UNIVERSITY of STRATHCLYDE
MARITIME SAFETY RESEARCH CENTRE

University of Strathclyde Engineering

Classification of causal factors of major maritime accidents

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Convention vs Complex Reality

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Titanic, Reported causes
"Captain Smith had failed to take proper heed of ice warnings. Collision was the direct result of steaming into a dangerous area at too high a speed." Neither White Star Line nor its parent corporation IMM were mentioned.

→Human error ("*mistake*", "*Act of God*")

Titanic, Unreported causes (systemic!)
Commercial pressures, management complacency, poor safety culture, no harmonised safety regulations and safety control system

Costa Concordia, Reported causes (official report, 2013)
"Human element is the root cause in the Costa Concordia casualty, …, which means the unconventional action which caused the contact with the rocks. … Ship was in full compliance with all regulations." "Poor organisation of Bridge Team."

→ **Human error (principally Captain)**
→ **Poor organisation/management on the sharp end**

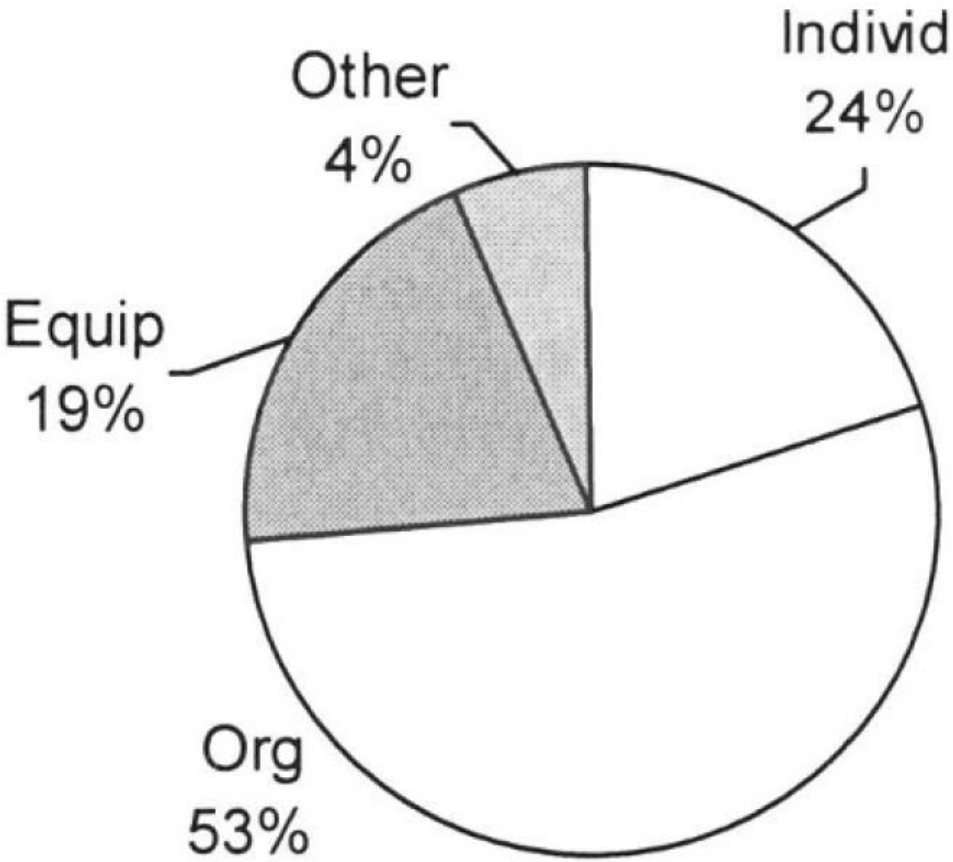
Other causes (systemic!)
Saluting practices close to shore due to commercial pressures, poor evacuation process and useless lifeboats, i.e. wider organisational and regulatory issues

RMS Titanic, 1912

Costa Concordia, 2012

Maritime accident causal factors

(1996-2006, 22 reports)

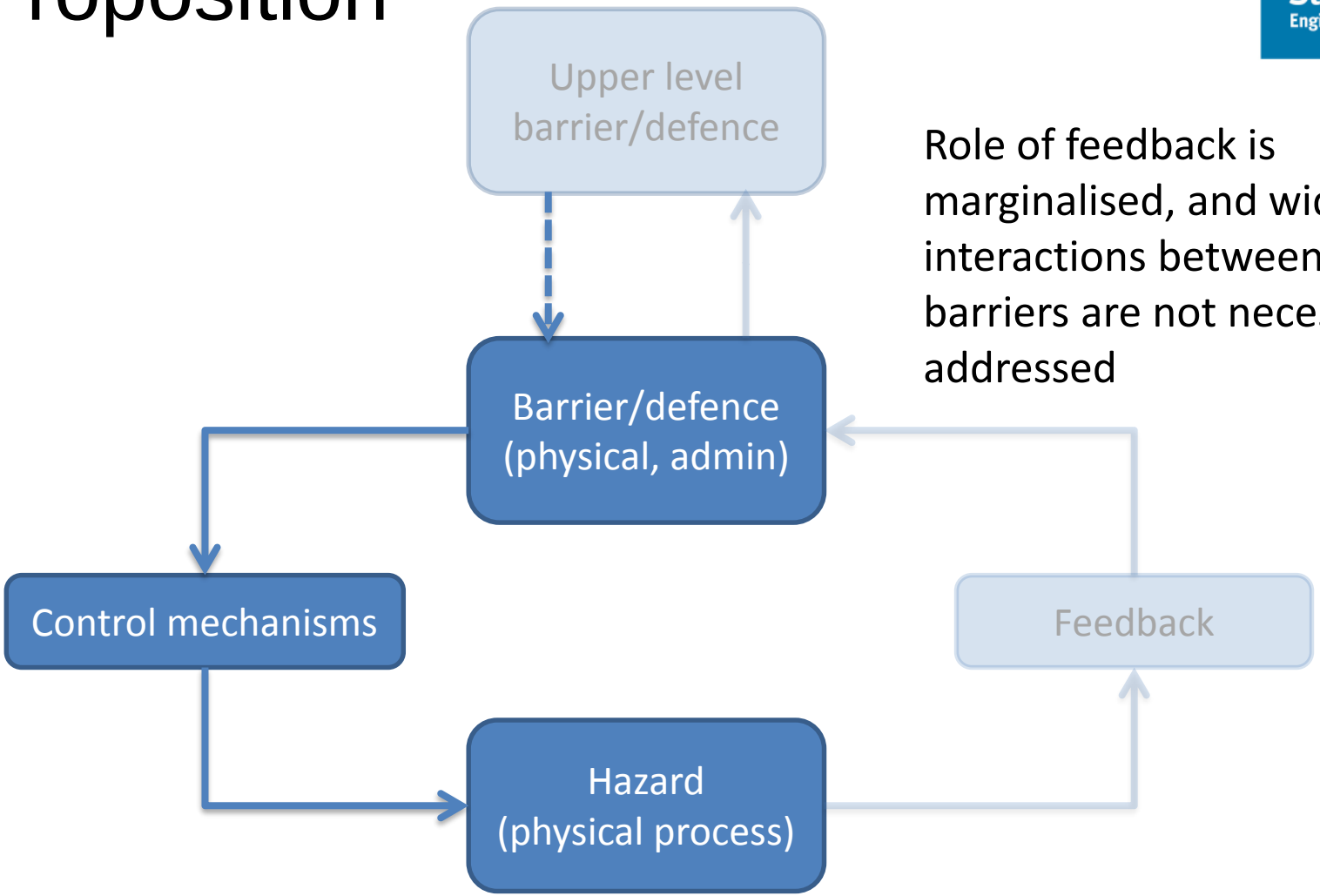


(Johnson et al, 2007)

