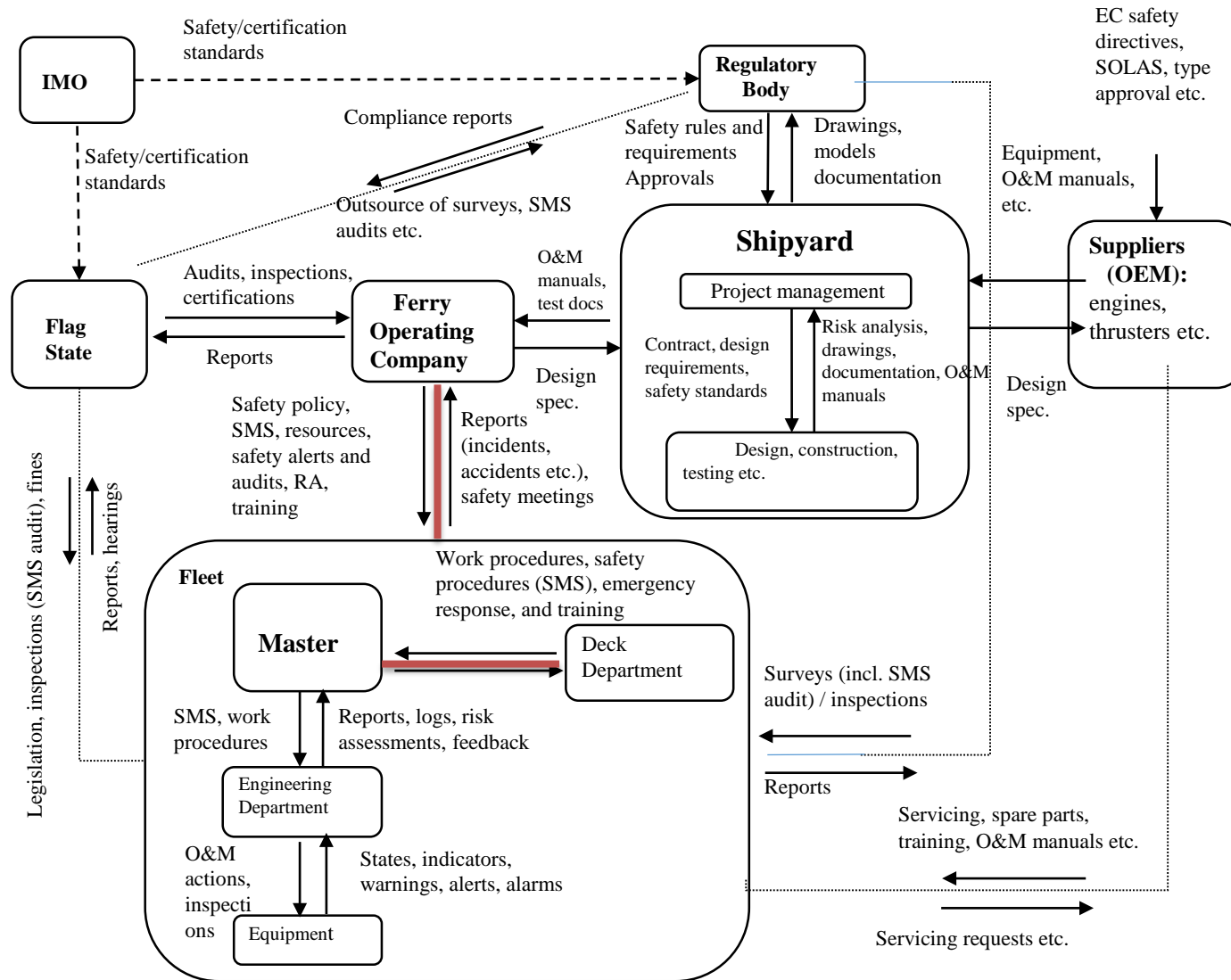
Methodology

- Plan is to conduct a STAMP (Systems-Theoretic Accident Model and Processes) – analysis of the SMS at each of two ferry operating companies and two cruise ship companies. This paper shows results for the first ferry company assessed.
- Safety constraints are created and imposed within the entire socio-technical system, mainly through interactions between SMS controllers (e.g. officer interacts with navigation controls, engineers interacts with critical equipment, auditors verify safe operations, etc.)

