Applying FRAM to enhance Formal Safety Assessment in the Maritime Domain

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Formal Safety Assessment (FSA)

• Systematic & structured methodology
  – Considers organizational, human and technological aspects
  – Help decision makers to identify most efficient safety measures

• 5 steps:
  – Hazard Identification – What can go wrong?
  – Risk Assessment - How bad and how likely?
  – Risk Control Options - Can matters be improved?
  – Cost Benefit Analysis - What would it cost & how much better would it be?
  – Recommendations on Decision Making - What actions should be taken?

• Encourages use of expert judgement

• Mostly application of quantitative assessment methods
Aim of this study

• Explore if & how FRAM can offer a way of formalizing expert input to complement more traditional assessment methods

• Three main questions:
  – Can FRAM be used to compliment the traditional approaches to risk assessment used within the settings of the FSA?
  – If so, what are the benefits of applying FRAM within hazard identification and risk control options?
  – How can results of a FRAM analysis best be communicated to maritime stakeholders?
Methodology

• FRAM-model based on task analysis & expert input
• ”Success”- tree
• Two focus groups with 3 participants with a maritime background
• Focus on ”Hazard Identification” and ”Risk Control Options”
  – Identify hazards, consequences & potential risk control options
Results I: FRAM-model and the success tree

• Identify functions based on task analysis & expert input from 3 researchers with navigator background
• Identify potential variability through data from accident analysis
  – Which functions are most likely to vary?
  – Which are the critical couplings for the system to succeed?
"Success" - tree

Collision Avoided

Appropriate action own ship

Appropriate action other ship

Appropriate decision making

Successful execution

Target Identified

Correct Assessment made

Qualification

Fit

Automatic

Manual

Appropriate Manning

Workload Appropriate

Appropriate rest

ARPA

Visual/Audio
### Scenario: Collision with Other Ship

<table>
<thead>
<tr>
<th>Event/Failure</th>
<th>Conseq.</th>
<th>Prod.</th>
<th>Cons.</th>
<th>Total</th>
<th>Rec</th>
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| **Detective Data**
  - Target data not complete | **Confusion** | 4 (1) | 2 (1) | 6 (2) | ARPA assistance & echo sounding |
| **Comming Error**
  - Less comming
  - Wrong readings | | | | | |
| **ECNS Overload**
  - Erratic Signal
  - Wrong inputs | **Error in Judgement** | 1 | 3 | 4 | |
| **Other**
  - Paper charts missing
  - Doors to habitable| | | | | |

Note: The table shows the sequence and consequences of events leading to a collision. The numbers in parentheses indicate the severity or frequency of each event.
Results II

• Wide range of identified hazards and scenarios
• Generally little focus on “error”
  – Hazard “Monitor navigation equipment stand alone”
  – Consequence “OOW needs to walk a lot & does not have time to check the visual”
  – RCOs “Better integration of technical equipment”
• Function-based approach helped to identify wide range of potential RCOs
  – Design of equipment, manning, training
Results III

• Participants in general were more positive towards FRAM-model than towards the success tree
  – Shows the complexity of work onboard
  – Shows interdependencies among functions
  – Helps to track effects of RCOs
  – Offers a macro-level for analysis

• BUT:
  – Not quantifiable -> hard to have a standalone method within the FSA
  – Fault-tree better for isolated problems/micro perspective
  – FRAM requires a lot of time
Discussion

• Models need to be comparable to identify potential for hazard identification
  – FRAM can model positive and negative output
  – Problem to adapt fault-tree to ”positive” outcome
    • Collision Avoided
• Problems to make ”generic” FRAM
  – Stuck to instantiation to make a case
• FRAM requires more ”creativity”
• Difficulties to create and work with the fault-tree after FRAM discussion (cannot be ”unseen”)
Conclusions

• FRAM enriches the assessment & triggers a different type of discussion
  – Function-based vs. error-based
  – Complexity & interdependencies
• Facilitates to identify the consequences of risk control options and presents a new perspective on the ”cost” of an option
• Need to test models further and iterate both for next set of focus group
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Thank you for your attention!

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