Proposition

- Maritime accidents are conventionally treated as a reliability problem, rather than of loss of control
- Accident investigators look for sequential, random failures in barriers, defences, etc. due to active and latent conditions
- Hence, the role of feedback is marginalised, and wider interactions between barriers (controllers) are not necessary addressed
- Systemic view, systems thinking on accidents is missing, undermining rational resource allocation and risk assessment

Proposition

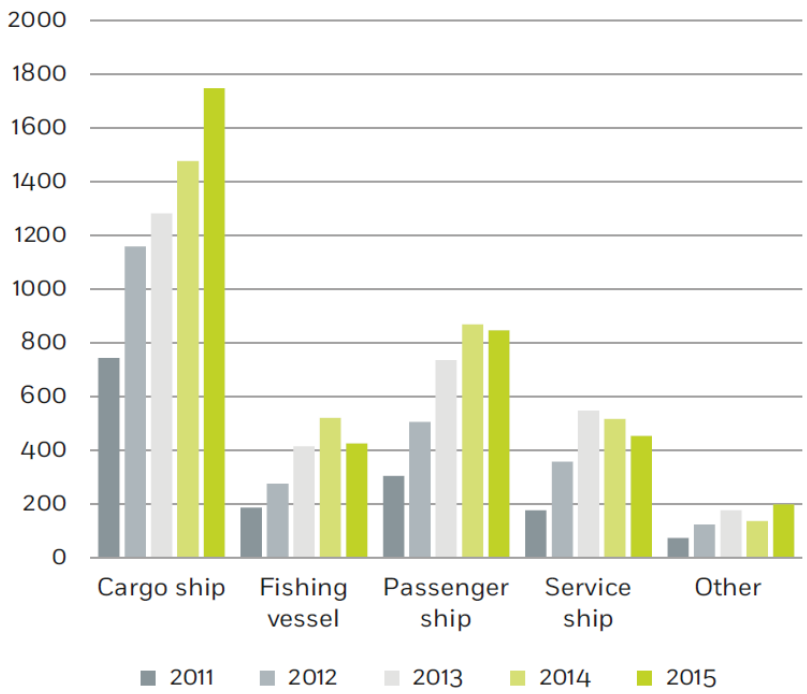


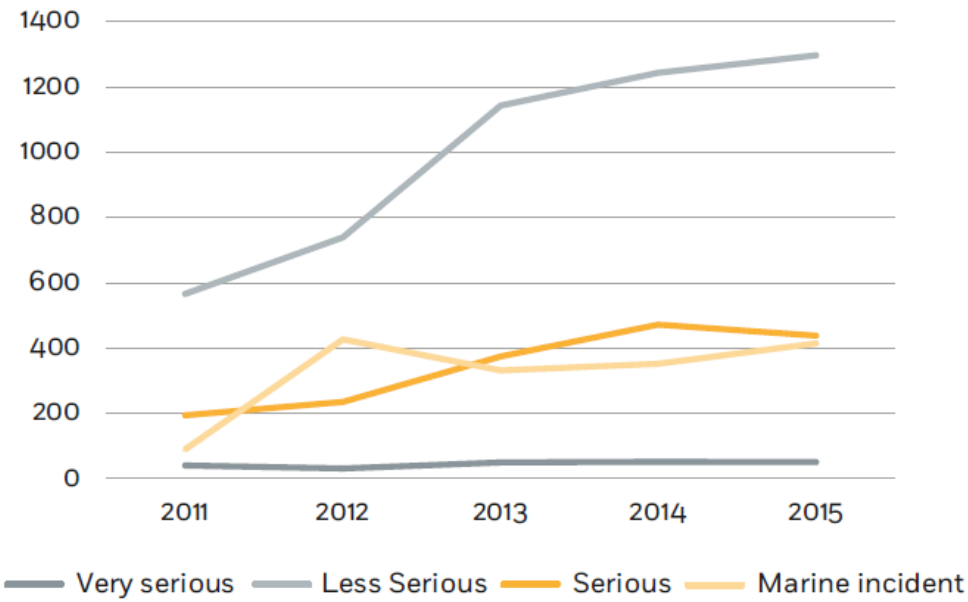
Role of feedback is marginalised, and wider interactions between barriers are not necessary addressed