Methodology - continued

- The ferry operator's control structure was established from management documents, policy documentation, and interviews
- The corresponding flow of risk and safety information to the broader control environment was established (next slide)
- An STPA analysis was done on the SMS hierarchy using the proposed generic SMS

Simplified ferry company control structure



Analysis

- **System goal: Safe operation.**
- **System Hazard:**

Poor safety and risk management creates a drift towards riskier operations with the possibility for the loss of a ship, or serious injury to crew and passengers.
- **Required organisational culture:**

The existing safety process is patterned after the IMO minimal guidance for creating a Safety Management System (SMS). Upper management supports the development of this safety culture by having staff attend training, documenting the steps necessary and making sure the effectiveness of the process is checked annually.
- **System Safety Requirements and Constraints:**

The requirements and constraints are generated by applying STPA to the overall SMS and Risk management approach.

Analysis - continued

Accidents:

System accidents:

SA-1 Ship is lost, or sustains major damage.

SA-2 Loss of life on a ship, at a port facility, or on a shore excursion.

SA-3 Ship release of hazardous materials causes damage to environment

Safety Management System (SMS) accidents:

SMSA-1 SMS fails an audit, implying a weak safety process (the type of findings that indicate poor SMS design and implementation and can lead to suspension of operating licensee)

SMSA-2 Poor safety performance (under the premise that a well-operated SMS will increase safety performance)

SMSA-3 Risk Management System (RMS) fails to identify critical risks (under the premise that a well-operated RMS provides an indication of how well the SMS is performing)

Analysis - continued

Hazards:

System Hazards:

SH1: Ship is lost or seriously damaged from collision, grounding or fire (SA-1)

SH2: Passenger or crew dies from accident or incident on-board, at port facility or on a ship sponsored shore excursion (SA-2)

SH3: Ship releases hazardous materials to environment in violation of rules and regulations (SA-3)

System Level Requirements:

SR1: Effective design, training and safety culture shall exist for the crew to prevent damage from collision, grounding and fires.

SR2: Effective design, training and safety culture shall exist for the crew to prevent accidental death of a crew or passenger on-board ship, at a port facility or on a ship sponsored shore excursion.

SR3: Effective training and safety culture shall exist for the crew to prevent releases of hazardous materials to the environment.

Analysis - continued

Hazards:

Safety System Hazards:

SSH1: SMS is not designed according to standards (SMSA-1, SMSA-2)

SSH2: RMS is not mature, fails to identify critical risks, and does not implement Enterprise Risk Management (ERM) (SMSA-3)

SSH3: SMS and RMS are not well integrated (SMSA-1, SMSA-2, and SMSA-3)

SSH4: SMS and RMS are not suitable for the organization (SMSA-2, SMSA-3)

SSH5: SMS and RMS are not effective (SMSA-2, SMSA-3)

SSH6: SMS is not implemented according to Standards (SMSA-1)

Safety System-level requirements:

SSR1: SMS shall be designed according to standards

SSR2: RMS shall be mature, use ERM and identify critical risks

SSR3: The SMS and RMS shall be well integrated

SSR4: The SMS and RMS shall be suitable for the organization

SSR5: The SMS and RMS shall be effective.