Outline

- Background to Proposition
- Objectives
- Methodology
- Results
- Conclusions

Global maritime accident trends



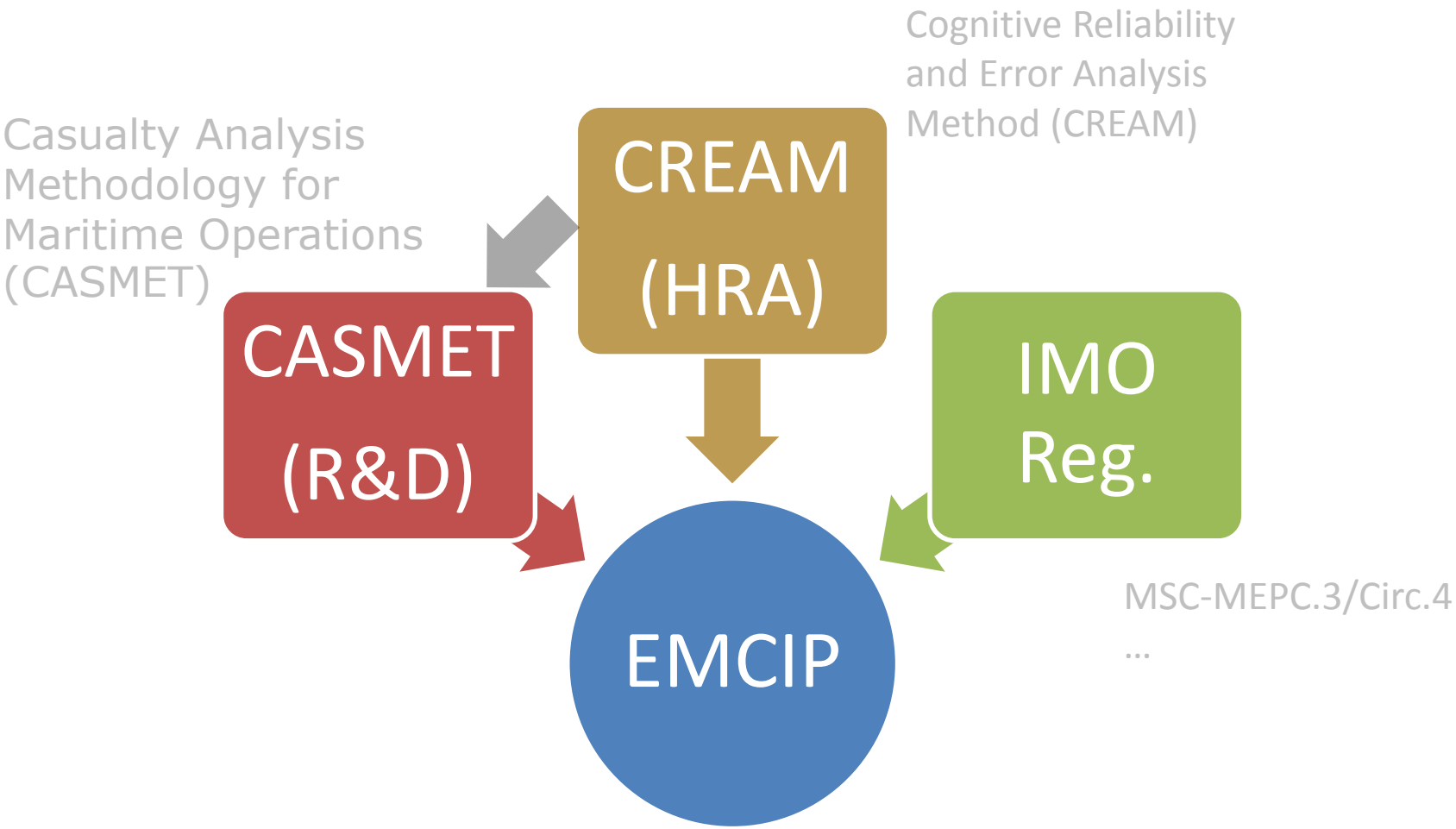


Based on EMCIP (EMSA2016)

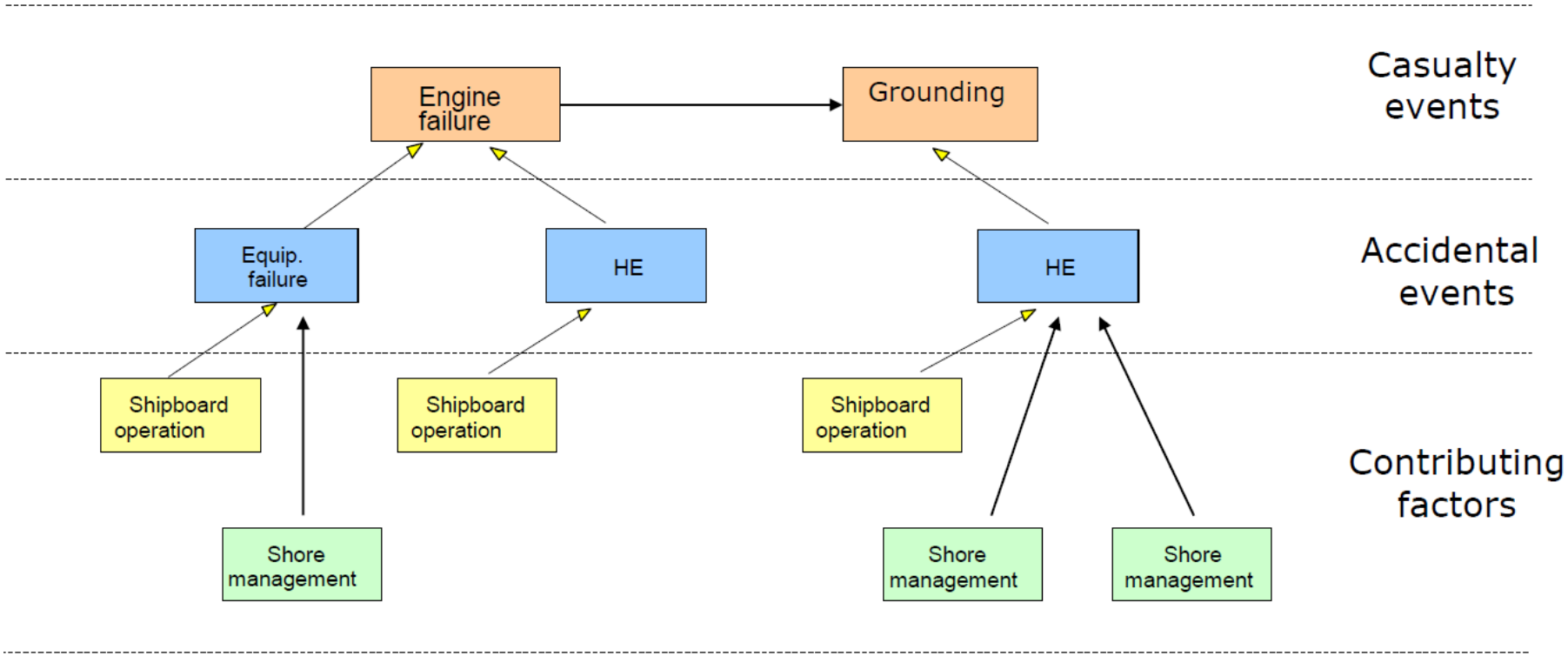
European Marine Casualty Information Platform (EMCIP)

- EU Directive 2009/18/CE (article 17) considers submission of data to, and the general use of, **EMCIP as an integral part of the overall safety investigation system**.
- EMCIP provides the means to **store data and information** related to marine casualties involving all types of ships and occupational accidents. It also enables the production of **statistics and analysis** of the technical, human, environmental and organisational factors involved in accidents at sea. Inter alia, **used for safety development**
- Taxonomy has been developed by EMSA in consultation with the Member States, on the basis of European research and international recommended practice and procedures.
- The EMCIP technical platform makes use of a similar platform developed for the **aviation industry**: the ECCAIRS Common Framework software, developed by the Institute for the Protection and Security of the Citizen - JRC of the European Commission.

EMCIP taxonomy



EMCIP structure (eg)



(EMSA)

EMCIP contributing factors

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Shipboard Operations

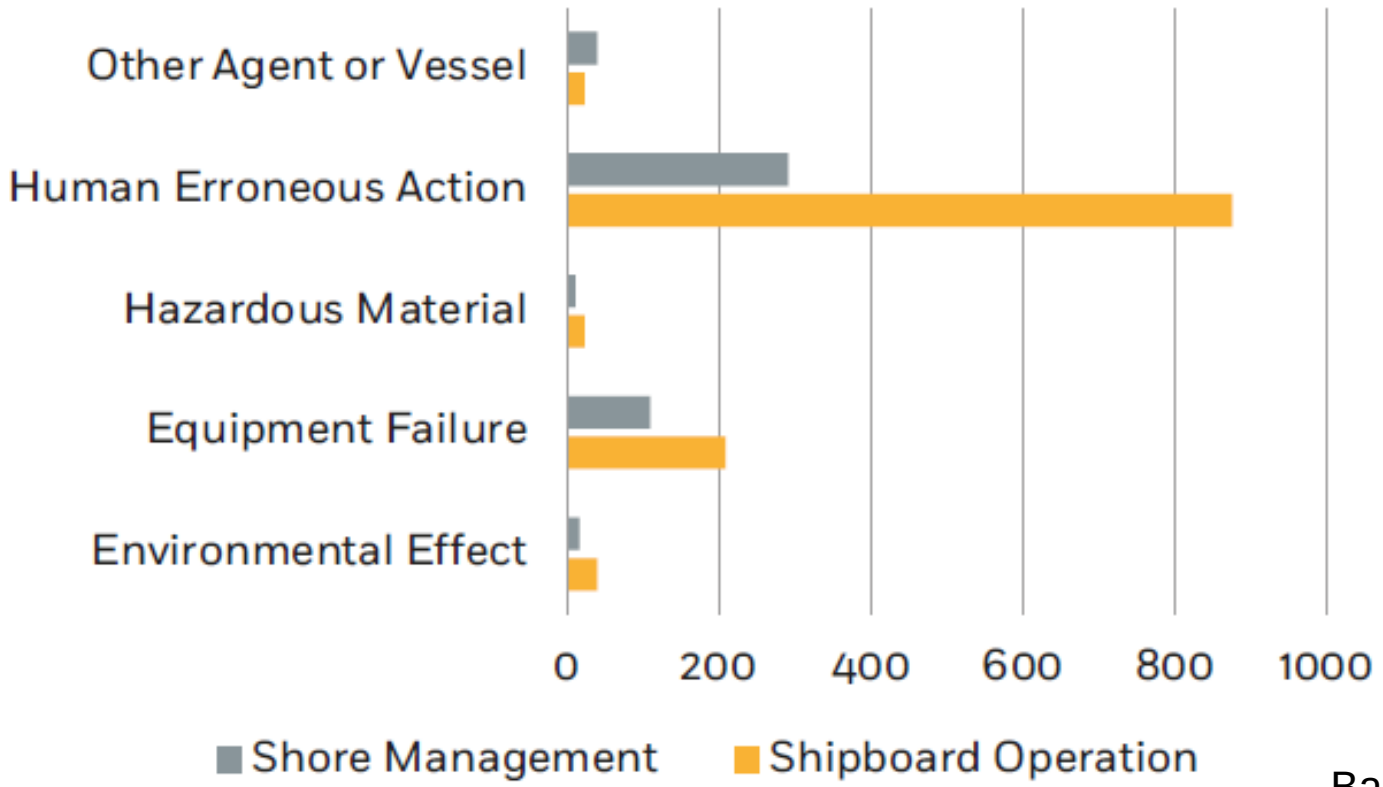
1	Social environment
2	Supervision
3	Manning
4	Personnel
5	Work place conditions
6	Physical stress
7	Inadequate tools & equipment
8	Maintenance
9	Environmental conditions
10	Emergency preparedness

Shore Management

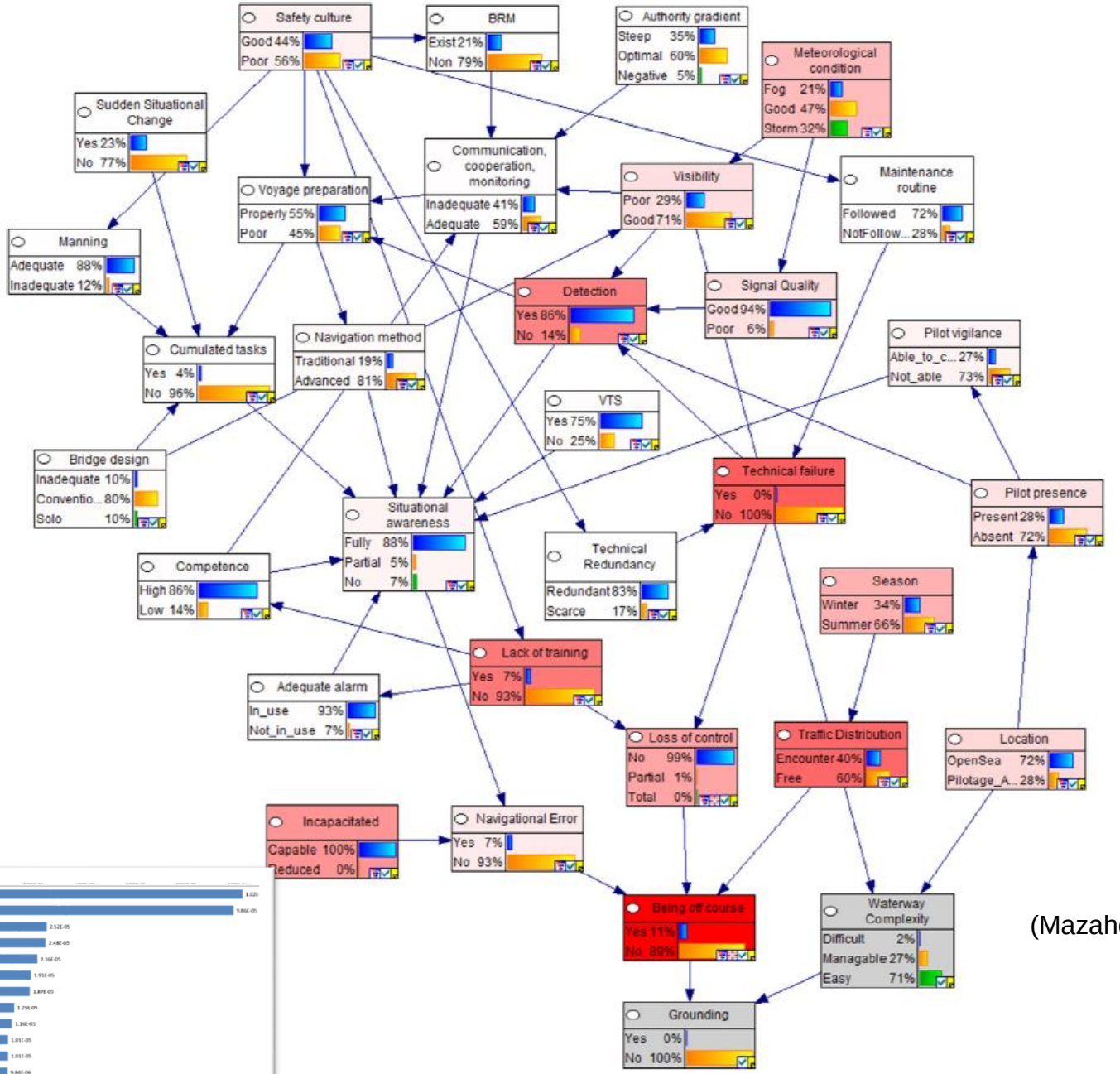
1	Business climate
2	Organization & general management
3	Operations management
4	Safety & environmental management
5	Occupational health management
6	Personnel management
7	System acquisition
8	Design
9	Maintenance policy
10	Emergency preparedness