SSR6: The SMS shall be implemented according to Standards

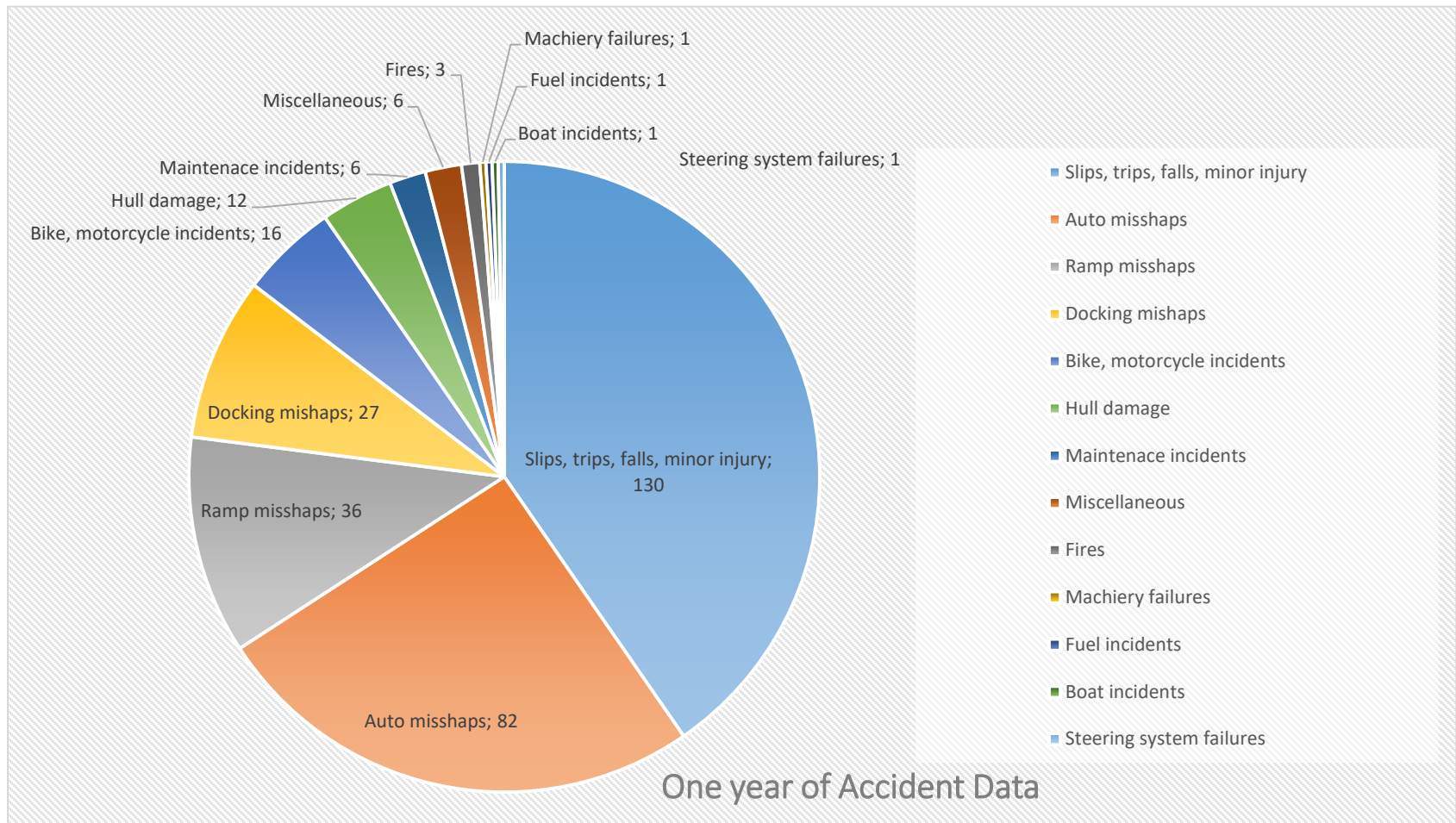
Analysis

- The 27 controllers identified in the paper were based on a preliminary analysis.
- The STPA analysis identified 103 control actions with a corresponding 376 unsafe control actions.
- A total of 1128 requirements and indicators were identified.
- The indicators were analysed in the context of the ferry company's last several years of accident and near miss data.
- A set of Key Indicators and regular indicators were created
- The ERM Maturity was assessed via surveying the risk and safety management approach at the company. The current maturity is ~2.5

Analysis - continued

- Several years of audit data were analysed
 - This data provides validation of many risk and safety indicators identified via the STPA

Analysis - continued



Conclusions

- STAMP/STPA applied to the safety and risk management organization of a ferry company provides good insight into the critical requirements
 - The STPA on an existing safety organization generates a large amount of data; final results must be created in consort with the company
- A set of Key and regular indicators, linked to hazards identified through the STPA analysis, was created and provides a strong management tool.
- Clear gaps in risk management were observed
- Analysing air and rail approaches to SMS provided insight in establishing a new generic SMS template for maritime usage
- Initial company's risk processes are not mature, allowing room for improvements based on the STAMP results

Next Steps

- Conduct STAMP/STPA on three more cruise and ferry companies
- Based on the STAMP/STPA analysis, recommended changes to the risk and safety approaches at each company will be made
 - The impact of these changes will be tracked to determine the effect on accidents, near misses and financial performance
 - The STAMP/STPA analysis can be rerun periodically as organizations change, or fleet operations change.
- Additional cruise and ferry companies should be analysed (another PhD - anyone interested?)



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