- Deviation from standards/specifications
- Inappropriate regulations
- Design error
- LTA design verification
- LTA System review and evaluation
- LTA change-management

Accidental events and contributing factors (2011 – 2015)



Based on EMCIP (EMSA2016)



(Mazaheri et al., 2016)

Objectives

Motivated by Casual Analysis based on STAMP (CAST)

- Create a generic safety control structure of maritime safety with key actors and interactions
- Analyse accidents wrt organisational factors, identifying the weak links (dysfunctional interactions) in safety control structure
- Compare the analysis results against conclusions in accident investigation reports
- Suggest research and policy directions for safety improvement

Methodology

- Collect investigation reports over the last 10 years. Reports found online.
- All major accidents regardless the type of event (fire, flooding etc.), medium to large size passenger ships (ropax, cruise, offshore, etc.)
- Analyse reports, looking for
  - Causal factors (from report)
  - Contributing factors (from report)
  - Failed/dysfunctional interactions
    - Control, feedback, or both
    - Failure mode: not given, wrong given, given too late/early, etc.
    - Degree of mention in conclusions / recommendations

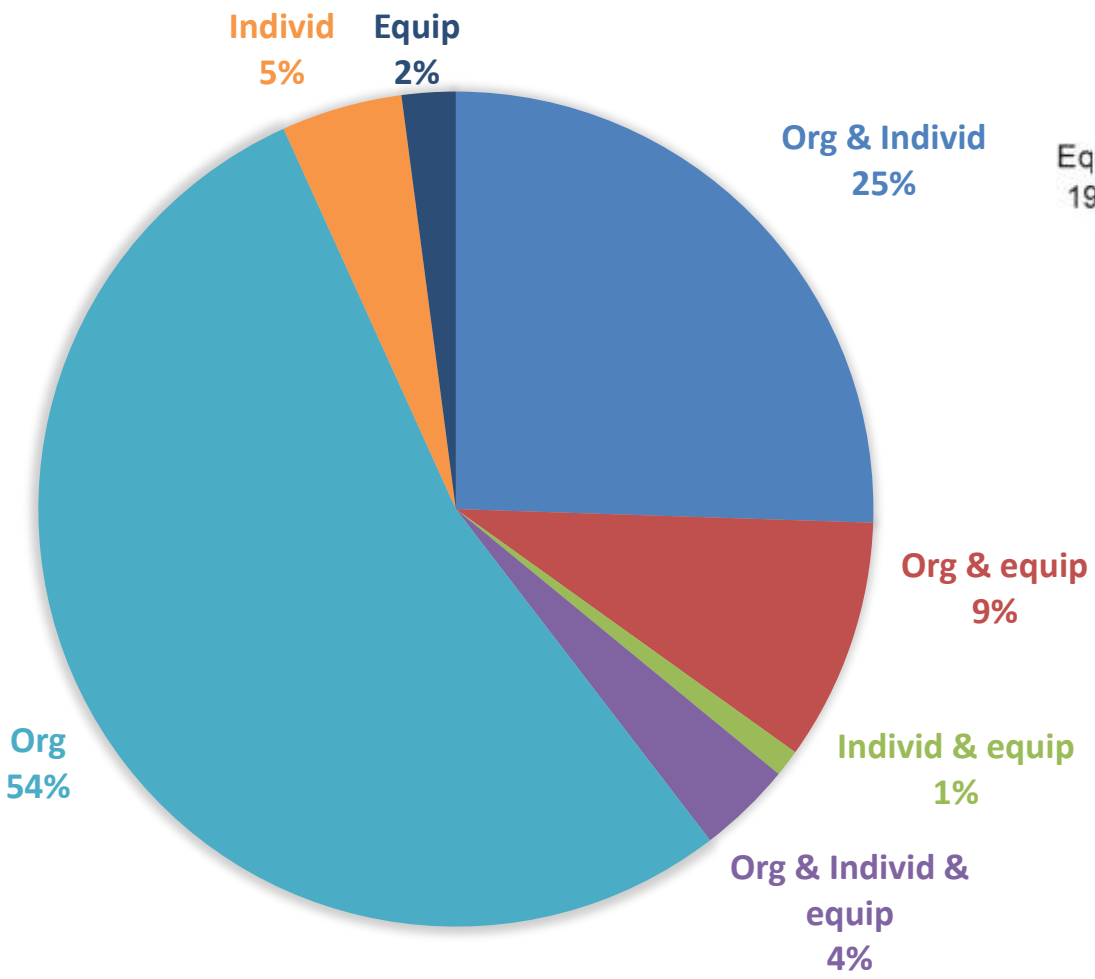
- Summary the results and map them to generic safety control structure
- Identify main weakest links and summarise causes

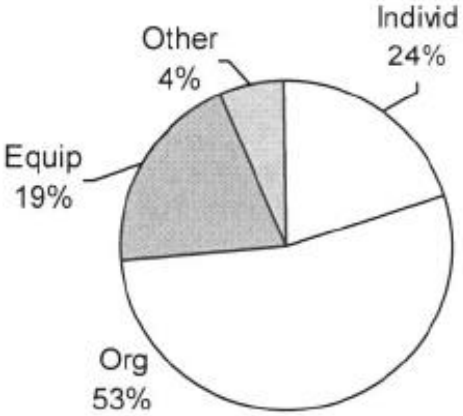
Key facts

- 201 reports analysed
  - 2006 – 2017, worldwide
  - Downloadable from our website
- 3 analysts (senior, postdoc, PhD)

Results | Accident causal factors

(2006 – 2017, 201 reports)

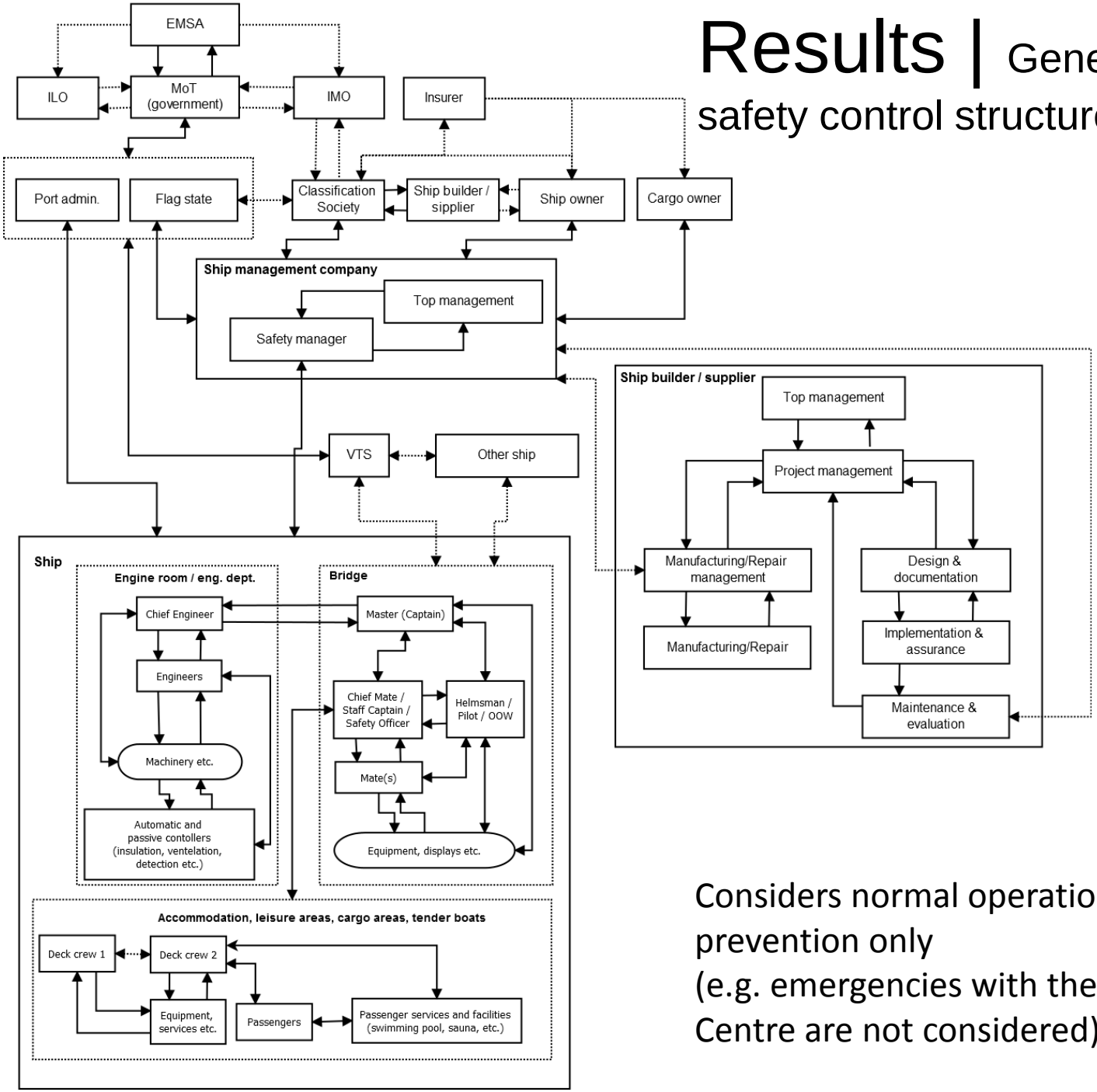




(1996-2006, 22 reports)

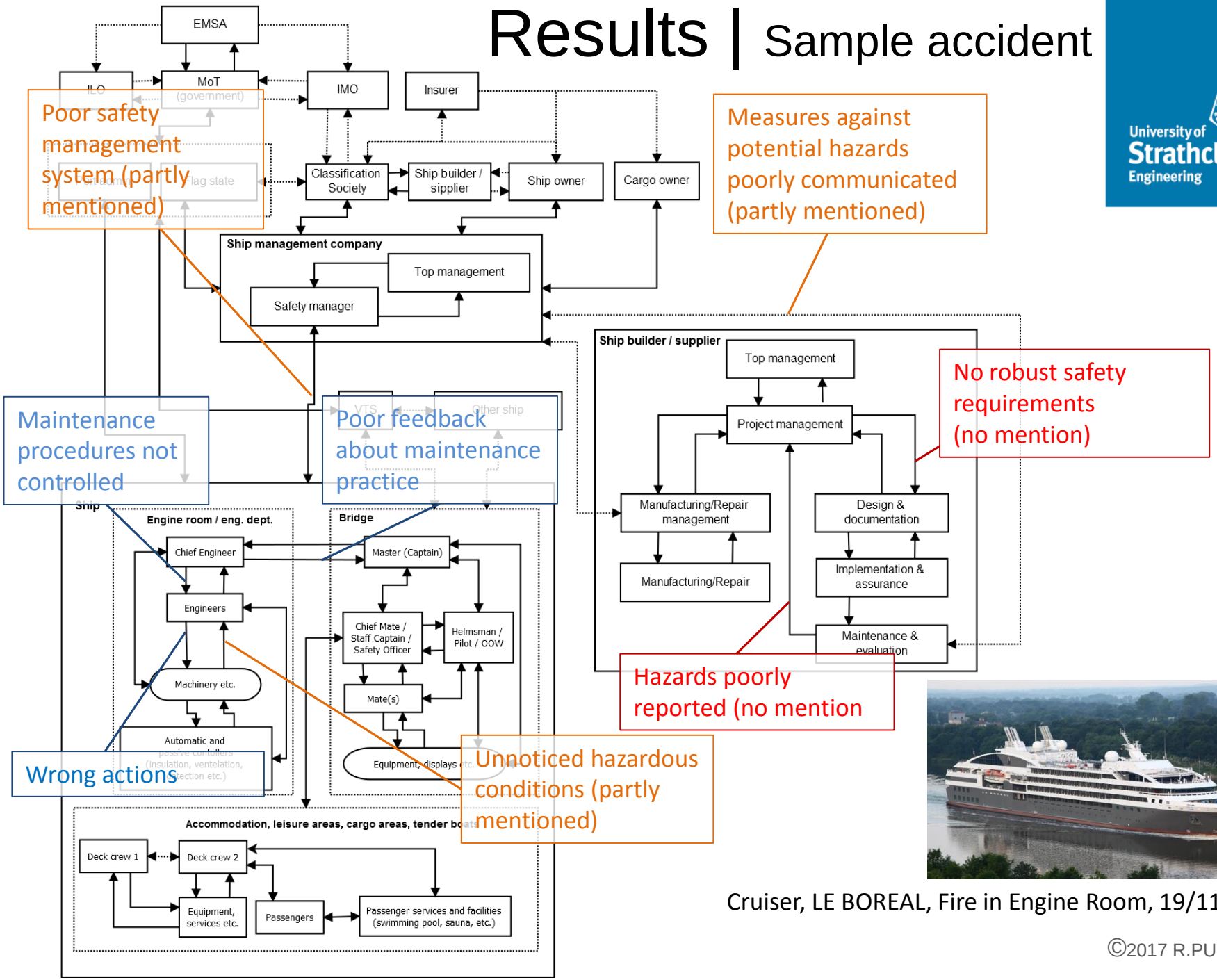
(Johnson et al, 2007)

Results | Generic safety control structure



Considers normal operation with focus on prevention only
(e.g. emergencies with the use of Safety Centre are not considered)

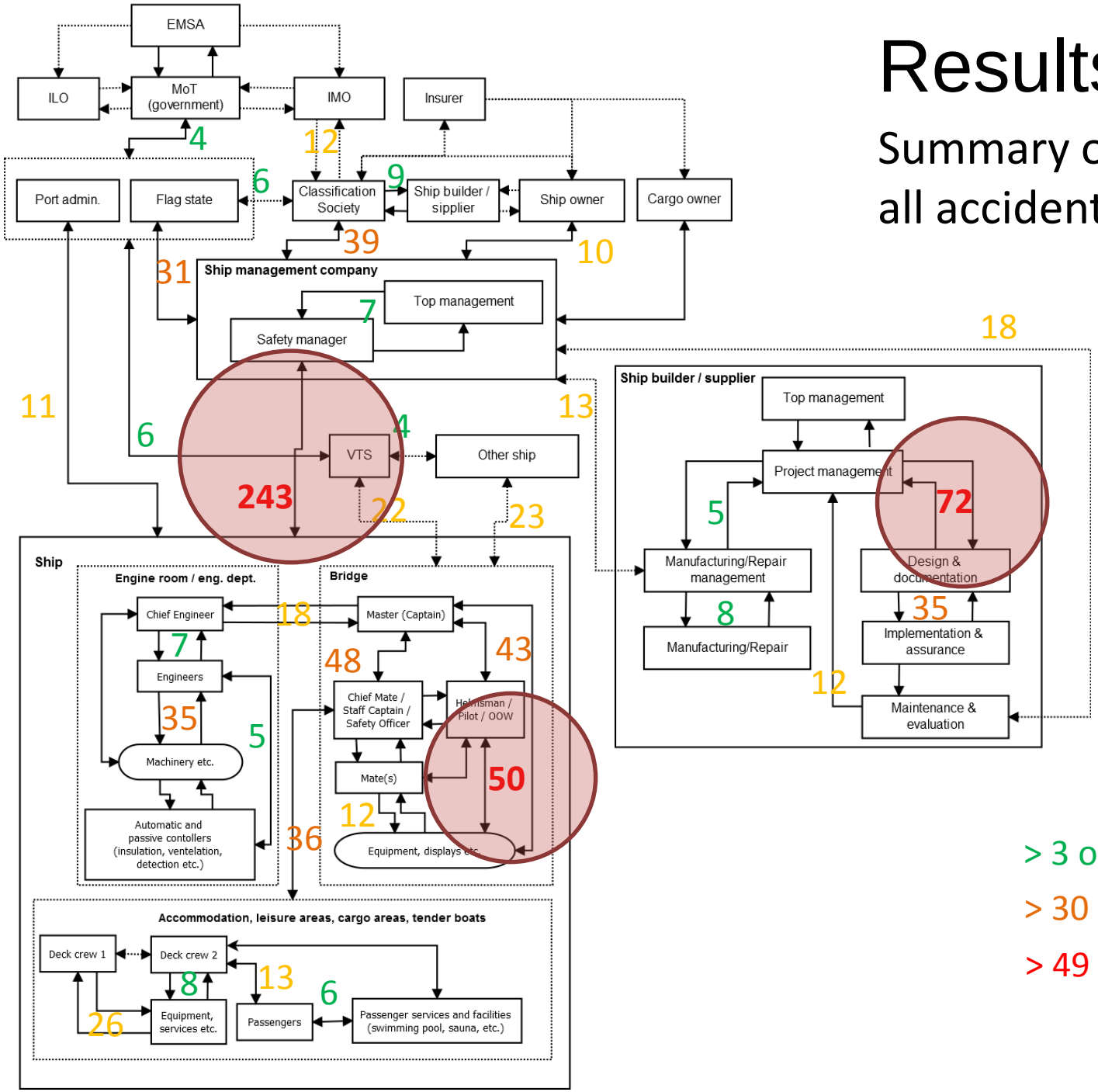
Results | Sample accident



Cruiser, LE BOREAL, Fire in Engine Room, 19/11/2015

Results

Summary of all accidents

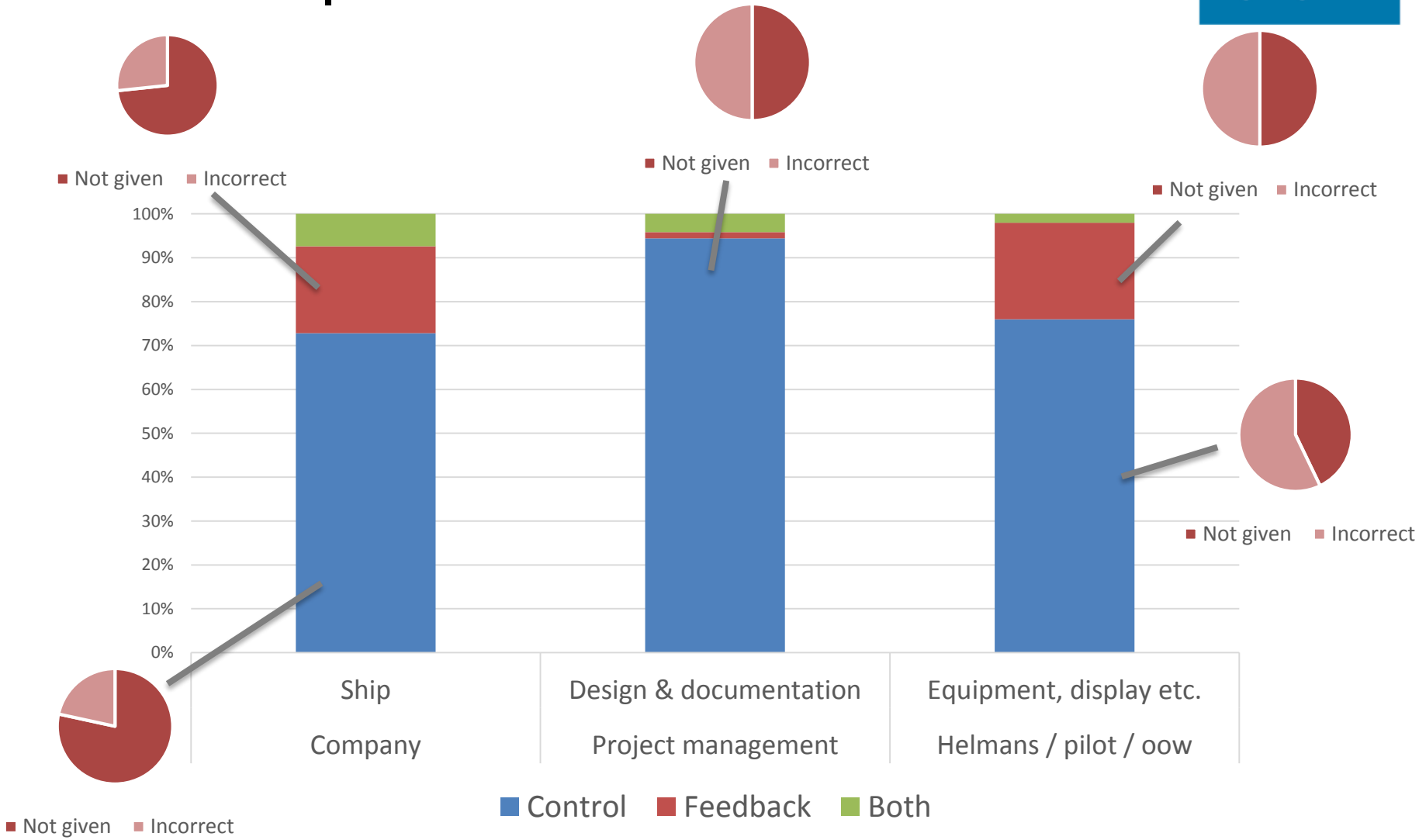


> 3 occurrences

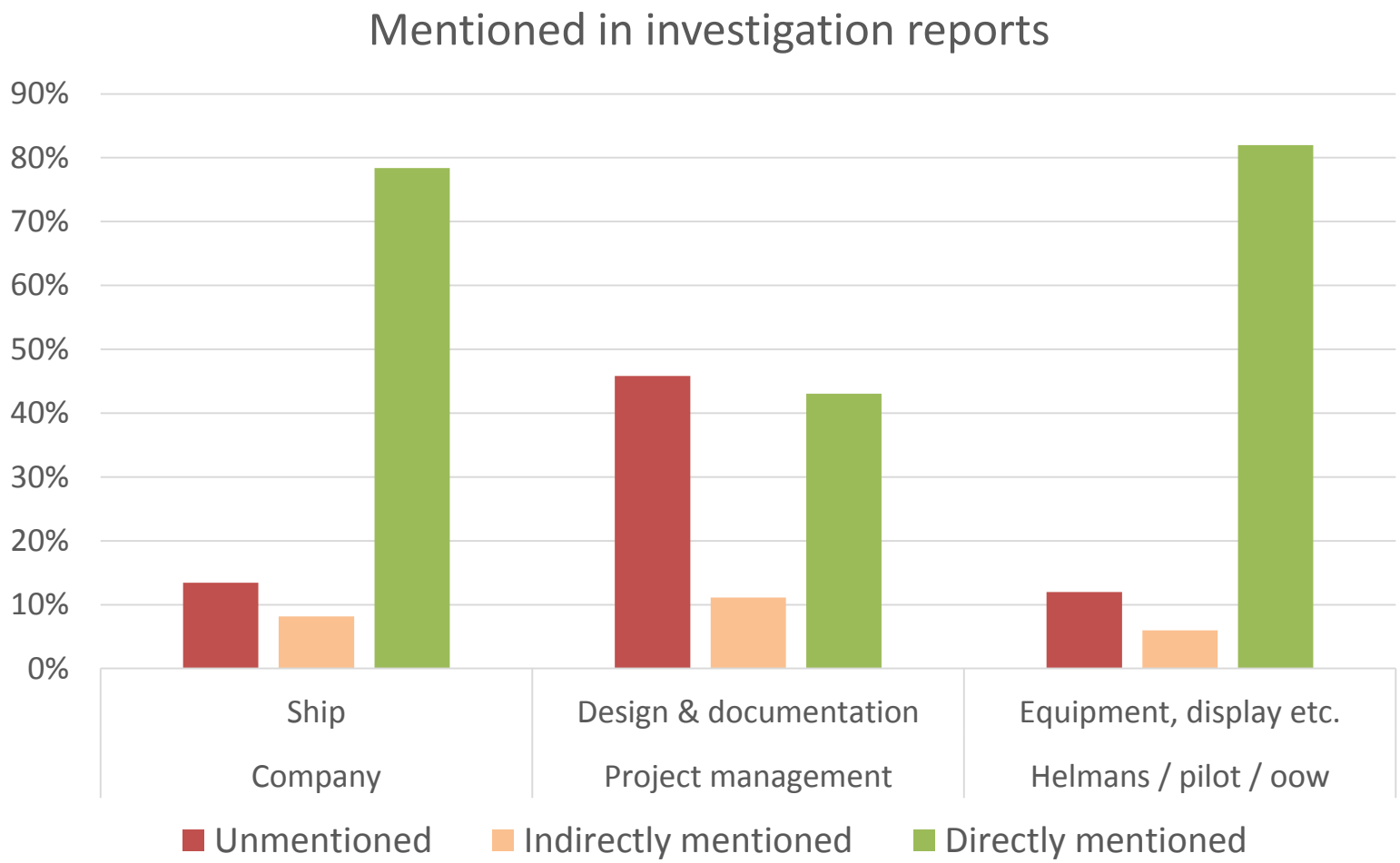
> 30 occ.

> 49 occ.

Results | Cause classification



Results | Investigation gap



Conclusions & recommendations

- Majority of accidents with passenger ships are due to organisational factors, i.e. dysfunctional interactions between actors involved in safety control (management, regulatory, etc.)
- Inadequate interactions are observed across the board
- Inadequate interaction between Ship Management Company and Ship (Master, Chief Eng.) is a dominant hazard in majority of analysed accidents. Primarily reason is provision of inadequate training and SMS.
  - R1: Focus on training and personnel
  - R2: Focus on SMS and its cost effectiveness
- The use of CAST-like analysis, allowed to identify additional systemic accident causes that were overlooked during accident investigations. These are mainly design errors resulted from incomplete risk assessment.
  - R1: Focus on safety objectives and hazard identification (eg STPA), system safety

Þakka þér fyrir!

Thank you!

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